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QUALITY CONTROL FOR CONVENTIONAL X-RAY MACHINES

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Abstract:

Introduction: *This study will be conducted to quality controlassessment of conventional radiology X-ray devices. The importance of radiology to confirm diagnoses and management plan became in priorities in diagnosis nowaday, as well as it is evident. Also, the whole medical field seek towards the development and control of equipment ofX-ray*

Marital and method: *We will use standard quality control assessment tests that will be performed in this study, which include voltage accuracy as the first test, and reproducibility, then degree of exposure time, also we will use standard of tube output reproducibility, linearity, filtration, and beam alignment will be performed and evaluated. All of this assessment will be performed by using multi-purpose detector.*

Result: *By using the tools for calibration and Ray safe for measurement phantommeasurement (HVL filter Exposure parameter :(Kv- mAs -HVL- image quality - Sensor) after takeall measurement collected and analysis dates Excel sheet Compare radiation dose with national diagnostic reference level (AAPM74)*

Conclusion: *The primary objective of a quality assurance program in the radiology department is to ensure prompt and accurate diagnosis withminimal potential harm to patients and staff Assessment and Optimization ofmeasurement for calculate dose checking the value of exposure to the X-ray machine.*

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INTRODUCTION:

X-Rays and early radiography by Rontgen (1895–1928) For his discovery of X- Rays in 1895, Wilhelm Rontgen was awarded the Nobel Prize in 1901[1]. His reports included the first human radiograph of his wife, Anna Bertha's, hand. Other early radiographs emerging from a penchant for radiographing family and friends [2] are better, as are later radiographs of his buddy Albert von Kolliker's hand. Rontgen was a firm believer in open science and did not patent his discoveries, which he believed should be publicly available. Similarly, he gave his Nobel Prize money to science and later turned down a nobility offer. He was invited to join the Rontgen Society in the United Kingdom, which was the first medical X-Ray organization, but he rejected. Within a year following Rontgen's article, X-Rays were being used for diagnosis and therapy all around the world. While there were substantial benefits, there were also major risks to operators and patients. Intuitive protection measures began to be debated, albeit it took a long time for professional bodies to consider them, and much longer for them to become legally binding. This pattern is common; innovation and development come before formal norms and the law, and individuals with responsibility in these areas must be aware of this. In the year following Rontgen's discovery, approximately 1,100 publications on X-Rays were published due to the tremendous degree of curiosity in his invention.

Skin burns, dermatitis, skin malignancies, hair loss, and eye impairment were among the side effects recorded in the decades afterward [2]. Wolfram Conrad Fuchs of Chicago, who suggested keeping exposures as brief as possible and situating the x-ray tube at least 30 cm from the body, was one of the first attempts to offer safety guidance, mostly but not exclusively for employees. Filtration of the x-ray beam and collimation were suggested by others. Protective tube housings, leaded glass eyewear, collimated beams, and pulsed fluoroscopy were all advocated by Boston dentist William Rollins. The German Rontgen Society (Deutsche Rontgen-Gesellschaft) and others took notice of the proposals made during this time period and followed up on them. In 1913, the former published a one-page danger notice.

Further comment on the governance and ethics of positions taken by Rontgen is not relevant here because he resigned early from engagement with the medical development of his discoveries. The radiograph of his wife's hand (rather than his own) and his early unrestrained passion for hand radiography, however, lead to some suspicion. Such radiographs would obviously be inappropriate under today's radiation safety requirements. However, there was little, if any, understanding of the risk(s) that may be associated at the time. It's also possible that Rontgen's purpose was a desire to share the spotlight (which he didn't like for) with his wife, to whom he was devoted. There was also the prospect of a societal advantage in convincing people of the new discovery's usefulness. Rontgen's generosity in not patenting or restricting access to his invention, as well as in disbursing his Nobel Prize funds, was exceptional, and it is clear that he possessed a number of admirable traits [5-9].

History of x-ray:

X-rays were formerly thought to be a sort of unexplained radiation emitted by experimental discharge tubes before its discovery in 1895. Scientists studying cathode rays produced by such tubes, which are intense electron beams originally identified in 1869, noticed them. Many of the early Crookes tubes (developed around 1875) probably emitted X-rays, as evidenced by the effects noted by early researchers, as recounted below. Crookes tubes generated free electrons by ionising the tube's remaining air with a high DC voltage ranging from a few kilovolts to 100 kV. The electrons arriving from the cathode were accelerated to such a high velocity that they formed X-rays when they hit the anode or the tube's glass wall. [1].

William Morgan was the first researcher to be suspected of accidentally producing X-rays. He submitted a report to the Royal Society of London in 1785 explaining the effects of running electrical currents through a partly evacuated glass tube to produce an X-ray glow. [5][6] Humphry Davy and his assistant Michael Faraday expanded on this work.

Fernando Sanford, a physics professor at Stanford University, unintentionally produced and identified X-rays while developing his "electric photography." He had studied in the Hermann Helmholtz laboratory in Berlin from 1886 to 1888, where he became familiar with the cathode rays formed in vacuum tubes when a voltage was placed across different electrodes, as Heinrich Hertz and Philipp Lenard had previously explored. His letter to The Physical Review on January 6, 1893 (describing his finding as "electric photography") was duly published, and the San Francisco Examiner published a storey headlined Without Lens or Light, Photographs Taken With Plate and Object in Darkness. [9].

Philipp Lenard began experimenting in 1888 to investigate if cathode rays might escape the Crookes tube and into the air. He designed a Crookes tube with a thin aluminium "window" at the end facing the cathode so that the cathode rays would impact it (later called a "Lenard tube"). Something came through, exposing photographic plates and causing fluorescence, he discovered. He tested the beams' penetrating capability across various materials. At least some of these "Lenard rays" may have been X-rays, according to certain theories. [8].

Ivan Puluj, a lecturer in experimental physics at the Prague Polytechnic who had been building several types of gas-filled tubes to examine their characteristics since 1877, wrote a paper in 1889 on how sealed photographic plates got black when exposed to the tubes' emanations [5-7].

Hermann von Helmholtz developed X-ray mathematical equations. Before Rontgen's discovery and presentation, he proposed a dispersion hypothesis. He used the electromagnetic theory of light as his foundation. He did not, however, experiment with genuine X-rays.

Nikola Tesla began exploring this invisible, radiant energy in 1894 after noticing damaged film in his lab that appeared to be related with Crookes tube studies. Following Rontgen's discovery of the X-ray, Tesla began creating his own X-ray images with high voltages and tubes of his own design, as well as Crookes tubes.[2-7]

X-RAY MACHINE

X-RAY PRODUCTION:

When electrons in motion collide with matter, X-rays are produced. Electrons interact with a target in an x-ray tube, and some of their kinetic energy is transformed into x rays or electromagnetic energy. Figure 1 shows a simple electrical x-ray tube system that depicts the fundamental method of producing x-rays with a radiographic tube. The x-ray machine creates a potential gap of 20-150kV between the anode and cathode of the x-ray tube [7]. A separate low voltage circuit generates current through a filament on the cathode side. The filament heats up and expels electrons due to the thermionic emission effect, which is caused by the current in the filament. An electron is produced by the large potential difference between the anode and the cathode. Tube voltage refers to the mobility of electrons between anode and cathode, whereas filament voltage refers to the energy of electrons in the cathode filament.

The two methods of converting energetic electrons to x-rays at the anode side are the Bremsstrahlung process and characteristic x-ray generation. X-rays escape from the tubes in both directions, but are limited by lead boxes and collimators to the properbeam size, where they interact with the subject and the sensor to produce a realistic image.

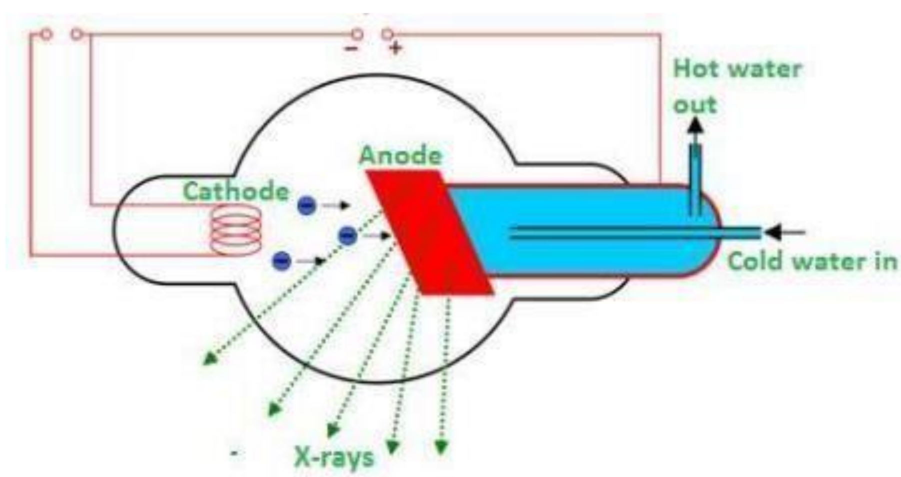


Figure 1. Basic x-ray production process.

x-ray generator:

A device that generates X-rays is known as an X-ray generator. It is frequently utilised in a range of applications, including medicine, X-ray fluorescence, electronic assembly inspection, and material thickness measuring in manufacturing operations, when combined with an X-ray detector. X-ray generators are used in medical applications by radiographers to get x-ray pictures of the interior structures (e.g., bones) of live creatures, as well as in sterilizing. [8]

To create X-rays, an X-ray generator usually includes an X-ray tube. Radioisotopes might perhaps be utilised to create X-rays.

