Grupa LOTOS S.A.	**TECHNICAL SPECIFICATION**	Spec. N° 4500
	Lightning, earthing and static electricity protection systems	

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 4
4.1 Designations 4
5 Description 4
5.1 Ambient conditions 4
5.2 Power network parameters 4
Medium voltage 15kV (LOTOS Railway, North Marine and 4
5.3 Basic design requirements 5
5.3.1 Documentation 5
5.3.2 General requirements 5
5.4 Design requirements 5
5.4.1 Lightning protection system 5
5.4.2 Protective earthing 7
5.4.3 Earthing and protective conductors for electronic systems 8
5.4.4 Earthing of pipelines 8
5.4.5 Exclusions from above pipeline earthing requirements 9
5.4.6 Earthing of objects, devices, installations and elements made from non-metal conductive materials 9
5.4.7 Working earthing 10
5.4.8 Static electricity protection 11

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5.5 Scope of design and deliveries 12
5.5.1 Scope of design 12
5.5.2 Scope of deliveries 12
5.5.3 Spare parts 12
5.5.4 Notification about deficiencies 12
5.6 Factory testing 12
5.7 Quality system 12
6 Relevant documents 13
7 Codes and standards 13
8 Record of changes 15

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 lightning protection and earthing systems.

The specification applies to the following systems:

- lightning protection for process objects
- lightning protection for buildings
- protective earthing
- working earthing
- equipotential bonding electrostatic protection.

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

Scope of this specification does not include requirements regarding accessories of power engineering equipment and electric fittings for earthing purposes.

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 GLSA

- Data Sheets approved by GLSA
- This Specifications
- Other Specifications
- Drawings and other documents
- Standards

4 Definitions and designations

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

SUPPLIER: BIDDER / VENDOR / CONTRACTOR

4.1 Designations

GL SA LOTOS Group S.A.

LV – low voltage

KiA – Control and Automatics

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 Power 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

List of documentation that shall be delivered to LOTOS Group S.A.:

- list of documents,
- catalogue sheets for fittings of lightning protection system
- manufacturer's declarations regarding product execution conformance to standards

5.3.2 General requirements

Lightning protection, earthing and static electricity protection systems shall be designed and executed according to valid PN-EN/PN-IEC standards, in a manner ensuring their proper functioning and safe operating. For areas where IEC/EN standards have not been developed, but national standards exist, the latter shall be observed.

The systems shall be executed according to execution project. All deviations from the project must be adjusted with designer and LOTOS GROUP representative.

Directions and guidelines of fittings' manufacturer shall be taken into account and observed during assembly.

Assembling company is also obliged to employ requirements resulting from Health and Safety at Work Regulations, Building Law, as well as internal GL regulations regarding Health and Safety at Work and Fire Protection.

5.4 Design requirements

5.4.1 Lightning protection system

5.4.1.1 Basic requirements

Lightning protection system shall be designed and executed in such a way, which prevents, or at least significantly reduces risk of losses caused by atmospheric discharges in protected objects.

On designing stage one shall exploit to maximum electrical conducting elements for the system purposes, such as:

- reinforcement of foundations
- supporting structures
- structural elements of equipment, vessels, etc.
- structural elements of buildings

as its natural members.

Additionally designed (artificial) parts of lightning protection system, shall be executed only in case of need for natural parts complementing, or if such parts are missing.

Continuity of connections, executed as non-separable or separable, shall be provided for conducting elements, constituting natural and artificial parts of lightning protection system.

The following connections can be used without limitation:

- welded and pressure welded,
- riveted and pressed, if connected elements have no insulating jackets
- reinforcement bars of reinforced concrete elements, made by means of special clamps or welded and covered with concrete (may be used only solutions given in attachemtn E of PN-EN 62305 code_

Riveted, glued and pressed connections cannot be used, if connected elements have anti-corrosion coatings.

Use of screwed, clamped or butt connections for connecting of elements covered with anti-corrosion layers is allowed.

In 0 and 1 explosion hazard zones screwed connections are not allowed; only welded joints can be used.

Utilization of metallic structural members in lightning protection shall be taken into account in design documentation of building – constructional branch.

5.4.1.2 Lightning protection system for buildings

Lightning protection system for buildings shall be designed and executed according to PN-EN 62305 standard.

Horizontal and vertical air terminals systems, as well as down-conductor systems shall be arranged in such a way, that all parts of protected object would be contained inside protective zone of air terminals.

