Original Research Article

Analysis of Quality control of some ~~fixed~~ and portable X- ray units in Maharishi Markandeshwar Hospital India.

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ABSTRACT

The quality assurance of all the radiographical instruments is very important for ensuring its proper and better functioning. Quality assurance (QA) is a program used by management to maintain optimal diagnostic image quality with minimum hazard and distress to patients. The program includes periodic quality control tests, preventive maintenance procedures, administrative methods and training. The present study is a prospective study which was carried out on seven X-ray units of Radiology department at Maharishi Markandeshwar Hospital, Mullan, Ambala, Haryana. In this study seven units of X-rays were ~~analysed~~ in which five were fixed and two were portable for their quality assurance through different test such as Congruence of radiation and optical fields, Focal spot size measurement etc. The results of the study revealed the ~~the~~ good quality and proper functioning of all the instruments used in the present study.

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Keywords: Quality assurance; Radiology, X-ray machines; Focal spot, Optical fields.

INTRODUCTION

X-rays are ~~an~~ electromagnetic radiation with a very high frequency which are produced when a fast traveling cloud of electrons are suddenly stopped, X-rays ~~are~~ produced in such a way is called Bremsstrahlung radiation. It is also known as barking radiation [1,2].It was first discovered by a German physicist, Sir Wilhelm Conrad Roentgen on 8th November 1895[3]. Very quickly after their discovery, they were being utilized as facility in medical sector for

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diagnostic imaging. The X-ray tube is constructed mainly of ~~Inner~~ components and the ~~Outer~~ components. The ~~Inner~~ components are two. ~~one~~ is cathode which is a negative terminal and the ~~another~~ is anode which is a positive terminal. The outer components are Support system, Protective Housing, Glass or Metal Enclosure [1,4]. Other than these two components filters, collimators are also present. Through filters the process of filtration of x-rays occur. And collimator is the best beam restrictor device in x-ray tube.

The quality assurance of all the radiographical instruments is very important for ensuring its proper and better functioning [5,6]. In hospitals most of the equipment's used for diagnosing disease or any abnormal condition are located in the radiology department and some of them are used since many year of time which may have improper functioning, misalignment of light and radiation beam, leakage radiation, alteration of filter and focal spot. Fault in any single factor may impact the final image quality and result in contribution to a large radiation dose to the patient and staff along with improper diagnostic information. Therefore quality control in diagnostic facilities is very much required for the safety and improved performance of the systems. The quality assurance (QA) in diagnostic radiology is the combined practice by the radiographer, radio technologist and departmental staff conducting different procedure or techniques to ensure that the radiographic images produced are of good quality so that it will provide enough diagnostic information with a low cost possible and less radiation dose to the patient to achieve the ALARA principle[7,8].

Therefore, in view of the above fact a study has been done to check the quality assurance of all the technical parameters of the stationary and portable X-ray equipments available in the radiology department at MMIMSR, Mullana, Ambala, Haryana.

Methodology:

The study was a prospective study which was carried out on seven X-ray units of Radiology department at Maharishi Markandeshwar Hospital, Mullan, Ambala, Haryana. In this study seven units of X-rays were analysed in which five were ~~fixed~~ and two were portable for their quality assurance.

Materials used:

All in one test tool plate, Beam alignment test tool, Fluke survey meter (ionization chamber type), Resolution test tool, Focal spot test tool (Bar pattern type), Piranha all-in-one dosimeter, Measuring tape. All materials ~~was~~ provided by the department.

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The test done for Quality assurance are as follows and the details of the instruments which were used in this study given in table 1.

1. **Congruence of radiation and optical fields:** Pro-RF basic tool phantom (All –in-one test tool plate) was placed over the loaded cassette on the table at100 cm FFD. Collimation light was aligned (collimated) to the outline marked on the Pro-RF basic tool phantom (beam alignment test tool). The X-ray machine was set to 45 kVp and 10 mAs and exposure was made to check the congruence of radiation and optical field[9].

2. **Central beam alignment:** Pro-RF basic tool phantom (All –in-one test tool plate) was placed over the cassette on the X-ray table at the 100 cm FFD. The central beam alignment test tool (cone type) was placed on the center of the all-in-one plate. Collimation and central ray was correctly aligned with the test tool. The machine was set to 45 kVp and 10 mAs and exposure was made to check the central beam alignment. In the image ~~the~~ both circles should not overlap. (if overlap i.e., there is shift of < 1.5˚ of the central beam [10].

