

## EUROPEAN INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH AND MANAGEMENT STUDIES

VOLUME03 ISSUE01

DOI: <https://doi.org/10.55640/eijmrms-03-01-13>

Pages: 78-83



### TECHNICAL PARAMETERS OF X-RAY EQUIPMENT

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#### ABOUT ARTICLE

**Key words:** X-ray diagnostics, devices, source, X-ray radiation, X-ray imaging, multifunctionality.

**Received:** 14.01.2023

**Accepted:** 19.01.2023

**Published:** 24.01.2023

**Abstract:** The technical requirements of X-ray diagnostic devices are given at work. It is shown that the complex of X-ray apparatuses consists of an X-ray source, an X-ray receiver, an X-ray image visualization station and multifunctional tripod device.

#### INTRODUCTION

Significant variety of equipment for X-ray examinations often causes difficulties in their operation due to insufficient awareness of physicians about the physical and technical features of X-ray equipment.

The rapid transition from analog to digital X-ray systems has improved the quality of X-ray studies in many areas. In recent years, virtually all components of X-ray equipment have undergone significant changes. Digital X-ray image receivers, high-resolution monitors, new techniques and specialized software for various areas and diagnostics of nosological forms have led to sharp improvement in X-ray diagnostics.

At the same time, radiologists are constantly faced with a shortage of materials for new developments in x-ray technology. For practical healthcare, it is extremely important to take into account the rapid dynamics of X-ray equipment for the speedy introduction of new diagnostic technologies in medical institutions of any level.

## Technical requirements

When conducting X-ray diagnostic studies in non-stationary and (or) non-specialized conditions, a complex is used that includes an X-ray source and a set of devices. The complex must comply with the requirements of state sanitary standards in the field of radiation safety; have a registration certificate and declaration of conformity.

## Requirements for the complex as whole

The complex should consist of:

- x-ray source (XRS);
- X-ray detector (XRD);
- x-ray image visualization station (XRVS);
- multifunctional tripod device (MTD).

## Technical characteristics of the complex:

- the mass of the complex should be no more than 250 kg;
- overall dimensions (in position for transportation) should not exceed: height - 1800 mm, width - 800 mm, length - 1600 mm;
- the power supply of the complex must be carried out from the electrical network of alternating single-phase current with a voltage of 220 V and a frequency of 50 Hz;
- rated power consumed by the complex from the electrical network, not more than 3600 W;
- distance from the focal spot of the X-ray tube to the floor (for XRS installed in a tripod) is not less than 1050 mm.

## List of technical requirements for XRS

IRS is designed to generate electromagnetic radiation in the X-ray range (X-ray radiation) for conducting X-ray diagnostic studies. IRI is designed according to a monoblock scheme based on a domestic sharp-focus X-ray tube. Information about the modes is displayed on the LCD display of the XRS control panel.

The main nodes of the X-ray source are:

- x-ray tube. When choosing an X-ray tube for an X-ray source, preference should be given to Russian manufacturers. The X-ray tube power supply type is constant voltage. The X-ray tube must have a straight-line type cathode;
- voltage multiplier, providing the value of the anode voltage in accordance with the terms of reference;
- high voltage transformer;
- transformer to provide power to the X-ray tube heat;
- a device for detecting the resting phase of the patient's heart rate;
- microprocessor control board with control via Ethernet-interface;
- monoblock power board.

IRI must have the following technical characteristics:

- performance of the anode voltage settings in the range from no more than 40 kV to at least 120 kV in increments of 1 kV must be ensured;
- execution of the anode current settings in the range from 0.5 to 3 mA with a step of 0.1 mA should be ensured;
- performance of exposure time settings in the range from 0.01 to 1 s should be ensured;
- Execution of the current-time product settings in the range from 0.005 mA•s to 3 mA•s must be ensured;
- Accurate synchronization of the moment of the beginning of X-ray generation with the moment of the beginning of the resting phase of the heart rate according to the ECG signal from the patient must be ensured;
- the nominal value of the focal spot of the X-ray source should not exceed 0.3 mm;
- linearity of the radiation output with a tolerance not worse than 0.2;
- the mass of the X-ray source is not more than 4 kg;
- type of digital Ethernet interface;
- rated electrical power of the X-ray source is not more than 700 W;
- the possibility of providing power from the battery;
- X-ray source must be designed as a monoblock;
- the number of X-ray images during battery operation, performed at maximum operating conditions of the X-ray source, at least 10;
- the adjustable diaphragm of a specialized collimator should ensure the possibility of taking x-ray images on x-ray image receivers from no more than 10x10 mm to no more than 430x430 mm in a

