Contents

1 Subject of specification 3
2 Scope of validity 3
2.1 Deviations 3
2.2 Exclusions 3
3 Hierarchy of documents 3
4 Definitions and designations 3
4.1 Designations 4
5 Description 4
5.1 Ambient conditions 4
5.2 Electrical network parameters 4
5.3 Basic design requirements 5
5.3.1 Documentation 5
5.3.2 General requirements 5
5.4 Design requirements 6
5.4.1 Electrical parameters 6
5.4.2 Mode of operation 6
5.4.3 Technical requirements 6
5.4.4 Cooling system 6
5.4.5 Insulation 7
5.4.6 Short-circuit voltage 7
5.4.7 Noise level 7
5.4.8 Electrical losses 7
5.4.9 Enclosure 7
5.5 Design and equipment 7

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5.5.1 Windings and magnetic circuits 7
5.5.2 Connections 8
5.5.3 Control instruments 8
5.5.4 Taps for MV voltage change 8
5.6 Preparations for shipment 8
5.7 Data plate 9
5.8 Protection of surface 9
5.9 Suppression of vibrations 10
5.10 Quality control 10
5.10.1 Inspection 10
5.10.2 Factory tests 10
5.10.3 Acceptance 11
5.10.4 Tests on installation site 11
5.11 Guarantee requirements 11
5.12 Deliveries 11
6 Codes and standards 11
7. Record of changes 12

1 Subject of specification

This specification used in conjunction with standard technical specifications of LOTOS Group S.A., establishes minimal requirements regarding designing and execution of power transformers.

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 cover requirements regarding transformer chambers. Such requirements are included in building branch 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

CUSTOMER: GL SA. LOTOS Group S.A. / BUYER

SUPPLIER: BIDDER / VENDOR

4.1 Designations

GL SA – LOTOS Group Inc.

GL – **LOTOS Group**

MV – medium voltage

LV -- low 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

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

High voltage	110 000 V, 3-phase, earthed neutral point of transformer
Medium voltage	15kV (LOTOS Railway, North Marine and Przejazdowo Water Supply Point), 10.5kV (GPZ3), 6kV (GPZ1, GPZ2), 3-phase, IT (isolated network)
Frequency	50Hz with allowable tolerance +4%/–6%
Direct current control voltage	110V DC, (220V DC for GPZ1, S7 and S9 subst.

5.3 Basic design requirements

5.3.1 Documentation

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

- List of documents
- Catalogues
- Dimensional drawings
- Data sheets filled by supplier
- Basic wiring diagram
- Equipment list
- Spare parts list
- Painting procedure
- Transport and storage procedure
- Tests schedule
- Certificates
- EMC declarations
- Declaration of conformity

5.3.2 General requirements

Reliability, smooth operation easy handling and and the availability of spare parts 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.

Rated data for transformers shall correspond to continuous operation nominal rated data of the transformers, with allowable load variations, at specified (previously given) working conditions.

In the case of two section power switchboard (each transformer works on a separate section, with an open section switch in the normal switchboard working layout), each transformer shall calculated and designed to cover power consumption of two sections.

Limit temperature rise shall conform to PN-EN 60076-2 standard.

Rated short-duration power-frequency withstand voltage and rated lightning impulse withstand voltage shall conform to PN-EN 60076-3 and PN-EN 60076-4 standards.

Short-circuit strength of transformer shall conform to PN-EN 60076-5 standard. Short-term, 2-second short-circuit current shall be used for calculations of thermal strength, unless otherwise stated in data sheet.

The transformer 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 Electrical parameters

Primary rated voltage	15kV; 10,5kV; 6,3kV ±10%
Secondary rated voltage	0,4kV
Short—circuit voltage	6%
Rated frequency	50Hz ±2,5%
Windings wiring layout	Dyn5 with permanently earthed neutral point on 0.4 kV side

5.4.2 Mode of operation

The transformer shall be adapted to continuous operation, at rated current and short-term parallel operation (up to 60 s).

The transformer shall be suitable for continuous operation at rated load current and ready for parallel working with the same type transformer.

5.4.3 Technical requirements

Power transformers shall be:

- Made as a dry type, resign or oil (type shall be each time to agree with GL SA)
- adapted for operation in closed premise and ambient conditions given in p. 4.1.
- standard designed to work with a grounded (earthed) zero point of the secondary winding
- all steel parts of the structure of the transformer shall be galvanized
- the transformer shall be highly resistant to moisture, transformers shall be ready for immediate work on nominal parameters even after long period of idle run operation.
- checked and protected against mechanical damages, vibrations, long-term overloads, thyristor controlled loads, high temperatures and cracks.
- in the case of dry type transformers it required to install two-stage (with alarm) temperature control system of the transformer (for example, type RTT14) with a local display of temperature. Temperature control system shall be installed directly on the transformer from the entrance door. After opening the door will be possible to read the current temperature by the service.
- in the case of oil-transformers, two-stage Buchholz relay and temperature measurement is required. Bucholtz reay shall have two adjustable alarm levels (degree of alarm and shutdown). Temperature measurement system must be installed directly on the transformer from the door trafo Chamber, in such a way that after opening it was possible to read the current temperature for a service. .

