



NET4GAS, s.r.o

COMPRESSOR STATION JIRKOV 73 BAR

Earthing and Lightning Protection - Specification

26.06.2017

ILF CONSULTING ENGINEERS

Werner-Eckert-Strasse 7, 81829 München, DE
Jirsíkova 5, 186 00 Praha 8, CZ

Phone: +49 89 25 55 94-0

+420 255 091 420

E-mail: info.muc@ilf.com

info.prg@ilf.com

Website: www.ilf.com



REVISION HISTORY

Rev.	Date	Issue, Purpose	Prepared	Checked	Approved
B01	26.06.17	Issue for Review	LodT	HeiW	SchY
A01	31.05.17	Issue for IDC	LodT	HeiW	SchY

TABLE OF CONTENTS

1	GENERAL	5
1.1	Scope of the Document	5
1.1.1	In Contractor's scope	5
1.1.2	Not in Contractor's scope	5
1.2	Definitions	6
1.3	Abbreviations	6
1.4	References	6
1.5	Codes and Standards	8
1.6	Environmental Conditions	8
1.7	Tagging	9
1.8	Units and Scales	9
1.9	Earthing and Lightning Protection Concept	9
2	EARTHING SYSTEM	10
2.1	General	10
2.2	Soil Conditions	11
2.3	Design Requirements	11
2.4	Earthing Material	11
2.5	Installation of Earthing System	13
2.5.1	Main Earthing Grid	13
2.5.2	Foundation Earthing	14
2.5.3	Outdoor Connecting Terminals	14
2.5.4	Indoor Connecting Terminals	14
2.5.5	Buildings and Supports, Steel Structures	15
2.5.6	Transformers	15
2.5.7	Switchgears, Sub-Distribution Boards	16
2.5.8	Power Consumers	16
2.5.9	Cables and Cable Jointing Boxes	16
2.5.10	Instrumentation Earthing System	16
2.5.11	Vent	17

Compressor Station Jirkov 73 bar	C4G-JI73-ILF-GENER-ELE-SPC-807-B01
Earthing and Lightning Protection - Specification	26.06.2017
2.5.12 Pipes	17
2.5.13 Fence, Lighting Poles	17
2.5.14 Risers	17
2.5.15 Surge Arrestors	17
2.5.16 Local Cathodic Protection	17
3 EXTERNAL LIGHTNING PROTECTION	18
3.1 General	18
3.2 Air Termination Network	18
3.3 Natural Lightning Conductors	19
3.4 Mesh-Type Termination Network	19
3.5 Lightning Rods	19
3.6 Down Conductors	20
4 INTERNAL LIGHTNING PROTECTION SYSTEM	21
4.1 Separation Distance	21
4.2 Lightning Equipotential Bonding	21
4.3 Lightning Protection Zone Concept / EMC	22
5 MARKING AND LABELLING	22
6 TESTS	23
7 DOCUMENTATION	24
8 SHIPPING	25
9 SPARE PARTS AND SPECIAL TOOLS	25

1 GENERAL

1.1 Scope of the Document

This specification covers the technical requirements for design, construction, installation and test of the earthing and lightning protection systems for the compressor station Jirkov.

1.1.1 In Contractor's scope

The scope of delivery for the "Earthing and Lightning Protection" package is defined as follows:

- Planning, design, supply, installation, connection and testing of all required components for the lightning protection system
- Planning, design, supply, assembly, connection and testing of all necessary components for the grounding system
- Design, supply, assembly, connection and testing of lightning protection measures for masts and steel structures
- Scheduling / coordination of on-site assembly work with employer / third parties
- Final inspection on site and commissioning
- Technical Inspection Czech Republic incl. all necessary documents in Czech language
- Acceptance by an independent expert
- Optional personnel training (one-day) including all documents for employers operating personnel
- Documentation according to chapter 7 of this specification
- Supply of spare parts for commissioning
- Supply of spare parts for "2 years operation"

Points which are not clearly defined in the documents and the tender documentation are to be indicated in the offer. Unless stated in the documentation, the details, such as the exact location of individual installations, must be defined with the site management before commencing work.

