



TECHNICAL REQUIREMENTS

AUTOMATION AND INSTRUMENTATION

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FIELD INSTALLATION

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1. SCOPE

This Specification contains requirements for designing and installation of the field connection between field instruments and control rooms .

2. REFERENCES

2.1 Design and execution of the equipment shall meet requirements of Lithuanian law, Directives of European Union, standards and regulations as well as this elaboration, in the following priority order:

- Legislation of the Republic of Lithuanian;
- Directives of European Union;
- LST (LST EN) – Lithuanian Standards (consistent with standards of European Union);
- CEN/CENELEC – European Committee for Standardization / European, Committee for Electrotechnical Standardization;
- IEC – International Electrotechnical Commission;
- ASME – American Society of Mechanical Engineers;
- API – American Petroleum Institute;
- ISA – International Society of Automation;
- ISO – International Organization for Standardization;
- ANSI – American National Standards Institute.

2.2 The most recent edition of the standards or regulations shall be employed.

LT Techninis reglamentas *Elektromagnetinio suderinamumo techninis reglamentas Nr IV-1328*

LST EN 60079 *Electrical apparatus for explosive gas atmospheres. Elektriniai aparatai, naudojami potencialiai sprogiose atmosferose*

Directive 2004/108/EEC *Electromagnetic compatibility (EMC)*

Directive 94/9/EC *Equipment and protective systems in potentially explosive atmospheres (ATEX)*

IEC 60331-11 *Tests for Electric Cables under Fire Conditions - Circuit Integrity - Part 11: Apparatus - Fire Alone at a Flame Temperature of at Least 750 Degrees Celsius*

IEC-60331-21 *Tests for electric cables under fire conditions - Circuit integrity - Part 21: Procedures and requirements - Cables of rated voltage up to and including 0,6/1,0 kV*

LST EN 60529 *Degrees of protection provided by enclosures (IP code) (IEC 60529)*

LST EN 61000-4-2 *Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test (IEC 61000-4-2)*

LST EN 61000-4-3 *Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test (IEC 61000-4-3)*

LST EN 62382	<i>Electrical and instrumentation loop check (IEC 62382)</i>
LST EN ISO 12944-2	<i>Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 2: Classification of environments (ISO 12944-2)</i>
NAMUR NE 43	<i>Standartization of the Signal Level for the Failure Information of Digital Transmitters (NAMUR NE 43)</i>
Rekomendacijos R 14-2011	<i>R 14-2011 Santrumpos ir raidiniai žymėjimai ir santrumpos projektinėje dokumentacijoje.</i>
OL-TR-GR-000	<i>General Requirements</i>
OL-TR-IR-000	<i>Automation and Instrumentation. General</i>

3. TERMS AND DEFINITIONS

AISI	American Iron and Steel Institute
API	American Petroleum Institute
APS	Abandon Platform Shutdown
ASME	The American Society of Mechanical Engineers
ATEX	Equipment intended for use in potentially explosive atmospheres
BMS	Burner Management System
BS	British Standard
BSPP	British Standard Pipe Parallel
DIN	Deutsches Institut für Normung
EN	European Standard
ESD	Emergency Shut Down
FF®	Foundation Fieldbus
GRP	Glass-fiber Reinforced Plastic
HART®	Highway Addressable Remote Transducer
HVAC	Heating, Ventilation and Air Conditioning
IE	Instrument Earthing
IEC	The International Electrotechnical Commission

IS	Intrinsically Safe
ISA	International Society of Automation
ISO	International Organization for Standardization
IP	Ingress Protections
IR	Infra-Red
JB	Junction Box
MCT	Multi Cable Transit
N/A	Not Applicable
NAMUR	Normenarbeitsgemeinschaft für Mess- und Regelungstechnik in der Chemischen Industrie
NPT	National Pipe Thread
OD	Outside Diameter
PED	Pressure Equipment Directive (97/23/EC)
Profibus DP	-PA® Profibus Nutzerorganization
PSD	Process Shut Down
RTD	Resistance Temperature Detector
SAS	Safety and Automation System
SI	System International
SIL	Safety Integrity Level
SMART	Field Instrument with Distributed Intelligence
SS	Stainless Steel
UPS	Uninterrupted Power Supply

4. LOCAL CONTROL PANELS AND ACCESSORIES

The basic requirements for the local control panels and field-installed cabinets are set forth in this chapter.

