Spectroflash Ltd

MART-200 / MART-250
PORTABLE X-RAY GENERATOR

Operating Manual

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Radiation Protection Information

Dear Customer,

You have received X-ray generating equipment from our company. This equipment includes an X-ray radiating unit with a built-in X-ray tube, which is an actual source of X-ray radiation.

We have an important legal obligation to inform our customers about certain measures of protection against X-ray radiation. Therefore, we strongly recommend that you should take the following steps.

1) Once energized, your X-ray device become a source of X-ray radiation and may pose a health hazard. When operating the device, follow your country's safety regulations on working with sources of ionizing radiation.

2) Carefully read the Operating Manual and pay special attention to Section 6.

3) Keeping your distance from the source of radiation is often the cheapest and most effective way to protect yourself against radiation. When handling a portable X-ray generator, make use of the full length of the connecting cable between the radiating unit and the control unit.

No operator intervention is required during radiation time once the automatic control system takes over control of the operating process variables. Therefore, the operator can walk farther away from the X-ray tubehead immediately after energizing the high voltage circuits of the unit. The benefit of this measure is enhanced by using a slow high-voltage ramp from zero to a preset value over approximately 30 seconds.

4) Please always keep in mind that X-ray radiation is generated whenever the "X-RAY ON" LED indicator is active.

5) Never leave the key-operated switch in the control unit during breaks at work. Keep the key-operated switch in a safe place to prevent unauthorized use.

1 Introduction

1.1 This manual is intended for personnel involved in the operation of MART-200 and MART-250 portable X-Ray Generator (hereinafter 'device') and gives the user important information about the device specifications, design, operating principle and standard operating procedure to ensure that device functionalities are fully used.

2 Application

2.1 This device is designed to be used as a source of X-ray radiation for non-destructive radiographic testing of materials.

2.2 The devices of MART Series are included in Gazprom's Register of Non-Destructive Test Equipment for Welded Joints.

3 Specifications

Table 1 – Summary of X-ray radiographic specifications

Parameter	Value	
	MART-250	MART-200
3.1 Minimum exposure dose of X-ray radiation [1](R)	5	3
3.2 Anode current, uncontrolled (mA)	0.8	0.5
3.3 X-ray tube voltage control range (kV)	130 – 250	105 – 200
3.4 Steel penetration thickness for radiography [2](mm)	30	20
Notes 1 Based on 1-minute direct beam exposure at a distance of 500 mm from the focal spot at the maximum anode voltage for this device 2 Based on 10-minute exposure using AGFA D7 film with lead shields at a focal distance of 700 mm		

3.5 The weight and overall dimensions of device components should not exceed the limits specified in Tables 2 and 3:

Table 2 – Weight of device components

In kilograms

Component	MART-250	MART-200
X-Ray Tubehead	9	6
Control Unit	4	4

Table 3 – Overall dimensions of device components

In millimeters

Component	MART-250	MART-200
X-Ray Tubehead	580×140×190	430×100×160
Control Unit	330×260×170	330×260×170

3.6 Beam exit geometry:

- MART-250 – tubehead side cone with maximum 50° directional beam angle;
- MART-200 – tubehead end cone with 140° panoramic beam angle and 60° directional beam angle.

3.7 Actual radiographic sensitivity conforms to Class 1 of GOST 7512.

3.8 Repeatable short-cycle runtime; maximum 10-minute runtime of energized X-ray tube; duty cycle 1:1.

3.9 Focal spot diameter at maximum anode power is specified in Table 4.

Table 4 – Focal spot diameter

In millimeters

Model of device	Nominal	Maximum
MART-250	0.8×1.2	0.9×1.4
MART-200	2.0	2.2

3.10 Maximum power consumption: 450 VA.

3.11 Supply voltage: single-phase 230Vac ± 10% or 220Vac ± 10%, 50 ± 1Hz.

3.12 Degree of protection with connectors plugged in: IP20.

3.13 Operating conditions in terms of external climatic factors: ambient temperature of minus 20 °C to plus 40 °C, atmospheric pressure of 86.6 to 106.7 kPa (650 to 800 mm Hg); relative humidity of 98% at plus 25 °C and lower temperatures without moisture condensation.

3.14 Protection class: Class I by GOST R 58698 (IEC 61140:2016).

3.15 The level of radio interference generated by device in operation does not exceed the limit values for Class A equipment as per GOST R IEC 61326-1.

3.16 Mean time to failure is minimum 200 hours. Failure is understood to mean a reduction in the exposure dose by 25% or more compared with the minimum value stated in Section 3.1. The above mean time to failure parameter is achieved if consumer operator implements the required operating conditions and provides proper maintenance and repair.

3.17 The full average service life of device is 5 years provided that X-Ray tube is replaced as soon as it fails past its useful life and the device is properly maintained on a regular basis.

NOTE: Depending on the product's condition, the actual lifetime may exceed the above period.

4 Scope of Supply

4.1 The standard scope of supply includes:

- X-Ray Tubehead,
- Control Unit,
- Connection cable and Power supply cable,
- Operating Documentation,
- Carrying Case or Bag.

4.2 Accessories and Options

4.2.1 The scope of supply may include tubehead mounting accessories listed in Appendix B.

4.2.2 Each MART-200 model comes complete with a 60×60° collimator assembly.

Note – Collimator assembly includes a lead diaphragm and a holder.

4.2.3 An optional collimator kit for various angles of coverage (Appendix C) may be ordered for inclusion in the MART-200 supply package.

4.2.4 Additional connecting cables may be ordered for inclusion in the supply package.

5 Overview and Operating Procedure

5.1 Design and Operating Procedure

MART-250 model supports directional beam mode only, MART-200 model supports both directional and panoramic (within certain limits) beam modes; in directional beam applications, a collimator assembly is attached to the device to limit the solid angle of X-ray radiation.

The device operates on the conventional thermionic emission principle, whereby X-ray radiation is generated in an X-ray tube by applying constant potential high voltage to the tube electrodes.

The main electric circuit includes intermediate frequency conversion to reduce the size and weight of the device, suppress high voltage pulses and stabilize supply voltage.

The high-voltage section is based on a voltage multiplier circuit. The X-ray tube uses constant stabilized voltage

5.2 Description of Device Components

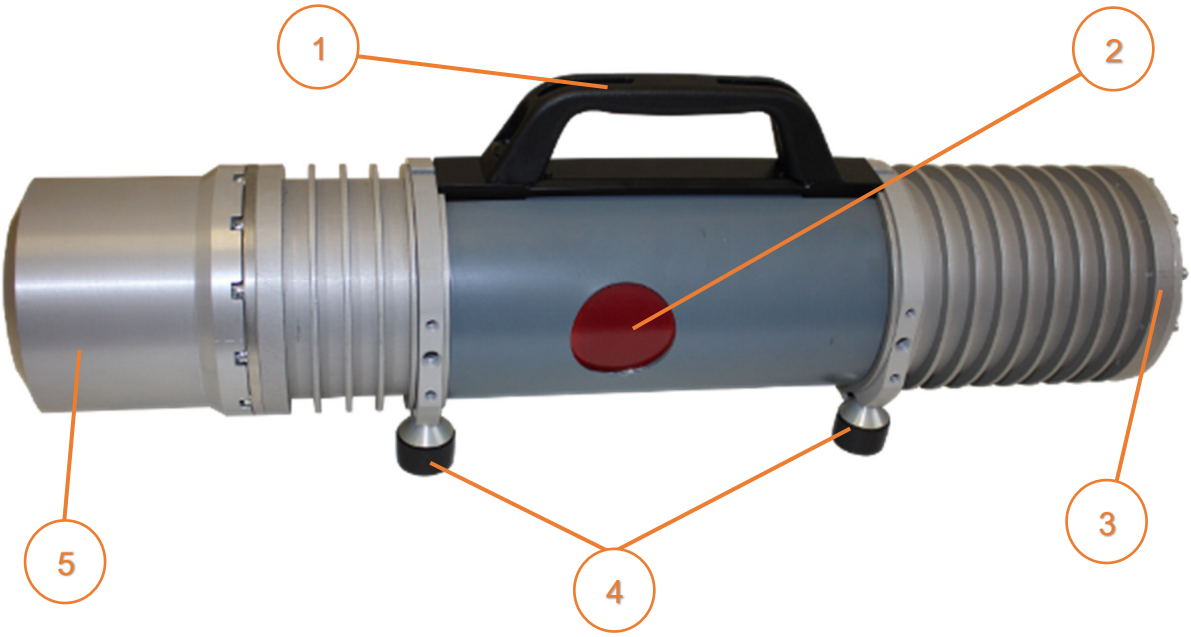
The device structurally consists of X-Ray Tubehead and external Control Unit interconnected by a 30-meter cable.

5.2.1 X-Ray Tubehead

The X-ray tubehead is filled with transformer oil and contains a source of constant potential high-voltage and a thermionic X-ray tube.