Rated parameters of transformer for continuous operation shall be ensured at natural ventilation, without need for additional fan usage.

The transformers shall be prepared for expansion with forced ventilation system, in order to transmit of higher power.

The transformer must be equipped with no load type changer ±2x2,5%, at the primary windings side in accordance with the requirements of point 4.5.4.

5.4.4 Cooling system

The transformer shall be air cooled, with naturally forced air circulation. Transformer design shall enable application of forced air circulation (in order to transfer of higher power), if required. Cooling surface, suitable for forced air circulation, shall be provided.

Increasing of rated power of the transformer by use of forced cooling shall be taken into account when selecting conductors for windings.

5.4.5 Insulation

Class of insulation shall conform to standards.

Insulation class of windings shall in general correspond to F class.

5.4.6 Short-circuit voltage

Standard short-circuit voltage values are preferred. Short-circuit voltage shall not exceed 8,5% value.

5.4.7 Noise level

Noise level (measured at 1 m distance)1600kVA < 85dB

5.4.8 Electrical losses

Electrical losses of power transformers shall have standard values.

5.4.9 Enclosure

Transformers without additional enclosures are preferred (IP 00 protection degree).

The transformer shall be adapted for connecting by means of:

- cables, both on primary and secondary side
- cables on primary side, and with bus duct on secondary side.

The method of connection shall be each time agreed with GL SA.

In case of justified need, and after adjustment with GL SA, transformers with enclosures may be delivered. Required degree of protection IP 31.

For power transformers furnished with additional cover protecting against unintentional contact, the cover shall be made in such a way, that natural air-cooling would not be obstructed, and rated power of the transformer not reduced.

The enclosure shall be partially dismountable in places of high- and low voltage connections, as well as in place of tap switch. Two handles shall be welded to each dismountable part of transformer enclosure, in order to facilitate lifting.

Standard method for enclosed transformer connecting, shall be cable connection. If is required to connect transformer to busbars, insulated flexible connection shall be used.

5.5 Design and equipment

5.5.1 Windings and magnetic circuits

All windings shall be made of electrolytic copper or of aluminium (use of aluminium windings is allowed after prior agreement with GL SA)

The highest grade materials shall be used for transformer windings, ensuring their long-life.

In the standard design of the transformer for GL SA primary side windings shall be connected in a delta, while secondary side windings in a star configuration. Earthed neutral point shall be led out on terminal.

5.5.2 Connections

Supply cables on primary side, as well as on low secondary side, shall be entered into the Chamber from the bottom of the transformer.

Connection of transformer with bus duct on low voltage side, shall be made from upper side of the transformer with using insulated flexible connectors. .

Frame of the transformer shall be equipped with minimum one earthing terminal, which shall be marked as earthing connection point.

. Manufacturer of the transformer shall deliver adequate cable glands for cables serving external connections of auxiliary ciruits. Junction box shall be located outside of the enclosure, described in p. 4.4.9.

5.5.3 Control instruments

The transformer shall be equipped with:

- PTC sensor in each phase of winding on low voltage side, interacting with thermal relays. Sensors of the three phases shall be connected in serial, and end of conductors connected to thermal relay. Double protecting system shall be used with two level of protections. All connections shall be led out to common junction box.
- Temperature monitoring system (a box with set of thermal relays, fuses and terminal strip for PTC sensors) shall be included in scope of delivery, but separately supplied (dismounted for time of transport). The equipment shall be matched to auxiliary 110V DC voltage electrical substation when the transformer will be installed.. Temperature monitoring system shall be placed from side of chamber entrance door and be able to read the local temperature (e.g. LED display)
- the other, required by the manufacturer protection devices to prevent damage to the transformer

Oil type transformer shall be equipped with:

- analogue thermometer with two adjustable signalling levels (I – signalling level, II- switch off)
  In case of using additional cover protection of transformer (section 4.4.9), the thermometer shall be placed on the outside of the casing and from the transformer Chamber doors
- protection against excessive pressure in the tank (gas-Bucholtza blowing relay)
- the other, required by the manufacturer of the corporate protection, solutions to prevent damage to the transformer

Output contacts of transformer monitoring system shall be normal open and should not chane position on supply auxiliary voltage failure.

5.5.4 Taps for MV voltage change

Standard type of transformer shall be equipped with manual taps for MV voltage change in voltage-free state. The taps shall enable change of voltage in range of -5%, -2,5%, 0% +2,5%, +5% rated voltage.