The cathode, which guides a stream of electrons into a vacuum, and the anode, which gathers the electrons and is composed of tungsten to expel the heat created by the impact, make up an X-ray tube. When electrons clash with a target, only approximately 1% of the energy is released as X-rays, while the other 99 percent is released as heat. The target is commonly built of tungsten due to the tremendous energy of the electrons that approach relativistic speeds, even though other materials can be utilised in XRF applications.

An X-ray generator must also have a cooling system to keep the anode cold; many X-ray generators employ recirculating water or oil systems[9].

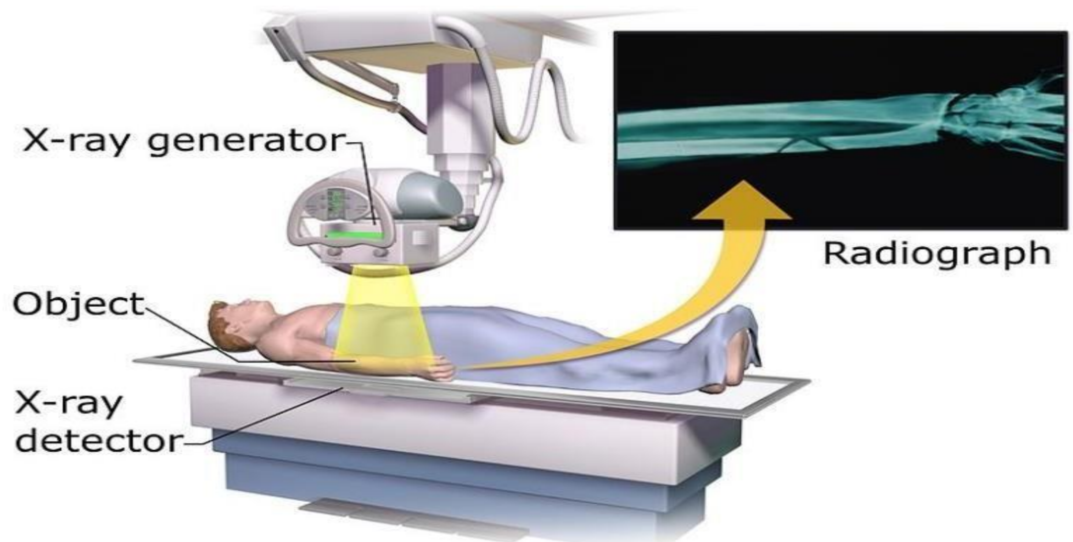


Figure 2 X-ray generator

Bremsstrahlung process:
The energy expended by an electron is determined by the electron path's direct contact with the nucleus, and hence by the frequency of the corresponding x-ray. The electrons were steered towards the target by creating a variety of radiography energies at various wavelengths through nuclei. The greatest potential x-ray energy is produced when an electron enters a nuclear reactor and releases all of its kinetic energy as an x ray. The energy spectrum for brake radiation is shown in Figure 2 [10]. The entire amount of energy given up by an electron is determined by the distance between the electron route and the nucleus, which determines the x-ray intensity. The nucleus produces a spectrum of x-ray energy when electrons travel at different rates across the target surface. Because the distance between the target nucleus and the nucleus width is quite large, low-energy x-rays are emitted rather than high-energy x-rays. This only happens when electrons go through the nucleus. The greatest possible x-ray power is emitted when an electron comes into direct touch with the nucleus and gives up all of its energy. Figure 2 depicts a bremsstrahlung energy spectrum. The energy released by bremsstrahlung x-rays on an unfiltered spectrum ranges from 0 to a peak value computed by the engine's KV peak setting. To improve bremsstrahlung x-ray efficiency, it is preferable to employ a target material with a high atomic number and hence a nucleus with a significantly higher energy; this strategy results in more efficient electrostatic diversion of the streaming electron beams. Because tungsten has a high melting point and atomic number, it is commonly employed as a target [11].

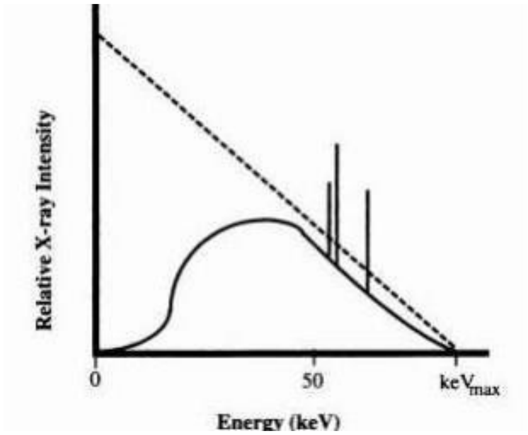
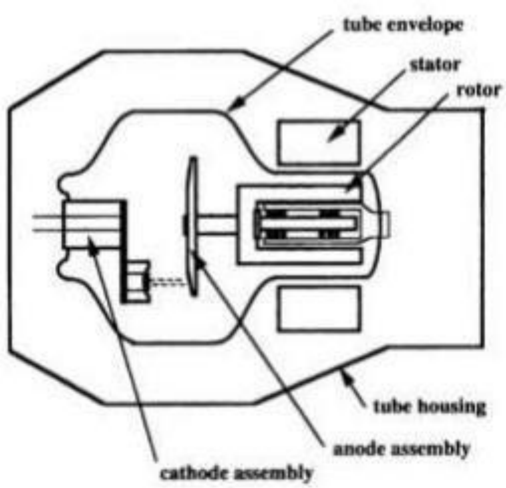


Figure 3. Spectrum of emission to a tungsten target.

The unmediated component of the x-ray spectrum created by bremsstrahlung label is represented by the dotted line in fig.2. The whole spectrum of x-rays is depicted in clear line format after escaping from the x-ray tube. Vertical straight lines depict the beams released by the x-ray tube. Bremsstrahlung and signature radiation are both included in the broad spectrum of pollutants. [12]

Components of x-ray tube:

The x-ray tube's main components are the anode, cathode, stator, rotor, and tank housing [13]. The surface of the tube, as well as the components inside it, is referred to as the tubing wrapping. When an x-ray tube cracks, it's usually only a matter of patching it together. The tube enclosure is removed, and oil is poured into the area between the shell and the casing to assistcool the tube and provide electrical shielding.



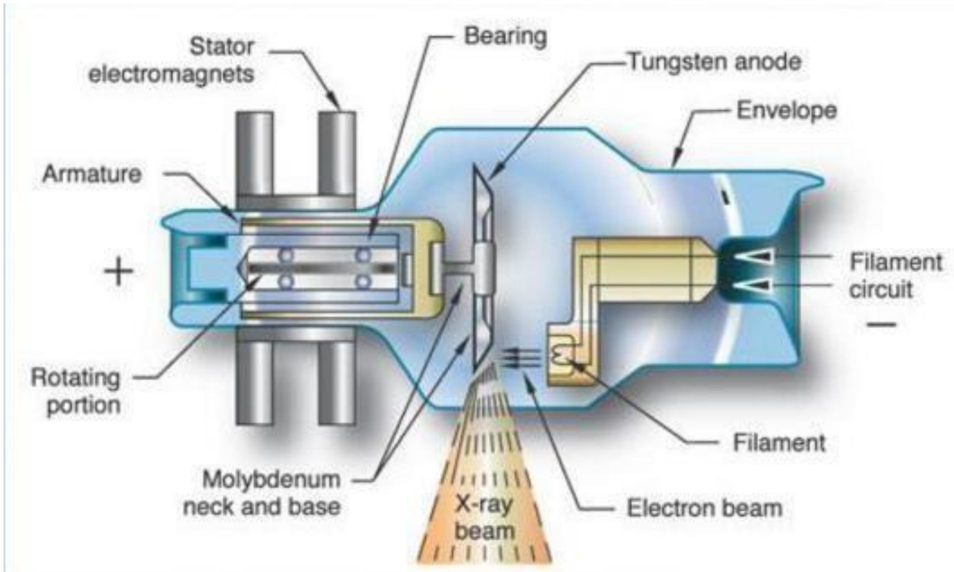


Figure 5. X-ray tube elements

The basic components of an x-ray tube are:

- To survive the extreme heat generated at the anode, a sealed glass tube envelope is built of glass or metal-ceramic with a high melting point. To avoid oxidation of the electrode materials, to allow rapid transit of the electrical current without ionisation of the gas within the tube, and to provide galvanic isolation between the electrodes, a vacuum distillation environment for the tube elements is required.
- A source of electrons i.e. heated tungsten filament (cathode).
- A metal target (anode). [14]

DESIGN CONSIDARATIONS FOR EQUIPMENT:

To provide a crisp image, the focal point size is kept as tiny as feasible. The size of the focus point is a crucial factor in image quality. To generate an x-ray image with the least amount of blur, a tiny focus spot size is employed. Small focus spots concentrate heat and put a strain on the focal spot region. The anode surface might melt if the amount of heat provided during a single exposure exceeds the track capacity. To create X-Ray effectively, the anode must have the right material, area, and angulations. To minimize excessive heat production, choose revolving and stationary anodes. To cool the target, an efficient heat dissipation system is necessary. [15]

To keep exposure durations to a minimum, you'll need a lot of filament current. The light beam and the x-ray beam must be parallel. Filtration that is both additional and changeable should be accessible.