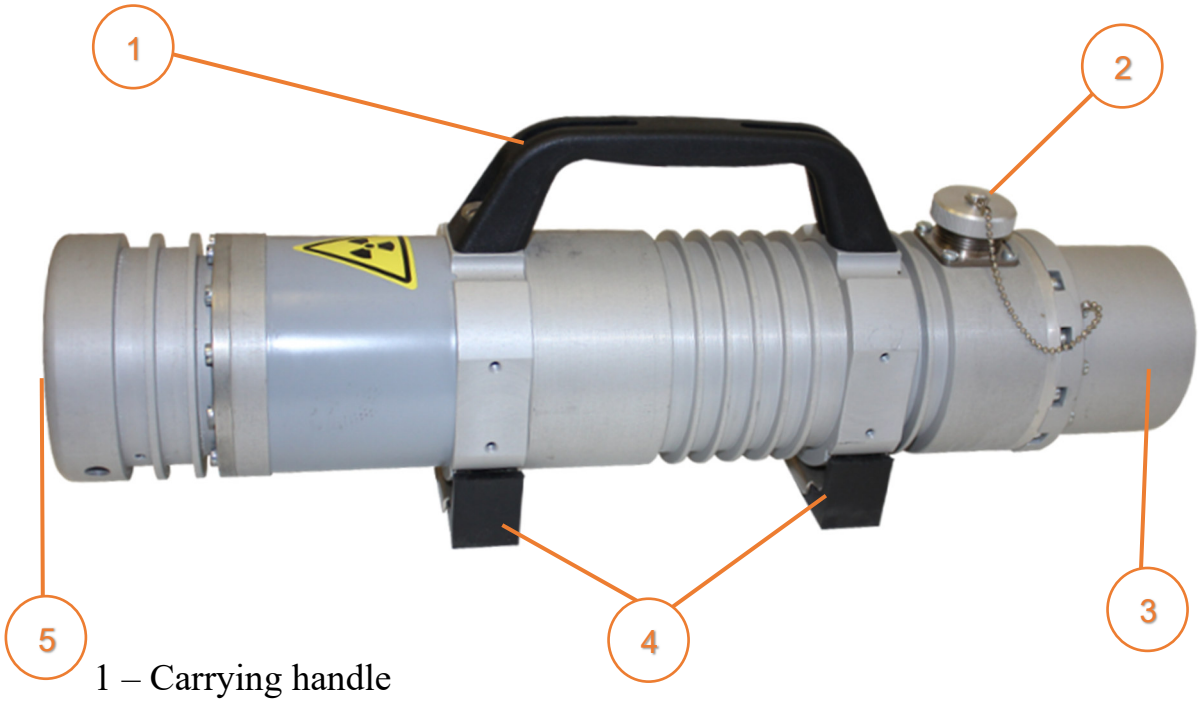
The source of constant potential high-voltage consists of a connection closed ferrite core transformer and a high-voltage multiplier.

General views of MART-200 and MART-250 X-ray tubeheads are shown in Figures 1 – 4.

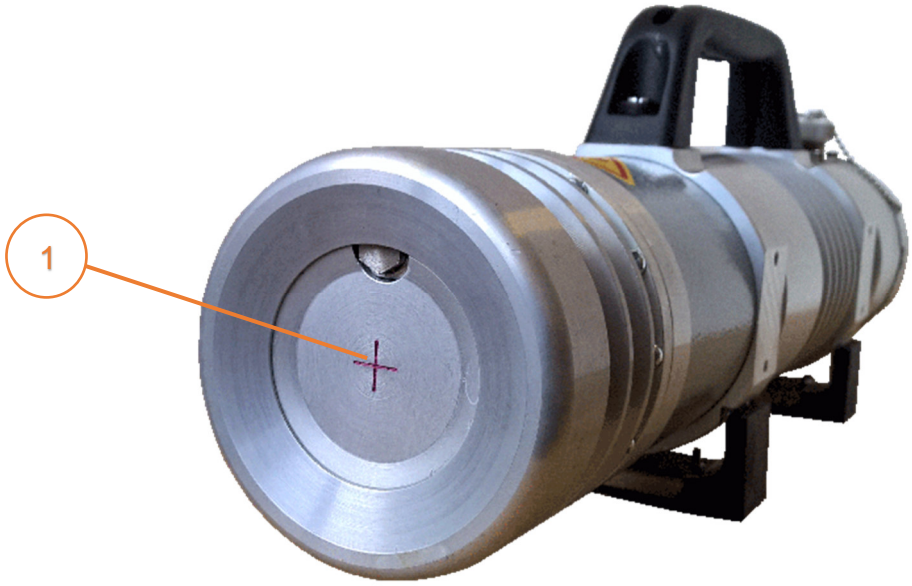


1 – Carrying handle.
2 – X-ray beam exit window.
3 – Connection side for connection cable.
4 – Rubber pad legs.
5 – Oil expansion compensator cover.
Figure 1 – MART-250. X-ray tubehead, beam exit side

1 – Connection port for connection cable.
2 – Protective cover for unused connection port.
Figure 2 – MART-250. X-ray tubehead, connection port side



1 – Carrying handle
2 – Connection port for connection cable.
3 – Oil expansion compensator cover.
4 – Rubber pad legs.
5 – X-ray beam exit side. Collimator assembly location
Figure 3 – MART-200. Side view



1 – Center of X-ray beam exit window.
Figure 4 – MART-200. View of beam exit side

5.2.2 Control Unit with Digital Indicator

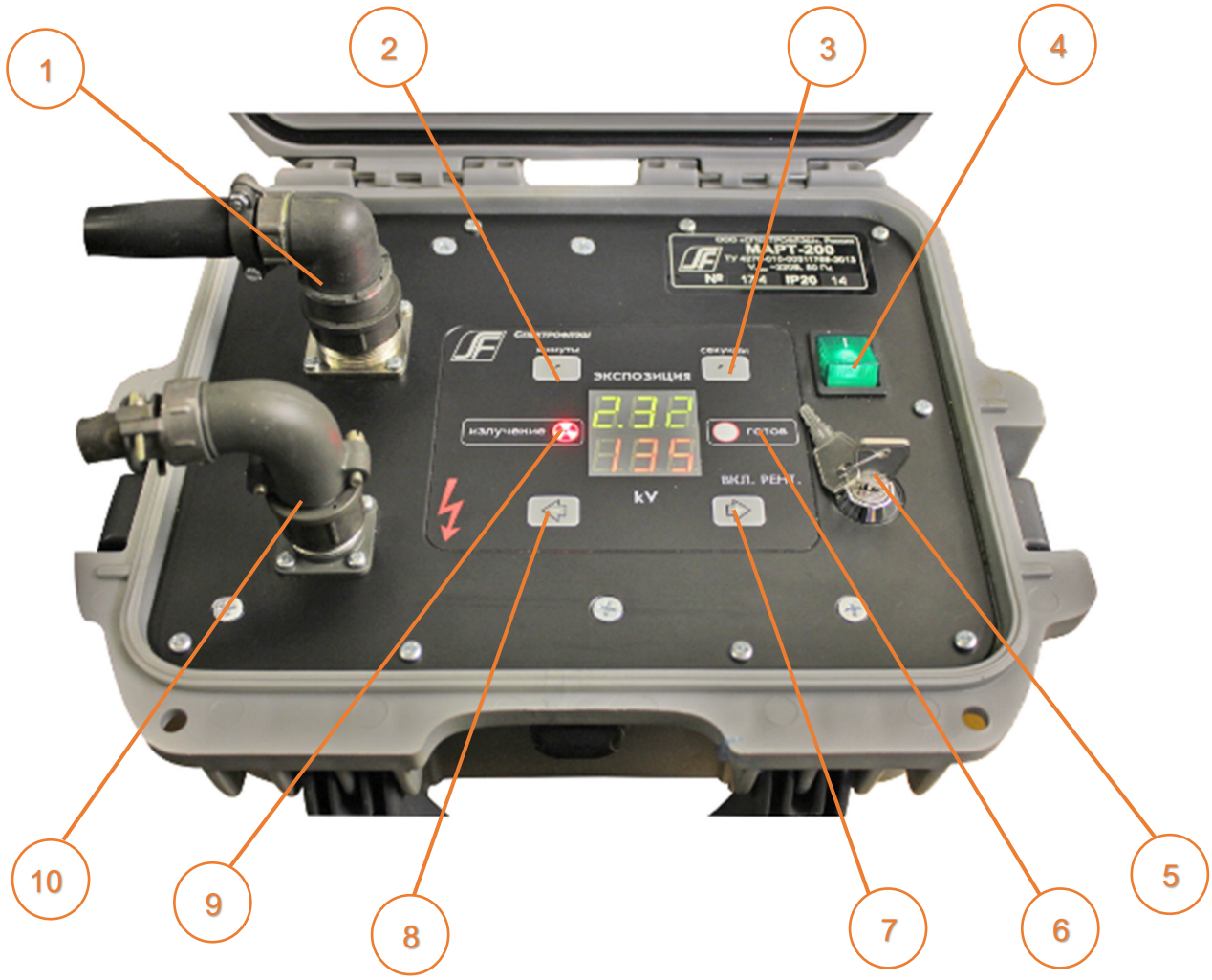
The Control Unit contains power supply unit, frequency converter, anode-current and high-voltage stabilizer circuits, and device controls.

The following controls and indicators are located on the front panel:

- "POWER" supply rocker switch;
- "X-RAY ON" key-operated switch for energizing high-voltage circuit;
- Digital indicator of exposure time and voltage;
- Pushbuttons for setting exposure time in minutes (‘) and seconds (‘‘)
- Pushbuttons for setting high voltage (kV): (-) and (+);
- "READY" LED indicator. Its lit state indicates that the high voltage circuit cannot be energized;
- "X-RAY ON" LED indicator. Its lit state indicates that the high voltage circuit is energized.