3. **Effective Focal spot size measurement:** Pro-RF basic tool phantom (All –in-one test tool plate) was placed over the cassette on the table at the 60cm FFD. The resolution bar pattern test tool was kept in its specific area mentioned on the all-in-one test tool plate and was fixed correctly. The X-ray machine was set to 55 kVp and 20 mAs and exposure was made to see the measurement of effective focal spot size [11].
4. **Accuracy of Accelerating Tube Potential:** Piranha all-in-one multifunction meter was placed on the table. The X-ray tube collimation was set to the specific area of the all-in-one multifunction meter. The kV ~~station~~ of the X-ray machine was set constant and mA ~~was kept variable to the different 3 exposures.~~ The exposure was made 3 times at different kV ~~stations~~ such as at 60 kV, at ~~8 kV~~ and at 100 kV [12].
5. **Linearity of radiation output:** Piranha all-in-one multifunction meter was placed on x-ray the table. The X-ray machine was set to the 100 Cm FFD. The kVp and exposure time was made constant, 60 kVp and time 0.10 second and the exposure was made at different mA stations. The average readings were taken [10].

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$$\text{Coefficient of linearity} = \frac{X_{max} + X_{min}}{X_{max} - X_{min}}$$

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6. **Reproducibility of radiation output:** Piranha all-in-one multifunction meter was placed on the x-ray table. The FFD was set to 100 cm. Collimation was made to the specific area of the all-in-one multifunction meter. The kVp and mA station was made constant and exposures are made at different time to measure the coefficient of timer linearity[10].

7. **Radiation leakage through tube housing:** The collimator of the X-ray tube was made totally closed. The X-ray machine was set to the 100 cm, kVp was set to 100, mA was set to 100 and time was set to 0.5 second. The Fluke Survey Meter was placed at one meter distance from the tube to the left, to the right, to the back, to the front and at the top to measure the leakage radiation from the X-ray tube. The Leakage radiation was measured on the basis of work load of the unit. Work load of the unit = 180 mA - min. in one hour[13].

   Maximum leakage from the tube is calculated by:

$$\frac{\text{mA-min. in one hour} \times \text{max. Leakage level mR / hr}}{\text{60 min.} \times \text{mA used for measurement.}}$$

Data analysis

Results:

The results of different quality control tests conducted on different X-ray unit given separately ~~and~~ are as follows:

ROOM 1:

Type of Equipment: - Fixed X-ray Machine

Model Name: - DigiX FDX

Sr. No: - 2K 18080001DX / DR-FDX

Sr. No.	Parameters Tested	Specified Values	Measured Values	Tolerance	Remark
1	Congruence of radiation and	Measurement at 45 kV	**0.8 % (X+X')**	Tolerance : I X I + I X' I ≤ 2% of	**Pass**

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	optical field		**0.9 % (Y+Y')**	FFD I Y I + I Y' I ≤ 2% of FFD	
2	Central Beam Alignment	Measurement at 45 kV	**$< 1.5^0$**	Central Beam Alignment $< 1.5^0$	**Pass**
3	Effective Focal Spot Measurement FFD= 60 cm	1.2 mm X 1.2 mm 0.6 mm X 0.6 mm	**1.2 mm X 1.2 mm** **0.6 mm X 0.6 mm**	Tolerance : + 0.5 f for f < 0.8 mm + 0.4 f for 0.8 ≤ f ≤ 1.5 mm + 0.3 f for f > 1.5 mm	**Pass**
4	Accuracy of Operating Potential (kV)	At 150 kV	**152.7 kV**	± 5 kV	**Pass**
5	Accuracy of Irradiation Time	N/A	**-**	% Error < 10 %	-
6	Total Filtration	Measurement at 150 kV	**14.2 mm of Al**	Tolerance : 1.5 mm Al for kV ≤ 70 2.0 mm Al for 70 < kV ≤ 100 2.5 mm Al for kV > 100	**Pass**
7	Linearity of mAs Loading Stations		**0.0**	CoL<0.1	**Pass**
8	Consistency of radiation output	At 60 kV	**0.027**	CoV ≤ 0.05	**Pass**
9	Radiation leakage level at 1m from Tube Housing and Collimator	Measurement at 100 kVp and 150 mA	**0.115 mGy** **0.124 mGy**	Tube Leakage < 1 mGy in one hour	**Pass**