Fastening of air terminals shall be durable.

All non-conducting building elements, located above roof surface (chimneys, fire walls, etc.) shall be equipped with air terminals and connected with air terminals network fastened on the roof surface.

All metallic parts of building, located on the roof surface (chimneys, ventilating hoods, barriers, etc.) shall be connected to the closest air terminal or down-conductor system .

Routing of air terminals over mouth of chimneys shall be avoided.

Metal draining rain gullies made shall be connected to air terminals.

Artificial down conductors shall be installed on building objects, which load-bearing structure is made of non-conducting elements. Such conductors shall be laid on outer walls of building object on brackets, or with use of another method ensuring maintaining of proper distance from the wall and fastening reliability not worse, than on brackets.

Artificial down conductors shall be laid along the shortest possible route between air terminal and earthing.

Connections of down conductors with earthing or earthing conductors shall be made through test joints .

Earth electrode, as well as artificial down-conductor system shall be made of zinc coated tape or stainless stell with molibden addition . Dimensions of zinc coated tape shall be 30 x 4 mm at least.

For lightining protection purpose artificial electrodes shall be used.

Natural earthing can be used only as additional protection.

5.4.1.3 Lightning protection system for process object

Lightning protection system for objects under fire hazard and objects under explosion hazard, shall be designed and executed according to PN-EN 62305-3:2009 standard, particularly with reference to Annex D.
Lightning protection system for remaining objects and elements of process plants, shall be designed and executed according to PN-EN 62305 D standard, ,.

5.4.2 Protective earthing

5.4.2.1 Basic requirements

Earthing system shall be used in order to provide safety for people, machinery and equipment.

There is single Central Earthing System within LOTOS Group S.A. area, to which new objects shall be connected directly, or locally through already connected objects, and always in two points at least, on opposite sides of the technological object, instalation.

Coexisting in a single object, installation :the installation of lightning protection, electrical cables protective conductors network, a network earthed protective conductors, a network of protective conductors for electronic devices, that require to work defined grounding, shall have its own separate grounding systems.
Each of the sub-network (excluding the lightning protection system) shall have their own local grounding bus connected finally to a common point of the main grounding bus of the object, instalation. These networks shall be connected to the existing Lotos Group grounding system.

Horizontal earth electrodes shall usually be laid on depth of 1.0 m below ground surface. Type and location depth of earth electrodes shall be such, that drying and freezing of ground would not cause increasing of resistance above required value.

In case of vertical earth electrodes, their upper end shall be positioned below ground surface. Usage of vertical or skew earth rod electrodes is particularly advantageous, where ground resistivity decreases with depth.

Each earthing system shall be composed of main earthing bus bar, or main earthing terminal. earthing conductors

5.4.2.2 Earthing conductors

Connection of earthing conductor with earth electrode shall be made in durable manner in mechanical and electrical respect.

A connection, located in accessible place, enabling disconnection of earthing conductor shall be provided. Its required location is next to main bus bar or earthing terminal, in order to enable earthing resistance measurements execution. The connection shall be mechanically and electrically durable, and its disconnection can be done only with use of tool.

5.4.2.3 Protective conductors

Protective conductors shall be calculated and selected according to PN-IEC 60364-5-54 standard.

The following can be used in capacity of protecting conductors:

- conductors in multi-conductor leads (cables)
- permanently laid, bare or insulated wires
- metal sheaths, as for example, jackets, screens and armours of leads (cables)

- metal gullies or other guards
- adequate, foreign conducting parts on condition, that they meet requirements of PN-IEC 60364-5-54 standard.

Protective conductors shall be suitably protected against mechanical and chemical damages, as well as damages resulting from impacts of electrodynamical forces.

Connections of protective conductors shall be accessible for inspection and testing.

If electric control of earthing continuity is employed, then placing of any switchgear or coils of testing devices in protective conductors is not allowed.

5.4.2.4 Equalizing connections

Equalizing connections shall be designed and executed according to PN-EN 62305 standard in such a way, that internal and external conducting parts, as well as power engineering and telecommunication systems can be connected with short equalizing leads, and, where necessary, by plugging –in of voltage reducing devices. All connections shall conform to PN-IEC 60364.

