

PUBLIC COMPANY ORLEN LIETUVA

APPROVED BY:
Deputy General Director
for Operations
5 March 2021 Order No TV1(1.2-1)-127

OPERATING INSTRUCTION BE-4 FOR EARTHING, LIGHTNING PROTECTION AND STATIC PROTECTION EQUIPMENT

I. PURPOSE

1. The purpose of this Instruction is to establish safety and maintenance requirements for the operation of earthing, lightning protection and static protection equipment in Public Company ORLEN Lietuva (hereinafter – the Company).

II. APPLICATION

2. The requirements of this Instruction shall be complied with by the employees of the Company and, where provided for in relevant work (service) contracts concluded with the Company, by contractor employees (hereinafter – the Contractor) who maintain and operate the Company's buildings, process equipment, pipelines, vessels, electric equipment, process control and automation equipment (control and measurement devices, telemechanic and alarm systems, automated control systems), process control systems, digital and telecommunication devices.

III. REFERENCES

3. STR 2.01.06:2009. Protection of Structures Against Lightning. External Protection of Structures against Lightning.

4. Basic Fire Safety Requirements approved by the 7 December 2010 Order No 1-338 of the Director of Fire and Rescue Department under the Ministry of the Interior.

5. General Fire Safety Regulations approved by the 27 July 2010 Order No 1-223 of the Director of Fire Prevention and Rescue Department under the Ministry of the Interior.

6. Norms and Scope of Electrical Equipment Testing approved by the 24 April 2001 Order No 1-281 of the Minister of Energy of the Republic of Lithuania;

7. General Rules for the Installation of Electrical Equipment approved by the 3 February 2012 Order No 1-22 of the Minister of Energy of the Republic of Lithuania.

8. Rules for the Installation of Electrical Equipment in Switchgears and Substations approved by the 15 December 2011 Order No 1-303 of the Minister of Energy of the Republic of Lithuania.

9. Rules for the Installation of Electrical Equipment in Special Purpose Premises and Process Facilities approved by the 3 March 2013 Order No 1-52 of the Minister of Energy of the Republic of Lithuania.

10. Rules for the Installation of Electrical Power Equipment approved by the 2 January 2012 Order No 1-1 of the Minister of Energy of the Republic of Lithuania.

11. Rules for the Operation of Power Stations and Electrical Networks approved by the 29 October Order No 1-211 of the Minister of Energy of the Republic of Lithuania.

12. LST EN 62305-1,2,3,4. Lightning protection.

13. Правила защиты от статического электричества в производствах химической, нефтехимической и нефтеперерабатывающей промышленности. Maskva, „Химия“, 1976.

14. ВНЭ 5-79 ППБО-103-79 Правила пожарной безопасности при эксплуатации предприятий химической промышленности, „Химия“, 1991.

15. У-ЭТ-06-89 Указания по проектированию защиты трубопроводов и оборудования от статического электричества вторичных проявлений молний и от заноса высоких потенциалов в здания и сооружения по трубопроводам, Lengiproneftechim, 1989

16. The legislation (as amended to date) listed in this Section, with the exception of [13, 14, 15], shall apply in conjunction with this Instruction.

IV. ABBREVIATIONS, TERMS AND DEFINITIONS

Lightning protection – a set of measures designed to protect structures from the direct effects and the secondary effects of lightning such as fire, explosion, collapse, destruction of buildings, structures and damage to equipment.

Static protection – a set of measures designed to prevent arcing caused by static electricity.

Secondary effects of lightning – potential induced in metallic structures by a lightning strike that creates a risk of arcing.

Protective earthing – earthing of passive parts of electric installations to protect people against exposure to electric current.

Operational earthing – earthing of a certain point in the circuit to ensure the normal operation of a facility.

Neutral earthing – for networks up to 1000 V – connection of passive parts of electric equipment to a directly earthed neutral of three-phase power supply (transformer, generator), to directly earthed point on the winding of single-phase power supply, or to directly earthed pole of DC supply.

Earthing – connection of process equipment enclosures, civil structures, piping, and passive parts of electric equipment to an earthing system.

Earthing system – a system that consists of an earthing device and earthing conductors.

Earthing device – a device that consists of underground electrodes, connecting conductors and equipotential bonding system.

Earthing conductor – a conductor that connects an earthed piece of equipment to an earthing device or main earthing conductor.