5.6 Preparations for shipment

The transformer shall be equipped with:

- lifting lugs
- lugs on assembly frame, serving for towing (longitudinal and transverse relocation in horizontal plane)

The transformer chassis shall be equipped with wheels adjustable by 90º, thus enabling relocation of transformer in two perpendicular directions.

5.7

Data plate

Rated data of the transformer, such as:

- rated power
- rated voltages of primary and secondary side
- rated level of insulation
- group of connections
- range of regulation
- wiring diagram for voltage regulation
- rated short-circuit voltage
- idle run losses
- load losses
- IP protection degree
- cooling method
- noise level
- total weight
- serial number

shall be placed on data plate, which shall be mounted on transformer in visible place.

Data plate shall be made according to valid norms.

Wiring diagram of external auxiliary circuits shall be additionally presented in junction box.

Data plate and labelling plate shall be made of material resistant to corrosion, and protected against slackness.

All labels shall be made in polish language.

5.8 Protection of surface

Metal parts of the transformer shall be protected by painting , in accordance with the standard implementation of the manufacturer.

All connecting, auxiliary and guarding elements of transformer shall be electrolytic zinc coated and chromium plated. All bolts, washers and nuts shall be made of stainless steel.

Final RAL … colour should be adjusted with GL SA.

5.9 Suppression of vibrations

Each transformer shall be equipped with vibration dampers. The final coating in accordance with the standard implementation of manufacturer.

In order to reduce the transmission of vibrations from the transformer on the busbar (switchboard) it is requires to use of insulated flexible connections between the transformer and busbar.

5.10 Quality control

Quality control shall be done according to requirements of valid ISO 9001 codes and regulations. Procedures of manufacturer shall be employed as a minimum.

5.10.1 Inspection

Inspection of transformers 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 contained in this specification.

5.10.2 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.

The supplier shall submit to GL SA for revision schedule of planned 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.

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As far as the manufacturer of the transformer does not recommend otherwise, it is required to carry out the following tests for each transformer:

- measurement of windings' resistance, according to PN-EN 60076-1 standard
- measurement of transforming ratio and vector voltage of transformer, according to PN-EN 60076-1 standard
- measurement of short-circuit voltage, short-circuit impedance and load losses, according to PN-EN 60076-1 standard
- measurement of idle run losses and current, according to PN-EN 60076-1 standard
- measurement of dielectric strength, including tests at induced overvoltages, according to PN-EN 60076-3 standard.

Moreover the following tests shall be carried:

- heating test, according to PN-EN 60076-2 standard
- test of lightning impulse, according to PN-EN 60076-4 standard

as well as measurement of noise level.

GL SA may resign from carrying out of above-mentioned tests on condition, that manufacturer shall deliver certificates of tests carried out for identical transformers.

5.10.3 Acceptance

Acceptance of the transformers by Buyer can proceed after:

- carrying out of all tests by supplier, with positive test results authorizing the transformer for operation on the buyer Approving by Buyer of all documents listed in purchase documentation.

5.10.4 Tests on installation site

It is necessary to carry out tests on place of transformer installation, according to technical and operating documentation of its supplier.

5.11 Guarantee requirements

Main requirements regarding the guarantee are contained in purchase documentation. The guarantee shall ensure maintaining of specified output parameters of the transformer, throughout its lifetime.

5.12 Deliveries

The transformer shall be delivered to GL SA 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 transformer.

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

Not connected terminals of cables and leads shall be protected against current leakage caused by moisture.

6 Codes and standards

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

PN-EN 60076-1	Power transformers. General requirements.
PN-EN 60076-2	Power transformers. Temperature rise.
PN-EN 60076-3	Power transformers - Part 3: Insulation levels, dielectric tests and external clearances in air
PN-EN 60076-4	Power transformers - Part 4: Guide to the lightning impulse and switching impulse testing. Power transformers and reactors
PN-EN 60076-5	Power transformers - Part 5: Ability to withstand short circuit.
PN-EN 60076-8	Power transformers - Part 8: Application guide.
PN-EN 60076-10	Power transformers - Part 10: Determination of sound levels.
PN-EN 60076-11	Power transformers - Part 11: Dry-type transformers.
PN-EN 62041	Power transformers, power supply units, reactors and similar products. EMC requirements.

PN-IEC 542	Power transformers. Application guide for On-load tap-changers
PN-E-81003	Power Transformers. Marking of terminals and windings taps, arrangement of terminals.
PN-EN 60529	Degree of protection provided by enclosures. (IP Code)

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

7. Record of changes

No.	Date	Description	Introduced by
0		This specification entirely replaces the former LOTOS Group S.A. standard No. PR 07 422 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 contents changes.	T. Wróbel