TUBE HOUSING AND COLLIMATOR:

The tube housing contains an opening that allows a beneficial X-Ray beam to emerge while simultaneously shielding it from harmful radiation. Leakage radiation must adhere to strict guidelines. Oil is used in the tube housing for electrical insulation and heat dissipation. To customise the size and form of the X-Ray, a useful beam is directed at the patient using an adjustable collimator.

CONTROL CONSOLE:

Voltage (kVp), current (mA), and time are the three basic controls on the control console (s). The quality of the X-Ray is controlled by voltage, while the amount is controlled by current and time. The layout and functionalities of the control console are determined by the system and functions used. (Fig. 3).[16]

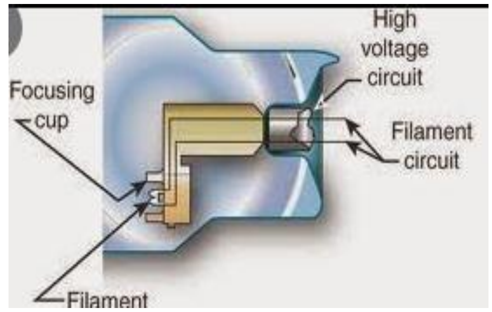


Figure 6. Control Console.

Cathode tube:
The electrons in the Coolidge tube are created by the thermionic action of a tungsten filament heated by an electric current. The tube's cathode is the filament. Between the cathode and the anode is a high voltage potential, which accelerates the electrons before they hit the anode.

End-window tubes and side-window tubes are the two types of tubes. End window tubes often feature a "transmission target" that is narrow enough to let X-rays flow through (X-rays are emitted in the same direction as the electrons are moving.) The filament is wrapped around the anode ("annular" or ring-shaped) in one form of end- window tube, and the electrons follow a curved route (half of a toroid) [17]

An electrostatic lens is employed to concentrate the beam into a very small region on the anode, which makes side-window tubes unique. The anode has been built specifically to remove the heat and damage caused by this extremely focussed assault of electrons. The anode is carefully tilted at 1-20 degrees off perpendicular to the electron current to allow part of the X-ray photons produced perpendicular to the electron current's direction to escape. Tungsten or molybdenum are commonly used as anodes. The tube contains a window that allows the produced X-ray photons to exit. A Coolidge tube's output typically varies from 0.1 to 18 kW.[18]

Anode tube:
A stationary anode's focal spot (the area where the beam of electrons from the cathode strikes) generates a significant amount of heat. Instead, a rotating anode allows the electron beam to traverse a broader region of the anode, recouping the benefit of increased emitted radiation intensity as well as lower anode damage when contrasted toa stationary anode.[19-24]

During an exposure, the focus point temperature may reach 2,500 °C (4,530 °F), and the anode assembly can reach 1,000 °C (1,830 °F) after a series of long exposures. Anodes with a tungsten-rhenium target on a molybdenum core and graphite backing are common. The addition of rhenium to tungsten makes it more ductile and resistant to wear from electron beam impact. Heat is conducted from the target by molybdenum. The anode's thermal storage is provided by graphite, which also reduces the spinning mass of the anode.[24-27]

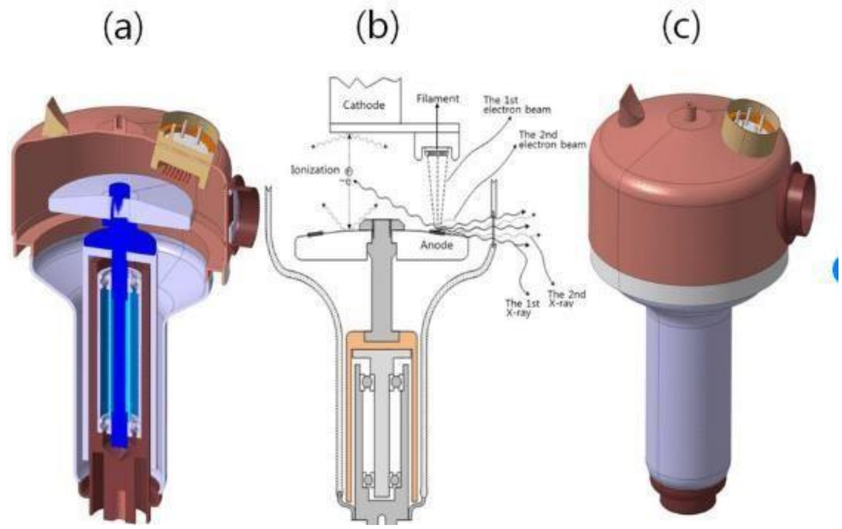


Figure 7. Anode tube

(Color online) (a) Internal model of the rotating anode X-ray tube, (b) schematic diagram of X-ray emission models, and (c) rotating anode X-ray tube model of thecompleted.

Applications in various fields:

1 The use of x-rays in clinical medicine was extremely crucial. X-ray images take use of the fact that higher-quality bones and teeth are less apparent on x-rays than other sections of the body [29]. In these professions, X-rays are frequently utilised for diagnostic purposes. Witnessing cracked bones and torn footballer's ligaments, diagnosing individuals with breast cancer, or discovering cavities and damaged intelligence teeth are just a few examples.

2 Computerized axial tomography, or CAT scans, is a relatively recent way of using x- rays in the area of pharmaceuticals. These scans provide a clearer cross-section view of a portion of the body than a traditional X-ray. This is due to the fact that a typical chest x- ray also exposes overlaid organs and chest parts. A narrow x-ray beam is transmitted across the region of interest from multiple different angles to make a CAT scan, and the cross-sectional representation of the area is reformed using a computer. [29].

3 Moseley discovered that the intensity of a natural element's hallmark x rays may be used to detect it. This fact allows for a useful approach of baseline analysis. When x rays of sufficient strength are used to impact a sample of unknown origin, the electrodes of the atoms of diverse sample components are disturbed, and the x rays are typical of such atoms. The elements identified in the sample may be estimated using the energy analysis of these x-rays. The technique is known as x-ray fluorescence research. It is commonly employed by chemists and law enforcement agencies for a non-destructive primary examination since it is necessary to discover what components are contained in a hair or blood sample, or any other substance that is utilised as proof in a forensic investigation.

4 The X-rays can be utilised for sales in a variety of other industries. Entire Xray images/engine components, for example, may be designed to identify flaws in a practical

5 way [30]. It's also possible to check for holes or broken welds in sections of the oil or gas tube lines. To screen for weapons or illegal materials, airlines frequently utilise radiograph detectors in passenger baggage. Synchrotron radiation is a fascinating new X-ray source that has recently been created. Most particle accelerators increase the energy of charged particles such as protons or electrons by enabling them to move in an accelerator along a circular route. A round ring of magnets protects the element in this circular orientation.[31-32]

6 X-ray lithography, which is utilised in the electronics industry for high-performance integrated circuits, is one of the most important industrial uses of synchrotron radiation. By etching successive types of electrical circuits into a wafer of semiconductor material, such as

silicone, integrated circuit boards are created. The shielding by a photographic resistant and blinding light of a mask-like stencil of the wafer on the top determines the circuitry's particular. [33-34]. The electric circuits' pattern is sliced into the mask, which can simply be wiped away from the exposed photo resistance, leaving the circuit outline in the remaining photo resistance. The amplitude of the waves is reduced by the circuit elements when the wavelength is shorter and the circuit elements are smaller. The circuits on a wafer may be greatly reduced when x rays are utilised instead of light, and a specific size wafer can be used to produce much smaller electronic equipment, such as computers.[35]

Effects of radiation exposure on human body:

Radiation has two kinds of health effects: acute perturbation and delayed perturbation. Acute disruption is an unavoidable impact that occurs when exposure exceeds a particular threshold. The radiation sensitivity of the tissues and cells that make up the human body varies, and symptoms occur in order starting with the tissues that are most susceptible to radiation. Alopecia, erythema of the skin, damage to blood components, damage to the gastrointestinal tract, and damage to the central nervous system are among the clinical symptoms of acute disorder. As the radiation dose is increased, symptoms such as alopecia, erythema of the skin, damage to blood components, damage to the gastrointestinal tract, and damage to the central nervous system appear. Among symptoms such as cancer, non-cancerous illnesses, and hereditary influence, cancer is the most common health impact in late-onset condition. Cancer and genetic impact are both considered random effects with no threshold. The risk of cancer caused by radiation exposure increases linearly with increasing dosage when the radiation dose is equal to or more than 100 mSv. On the other hand, the danger of cancer from low-dose radiation exposure (less than 100 mSv) has yet to be properly established.[37]

Quality control:

Medical imaging device quality control (QC) processes are mostly undertaken by certified businesses that are overseen by the National Radiation Protection Department (NRPD). In addition, QC checks on traditional radiological instruments are done every two years [36]. In 2003, the Atomic Energy Organization of Iran (AEOI) reported that 18,867,000 x-ray exams were performed on 12,963,000 patients [38]. Medical practitioners' increasing need for x-rays has resulted in unnecessary patient exposure. Routine quality control tests (daily, weekly, and monthly) are not conducted on a regular basis in any radiology department. This is due in part to a lack of skilled employees, but mostly to the flaws in the guidelines and the lack of proper equipment for QC testing. Furthermore, QC testing are only conducted every two years. Several studies have been conducted in several Iranian districts, taking into account the role of QC testing in patients' radiation exposure. [39]. In Chahar Mahal Bakhtiari province, seven radiological instruments were investigated for QC influence on patient dosage. They discovered that quality control can minimise patient dosage by at least 30%. [9] Furthermore, in a study of 44 devices in Golestan Province, Iran, [40] et al. discovered that exposure time accuracy was out of the normal range in 43.2 percent of radiological equipment [10]. Furthermore, [41] et al. investigated the effect of QC on 10 radiological equipment in Tehran province, finding that completing QC testing on these devices reduced patient dosage in 65 percent of cases. [10].