- 4.1** All panels shall be steel construction, finish paint to color RAL 7032, IP-65 minimum and Exe. The console shall be front-accessible. They shall have a canopy against weather conditions and four transportation lugs in each corner. Hinged front door shall be easily opened without causing any damage to internal cabling and installed equipment. The console ought to have terminals for grounding connection.

- 4.2 The panels and other equipment shall be attached to the support steel structure so that the bolts and nuts do not protrude beyond the panel front.
- 4.3 Intrinsically safe barriers or relays shall be installed on mounting rails in arrangement of separate columns. Installation shall conform to ATEX Standards.
- 4.4 The intrinsically safe signal cables shall be laid in separate cable trays from 24V DC and 230V AC power cables.
- 4.5 All cable cores shall be connected to spring terminals on the terminal strips.
- 4.6 Earth of the intrinsically safe loops shall be performed in accordance with recommendations concerning the intrinsically safe loops.
- 4.7 Both ends of all cables connected to the spring terminals as well as the accessories on the panel shall be marked with the tag number as per drawings.
- 4.8 The internal cabling shall be carried out with cables of the following colors:
 - 4.8.1 Low voltage (24V DC) – light grey or white (for signal transmitting).
 - 4.8.2 Intrinsically safe – light blue.
 - 4.8.3 AC power (phase-brown, zero-dark blue, earth – yellow and green stripes).
 - 4.8.4 24V DC power ("+" – red, "-" – black).
 - 4.8.5 Thermocouples – according to the thermocouple type.
 - 4.8.6 Earth – , inner insulation – black, outer insulation – yellow and green stripes.
 - 4.8.7 The above indicated cable colors shall also be used for cabling of PLC and DCS systems, intermediate and marshalling cabinets and for the remaining equipment installed in the control room.
- 4.9 In local control panel shall be used LED type lamps.
- 4.10 20% spare connections shall be provided on the terminal strips.
- 4.11 All panels, cabinets and consoles shall be painted with RAL 7032 colors.

5. PROCESS UNIT EMERGENCY SHUTDOWN (STOP) SWITCHES

A switch for emergency shutdown (switching off) of process units (except ESD switches for pumps, el. motors, compressors and other mechanisms) shall be button type and meet the following requirements:

- 5.1 Type – push button.
- 5.2 Designed with fixation in push–down position.
- 5.3 Button color – red; form – mushroom-shape.
- 5.4 Over the button – an approximately 100 x 30mm metal plate or durable sticker reading „AVARINIS STABDYMAS” (EMERGENCY SHUTDOWN) as well as the name of the process unit to be shut down.

- 5.5** It shall be equipped in a separate casing; if installed in auxiliary ESD panel (Top Box) or the process unit control panel/cabinet – casing is not necessary.
- 5.6** Casing color:
- 5.6.1** If installed indoors and outdoors in regular environment – yellow;
- 5.6.2** If outdoors in a potentially explosive environment – black, with a yellow contrasting sticker on the front part.
- 5.7** Equipped with protection against accidental pushing (a cap, protective shield or collar) and with a slot for running seal wire through. The seal wire shall be copper, monolithic, not more than 0.1mm² thick (D = 0,36mm) with not more than 30N force needed to break it off.
- 5.8** Button contacts: three normally–closed (NC) (meant for breaking circuits with logic 2 of 3).
- 5.9** If used outdoors, operating temperature shall be in range from –30°C to +40°C.
- 5.10** Casing and button protection degree IP:
- 5.10.1** If installed indoors and outdoors in regular environment – yellow;
- 5.10.2** If outdoors in a potentially explosive environment – black, with a yellow contrasting sticker on the front part.
- 5.11** When used in a potentially explosive environment, shall be labeled with intrinsically safe marking, as per ATEX Directive 94/9/EC requirements.
- 6. INSTRUMENT HEAT TRACING**
- 6.1** Instrument heat tracing shall be consistent with obligatory regulations and the following requirements. Specification of the instruments and equipment requiring of heat tracing shall conform to P&ID except pressure and differential pressure transmitters.
- 6.2** Electrical heat tracing shall be applied to the following instruments and equipment:
- 6.2.1** For all field pressure and differential pressure transmitters and their impulse lines.
- 6.2.2** Displacement type instruments and gauge glasses, including the connecting pipes.
- 6.2.3** Analyzers and local control panels.
- 6.2.4** Protection enclosures for instrument.
- 6.3** When electrical heating is not possible, steam tracing incorporated in mechanical discipline shall be foreseen.
- 6.4** Electrical heat tracing for impulse lines shall be made with self-regulating heating cables including all necessary equipment and accessories in field and in electrical center. Typically use O'BRIEN (or other manufacturer) TPE1(2)-B4-N5 preinsulated tubing bundle with self-regulating electric tracing for freeze protection and TPE1(2)-B4-N10 for high viscosity products and for gas anti-condensation inside impulse lines. Instrument enclosures should be equipped with electric heaters

