Grupa LOTOS S.A.	**TECHNICAL SPECIFICATION**	Spec. N° 3110
	Signal connection: cables, pneumatic connections, junction boxes, cable trays	

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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 cable and pneumatic routes.

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.

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.

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 specification
- Other Specifications
- Drawings and other documents
- Standards

4 Definitions and designations

GLSA – Grupa Lotos S. A.

Cable room – a compartment of control room building, which main and sole function is distribution of cables entering the building to consumer points (system cabinets) located above this room. The room also serves routing of cables between system cabinets. It constitutes analogy to raised floor.

Cable line – multi-core cable or bunch of cables, laid on common route

Cable channel – a channel in wall, ceiling, floor or ground covered with plates that can be partially or completely removed, not intended for moving of staff inside it.

Cable platform of piperack – the area of piperack destined for routing of cable line

Digital communication signals –FIELDBUS, MODBUS, PROFIBUS, ETHERNET communication circuits, using such carriers as copper cable or fibre optic cable can be numbered among them

Intrinsically safe loop – output signals of intrinsically safe measuring transmitters and signals of intrinsically safe executing equipment. Loops of intrinsically safe binary signals can be listed among them as well.

Non-intrinsically safe loop – output signals of non-intrinsically safe measuring transmitters, signals of non-intrinsically safe executing equipment, as well as non-intrinsically safe supply circuits 24V, 48V. Loops of non-intrinsically safe binary signals can be listed among them as well.

Strongly interfering circuits – these include frequency converters and cables connecting motor to converter

Cable guard – a structure intended for protection of cable against mechanical and chemical damage, and action of electric arc. The following types of guards can be distinguished:

Cover – the guard laid over the cable, in order to protect it against mechanical damage from above

Partition – the guard laid along the cable, in order to isolate it from adjacent cable, or other equipment

Air-tight conduit (air-tight pipe guard) – the guard of oval cross-section, sectional or non-sectional, protecting the cable from all sides and sealed on both ends

Open conduit (open pipe guard) – the guard of oval cross-section, sectional or non-sectional, both ends unsealed

Cable tray – the structure destined for routing of cable line, in form of single element and three solid walls. It shall be equipped with cover.

Cable culvert – the structure ensuring fulfilment of specified requirements regarding routing of cable line in particular place, e.g. under roads, terrain obstacles, or passage of cable line into building.

Crossing – such place on cable line route, in which any part of vertical/horizontal projection of cable line, intersects or covers any part of horizontal/vertical projection of other cable line or other underground or overground equipment, e.g. pipeline, road.

Cable route – part of terrain or space, which axis of symmetry is straight, crooked or wavy line, connecting two or more electrical equipment, within which one or more cable lines are laid.

Cable tunnel - the tunnel for laying of cables inside it, and adapted to moving of staff in its interior.

5 Description

5.1 Cable routes

Main cable routes shall be led in cable channels and on pipe rack, while it is preferred that between control room and an installation cables shall be led in cable channels, but within an installation - on piperack . In justified cases deviation from this rule is allowed, after GLSA approval.

Leading of cables directly in ground is allowed in specific cases, on condition that requirements specified in table p. 4.1.11 and in Attachment No 1 are met, and after presentation of method for laying them and obtaining GLSA approval.

5.1.1 Types of cable lines in respect of cable types

Four types of cable lines can be distinguished:

1. Cable line for digital communication
   They serve for laying of digital communication cables in them (for definition refer to p. 3)

2. Intrinsically safe cable line
   They serve for laying of intrinsically safe loops' cables in them (for definition refer to p. 3)
3. Non-intrinsically safe cable line
   They serve for laying of non-intrinsically safe loops' cables in them (for definition refer to p. 3)
4. Power cable lines
   They serve for laying of supply circuits' cables in them, of voltage 230V and 110V

Above-mentioned types of lines shall be laid with consideration given to minimum distances, specified in p. 4.1.9, 4.1.10, 4.1.11.

