Grupa LOTOS S.A.	**TECHNICAL SPECIFICATION**	Spec. N° 3130
	UPS supplied voltage distribution 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 3
5 Description 4
5.1 General requirements 4
5.2 Supply feeding to distribution cabinets 5
5.2.1 Supply of UPS units on primary side 5
5.2.2 The UPS 5
5.2.3 Feeding of supply from UPS units to distribution cabinets 5
5.3 Requirements for UPS units 6
5.3.1 General requirements 6
5.3.2 Design requirements 6
5.3.3 Power supply 11
5.3.4 The rectifier 12
5.3.5 Battery pack 12
5.3.6 The inverter 12
5.3.7 Intercircuit change-over switch (static switch) 13
5.3.8 Control panel 13
5.3.9 Control, protecting and signalling equipment 13
5.3.10 Connections to DCS 15

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5.3.11 Marking 15
5.3.12 Painting 15
5.4 Power supply distribution 16
5.4.1 Power supply distribution cabinets – general requirements 16
5.4.2 Power supply redundancy 16
5.4.3 230V AC and 24V DC voltage levels separation 17
5.4.4 Protection for safety 17
5.5 Diagnostics of supply network 19
5.6 Cabling system 19
5.6.1 Cable types 19
5.6.2 Redundant cables 19
5.7 Co-ordination of cables and protection devices selection 20
6 Relevant documents 20
7 Standards and regulations 20
7.1 European Union Directives 20
7.2 PN-IEC 20
7.3 PN-EN 21
8 Attachments 22
9 Record of changes 23

1 Subject of specification

This specification used in conjunction with other technical specifications of LOTOS Group S.A., establishes minimum requirements for the design, manufacture of uninterruptible power supply (UPS) distribution systems for instrumentation.

2 Scope of validity

This specification applies to the preparation of tender documents, inquiries and contracts concerning new investments and modernization projects planned by LOTOS Group S.A..

It shall also be a basis for preparing both detailed specifications and inquiries for individual or package unit supplies.

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

The following equipment or works, connected with this specification subject matter, are included in scope of design works and supplies of other branches:

- Protection against atmospheric and switching overvoltages in power mains - electric branch, 4140
- Ordinary power supply for instruments, which do not need UPS supply – electric branch, 4110.

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.

DCS - Distributed Control System

PLC - Programmable Logic Controller

ESD - Emergency Shutdown System

SIS-PLC - PLC, that implements SIF functions, with defined SIL requirements

ESD-PLC - PLC, that implements functions without SIL requirements

I/O - Input/Output

DC - Direct Current

AC - Alternating Current

UPS - Uninterruptible Power Supply

CR - Operator room / Control Room

TIR - Technical Instrument Room

ER - Engineering room

Field - the term applies to process part of plant. In relation to instrumentation, the field as opposed to control room (CR, TIR and ER), constitutes a place where measuring and control instruments are installed.

Uninterruptible Power Supply- electric power supply downstream of UPS equipment, ensuring continuous power delivery.

Ordinary power supply - electric power supply without UPS back-up

Redundancy - elements (or their sub-assemblies) multiplication technique in designed plant, used in order to minimise downtime likelihood of the plant, or even its part, as a result of single element failure. The solution that is most frequently used in case of instruments, is doubling of elements, so that in case of basic equipment failure, the stand-by equipment takes over all the duties in fully automatic way. What matters, is that switching over proceeds imperceptibly for the process, with no influence on functionality provided by those doubled elements.

5 Description

5.1 General requirements

For purposes of this specification, the term instrumentation (receiver, equipment) , is used in relation to all control and measuring devices, while accurate range in relation to instrumentation along with exclusions schedule, is given in 3010.

In process of power supply system designing for instrumentation, the requirement for supplying every receiver from uninterruptible power supply source (UPS) of electric energy shall be adopted as general principle. The only exceptions are analysers of high power consumption, installed in shelters, unless they are operated in control loops, or are important for the plant safety. In order to increase plant operation reliability, supply system shall fulfil the request of overall redundancy idea (detailed requirements are described in following paragraphs).

For newly built, complex plants of key importance from process point of view, full supply redundancy is required, starting with feed for UPS from switchgear, through independent UPS units, till distribution network together with doubled power supplies for some strategically important end

receivers (e.g. control system servers, operator stations). For small, less important investments, single supply is allowed in turn, if previously agreed with GLSA.

This specification places main emphasis on requirements towards full redundancy of supplies.

Transfer of electric energy, in fundamental version, starting from low voltage switchgear, through UPS units till power supply distribution cabinets, is presented in Attachment N° 1.

The system of uninterruptible power supply based on single-phase low-voltage mains, 230V 50Hz, is assumed basic solution. Distribution of this supply takes place in 230V AC voltage distribution cabinet. For instrumentation receivers supplied with 24V DC voltage, dedicated 24V DC voltage distribution cabinet is provided. Distribution cabinets will be built and furnished according to detailed recommendations given in following paragraphs.

Where three-phase, 3x400V 50Hz supply is required for instrumentation (e.g. imposed by specific requirements of DCS system supply), UPS units with three-phase output voltage shall be used. In such case it is necessary to ensure uniform load of each phase while designing supply network, as well as take this fact into account in protection's sizing.