Connection ports for power cable and connection cable are located on the control panel.

External view of the Control Unit and layout of controls is shown in Figure 5. The general layout and functions of controls are identical for both models of device.



1 – Connection port for connection cable to connect the Control Unit to the X-ray tubehead. MART-200 andMART-250 models use different types of connectors.
2 – Pushbutton for setting exposure time in minutes.
3 – Pushbutton for setting exposure time in seconds.
4 – Power rocker switch for 230 V supply mains.
5 – key-operated switch / X-RAY ON switch.
6 – "READY" LED indicator
7 – Pushbutton for decreasing high voltage.
8 – Pushbutton for increasing high voltage.
9 – "X-RAY ON" LED indicator.
10 – Connection port for power cable from 230 V mains.

Figure 5 – Control Unit of MART-200/MART-250 devices

5.3 Operating Procedure

Power up the device by toggling its Power rocker switch from position ⓿ to position ❶, the neon lamp inside the switch lights up. At the same time, the digital indicator lights up displaying the last used settings of time in minutes and seconds (top section) and voltage in kilovolts (bottom section).

The "READY" LED lights up in red, indicating that voltage is now supplied to the filament of the X-ray tube to warm up the filament. Wait 1 – 2 minutes for the "READY" LED to go off. This means that the filament is sufficiently warmed up and the device is ready to energize X-ray radiation. Whenever the temperature inside the X-ray tubehead exceeds the overheat limit of 70°C at any time during operation, the high-voltage circuit is deactivated automatically. This is indicated by the "READY" LED returning to its lit state. The high voltage circuit will remain deactivated until the "READY" LED goes off.

Select exposure time by using pushbutton (**‘) in one-minute increments** and pushbutton (**‘‘)** in 10-second increments to set a value in the range from maximum 9 minutes 59 seconds to minimum 40 seconds.

Select high voltage values in 5 kV increments by using pushbuttons (-) and (**+**). Available for selection are voltage ranges from 105 kV to 200 kV in MART-200 model, and from 130 kV to 250 kV in MART-250 model.

Energize the high voltage circuit by turning the "X-RAY ON" key-operated switch 90° clockwise. Now the timer starts counting down the exposure time, "X-RAY ON" LED indicator lights up, and the voltage indicator at the bottom keeps displaying selected value. Once exposure is completed, the "X-RAY ON" LED indicator goes off, the timer starts counting down the required pause time, and the voltage indicator displays dash marks.

The pushbuttons remain interlocked for as long as the timer is active to prevent changes to the operating mode. Once pause is completed, you are allowed to make changes to the operating mode.

Before re-energizing the X-ray tube, turn the "X-RAY ON" key-operated switch 90° counterclockwise to its initial position.

6 Safety Instructions

6.1 Types and Sources of Hazard

6.1.1 The device may become a hazard as a source of X-ray radiation (for as long as its X-ray tube is energized). The device generates X-ray radiation from the X-ray tube, which is installed in the X-ray tubehead. The X-ray tube neither contains nor generates under operating conditions any radioactive substance. The X-ray tube becomes a source of ionizing radiation only when energized with supply voltage. In its de-energized state, the X-ray device is not a radiation hazard and does not require special radiological protection in transportation and storage.

6.1.2 This device is classified as a portable item in terms of its use method.

6.2 Key Safety Requirements and Applicable Precautions

6.2.1 Once energized, the X-ray device becomes a source of X-ray radiation and may become a health hazard. When operating the device, follow your country's safety regulations on working with sources of ionizing radiation.

6.2.2 The operator must stand in the opposite direction to the X-ray propagation, at a distance that ensures an average dose rate of 10 μSv/h. If no extra protections are applied, such distance should be 30 meters.

6.2.3 To meet the above requirements, the time of handling the X-ray generator without any extra protections should not exceed 30 minutes per hour.

6.2.4 The approximate radius of restricted access area for operating the device in an open space (without allowance for any protective equipment) is estimated for reference as shown in Table 6.

Table 6 – Provisionally estimated radii of restricted access areas

In meters

MART-200			MART-250		
In front of the beam	Alongside the beam	Behind the beam	In front of the beam	Alongside the beam	Behind the beam
225	80	65	320	95	95

NOTE – These distances are estimated assuming the device runtime is limited to 30 minutes per hour, a dummy target of 5-mm steel thickness is exposed in front of the beam, and, for directional beam mode, the radiation divergence angle is collimated to 60°.

The radius of a radiation hazard area may be reduced by using X-ray protective screens.

6.2.5 When performing industrial X-ray radiography within indoor process areas, on outdoor locations and out in the field, make sure that all non-essential personnel stay away from the restricted access area for as long as the X-ray generator is energized. Install protective barriers and safety signage around the restricted access area with warning symbols/lettering clearly visible from a minimum distance of 3 meters.

It is recommended to perform X-ray radiography in industrial buildings outside of working hours.

6.2.8 Use only special storage rooms for safekeeping of X-ray devices to prevent stealing or unauthorized use.

6.2.9 Only specially licensed service companies or specially qualified in-house personnel shall be permitted to repair X-ray devices.

6.2.10 Always assign two employees to perform X-ray radiography within indoor process areas, on outdoor locations and out in the field.

6.2.11 When operating the X-ray device, make sure the radiation hazard area directly in front of the X-ray beam does not reach any buildings, workplaces or walking routes to minimize the risk of people accidentally entering the radiation hazard area.

6.2.12 The X-ray device operator must be positioned outside the radiation hazard area (at least 30 meters behind the source of X-ray beam).

6.2.13 A third ground wire is a mandatory requirement for the power supply mains to provide grounding via the respective ground wire in the power cable of the X-ray devices as per GOST 12.1.030.

7 Preparing Device for Operation

7.1 Visually inspect the device in accordance with the Manual on Maintenance and Electrotechnical Tests.

7.2 CAUTION: Make sure the connector contacts are free from dirt, moisture/snow.

Remove dirt by using coarse calico wipes dabbed in ethanol (wring out excess ethanol).

7.3 When operating the device, protect its control unit and connector ferrules from ingress of atmospheric precipitation to prevent damage to the device.

Remove dirt and moisture (if any) from the outside of connector ferrules and dry out their surface before unplugging connectors to prevent ingress of dirt and moisture into the connector port and in between contacts.

CAUTION: Take special precautions when using this device at sub-zero centigrade temperatures! Energizing the tubehead under such conditions will result in disruptive discharge and damage to the device.

If taken from a sub-zero centigrade storage temperature, the device needs to warm up to approx. 0°C, which can be achieved e.g. after 3...5 hours at room temperature. Please keep in mind that there is a considerable delay in heat transfer

from the housing walls to the inner parts of the unit, meaning that the unit's outer surface appears sufficiently warm long before its internals reach the same temperature.

Condensate may form on electrical connectors after warming up. Closely check connectors for signs of moisture. Remove any condensate from connectors with ethanol.

Then take 3 exposures 10 minutes each at minimum voltage. Make sure to complete all of the above steps before proceeding to the X-ray tube seasoning sequence. Once energized, the tubehead will generate sufficient heat to remain operational.

Do not leave the tubehead at freezing outdoor temperatures for extended breaks at work.

7.5 An attempt to energize the tubehead at a lower temperature may result in a high-voltage insulation fault. This will damage the tubehead beyond repair.

7.6 Connect the Control Unit to the X-ray tubehead with connection cable (by connecting the right-angle connector to the control unit).

CAUTION: Never use the X-ray tubehead in combination with a control unit that has a different assembly number, and never use for connection a connection cable supplied for a different device.

When using a replacement connection cable supplied by the manufacturer, apply extra limits to the range of operating voltages as follows: decrease by 10% the maximum operating voltage and increase by 10% the minimum operating voltage against respective data-sheet values of the product passport. Only approved rated cable can be expected to support the maximum and minimum values of operating voltage. The assembly number of such a cable is identical to the assembly number of the device. The cable has marking on one of its connection ends. A replacement cable has no assembly number. Only one approved cable can be supplied together with the device.

7.7 Make sure the POWER switch is set to position ⓿.

7.8 Connect the power cable of the Control Unit to 230 Vac power mains.

7.9 Set up and orient the X-ray tubehead as required to inspect the target.

7.9.1 When adjusting the orientation of MART-250 tubehead in relation to the target weld, keep in mind that the cone of X-ray beam has different angles of longitudinal and transverse divergence, and the cone axis is angled at 5 degrees toward the device housing. The recommended orientation of the X-ray tubehead is ALONG THE PIPE AXIS to maximize the coverage of weld length within wider divergence angle of 50° exposed at a small tubehead-to-weld offset as shown in Figure 6.

It is not recommended to orient the X-ray tubehead along the weld axis as shown in Figure 7. A comparison of the diagrams indicates that the latter orientation covers a smaller weld segment (within 40° angle) and, therefore, requires more exposures.