5.1.2 Selection of cable route

Cable route shall be established with consideration given to the following provisions:

- Number of crossings and approaches of cable on route with other equipment, as well as number of passages through walls, ceilings and other obstacles shall be minimised
- Distance between cable and hot pipeline shall take thermal effects into consideration
- The cable shall be
- the least of all exposed on mechanical and chemical damages
- Laying of cables shall be done in a manner excluding their damage in effect of bending, twisting, stretching, etc.

5.1.3 Laying of cables on vertical and inclined sections

Cables laid vertically or on inclinations shall be such fastened, so that tension force would not generate stresses in the cable nor cause axial displacement of cables.

5.1.4 Types of cables laid in channels, on racks and in rooms

Acceptable types of cables and their parameters were specified in technical specification GLSA 3120.

5.1.5 Cable channels

Cable channels outside buildings shall be made as concrete structures, and built in such a way, so that penetration of water and contaminations to their interior would be made difficult. Drainage shall be provided.

Filling of channels with sand is preferred.

If relative density of gases and explosive vapours in vicinity of channel path is greater than 0.8, then in case of channels that are not filled with sand, ventilation of the channel is required. If explosion of dusts is likely, then cable channels shall be protected against dust penetration.

If cable channels are not filled with sand on the whole length, then they shall be divided into fire zones by means of fire bulkheads made of sand, layer of 1 m length, encased on both sides with bricks. The bulkheads cannot make difficult of channels' draining.

Cables shall be laid in channels in layers backfilled with sand and separated with foil.

Cables shall be laid in the following order, from the top:

- Fibre optic circuits (if present)
- Intrinsically safe loops
- Non-intrinsically safe loops

- 230V and 110V power cables

5.1.6 Cable platforms (on piperack)

It is preferred that cable routes of Instrumentation and Electrical Departments would have their own levels on rack, assigned above level of pipelines.

In case when cable routes are led on the same level as pipelines, then it is necessary to keep clearance between them, so as to access for laying them and further modification would not be made difficult, as well as with consideration given to distances specified in p. 4.10.

Leading of main cable routes in fireproof space of piperack shall be avoided, considering increased fire hazard in this area.

The platforms shall be equipped with adequate shelves for cable trays.

Method of cable trays arranging was presented on sketch 1 Attachment No 1 to this specification.

Structure of piperack shall provide guarding of cables on the whole length against direct sunlight.

Cable trays shall be grounded on beginning, in the middle and the end of the piperack, by metallic connection to grounding system busbar.

For loops of key importance for safety of plant, which shall operate also during fire, fire resistant cable guards shall be used, or cables with fire resistant insulation.

5.1.7 Laying of cables in protective conduits (in pipes)

In case when necessity arises of bringing cable to a place, where erection of overhead structure is impossible, the cable can be led in protective conduit placed in ground or concrete entablement (if any exists). Both ends of protective conduit shall be protected against penetration of water, gases, hydrocarbons, and resistant to weather conditions. The conduit protruding from the entablement must be made of metal, in order to protect cables against damage. If such conduit protects cable of 230V 50Hz voltage , then it must be connected to earthing network. Example of arrangement is shown on diagram 3 Attachment No 1 to this specification.

5.1.8 Laying of cables directly in ground

In particular cases, leading of single cables or their small bunches directly in ground is allowed. It is then necessary to observe distances quoted in p. 4.1.11. Method of laying of cables directly in ground is shown on sketch 2 in Attachment No 1 to this specification.

5.1.9 Distances between cables

Minimum vertical (horizontal) distances between cables laid in parallel

Minimum vertical (horizontal) distance, [cm]	Power cables 110/230 /400 V	Power cables above 400V and frequency converters circuits
Digital communication signals	30	120
Intrinsically safe loops	30	120
Non-intrinsically safe loops	30	120

Minimum vertical (horizontal) distances between cables at crossing

Minimum vertical (horizontal) distance, [cm]	Power cables 230 and 110 V	Power cables above 400V and frequency converters circuits
Digital communication signals	10	25
Intrinsically safe loops	5	5
Non-intrinsically safe loops	5	5

Above-quoted distances must be kept in order to avoid electromagnetic interferences from adjacent cables.