For small, compact sized plants or package deliveries, use of so-called "DC UPS" with 24V DC voltage on secondary side, is allowed solution (an alternative).

5.2 Supply feeding to distribution cabinets

5.2.1 Supply of UPS units on primary side

Three-phase, 400/230V AC supply will be fed to two independent UPS units, from two separate sections of electric switchgear.

It is rigorously required to keep supply system, in which:

UPS1, basic supply – from Ist section

UPS1, by-pass supply – from IInd section

UPS2, basic supply – from IInd section

UPS2, by-pass supply – from Ist section.

In situation where two switchgears are available, basic supply of UPS units shall be fed from separate sections, of different switchgears.

The devices protecting UPS units against overloads and overvoltages shall be installed in switchgear's outgoing feeders.

5.2.2 The UPS

The requirements for UPS units are described in point 4.3.

As mentioned above, the basic and preferred supply system is the distribution network based on operation of two independent UPS units (refer to Appendix N° 1). In special cases, where safety reasons (or other essential requirements, influencing the plant operation) are imposing use of instruments with single 230V AC supply, one shall consider, and after GLSA approval, use the redundant UPS units working on common output bus-bar, together with adequately designed voltage distribution network.

5.2.3 Feeding of supply from UPS units to distribution cabinets

Redundant power supply from two independent UPS units shall be fed to 230V AC voltage distribution cabinet, by means of two cables, routed separately if possible. Redundant 230V AC

supply voltage shall be in turn fed to 24V DC voltage distribution cabinet, by means of two cables from 230V AC voltage distribution cabinet.

5.3 Requirements for UPS units

For instrumentation supply purposes, it is necessary to provide two identical UPS units, each of them separately guarantying taking over of all assigned receivers supply, in power range required. Maximum load of single UPS, which takes over power supply (while the second UPS is not operating), cannot exceed 80% of its rated output.

5.3.1 General requirements

For all equipment used, reliability, smooth operation and easy handling is required. One shall use typical equipment, used since 5 years at least. Prototype equipment, not registered and not allowed for production must not be used.

Service response, required for delivered equipment, determined as the time elapsing from the moment of notification to the moment of service arrival, shall be not longer than 4 hours.

Spare parts shall be available through period of 10 years minimum.

Rated data of equipment shall correspond to rated data for continuous operation of the equipment in specified working conditions.

Nominal working conditions of equipment shall fulfil requirements for at least nominal voltage and nominal current ranges, for all applications and for voltage tolerance ±10%.

The supplier shall submit heat balance emitted by the equipment, assuming that all are working at full load.

The UPS must meet requirements of EMC directive, which means that it shall operate properly in specified electromagnetic environment, while not introducing additional electromagnetic interferences.

5.3.2 Design requirements

5.3.2.1 Electric parameters

Primary side rated voltage (including by-pass)	**400V ±10%, 50Hz ±5%, (3L+N+PE)**
Secondary side rated voltage	**230V ±10%, 50Hz ±5%, (1L+N+PE)** or **400V ±10%, 50Hz ±5%, (3L+N+PE)** or in special cases **24V DC** (for DC UPS)
Autonomous operation time (Back-up time)	**60min.**
Normal operating mode:	„**On-line**" (double conversion)

5.3.2.2 Operating conditions

The UPS will be installed in separated compartment of Central Control Room building.