Main earthing conductor – an earthing conductor that connects two or more pieces of equipment to an earthing device or a neutral point of power source.

Earthing electrode – a conducting element buried in the ground that facilitates the flow of the earth-fault current in case of fault or lightning discharge.

Equipotential bonding – changing earth surface potential for the points of earth leakage current by using special electrodes or equipotential bonding network.

Natural earthing device – different metallic conductors buried in the ground used for earthing of electric equipment.

Lighting arrester – a device consisting of a lightning rod, earthing conductor, earthing device, earthing electrode (being the main part of the device), designed to protect a structure from the direct effects of lightning, i.e. to receive the lightning strike and deliver the current to the ground.

Visual inspection (hereinafter – **VI**) – inspection of the facility's earthing, lightning and static protection equipment to identify defects that are visually apparent without the use of any tools.

Technical inspection (hereinafter – **TI**) – visual and technical inspection, measurement, testing and other conformity assessment activities of the facility's earthing, lightning and static protection equipment.

All other terms used herein correspond to the definitions used in the documents referred to in Section III.

V. RESPONSIBILITY

17. Managers of organizational units in charge of the Company's structures and engineering networks (buildings, pipelines, process equipment, tanks, etc.) (hereafter - the facility) shall be responsible for the operation of the earthing, lightning and static protection equipment located in the facility.

18. Managers of organizational units or employees appointed by them shall be responsible for conducting timely visual inspections of the earthing, lightning and static protection equipment located in the facility.

19. Employee in charge of organizing maintenance and repairs of the electric equipment of the facility shall be responsible for the filing, storage and updating of the technical documentation of the earthing, lightning and static protection equipment.

20. Employee in charge of organizing maintenance and repairs of the electric equipment in the facility shall be responsible for conducting timely technical inspection of the earthing systems.

21. Employees in charge of organizing maintenance and repairs of electrical, automation, instrumentation, mechanical (structures and rotating) equipment, buildings, process equipment and piping of the facility shall be responsible for conducting timely repairs, including rectification of work defects, of the earthing, lightning and static protection equipment.

22. Employees acting in violation of the requirements set forth herein shall be liable in accordance with the procedure established by the applicable legislation of the Republic of Lithuania and procedures effective in the Company.

VI. DESCRIPTION OF ACTIONS

23. Frequency of VI and TI:

23.1 VI shall be performed at least every 6 months for earthing, lightning and static protection equipment located in an explosive or chemically active environment and at least once a year for equipment located in other places.

23.2 TI shall be performed at least once a year for general earthing, lightning and static protection equipment located in an explosive or chemically active environment, also for lifts (elevators), laundry, sauna equipment, crane lifting mechanisms, other electrical equipment operated in hazardous and highly hazardous premises, and at least once every two years for equipment located in other places. Frequency of TI for individual earthing systems (used for

earthing only) depends on the voltage of electric equipment: every 3 years for electric equipment up to 1 kV and every 6 years for electric equipment above 1 kV.

23.3 The underground earthing system shall be subject to corrosion damage inspection at least once every 12 years.

23.4 A TI schedule for earthing, lightning and static protection equipment shall be drawn up by an employee responsible for maintenance of respective electric facilities and shall be in line with the inspection intervals established by a decree of Deputy General Director for Operations.

23.5 Organizational unit managers shall, through a decree, establish VI intervals, which shall be no longer than those laid down herein.

24. VI shall always be carried out for lightning protection systems after a hurricane wind, flood, earthquake, fire, intense storm, lightning discharge, after repairs, or after replacing parts of the lightning arrestor.

25. The following shall be checked during VI:

25.1 Whether changes to buildings require the installation of an additional lightning protection system;

25.2 Whether connecting conductors are intact;

25.3 Whether fittings are in good condition, not broken;

25.4 Whether equipment is not corroded;

25.5 Whether aboveground parts of earthing systems are in good condition.

26. In the Company's facilities, where employees (e.g. operators) are on duty at all times, visual inspection of the earthing, lightning and static protection equipment shall be carried out by the above-mentioned employees at the intervals determined by an organizational unit manager (recommended to be carried out together with the inspection of the facility or a part of the facility or its equipment) and documented in a shift log. In other facilities, timely VI shall be ensured by an employee responsible for the technical condition of the particular facility, and the completion of VI shall be recorded in an appropriate document (e.g., a report) or in the relevant IT system in accordance with the procedure established by the Company.

