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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 Power Electronic Converters for controlling of electrical motors operation.

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

All deviations from both this specification, relevant norms, standards and other applicable documents (together with proposals) which in bidder's opinion show more economical and/or technically better solutions, shall be presented in written form for LOTOS Group S.A. check and approval. Any deviations that have not been approved in written form by LOTOS Group S.A. are impermissible.

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 regarding electrical motors. Such requirements are included in specification of electrical branch – standard N° 4200 „Electrical motors".

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: LOTOS Group S.A. / BUYER / CONTRACTOR

SUPPLIER: BIDDER/ SUPPLIER

4.1 Designations

GL SA – LOTOS Group Inc.

MV – medium voltage

DC – direct current

IT – electrical network with isolated neutral point

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 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 allowable tolerance +4% /-6%
Low voltage	400V, TN-C-S with allowable tolerance +/-10%
Low voltage (lighting, heating)	230V, TN-S
Low voltage (emergency lighting)	110V DC
AC control voltage	230V, 1-phase
Direct current control voltage	24 V DC, 110V DC or 220V DC

5.3 Basic design requirements

5.3.1 Documentation

A Bidder (supplier) shall deliver to Lotos Group the following documents:

- List of documents
- Dimensional drawings
- Data sheets filled by Supplier
- Basic diagram of converter
- Requirements for supply and control cables
- Technical and operating documentation
- Spare parts list
- Transport and storage procedure
- Tests' schedule
- Certificates
- EMC Declarations
- Declaration of conformity.
- Erection and operating instruction

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 through 10 years minimum.

Power electronic converter shall be designed, manufactured and installed according to this specification.

Design solutions of the converter, recommended by supplier, shall fulfil requirements of valid norms and regulations, and shall be adjusted with Lotos Group .

The Supplier shall indicate in which scope the requirements included in this specification bring about changes in relation to typical solutions. The Supplier is obliged to indicate all differences.

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

5.4 Design requirements

5.4.1 Electric supply conditions

The converter shall be designed with consideration given to the following parameters:

Rated frequency:	50Hz , ±2%
Rated voltage of motors:	400V AC, (TN-S network configuration), ±10%
Control system:	Profibus or binary signals for signals sent to central control room. Binary signals for local control

Electrical circuits of converter shall be designed in such a way, so that interferences of other systems and equipment operation supplied from the same network as the converter, would be minimised.

In standard application power electronic converter shall be supplied from low voltage switchgear through fused disconnector equipped with fuses of gL type, in order to protect supply cable.

5.4.2 Rated parameters

Rated parameters of the converter shall correspond to rated data of motor, for which it is selected. First of all the following rated data shall be taken into account:

- Base speed
- Frequency
- Voltage
- Power

Base rated speed of converter shall correspond to the lowest speed, at which the drive continuously maintains rated power.

The converter, which enables operation at speed higher than base speed by means of frequency increase, shall have maximum rated frequency corresponding to rated power.

5.4.3 Load requirements

In case of continuous operation at rated torque, the converter shall be adapted to transfer 150% of rated torque at base speed, for 1 minute, in occurring cycles of light load of such duration, so that effective value of torque would not exceed rated continuous torque without exceeding of temperature increase limitation specified in adequate norms.

Magnitude of maximum load, at specified range of minimum speed, shall be maintained and shall not be less than 100% of rated torque value. System shall allow to obtain maximum or nominal load of motor in full scope of regulations i.e. from minimal to nominal speed of motor.

Unless otherwise specified, for synchronous motors the converter shall have synchronisation at torque equal to at least rated torque with specified load inertia, at minimum operating frequency.

Lotos Group shall relay the supplier information concerning motor predestined to cooperation with converter, i.e. requirements regarding load for starting torque and load inertia.

5.4.4 Constructional and technical requirements

The converter shall have free-standing enclosure, adapted to operation in closed room, outside explosion hazard zone.

Power electronic converter shall be designed for continuous operation S1, according to PN-EN 60034-1 norm.

Additional space shall be foreseen in each cabinet, necessary for installation of sinusoidal filter adequate for converter installed in specific cabinet.

Converter shall be equipped in “by-pass” system which allow easy dismounting of converter in case of needs of replacement.

Enclosures shall be equipped with suitable ventilation system, conforming to PN-EN 60146-1-1 norm, preventing overheating of semiconductor elements of converter, for various values of speed and load that can occur.

Forced ventilation system shall be equipped with all necessary elements, i.e. filter, fan, starter together with overload relay, and auxiliary relays enabling transmission of defect and alarm signals. Replacement of the filter shall be possible without need to equipment switching-off.