Because medical facilities in Cameroon have been unable to create any quality control programme, quality control (QC) testing on medical imaging devices are solely undertaken by the National Agency for Radiation Protection. The rapidly growing desire for medical practitioners to use x-rays has resulted in unwarranted patient exposure. No radiology department conducts routine quality control checks (daily, weekly, or monthly). This is due in part to a shortage of qualified employees, but primarily to bad rules and inadequate quality control testing equipment. Several studies have been undertaken in various countries [42] due to the necessity of quality control testing in patients' exposure to radiation. Quality control can minimise a patient's dosage by at least 30%, according to several of these studies. [43].saied that According to the ALARA principle, the average goal in diagnostic radiology is to give high-quality diagnostic images while limiting patient and worker doses to a minimum. An effective quality assurance (QA) procedure should be in place to maximise diagnostic radiology practise. In this study, 18 hospitals in Khartoum state were analysed, each with 18 x-ray equipment. Kvp and time reproducibility, precision of Kvp and time, mAs linearity, and coincidence between light and radiation beams were all verified on each x-ray machine. The fog level was also assessed in the dark rooms. This investigation was conducted using a PTW CONNY II QC Dosimeter. Two out of eighteen units had a problem with mAs linearity, two out of eighteen units had a problem with kVp accuracy, and one had a problem with kVp reproducibility, according to the results. Three devices exhibit flaws in terms of optical and radiation field adaption. More than half of the darkrooms experienced issues with fog, although time accuracy and repeatability were within acceptable limits. To ensure that radiological devices work properly, quality control should be done on them on a regular basis and any problems should be addressed. Most of these machines require servicing due to a lack of frequent implementation of the quality control programme, indicating that quality control programmes should be expanded on a regular basis. Because dark rooms are such an essential feature of traditional radiology departments, such as those in Sudan, they must be reviewed on a regular basis to ensure that the fog does not build up. suggested that The link between the radiation dosage provided to a patient and picture quality in X-ray diagnostic radiology provides a clear grasp of the relationship in optimising medical diagnostic radiology. Because a certain quantity of radiation must be supplied to patients, it should be kept as low as possible. Several X-ray diagnostic equipment were utilised in Egypt to examine the beam quality and dosage provided to the patient at various medical diagnostic institutes. For various tests, this article investigates parameters such as the kilovolt peak (kVp), exposure time (mSc), tube current (mAs), and absorbed dosage in (Gy). The highest absorbed dosage measured per mAs for the belly and chest, respectively, was 594 239 and 12.5 3.7Gy, whereas the absorbed dose at the elbow was 18 6Gy, which was the lowest dose recorded. These measurements came with 4 0.35 percent and 8 0.7 percent compound and extended uncertainty, respectively. As part of the acceptance procedures, the measurements were made using quality control testing. reported that, At the Iranian province of Khuzestan, quality control (QC) assessments of traditional radiology instruments were carried out in commonly frequented radiology centres. In addition, Based on the procedure described in Report No. 77 by the Institute of Physics and Engineering in Medicine, fifteen conventional radiology instruments were tested (IPEM). Ten standard quality control tests were carried out and evaluated, including voltage accuracy and reproducibility, exposure time accuracy and reproducibility, tube output linearity (time and milliampere), filtration (half-value layer), tube output (70 kV at FSD =100 cm), tube output reproducibility, and beam alignment. The Barracuda multi-purpose detector was used for all measurements. The results reveal that all devices satisfied the required requirements for voltage, exposure time, and dosage output repeatability, as well as output linearity. The beam alignment test, on the other hand, yielded unsatisfactory results in 60% of the units. We also discovered that 66.7 percent of the units investigated serve more than 18,000 individuals each year, or 50 patients per day. found There is a significant concentration in the categories of conventional and portable X-ray equipment, which account for 72 percent and 84 percent of the total number of equipments, respectively. Half-value layer (HVL), a mechanical property crucial not only for picture quality but also for radiation protection, showed significant improvements. Only 58 percent of portable X-ray equipment had HVL values that were indicated for 80 kVp (above 2.3 mm Al) in 2005, up from 76 percent in 2006. In the case of mammographers, which are more recent machines, all of the evaluated systems had acceptable HVL values. The conformance index of conventional X-ray machines increased from 89 percent in 2000 to 94 percent in 2006. All of this progress was due to the state of So Paulo's continued and vigorous execution of Regulation Act 453. The increase in device quality control standards is projected to result in better image quality as well as a decrease of exam rounds, lowering the patient's radiation exposure. showed The ALARA concept states that the major goal of diagnostic radiology is to give high-quality diagnostic images while limiting patient and worker doses to a minimum. Important diagnostic radiology performance tests were carried out in Cameroon according to a quality control strategy, with the measured parameter values compared to the appropriate acceptance limits. Ten standard QC tests were performed to assess the device's performance, including voltage accuracy and reproducibility, exposure time accuracy and reproducibility, tube output linearity (time and milliampere), filtration (half-value layer or HVL), tube output (70 kV at FSD=100 cm), tube output reproducibility, and beam alignment. The Institute of Physics and Engineering in Medicine provided a procedure for QC testing in Report No. 77. (IPEM). Certain tests, such as tube output at 70 kV (43.48 percent of the units), tube output linearity of the current (23.3 percent), and voltage accuracy (21.73 percent of the units), had the worst results. Furthermore, 43.48 percent of the units passed all of the tests. Based on the bad result of the tube output at 70kV, an inquiry was conducted that led to the conclusion that, while 43.48 percent of the X-ray machines failed the tube output test, only 21.74 percent of all X-ray machines required a tube replacement.

Literature Review:

A quality assurance (QA) software in diagnostic imaging is defined by the World Health Institution (WHO) as an organised effort by the organizations working a factory to ensure that the clinical images produced are also of sufficient high quality to regularly deliver adequate clinical information at the least total price although with the lowest potential patient exposure. The nature and extent of this strategy will be determined by the facility's size and kind, the sort of exams undertaken, and other variables. The diagnostic radiology institution that produces the pictures will determine what constitutes excellent quality in any QA programme. The quality assurance programme must include the complete X-ray system, from the equipment to the processing to that same viewing box.

Both quality control (QC) methodologies and quality administration processes are included in quality assurance actions. Quality control techniques including those employed in the monitoring (or testing) and maintenance of the technical aspects or components of an X-ray system are usually included in the QA programme.
As a result, the quality control approaches are directly concerned with the equipment that might impact the picture quality, i.e. the component of the QA programme that deals with instruments and equipment. An X-ray system is a collection of components that allows for the precise creation of diagnostic pictures using X-rays. An X-ray high voltage generator, an X-ray control device, a tube-housing assembly, a beam-limiting device, and the essential supporting structures are included as a minimum. Image receptors, image processors, automated exposure control devices, view boxes, and darkrooms are some of the other components that work with the system. The basic purpose of a quality control programme is to guarantee that the diagnosis or intervention is accurate (optimising the outcome) while reducing the radiation dosage. [49-61].

Condition that objective in a typical diagnostic radiology facility, QC procedures may include the following:

a. Activation and acceptance testing New equipment is subjected to an acceptance test to ensure that it meets the manufacturer's standards and requirements. Commissioning is the process of gathering all of the data from technology so that it may be used clinically in a certain department. The baseline values for the QC processes will be determined by this commissioning test.
b. Constancy tests are run at regular intervals to ensure that some important parameters are performing as expected. The control of consistency frequencies stated may have a tolerance of 30 days.
c. Status tests are normally performed with full testing at longer periods, e.g. annually.
d. Performance tests are specific tests performed on an X-Ray system after a pre-determined period of time.
e. Verification of radiation protection (RP) and QC equipment and material.
f. Follow-up on any essential remedial steps done as a result of earlier QC processes' outcomes. This is critical since QC measures alone are insufficient without documentation of remedial actions and follow-ups. Quality administration processes, on the other hand, are management activities that ensure that monitoring techniques are correctly implemented and assessed, as well as that appropriate corrective actions are made in response to monitoring results. The quality assurance program's organisational foundation is provided by these processes. Any facility that uses an X-Ray system(s) in any process that requires irradiation of any portion of the human or animal body for the purpose of diagnosis or visualisation is referred to as a diagnostic radiology facility in this meaning.