1.1.2 Not in Contractor's scope

- Necessary excavation works

- Foundations as required

1.2 Definitions

Term	Explanation
Project	Compressor Station Jirkov 73 bar
Employer	NET4GAS
Consultant	ILF Consulting Engineers
Contractor	Company supplying the herein described scope of work

1.3 Abbreviations

Term	Explanation
ATEX	Potentially Explosive Atmospheres Directive
CS	Compressor Station
EMC	Electromagnetic compatibility
HVAC	Heating, Ventilation, Air-Conditioning
LEMP	Lightning Electro-Magnetic Pulse
LPS	Lightning Protection System
LPZ	Lightning Protection Zone
PVC	Polyvinyl Chloride
TIČR	Technical Inspection of Czech Republic
VSD	Variable Speed Drive

1.4 References

No.	Number	Title
1	C4G-JI73-ILF-GENER-ELE-SPC-800	Design and Construction of Power Supply Systems - Specification

2	C4G-JI73-ILF-GENER-ELE-SPC-806	Cables and Cable Laying - Specification
3	C4G-JI73-ILF-GENER-ELE-VYK-002	Typical Earthing, Lightning Protection and Electrical Installation
4	C4G-JI73-ILF-GENER-PMA-MAN-902	Tagging and Numbering Philosophy
5	C4G-JI73-ILF-KS007-BOZ-TZP-903	Hazardous Area Classification Plan
6	C4G-JI73-ILF-KS007-ELE-SIT-305	Outdoor Cable Route Drawing
7	C4G-JI73-ILF-KS007-ELE-SIT-310	Station - Earthing Layout
8	C4G-JI73-ILF-KS007-ELE-SPC-801	Station Cathodic Corrosion Protection - Specification
10	C4G-JI73-ILF-KS007-ELE-VYK-430	Transformer Building - Earthing and Lightning Protection Drawing
11	C4G-JI73-ILF-KS007-ELE-VYK-450	Administration and Control Building - Earthing and Lightning Protection Drawing
12	C4G-JI73-ILF-KS007-ELE-VYK-460	Electrical Building - Earthing and Lightning Protection Drawing
13	C4G-JI73-ILF-KS007-ELE-VYK-470	Compressor Building - Earthing and Lightning Protection Drawing
14	C4G-JI73-ILF-KS007-GEN-MAN-901	Geographical Climatic and Environmental Conditions
15	C4G-JI73-ILF-KS007-GEN-SEZ-840	List of Relevant Regulations, Standards and Specifications
16	C4G-JI73-ILF-KS007-GEN-TZP-010	Description of Technical interfaces for Contractor
17	C4G-JI73-ILF-KS007-GEN-TZP-016	Soil Resistivity Survey - Report
18	C4G-JI73-ILF-KS007-	List of Relevant Regulations, Standards and Speci-

	GEN-SEZ-840	fications
19	C4G-JI73-ILF-KS007-ELE-VYK-501	Cathodic Protection – Drawing

1.5 Codes and Standards

The designs, construction, installation, test and commissioning of earthing and lightning protection systems shall be in accordance with the following codes and standards, at least. The latest revision of the publication referred to shall apply.

No.	Number	Title
1	EN 60079	Explosive atmospheres
2	EN 61000	Electromagnetic compatibility (EMC)
3	EN 62305	Protection against lightning
4	EN 62561	Lightning Protection System Components
5	IEC 60364	Low-voltage electrical installations

Reference is also made to the standards as mentioned in the “List of Relevant Regulations, Standards and Specifications”, Doc. No. C4G-JI73-ILF-KS007-GEN-SEZ-840.

As far as the power supply authority or permits of other authorities require additional codes and standards, respectively impose additional requirements, these are also part of the contract.

1.6 Environmental Conditions

The lightning protection system with all auxiliary equipment shall be designed and constructed under the climatic and environmental conditions as described in the Specification for “Design and Construction of Power Supply Systems”, Doc. No. JI73-ILF-GENER-ELE-SPC-800. To avoid conflicts and/or corrosion of buried parts of the earthing system, the requirements described within the Specification for “Station Cathodic Corrosion Protection”, Doc. No. C4G-JI73-ILF-KS007-ELE-SPC-801 shall be considered.

1.7 Tagging

All components, equipment and installations shall receive the respective tagging plates, labels, etc., which have to be of extremely durable material resistant against the environmental conditions.

For further requirements, reference is made to the specification "Design and Construction of Power Supply Systems", Doc. No. JI73-ILF-GENER-ELE-SPC-800.

1.8 Units and Scales

The metric system on basis of SI-units shall be used for all scales and indications.

1.9 Earthing and Lightning Protection Concept

In the construction of the compressor station Jirkov the earthing and lightning protection concept described in this document shall be applied.

The earthing and lightning protection system shall be in accordance with EN 62305.

The lightning protection concept is divided into the external lightning protection and the internal lightning protection. Additionally for the protection of electronic system a lightning protection zone concept shall be applied.