ROOM 2

Type of Equipment:- Fixed X-ray Machine

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Model Name:- MARS 50+

Sr. No:- 2K11150797-XHF

Sr. No.	**Parameters Tested**	**Specified Values**	**Measured Values**	**Tolerance**	**Remark**
1	Congruence of Radiation and Optical Field	Measurement at 45 kV	**1.0 % (X+X')** **0.4 % (Y+Y')**	Tolerance : I X I + I X' I ≤ 2% of FFD I Y I + I Y' I ≤ 2% of FFD	**Pass**
2	Central Beam Alignment	Measurement at 45 kV	**< 1.5^0**	Central Beam Alignment < 1.5^0	**Pass**
3	Effective Focal Spot Measurement FFD = 60 cm	1.2 mm X 1.2 mm 0.6 mm X 0.6 mm	**1.2 mm X 1.2 mm** **0.6 mm X 0.6 mm**	Tolerance : + 0.5 f for f < 0.8 mm + 0.4 f for 0.8 ≤ f ≤ 1.5 mm + 0.3 f for f > 1.5 mm	**Pass**
4	Accuracy of Operating Potential (kV)	At 120 kV	**124.5 kV**	± 5 kV	**Pass**
5	Accuracy of Irradiation Time			% Error < 10 %	**N/A**
6	Total Filtration	Measurement at 100 kV	**3.56mm of Al**	Tolerance : 1.5 mm Al for kV ≤ 70 2.0 mm Al for 70 < kV ≤ 100 2.5 mm Al for kV > 100	**Pass**
7	Linearity of mAs Loading Stations		**0.024**	CoL<0.1	**Pass**
8	Consistency of Radiation Output	At 60 kV	**0.013**	CoV ≤ 0.05	**Pass**

9	Low Contrast Resolution		**2.0 mm is Visible**	3.0 mm Hole Pattern must be Resolved	**Pass**
10	High Contrast Resolution		**1.70 lp/mm is Visible**	1.5 lp/mm Pattern must be Resolved	**Pass**
11	Exposure Rate at Tabletop	100 KV	**3.654R/min**	Tolerance : 1. Exposure Rate without AEC mode ≤ 5 cGy/Min 2. Exposure Rate with AEC mode ≤10 cGy/Min	**Pass**
12	Radiation Leakage Level at 1m from Tube Housing and Collimator	Measurement at Maximum 100 and 100 mA	**0.131 mGy** **0.142 mGy**	Tube Leakage < 1 mGy in one hour	**Pass**

key

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ROOM 3

Type of Equipment:- Mobile X-ray machine

Model Name: - Skanmobile

Sr. No: - MY 1119R0038

Sr. No.	Parameters Tested	Specified Values	Measured Values	Tolerance	Remark
1	Congruence of Radiation and Optical Field	Measurement at 45 kV	**1.1 % (X+X')** **0.8 % (Y+Y')**	Tolerance : I X I + I X' I ≤ 2% of FFD I Y I + I Y' I ≤ 2% of FFD	**Pass**

2	Central Beam Alignment	Measurement at 45 kV	**< 1.5^0**	Central Beam Alignment < 1.5^0	**Pass**
3	Effective Focal Spot Measurement FFD = 60 cm	1.8 mm X 1.8 mm	**1.7 mm X 1.8 mm**	Tolerance : + 0.5 f for f < 0.8 mm + 0.4 f for 0.8 ≤ f ≤ 1.5 mm + 0.3 f for f > 1.5 mm	**Pass**
4	Accuracy of Operating Potential (kV)	At 100 kV	**101.7 kV**	± 5 kV	**Pass**
5	Accuracy of Irradiation Time		**NA**	% Error < 10 %	**Pass**
6	Total Filtration	Measurement at 100 kV	**3.10mm of Al**	Tolerance : 1.5 mm Al for kV ≤ 70 2.0 mm Al for 70 < kV ≤ 100 2.5 mm Al for kV > 100	**Pass**
7	Linearity of mAs Loading Stations		**0.017**	CoL<0.1	**Pass**
8	Consistency of Radiation Output	At 60 kV	**0.008**	CoV ≤ 0.05	**Pass**
9	Low Contrast Resolution		**2.0 mm is Visible**	3.0 mm Hole Pattern must be Resolved	**Pass**
10	High Contrast Resolution		**1.70 lp/mm is Visible**	1.5 lp/mm Pattern must be Resolved	**Pass**
11	Exposure Rate at Tabletop	100 KV	**3.654R/min**	Tolerance : 1. Exposure Rate without AEC mode ≤ 5 cGy/Min 2. Exposure Rate with	**Pass**