The most often used instrument in the detection of illnesses is X-ray, which accounts for a significant portion of man's exposure to artificial resources. In medicine, X-ray imaging is an effective diagnostic tool for which there is no acceptable substitute. X-ray exams should deliver pictures containing significant diagnostic information with the lowest possible radiation dosage, according to the idea of "as low as reasonably feasible" (ALARA). [62].

Some legislative bodies have created quality assurance procedures in hospital medical imaging departments to attain this purpose. Medical imaging device quality control (QC) processes are mostly undertaken by certified businesses that are overseen by the National Radiation Protection Department (NRPD). In addition, QC checks for traditional radiological instruments are undertaken every two years. According to the Atomic Energy Organization's (AEO) official data, 18,867,000 x-ray exams were performed on 12,963,000 patients in 2003 3.)

Medical practitioners' increasing need for x-rays has resulted in unnecessary patient exposure. Routine quality control tests (daily, weekly, and monthly) are not conducted on a regular basis in any radiology department. This is due in part to a lack of skilled employees, but mostly to the flaws in the guidelines and the lack of proper equipment for QC testing. Furthermore, QC testing are only conducted every two years. In light of the significance of QC testing in terms of patient radiation exposure.[63]

MATERIAL AND METHODS:

Parameter comparison with standard AAPM74and then degree of exposure time, also we will use standard of tube output reproducibility, linearity, filtration, and beam alignment will be performed and evaluated.Conventional X-ray devices in hospitals in Mecca city will be assessed , all such information and data elements in a specific and meaningful fashion. -measurment phantom dose (american association of physcicists in medcine (AAPM) - Raysafe for measurment - Excel sheet for cllected and anlaysisi dats - Snsor - HVL filter - Exposure parameter : Kv, mAs HVL , image quality) and Accurate and safe determination of the radiation dose.

X-ray QA Instruments:

RaySafe X2 X-ray Measurement System

Figure 7 .RaySafe X2 X-ray Measurement System

RaySafe X2 combines state-of-the-art sensor technology with a completely new userinterface, making X2 the ultimate in x-ray measurement systems.

- Large touch-screen display for simple operation and great overview of all measuredparameters.
- Full waveforms directly in the base unit for quick analysis of measurements.
- No special settings to handle different types of X-ray machines. Just connect andmeasure.
- Built-in memory – up to 10 000 measurements with waveforms are stored in the baseunit.

Figure 9. RaySafe X2 Solo X-ray Measurement System

RaySafe X2 Solo is a new product line from RaySafe that covers the measurement needs of your specific X-ray modalities. It's based on the same technology as RaySafe X2, highly esteemed for its userfriendliness and performance, but instead of multi-modality capability, each model meets specific needs. Within your X-ray modalities the X2 Solo will meet all your QA or service measurement needs.

- RaySafe X2 Solo R/F - for conventional X-ray, interventional radiology, surgery, CR, DR, dental (Intraoral, Panoramic, CBCT) and CT (kVp, HVL and time only)
- RaySafe X2 Solo DENT – tailor made for dental X-Ray supporting all types of dental machines; Cone Beam CT, Panoramic and Intraoral. Includes holder for panoramic measurements.
- Options include HVL & Total Filtration as well invasive mAs measurements

Figure 10 . RaySafe ThinX X-ray Measurement System

- RaySafe ThinX has been optimized to meet the need for a basic multi-parameter instrument for simultaneous measurement of dose,dose rate, kVp, HVL, exposure timeand pulses. All parameters are conveniently displayed in the large LCD.
- Provides a fully automatic user interface
- Perfect choice for radiation measurements in radiographic applicationsPacked with world-leading, state-of-the-art technology to make your measurements effortless

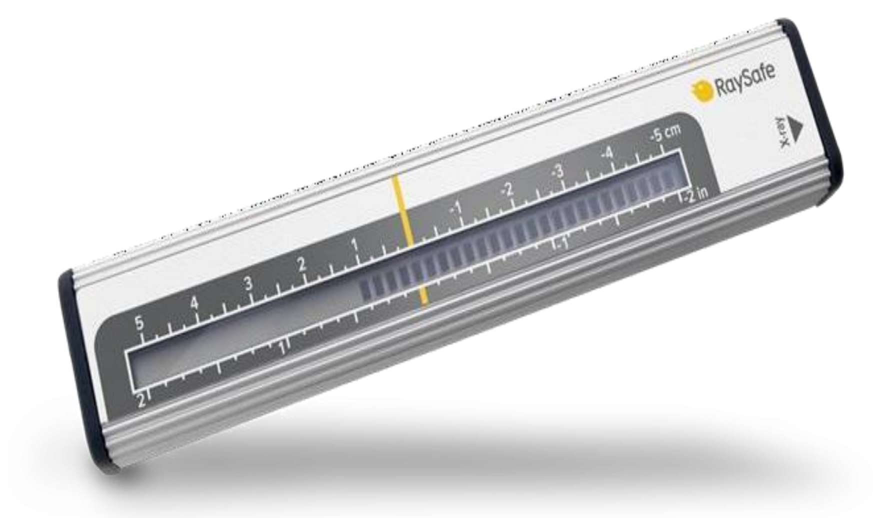


Figure 11 . RaySafe DXR+ X-ray ruler

The pocket-sized RaySafe DXR+ operates down to 30 kVp and gives an objective, reproducible and immediate read-out.

- Fully automatic
- Radiographic and Mammography
- Ideal for digital imaging
- - 8 years battery life

Test of RaySafe X2:

Voltage accuracy:
At constant tube currents, clinical tube voltages (60-110kVp) were tested (5 kVp steps). Then, the measurements were compared with the specified values to determine the differences.

Voltage reproducibility:
Exposure was performed at constant tube voltages and clinical tube loadings. The experiments at this step were
repeated at least three times to enable statistical analysis on the obtained data. Afterwards, standard deviation (SD) and coefficient of variation (CV) were calculated for the measured voltages.

Exposure time accuracy:
At a constant tube voltage (usually 70 kVp) and adjustable tube current, exposure times were tested (0.1-0.5, 0.1 s steps) at 0.1s intervals from 0.1s to 0.5s. Then, the measurements were compared with the specified values to evaluate the differences.

Exposure time reproducibility:
At the constant exposure time and clinical tube loadings, at least three exposures were performed. Then, SD and CV were calculated for the measured exposure time.

The linearity of tube output (D=f(s)):
At constant tube voltage and current, two exposures were performed at different time intervals (e.g.,
0.1 and 0.2). Dose-to-mA ratio(x) The X parameter was defined as "Dose to mA ratio" and was calculated for both exposure times. Afterwards, linearity coefficient (L) was calculated, using the formula presented intable

The linearity of tube output (D=f (mA)):
At a constant tube voltage and time, two exposures were performed with different tube currents (e.g., 100 and 200). Dose-to-mA ratio(x) The X parameter was calculated for both tube currents, and L value was determined. Filtration (HVL): At clinical tube voltages, an aluminum attenuator was used to reduce the intensity to half of its initial value. Afterwards, the attenuation curve was plotted and HVL value was extracted.

Tube output (70 kV at FSD=100 cm):
At 70 kVp and typical mAs, the tube output was measured by placing MPD at 100-cm FSD. This parameter canbe used for evaluating patient's skin dose.

Reproducibility of the tube output:
At constant tube voltages and clinicaltube loadings, at least three exposures were performed. Then, SD and CVwere calculated for the measured dose.

Beam alignment:
In order to have a more congruent form of lightand x-ray beam, the collimator pattern was applied. Based on IPEM Report No.77, the devices were categorized into three groups: "good","normal"and "poor" (< 5%, 5-10% and > 10% of error and CV, respectively).