The earthing and lightning protection system for all buildings and structures within the CS Jirkov shall fulfil the requirements of lightning protection system class II (LPS II) as described in EN 62305. For buildings with control equipment the requirements of LPS I shall be fulfilled.

External Lightning Protection

The external lightning protection consists of the air termination system, down conductor system and earth termination system.

The air termination system shall be arranged to the most practicable method on the buildings, installations and open spaces. The down conductors shall be arranged in a way that, that the length of the current paths are as short as possible and that there are several parallel current paths between the point of strike and earth. The earth termination shall consist of via earthing bars connected, intermeshed ring earth electrodes for each building, base plate or pan which is protected against lightning.

Inner Lightning Protection

For the inner lightning protection standard-compliant electrical insulation from the external lightning protection system and lightning protection potential compensation measures shall be taken. For potential control a meshed equipotential bonding must be provided.

Lightning Protection Zone Concept

The lightning protection zone concept serves the special protection of electrical and electronic systems in buildings. For this purpose, the outside area and all interior areas are to be assigned to specific lightning protection zones.

Corresponding to the necessary protection for the respective zones, measures such as the installation of overvoltage protection devices, close mesh screen shields, shielding of cables, ring potential equalizing rails etc. are necessary.

2 EARTHING SYSTEM

The compressor station in Jirkov shall be equipped with an earthing system for the protection and operation of the electrical systems. Since the earthing system is integrated in the external lightning protection, a corresponding standard-conform design according to EN 62305 or equivalent must be ensured. For buildings with hazardous areas the requirements in EN 62305-3 Appendix D must be met.

2.1 General

To achieve equipotential bonding, stations shall be equipped with an intermeshed earthing network. All exposed conductive parts or elements of the station systems will be connected to this network, in detail:

- electrical equipment
- electric motors, pumps, compressors and other machinery
- metallic frame works, structures, walkways, etc.
- filters and all kinds of metallic containers
- metallic framework of buildings and houses
- metallic reinforcement of concrete foundations

The earthing systems of the various stations are part of the protection systems for electrical power supply, instrumentation, control and supervisory system.

The earthing system consists of the main earthing grid, earthing bars, the ring earth electrodes, the earthing rods where necessary, the building foundation earthing and the equipment earthing.

All buried gas piping structures within the station limits are protected by a cathodic corrosion protection system. The Contractor shall consider the protection area of the cathodic corrosion protection system in the implementation planning of the earthing system and

coordinate with the contractor of the cathodic corrosion protection system, so that the protection criteria for the protected property are met.

2.2 Soil Conditions

For the design of the earthing systems, the soil resistances shall be considered. These are provided within the report "Soil Resistivity Survey", Doc. No. C4G-JI73-ILF-KS007-GEN-TZP-016.

However, before the installation of the earthing network, the Contractor shall verify and protocol the actual soil conditions within the station area if they have changed relatively to the above mentioned report for soil resistivity.

2.3 Design Requirements

The earth resistance of the overall interconnected station earthing network shall not exceed 1 Ω .

The required conductor spacing, the total length of the earthing grid and the required earthing material cross-section shall be calculated under consideration of the maximum earth fault current, to maintain touch and step voltages within reasonable limits. The impedance of the fault current path and protective devices shall be chosen in a way that the faulted circuit will be disconnected from the supply within the required time. A respective earthing calculation with report shall be performed and is to be submitted to the employer for approval.

Multiple connections of earthing conductors shall only be carried out above ground. For these connections the respective earthing bars are to be installed. Extensions of single earthing conductors can be permitted below ground using compression connectors or welding connections, with repair painting and coating of the connection point.

All connections of conductors on equipment shall be performed with pressure type lugs or connectors and threaded bolts, screws, spring-washers and washers. Special care shall be taken to avoid galvanic corrosion of dissimilar metals.

Connections between bare copper and iron parts must be protected in a special manner, e.g. bimetal clamps, and shall only be executed on above-ground connection points (earthing bars) or inside pits.

2.4 Earthing Material

The material and minimum dimension shall be selected in conformity with the relevant standards. The earthing network shall consist of buried flat steel, stainless steel V4A,

earthing and potential equalisation bars, earthing rods, copper cable and fastening / connection parts.