Equalizing leads shall be connected to equalizing bus bar, made and installed in a manner enabling easy access for inspection. In extensive objects, more than one equalizing bus shall be foreseen, providing their mutual connection..In the case of buildings such as power stations or control rooms,technical instrument rooms, main grounding bus shall be performed as a loop of the flat bar around all walls basement of the building.

Equalizing connections expecially shall be made for steel screwed constructions like piperacks, platforms and technological heaters

For technological objects it is allowed to use as earthing construction connections with other earthed objects. Those connections shall fulfil requirements regarding resistance of earthing connection.

Stationary tanks, apparatuses and other technological devices shall be earthed at least in two opposite points

In case of external conducting parts, equalizing connections shall be executed possibly nearest to input points to objects.

Equalizing connections of electric and telecommunication systems shall be established in conformance with PN-EN 62305 standard.

5.4.3 Earthing and protective conductors for electronic systems

Protective earthing and cables for electronic systems shall create inside the building a separate, isolated structure, connected with the whole earthing system through main earthing busbar. Main earthing busbar shall be located in ground or close to ground to minimize disturbances caused by equipotential currents.

Cable routes and electronic equipment sensitive to disturbance shall be placed separate from other networks, in particularly from the lightning protection system; narrowings and parallel routes shall be avoided.

Armors of armoured cables dedicated to electronic systems shall be earthed on both ends.

5.4.4 Earthing of pipelines

Earthing system for pipelines shall be designed and executed with consideration given to the following requirements:

Flanged joints of pipelines, in order to ensure galvanic continuity, shall be joined by means of gaskets made of electrically conducting material. The gaskets on flanged joints of pipelines shall be made of electrically conducting material:

- metal
- graphite - metal

Direct earthing of pipelines is required:

- on the beginning and end of pipeline
- on pipeline route, every 30 m,
- on the enter of pipeline to object.

Direct earthing shall consist in electrical connection of pipe to earthing network:

- through galvanized terminal – flat bar, welded directly to pipe or sliding part of pipe, on assumption that sliding part is directly welded to the pipe,
- through clamping ring – terminal for non-insulated pipes of cross-sections up to 2" with conductive anti-corrosion coatings.

Connecting terminals (screwed / welded) shall be located outside of external insulation of pipelines. Flexible connections, with necessary reserve for thermal compensation of pipeline, by means of insulated, yellow-green 16-25 mm^2 lead, shall be used for above-mentioned connections.

Direct earthing of beginning/end of pipeline can be replaced by:

- fixed or flange (with conductive material gasket) connection with other directly earthed pipeline
- fixed or flange (with conductive material gasket) connection with other earthed device or technological apparatus
- other direct earthing located not further than 15m (on pipeline way) from flange or weld being border of this pipeline

Places of pipe earthing (natural and artificial) shall be marked in visible place with characteristic "Earthing" graphic symbol.

5.4.5 Exclusions from above pipeline earthing requirements

It is not required to earth pipelines with length less than 30m which are connecting, through weld or flange connection (with conductive material gasket), earthed devices (other than pipelines) and technological apparatuses.

In case of modernization of existing pipeline (e.g. by tie-in or replacement of part of pipeline) it is allowed to leave existing earthing system on not chnged part of pipeline, without its adjustment to actual requirements of 4500 technical standard.

In case when tie-in or replaced part of pipeline is up to 15m long – additional earthing is not required.

In case when tie-in or replaced part of pipeline length is bigger than 15m but not longer than 30m it is required that new part of pipeline shall be earthed directly only in one point.

In case when tie-in or replaced part of pipeline length is bigger than 30m it is required that new part of pipeline shall be earthed in accordance with point 5.4.4 requirements.

5.4.6 Earthing of objects, devices, installations and elements made from non-metal conductive materials

Conductive construction elements, technological devices and installations made from non-metallic conductive materials shall be earthed wherein:

- Elements made from materials with addition of conductive carbon black, graphite, metal ply etc. shall be eathed by ensuring proper contact with metal elements. The highest acceptable leakage resistance is $10^6\Omega$. It is prohibited to use railings, floors, wallpapers etc. with leakage resistance above $10^6\Omega$.
- Those elements shall be equipped in lugs to connect earthing conductors. Those lugs must be clearly marked for easy localization and identification during montage or maintenance works.
- If there is the need to place in tank or technological apparatus conductive element, floating on liquid surface, such element must be earthed.

5.4.7 Working earthing

Working earthing shall be designed and executed for each station, supplying electric distribution network.