(radiators) with integrated temperature thermostats. For example, O'Brien VIPAK Instrument enclosures installed in series A: A1 cabinet - 150 watts power heaters, enclosures A3 - 300 W power heaters. Common tracing remote alarms in case of power failure of each heating group shall be provided in DCS. Heating temperature shall be adequate to the process medium.

- 6.5 The electrical equipment shall be in accordance with CENELEC Standards.
- 6.6 Directly installed in-line (in the process pipelines) instruments (control valves, Vortex flow meters, mass flow meters) and local equipment shall have common heating with these process lines (steam heating usually).
- 6.7 On the viscous products for Winter/Tracing use heating manifolds. Manifolds of instrument must be with integrated heating element (e.g. H.A.C.O) and with temperature control switch inside of instrument enclosure.
- 6.8 For power disconnections for instrumentation heat tracing should be provided switch the power outside of instrument enclosure.
- 6.9 For process lines and instruments impulse lines electrical heat tracing visual control shell be installed above insulation lighted end seals.
- 6.10 Pressure gauges installed on or near process piping and vessels, where the process media might be subjected to freezing, must have insulating heater covers.
- 6.11 In case I&D do not require a heated enclosure, I&D have to be installed under a protective roof.

7. INSTRUMENT CABLES

Instrument cables shall be provided according to LST EN, EN, IEC regulations and the following remarks:

- 7.1 Power supply cables shall be 3 core (phase, neutral and earth) 1,5mm² (as the min.) solid copper conductor. PVC insulated and overall PVC sheathed. Wire insulation color coding shall be black for phase, blue for neutral and green with yellow stripes for earth.
- 7.2 Solenoid valve cables shall be 2-core 1,5mm² (as the min.) solid copper conductor. PVC insulated and overall PVC sheathed. Powering of solenoid valves shall be 24V DC. For long distances the bigger conductors shall be used to avoid the voltage drop.
- 7.3 Single-pair 2-core signal cables shall be 1,0mm² of copper conductor, 20 twists per meter, black and white colors. 100% Al.-Mylar tape shielded with tinned copper drain wire, PCV insulated and overall PVC sheathed.
- 7.4 Signal multi-pair cables (from 4 to 20mA DC signals) shall be the same as above but with pairs numbered, conduction size of 1 mm², of tinned copper, and overall shield with drain wire (4 x 2 x 1 mm², 8 x 2 x 1 mm², 12 x 2 x 1 mm², 16 x 2 x 1 mm², 20 x 2 x 1 mm² or 24 x 2 x 1 mm²). Signal cables (for digital DC signals) conduction size minimum of 1 mm².
- 7.5 Thermocouple extension single-pair cables shall be ANSI MC96.1 AWG 16 (1,66mm²), PVC insulated twister pair, 100% AL.-Mylar tape shielded with tinned cooper drain wire, PVC insulated and overall PVC sheathed, colour coding of insulation and sheath to ISA MC96.1.