For the different application the following materials with the minimum measures shall be provided:

Application	Material
Main earthing grid, directly buried	Stainless steel strip V4A, 30 x 3.5 mm
Earthing rods	Stainless steel V4A, Ø 20 mm, minimum length 3 m
Earthing bars	Stainless steel V2A, 40 x 6 mm, minimum length 300 mm, when required with mounting insulators
Potential equalisation bars, within buildings	Copper, 40 x 5 mm, minimum length 200 mm, with cover
Foundation earthing	Hot dip galvanised strip steel, St/tZn 30 x 3.5 mm
Earthing ring within buildings, on the wall, in tubes	earthing / potential equalisation bars connected with PVC insulated copper cables with minimum cross section of 50 mm ² , both ends coated with shrinking tubes green/yellow
Connection between inner and outer earthing ring of buildings	Waterproof wall bushings, V2A, connected with PVC insulated copper cables with minimum cross section of 50 mm ² both ends coated with shrinking tubes green/yellow, or Stainless steel strip V4A, 30 x 3.5 mm. For high current rooms or applications products with high current rating shall be used
Earthing terminals for connections to concrete foundation earthing	Fixed earthing terminals V2A, connected with PVC insulated copper cables with minimum cross section of 50 mm ² , both ends coated with shrinking tubes green/yellow, or Stainless steel strip V4A, 30 x 3.5 mm. For high current rooms or applications products with high current rating shall be used
Equipment connections	Insulated copper cable NYY-J (NYY-O for outside areas), cross section of 120, 50, 35, 16 or 6 mm ² , depending on equipment, both ends coated with shrinking tubes green/yellow

Earthing ring within buildings in all rooms with false floor, installation in the false floor	In LV-rooms: Stainless steel V2A, 40 x 6 mm In MV-rooms: Copper strip, 40 x 5 mm
---	---

2.5 Installation of Earthing System

2.5.1 Main Earthing Grid

The main earthing grid of a mashed earthing network consists of earthing conductors (stainless steel V4A) for earthing loops, earthing rods and the connections between each earthing system. The resulting mesh shall not exceed a size of 20 x 20 m. If no building or other object is within proximity of 30 m the mesh size can be increased to 40 x 40 m

The connection of three or more earthing conductors is generally to be carried out above ground using earthing bars. To reduce the risk of an accident, these are preferably installed on foundations, building facades, or the like. For installation in exposed areas, a protective guard rail with black-yellow colouring must be installed to avoid the risk of tripping, see C4G-JI73-ILF-GENER-ELE-VYK-002" Typical Earthing, Lightning Protection and Electrical Installation "

The conductors for the main earthing grid shall be laid at least 0.5 m below final grade in natural soil with at a distance of at least 1 m from buildings and equipment. The combined laying of earthing conductors and other cables in the same trench is acceptable.

Above the main cable routes earthing conductors shall be installed, the conductors need to be laid at least 0.5 m below final grade and 0.5 m above the cables. The earthing conductors shall be surrounded at least 10 cm with compacted material prior to sand bedding. In cable trenches above 80 cm width, two parallel earthing conductors shall be installed. These earthing conductors are to be interconnected according to the mesh size of the main earthing grid, in this case underground connections are acceptable.

For each building, base plate or pan which is protected against lightning a surrounding earthing loop must be provided. The ring earthing electrodes shall be laid at a distance of 1 m from buildings and equipment, and at a depth of at least 0.5 m. According to the mesh size for the lightning protection system the ring earthing electrodes and a potentially foundation earthing shall be interconnected via earthing bars.

Earthing rods shall be installed in sufficient number to reduce the effective earth resistance if necessary. The earthing rods shall be driven into the ground and sheltered by a suitable precast pit. The connection to the main earthing grid shall be performed inside the pit by compression connectors or screwed connection terminals. Additionally, separate earthing rods can be provided for the down conductors of lightning protection system, if necessary.

In the case of connections between earthing system and constructions, earthing bars, etc., the connections must be designed removable and easy accessible for measuring purposes.

In the case of expansion joints or movable elements, ensure that authorized, clean and elastic connections are used.

2.5.2 Foundation Earthing

For foundation earthing a closed loop of steel strip shall be laid into the concrete foundations of outer building walls. Larger buildings (e.g. compressor building, electrical building, etc.) are to be equipped with additional cross-connection to achieve a meshed network (maximum mesh size 10 x 10 m).

The reinforcement shall be connected at suitable points by suitable measures and is to be connected at least every 2 m to the foundation earthing loop or cross-connections respectively.

For connection to inside and outside of the buildings fixed earthing terminals shall be installed.

Smaller equipment foundations, with a concrete volume of less than 1 m³, such as for outdoor lighting etc. do not require foundation earthing.