5.1.10 Distances of cable routes from pipelines

Distances from pipelines are listed in the following table.

Type of pipeline	Minimum allowable distance from pipelines [cm]	
	not requiring periodical maintenance	requiring periodical maintenance
Pipelines of compressed air, ventilation, water supply, flammable gases of pressure up to 0.04 Mpa	20	100
Insulated heat, water and steam pipelines	50	100
Not insulated heat, water and steam pipelines	120	120
Pipelines with flammable liquids	100	150
Other process engineering equipment	100	150
* Sections of pipelines with valves, gate valves and other fittings are to be considered as requiring periodical maintenance		

5.1.11 Distances of cables laid directly in ground, from underground objects (does not apply to cable ducts)

Item	Type of underground object	Minimum allowable distance [cm]	
		Laid in parallel	At crossing
1	Water supply, sewage, heat, gas pipelines with incombustible gases	25+pipeline diameter	25+pipeline diameter
2	Pipelines with flammable gases and liquids	not less than in item 1.	
3	Tanks with flammable gases and liquids	200	cannot be crossed
4	Underground parts of overhead lines (footing, support, stay wire)	40	cannot be crossed
5	Walls of buildings and other structures,	50*	cannot be crossed

	e.g. bridgeheads, excluding equipment listed in items 1, 2, 3, 4		
6	Terminal rail of traction	250*	100- between cable guard and rail foot 50- between cable guard and draining ditch bottom
7	Equipment for protection of buildings against atmospheric discharges	Acc. to PN-86/E-05003/01. Lightning protection of buildings. General requirements.	
* Decreasing of distances given in this table is allowed on condition, that surrounding guards are used, and deviation is agreed with involved departments			

5.1.12 Crossings

Mutual crossing of cables in ducts and tunnels shall be avoided.

In place of cable channels crossing on the same level, cables of both ducts shall be mutually separated by guards, e.g. by laying them in conduits on whole length of the crossing.

Additional guarding of cables in place of channels crossing on different levels is not required.

5.1.13 Leading of cables and pipelines in cable channels

Utilization of cable channels for leading of water supply, ventilation, sewage and incombustible gases (e.g. compressed air) pipelines is allowed, on condition that relevant regulations concerning laying of pipelines permit laying them together with cables of specified voltages and types.

Cable channels in which pipelines conveying gas or flammable media are laid, must be equipped with devices detecting and signalling leakage of specific media from the pipeline.

Furthermore, laying of cables in channels of heat pipelines is allowed, with consideration given to thermal influence.

5.1.14 Laying of fire resistant cables

Fire resistant cables according to IEC 60331 shall be led on structures and handles of fire resistance not worse, than required resistance of cable.

Fire resistant cables, laid horizontally or with inclination at angle less than 15º from level, shall be routed in cable trays or in handles, while fire resistant cable laid with inclination at angle greater than 15º from level, as well as fire resistant cables laid vertically shall be fastened in handles attached to supporting structures or directly to walls.

5.1.15 Laying of cables in buildings

Cables can be laid in buildings in the following manner:

- Directly next to walls and under ceilings, on adequately prepared supporting structures
- In cable channels, in a manner facilitating their dismantling.

Permanent fixing of cables into walls, floors or ceilings is impermissible.

5.1.16 Routes of individual cables

For laying of individual cables, cable tray 40x40 mm or bigger shall be used, depending on needs. Routing of cables close to hot pipelines shall be avoided.

In particular cases and on GLSA approval, it is allowed to route individual cables in individual conduits.

5.1.17 Routing of cables of redundant loops

Mutually redundant cables of digital communication circuits shall be laid on separate routes.

Entering of redundant circuits to the same junction box and leading them in single, multipair cable is allowed.