Table 1. The definition and grading of the most important parameters for QC evaluation of conventional radiology units

Parameters	Definition	Good	Normal	Poor
Voltage accuracy	$\frac{Kv(measured) - Kv(nomiral)}{Kv(nomiral)}$	±5%	±10%	±**10**%
Voltage Reproducibility	$SD = \sqrt{\frac{\sum(X_i - X^{-})^2}{B-1}}$ $CV = \frac{SD}{X^{-}}$	±5%	±10%	±**10**%
Exposure time Accuracy	$\frac{time\ (measured) - time\ (nominal}{time\ (nomainal)}$	±5%	±10%	±**10**%
Exposure time				

Reproducibility	$SD = \sqrt{\frac{\sum(X_i - X^-)^2}{B-1}}$ $X = \frac{Dose}{mAs}$	±5%	±10%	±**10**%
Tube output linearity (D=F(s))	$L = \frac{X_1 - X_2}{X_1 + X_2}$ $X = \frac{Dose}{mAs}$	±5%	±10%	±**10**%
Tube output linearity (D=F(mA))	$L = \frac{X_1 - X_2}{X_1 + X_2}$ $X = \frac{Dose}{mAs}$	±5%	±10%	±**10**%
Filtration (HVL)	Thickness of ~~aluminum~~ filterreducing X-ray intensity to half	$> 2.5mmAl$	-	$> \mathbf{2.5mmAl}$
Tube output (70 Kv at FSD = 100 cm)	$X = \frac{Dose}{mAs}$	43-52	26 -43,	$< \mathbf{26\ \mu Gy/mAs}$
		$\mu Gy/mAs$	$< 52 - 69\ \mu Gy/mAs$	$< \mathbf{69\ \mu Gy/mAs}$
Tube output Reproducibility	$SD = \sqrt{\frac{\sum(X_i - X^-)^2}{B-1}}$ $CV = \frac{SD}{X^-}$	±5%	±10%	±**10**%
Beam alignment	The distance between light and x-ray field	< 1%	< 2%	< **2**%

Study Subjects:
Our target is a optimization of radiation X-ray dose and risk estimation for patients. We will use (the cat tools) for standard quality control assessment tests that will be performed in this study, which include voltage accuracy as the first test, and reproducibility, Study objectives/ AMIS:Parameter comparison with standar AAPM74an then degree of exposure time, also we will use standard of tube output reproducibility, linearity, filtration, and beam alignment will be performed and evaluated Conventionall X-ray devices in hospitals in Mecca city will be assessed, all such information and data elements in a specific and meaningful fashion. — measurement phantom dose (American association of physicists in medicine (AAPM74) — Ray safe for measurement — Excel sheets for collected and analysis dates — Sensor — HVL filter — Exposure parameter : KVP, m As HVL, image quality) and Accurate and safe determination of the radiation dose Communicationss in Medicine

Study Area/Setting:
it will be conducted at X-ray Machines radiology department in Maternity and ChildrenHospital

Study Design:
It is a retrospective study by utilizing the software (raysafe for Measurements) and phantoms.

Sample Size:
X-ray Machines at radiology department

Sampling Technique:
Data will be collected Radiation dose by scanning devices at different doses. We will use standard quality control assessment tests that will be performed in this study, which include voltage accuracy as the first test, and reproducibility,then degree of exposure time, also we will use standard of tube outputreproducibility, linearity, filtration, and beam alignment will be performed and evaluated. Conventional X-ray devices in hospitals in Mecca. Figures and tables will be used to represent the result.

We will use (the cat tools) for standard quality control assessment tests that will be performed in this study, which include voltage accuracy as the first test, and reproducibility,

RESULTS AND DISCUSSION

Continuous variables were presented as mean and standard deviation if are normally distributed or median and interquartile range if their distribution is skewed. Student's t-test will be implemented to test for differences between the various characteristics among cases and control, where applicable, or Mann–Whitney test will be used if the assumptions of the t-test will not be met. A chi-square test will be used for comparisons between categorical variables. Simple and multiple logistic regression analyses will be used for the estimation of the crude and adjusted odds ratios. All statistical calculations will be performed using SPSS (version 21.0.)

Machine Equipment:
Physical Inspection:

1. Physical Inspection:	
	Result
	PASS
2. Source to image Distance Indicator Present and ccurate	PASS
3. If filters can be removed there should be a visible indicator of filter absence	PASS
4. Tube perpendicularity indicator is present	PASS
5. Tube angulation indicator is present	PASS
6. Locking devices are effective.	PASS
7. The light beam is switched off automatically.	PASS
8. The diaphragm can be closed completely.	PASS
9 Tubeheads and supports are smooth and easy to use	PASS
10. Table Bucky lock is functioning properly	PASS
11. Table Bucky Cassette lock holds cassette firmly	PASS
12. Stand Bucky is functioning properly.	PASS
13. Stand Bucky cassette lock holds cassette firmly.	PASS
14. Cable covering are intact.	PASS
15. AEC detector positions are clearly marked and visible.	PASS

X-ray Control Panel:

2. X-ray Control Panel:	
	Result
1. There is visible light on 'prepare' andexpose"	PASS
2. If more than one tube is used from the panel, the tube selector switches should be labeled.	PASS
3. Panel indicators are functioning correctly.	PASS
4. Control buttons are functioning correctly.	PASS
5. The radiographer has a clear view of the table and chest stand from the panel.	PASS
6. Tube overload protection circuit is working properly	PASS

kVp Accuracy & Reproducibility

FDD = 100 cm				mAs = 20			Focus = BF
KVp Accuracy							Reproducibility
Set kV	Measured kVp			Average	Accuracy %	SD	Coefficient of Variation
60	59.4			59.4	-1		
70	69.1			69.1	-1.2857		
81	80.3	80.3	80.4	80.3333	-0.823	0.05774	0.000718693
90	89.5			89.5	-0.5556		
102	102.1			102.1	0.09804		
Result					PASS		PASS

FDD = 100 cm				mAs = 20			Focus = FF
KVp Accuracy							Reproducibility
Set kV	Measured kVp			Average	Accuracy %	SD	Coefficient of Variation
60	59.3			59.3	-1.1667		
70	69.3			69.3	-1		
81	80.4	80.4	80.5	80.4333	-0.6996	0.05774	0.0007178
90	89.7			89.7	-0.3333		
102	102.4			102.4	0.39216		
Result					PASS		PASS

Results:

kVp Accuracy is within accepted limits

kVp Reproducibility is within accepted

.

Expousre Timer Accuracy & Reproducibility:

FDD = 100 cm kV = 81

							Reproducibility	
KVp Accuracy								
Set ms	Measured ms			Average	Accuracy %	SD	Coefficient of Variation
25	24.4			24.4	-2.4		
50	48.9			48.9	-2.2		
100	97.8	98.8	97.9	98.16667	-1.83333	0.550757	0.005610428
200	195.9			195.9	-2.05		
400	392.3			392.3	-1.925		
Result					PASS		PASS

Results:

mSec Accuracy is within accepted limits

mSec Reproducibility is within accepted .

Reference :

AAPM Report Number 74 , 2002

Criteria: Timer Accuracy (+/-) 5 % (For times > 10 msec)

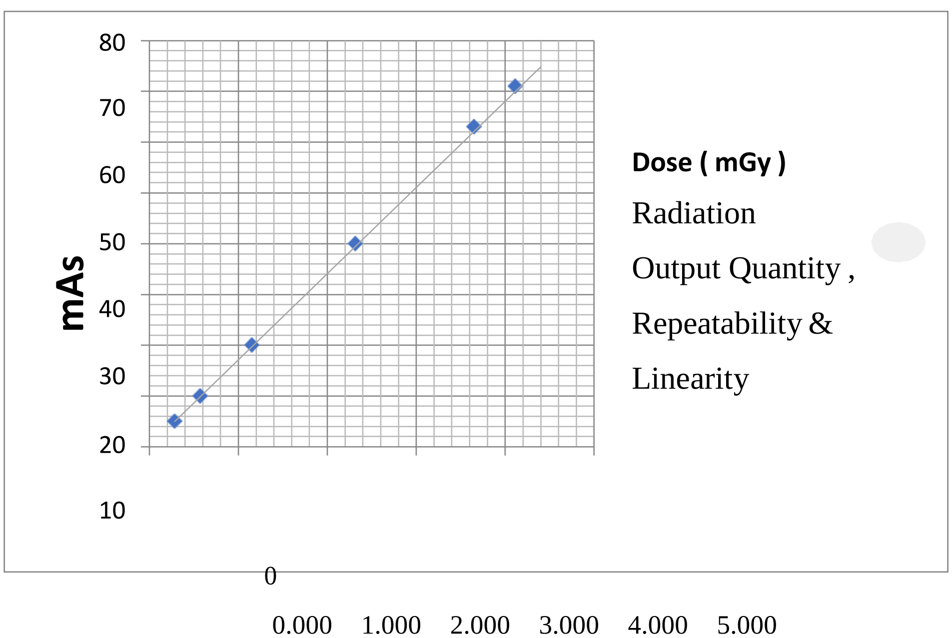
Timer Accuracy (+/-) 10 % (For times < 10 msec)

Expousre Timer Reproducibility less than 0.05

Radiation Output Quantity , Repeatability & Linearity:

FDD = 100 cm				kVp = 81			Focus = BF	
mAs (output) Linearity						Linearity	Repeatability	
Set mAs	Measured Dose (mGy)			Average	mGy/mAs		SD	Coefficientof Variation
5	0.2814			0.2814	0.05628	0.014443		
10	0.571			0.571	0.0571			
20	1.154	1.15	1.151	1.151667	0.057583		0.002082	0.001807525
40	2.313			2.313	0.057825			
63	3.649			3.649	0.057921			
71	4.113			4.113	0.05793			
Result						PASS		PASS

$$Linearity\ Coefficient = \frac{(max\ value\ of\ output - min\ value\ of\ output)}{(max\ valueof\ output + min\ value\ of\ output)}$$