Working earthing shall be connected with neutral point of supply system, and if not accessible, then with another active part. The connection shall be sized to fulfill its function independently of the existing cable network and other connections between the neutral and earth point.

Common earthing for high and low voltage station equipment can be executed, on condition that the following criteria are satisfied:

- Neutral point of low voltage network or PEN leads can be connected with high voltage earthing system, if during earth faults the following conditions are met:
  - dangerous touch voltages would not appear in low voltage network or in receiving systems supplied from this network (this shall be achieved, if earthing voltage of common earthing system would not exceed values given in PN-EN 61936-1 standard, and in PN-HD 60364-4-442 standard).
  - Value of voltage (of network frequency) arising in low voltage recipient equipment, would not exceed value resulting from earthing voltage of earth electrode, to which low voltage network neutral point is connected, and given in PN-EN 61936-1 standard, as well as in PN-HD 60364-4-442 standard.
- If high voltage devices are supplying recipients of low voltage, located within area of high voltage equipment earthing system, then all protective and working earthing of recipients shall create common earthing system. In such case, above compiled conditions for those low voltage recipients can be considered fulfilled.

If low voltage receiving systems are located outside of high voltage equipment earthing system, then conditions for execution of common earthing system can be considered fulfilled, when:

- Earthing system of considered high voltage switchgear is connected with combined earthing system,

or when

- Conditions, determined in PN-HD 60364-4-442 standard, conditional upon low voltage network type and earth fault time, are met.

Wherever allowable, carrying out of common earthing system is recommended.

Earthing systems for high and low voltage shall be executed as separated, if none of above stated conditions can be satisfied.

Separation of earth electrodes shall be such executed, that hazard for persons and equipment in low voltage equipment is precluded, i.e. earthing voltage of low voltage equipment resulting from earth fault in high voltage equipment, would be lower than values given in PN-HD 60364-4-442 standard.

Execution of low voltage earth electrodes within area adjacent to high voltage earthing system, in distance shorter than 20 m, is forbidden. If low voltage earth electrode shall be made within above-mentioned area, then use of special measures is necessary.

Separate earthing systems can be connected within station area by means of overvoltage limiter, providing lightning protection. Voltage limiter suppression voltage, or permanent working voltage of oxide varistor type, spark-gap less voltage limiter, shall be higher than earthing voltage of high voltage earthing system.

5.4.8 Static electricity protection

Static electricity protection shall be designed and executed according to: PN-92/E- 05200, PN-92/E-05201, PN-92/E- 05202, PN-92/E- 05203 as well as PN-E- 05204 standards, until replaced with planned for issue PN-EN or PN-IEC and PN-EN 61340-5-1 standards.

Static electricity protection shall be used in premises and spaces endangered with fire and/or explosion, where combustible media are present.

Application of static electricity protection in premises and spaces not endangered with fire or explosion is necessary only then, when static electricity phenomenon creates hazard for personnel (electric shock, prolonged stay within strong electrostatic fields), creates significant disturbances in production process course, influences deterioration of products quality or generates interferences in electronic measuring and control-regulation systems, as well as in systems of electronic data processing.

Protection against static electricity shall be accomplished by use of anti-electrostatic materials, equipotential connections and execution of effective earthing.

For all objects endangered with explosion, earthing network shall be designed and executed, to which all equipment and auxiliary instruments present on such objects shall be connected.

Earthing network for static electricity protection shall be connected to earth electrodes of power engineering and lightning protection systems. It is necessary to ensure continuity of earthing network, as well as required effectiveness of earthing (total resistance of earthing network used for static electricity protection cannot exceed 10 ohms value).

Earthing of conductive construction elements, technological apparatues, pipelines and installations is required, wherein:

- As earthing for technological apparatuses their construction connections with other earthed apparatuses shall be used, if those connections provide required leakage resistance. For earthing of individual apparatuses flexible conductors shall be used, ended by compressor or hollow clamp; using of chains is prohibited.
- The best way to provide proper earthing parameters for flange connections is using of spring gaskets or other metal type.
- For flange connections which are part of earthing net system it is forbidden to use gaskets or spacers made from insulation materials and connection point cannot be painted
- Bonding of flange connections in transmission pipelines, covers or inspection manholes in technical apparatuses is not required, if all elements are reliable connected together by means of screws and conductive gaskets are used.