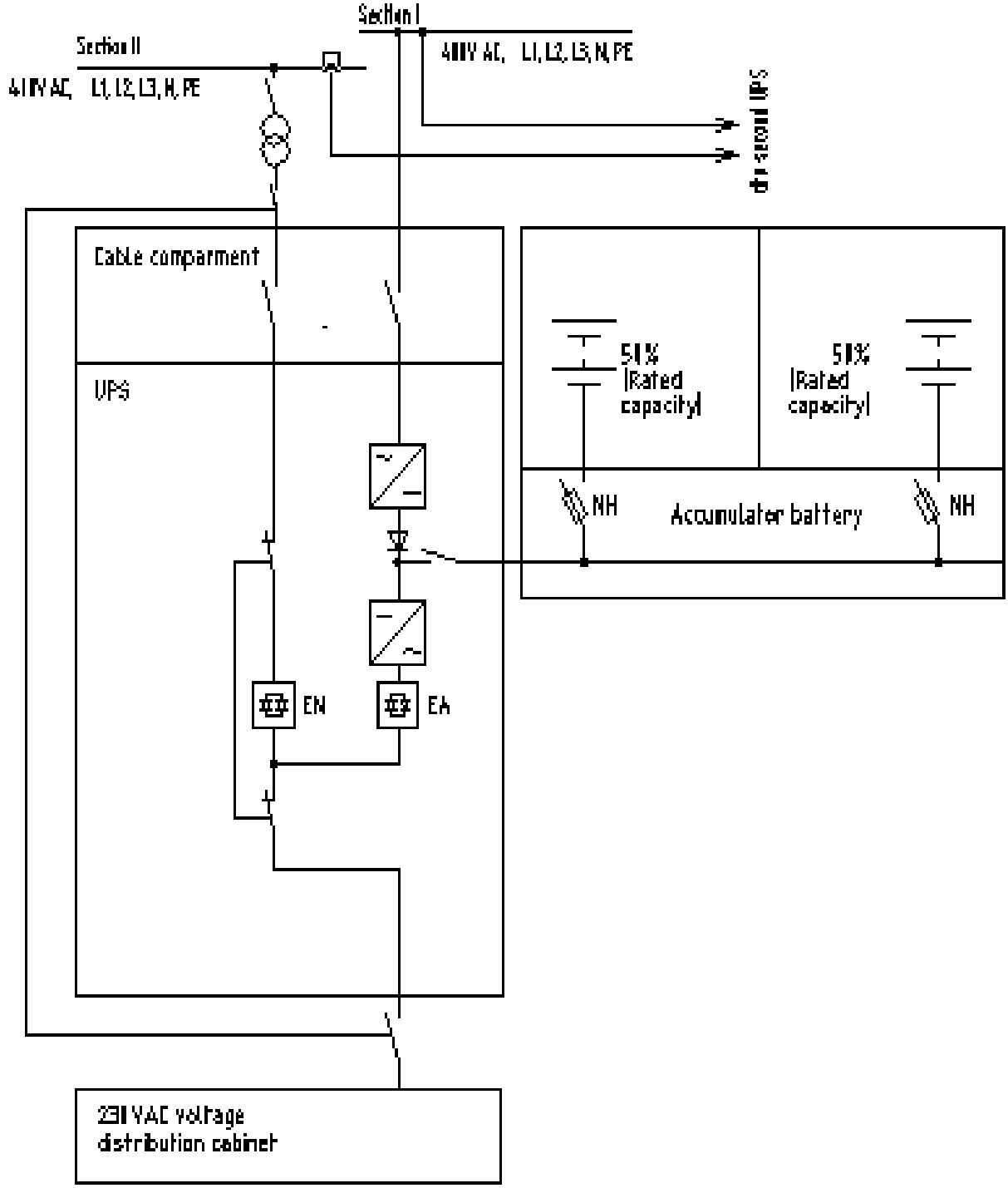
5.3.2.3 Basic technical requirements

The UPS shall consist of following components:

- Semiconductor rectifier (with 100% power output) with galvanic separation to inverter supply (with 100% power output) as well as to battery pack charging / recharging

- Serviceless lead-acid battery pack
- Transistorised inverter with sinusoidal output
- Static by-pass (static switch), that is intercircuit change-over switch
- Manual service by-pass supplied from mains through separating transformer,
- Multifunction panel with operating unit, digital measurements of state and the UPS self-diagnostic module, and alarm signalling (for example information about UPS operation interferences/disturbances)
- Inputs and outputs protected against overvoltage by means of overvoltage limiters, suitably selected for working conditions of UPS unit and UPS supplied devices.

Block diagram of the UPS is given below:


Section I
Section II
400V AC, L1, L2, L3, N, PE
400V AC, L1, L2, L3, N, PE
Cable compartment
UPS
51%
Rated
capacity
51%
Rated
capacity
NH
Accumulater battery
NH
EN
EA
230 VAC voltage
distribution cabinet

Basic constructional requirements

The UPS units shall be enclosed in separate, metal housings of IP40 protection class.

Sufficient ventilation shall be provided for enclosed UPS units.

The devices, enclosed inside housings, shall be easily accessible.

The housings, as well as all devices inside them, shall be unequivocally marked, according to design.

5.3.2.4 Cable compartment

The cable compartment shall be made in such a way, that supply and control cables could be easily connected to adequate terminals of each outflow.

Grounding terminals, intended for grounding of screens or armouring of cables, shall be executed inside cable compartment.

All elements, which can be live shall be shielded. Cable compartment shall be suitable for safe routing and connecting of cables without need for use of additional precautions in case when the switchgear is live.

All cable glands and other insulation materials necessary for completion of connections constitute part of the UPS, and shall correspond to the number and type of used cables. The cables shall be entered from below of housings.

Adequate facilities shall be provided in cable compartment for fastening of cables.

5.3.2.5 UPS compartment

All necessary protection methods, precluding access to devices installed inside the housing shall be employed. All permanent insulated contacts shall be shielded.

Power electronics of the UPS shall be placed in metal case, ensuring electromagnetic compatibility (EMC).

On top or bottom of the housing one shall install dismountable holders intended for carrying. Upper frame shall be strong enough to withstand all stresses present during transport.

Control devices, relays, fuses, overcurrent circuit breakers (MCBs), shall have got main current circuits insulated from auxiliary circuits.

In order to provide proper protection against electric shock and static electricity, all UPS compartments shall be furnished with grounding terminals. The terminals shall be connected to grounding bus-bar, which in turn shall be connected through control terminal to main grounding system. Grounding terminals shall be accessible without need for using any additional tools.

All specified spare elements shall be completed and delivered along with UPS delivery.

5.3.2.6 Wiring

Main current circuits:

Copper lead in PVC jacket – cross-section area according to vendor standard.

Control circuits:

Copper lead in PVC jacket – cross-section area according to vendor standard.

The wiring shall be made with care, according to documentation, valid regulations, standards and long-term code of practice, and in such way, so as to any possible failures would be easy to locate and rectify.

Only single lead can be connected to single terminal.

