EVALUATION OF THE PERFORMANCE OF DIAGNOSTIC X-RAY EQUIPMENTS

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Abstract
Quality check of X-ray equipments is a very important part of quality assurance programme in a radiology department for ensuring the image quality with the minimum dose to the patients and staff. The performance of radiological equipment has a huge impact on radiation doses received by patients, personnel and general public. For this reason, technical control and monitoring of the equipment for maintaining the quality of these parameters is very important. Testing should cover all the basic parameters as voltage, exposure time and filtering.
This work consists in measuring the deviation of the data obtained from the X-ray testing device in real time with the data provided on the control panel. All these measurements must be within the parameters tolerance provided by the Albanian legislation.

Key words: quality control, diagnostic, X-ray, voltage, exposure time, filtering.

Introduction

Wilhelm Conrad Roentgen, a Bavarian physicist discovered X-rays. He was working with sealed glass vacuum tubes that contained a cathode and an anode. During his experiments, he applied voltage to these tubes and noticed that a screen near the tubes was glowing. He blocked the path of these newfound rays to see what would prevent the screen from glowing. When he placed his own hand there, he could see the outline of his bones on the screen. This historic discovery on November 8, 1895 dramatically changed diagnostic procedures for medicine. Roentgen (in some references spelled “Röntgen”) received the first Nobel Prize in physics in 1901 for his discovery of x rays (Figure 1).

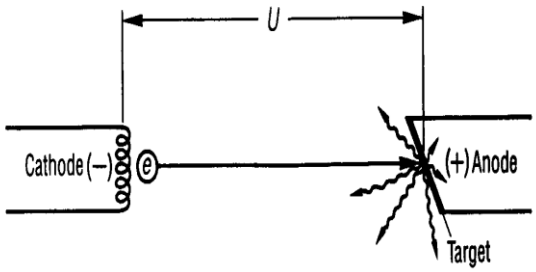

Figure 1. The physics of X-ray production

During time the use of diagnostic equipment was widely used for diagnostic purposes (European Guidelines June 1996). After that, the main concern started to be lowering the dose for patients and staff during examinations.
The performance of radiological equipments has a huge impact on radiation doses in personnel, patients and the public (ICRP, Publication 73, 1996). For this reason, technical control and monitoring of equipment for maintaining the quality of these parameters is very important.

All devices are tested for compatibility with their specifications at the time of receipt. Testing should cover all the basic parameters for maintaining their quality. Technical control of X-ray equipment is necessary because the device parameters directly affects the patient, the staff and the public's dose, prevent incidents with the device and give unnecessary doses to the patients, also directly affects the image quality (Series GSR part III, 2014). This work consists in measuring the deviation of the data obtained from the radiography device in real time with the data we provided on the dashboard. Measurements will be made for voltage, current, exposure time and filtering. All these measurements must be within the parameters provided by Albanian legislation.

Materials and methods

The measurements are done to check the quality of the radiation emitted from the X ray source of a radiography equipment. The radiography equipment consists of a generator control console where the operator selects desired techniques to obtain a quality readable image, an x-ray generator which controls the x-ray tube current, x-ray tube kilovoltage and X-ray emitting exposure time, an X-ray tube that converts the kilovoltage and mA into actual X-rays and an image detection system which can be either a film (analog technology) or a digital capture system.

To perform the measurements it was used the "Black Piranha" device. The Piranha comes ready-to-use with everything we need included. It is really an

all-in-one multifunction meter. This device is connected to the computer wireless or via USB and we can have a complete QA-system.

This device was positioned 100 cm from the source of X-ray by adjusting it through the movement of the X-ray lamp system (Figure 2) (AAPM Report No. 74, 2002). The X-ray beam was open according to the size of the Black Piranha detector. Piranha has a unique feature that makes it possible to check the position of the detector before measuring. By using the "Position Check" function, you can verify that the detector area is fully irradiated. Possible field inhomogeneities are also neutralized.