27. After a visual inspection, the employee shall record the defects identified in accordance with the Company's procedures, using a fault reporting tool available in the facility (TP.shell, logbook) and, depending on the type and location of the defect found (electric equipment, automation and instrumentation, rotating equipment, process equipment and apparatus, piping, construction), shall inform the employee responsible for organizing maintenance of the respective equipment in the particular facility. Defects recorded in TP.shell do not have to be reported separately to other staff members.

28. VI and the following measurements shall be carrying out as part of TI:

28.1 Transient resistance of connections between an earthing device, earthing conductor and a lightning rod;

28.2 Resistance of the earthing device;

28.3 If necessary, the underground earthing system shall be checked for corrosion and the measurements provided for in the applicable legislation [3, 6, 11] shall be carried out.

29. The results shall be recorded in inspection reports or other relevant documents (e.g. statements).

30. After any repairs, upgrade of the systems for lightning protection, or upon other works during which the earthing conductors were disconnected or replaced, additional non-scheduled resistance measurements shall be performed.

31. VI of lightning and static protection equipment and TI, if any, shall be performed before the 1th May of each year, i.e. before the thunderstorm season.

32. Before measuring the transient resistance of connections, earthing systems shall be visually inspected and all deficiencies corrected.

33. Organizational unit manager shall be responsible for preparing a list of process equipment and pipelines to be earthed, with the exact tag numbers (necessary for the execution of measurement documents), and submitting it to the staff member organizing the relevant measurements.

34. Employee organizing the resistance measurements of earthing devices shall prepare a copy of the topographic survey of earthing electrodes and shall ensure that the contractor uncovers the earthing electrode at an appropriate location, i.e. that the conductor connecting the earthing electrodes and the point of connection of at least one earthing electrode to the conductor are visible.

35. If the measurement technology requires the earthing device to be disconnected from the main earthing conductor, all measures shall be taken to ensure that this is done safely, i.e. without causing arcing or any disturbance to the operating equipment.

36. Faults identified during VI and TI shall be immediately fixed. Earthing switches and earthing conductors damaged by corrosion shall be replaced if their cross-sectional area is reduced by more than 25 %.

37. For facilities equipped with lightning and static protections, technical documentation (technical passports) shall be prepared in accordance with the design and the technical documentation drawn up at the time of acceptance of the particular facility as fit for use and shall include:

37.1 Topographical survey of the earthing device and the plan with indicated connections to particular structures – a copy;

37.2 The date of commissioning (statement on acceptance as fit for use or certificate) – a copy;

37.3 Drawings of the earthing system and the main parameters of the earthing switches (material, cross-section, linear dimensions) – numbers of design drawings shall be indicated or copies thereof shall be attached;

37.4 Resistance of the earthing device, soil resistivity – measurement reports shall be attached;

37.5 Data on the resistance of a metallic connector between the equipment and the earthing system – measurement reports shall be attached;

37.6 Information about TI and VI performed and eliminated defects – information is stored in dedicated computer systems and documents.

38. Lightning and static protection for buildings and structures shall be installed in accordance with the design and the requirements of the applicable legislation referred to in Section III [3, 4, 5, 6, 7, 8, 9, 10, 11, 12]. Annex 'Technical Requirements for the Installation of Earthing, Lightning and Static Protection Equipment' shall be followed to the extent that it does not conflict with the applicable legislation specified.

39. Lightning and static protection equipment for buildings and structures shall be completely installed and commissioned before the start of the finishing work and, in explosive environments – before complex testing of the process equipment.

40. Any changes or additions to the earthing, lightning and static protection equipment shall be noted in the technical documentation and technical passports.

41. Scaffolding shall be earthed when used for construction, repair and installation work involving electrical tools, electric lighting, electric welding, product spraying (e.g., painting). Requirements applicable to earthing of scaffolding are laid down in the Company's Procedure BDS-11 'Works at Height'.

VII. DOCUMENTS AND RECORDS

42. The following records shall be maintenance compliant with this Instruction.

Name of record	Place of storage	Responsible person	Storage period
Technical documentation (technical passport) of lightning and static protection equipment	Company facility	Employee responsible for organizing maintenance of the electric equipment in the facility	During the lifetime of the facility

VIII. FINAL PROVISIONS

43. Director of Maintenance shall be responsible for arranging periodic reviews of this Instruction and its update, if necessary.