The conductor shall be multi-wire. The leads used for flexible connections (e.g. for devices mounted on the housing/cabinet door), shall be protected against mechanical damage by means of flexible protective tubes.

Each conductor end shall be furnished with connector enabling connection to terminal block, as well as with terminal/tip enabling connection to equipment. For multi-wire conductors, sleeve type cable terminals shall be used.

Green and yellow colours for cable jackets cannot be used, in order to avoid mistake for yellow-green PE lead.

All leads shall be marked adjacent to connection place. Terminals of equipment and/or any devices shall be marked as well, which will enable to avoid erroneous connections to terminal strips.

Insulation of conductors shall be fire resistant, with fire resistance exceeding 15 sec.

In places where fire resistant conductors will not be used, adequate barriers preventing fire spreading among switchgear compartments shall be used instead.

Connections to external monitoring systems (DCS, PLC) shall be made with use of instrument measuring cables, according to requirements of GLSA 3120 specification, or in case of data transmission in accordance to GLSA3710. Possible connections made by means of fibre optics shall be each time agreed with GLSA.

The following colour scheme for insulation jackets shall be used:

AC current circuits:	brown to depict phase, ends and terminals (L1, L2, L3)
AC neutral lead:	light blue
AC control circuits:	grey with ends numbering
DC circuits:	red (+) / blue(-), with ends numbering
PE protection bar:	yellow / green

The method of leads marking must correspond to requirements imposed by specifications GLSA 3030 and GLSA 6120.

5.3.2.7 Terminals

All supply and outflow fields shall be furnished with separate terminals.

Terminals with short-circuiting switches shall be used for main circuits, so that switching off of individual cable does not result in switching off the remaining ones.

All terminals shall be adequately selected to the applied cables.

All terminal strips, as well as all terminals shall be unequivocally labelled.

Connecting terminals shall be grouped in the following way:

- Separately for measuring transformers
- Separately for direct current DC
- Separately for control circuits.

Individual groups of terminals shall be separated one from another by means of insulating barriers (partitions).

Only one lead can be brought into single terminal. Interconnections shall be made by means of bridges.

Measuring terminals shall be foreseen for voltage and current transformers, together with adequate short-circuit protection.

For each terminal strip 10% of reserve (spare) terminals shall be provided.

All terminals and terminal strips shall be of the same type (the same manufacturer).

The terminal strip shall be made for all internal and external control, measuring, protections and supply circuits.

The terminal strips shall be arranged in cable compartment in a way that ensures adequate space, necessary for execution of connections, switching over of conductors and cables, and placing of tags.

5.3.3 Power supply

The power supply fed to UPS unit from outside, shall be realised with two supplying cables.

The UPS shall be furnished with two supply circuits:

- Main supply
- By-pass supply

5.3.4 The rectifier

Direct current part of the rectifier shall be equipped with:

- current intensity limiter, matched to battery pack characteristics,

- non-earthed output, protected against overloads.

Selection of the rectifier output parameters shall ensure:

- variable charging of the battery pack when the UPS is loaded in range from 0 up to full load, with power factor varying from 0.7 for inductive load, up to equal 1.0
- quick battery charging, from partial discharge state up to 96% of its rated capacity during 10 hours period, at full UPS load and with power factor varying from 0.7 for inductive load, up to equal 1.0

The rectifier shall feature gentle start-up characteristics curve, in order to avoid strong current surge.

The rectifier shall feature manual and automatic operating mode for increasing possibility of battery recharging. In case it is adjusted manually for battery recharging, and the rectifier output voltage is too high for the inverter, the rectifier shall switch over to conversion charging mode.

The rectifier shall feature regulation function and voltage fluctuation compensation on direct current side. Voltage fluctuations shall not exceed allowed range of ±1%.

5.3.5 Battery pack

Bi-sectional battery pack shall be provided for each UPS unit.

The battery shall be composed of serviceless cells.

The battery size shall be such selected, so as to UPS output parameters are reached at minimum temperature of +5°C.

Allowable number of full discharge cycles during its guaranteed life period, shall be equal to 250 minimum, 400 maximum.

The battery pack shall be automatically recharged during normal UPS load.

The battery pack shall be connected to bus-bar and designed for 60 min back-up operation time.

The batteries featuring 10-year life time shall be used.

5.3.6 The inverter

The inverter shall be suitable for operation in range of output parameters specified in project, both during continuous supply from the rectifier with battery connected, and during temporary supply from battery pack while rectifier failure.

The inverter shall be automatically disconnected from direct current supply at allowable minimum (and lower) voltage level on input, or when allowable tolerance ranges are exceeded both for voltage or for frequency on output. In such case UPS supply shall proceed through by-pass. Switching over of supply shall take place uninterruptedly.

The inverter shall enable UPS operation with disconnected battery pack.

When the main system is ready to operate, the inverter shall be synchronised to 1% limit in relation to mains frequency. If main system frequency exceeds allowable limits, the inverter shall select its own generated frequency.

Allowable frequency change shall be equal to 1Hz/s both for system synchronization, and when out of synchronization.

The inverter shall be adapted for the following overloads:

- 105% for continuous operation
- 125% for 10 mint
- 150% for 1min.