2.5.3 Outdoor Connecting Terminals

The outdoor connecting terminals of the foundation earthing are intended for connections to the main earthing grid and the conductor of the lightning protection system.

The connecting terminals shall be fixed earthing terminals and preferably located above ground. The terminals shall be placed according to the mesh size of the foundation earthing and connected to earthing bars by means of copper cables.

In any case, for buildings and shafts a minimum of two connection terminals shall be provided. Buildings with hazardous areas shall be equipped with 4 fixed earthing terminals, at least.

2.5.4 Indoor Connecting Terminals

The indoor foundation earthing terminals are provided for equipotential bonding of equipment and conductive installations.

All buildings and rooms containing power supply/distribution facilities and control systems, or process installations shall be provided with indoor earthing terminals. The quantity of earthing terminals depends on size of structure and the equipment placed in the respective building or room. In energy rooms one earthing terminal shall be in the area of the infeed.

In the case of multiple connections in the vicinity of a single earthing terminal, additional equipotential earthing bars shall be provided. Earthing bars must be installed such that easy access for inspection and maintenance is possible. For rooms with false floor, the indoor earthing terminals shall be connected to the wall mounted earthing ring surrounding the whole room 0.3 m above the base floor.

2.5.5 Buildings and Supports, Steel Structures

All foundations and shafts shall be equipped with foundation earthing. Small foundations with a concrete volume of less than 1 m³ (e.g.: for lighting poles, earthing bars, electrical equipment and small concrete supports) do not need foundation earthing.

According to section 2.5.1 each building, base foundation etc which is protected against lightning or is provided with an equipotential bonding system shall be provided with a earthing loop, surrounding the structure at a distance of 1 m and a depth of at least 0.5 m. Earthing bars shall be used for the connection between loops and foundation earthing of buildings, steel structures and shafts.

Earthing bars shall be installed every 10 m respectively at the outlet-points of foundation earthing terminals in a height of min. 0.35 m above ground level. Internal loops or internal equipotential bus bars shall be connected to the outside earthing bars at suitable points via separate wall bushings.

Steel structures have to be welded or screwed together in a manner such that a good conductivity of these connections is ensured. Each steel supporting pillar or stack is to be connected to the earthing system.

For earthing connection of equipment inside of buildings PVC insulated copper conductors shall be laid into cable ducts or conduits, on cable trays, or direct wall mounted with clamps depending on equipment type and location.

2.5.6 Transformers

Transformers have to be connected with their steel structures, transport rails and foundation steel structures individually to the earthing network.

The connection of the neutral or star-point of the transformers to the earthing network depends on the general system earthing of the various voltage levels. The neutral/star-point connection for each transformer must be placed at an individually identified and easy accessible terminal. An additional earthing connection of the star-point e.g. in the transformer housing is not allowed.

2.5.7 Switchgears, Sub-Distribution Boards

All switchgear protective earthing bus bars must be connected twice to the building earthing or equipotential bonding system. For distribution boards a single connection is sufficient.

Furthermore, each cabinet, cubical, enclosure or frames of a switchgear, distribution board, or control unit shall be connected to the earthing system. If a system consists of more than one cabinet, and if all neighbouring cabinets are conductively linked to each other, than earthing of the outer units on both ends is sufficient.

2.5.8 Power Consumers

All motors, generators, valve actuators, ventilators and other power consumers shall be connected to the earthing network with the earthing conductor of their feeding power cable. In addition, the power consumer casings and/or their steel base frames shall be connected to the earthing network by separate copper cable.

If the ATEX certificates of transmitters, transducers, etc. require a potential equalization of the housings, these devices must be connected to the common earthing system.

2.5.9 Cables and Cable Jointing Boxes

In each cable jointing box the earthing conductor of the two cables has to be joined. When using metal sleeves, the earthing conductor shall be connected to the sleeve casing, too.

Medium voltage cables have to be connected with their screens or shields to the earthing terminal in the equipment terminal box and in the switchgear.

The metal screens or shields of the power and control cables have to be connected with the earthing conductor on both sides. Inside of junction boxes the screens and shields are to be interconnected and connected with the earthing system. For the screens of instrument cables the requirements for the instrumentation earthing system as described in 2.5.10 apply.

Reserve cables have to be connected to the earthing conductor on both sides.

2.5.10 Instrumentation Earthing System

The instrumentation earthing must be insulated from panel steel or any other earth system. The instrument earth shall be left floating at the field end and be electrically continuous connected via the overall instrument screen to the centralized instrument earth bar in the marshalling cabinets or control panel.