FDD = 100 cm				kVp = 81			Focus = BF	
mAs (output) Linearity						Linearity	Repeatability	
Set mAs	Measured Dose (mGy)			Average	mGy/mAs		SD	Coefficient of Variation
5	0.2765			0.2765	0.0553	0.03249		
10	0.5613			0.5613	0.05613			
20	1.128	1.13	1.13	1.129333	0.056467		0.001155	0.001022462
40	2.266			2.266	0.05665			
63	3.57			3.57	0.056667			
71	4.19			4.19	0.059014			
Result						PASS		PASS

Results:

Linearity coefficient is within accepted limits

Reproducibility is within accepted limits

Reference :

AAPM Report Number 74 , 2002

Criteria: Linearity cofficient < 0.10

Reproducibility less than 0.05

Beam Quality Half Value Layer (HVL):

FDD = 100 cm kVp = 81 mAs = 20 Focus = BF

Thickness (d) mmAl	D 0 (mGy)	D (mGy)	% Transmission	
0	1.166	1.166	100	HVL by Equation = **3.3**
1	1.166	0.9061	78	
4	1.166	0.5137	44	

HVL = 3.3 mmAL

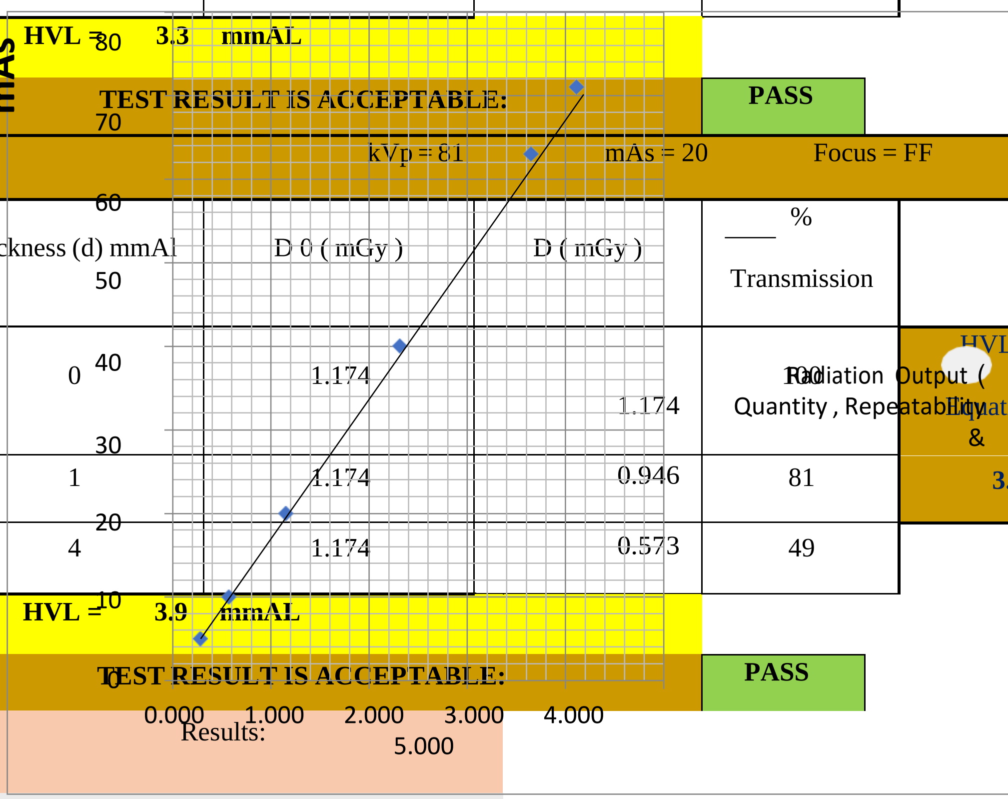
TEST RESULT IS ACCEPTABLE: **PASS**

kVp = 81 mAs = 20 Focus = FF

Thickness (d) mmAl	D 0 (mGy)	D (mGy)	% Transmission	
0	1.174	1.174	100	HVL by Equation = **3.9**
1	1.174	0.946	81	
4	1.174	0.573	49	

HVL = 3.9 mmAL

TEST RESULT IS ACCEPTABLE: **PASS**



Results:

HVL is within accepted limits

Reference :

AAPM Report Number 74 , 2002

Criteria: HVL > 2.5 mm Al

Radiographic Collimation & SID:

FDD = 100 cm kVp = 81 mAs = 10 Focus = BF

	Anode (+)	Cathode (-)	Front	Back
Differ (cm)	0.5	0	-0.2	-0.6
Total	0.5		-0.8	
Result	PAS S		PASS	

Result = PASS

Reference :

AAPM Report Number 74 , 2002

Criteria: X-ray field and light fild boaders agree

Image Quality & Resolution:

FDD = 100 cm kVp = 60 mAs = 10 Focus = BF

Low Contrast	5
Dynamic range	5
Resolution	2.6

PASS

CONCLUSIONS:

Although various laws govern the use of radiation in medicine, the legal framework does not include the areas of quality assurance and quality control. In light of this, various international recommendations are employed in addition to legal texts. Despite this, there are still many parts of our approach that are unsatisfying. As a result, patient dosimetry and picture quality must be included in the quality management system that should be in place in every diagnostic radiology department. The quality control programme, in our experience, has a good influence on the performance of X-rayequipment over a period of a few years. At least once a year, quality control tests on all installed x-ray units are required. This will result in consistent x-ray pictures with a low cure rate, lowering the patient's dosage. Many factors interact in a complicated way to determine the dosages given to patients. In hospitals, it is critical to take accurate patient dosage measurements.

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Appendix:

Machin Data (20) kVp Accuracy & Reproducibility

FDD = 100 cm mAs = 20 Focus = BF

KVp Accuracy						Reproducibility	
Set kV	Measured kVp			Average	Accuracy %	SD	Coefficient of Variation
60	59.4			59.4	-1		
70	69.1			69.1	-1.2857		
81	80.3	80.3	80.4	80.3333	-0.823	0.05774	0.000718693
90	89.5			89.5	-0.5556		
102	102.1			102.1	0.09804		
Result					PASS		PASS

FDD = 100 cm mAs = 20 Focus = FF

KVp Accuracy						Reproducibility	
Set kV	Measured kVp			Average	Accuracy %	SD	Coefficient of Variation
60	59.3			59.3	-1.1667		
70	69.3			69.3	-1		
81	80.4	80.4	80.5	80.4333	-0.6996	0.05774	0.0007178
90	89.7			89.7	-0.3333		
102	102.4			102.4	0.39216		
Result					PASS		PASS

Results:

kVp Accuracy is within accepted limits
kVp Reproducibility is within accepted .

Reference :

AAPM Report Number 74 , 2002
Criteria: kVp Accuracy (+/-) 5 %
kVp Reproducibility less than 0.05

Expousre Timer Accuracy & Reproducibility

FDD = 100 cm kV = 81

KVp Accuracy						Reproducibility	
Set ms	Measured ms			Average	Accuracy %	SD	Coefficient of Variation
25	24.4			24.4	-2.4		
50	48.9			48.9	-2.2		
100	97.8	98.8	97.9	98.16667	-1.83333	0.550757	0.005610428
200	195.9			195.9	-2.05		
400	392.3			392.3	-1.925		
Result					PASS		PASS

Results:

mSec Accuracy is within accepted limits
mSec Reproducibility is within accepted .

Reference :

AAPM Report Number 74 , 2002
Criteria: Timer Accuracy (+/-) 5 % (For times > 10 msec)
Timer Accuracy (+/-) 10 % (For times < 10 msec)
Expousre Timer Reproducibility less than 0.05

Radiation Output Quantity , Repeatability & Linearity

FDD = 100 cm				kVp = 81			Focus = BF	
mAs (output) Linearity						Linearity	Repeatability	
Set mAs	Measured Dose (mGy)			Average	mGy/mAs		SD	Coefficient of Variation
5	0.2814			0.2814	0.05628	0.014443		
10	0.571			0.571	0.0571			
20	1.154	1.15	1.151	1.151667	0.057583		0.002082	0.001807525
40	2.313			2.313	0.057825			
63	3.649			3.649	0.057921			
71	4.113			4.113	0.05793			
Result						PASS		PASS

FDD = 100 cm				kVp = 81			Focus = BF	
mAs (output) Linearity						Linearity	Repeatability	
Set mAs	Measured Dose (mGy)			Average	mGy/mAs		SD	Coefficient of Variation
5	0.2765			0.2765	0.0553	0.03249		
10	0.5613			0.5613	0.05613			
20	1.128	1.13	1.13	1.129333	0.056467		0.001155	0.001022462
40	2.266			2.266	0.05665			
63	3.57			3.57	0.056667			
71	4.19			4.19	0.059014			
Result						PASS		PASS

Results:

Linearity coefficient is within accepted limits

Reproducibility is within accepted limits

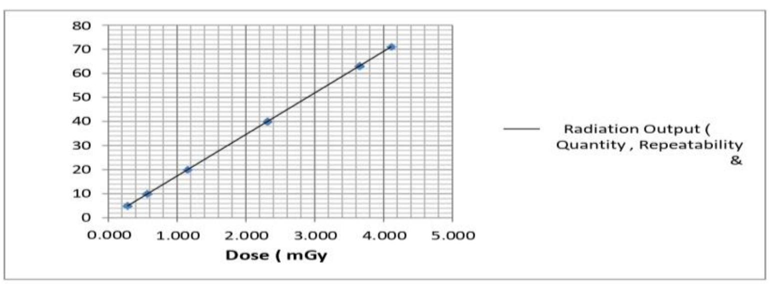
Reference :