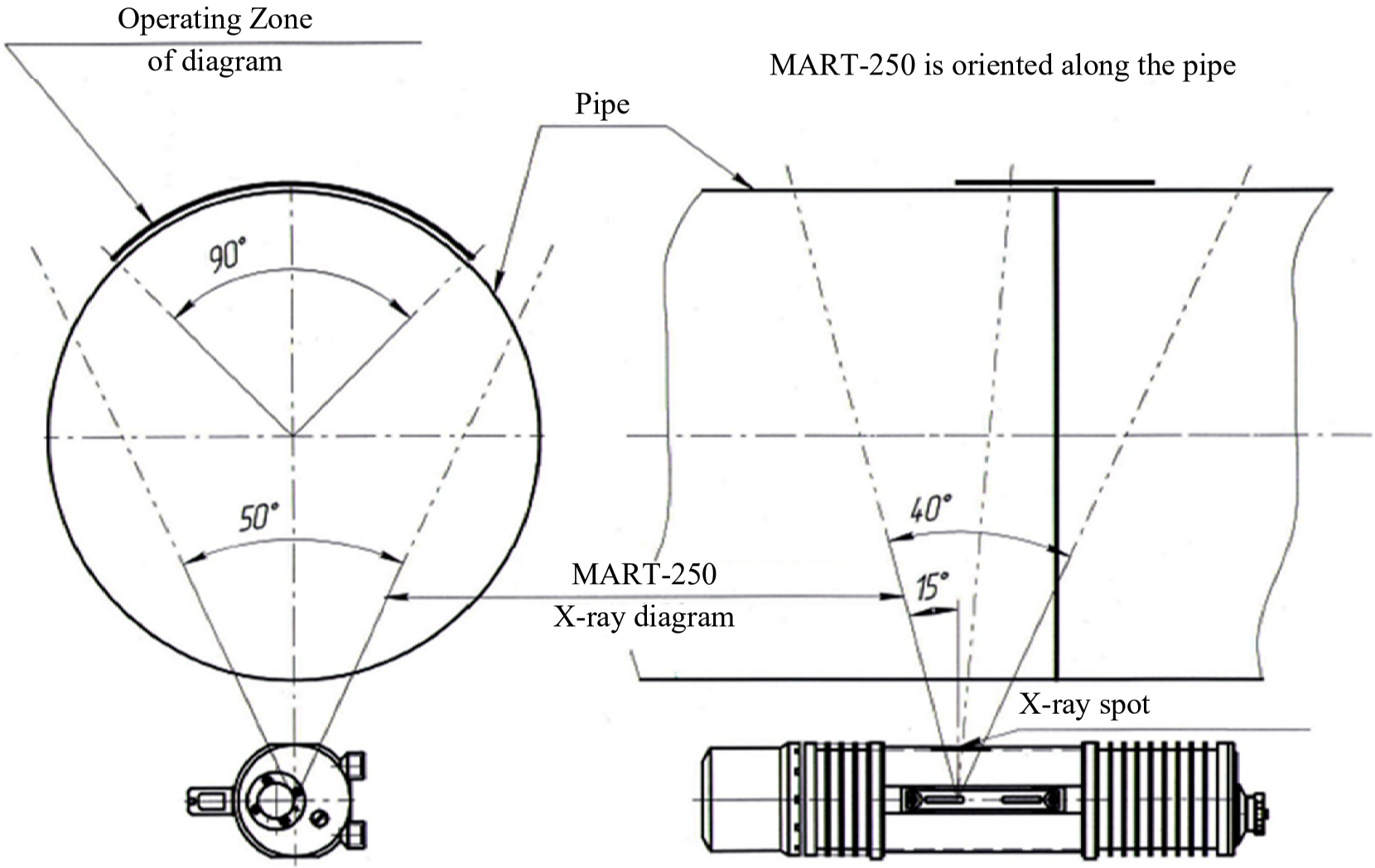


Figure 6 – Recommended orientation of the MART-250 tool

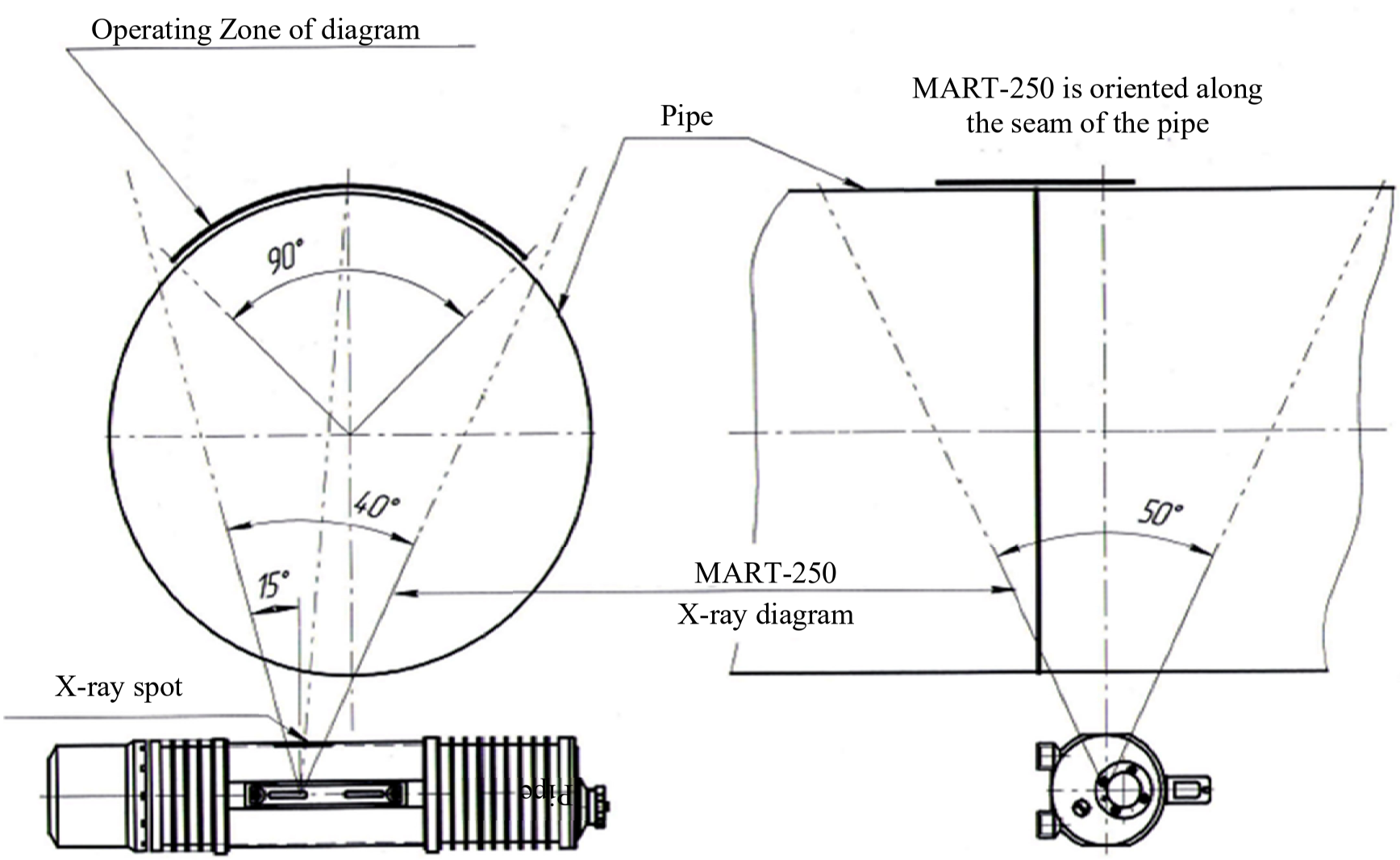


Figure 7 – Non-recommended orientation of the MART-250 tool

7.9.2 In its panoramic beam mode, MART-200 tubehead needs to be offset a certain distance from the weld. A schematic diagram of the tubehead position inside a pipe is shown in Figure 8.

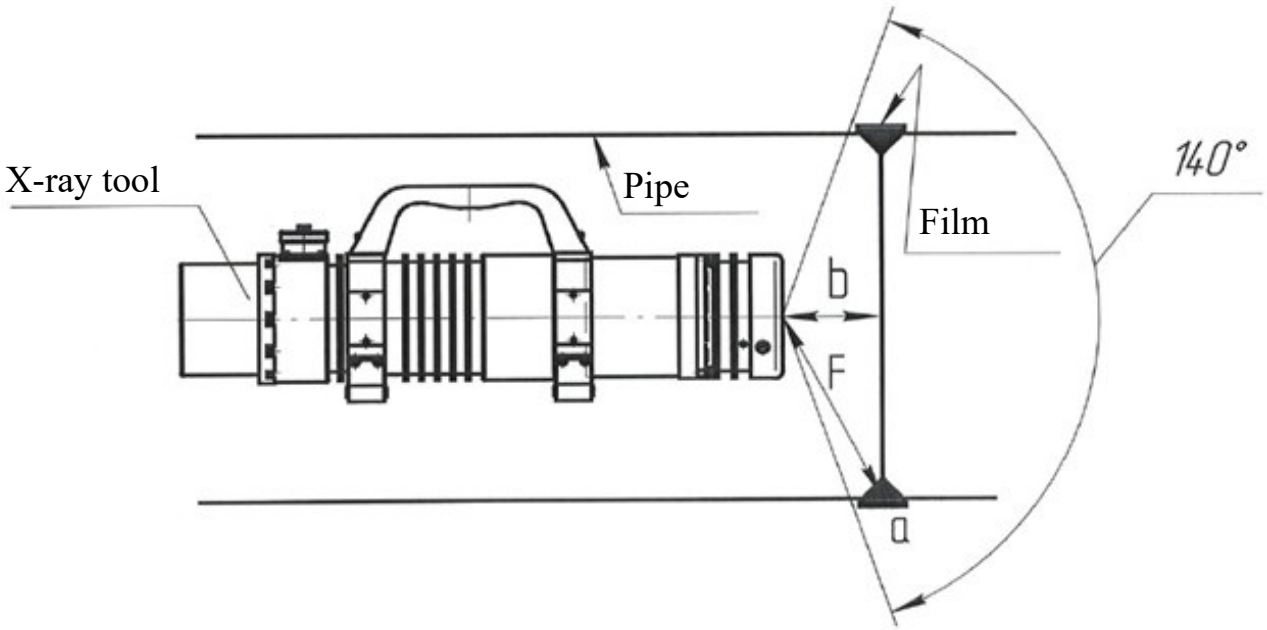


Figure 8 – MART-200 tool offset for panoramic beam imaging

Two parameters are of interest: tubehead-to-weld offset (b) and focal distance (F). These can be calculated from the known pipe diameter (D) and film width (a).