5.3.7 Intercircuit change-over switch (static switch)

Intercircuit change-over switch shall enable switching over of main UPS supply on direct supply from main alternate current supply network, and shall be composed of a contactor with change-over contacts and thyristors connected in parallel, ensuring uninterruptible switching-over.

In normal change-over switch position, UPS supply shall proceed through the inverter. In case of failure of supplying through the inverter, intercircuit change-over switch shall automatically switch over the supply on direct supplying from main alternate current supply network without supply interruption for receivers.

Interrupted change-over shall be allowed for non-synchronous switching over in case of the inverter failure. The interruption time shall not be longer than 20 ms.

5.3.8 Control panel

All the functions necessary for UPS control and monitoring shall be accomplished by means of control and monitoring panel. The panel shall be equipped with LCD display, LED lighting diodes, control pushbuttons and a keypad, enabling convenient interface between the UPS and its user.

Mode of operation, as well as basic UPS functions monitoring, shall be accomplished by means of LED indicators. For increased visibility and for easier UPS operation handling, the UPS shall be equipped with simplified synoptic (classic type), which indicates the positions of UPS breaker switches by means of LED indicators. The LCD display shall serve for handling of UPS operation, UPS power supply operation monitoring, as well as for displaying of alarm information.

5.3.9 Control, protecting and signalling equipment

Each UPS unit shall be equipped with control unit, performing functions listed in point 4.3.8.

5.3.9.1 Protection of outflows (outgoings)

All outflows shall be protected with double-pole over-current circuit breakers. Selected protections shall guarantee selectivity of overload and short-circuit protections' operation.

Over-current circuit breakers shall be manually switched on and off, as well as shall be equipped with auxiliary contacts enabling monitoring of these circuit breakers.

Control and signalling system shall be supplied with 230V AC, 50Hz voltage.

5.3.9.2 Auxiliary relays

The auxiliary relays shall be used in order to:

- auxiliary contacts multiplication
- obtain time delays in control
- voltage condition monitoring in control circuits.

5.3.9.3 Current transformers

When necessary, current transformers shall be used with 1A secondary current, at rated primary current.

Secondary windings shall be appropriately connected to terminal strip and unequivocally marked.

The current transformers shall be selected according to requirements of measuring instruments used.

Dynamic and thermal strength of current transformers shall correspond to short-circuit parameters of individual system elements.

The current transformers shall work uninterruptedly at load equal to 1.2 x rated current.

- Current transformers shall be of class 0.5 (for ammeters)
- Measuring current transformers shall be of class 1 (for measuring instruments excluding ammeters)
- Current transformers for protecting devices shall be of class 3.

5.3.9.4 Auxiliary – service equipment

Below listed equipment shall be installed in UPS unit as a minimum outfit:

- Charge mode selection switch for rectifier
- A device enabling rectifier current limit setting
- A device enabling inverter output voltage setting
- A device enabling inverter output frequency setting
- A device enabling inverter synchronisation range setting
- Selector switch for intercircuit change-over switch

Below listed auxiliary equipment shall be installed as the minimum outfit:

- Manual switches: rectifier on/off; battery on/off; main supply on intercircuit change-over switch on/off; service by-pass switch
- Measuring instruments: a device (module) for output current measurement, a device (module) for inverter output voltage measurement, a device (module) for inverter output frequency measurement
- Indicators / alarms: All alarms and control signals shall be multiplied through potential-free contacts for remote indication in DCS

5.3.9.5 Arrangement of circuits

Control, protection, monitoring and signalling circuits, present in switchgear, shall be executed according to closed circuit principle.

The above listed circuits shall be single-phase supplied.

All control circuits shall be controlled by voltage monitoring relays or by miniature circuit breakers, equipped with auxiliary contacts. Voltage absence shall be signalled by adequate pilot lamp.

Number of voltage monitoring relays, auxiliary contacts and pilot lamps shall correspond to needs and shall ensure proper monitoring of control circuits.

5.3.10 Connections to DCS

Connections to DCS system, for purposes of UPS operating state and its diagnostics visualisation, can be realized as hard-wired or communication link (Modbus RTU or Profibus DP).

The following diagnostic signals shall be sent from each UPS unit to DCS:

- Przejście na stan awaryjny (styk bezpotencjałowy)
- battery operation (styk bezpotencjałowy)
- supply through by-pass
- battery low voltage level
- failure of basic and reserve supply network
- output overload
- output failure
- battery voltage level

5.3.11 Marking

Marking of equipment shall meet requirements of GLSA 3030 specification, which has superior significance in this respect.

Main and auxiliary bus-bars must be marked.

Labelling tag plates shall be placed on housing front. If rear access to UPS unit is foreseen, then necessary labelling tag plates shall be placed on housing back as well.

All inscriptions shall be prepared in Polish language.

Each equipment shall be labelled with use of permanent labelling tag plates, according to control diagram and assembly diagram.

Colour scheme for indicating lamps and control pushbuttons shall comply with codes and standards' requirements.

All cables and leads shall be labelled according to assembly diagram.

The content of labels on tag plates shall be agreed with GLSA.

5.3.12 Painting

Factory painting standards, suitable for GLSA determined harsh environment conditions shall be employed.

Minimum thickness of paint layer shall be greater than 60 micrometers.

Final colour is to be RAL1015.