5.2 Passing of cables through walls

5.2.1 Entering of cables from outside of building and container

Entering of cables from outside to central control room building (cable room) located outside explosion hazard zone, and to local control rooms located within explosion hazard zone, shall be accomplished by means of culvert from cable channel.

Cable culvert is made in form of tubular guards mounted in the wall. The guards shall pass through the whole thickness of building foundation or wall with inclination to outside. Point of cable entry to building shall be protected against water penetration to the building interior. The sealing shall be also resistant to hydrocarbons and weather influences.

Entering of cables to container shall be made with use of brand original modular cable sealing systems, ensuring individual sealing of each cable, resistance to fire, water, gas and rodents.

5.2.2 Cable passages from cable room to technical instrument room

Cable passages through ceiling from cable room to technical instrument room shall be made with use of original seals block system, ensuring individual sealing of each cable, resistant to fire, water, gas and rodents.

5.3 Marking of cable routes intersections

Cable routes can pass through part of unit belonging to various sub-contractors. Each sub-contractor obtains from main contractor range of ordinal numbers for marking of instruments, equipment and machine elements (refer to specification GLSA 6120, p. 6.3).

Example 1:

Example for 5 sub-contractors on unit 110:

Main contractor - range 001-400

Sub-contractor 1 - range 401-600

Sub-contractor 2 - range 601-800

Sub-contractor 3 - range 801-900

Sub-contractor 4 - range 901-999

In order to unify marking of intersections and avoid doubling of marking of various sub-contractors intersections, the following method of marking is being set:

Marking of cable route intersection consists of three parts:

- Symbol of unit
- Part identifying sub-contractor

- Literal designation of subsequent intersection

Symbol of unit consist of superposition of area number and first digit of sub-area, e.g. 110 according to Documentation Numbering Procedure – specification GLSA 6110.

Part that identifies sub-contractor of specific part of unit, that is the first digit of ordinal numbers range beginning, e.g. for sub-contractor 1 from example 1 it would be digit 4, and for sub-contractor 3, digit 8.

Literal designation of subsequent intersection, that is the capital letters from A-Z range, without dialect characters. If the number of letters is insufficient, than two-character designations shall be used, following the rule that after spending of all A-Z range letters, the following scheme shall be used: AA, AB, AC, ...AZ, then BA, BB, BC, ...BZ, CA,CB, and so on.

Examples of intersections' designations:

For main contractor from example 1: these would be intersections 110_0A, 110_0B, 110_0C etc.

For sub-contractor 1 from example 1: these would be intersections 110_4A, 110_4B, 110_4C etc.

For sub-contractor 2 from example 1: these would be intersections 110_6A, 110_6B, 110_6C etc.

For sub-contractor 3 from example 1: these would be intersections 110_8A, 110_8B, 110_8C etc.

Numbering of intersections shall always be started from control room side.

5.4 Cable trays

Solid trays (not- perforated) with cover, made of galvanized steel shall be used. Thickness of galvanizing coating min 2 mm.

In order to provide electric shock protection and resistance to electromagnetic interferences, cable trays shall be connected to earthing network, common for the whole unit. In order to improve electromagnetic resistance and to obtain reduction effect of interferences penetration into cable, electrical continuity of whole length of tray shall be ensured. At passages through obstacles, trays laid on both sides shall be galvanic connected. Connection of trays means as direct connection of trays' steel sheets, or connection with use of possibly widest elements, e.g. band, which are simultaneously as short as possible (connection of length exceeding 1 m thwarts reduction effect). Cable trays shall be earthed on the beginning, in the middle and on the end of piperack.

Sum of cables' cross-sections in specific tray shall constitute approx. 30% of the tray cross-section area. When selecting spacing of cable tray supports, recommendation of trays' manufacturer shall be taken into account.

5.4.1 Cable trays size series of types

It is recommended to use the following widths of cable trays:

- 40mm
- 100mm
- 200mm
- 300mm
- 400mm

Cable trays with widths higher than 400 mm shall be accepted by GLSA.