The individual instrumentation earthing systems shall be connected to the station earthing system at only one connection point.

2.5.11 Vent

The steel structures of the Vent have to be welded or screwed together in a manner such that conductivity of these connections is ensured. The Vent must be connected at two points to the station earthing network.

2.5.12 Pipes

Above ground pipes outside of buildings do not call for separate earthing systems but shall have adequate conductive joints to pipe support structures.

At entries into buildings or shafts each metallic pipe shall be connected with the earthing system.

2.5.13 Fence, Lighting Poles

Each lighting pole and mast shall be connected to the station earthing system. For termination with the buried part of earthing grid a multiple underground connection is allowed, which has to be provided following the procedure for earthing conductor extensions.

Stations fences are generally only to be connected to the earthing system at points where electric or metallic installations can be touched at the same time as the fence or electrical equipment is located in the directly adjacent fence post. Gate posts must be connected to the grounding system.

2.5.14 Risers

Conductors rising from below ground shall be protected with rigid non metallic, heavy duty conduits for approx. 0.5 m below and 0.3 above ground surface. The conduits have to be sealed with durable sealing compound and must be fixed on foundations, structures, etc. Rising earthing steel strips do not require conduits. Nevertheless, steel strips shall be isolated 0.3 m below above grade using heat shrink tubing or equivalent isolation material (green/yellow).

2.5.15 Surge Arrestors

For all equipment, which might be affected by lightning shocks, the necessary protection measures shall be provided. Surge arrestors shall be provided in order to protect the sensitive equipment and instruments (this applies in particular to electrical equipment, field instrument circuits, station and unit control system and telecommunication system and radio equipment).

2.5.16 Local Cathodic Protection

All underground gas pipes are in the protection area of the cathodic corrosion protection system. The Contractor shall consider the protection area of the cathodic corrosion pro-

tection system (see C4G-JI73-ILF-KS007-ELE-VYK-501, "Cathodic Protection – Drawing") in the implementation planning, so that the protection criteria for the protected property are met. Eventual adaptations to the earthing system shall be coordinated in time with the Employer and with the contractor of the cathodic corrosion protection system.

At intersections between earthing steel strips and the protection area of the cathodic protection system, the strip iron should be partially electrically insulated (for example by shrink tubing).

3 EXTERNAL LIGHTNING PROTECTION

3.1 General

All buildings, towers and conductive structures as well as all process field equipment of the new compressor station shall be protected against direct lightning strikes and electrostatic discharges by means of an external lightning protection system.

The lightning protection for buildings with control equipment shall fulfil requirements for Lightning protection system class I (LPS I). Buildings with hazardous areas or process equipment shall have at least a lightning protection system of class II (LPS II). Other structures will receive at least a LPS II too

The lightning protection system consists of lightning poles, collector rods (air terminals), collector lines, down conductors and the necessary fixing, connection and termination elements.

The down conductors of the buildings and structures are to be connected with the earthing system via the earthing bars of these buildings or structures.

Shafts shall not be equipped with separate lightning protection. All outer metallic parts will be connected either with the internal potential equalization bars or the earthing bars at outside.

All connections between the different parts of lightning protection systems and the connections to the earthing system must be performed in a manner such that the arising galvanic corrosion of dissimilar metals will be avoided.

3.2 Air Termination Network

The air termination network shall be determined in accordance with the in EN 62305-3 defined protection angle method and rolling sphere method.

The air termination network may comprise a combination of the following main components:

- collector lines
- air termination rods or masts
- Lighting poles, high metal structures as well as other natural metal components

3.3 Natural Lightning Conductors

Metal cladding, metal roof structures, metal components of roof structures, gutters and railings may be considered as natural components of lightning conductors.

The requirements regarding EN62305-3, such as the following, have to be considered:

- Permanent conductive bonding of all parts
- Minimum thickness of the metal involved
- Cross-sections of the parts.

Installations with metal casings meeting above-mentioned minimum requirements do not require the installation of additional lightning conductor.

Protective coatings or insulation between metal parts shall be electrically bridged.

3.4 Mesh-Type Termination Network

Buildings shall be provided with a combination of a mesh-type termination network and lightning rods. For mesh-type termination networks, no part of the roof shall have a greater distance to the next air termination conductor as standardized for the respective lightning protection level.