5.4 Power supply distribution

Below given requirements regarding supply distribution rules, shall equally refer to subsequent levels of its hierarchic structure. Basic distribution takes place in supply distribution cabinets (refer to Attachment N° 2). However on designing stage of outflows re-distribution on subsequent distribution levels (e.g. cabinets for DCS, PLC and others), all recommendations regarding principles of distribution, redundancy, protective measures selection, and others shall be fulfilled, adequately to specific level.

5.4.1 Power supply distribution cabinets – general requirements

General requirements for cabinet's design and it's equipment are detailed in GLSA 3640 specification.

Power supply distribution for 230V AC and 24V DC voltage levels shall be accomplished in separate cabinets.

The used 24V DC power supplies shall always employ secondary voltage stabilization and redundant configuration.

Each designed supply outflow (to individual receiver), regarding both 230V AC and 24V DC, shall be connected to separate group of terminals. Supply outflows shall be protected with separate, dedicated protecting devices, meeting adequate protection requirements in order to ensure safety (described below).

5.4.2 Power supply redundancy

For each element of control and monitoring system, redundant supply shall be provided. The following elements shall be included in this group:

- controller cabinets, Input/Output modules, multiplexers and communication links (all referred to: DCS, PLC, SIS-PLC, ESD-PLC, BMS, machinery monitoring system, rotational speed controllers for machines, gas detection systems, and others)
- servers, visualisation stations (operator stations), engineering stations.

It is required in such cases that specified receiver is equipped with two power supplies (irrespective of the fact, that those receivers are most frequently redundant devices!). If for any reasons this is impossible, then alternative solutions shall be sought that ensure redundancy on functionality level supported with power supply redundancy, e.g. by using of two operator stations for the same tasks, but supplied from independent UPS sources.

Wherever supply redundancy in relation to instrumentation (besides above mentioned elements) is technically practicable and justified, such possibility shall be utilized, or at least submitted to GLSA for opinion. Equipment with 230V AC non-redundant supply (e.g. mass flow-meters), shall be supplied with single line, from single source UPS. It shall be borne in mind then, that design of UPS1 and UPS2 distribution shall take into account power balance equilibrium for both sources (one shall strive for equal power load). In case of equipment supplied with 24V DC voltage, power balance of each UPS unit shall take into account all outflows being designed (because 24V DC power supplies are outputting on common distribution bus-bar).

5.4.3 230V AC and 24V DC voltage levels separation

While designing and manufacturing cabinets, where both 230V AC and 24V DC voltages exist (e.g. 24V DC voltage distribution cabinet, DCS cabinets with own power supplies), it shall be borne in mind that voltage levels separation is stringently required. Separate terminal strips, separate bars for protective devices assembling as well as separate wiring (and cable trays) shall be used for phase 230V AC and 24V DC voltages.

5.4.4 Protection for safety

In relation to protective measures for safety, requirements of suitable sheets of PN-EN 60364 part 4 standard apply, and in particular those related to electric shock protection and over-current protection.

In scope of electric shock protection for UPS supplied receivers, one shall take into account all requirements determined in this regard in GLSA 4600 specification, point 4.7.2. Considering fact, that TN system network is the electrical supply system valid for GLSA plants, quick automatic disconnection of the supply shall be compulsory used among protection measures against electric shock. In order to ensure quick disconnection effectiveness, all metallic parts (conducting ones) of specific equipment shall be connected with protective leads to grounded point of supply network. In case of failure (insulation breakdown on equipment), the fault current in effect of protection action shall automatically disconnect supply in specified time.

In scope of over-current protection, application of protective measures against over-currents and fault currents is binding.

Mutual co-ordination in scope of mentioned protection in course of protective devices choosing, is discussed in paragraph “Co-ordination of cables and protection devices selection”, whereas the issue of protections co-ordination for different levels of distribution network, is subject of paragraph “Selectivity of protections”.

5.4.4.1 Circuit breakers (MCBs)

In order to provide adequate electric shock protection, as well as over-current protection, double-pole over-current circuit breakers (MCBs) of B characteristics shall be employed as standard solution. In justified, documented cases, C or other characteristics MCBs are allowed (e.g. in case of particular recommendations of instruments or circuit breaker’s manufacturers).

5.4.4.2 Fused disconnectors (with fuse-link)

Fused disconnectors with fuse-links can be used alternatively to MCBs, particularly where this is required by protections’ selectivity criterion.

5.4.4.3 Selectivity of protections

Power supply system design shall be characterized of applied protections system selectivity, ensuring continuity of supply delivery to receiver’s totality. Though this task is difficult to accomplish, and sometimes requires multiple additional designing works, all efforts shall be made in order to fulfil its requirements to the best effect.

Selectivity of protections shall be understood as system capability to separate (disconnect) individual branches of supply, in the event of defect or disturbance occurrence, while this disconnection is accomplished by protection device located just upstream of defect occurrence. It is necessary to consider here gradation of protections (current selectivity), as well as time selectivity of protections (delayed protections) and co-ordination between them.

Current selectivity – essential in low overloads range. Current nominal value (set value) of the protection device for power supply feeding branch (closer to power source), shall be higher than protection set value for individual outgoing branches (closer to power receiver).