Height of cable trays shall be selected depending on number of cables foreseen for laying in specific tray.

5.5 Leading of pneumatic routes

On new-designed plants, leading of pneumatic routes to control room is not foreseen. Pneumatic routes in region of unit shall be laid with use of suitable holders or cable trays. Laying of pneumatic route together with cables in cable tray is allowed in justified cases.

System of instrument air supply was described in specification GLSA 3140.

5.6 Junction boxes

5.6.1 General requirements

Below given requirements apply both boxes intended for use in explosion hazard area and outside such zone. Paragraph 4.6.2 gives additional requirements for junction boxes in hazard zone.

Junction boxes made of glass fibre reinforced with polyester are preferred. In justified cases boxes made of aluminium or stainless steel can also be used.. Stainless steel junction boxes shall obligatory be used on units processing H_2S and sulphur.

Junction boxes shall be specified for operation in climatic conditions presented in specification GLSA 3010.

Degree of protection against solid matter and water shall be at least IP65.

Voltage test minimum 500V RMS AC.

Method of assembly shall enable installation of junction box on vertical frame or wall. The junction box shall be equipped with fixing bolts.

Cable entrances shall be located on the bottom of box. Each of them shall be equipped with cable gland. Cable glands with threads M(…) shall be used. Openings not filled with cables shall be equipped with hole plugs.

Junction box shall be equipped with screwed terminal strips.

Cable conductors shall be terminated with cable terminals of sleeve type (excluding connections of thermocouples).

If safety loops are not connected to SIS-PLC via separate junction boxes the loops, that do not constitute part of safety functions shall be connected starting from the first terminal. Loops, that do constitute part of safety functions shall be connected starting from the last terminal. This is to create visible gap between these circuits and to indicate particular role of SIL loop. Terminals of safety loop (SIL) shall be in yellow colour. This solution conforms to recommendation of PN-EN-61508 standard, chapter (…).

Numbering of terminal strip terminals for screened cables shall proceed according to 1, 2, S, 3, 4, S, 5, 6 etc. series. Numbering of terminal strip terminals for unscreened cables shall proceed according to series 1, 2, 3, 4, 5, 6 etc.

Layout of connections in junction box is presented in Attachments 45, 46, 48 of specification GLSA 3020.

Screen of individual cables, screen of cable pairs in multipair cable, as well as overall screen of multipair cable in Exi loops shall be connected to earthing network only in single point – in control room.

Number of terminals shall be adequate to number of cores in multi-core cable.

Each junction box shall be marked according to p. 4.5 of specification GLSA 6120. Marking shall be made in durable manner, e.g. engraved label plate.

Junction boxes of Exd and Exe design shall be marked with white letters on black data plate.

Junction boxes for intrinsically safe loops shall be marked with blue letters on white data plate.

Preferred colours of enclosure and cable glands for corresponding type of junction box are given in the following table.

Design	Colour of enclosure
Intrinsically safe	light blue is preferred
Flameproof	grey
Other than intrinsically safe, for use within explosion hazard areas	black
For safe areas	black
Special types, not listed above, e.g. junction box contains loops for both explosion hazard areas and safe areas.	black

5.6.2 Junction boxes located in hazardous area.

The following junction boxes are foreseen for use in explosion hazard zones:

- For non-intrinsically safe loops – of flameproof design „d", or of increased safety „e"
- Junction box for intrinsically safe loops need not to be of explosion-proof design (direction according 4.23.2), but must have declaration of manufacturer about approval for use in intrinsically safe loops.

Flameproof and increased safety junction boxes can be used without additional types of protection in zone 1 and 2.

In zone 0, only such junction boxes can be used, which correspond to category 1G. In zone 2G only such junction boxes can be used, which correspond to category 1D. Equipment used there require two independent protection types, e.g. flameproof enclosure and intrinsically safe loop of „ia" category.

Junction box of flameproof or increased safety design (together with cable glands) shall possess certificate of conformity ATEX, confirming possibility for use in explosion hazard zone.