				AEC mode ≤10 cGy/Min	
12	Radiation Leakage Level at 1m from Tube Housing and Collimator	Measurement at Maximum 100 kVp and 20 mA	**0.137 mGy** **0.163 mGy**	Tube Leakage < 1 mGy in one hour	**Pass**

ROOM 4

Type of Equipment:- Fixed X-ray Machine

Model Name: - DX 525

Sr. No: - 933-52443

Sr. No.	Parameters Tested	Specified Values	Measured Values	Tolerance	Remark
1	Congruence of Radiation and Optical Field	Measurement at 45 kV	**1.8 % (X+X')** **1.7 % (Y+Y')**	Tolerance : I X I + I X' I ≤ 2% of FFD I Y I + I Y' I ≤ 2% of FFD	**Pass**
2	Central Beam Alignment	Measurement at 45 kV	**< 1.5^0**	Central Beam Alignment < 1.5^0	**Pass**
3	Effective Focal Spot Measurement FFD = 60 cm	1.8 mm X 1.8 mm	**1.7 mm X 1.8 mm**	Tolerance : + 0.5 f for f < 0.8 mm + 0.4 f for 0.8 ≤ f ≤ 1.5 mm + 0.3 f for f > 1.5 mm	**Pass**
4	Accuracy of Operating Potential (kV)	At 100 kV	**96.55 kV**	± 5 kV	**Pass**
5	Accuracy of		**NA**		**Pass**

	Irradiation Time			% Error < 10 %	
6	Total Filtration	Measurement at 100 kV	**2.58 mm of Al**	Tolerance : 1.5 mm Al for kV ≤ 70 2.0 mm Al for 70 < kV ≤ 100 2.5 mm Al for kV > 100	**Pass**
7	Linearity of mAs Loading Stations		**0.071**	CoL<0.1	**Pass**
8	Consistency of Radiation Output	At 100 kV	**0.013**	CoV ≤ 0.05	**Pass**
9	Low Contrast Resolution		**2.0 mm is Visible**	3.0 mm Hole Pattern must be Resolved	**Pass**
10	High Contrast Resolution		**1.70 lp/mm is Visible**	1.5 lp/mm Pattern must be Resolved	**Pass**
11	Exposure Rate at Tabletop	100 KV	**3.654R/min**	Tolerance : 1. Exposure Rate without AEC mode ≤ 5 cGy/Min 2. Exposure Rate with AEC mode ≤10 cGy/Min	**Pass**
12	Radiation Leakage Level at 1m from Tube Housing and Collimator	Measurement at Maximum 100 kVp and 20 mA	**0.166 mGy** **0.185 mGy**	Tube Leakage < 1 mGy in one hour	**Pass**

ROOM 5

Type of Equipment:- ~~Fixed~~ **X-ray Machine**

Model Name: - **ALLENGERS 525**

Sr. No: - **2K40550210**

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Sr. No.	Parameters Tested	Specified Values	Measured Values	Tolerance
1	Congruence of radiation and optical field	Measurement at 45 kV	**1.3 % (X+X')** **1.5 % (Y+Y')**	Tolerance : I X I + I X' I ≤ 2% of FFD I Y I + I Y' I ≤ 2% of FFD
2	Central Beam Alignment	Measurement at 45 kV	**$< 1.5^{0}$**	Central Beam Alignment $< 1.5^{0}$
3	Effective Focal Spot Measurement FFD= 60 cm	2.0 mm X 2.0 mm 1.2 mm X 1.2 mm	**2.0 mm X 2.0 mm** **1.2 mm X 1.2 mm**	Tolerance : + 0.5 f for f < 0.8 mm + 0.4 f for 0.8 ≤ f ≤ 1.5 mm + 0.3 f for f > 1.5 mm
4	Accuracy of Operating Potential (kV)	At 90 kV	**85.64 kV**	± 5 kV
5	Accuracy of Irradiation Time	At 0.10 Sec	**0.101 Sec**	% Error < 10 %
6	Total Filtration	Measurement at 100 kV	**2.03 mm of Al**	Tolerance : 1.5 mm Al for kV ≤ 70 2.0 mm Al for 70 < kV ≤ 100 2.5 mm Al for kV > 100
7	Linearity of mA/mAs loading Stations		**0.045**	CoL<0.1
8	Consistency of radiation output	At 60 kV	**0.031**	CoV ≤ 0.05
9	Radiation leakage level at 1m from tube housing and	Measurement at 100 kVp and 100 mA	**0.121 mGy** **0.127 mGy**	Tube Leakage < 1 mGy in one hour