- 7.6** Thermocouple extension multi-pair cables shall be the same as above but with AWG 20 conductors, numbered pairs, 0,5mm² with additional insulated copper wire for communication, in overall shielding and tinned copper drain wire.
- 7.7** RTD single triad cables - size shall be 1,0mm². Temperature measurements on MV electrical motors are described in electrical part.
- 7.8** All cables shall be identified by means of ferrules.
- 7.9** Cables for intrinsically safe loops shall meet technical requirements regarding intrinsically aspect – it is valid to capacity, inductance, flameproof, etc. Instrument cables for intrinsically safe loops (Exi) shall have the light blue outer sheath.
- 7.10** All cables shall be fire-retardant, except fire protection system – non-flammable cables required. Some emergency shutdown and emergency depressurizing systems do not move to a safe position on loss of motive power or circuit continuity. Fireproofing shall be applied to electrical and instrumentation installations for all such systems.
- 7.11** Color of cables outer sheath for non Ex(i) circuits: power supply (230V AC) – black, power supply (24V DC) – grey, signal – grey, fire protection system – orange or red.
- 7.12** OL shall be addressed when coordinating application of reinforced cables.
- 7.13** The cables for intrinsic safety circuits should be supplied with vendor certificate that confirms cable technical characteristic.
- 8. JUNCTION BOXES**
- 8.1** Separate junction boxes shall be used for the following types of loops:
- 8.1.1** Intrinsically safe analogue signals.
- 8.1.2** Intrinsically safe digital signals.
- 8.1.3** Low voltage cables in non-intrinsically safe loops.
- 8.1.4** Low voltage non intrinsically safe digital signals.
- 8.1.5** 230V, 50 Hz power supply.
- 8.1.6** Solenoid valves.
- 8.1.7** ESD system;
- 8.1.8** Fire / Toxic Gas monitoring system.
- 8.1.9** Communication.
- 8.2** All junction boxes shall be provided with mounted terminal blocks. Metal strips with terminals, isolated from box body, shall be provided for termination of shield drain wires. Junction boxes shall be IP-65 minimum.
- 8.3** Single-pair and multi-pair cables shall be entered from the box bottom. Cable entries from the box top and box side will be not accepted.
- 8.4** The cable cores shall be directly terminated. Cables shall be entered into the junction boxes only through the cable glands. The cable glands shall be weatherproof. The cable

glands used in Ex(e) (preferred), Ex(i), and Ex(d) junction boxes shall have the appropriate manufacturing certificate. Unused cable entries to the junction boxes shall be fitted with plugs. Execution of the plugs in explosion proof boxes shall correspond to execution of the related junction box.

- 8.5 All junction boxes shall have white nameplates with black and blue letters for EEx(d) and EEx(i) executions, respectively. The nameplate must be permanently attached to the junction box. It has to be weatherproof and aggressive environment.

9. PROTECTION BOXES

- 9.1 Instrument protection boxes shall be designed in such a way that removal of transmitters was possible without disturbing the pulse tubes. Process connections shall be at the rear of the box. The process connections shall be sized in accordance with the above-mentioned standards.

- 9.2 If process required the instrument, protection boxes shall be electrically heated.

- 9.3 The protection boxes shall not be installed below 1,5m from the grade / platform level.

- 9.4 The protection boxes will be used for:

- 9.4.1 Differential pressure transmitters in the level measuring systems.

- 9.4.2 Pressure switches and transmitters.

- 9.4.3 Differential pressure switches and transmitters.

- 9.4.4 Analyzers installed in the field.

- 9.5 A certificate of anti-static execution is required for all protection boxes.

10. CABLE DUCTS AND SECOND ROUTING

- 10.1 Cables shall be supported in cable trays.

- 10.2 Separate cable trays shall be used for the following cable types:

- 10.2.1 230V, 50Hz power cables.

- 10.2.2 Low voltage in non-intrinsically safe analogue and digital loops.

- 10.2.3 Analogue and digital intrinsically safe marked with blue color.

- 10.2.4 Communication cables (fiber optic).

- 10.2.5 Main cable ducts shall be run along pipe racks in designated trays or on brackets.

- 10.3 The cable trays (ducts) shall be closed with lid.

- 10.4 The cable trays cannot have openings or be perforated, with exception of mounting and draining holes.

- 10.5 Spacing of the cable tray supports shall not exceed 3m.

- 10.6** If many cable ducts are connected in long runs, substantial deformations may arise due to considerable temperature difference. To avoid this expansion, breaks between the runs can be applied.
- 10.7** Cable trays, supports, connecting components shall be hot dip galvanized after fabrication in accordance with LST EN ISO 1461 (DIN 50976), ASTM 386. The zinc coat thickness shall be between 50 and 80 microns on each side (depending on material thickness). Corrosion resistance shall be minimum C4 class (in accordance with LST EN ISO 12944-2 standard). Thickness of sheet should be no less than 1,5 mm.
- 10.8** GRP (Glass-fiber Reinforced Polyester) cable trays shall be used if plant environment requires.
- 10.9** Individual cables shall be routed in galvanized conduits or sectional cable trays.
- 10.10** All cable trays must be earthed and intrinsically safe cable trays have to be additionally designed with „Exi” symbol.