The maximum permitted mesh size is as follows:

- | | |
|--|-----------|
| • Buildings containing control systems (LPS I) | 5 x 5 m |
| • Buildings within hazardous areas (LPS II) | 10 x 10 m |
| • Other buildings (LPS II) | 10 x 10 m |

Protruding roof superstructures, such as ladders, chimney stacks pipes, antenna mounting brackets, etc. and other metallic parts of buildings which are located near the roof (e.g. louvers of ventilation openings) must be protected using lightning rods.

3.5 Lightning Rods

Lightning rods shall be used for all roof superstructures, such as ventilators and non-conductive parts projecting from the mesh plane by 0.3 m. The angle of protection and the minimum distance have to be observed.

Outdoor electrical facilities not located in the protected area of earthed structures, installations or buildings, including exposed electrical equipment shall be protected by lightning rods. Separation distances must be verified by calculation.

For buildings with sheet metal roofs, the lightning conductor termination network must be equipped with rods of sufficient quantity and length to avoid lightning strokes in the sheet metal.

3.6 Down Conductors

Down conductors shall be selected in a manner such that there are several parallel current paths between the air terminals and the earthing system. The length of each down conductor is to be kept as short as possible.

Steel structures and steel stacks or pillars of buildings may be used as down conductor, if the minimum cross-sections and thickness meet all standards and is approved by employer. In each case the connections with the earthing system and down conductor must be visible and removable.

Starting from the corners of the structure all down conductors should be evenly spaced. They should be routed as directly as possible from the air termination network to the earth termination network and connected to earthing bars. The minimum distance between conductors and doors/windows shall be 0.5 m, in any case the separation distances according to EN 62305-3 shall be respected.

If not already connected with the air termination network or equipotential bonding system, larger metal parts mounted in/on the building outer walls (e.g. frames of doors, ventilation louvers) shall be connected with the down conductors.

The minimum number of down conductors and the maximum distance between the conductors is given as follows:

- a) Buildings containing control systems:
 - minimum number of conductors: 4
 - maximum distance between conductors: 10 m
- b) Buildings within hazardous areas:
 - minimum number of conductors: 4
 - maximum distance between conductors: 10 m
- c) Other buildings:
 - minimum number of conductors: 2
 - maximum distance between conductors: 10 m

All down conductors and equipotential bonding conductors which are connected to the earthing system must be provided with an accessible test clamp for measuring purposes. Down conductors must be connected to the earth electrode system via earthing bars to be installed on the walls.

The routing of down conductors through Ex zones 1 is prohibited.

4 INTERNAL LIGHTNING PROTECTION SYSTEM

The internal lightning protection is designed to prevent dangerous sparks due to potential differences between electrically conductive parts, which can occur as a result of a lightning strike.

Internal lightning protection will be ensured by lightning equipotential bonding for all metal installations. At a building entry, the shields of cables will be connected with the earthing system to ensure equipotential bonding.

To ensure EMC compliance for buildings in industrial use, the legal requirements of EN 61000 shall be used. Additional actions for VSD, for example shielded cables, mains filter, etc. shall be coordinated during detail design stage with the relevant supplier.

Surge arrestors will be used for cables which pass different lightning protection zones. The definitive requirement of surge arrestors depends on the lightning protection concept. The internal lightning protection shall be considered in the lightning protection concept during detail design stage.

4.1 Separation Distance

Inadmissibly short distances between the lightning protection system and metallic installations or electrical equipment shall be prevented. Separation distances according to EN 62305-3 shall be respected and must be verified by calculation.

If separation distances can't be kept, appropriate measures shall be taken. Special care shall be taken in hazardous areas. In potentially explosive atmospheres, sparks must be completely excluded, which is why only equipotential bonding shall be used for areas of zone 0.

Lightning protection system supplier shall provide all necessary calculation, for employer's approval.

4.2 Lightning Equipotential Bonding

Equipotential bonding is achieved by interconnecting all electrically conductive components on the station, by means of equipotential bonding bars, to the earthing system. In-

terconnecting means can be depending on the application bonding conductors, surge protective devices (SPDs) and isolating spark gaps.

All EI&C rooms are to be equipped with a potential equalization ring in the double floor. The ring should consist of stainless steel strip respectively copper strip for MV-rooms as per section 2.4 and be installed wall mounted 0,35 m above the ground floor. Connections to equipment must be made using appropriate connection camps or cable lugs, bores are not permitted.

For metal structures generally equipotential bonding conductors, routed on the shortest way, can be used. All cables, metal tubes and pipes and any metal construction as well shall be solidly earthed immediately at the building cross over point. For this purpose, outdoor cables have to be shielded and the shield must be connected to the potential equalization.