A space of height at least 300 mm shall be foreseen in lower part of each cabinet for cable connections.

The converter shall be equipped with terminals enabling connection of supply and control cables. All measuring and control circuits shall be led out onto terminal strip.

Fuses with quick-break fuse-links and characteristics ensuring proper protection of semiconductor elements, shall be used in all phases of supply circuit.
Automatic restart after power failure shall be applied for the converters, with option yes/no and adjustable delay time start-up.
Automatic restart function can be can be achieved using external relay systems built in the inverter cabinet.
Converter automation should allow to "catch" rotating motor in such way that after short voltage drop coverter shall be able to continue work on actual rotating speed without stop of motor.
It is preferred to supply of converter control, signalization and protection circuits from external guaranteed voltage to prevent signal fluctuation during fluctuation of main converter power supply (to avoid fading of START/PRACA signalization). 110V DC guaranteed voltage is preferred.
Wiring of coverter cubicles shall be made in accordance to the following requirements:

- Main current circuits - Copper conductor in PVC jacket – minimum cross section 2.5mm$^{2.}$
- Control circuits - Copper conductor in PVC jacket – cross area 1.5 mm^2 as minimum.

5.4.5 Special requirements

When making selection of converter for motor installed in explosion hazard zone, it is necessary to verify if the motor is adapted to cooperation with the converter, i.e. if it meets requirements of PN-EN 50014 norm.

All functions of converter's indicators shall be described in Polish language.

Converters, and particularly reactors and filters, shall be matched to cables of length determined in specification and data sheet.
For the motors installed in the hazardous areas Ex, operating with inverters (VSD), are required :
– PTC temperature sensors (or optional PT100), as the motor thermal protection in Ex zone
– temperature signal shall be wired directly to the to the converter cabinets, installed in the substation on certfied converter input or on certified safety relay
LV motors space heaters shall be supplied from converter cubicle (230V AC).

For SIL circuits shall be prepared separate terminals strips. SIL safety relays shall be installed in converter cabinets.

SIL or emergency switch-off circuits shall be realised by menas of prprt class contactors together with "safety switch off" circuits or by converter execution in proper SIL class.

Converters operating with motors installed in hazardous areas Ex, which are using temperature PT100 sensors to temperature measurement, connection from sensors shall be made :
-directly to a dedicated input converter card, compliant with the requirements of Directive 94/9/EC. (preferred solution),
-or directly to the external safety relay, certified for compliance with the requirements of Directive 94/9/EC (if a solution from the first point is not possible to meet.)

The Supplier shall notify Lotos Group about necessity for relaying of:

- additional information regarding motors
- cable types.

5.4.6 Degree of protection

Degree of protection shall comply with PN-EN 60529 norm, but not less than IP 41.

5.4.7 Equipment

Converter cabinets shall be provided with the following instruments and devices:

- Main disconnecting switch
- Quick-break fuses
- Optional in contactor (depending of the power supply design)
- Restart relay, or control device accomplishing automatic restart in setted time
- The converter
- Microprocessor motor protection relay (for solution with “by-pass”)
- Switch of mode selection: converter – by-pass (for solution with “by-pass”)
- Insulation control relay (for IT networks) to control motor-converter set
- Terminals, auxiliary terminals with complete wiring
- Input filter choke in the form of AC or DC reactor (depending of the converter design solution)
- Suppression EMC input filter meets the requirements for electromagnetic compatibility
- Output filter dU / dT or sine filter if it is required.

Control panel indicators, microprocessor motor protection relay panel (for solution with “by-pass”) shall be placed on the cabinet doors.

Converter system shall be equipped with all necessary protections, control and alarm devices.

For purposes of communication between converter and KiA branch system (DCS system in central control room), the converter shall be equipped with PROFIBUS module and RS 485 port..

5.4.8 Protections

The following protections are required:

- Motor temperature protection shall be compliant with the requirements of Directive 94/9/EC.
- Short-circuit protection of motor
- Overcurrent protection of motor
- Short-circuit protection of converter
- Overcurrent protection of converter
- Thermal protection of motor and converter
- Protection against control voltage failure
- Motor off
- Phase failure on motor

5.4.9 Equipment for control and signalling purposes

- On/Off from control console (prefered are potential-free contacts, impulse contacts option)
- Start-up interlock / Safety switch (permanent potential-free contact)

- On / Off from KiA control room (potential-free contacts, PROFIBUS to be agreed)
- Control input signal (prefered 4-20mA,PROFIBUS to be agreed)
- Output signal of speed for remote control (prefered 4-20mA,PROFIBUS to be agreed)
- Converter internal system of interferences recording shall be applied, additionally external trip signal shall be recorded.
- The converter shall be equipped with adjusting instruments, by means of which ranges of current, frequency, start-up time, minimum and maximum frequency, etc. would be possible to set.
- Cumulative alarm signal and operation signal to control room

Indications of the converter:

- Output frequency
- Output current
- Output voltage
- Operational readiness, operation, alarm

Unless otherwise agreed, output contacts shall be of changeover, potential-free type.