Time selectivity – essential for fault currents (in short circuits). Protection located closer to supply source shall act "slower" than protection located closer to receiver (the protection located further from supply source shall act as the first one).

Taking into account selectivity requirement and considering active limiting of UPS output current, it is necessary to observe principles and requirements quoted in point 4.7.2 of GLSA 4600 specification, in course of protections' selection for UPS supplied receivers.

A. General note

Selection of overload and short-circuit protections for distribution system supplied from UPS, shall be established on the basis of selectivity tables given by protection devices producer (this applies to both MCBs and fuse-links).

B. Guidelines for selection and installation location of overload and short-circuit protections

Schematic hierarchy of protection system is given in Attachment N° 3.

- In order to ensure short-circuit selectivity, number of protection's stages in supply line shall be minimised. For this purpose one shall strive for elimination of overload/short-circuit protection on feeding lines in redistribution substations (these protections are already installed in outflow panel/cabinet, located upstream), but use only disconnectors (the protection installed on upstream substation outflow will take over protecting function in this arrangement).
- In exceptional cases, equally the same protection on outflow side (upstream) and receiving cabinet (downstream) can be used – this may be forced by project organization, in situation where vendor of receiving cabinet (e.g. package PLC) forces the use of protection device on own cabinet input, in order to protect it.
- While selecting protection of outflows for receiver's of large starting currents (e.g. pulse power supply), one shall follow recommendations from these receiver's manufacturers, and in case of necessity, recommendations from protecting devices manufacturer (e.g. specific characteristics of protecting devices).
- Overload / short-circuit protections installed in UPS on secondary side, shall enable settings that ensure selectivity in relation to protections of system being supplied.
- Protections employed by electric branch on UPS feeding outflows (use of fuses is suggested) must be co-ordinated in scope of selectivity with settings of protections on primary UPS side.

5.4.4.4 Overvoltage protection

Electric branch shall provide overvoltage limiters in low voltage switchgear, accordingly to surge strength category of instrument related equipment (overvoltage category). Surge voltage required shall be determined by instrument discipline, on the grounds of information regarding used instrumentation.

Additionally, for field supply distributing cables (outside the building), it is necessary to consider, in co-ordination with electric discipline, use of protective measures against atmospheric overvoltage in power supply distribution cabinet.

5.5 Diagnostics of supply network

In order to facilitate location of defects/failures, power supply distribution network shall be furnished with diagnostics system. Besides of requirements valid for UPS in this regard, below given list is obligatory as minimum requirements for signalling purposes:

- presence of both feeds from UPS units in 230V AC voltage distribution cabinet (individually, for each phase)
- presence of both 230V AC feeds in each receiving cabinets (after distribution). This applies to all "complex" receivers (e.g. DCS, PLC, SIS-PLC, ESD-PLC, gas detection system cabinets, etc.)
- presence of 24V DC voltage on output of each power supply unit (this applies to power supplies that power supply cabinets are equipped with, and to those in individual receiving cabinets – e.g. DCS, PLC cabinets).
- presence of 24V DC voltage after distribution in power supply cabinet – reasonably justified diagnostic system is to be proposed (e.g. diagnostics for distribution groups)
- presence of 24V DC voltage after distribution in individual system cabinets (e.g. DCS, PLC) – this applies to feeds being distributed to individual modules. If any system (e.g. DCS, PLC) enables internal diagnostics of voltages (from the system), then it shall be employed.
- exceeding of allowable temperature inside the power supply cabinet, in situation where such event is actually possible.

It is necessary to foresee dedicated synoptic page in control and monitoring system (e.g. DCS) for diagnostic purposes, which deals with supply system diagnostics in complete manner.

5.6 Cabling system

5.6.1 Cable types

For purposes of supply distribution, one shall use the following cables depending on requirements of receivers:

- three-core (L, N, PE), for 230V AC supply,
- five-core (L1, L2, L3, N, PE), for 3x400V AC supply
- two-core (+, –), for 24V DC supply.

Requirements for cables are given in GLSA 3120 specification.

5.6.2 Redundant cables

As a result of solutions adopted in scope of supply redundancy, it is necessary to use redundant cables according to requirements of supply distribution design in this regard.

For field routed redundant cables, separate cable routes shall stringently be kept. Separateness of cable routes shall also be kept for redundant cables distributed in TIR and CR, if possible.

5.7 Co-ordination of cables and protection devices selection

On selection of protecting device (current rated value, characteristics), as well as corresponding to it supply cable (cross-section area, at specified length), it is each time necessary to ensure co-ordination of the following requirements / criteria:

A. cable protections against overload and short-circuit current
It is necessary to additionally consider starting current of equipment being supplied (e.g. particularly important in case of pulse power supplies).

B. electric shock protection
It is strictly required to check effectiveness of automatic power supply disconnection in specified time.

C. allowable voltage drop on cable, ensuring proper operation of specified receiver, but in case of 230V AC supply not greater than 4% on the route from UPS unit to the receiver.

Final selection of protections and supply leads shall be documented with adequate analysis.

6 Relevant documents

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

7 Standards and regulations

Designing, execution and assembly shall comply with the latest editions of below listed standards and regulations.

The standards that specifically relate to electric systems are mainly listed here. The remaining standards regarding control and automatics are listed in GLSA 3010 specification – General requirements.