Note – The film width is important because the cone of X-ray beam divergence needs to cover the weld line as well as the entire width of the film.

The offset between the end of tubehead and the weld can be calculated from the equation:

$$b = \frac{D}{5.5} + \frac{a}{2} \quad (1)$$

where:

b is the offset between the end of tubehead and the weld;

D is the pipe diameter;

a is the film width (margin of tolerance to be selected based on experimental data).

The focal distance can be calculated from the equation:

$$F = \sqrt{b^2 + \left(\frac{D}{2}\right)^2} \quad (2)$$

where:

b is the tubehead offset calculated from equation (1);

D is the pipe diameter.

Table 7 lists provisionally estimated values of tubehead-to-weld offset for certain pipe diameters assuming that 100-mm film is used.

Table 7 – Tubehead-to-weld offset for positioning MART-200
In millimeters

Pipe diameter	Offset (b)	Focal distance (F)
200	90	135
300	105	185
400	125	235
500	145	290
600	160	340
700	180	395

7.9.3 In directional beam applications of MART-200, the solid angle of X-ray radiation needs to be limited. This is achieved by assembling and fixing a beam-limiting collimator onto the end of the X-ray tubehead as shown in Figure 8a. Assemble collimator with its black painted side facing inward.

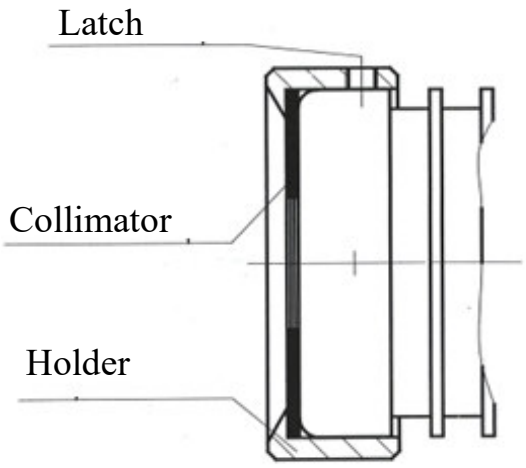


Figure 8a – Collimator assembly on tubehead

7.10 Position the Control Unit a safe distance away from the X-ray tubehead. Failing any additional protection, the safe distance is the length of the connection cable.

7.11 The tubehead can be mounted on the target using the mounting accessories listed in Appendix B. A flash lamp indicator may be used as an X-ray radiation warning accessory (see Appendix C).

7.12 Connecting any equipment that is not included in the scope of supply may result in electromagnetic emission exceeding the limit values of GOST R IEC 61326-1.

8 Operating Procedure

8.1 General Requirements

8.1.1 CAUTION: Thermionic emission X-ray tubes must complete a seasoning sequence at initial start-up and after extended downtime. Failure to meet this requirement may result in damage to the device.

8.1.2 Make sure the device is disconnected from the power mains before setting up and moving the X-ray tubehead**.**

8.1.3 CAUTION: When unplugging cable connectors, prevent ingress of dirt and moisture to connector contacts.

8.1.4 CAUTION: Take special precautions when using this device at sub-zero centigrade temperatures! Read section 7.4 before powering up.

8.2 Seasoning Sequence

8.2.1 A daily seasoning sequence has to be run on the X-ray tube every day before the start of work.

If this device has not been used for more than one month, take at least 4 exposures 10 minutes each at minimum voltage, and then 5 exposures at half voltage before proceeding to the seasoning sequence.

8.2.2 For seasoning, select the maximum voltage setpoint that will be used in actual operation, use pushbutton (‘) to select (E), and then start the seasoning sequence by turning the "X-RAY ON" key-operated switch**.** This will ramp up the tube voltage from minimum value to the setpoint in 10 minutes.

CAUTION: When using a replacement connection cable, do not bring the setpoint to the maximum anode voltage (see Section 7.6).

8.3 Operating Sequence

8.3.1 Select the desired setpoint value of high-voltage taking into account limitations of Section 7.6. Select a high voltage setpoint value in 5 kV increments by using pushbuttons (-) and (+**)**.

8.3.2 Set the required exposure time that should be at least 40 seconds.

CAUTION: Do not exceed the continuous runtime limit of 10 minutes.

If necessary, split the required total exposure time into several portions, each not more than 10 minutes. Pause between exposures/portions of exposure, making sure that the time of each pause equals or exceeds the preceding exposure runtime.

8.3.3 Energize HV circuit by turning the "X-RAY ON" key lock switch**.**

8.3.4 Space charge is generated on the X-ray tube glass in the process of operation. Space charge does not interfere with the device operation except in transition to lower anode voltage (compared with the previous cycle), when space charge tends to delay the rise in anode current by a few minutes resulting in an underexposed first X-ray image. This can be avoided by shutting down the device for at least 1 hour before making transition to lower anode voltage, or by taking a 10-minute exposure without X-ray imaging.

8.3.5 MART-250 is designed for directional beam applications only. The focal point of its X-ray tube is located inside the X-ray tubehead, providing 50° of solid angle radiation.

8.3.6 The end-cone beam exit geometry of MART-200 with about 140° of solid angle radiation coverage provides a nearly panoramic beam imaging. For directional beam applications, assemble a beam-limiting collimator as shown in Section 7.9.3. A specially designed Collimator Kit (see Appendix C) can be used to effectively limit the unused portion of X-ray radiation.

8.3.7 It should be noted that being designed for a relatively low radiation output, the devices of MART series tend to substantially benefit from the use of fluorometallic (RCF) screens and STRUCTURIX F8 X-ray film, or from digital radiography processes.

Appendix A shows provisional exposure charts. All exposure charts are calculated assuming the use of 700-mm focal distance and AGFA D7 film with lead shields.

Consider using Exposure Calculator on our website sections Documentation – Tools.

8.3.8 Monitor the X-ray tubehead temperature during work breaks to make sure it equals or exceeds minus 10°C.

9 Care and Maintenance

9.1 Please note that thermionic emission X-ray tubes must necessarily complete a seasoning sequence at initial start-up and after extended downtime in operation. The seasoning sequence is described in Section 8.2.

9.2 Maintain the connector interfaces of the Control Unit, X-ray tubehead and connection cable in clean condition and protect them against ingress of dirt and moisture. Remove dust and dirt by using coarse calico wipes dabbed in ethanol (wring out excess ethanol).

9.3 Visually inspect the outer surfaces of the device on a regular basis. For visual inspection procedure refer to the Manual on Maintenance and Electrotechnical Tests.

9.4 When operating the device, protect the Control Unit and connector ferrules from ingress of atmospheric precipitation.

9.5 Protect your devices from falls and impacts, because hard impacts may damage the X-ray tube.

10 Measurements and Functional Tests

10.1 The device should be functionally tested by using any properly certified dosimeter to measure the exposure rate of X-ray radiation. Functional test is understood to be passed if the dose value is not lower than the value stated in Section 3.1.

10.2 For measurement procedure and required instrumentation refer to the Manual on Maintenance and Electrotechnical Tests.

11 Troubleshooting

11.1 Generally, it is the X-ray tube or a component of the high-voltage power cell that may fail. A device in need of repair should be sent to the manufacturer.

12 Packaging

12.1 The manufacturer ships devices packed into transportation cardboard boxes and protected with impact absorbing polystyrene foam. Alternatively, wooden boxes of appropriate strength may be used.

12.2 Cold-corrugated cardboard, polyurethane foam, packing paper and the like are used as filling materials.

13 Transportation and Storage Requirements

13.1 Transportation

13.1.1 Transportation conditions conform to Mechanical Stability Category "Л" of GOST R 51908; and are equivalent to Climatic Stability Category 2 of GOST 15150 with special provision for a modified temperature range from minus 30°C to plus 50°C.

13.1.2 The device can be transported by any means of conveyance in enclosed vehicles as per the freight transportation rules applicable to a given means of conveyance.

13.1.3 The devices shall be firmly positioned and secured inside the vehicle to prevent them from moving around during transit.

13.1.4 During loading and unloading, pay attention to package marking symbols and take every precaution to prevent damage to the packing and contents.