plane perpendicular to the axis of the x-ray beam, at a distance from the focal spot to the x-ray image receiver ( $1000 \pm 10$ ) mm.

- the angle of rotation of the X-ray field around the radiation axis is not less than  $\pm 85^\circ$ ;
- own filtration of the collimator Al not less than 2 mm;
- the weight of the specialized collimator is not more than 0.9 kg.

#### List of requirements for an X-ray imaging system

The XRVS is designed to obtain an x-ray image in a format that arrives via a wireless channel from an x-ray detector, as well as its subsequent processing and transmission to the PACS system. Viewing captured images and other information should be done using the LCD touch screen.

- XRVS for neonatology should be made on the basis of a flat panel digital detector;
- viewing of the received images and other information should be carried out using the LCD touch screen;
- XRVS power supply should be carried out from the built-in or replaceable BA.

The visualization system should consist of an X-ray detector, an automated workplace (AWP) laboratory assistant, a charging station for a battery pack that is part of the X-ray image detector.

The X-ray detector is designed to register the X-ray radiation that has passed through the object under study, as well as to transmit the visualized X-ray image to the SVR using a wireless communication channel. The X-ray detector is based on a flat-panel digital detector.

The flat panel digital detector is designed to provide high quality x-ray images of patients with the lowest possible input dose. The flat panel digital detector must be able to transmit images wirelessly to a workstation.

The laboratory assistant's workstation must be based on a tablet computer and is designed to receive, process and store images obtained from the X-ray detector, as well as transfer them in DICOM format to the PACS system or to the doctor's workstation (doctor's workstation and PACS are not included in the complex).

Software for the laboratory assistant's workstation from the scope of work on the development of the complex

The laboratory assistant workstation should have the following technical characteristics:



- clock frequency of the processor is not less than 1 GHz;
- the amount of RAM is not less than 4 GB;
- hard disk capacity of at least 0.1 TB;
- the diagonal size of the touch screen is not less than 25 cm;
- the resolution of the touch screen monitor is at least 1200×800 pixels.
- An X-ray imaging system must have the following specifications:
  - X-ray detector dimensions no more than 470×380×20 mm;
  - X-ray detector weight no more than 4 kg;
  - the normalized dose at the detector inlet with a contrast sensitivity of 1.5% is not more than 10.52  $\mu\text{Gy}$ ;
  - spatial resolution of the detector not less than: vertical/horizontal — 3 pairs of lines/mm; diagonal — 3.5 pairs of lines/mm;
  - signal-to-noise ratio at a normalized dose of at least 24 dB;
  - dynamic range of the detector not less than 400;
  - to transfer the X-ray image to the workstation of the laboratory assistant of the visualization system;
  - the size of the working field of the detector is not less than 420×340;
  - the value of the modulation transfer function of the detector is not less than 0.6 at a spatial frequency of 0.5 mm<sup>-1</sup>, not less than 0.4 at a spatial frequency of 1.0 mm<sup>-1</sup>;
  - DQE value of the detector not less than 0.2 at a spatial frequency of 0.5 mm<sup>-1</sup>, not less than 0.15 at a spatial frequency of 1.0 mm<sup>-1</sup>, not less than 0.1 at a spatial frequency of 1.5 mm<sup>-1</sup>, not less than 0.05 at a spatial frequency of 2.0 mm<sup>-1</sup>, not less than 0.02 at a spatial frequency of 2.5 mm<sup>-1</sup>;
  - the time of reading the data transfer from the detector to the workstation after the end of the exposure is no more than 3 s;
  - communication channel of the detector with the workstation — wireless, Wi-Fi;
  - power supply of the detector from a replaceable battery pack.

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