7.1 European Union Directives

2006/95/EC	Low voltage electric equipment
2004/108/EC	Electromagnetic compatibility
2008/768/CE	Decision No 768/2008/EC of the European Parliament and of the Council of 9 July 2008 on a common framework for the marketing of products, and repealing Council Decision 93/465/EEC

7.2 PN-IEC

PN-IEC 60364-3	Instalacje elektryczne w obiektach budowlanych. Ustalanie ogólnych charakterystyk
PN-IEC 60364-4-45	Instalacje elektryczne w obiektach budowlanych. Ochrona dla zapewnienia bezpieczeństwa. Ochrona przed obniżeniem napięcia
PN-IEC 60364-4-473	Instalacje elektryczne w obiektach budowlanych. Ochrona dla zapewnienia bezpieczeństwa. Stosowanie środków ochrony zapewniających bezpieczeństwo. Środki ochrony przed prądem przetężeniowym

PN-IEC 60364-4-482 Instalacje elektryczne w obiektach budowlanych. Ochrona dla zapewnienia bezpieczeństwa. Dobór środków ochrony w zależności od wpływów zewnętrznych. Ochrona przeciwpożarowa

PN-IEC 60364-5-52 Instalacje elektryczne w obiektach budowlanych. Dobór i montaż wyposażenia elektrycznego. Oprzewodowanie

PN-IEC 60364-5-53 Instalacje elektryczne w obiektach budowlanych. Dobór i montaż wyposażenia elektrycznego. Aparatura rozdzielcza i sterownicza

PN-IEC 60364-5-523 Instalacje elektryczne w obiektach budowlanych. Dobór i montaż wyposażenia elektrycznego Obciążalność prądowa długotrwała przewodów

PN-IEC 60364-5-537 Instalacje elektryczne w obiektach budowlanych. Dobór i montaż wyposażenia elektrycznego. Aparatura rozdzielcza i sterownicza. Urządzenia do odłączania izolacyjnego i łączenia

PN-IEC 60364-7-707 `Instalacje elektryczne w obiektach budowlanych. Wymagania dotyczące specjalnych instalacji lub lokalizacji. Wymagania dotyczące uziemień instalacji urządzeń przetwarzania danych

7.3 PN-EN

PN-EN 60146-1-1 Przekształtniki półprzewodnikowe. Wymagania ogólne i przekształtniki o komutacji sieciowej. Część 1-1: Wymagania podstawowe (oryg.).

PN-EN 60146-2 Przekształtniki półprzewodnikowe. Część 2: Przekształtniki półprzewodnikowe o komutacji wewnętrznej z uwzględnieniem bezpośrednich przekształtników prądu stałego.

PN-EN 60073 Zasady podstawowe i bezpieczeństwa przy współdziałaniu człowieka z maszyną, oznaczanie i identyfikacja. Zasady kodowania wskaźników i elementów manipulacyjnych (oryg.).

PN-EN 60896-11 Baterie ołowiowe stacjonarne – Część 11: Typy otwarte – Ogólne wymagania i metody badań..

PN-EN 60896-21 Baterie ołowiowe stacjonarne – Część 21: Typy wyposażone w zawory – Metody badań.

PN-EN 60896-22 Baterie ołowiowe stacjonarne – Część 22: Typy wyposażone w zawory – Wymagania.

PN-EN 61439-1 Rozdzielnice i sterownice niskonapięciowe. Część 1: Postanowienia ogólne (oryg.)

PN-EN 61439-2 Rozdzielnice i sterownice niskonapięciowe. Część 2: Rozdzielnice i sterownice do rozdziału energii elektrycznej (oryg.)

PN-EN 61439-3 Rozdzielnice i sterownice niskonapięciowe. Część 3: Rozdzielnice tablicowe przeznaczone do obsługiwania przez osoby postronne (DBO) (oryg.)

PN-EN 61439-5 Rozdzielnice i sterownice niskonapięciowe. Część 5: Zestawy do dystrybucji mocy w sieciach publicznych (oryg.)

PN-EN 61439-6 Rozdzielnice i sterownice niskonapięciowe. Część 6: Systemy przewodów szynowych (oryg.)

PN-EN 60445	Zasady podstawowe i bezpieczeństwa przy współdziałaniu człowieka z maszyną, oznaczanie i identyfikacja. Identyfikacja zacisków urządzeń i zakończeń przewodów (oryg.).
PN-EN 60947	Aparatura rozdzielcza i sterownicza niskonapięciowa.
PN-EN 60529	Stopnie ochrony zapewnianej przez obudowy (Kod IP)
PN-EN 50091-1-1	Bezprzerwowe systemy zasilania (UPS). Wymagania ogólne i wymagania dotyczące bezpieczeństwa UPS stosowanych w miejscach dostępnych dla operatorów.
PN-EN 62040-2	Systemy bezprzerwowego zasilania (UPS). Część 2: Wymagania dotyczące kompatybilności elektromagnetycznej (EMC).

8 Attachments

Attachment N° 1, Power feed to distribution cabinets

Attachment N° 2, Power distribution diagram

Attachment N° 3, Hierarchy of the protection devices in UPS distribution network

9 Record of changes

No.	Date	Description	Introduced by
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