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TECHNICAL REQUIREMENTS FOR THE INSTALLATION OF EARTHING, LIGHTNING AND STATIC ELECTRICITY PROTECTION EQUIPMENT

1. These technical requirements shall apply in conjunction with the existing legislation to the construction / installation of new and maintenance of the existing buildings and process units.

Earthing

2. Earthing is required for [7, 9]:

- 2.1 AC and DC electrical equipment of all voltages in potentially explosive atmospheres;
- 2.2 Electrical equipment operating in potentially explosive atmospheres mounted on metal structures, which are earthed or connected to a neutral point, except for equipment mounted in cabinets and panels, which are earthed or connected to a neutral point;
- 2.3 Metal structures of switchgears, metal cable terminations, metal sheath and armor of power and control cables, metal sheath of wires, metal wiring conduits, metal busbar covers and support structures, metal shelves, trays, straps and ropes to which cables and wires are attached, and any other metal structures on which electric equipment are installed;
- 2.4 Metal enclosures of portable electric users;
- 2.5 All electrically conducting civil and process structures, all fixed metallic piping, the housings of process equipment, tanks and vessels, cranes and railroad tracks, etc. shall be earthed for equipotential bonding; Reinforcement of the natural connections of these installations is not required;
- 2.6 Process – control and automation, electronic communications (telecommunications) equipment.
- 2.7 Metal parts of electric equipment, which may become energized if their insulation is damaged and may cause injuries to people, disrupt operation or cause breakdowns of equipment.

3. All equipment to be earthed shall be connected to the main earthing conductors or earthing devices using separate earthing conductors.

4. In addition to natural earthing devices, artificial earthing devices shall be used in the Company.

5. A closed-circuit earthing device shall be installed at a depth of at least 0.5 m for the earthing of the Company's facility, except in cases where it is not appropriate to do so, for example, when separate earthing devices are installed for lighting poles, office containers, etc. Underground electrodes shall be installed at the corners of earthing devices and at the connection points of lightning arresters. Earthing devices of adjacent facilities within a process unit shall be interconnected using at least 2 (two) earthing conductors and connected to the earthing device of the transformer house supplying power to them.

6. In premises and open areas (pump houses, compressor houses, ventilation rooms, etc.), transformer houses, server rooms, instrumentation and automation (I&A) rooms, the main earthing conductor shall be installed along the perimeter of the particular facility. The main earthing conductor shall be connected to the earthing device of the facility at no less than two different locations [6].

7. Artificial earthing devices shall be corrosion-resistant and mechanically robust. Copper, steel or reinforced concrete earthing devices – not painted. Earthing devices made of steel shall

have a conductive anti-corrosion coating. The minimum dimensions of earthing devices are shown in Table 1 [3, 6, 7].

Table 1

Minimum dimensions of earthing devices

Material	Shape	Minimum dimension		Comments
		Electrode	Connecting conductor	
Copper	Stranded	-	50mm ²	Minimum core Ø 1,7 mm
	Rod	Ø 15 mm	50 mm ² , Ø 8 mm	
	Strap	-	50mm ²	Minimum thickness 2 mm
	Tube	Ø 20 mm	-	Minimum wall thickness 2 mm
Steel	Galvanized rod ¹⁾	Ø 16 mm	Ø 10 mm	
	Galvanized tube ¹⁾	Ø 25 mm	-	Minimum wall thickness 3 mm
	Galvanized strap ¹⁾	-	90mm ²	Minimum thickness 4 mm
	Copper rod	Ø 14 mm	-	Minimum coat thickness 250 µm
Stainless steel	Rod	Ø 15 mm	Ø 10 mm	
	Strap	-	100mm ²	Minimum thickness 2 mm
1) Minimum coat thickness 50 µm for round conductor and 70 µm for flat conductor.				

8. Earthing devices shall not be installed over underground utility lines or in places where ground may be dried out by heat piping or other heat sources.

9. Earthing conductors installed in trenches shall be backfilled with homogeneous, fine and cohesive soil. Earthing conductors installed in the ground as well as main earthing conductor shall be connected by welding. Other earthing conductors shall be connected by welding or with the use of screws, special connectors and other mechanical devices installed in accordance with manufacturer's instructions and in such a manner as to prevent damage to the electrode or grounding conductor. Connectors shall be protected against corrosion and loosening. The weld length produced by manual arc welding with coated electrodes shall be at least twice the strap width for flat conductors and at least six times the conductor width for round conductors. Bolts shall not be used for underground connectors.