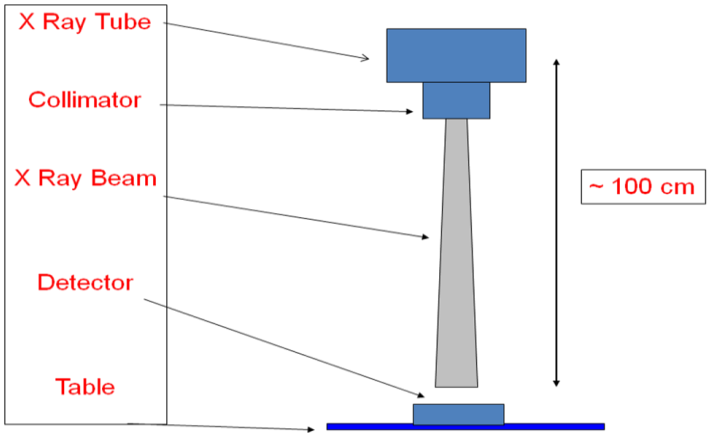

Figure 2. The position of detector for measurement

The laser of the radiograph machine has been used for making the correct position (Hendee, W, Chaney, E., & Rossi, R. 1984).
After we make the right position we connected the "Black piranha" to the computer by means of blue tooth. In the computer we have installed the program "Ocean 2014" with which the Black Piranha operates.
According to the Albanian law the difference between the energy of output and energy set should be less than 10 %.

$$\% \text{ kV error} = (V_{measured} - V_{set})/ V_{set} \text{ x}100 \quad (1)$$

The measurement was done for 3 different kV, 60 kV, 70 kV, 80 kV.
Also according to the Albanian law the difference between the exposure time given from the radiography and exposure time measured with Black Piranha should be less than 10 %.

$$\% \text{ ms error} = (T_{measured} - T_{set})/ T_{set} \text{ x}100 \quad (2)$$

The measurement was done for 1 exposure time, 100 ms.

The last check was done for the total filtration, which should be more than 2.5 mm Al.

Results and discusion

After, we have positioned the device in the correct way, we begin to perform the exposures. For all measurements to be carried out, the device was positioned in the same way (Figure 3).

Figure 3. The positioning of device under the beam

There were done measurements for three voltage values, 60 kV, 70 kV and 80 kV. These values are used frequently during different examinations (Table 1).

U (kV)	80	Deviation (%)	70	Deviation (%)	60	Deviation (%)
U_1 (kV)	80.79	0.987	69.38	0.85	59.67	0.55
U_2 (kV)	80.04	0.005	69.40	0.857	59.61	0.58
U_3 (kV)	79.85	0.187	69.41	0.857	59.59	0.68

Table 1. The values from the measurements of voltage

The results are lower than 1 %, and the limit in Albanian legislation for the

deviations is 10 % (IEC 61223-3-1:1999) as checked the deviation for the exposure time. From the control panel it was assigned the exposure value 100 ms (Table 2).

Meaurement	1	2	3
Exposure time in the control panel (ms)	100	100	100
Measured exposure time	99.86	100.4	99.87
Deviation (%)	0.14	0.04	0.13

Table 2. The values from the measurements of exposure time

The limit for the deviation of these measurements is 10 %. The results were less than 1 %.

Another check for the quality of beam is the total filtration which for a useful radius X should not be less than 2.5 mm Al.

Meaurement	1	2	3
Voltage	80	80	80
Total filtration	2.9	2.9	2.9

Table 3. The values for total filtration

As it is notes from the table 3 the values for total filtration are more than 2.5 mm Al.

Conclusions

Technical control of X-ray equipments is necessary because the device parameters directly affect the patient's dose, the staff and the public, prevent incidents with the device and also directly affects the image quality. These kind of checks are done also for conventional radiography unit. This study has evaluate the performance of the equipment by checking the voltage (kV), exposure time (ms) and half value layer in mm Al. These parameters were within the norms envisaged by the Albanian Legislation. The measurements carried out with the "Black Piranha" testing device showed that the parameters mentioned above were within the norms provided by Albanian legislation.

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