13.1.5 Non-hazardous freight.

13.2 Storage

13.2.1 When protected by its original packing and temporary preservation material, the device has a shelf life of 3 years.

13.2.2 Storage conditions conform to Mechanical Stability Category "M4" of GOST 30631 through the entire shelf life; and equivalent to Climatic Stability Category 2 of GOST 15150 with special provision for a modified temperature range from minus 30°C to plus 50°C.

13.2.3 Through the entire period of storage up to commissioning, the device packing shall be visually inspected once a year and in every transition to a new storage area.

14 Environmental Protection and Disposal Requirements

14.1 The device is not an environmental hazard – whether in storage, transportation or operation – as long as the requirements specified in its operating documentation and in applicable sanitary regulations are observed.

14.2 The requirements of OSPORB-99/2010 apply to the device disposal.

14.3 Hazardous materials resulting from the disposal of this device include transformer oil (used as a high-voltage insulation material in the X-ray tubehead) and lead-containing solder.

14.4 Disposal of this equipment should be handled by a specialized company.

15 Manufacturer's Warranty

15.1 Warranty claims shall only be considered if maintenance instructions are fully observed.

16 Further Information

For further information please contact us via any of the contact methods below:

- Visit our website www.spectroflash.com and use the Documentation section,
- Write us an e-mail: sbyt@spectroflash.ru
- Call our Sales Team using the phone numbers provided on page 2 of this Manual.

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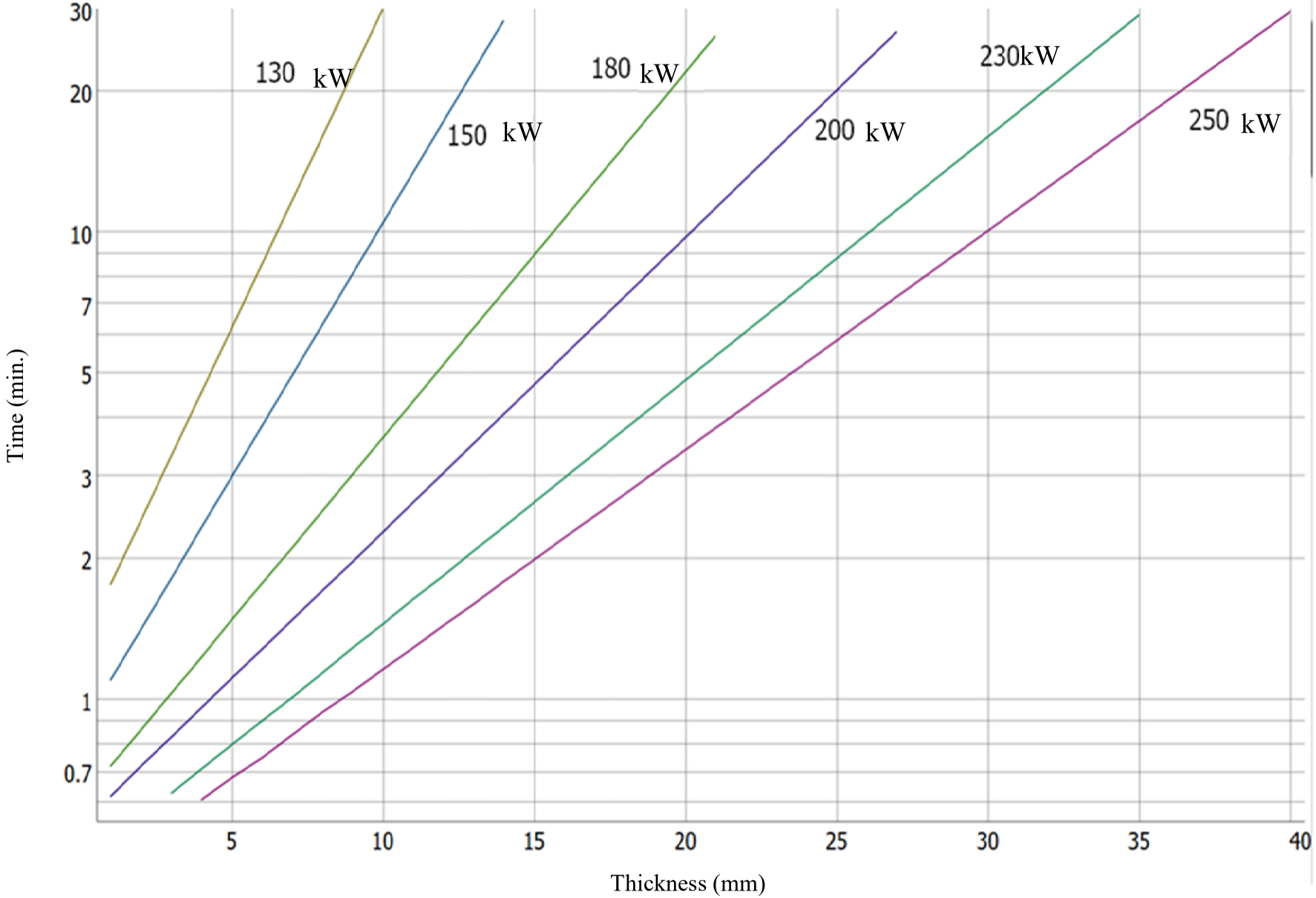
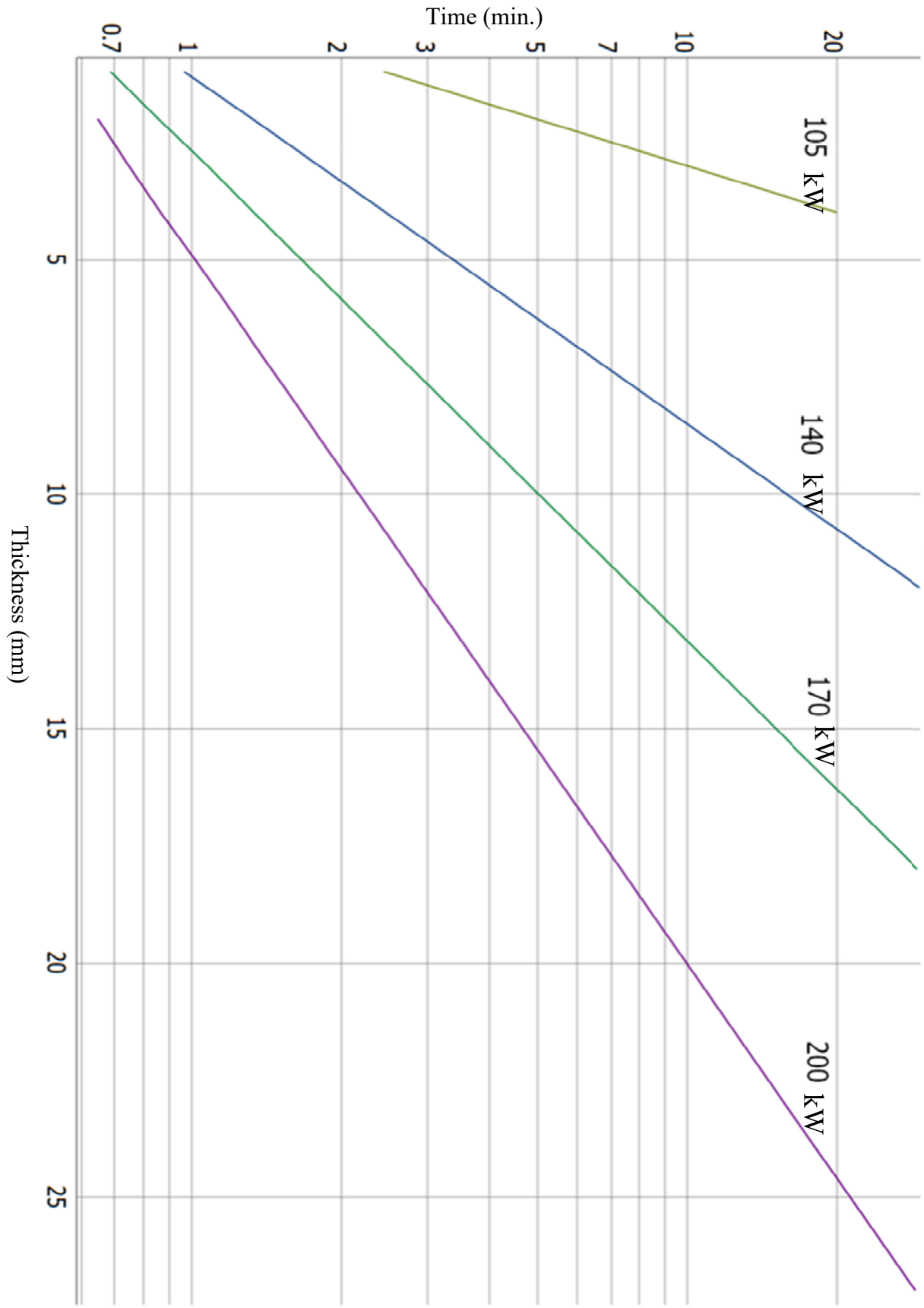
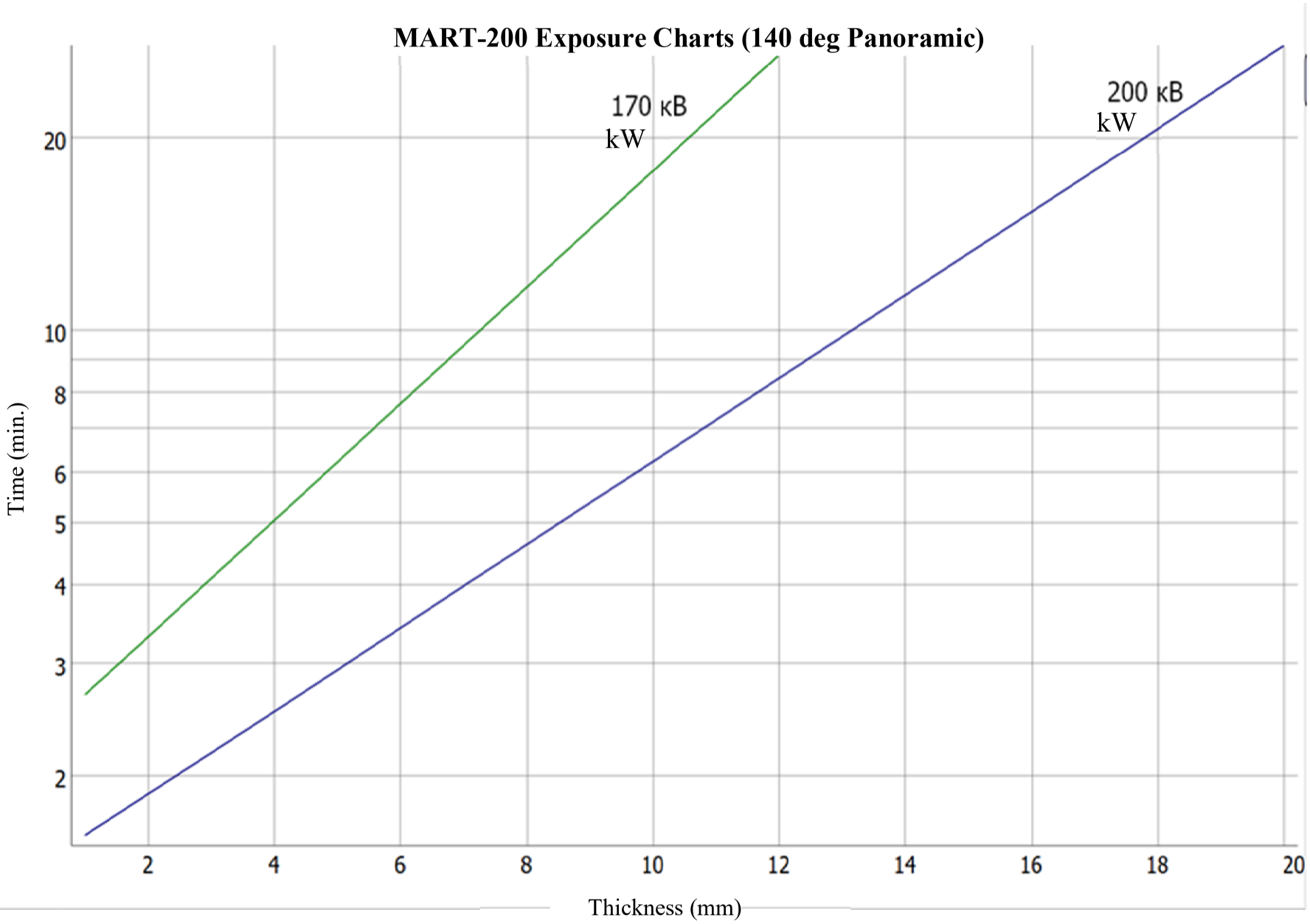
Appendix A (Reference)
Provisional Exposure Charts