10. The permissible minimum dimensions of earthing and protective conductors are provided in Table 2 [7]:

Table 2

Minimum dimension of earthing and protective conductors

Description	Copper	Aluminum	Steel
Cross-sectional area of uninsulated conductor, mm ²	4	6	-
Diameter of uninsulated non-galvanized conductor, mm	-	-	6 ¹⁾ (10)
Cross sectional area of insulated conductor, mm ²	1.5 ²⁾	2,5	-
Cross-sectional area of neutral and earthing conductors of cables and multi-stranded wires with phase conductors provided in a common sheath, mm ²	1	2,5	-

Cross-sectional area of steel strap, mm ²	16 (25)	35	36 (48)
Thickness of steel strap, mm	2	3	3 (4)
Wall thickness of steel angle bar, mm	–	–	2,5 (4)
Wall thickness of steel tube, mm	–	–	2,5 (3)
Diameter of copper or galvanized rod, mm	–	–	6 (10)

1) Uninsulated, non-galvanized conductors used outdoors shall be at least 10 mm in diameter.

2) The cross-section of protective conductors installed in tubes shall be not less than 1 mm² if phase conductors have the same cross-section.

NOTE. The minimum dimensions of conductors that are laid in the ground are given in parentheses.

11. The entries of earthing conductors into buildings, the points of conductor connection to the terminal block, etc. shall have a protective earthing sign $\frac{1}{\text{—}}$.

12. Earthing conductors shall be green and yellow. Earthing conductors shall be painted with transverse green and yellow stripes of the same width (between 15 mm and 100 mm) along their entire length in horizontal sections and not less than 2 m upwards in vertical sections. Heat-shrink tubing with longitudinal green and yellow stripes can also be used for this purpose [7]. 2 green and 2 yellow tapes designed for outdoor use may be applied to each side of conductors made of or coated with non-ferrous metals.

13. Earthing conductor penetrations through walls, partitions and ceilings shall be sealed with class A1 sealing products specified in the relevant regulations. There must be no branching or connectors at the penetrations [7].

14. Earthing conductors shall be connected to the earthed parts of equipment by bolts in visible and accessible places. Bolted contacts shall be protected against corrosion and loosening.

15. Equipment, which is frequently dismantled or installed on moving or vibrating parts, shall be earthed or connected to a neutral point with flexible conductors. Flexible earthing conductors shall be solid and ring terminals shall be used for connection.

16. Not more than 2 earthing conductors shall be connected to the main earthing conductor with one screw. All equipment or parts thereof shall be connected to the main earthing conductor using separate conductors. Earthing conductors of several equipment shall not be connected in series. However, an earthing conductor connected by permanent connectors may be used for earthing the individual parts of one equipment (e.g. the electric motor housing and cable junction boxes).

17. The transient resistance of connection between the earthing devices and earthed elements shall not exceed 0.05 Ω [6], and the resistance of earthing conductor from the main conductor to the equipment shall not exceed 0.25 Ω .

18. The resistance of earthing systems for power users and process equipment shall not exceed 10 Ω [7].

19. Steel structures used for cabling racks or cable installation shall have an uninterrupted electric circuit along their entire length. The metal sheaths, screens and armors of cables and the structures used to lay the cables shall be earthed at both ends of the route. Screens of special circuit cables may be earthed at one end if so provided for in the design or applicable legal acts.

20. Digital equipment and electronic communications equipment shall be earthed. A common earthing system of electric equipment shall be used for earthing, provided that its

resistance does not exceed 2Ω . If the existing earthing system's resistance exceeds 2Ω , the new earthing system shall be installed and connected to the existing system at a single point. Digital and electronic communications equipment shall be connected to the earthing system by a separate insulated conductor with a cross-sectional area of not less than 2.5 mm^2 or by a conductor in a common cable sheath with a cross-sectional area of not less than 1.5 mm^2 . The protective conductor in the power supply cable of equipment (cable supplied with the equipment) shall have a minimum cross-sectional area of 1 mm^2 . If the manufacturer's instructions include specific earthing instructions, the equipment shall be grounded in accordance with the manufacturer's instructions. The requirements of this Paragraph do not apply to personal computers and other office equipment that are earthed via standard power supply cables.