Required surface resistance $Rs=10^6 \div 10^9 \Omega$.

Design and workmanship of junction boxes must fulfil requirements of the following standards:

- PN-EN 50014
- PN-EN 50019
- PN-EN 50020
- PN-EN 50281
- PN-EN 60529

- PN-EN 60947
- PN-EN 60999

Junction box of flameproof design or of increased safety, besides label plate identifying the box on unit, must additionally have nameplate on which the following data shall be placed:

a) CE mark (with number of notified body verifying quality management system)

b) Designation of ATEX certificate of conformity, along with identifier of notified body

c) Special mark  followed by designation of group and category, e.g. IIG.

d) Ex symbol and protection type designation (e.g. „d" – flameproof design, „e" – increased safety, etc.).

e) Symbol of group for explosive atmosphere, e.g. IIA

f) Degree of protection against water and dust (IP Code) in specified temperature class

g) Symbol of temperature class or maximum surface temperature

h) Additional marking „X" or „U", if required

i) Ambient temperature (Ta or Tamb marking)

j) Name and address of manufacturer

k) Catalogue designation of element type

l) Serial number

m) Year of element production

Marking of cable glands:

There may be not enough space on cable glands in order to place marking similarly as for junction box, but at least the following data shall be given:

- Name of manufacturer or its trade mark
- Ex symbol and designation of protection type (e.g. „d" – flameproof design, „e" – increased safety, etc.)
- Name or sign of notified body
- Reference to certificate

5.6.3 Junction boxes located outside explosion hazard area

For application in safe areas, junction boxes of minimum degree of protection against water and dust IP65 are foreseen.

Besides label plate, identifying the junction box on unit, the following data shall be placed on the junction box:

a) CE mark (with number of notified body verifying quality management system)

b) Name and address of manufacturer

c) Catalogue designation of element type

d) Serial number

6 Relevant documents

Any “Technical Specification” issued by GRUPA LOTOS S.A. listed in Contract Files.

7 Standards and regulations

Design, manufacturing and erection shall comply with the latest editions of below listed norms and standards.

Only norms specifically connected with cable routes and junction boxes are listed here. The other norms regarding Instrumentation are given in specification GLSA 3010 – Instrumentation general requirements.

EC Directives:

2004/108/EC EMC Directive, repealing directive 89/336/EEC starting from 20 July 2007r

Polish Standards:

- N SEP-E-004 Power supply and signal cable lines – engineering design and construction (revision of PN-76/E-05125 standard)
- PN-EN 060079-0 Explosive atmospheresEquipment. General requirements.
- PN-EN 060079-1 Explosive atmospheresEquipment protection by flameproof enclosures "d".
- PN-EN 60079-7 Explosive atmospheresEquipment protection by increased safety "e".
- PN-EN 60079-11 Explosive atmospheresEquipment protection by intrinsic safety "i" .
- PN-EN 60079-14 Explosive atmospheresElectrical installations design, selection and erection..
- PN-E-05204 Protection against static electricity. Protection of objects, systems and equipment. Requirements.
- PN-EN 60529 Degrees of protection provided by enclosures (IP Code)
- PN-EN 60947 Low-voltage switchgear and controlgear
- PN-EN 60999 Connecting devices
- PN-EN 60950 Safety of information technology equipment
- PN-EN 55022 Electromagnetic compatibility (EMC). Information technology equipment – Radio disturbance characteristics -Limits and methods of Measurement
- PN-EN 55024 Information technology equipment – Immunity characteristics - Limits and methods of measurement
- PN-EN 61000 Electromagnetic compatibility (EMC)

8 Enclosures

- Attachment No 1, Example of cabling

9 Record of changes

No.	Date	Description	Introduced by
1	15.02.06	This specification entirely replaces the former LOTOS Group S.A. standard No. PR 07 303 with the same title.	M. Domaniewski
2	11.05.2011	1. Correction of item 2.1.	M.Baryła
3	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 contents changes.	T. Wróbel