11. MARKING AND LABELING

11.1 Labeling of Main Control Cable

1	–	MC	–	2	–	3	–	4	–	5
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- 1**–Unit section number or OL project number without “MN” or “OLP” label. Section number is indicated if AI part of the project covers the entire unit or greater part of it;
MC –multipair cable;
2 – cable number (increasing sequence of numbering);
3 – signal type:
A – analog signal (i.e. 4-20mA, 0-5V DC or similar) ;
D – discrete, impulse signal;
T – temperature measurement signal;
MUX – multiplexer;
C – communication signals (i.e. FFbus (Field Bus Foundation), FBus (Field Bus), MBus (Mod Bus), PBus (ProfiBus) and etc.);
24VDC or **230VAC** – power supply;
4 – system:
ESD - Emergency Shut Down System – indicated if dedicated to ESD system;
GDAS – Gas Detection and Analysis System – indicated if dedicated to GDAS system.
NOTE. All other cases – not indicated.
5 – equipment protected by “i” type method at potentially explosive area:
Exi – „i” protection method (subgroup not indicated);
NOTE. All other cases – not indicated.

EXAMPLE: 00010-MC-01-A-Exi; 1806-MC-11-D-ESD-Exi; 1706-MC-02-GDAS.

11.2 Labeling of Separate Devices of Main Control Cable

C	–	*	–	1
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- C** – single cable;
***** – device / equipment position / labeling;
1 – signal type:
24VDC or **230VAC** – power supply;

NOTE. All other cases – not indicated.

EXAMPLE: C-PT-2379; C-FT-216/1; C-GT-14-24VDC

11.3 Labeling of Junction Boxes

1	–	JB	–	2	–	3	–	4	–	5
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1 – Unit section number or OL project number without “MN” or “OLP” label. Section number is indicated if AI part of the project covers the entire unit or greater part of it;

JB – junction box;

2 – junction box number (increasing sequence of numbering);

3 – signal type:

A – analog signal (i.e. 4-20mA, 0-5V DC or similar) ;

D – discrete, impulse signal;

T – temperature measurement signal;

MUX – multiplexer;

C – communication signals (i.e. FFbus (Field Bus Foundation), FBus (Field Bus), MBus (Mod Bus), PBus (ProfiBus) and etc.);

24VDC or **230VAC** – power supply;

NOTE. Signal type is not indicated if junction box signals are different

4 – system:

ESD - Emergency Shut Down System – indicated if dedicated to ESD system;

GDAS – Gas Detection and Analysis System – indicated if dedicated to GDAS system.

NOTE. All other cases – not indicated.

5 – equipment protected by “i” type method at potentially explosive area:

Exi – „i“ protection method (subgroup not indicated);

NOTE. All other cases – not indicated.

EXAMPLE: 1806-JB-11-D-ESD-Exi; 00100-JB-03-GDAS; 200-JB-05-MUX-Exi

11.4 Labeling of Junction Boxes Dedicated to Single Device / Equipment / Intermediate Connection of the Equipment Circuit

JB	–	*	–	1	–	2
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JB – junction box;

***** – device / equipment position (labeling);

1 – system:

ESD - Emergency Shut Down System – indicated if dedicated to ESD system;

GDAS – Gas Detection and Analysis System – indicated if dedicated to GDAS system.

NOTE. All other cases – not indicated.

2 – equipment protected by “i” type method at potentially explosive area:

Exi – „i“ protection method (subgroup not indicated);

NOTE. All other cases – not indicated.

EXAMPLE: JB-GT-9-GDAS; JB-FT-8001-Exi

11.5 Labeling of Junction Boxes (for Electric Heating)

SD(*)

***** – position of measuring device which is dedicated to el. heating.

EXAMPLE: SD(FT-253); SD(FT-333,PT-245)

APPENDIX A. INSTRUCTION REGARDING SUBMISSION OF TECHNICAL DOCUMENTATION FOR INSTRUMENT PIPING

For references specification see:

OL-TR-MR-001 *Mechanical. General Welding Fabrication and Inspection*

OL-TR-MPR-001 *Mechanical. Piping*

Upon completion of instrument impulse line piping (hereinafter - piping) installation, revamp or welding, the following technical documentation shall be provided:

- A-1.** Sensor manifold diagram with design specification, indicating instrument position, medium, operating parameters and project No.
- A-2.** Instrument and Measuring Location Layout Plan (Design)
- A-3.** Isometric drawing of the installed impulse piping, indicating the following:
- a) Pipeline elements, their numbering according to the specification;
 - b) Numbering of welded connections;
 - c) Distances between supports (fastening points) and welded connections;
 - d) Passages through access platforms, flooring slabs, walls and other obstacles;
 - e) Welder's name, surname;
 - f) Name, surname of the engineer/technician, who developed the diagram.