21. Process equipment, vessels and petroleum product tanks with a volume of more than 50 m^3 or a diameter of more than 2.5 m shall be connected to an earthing device in at least two places on different sides [13].

22. Railroad tracks located in the territory of loading/unloading racks shall have an uninterrupted electrical circuit along their entire length, shall be interconnected in at least two places and shall be earthed in at least two places (at different ends).

Installation of lightning protection

23. Lightning – an electrostatic discharge through the atmosphere between two electrically charged regions, either both in the atmosphere or one in the atmosphere and one on the ground. Lightning can have two effects: it can cause direct damage to buildings and equipment, known as a direct strike (direct effect). Secondary lightning effects caused by electrostatic and electromagnetic induction as well as transmission of high potentials through metallic structures above and below the ground may also occur. A direct lightning strike is accompanied by the release of large amounts of heat that can damage civil structures, cause fires and explosions, and injure or kill people.

24. A lightning strike of up to 100 m from the point of discharge creates potential differences that can reach voltages of tens of kV and cause arcing in the air. Arcing can cause explosions in installations containing explosive mixtures of flammable gases, vapor or dust.

25. Lightning discharge can produce a wide range of electromagnetic radiation, which induces an electric current in the circuits of facilities made up of various metallic structures (pipes, wires, etc). Transmission of high potentials to facilities/structures is also possible via railroad tracks, racks, overhead power lines, underground pipelines, cables, and other long metal utility lines, and may be accompanied by powerful electrical discharges. The transmission of high potentials to structures is possible not only in the event of a direct lightning strike, but also when these utilities are in close proximity to the lightning arrester.

26. External lightning protection shall be installed in the facilities with explosive atmospheres.

27. Active lightning rods shall not be used.

28. The earthing conductor of a lightning rod shall be connected to an earthing device via a detachable connector and directly to earthing electrodes at the point of connection to the earthing device.

29. Reinforced concrete structures of earthing electrodes for free-standing lightning arresters:

- 29.1 One (or more) reinforced concrete block with a length of at least 2 m or one (or more) reinforced concrete pole with a length of at least 5 m.
- 29.2 A reinforced concrete support column with a diameter of at least 0.25 m² buried in the ground to a depth of at least 5 m;
- 29.3 A reinforced concrete foundation of any form with a minimum ground contact area of 10 m².
30. The spacing between the lightning protection grid rods (made of grid conductors) used for the protection of buildings or structures shall not exceed 10x10 m. If the building or structure is located in, adjacent to, or contains a hazardous area, the spacing shall not exceed 5x5 meters. The elements of the conductor shall be connected by welding or by special mechanical connectors provided by the element manufacturer. Metallic structures (pipes, air ducts, etc.) that extend above the roof of the building shall be connected to the lightning protection grid, and non-metallic structures shall have separate lightning rods installed and connected to the lightning protection grid. Lightning protection grid rods shall be connected to an earthing device at the average distance around the perimeter of the building, depending on the protection class of the building (I-10m, II-15m, III-20m, IV-25m), and at the corners of the building [1].
31. Lightning protection for tall structures Non-metallic towers, stacks, etc. with the height of 15 to 50 m shall have one lightning rod at least 1 m above such structures. Structures with the height of 50 to 150 m – two lightning rods connected to each other at the top part of the stack. Stacks over 150 m shall be equipped with at least three interconnected lightning rods of 0.2 to 0.5 m in height, or a steel ring with a cross-sectional area of at least 160 mm² installed at the top of the stack. Stacks up to 50 m may have one earthing conductor, and stacks over 50 m shall have no less than two earthing conductors provided at least every 25 m around the stack perimeter. Metal stair steps or other vertical metal structures can be used as grounding conductors. They must form an uninterrupted circuit along their entire length. The resistance of individual earthing electrodes shall not exceed 30 Ω. Metal stacks, towers, etc. with a diameter of more than 2.5 m shall be connected to the earthing system at two points or more. The functions of lightning rods and earthing conductors may be provided by their metal enclosures if the wall thickness is greater than 4 mm for metal enclosures, greater than 5 mm for copper enclosures and greater than 7 mm for aluminum enclosures.
32. To prevent the transfer of electric potential, process piping shall be earthed at the entrance to the facility (section, process unit area, or building) or at the nearest support at the entrance to the facility. The resistance of such earthing system shall be not more than 10 Ω [15].
33. Circuits in the power supply grid where overvoltages may occur as a result of secondary effects of lightning strikes or switchovers shall be protected by overvoltage dischargers and, if necessary, overvoltage limiters.