5.5 Scope of design and deliveries

5.5.1 Scope of design

Scope of design includes:

- Selection of lightning protection system
- Matching of earthing systems to required resistance
- Selection of building and constructional materials for static electricity protection
- Preparation of lightning protection system plans
- Preparation of earthing system plans
- Preparation of equalizing connections plans
- Preparation of static electricity protection earthing plans
- Schedule of materials

5.5.2 Scope of deliveries

In order assumptions, accepted by supplier (contractor), detailed scope of deliveries and services are not specified, but it is known that they have to satisfy all technical requirements of this specification, current codes as well as provide proper and safe operation of the system.

5.5.3 Spare parts

Spare parts necessary for lightning protection and earthing systems commissioning, shall be included in scope of delivery.

Spare parts for 2-year period of system operating can be ordered basing on prices submitted on tender stage, and in time determined by LOTOS GROUP.

5.5.4 Notification about deficiencies

The supplier (contractor) is obliged to notify, in proper time:

- about necessity for revision of basic data
- about information that have not been taken into account in the specification
- about design requirements
- that technical documentation is incomprehensible and shall be supplemented according to new technical knowledge, or prepared basing on components accessible on market.

5.6 Factory testing

LOTOS GROUP reserves the possibility for carrying of detailed visual inspection of manufactured products prior to packaging.

5.7 Quality system

The tender shall submit documents, confirming implementation of quality system.

If quality system is acknowledged according to ISO 9000 by quality office, then copy of certificate shall be submitted to LOTOS GROUP.

If quality system does not conform to ISO 9000 standard, then the tender shall submit detailed description of this system.

6 Relevant documents

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

7 Codes and standards

Lightning protection, earthing and static electricity protection systems shall be executed according to below listed Polish Standards PN-EN, PN-IEC, as well as European equivalents of IEC/CENELEC standards.

PN-IEC 60050-195	International electrotechnical vocabulary. Earthing and electric shock protection.
PN-EN 62305	Lightning protection standard (all parts)
PN-IEC 60364-4-443	Electrical installations of buildings. Protection for safety. Protection against overvoltages. Protection against overvoltages of atmospheric origin or due to switching
PN-HD 60364-5-54	Low-voltage electrical installations. Selection and erection of electrical equipment. Earthing arrangements and protective conductors.
PN-HD 60364-4-41	Low-voltage electrical installations.Protection for safety.Protections againts electric shock.
PN-IEC 60364-4-442	Electrical installations of buildings. Protection for safety. Protection against overvoltages. Protection of low voltage systems against transient overvoltages and damages resulting from earth faults in high voltage networks.
PN-IEC 60364-4-481	Electrical installations of buildings. Protection for safety. Choice of protective measures as a function of external influences. Selection of measures for protection against electric shock in relation to external influences
PN-IEC 60364-4-482	Electrical installations of buildings. Protection for safety. Choice of protective measures as a function of external influences. Fire protection.
PN-HD 60364-6	Electrical installations of buildings. Testing.
PN-EN 61936-1	Power installations exceeding 1kV a.c. – Part 1: Common rules.
PN-EN 61340-5-1	Protection against static electricity. Protection of electronic devices from electrostatic phenomena - General requirements.
PN-E- 05200	Protection against static electricity. Terminology.

PN-E- 05201	Protection against static electricity. Assessment methods of hazard caused by electrification of solid dielectric materials. Assessment methods of fire and/or explosion hazard.
PN-E- 05202	Protection against static electricity. Fire and/or explosion safety. General requirements.
PN-E- 05203	Protection against static electricity. Materials and products used in explosion hazard objects and zones. Methods of testing specific electric resistance and leakage resistance.
PN-E- 05204	Protection against static electricity. Protection of objects, systems and equipment. Requirements.

Design of lightning protection, earthing and static electricity protection systems, developed according other norms and standards, shall be submitted to LOTOS GROUP for approval.

8 Record of changes

No.	Date	Description	Introduced by
1.	28.04.2011	This specification entirely replaces the former LOTOS Group S.A. standard No. PR 07 460 with the same title.	J. Bućko K. Matyjaszczyk M. Rompa
2	03.03.2013	Correction of point 4.4.4. Add new point 4.4.5 and exclusions to earthing of pipelines	T. Wróbel
3	5.04.2013	Changes in point 4.4.4 start/end of pipeline earthing requirement has been established . Changes in point 4.45. Earthing of tie in has been established.	T. Wróbel
4	30-11-2013 (rev. 4)	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