Any control cable (trunk cables) towards the field or process area are consisting of an outer metallic armoured mesh, resisting lightning current with a cross section of min. 16mm². This mesh is connected to the earthing system immediately after building entrance and will not be continued along the cable into the building.

Requirements according to EN 62305-3 shall be respected.

4.3 Lightning Protection Zone Concept / EMC

The lightning protection zone concept provides a special protection for electrical and electronic devices, which can't be guaranteed by the external and internal lightning protection. In this concept, the exterior and interior areas are divided into lightning protection zones according to the sensitivity of the existing electrical and electronic systems. At the junctions between the zones shielding measures are necessary.

The lightning protection zone LPZ 0B (protected against direct lightning strikes) must be guaranteed by the external lightning protection for the immediate vicinity of buildings, free-standing parts and other to be protected components. All buildings are assigned to zone LPZ 1. At the transitions between the zones shielding measures are necessary. Possible surge arresters and connection to the potential equalization of all incoming conductive parts must be provided.

5 MARKING AND LABELLING

All earthing bars, terminating steel strips and earthing cables shall be individually identified and labelled.

Engraved aluminium or stainless steel labels shall be used to identify earth bars and steel strips, durable cable markers shall be used for earthing cables. Earth bars shall be

numbered according to the drawings, steel strips and cables will be numbered according to their destination.

For further details refer to specification "Tagging and Numbering Philosophy" Doc. No C4G-JI73-ILF-GENER-PMA-MAN-902.

6 TESTS

After erection of the earthing and lightning protection system, all installations shall be tested in accordance with applicable regulations and standards.

The following tests shall be carried out:

- Measurements of corrosive currents
- Check of all joints and connections
- Measurements of earthing system resistance
- Measurements of lightning protection system conductivity
- Check of mechanical details
- Compliance with specifications

The aim of the tests is to ensure the proper function of the complete scope.

The measuring results and the locations of the measuring points have to be indicated in respective drawings as a basis for future measurements.

Final test records and drawings shall be summarized in a single test document which has to be delivered along with the documentation.

The following data shall be included into test records:

- Employer
- Contractor (Testing)
- Equipment tested
- Type of test point
- Test equipment (including range etc.)
- Date
- Notes
- Date for repair/removal of deficiencies

Proper completion of works and compliance with all standards shall be certified. All final certificates shall be provided necessary for authority permission of the installation.

All installation which are vital for safe operation of the equipment and installation shall be shown to the employer to proof function, reliability and general plant safety.

7 DOCUMENTATION

Complete documentation shall be provided for the design, construction, testing, maintenance and repair of the earthing and lightning protection systems and their components.

The documentation shall be in English language, marked (*) documents shall be provided in Czech language, too.

Documents which are mandatory for a Third-Party approval (e. g. through TIČR) have to be in Czech language. The costs for translating and any other additional costs for this procedure have to be borne by the Contractor.

The final documentation of earthing and lightning protection system shall at least include the following documents and drawings (minimum requirements):

- a) Technical data sheets (*)
- b) Calculations (separation distance, etc.)
- c) Layout drawings
- d) Circuit diagrams
- e) Construction drawings
- f) List of used devices with manufacturer
- g) Photo documentation of all construction phases, all connections in concrete, all connections in earth
- h) Operation and maintenance manuals (*)
- i) Reports of tests with protocol
- j) All documents for a Third-Party (e. g. TIČR) approval (*)

The documents listed under a) to e) shall be handed over for approval to the employer before execution.

Special attention has to be given to the fact, that documentation must be submitted with sufficient time allocated for approval prior to manufacturing / assembly.

The documentation has to be prepared in accordance with the relevant ISO standards or in the absence of relevant details in those standards the EN standards shall apply.

The final documentation shall be delivered on paper in 3 copies and in electronic form also. Signed protocols shall be scanned and attached to the electronic documentation. The original signed protocols shall be in the first of the three documentation tranches. The type of the electronic files and the number of copies shall be agreed with the employer.

8 SHIPPING

All equipment, material and spare parts shall be sufficient packaged. The material, especially loose parts and spare parts shall be clearly labelled according to the designation. The deposal of packing is in scope of this specification.

9 SPARE PARTS AND SPECIAL TOOLS

The Contractor shall deliver all spare parts, which are necessary for commissioning and two years operation time (see "Description of Technical interfaces for Contractors").

Spare parts shall be available ten years after commissioning.

The following spare parts and special tools shall be supplied:

- special tools for maintenance,
- spare spark gaps, connectors, cable lugs, surge arrestor