Installation of static electricity protection

34. Static electricity (charges) can be generated by a free-falling fluid or fluid flowing through a pipeline at a speed greater than 0.7-1 m/s; deformation, crushing, spraying of various materials; movement of two layers of contacting bodies, fluid or bulk materials; and intensive mixing, crystallization and evaporation of various materials. Static discharges can cause fires, explosions and injuries.
35. Static protection measures shall be in place in explosive and fire hazardous zones where products with a specific volume resistivity equal to or greater than 10000 Ω/m³ are processed or transported. In premises or areas outside these zones, protection shall be provided in places where static electricity may adversely affect the production process or product quality [14].

36. In facilities subject to static project:
- 36.1 All conductive parts of process equipment shall be earthed regardless of whether other means of static protection are provided and applied;
- 36.2 The conductive enclosures and thermal insulating covers of equipment, vessels and piping, ventilation systems and air ducts shall have an uninterrupted electric circuit along the entire length and shall be connected to the earthing system in at least two places. Reinforcement of the natural connections of these installations is not required;
- 36.3 Equipment, tanks, assemblies etc., in which products are circulated and dispensed, enameled equipment and tanks, free-standing machines and assemblies not connected to the common system of equipment and tanks shall be connected to the earthing system using separate conductors, irrespective of the way in which any metal structures connected to them are earthed.
- 36.4 Metal ventilation ducts and thermal insulating covers for pipelines and equipment shall be earthed every 40 to 50 m or connected by conductors to grounded equipment, piping, or metal structures on which they are installed. Metal strips that are part of the thermal insulating cover can be used for the earthing of the cover. If the outer diameter of insulated pipe or equipment is less than or equal to 1 m, the width of the strip must be 40 mm, and if the diameter of insulated pipe or equipment is greater than 1 m, the width of the strip must be 60 mm. There must be an uninterrupted electric circuit through the entire length of ventilation ducts and insulating covers. Air ducts with flexible inserts (fabric or other) shall be connected with two flexible conductors [15].
37. Loading arms at the oil product loading racks shall be earthed.
38. Tank trucks shall be connected to the earthing system by a conductor when loading LPG and other flammable liquids. A flexible copper conductor with a cross-sectional area of not less than 6 mm² shall be used for the grounding of tank trucks. One end of the conductor shall be attached to the body of the tank truck and the other end shall be attached to the earthing system.
39. Hoses with metal nozzles used to discharge the flammable liquids shall be non-conducting and shall be wrapped around with a copper wire (minimum diameter 2 mm) or a copper cable (minimum cross-section 4 mm²), with a strand spacing not more than 100 mm. One end of the conductor shall be attached to the earthed metal structures of the pipeline or to the earthing system, and the other end – to the loading hose nozzle, which shall be made of a metal that does not produce sparks on impact (copper, bronze, aluminum).
40. The housings of coolers, compressor and pumps handling flammable liquids or gases shall be earthed by a separate conductor, regardless of the fact that the electric motors of such equipment are grounded.
41. The minimum dimensions of the conductors to be used for earthing are shown in Table 2.
42. The resistance of earthing systems intended solely for static protection shall not exceed 100 Ω [13].
43. For storage tanks with floating roofs or pontoons, at least two flexible conductors shall be connected between the roof or pontoon and the metal body of the tank [15].
44. Flanged connections of pipelines, vessels and other equipment have sufficient electrical conductivity to prevent the buildup of static electricity so that no additional measures are required to ensure an uninterrupted electric circuit. The use of washers made of dielectric

materials or coated with a non-conducting paint is not permitted for connections unless specified in the design and indented to ensure the proper functioning of corrosion protection systems [13].

45. In facilities with potentially explosive atmospheres, process pipelines shall be earthed at the intervals of at least 50 m and if the pipelines are installed within 10 cm of each other they shall be interconnected by conductors at the intervals of 20 to 30 m to ensure static protection [15].

46. Process vessels and tanks with flammable liquids or other flammable and explosive products shall be connected to the earthing system/main conductor at two points for static protection. Each vessel or tank shall be separately connected to the earthing system/main conductor. It is prohibited to connect several vessels or tanks to each other before connecting them to the earthing system/main conductor [15].