Colour of lamps and pushbuttons shall conform to PN-EN 60073 norm.

5.5 Design and scope of delivery

5.5.1 Battery Limit

The supplier of converter shall specify recommended types of supply cables, however they are not included in converter scope of delivery.

5.5.2 Design

The Supplier is fully responsible for:

- selection of all elements of converter unit along with filters
- selection of proper converter
- motor protections system
- proper selection of supply and control cables
- selection and execution of converter cabinets ventilation

5.5.3 Completeness of deliveries and services

The Supplier is fully responsible for:

- Delivery of factory assembled converter with complete wiring (including communication cable to connect converter with computer) and converter maintenance software.
- Delivery of motor, if it has been included in converter scope of delivery
- Delivery of cable glands for delivered equipment and for converter supply cable.

5.6 Marking

All equipment and instruments shall be labelled according to numbers specified on drawings, attached to factory documentation of the converter.

Wires inside the inverter cabinet shall be described by the address method . Is not permitted by the marking wire potential method.

Data plates shall be made of material resistant to corrosion and protected against slackening.

All inscriptions shall be made in Polish language.

The converter shall have data plate, containing as minimum the following data:

Input parameters: voltage, frequency, number of phases and current

Output parameters:

- Rated voltage
- Rated current
- Rated output
- Rated frequency
- Frequency range
- Number of phases
- Range of power factor

Moreover, in technical and operating documentation, or on data plate the following data shall be specified.:

- Minimum speed
- Maximum output at minimum and maximum speed
- Frequency at minimum and maximum speed
- Voltage at minimum and maximum speed

5.7 Painting

Factory painting standards for determined ambient conditions, according to environmental conditions specified shall be applied.

5.8 Quality control

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

5.8.1 Inspection

Inspection of converters 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.

5.8.2 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, 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.

Lotos Group can give execution of tests up, on condition that manufacturer shall deliver certificates of performed tests for identical converters.

5.8.3 Acceptance

Acceptance of converters 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.

5.8.4 On-site tests

The converter shall be tested on installation site according to directions of technical and operating documentation of its supplier.

5.9 Guarantee requirements

Main requirements regarding guarantee are contained in purchase documentation. The guarantee shall ensure maintaining of specified output parameters of the converter for its whole life cycle.

5.10 Deliveries

The converter shall be delivered to Lotos Group according to requirements contained in purchase documentation.

All equipment shall be protected for transport period. Particular attention shall be paid on protection of measuring instruments as well as protecting devices. Cable entrances shall be protected with airtight hole-plugs, featuring degree of protection corresponding to rated degree of converter protection.

Equipment shall be protected against moisture penetration, and their improper handling during transport and storage

6 Relevant documents

- Other Technical Specifications, shown on delivered List of Technical Specifications for GL SA

7 Codes and standards

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

PN-EN 60146-1-1	Semiconductor converters. General requirements and line commutated converters. Part 1-1: Specifications of basic requirements,
PN-EN 60146-2	Semiconductor converters. Part 2: Self-commutated semiconductor converters including direct DC converters

PN-EN 60034-1	Rotating electrical machines. Part 1: Rating and performance.
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	Degrees of protection provided by enclosures (IP Code)
PN-EN 60073	Basic and safety principles for man-machine interface, marking and identification. Coding principles for indicators and actuators.

Converters built according to another norms and standards shall be submitted to GL SA for approval. Shall any discrepancies arise between requirements of individual documents, then the following hierarchy of importance is to be observed:

- Polish regulations and GL requirements in force
- This specification
- Data sheets
- Other specifications
- Drawings and other documents
- Norms

8 Record of changes

No.	Date	Description	Introduced by
1	28.04.2011	This specification replaces the previous standard of Grupa LOTOS SA No PR 60019 with the same title. Taken review of content standards, a change resulting from the implementation of the proposals P10 +.	J. Bućko A. Filipiak M. Rompa
2	30-11-2013 (rev.2)	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