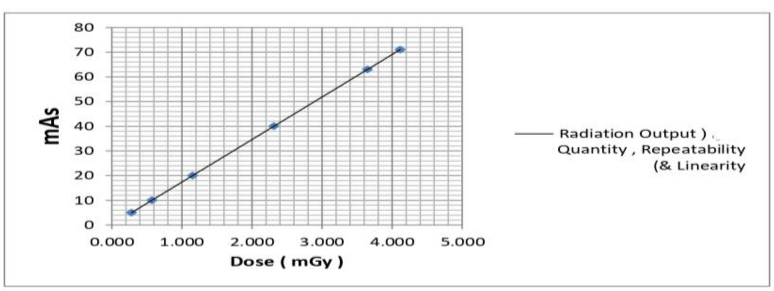
AAPM Report Number 74 , 2002

Criteria: Linearity cofficient < 0.10

Reproducibility less than 0.05

$$Linearity\ Coefficient = \frac{(max\ value\ of\ output - min\ value\ of\ output)}{(max\ valueof\ output + min\ value\ of\ output)}$$





Beam Quality Half Value Layer (HVL)				
FDD = 100 cm	kVp = 81	mAs = 20	Focus = BF	
Thickness (d) mmAl	D 0 (mGy)	D (mGy)	% Transmission	
0	1.166	1.166	100	HVL by Equation =
1	1.166	0.9061	78	3.3
4	1.166	0.5137	44	
HVL = 3.3 mmAL				
TEST RESULT IS ACCEPTABLE:			PASS	
FDD = 100 cm	kVp = 81	mAs = 20	Focus = FF	
Thickness (d) mmAl	D 0 (mGy)	D (mGy)	% Transmission	
0	1.174	1.174	100	HVL by Equation =
1	1.174	0.946	81	3.9
4	1.174	0.573	49	
HVL = 3.9 mmAL				
TEST RESULT IS ACCEPTABLE:			PASS	

Results:

HVL is within accepted limits

Reference :

AAPM Report Number 74 , 2002

Criteria: HVL > 2.5 mm Al

Radiographic Collimation & SID				
FDD = 100 cm	kVp = 81	mAs = 10	Focus = BF	
	Anode (+)	Cathode (-)	Front	Back
Differ (cm)	0.5	0	-0.2	-0.6
Total	0.5		-0.8	
Result	PASS		PASS	

Result = PASS

Reference :

AAPM Report Number 74 , 2002

Criteria: X-ray field and light fild boaders agree to within ± 2% of the SID

Image Quality & Resolution	
FDD = 100 cm kVp = 60 mAs = 10 Focus = BF	
Low Contrast	5
Dynamic range	5
Resolution	2.6
Result = PASS	

Machin Data (17)

kVp Accuracy & Reproducibility

FDD = 100 cm mAs = 20 Focus = BF

Set kV	KVp Accuracy: Measured kVp			Average	Accuracy %	Reproducibility: SD	Coefficient of Variation
60	60			60	0		
70	69.7			69.7	-0.4286		
81	80.9	80.9	80.9	80.9	-0.1235	0	0
90	89.9			89.9	-0.1111		
102	102			102	0		
Result					PASS		PASS

FDD = 100 cm mAs = 20 Focus = FF

Set kV	KVp Accuracy: Measured kVp			Average	Accuracy %	Reproducibility: SD	Coefficient of Variation
60	60			60	0		
70	69.7			69.7	-0.4286		
81	80.3	80.9	80.6	80.6	-0.4938	0.3	0.003722084
90	90.1			90.1	0.11111		
102	102.6			102.6	0.58824		
Result					PASS		PASS

Results:

kVp Accuracy is within accepted limits

kVp Reproducibility is within accepted .

Reference :

AAPM Report Number 74 , 2002

Criteria: kVp Accuracy (+/-) 5 %

kVp Reproducibility less than 0.05

Expousre Timer Accuracy & Reproducibility

FDD = 100 cm kV = 81

Set ms	KVp Accuracy: Measured ms			Average	Accuracy %	Reproducibility: SD	Coefficient of Variation
25	30.5			30.5	22		
50	61.4			61.4	22.8		
100	122.9	123	122.9	122.9333	22.93333	0.057735	0.000469645
200	246.1			246.1	23.05		
400	0			0	0		
Result					Pass		Pass

Results:

mSec Accuracy is within accepted limits

mSec Reproducibility is within accepted .

Reference :

AAPM Report Number 74 , 2002

Criteria: Timer Accuracy (+/-) 5 % (For times > 10 msec)

Timer Accuracy (+/-) 10 % (For times < 10 msec)

Expousre Timer Reproducibility less than 0.05

Radiation Output Quantity , Repeatability & Linearity

FDD = 100 cm				kVp = 81			Focus = BF		
mAs (output) Linearity						Linearity	Repeatability		
Set mAs	Measured Dose (mGy)			Average	mGy/mAs		SD	Coefficient of Variation	
5	0.339			0.339	0.0678	0.011215			
10	0.682			0.682	0.0682				
20	1.38	1.381	1.38	1.380333	0.069017		0.000577	0.000418269	
40	2.77			2.77	0.06925				
63	4.36			4.36	0.069206				
71	4.923			4.923	0.069338				
Result						PASS		PASS	

FDD = 100 cm				kVp = 81			Focus = FF		
mAs (output) Linearity						Linearity	Repeatability		
Set mAs	Measured Dose (mGy)			Average	mGy/mAs		SD	Coefficient of Variation	
5	0.327			0.327	0.0654	0.016095			
10	0.665			0.665	0.0665				
20	1.341	1.342	1.341	1.341333	0.067067		0.000577	0.00043043	
40	2.694			2.694	0.06735				
63	4.255			4.255	0.06754				
71	4.793			4.793	0.067507				
Result						PASS		PASS	

Results:

Linearity coefficient is within accepted limits

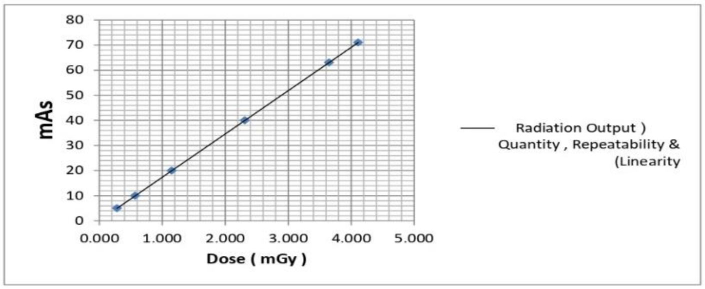
Reproducibility is within accepted limits

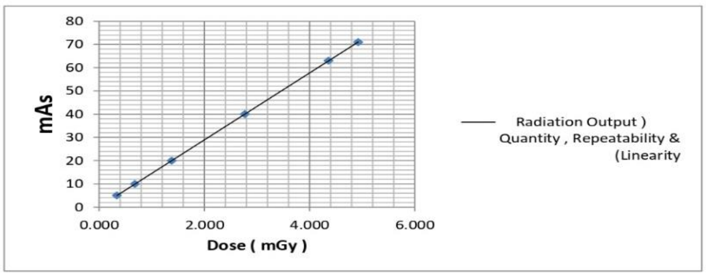
Reference :

AAPM Report Number 74 , 2002

Criteria: Linearity cofficient < 0.10

Reproducibility less than 0.05





Beam Quality Half Value Layer (HVL)

FDD = 100 cm kVp = 81 mAs = 20 Focus = BF

Thickness (d) mmAl	D 0 (mGy)	D (mGy)	% Transmission	
0	1.383	1.383	100	HVL by Equation =
1	1.383	1.074	78	3.3
4	1.383	0.606	44	
HVL = 3.3 mmAL				
TEST RESULT IS ACCEPTABLE:			**PASS**	

FDD = 100 cm kVp = 81 mAs = 20 Focus = FF

Thickness (d) mmAl	D 0 (mGy)	D (mGy)	% Transmission	
0	1.347	1.347	100	HVL by Equation =
1	1.347	1.049	78	3.4
4	1.347	0.596	44	
HVL = 3.4 mmAL				
TEST RESULT IS ACCEPTABLE:			**PASS**	

Results:

HVL is within accepted limits

Reference :

AAPM Report Number 74 , 2002

Criteria: HVL > 2.5 mm Al

adiographic Collimation & SID

FDD = 100 cm kVp = 81 mAs = 10 Focus = BF

	Anode (+)	Cathode (-)	Front	Bac
Differ (cm)	0	0.3	0.4	0
Total	0.3		0.4	
Result	**PASS**		**PASS**	

Result = PASS

Reference :

AAPM Report Number 74 , 2002

Criteria: X-ray field and light fild boaders agree to within ± 2% of the SID

Image Quality & Resolution

FDD = 100 cm kVp = 60 mAs = 10 Focus = BF

Low Contrast	5
Dynamic range	7
Resolution	3.1