Provisional exposure charts in this Appendix are for reference only, including MART-250 directional beam mode, MART-200 directional mode and pseudo-panoramic beam mode (140°).

MART-250 Exposure Charts




MART-200 Exposure Charts (Directional)
Time (min.)
20
10
7
5
3
2
1
0.7
105 kW
140 kW
170 kW
200 kW
5
10
15
20
25
Thickness (mm)


MART-200 Exposure Charts (140 deg Panoramic)
170 kB
kW
200 kB
kW
Time (min.)
20
10
8
6
5
4
3
2
2
4
6
8
10
12
14
16
18
20
Thickness (mm)

Appendix B
(Informative)
Mounting Accessories

B.1 SPIDER Series: Tubehead Magnetic Positioning Bracket

Designed for mounting an X-ray tubehead on target metal surfaces with magnetic properties. A knockdown mounting structure consisting of a steel base frame and four legs with adjustable ball-joint links to magnetic pads. The X-ray tubehead is positioned on the steel base frame and secured in place with screws. The focal distance is adjusted by replacing leg sets on a case-by-case basis. To this end, four sets of legs in different sizes are included in the supply package.

Figure B.1 – PAUK Spider Bracket with a set of replaceable legs to support MART-250 X-Ray Generator

Figure B.2 – PAUK Spider Bracket with a set of replaceable legs to support MART-200 X-Ray Generator

Recommended for use on target diameters of 219 mm and larger.

Comes in a number of modifications to suit mounting design of various tubehead models. When ordering please specify the model of your X-ray device to ensure compatibility with the accessory ordered.

On flat targets a MART-250 X-Ray Generator can be adjusted to provide focal distances of 119 mm, 159 mm, 254 mm, 341 mm.

On flat targets a MART-200 X-Ray Generator can be adjusted to provide a focal distance of up to 250 mm.

B.2 Chain-Down Stand

This stand is a mechanical mounting accessory that employs chains to fasten onto pipes of various diameters. A gear mechanism with a crank handle is used to tighten the grip of the stand base on the pipe surface. The stand is made of stainless steel and has a ball joint with a lockable coupling for mounting, spatial positioning and rigid locking of an X-ray tubehead. Designed to accommodate the radiographic testing of weld joints on pipelines of 57 to 1420 mm in diameter.

Comes in a number of modifications to suit mounting design of various tubehead models. When ordering please specify the model of your X-ray device to ensure compatibility with the stand ordered.

Figure B.3 – Chain-Down Stand

B.3 Tripod Stand

This stand is made of strong, lightweight duralumin alloy.

Comes in a number of modifications to suit mounting design of various tubehead models. When ordering please specify the model of your X-ray device to ensure compatibility with the stand ordered.

Figure B.4 – Tripod Stand

B.4 Latched Fastener

Designed for mounting a MART-250 tubehead onto a target pipe. With the help of this accessory the X-ray tubehead can be securely fastened on pipes of up to 1460 mm in diameter.

Compared with similar devices, it provides the easiest way to reposition and fasten the tubehead:

- Fix its lightweight base with a strap on pipe;
- Then latch up the tubehead onto the base
- To move to the next inspection point on the weld, push the latch to remove the tubehead, loosen the strap, and shift the lightweight base to the desired position.