NOTE: Accuracy of isometric drawings shall be approved by a representative of Instrumentation and Automation Shop (Shop 11) Operations Section.

- A-4.** List of the attached documents:
- a) A certificate issued by the Ministry of Environment entitling to perform instrumentation and automation equipment installation works in potentially explosive environment and other special structures in industrial, power generation and other economic activity applications (only for contractors)⁽¹⁾;
 - b) List of welders⁽¹⁾;
 - c) Copies of welders' certification records or copies of certificates⁽¹⁾;
 - d) List of welding procedures (LWP) (get approved with Shop 23 before start of work), if the seam is typical previously-approved LWP shall be attached;
 - e) Copy of Welding Work Manager certificate*;
 - f) Shop 23 Chemical Examination Report for welded connections and fittings (only for alloy steel pipe and elements (after installation, revamp or maintenance));
 - g) Certificates, Passports (originals or copies) for the following elements:
 - Pipes;
 - Fittings;
 - Welding materials;
 - Valves;
 - Studs, bolts;
 - h) Maintenance/installation (revamp) Quality Certificate.

NOTES:

- (1) *A set of document copies may be separately submitted to Shop 23.*
- (2) *Piping installation shall be performed according to the requirements included in Attachment No.1.*
- (3) *Submitted documentation shall be stored in Shop 23 (approved copies with the other as-built documentation shall be submitted to the company archive (only for projects)).*
- (4) *Interested employees of Instrumentation and Automation Shop and Contractors shall be familiarized with the Instruction.*

ATTACHMENT 1. REQUIREMENTS FOR INSTRUMENT PIPING INSTALLATION

- AT-1.** Installed “impulse” piping (hereinafter - piping) shall comply with the following requirements:
- The piping shall allow to inspect and test instruments, automation devices and the piping itself while installing, commissioning and operating it without process operation interruption;
 - The piping shall allow to “purge” and “flush” instruments, automation devices and the piping itself without process operation interruption;
 - The piping shall allow to “fill” automation devices and the piping itself with spacer fluids;
 - Removal of accumulated gas from instruments, automation devices and the piping (filled with fluid) itself;
 - Removal of accumulated condensate from instruments, automation devices and the piping (filled with fluid) itself.
- AT-2.** Installed piping shall have slopes for accumulated condensate release and accumulated gas draw. Therefore the piping filled with fat gas shall have condensate accumulation and drainage devices located at the “lowest” points, and the piping filled with gas shall have the devices for accumulated gas drainage located at the “highest” points. While measuring liquid or gas flow rate, the slope shall be directed to differential pressure meter; while measuring air or gas flow rate, the slope shall be directed to the device.
- AT-3.** Installed piping shall have the slopes of $\geq 1:50$ (pressure gauges) and $1:10$ (differential pressure meters).
- AT-4.** The piping from the “acceptance” point to metering converters shall be installed as short as possible parallel to walls, flooring slabs, construction towers, etc.
- The piping shall be installed so that it would not be affected by vibration or mechanically;
 - The piping shall have minimum arms and it shall be located as far from process units and el. equipment as possible;
 - The piping with toxic, explosive, combustible medium shall be installed, fastened and protected so that the piping could be easily inspected;
 - The piping shall be installed within the distance of 25...30 mm from the walls and flooring slabs.
- AT-5.** The piping with toxic, explosive, combustible medium and the piping with safe materials shall be installed separately. The pipelines cannot be installed along with the el. cables. The distance between them shall be ≥ 0.5 m (for piping).
- AT-6.** The piping seams are allowed only in the straight sections.
- AT-7.** The impulse piping shall be installed within the following distances:
- Impulse nonferrous metal piping: horizontal - 0.6...0.75 m, vertical - 0.75...1.0m;
 - Steel piping of diameter 8...14 mm: horizontal - 0.75 m, vertical - 0.75...1.0m;
 - Steel piping of diameter 22...60 mm: horizontal - 2...4 m, vertical - 3...50m.