	Collimator			

ROOM 6

Type of Equipment: - Fixed X-ray Machine

Model Name: - ALLENGERS 525

Sr. No: - 060350034

Sr. No.	Parameters Tested	Specified Values	Measured Values	Tolerance	Remark
1	Congruence of Radiation and Optical Field	Measurement at 45 kV	**1.4 % (X+X')** **1.3 % (Y+Y')**	Tolerance : I X I + I X' I ≤ 2% of FFD I Y I + I Y' I ≤ 2% of FFD	**Pass**
2	Central Beam Alignment	Measurement at 45 kV	**< 1.5^0**	Central Beam Alignment < 1.5^0	**Pass**
3	Effective Focal Spot Measurement FFD= 60 cm	2.0 mm X 2.0 mm 1.0 mm X 1.0 mm	**2.0 mm X 2.0 mm** **1.0 mm X 1.0 mm**	Tolerance : + 0.5 f for f < 0.8 mm + 0.4 f for 0.8 ≤ f ≤ 1.5 mm + 0.3 f for f > 1.5 mm	**Pass**
4	Accuracy of Irradiation Time	At 0.20 Sec	**0.209 Sec**	% Error < 10 %	**Pass**
5	Accuracy of Operating Potential (kV)	At 80 kV	**82.98 kV**	± 5 kV	**Pass**
6	Total Filtration	Measurement at 100 kV	**2.59 mm Al**	Tolerance : 1.5 mm Al for kV ≤ 70 2.0 mm Al for 70 < kV ≤ 100 2.5 mm Al for kV > 100	**Pass**

7	Linearity of mAs Loading Stations		**0.029**	CoL<0.1	**Pass**
8	Consistency of Radiation Output	At 60 kV	**0.012**	CoV $\leq$ 0.05	**Pass**
9	Radiation Leakage Level at 1m from Tube Housing and Collimator	Measurement at 100 kVp and 50 mA	**0.162 mGy** **0.172 mGy**	Tube Leakage < 1 mGy in one hour	**Pass**

ROOM 7

Type of Equipment: - Mobile X Ray Machine

Model Name: - MARS -2.5

Sr. No: - 2K10120282

Sr. No.	Parameters Tested	Specified Values	Measured Values	Tolerance	Remark
1	Congruence of Radiation and Optical Field	Measurement at 45 kV	**0.9 % (X+X')** **1.1 % (Y+Y')**	Tolerance : I X I + I X' I ≤ 2% of FFD I Y I + I Y' I ≤ 2% of FFD	Pass
2	Central Beam Alignment	Measurement at 45 kV	**< 1.5^0**	Central Beam Alignment < 1.5^0	Pass
3	Effective Focal Spot Measurement FFD= 60 cm	2.8 mm X 2.8 mm	**2.8 mm X 2.8 mm**	Tolerance : + 0.5 f for f < 0.8 mm + 0.4 f for 0.8 ≤ f ≤ 1.5 mm + 0.3 f for f > 1.5 mm	Pass
4	Accuracy of Operating Potential (kV)	At 100 kV	**102.3 kV**	± 5 kV	Pass

5	Accuracy of Irradiation Time		**NA**	% Error < 10 %	Pass
6	Total Filtration	Measurement at 100 kV	**2.14 mm Al**	Tolerance : 1.5 mm Al for kV ≤ 70 2.0 mm Al for 70 < kV ≤ 100 2.5 mm Al for kV > 100	Pass
7	Linearity of mAs Loading Stations		**0.007**	CoL<0.1	Pass
8	Consistency of Radiation Output	At 60 kV	**0.017**	CoV ≤ 0.05	Pass
9	Radiation Leakage Level at 1m from Tube Housing and Collimator	Measurement at 100 kVp and 20 mA	**0.159 mGy** **0.187 mGy**	Tube Leakage < 1 mGy in one hour	Pass

Discussion:

There are a number of reasons for developing quality assurance programs in dental radiography. Prior to 1974, there were no requirements for machine performance [14] and the operating stability of many x-ray generators in use today ~~is~~ uncertain. Studies have shown that there are a variety of types of machine malfunction which may occur as a result of use and aging [15.16] . There is evidence to suggest that ~~sight development~~ is a common practice used to compensate for inadequate machine performance, inadequate operator training, or defective processing chemistry

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Quality assurance (QA) is a program used by management to maintain optimal diagnostic image quality with minimum hazard and distress to patients. The program includes periodic quality control tests, preventive maintenance procedures, administrative methods and training. It also includes continuous assessment of the efficacy of the imaging service and the means to initiate corrective action. The primary goal of a radiology quality assurance program is to ensure the consistent provision of prompt and accurate diagnosis of patients. This goal will be adequately met by a QA program having the following three secondary objectives: ~~these are as~~ i) to maintain the quality of diagnostic images ii) to minimize the radiation exposure to patient and staff and iii) to be cost effective. Quality control (QC) consists of a series of standardized tests developed to detect changes in x-ray equipment function from its original level of performance. The objective of such tests, when carried out routinely, allows prompt corrective action to maintain x-ray image quality [17].

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A number of studies have been performed on the quality control and assurance of X ray machines in different countries across the world.A study has been done in Iran by Zahra et al in 2016, the results of their study suggests that because of high work flow and continued use of the equipment's gets older and develops some defect which can cause improper functioning, so they want the AEOI should change their polices and recommend QC test to every single year[18]. Another study done in Bangladesh in 2011. In this study they calibrate the important technical factors of X-ray machines over there to compare the output radiation dose to the patient for effective and safe use of X-ray machine. Results of the study suggests that Quality control program should be conducted on regular basis on every single year for safe operation of X-ray unit and to reduce population dose while ensuring proper diagnostic information[19].

Comment [DC48]: Send to literature review

The results of the present study suggests that the Optical and radiation beam alignment of X-ray rooms 1, 2, 3, 4, 5, 6 and 7 showed discrepancy of 0.8%,1.0%,1.1%,1.8%, 1.3%, 1.4% and 0.9% respectively and the central beam alignment of X-ray rooms 1, 2, 3, 4, 5, 6 and 7 had an error of less than 1.5˚ lies within acceptable limit. The effective focal spot of X-ray room number 1, 2, 3, 4, 5, 6 and 7 are 1.2mm× 1.2mm, 1.2mm× 1.2mm, 1.7mm× 1.8mm, 1.7mm× 1.8mm, 2mm× 1.2mm, 2mm× 2mm and 2.8 mm× 2.8 mm respectively. Results indicate that the focal spots of all the xray machines lies within acceptable limit. The accuracy of operating potential have an error of all x-ray machines 1, 2, 3, 4, 5, 6 and 7 is ± 5kv of all the machines which lies within acceptable limit. The linearity of mA loading stations of X-ray room number 1, 2, 3, 4, 5, 6 and 7 are 0.004mGy, 0.024mGy, 0.017mGy, 0.071mGy, 0.045mGy, 0.029mGy and 0.007mGy respectively. The output consistency (COV) of X-ray room number 1,2,3,4,5,6 and 7 are less than 0.05%, 0.013%, 0.008%, 0.013%,0.031%,0.012% and 0.017% respectively. The maximum radiation leakage from tube housing of X-ray room number 1,2,3,4,5,6 and 7 are 0.115 mGy, 0.131 mGy , 0.137 mGy, 1.66 mGy , 0.121 mGy, 0.162 mGy and 0.159 mGy in one hour and the maximum radiation leakage from tube collimator of the x ray machines number 1,2,3,4,5,6 and 7 are 0.124 mGy, 0.142 mGy, 0.163 mGy , 0.185 mGy , 0.127 mGy, 0.172 mGy, 0.187 mGy and 0.123mGy respectively. These findings comes within acceptable limits.

Comment [DC49]: This is not discussion. You only repeated the results in the tables.
NB For the discussion, for each of the QC parameters,(1)state the major results(2) say how your results relate-agree or disagree-to work in literature (3) say the implication(s) of the result (4) make recommendation(s) –if any.

Conclusion: From the findings of the study concluded that all the X- ray machines placed in room 1, 2, 3, 4, 5, 6 and 7 in the Radiology department at Maharishi Markandeshwar Hospital, Mullan, Ambala, Haryana are in good quality and ensure their proper functioning.

Comment [DC50]: It can be

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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