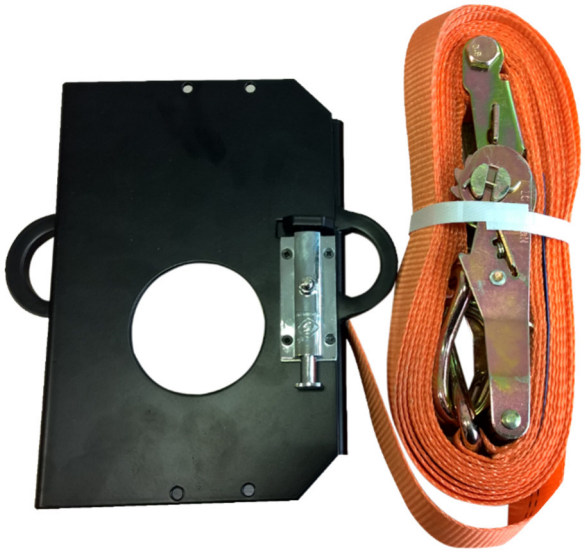


Figure B.5 – Latched Fastener

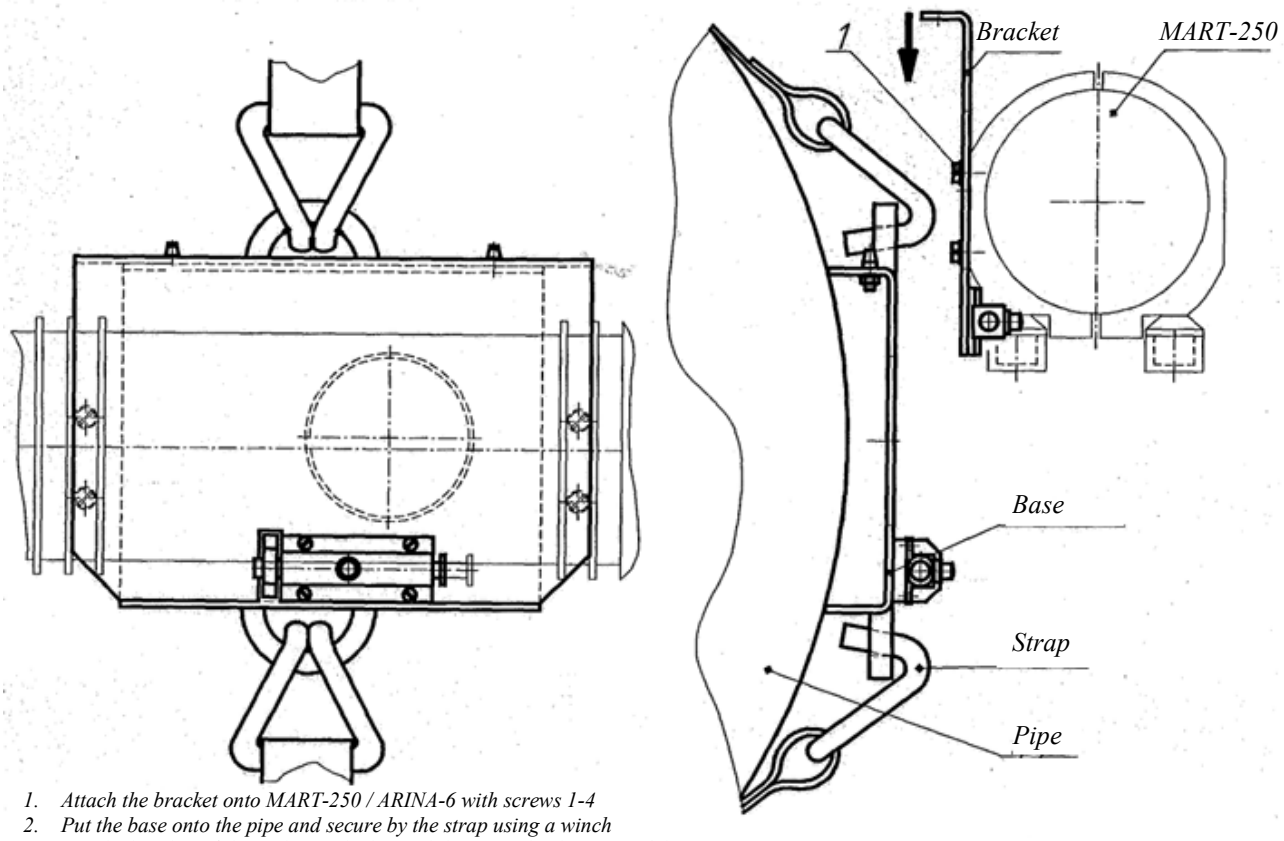
Components

This fastening accessory consists of 3 parts:

- U-section base for fastening onto pipe surface
- L-section bracket for tubehead fastening
- Ratchet strap

Procedure

Figure B.6 shows the main parts of the latched mounting.



1. *Attach the bracket onto MART-250 / ARINA-6 with screws 1-4*
2. *Put the base onto the pipe and secure by the strap using a winch*
3. *Put the bracket w/ the tool onto the base, sliding it in the direction of the arrow*
4. *Lock the latch*

Figure B.6 – Mounting procedure

First, attach the bracket to the tubehead, note the lockplate provided to engage the latch. Make sure that the hole in the bracket coincides with the beam exit window in the tubehead. The bracket will stay in this position through the entire inspection sequence.

Now wrap the strap around the pipe. Insert the end hooks of the strap into the pad eyes of the base. We recommend to orient the base so that its lock pins are pointing up.

Use the ratchet to tighten the strap.

Take the tubehead with the bracket attached and position the bracket on the base so that the grip pins of the base enter the holes in the bracket. Slide the bracket until it engages the latch.

Push the latch plate with your finger to lock the bracket on the base.

To remove the tubehead press the button located next to the lockplate of the latch. This will unlock the latch. Remove the tubehead from the base.

Appendix C
(Informative)

X-Ray Radiation Warning Accessories

B.1 Flash Lamp Indicator

The Flash Lamp Indicator is designed to provide X-ray radiation warning whenever X-ray generators are in operation.

Compared with similar devices on the market:

- It is lightweight and small in size
- Has inbuilt power supply
- Does not need cable connection

The lamp has magnets in its base for quick installation in any desired strategic position. The lamp is powered by six AA batteries. It operates based on the Geiger counter principle. Flashing/blinking warning light switches on once measured values become typical of X-ray generation

Figure C.1 – Flash Lamp Indicator

Specifications:

- Light color: Red

- Overall dimensions (DIA × H): (63 × 75) mm
- Max. weight, incl. batteries: 0.3 kg

Position the lamp at a distance of 1.5 to 15 meters from the inspection target (not in front of the beam) so that the operator can see the light indication.

Select target to lamp distance based on the fact that X-ray intensity depends on the X-ray tube voltage setting in your unit. The lamp will not light up if X-ray intensity is too low. Consider placing the lamp closer to the X-ray unit at low voltage and farther away at high voltage. Run tests to select the best distance for each operation mode.

Appendix D
(Informative)

Using the X-Ray Collimator Kit

Collimators are designed to limit the angle of X-ray beam divergence in directional beam applications. Collimators help to reduce the unused portion of X-ray radiation.

Spectroflash Ltd offers a set of collimators designed to fit MART-200 tubehead providing different angles of beam divergence.

The types of collimators included in the kit are listed in Figure C.1.

Collimators

L° × H°	*Note*
40°×40°	
60°×60°	
30°×15°	
40°×30°	
60°×15°	
60°×30°	
Segment	

Figure C.1 – Types of collimators for the MART-200 tool

Each collimator is a lead diaphragm assembled with a holder to fix the collimator on the end of the tubehead.

A collimator selection guide is provided in Figure B.2. For example, use a collimator with divergence angle of 40×30° and focal distance of 400 mm to achieve exposure size of about 300×210 mm.

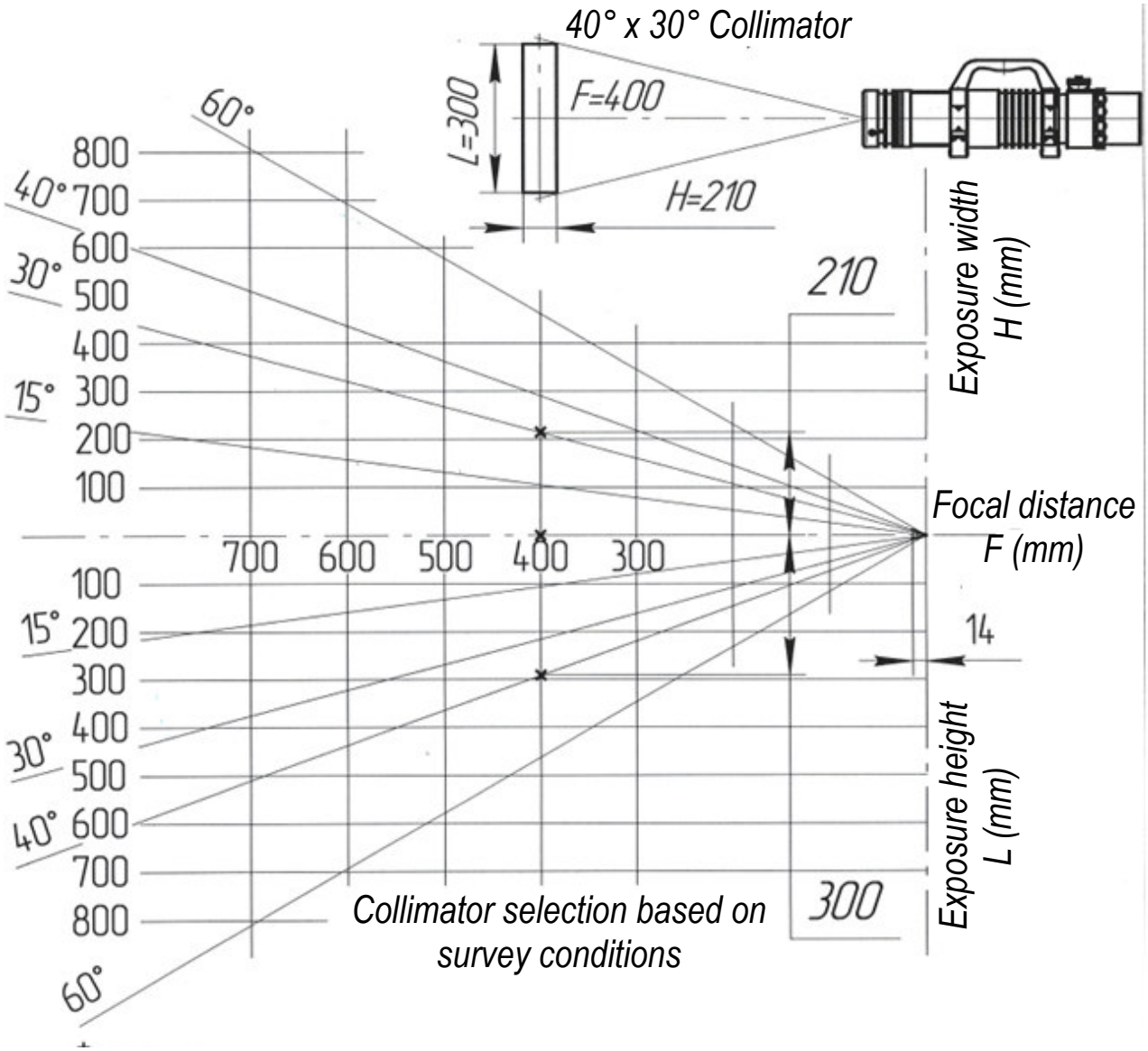


Figure C.2 – Collimator selection guide