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QUALITY ASSURANCE FOR DIAGNOSTIC X-RAY MACHINES IN TANZANIA

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Abstract

In this presentation it is being discussed a close relationship between the prevention of accidents involving apparatus that generates the ionizing radiation(x-ray tubes etc) and the need to perform quality control procedures and make follow-up corrective maintenance procedures. A summary of results of quality control performance of x-ray machines in certain centers in Tanzania is tabled and measures to overcome some of the observed problems are recommended. The number of X-ray units inspected were 219, out of which 123 were working, 75 were out of order, 6 units were not yet installed and those which are working with faulty parts were 15. The performance of quality assurance for X-Ray units (57) tested showed that 36.8% didn't qualify. About 80% of these equipment are more than 15yrs old.

1. Introduction

Quality control procedures on an x-ray machine are routine measurements of physical parameters of various components of the equipment. Quality administration in the x-ray machine is the management of the quality control procedures, this includes making sure that the equipment monitoring and performance evaluation is properly done, assessed and recorded. It also involves following up with necessary corrective measures [1],[2]. The diagnostic X-ray units in Tanzania is still very much affected by inadequate management in terms of quality control and preventive maintenance. Many of these equipment are functioning incorrectly or are inoperative altogether, because of a lack of proper maintenance services. Qualified service staffs are not available or expensive especially if are from Manufacturers/suppliers from overseas. Lack of service manuals and spare parts is another bottleneck. The situation is even more worse due to financial constraints to quarantee performance of quality control and preventive maintenance procedures let alone repairs. For these reasons the quality control procedures are not carried frequently and follow-up action like corrective maintenance, recalibrations and repairs are not done.

In view of this situation, NATIONAL RADIATION COMMISSION, (Regulatory Authority in Atomic energy matter in the Country) through its Nuclear Instrument maintenance section, with the assistance from INTERNATIONAL ATOMIC ENERGY AGENCY carried out quality control and Preventive maintenance programme for nuclear and related medical equipment, particularly x-ray machines in the country. The program of work was to establish an inventory, assess status of equipment, performance of quality control and Preventive maintenance, assess the local maintenance capabilities and skilled manpower and prepare the report on the observed problems and make recommendations.

2. Methods

During the survey of these equipment, we carried-out QC procedures, of which due to several reasons only four types of tests were carried out. These are:-kVp calibration, Timer accuracy , collimator/beam alignment checks and tube leakage test. Even these few were not performed every time because either the equipment to be tested were completely out of order; had some faults like, light beam diaphragm or the films or film processing chemicals are lacking. Some units did not meet the required specifications for certain quality control procedures (e.g a coned diaphragm does not meet specifications for timer or kVp test).Also unavailability of some test/monitoring instruments during survey work prohibited some quality control procedures to be done [3]

2.1. Beam alignment and collimation.

The RMI beam alignment tool (Model 161B) and collimation test tools were used. The placement of collimator and beam alignment test tool done according to RMI quality assurance handbook. The radiograph done on the 8" x 10" cassette. The exposure parameters to give good picture were selected accordingly.

2.1.1. Collimation; If the X-ray field falls just within the image of the rectangular frame there is a good alignment. E.g., if the edge of X-ray field falls on the 1st spot ,+-1cm on either side of the line, it shows that X-ray and light field is misalign by 1% of the distance between the X- ray source and the table. The maximum allowable misalignment is 2% of the source to image distance, (S.I.D).

***2.1.2. Beam alignment**; The X-ray beam should be perpendicular to the plane of the image* receptor. If the images of the two steel balls on the test tool overlap the central ray perpendicularly or within 1.5^0 away it is acceptable.

2.2. KVp tests

The tests are done as indicated on the RMI quality assurance handbook. The Instrument used is digital KVp meter, model 230. The exposure parameters were to be selected depending on whether the equipment is single or three phase unit. For single phase, time selected were > 0.2sec, mA > 20mA for radiograph and for three phase units, time set were >0.1sec. Three different KVp stations tested and data collected to each unit.

2.3. Timer test

The test for timer accuracy was done by RMI, digital X-ray exposure timer, model 231A.The source-detector distance set at 100cm for three phase unit and 75cm for single phase unit. The adjustment of beam limiting device to produce an X-ray field at the detector of about 2.5cm square done. In most cases the technique factors used were 80KVp, and 200mA and three settings of timer tested.

2.4. Tube leakage test

The leakage measurements for the X-ray tube for two X-ray units was done at 100cm, FDD positions at four different sides of the tube. The operating parameters during the leakage tests were 125KVp, and 250mAs for both units. Instrument used is Bethold dosimeter model LB 1310, S/no; 602-0405 with X/Γ probe model KZ25P, S/no; 3162.

3. Results and discussions

Misalignment of the light field and the x-ray field is a common problem for x-ray units surveyed. About 40% of the units tested indicated that the x-ray and light fields are misalign by more than 2% (-+ 2cm) which is unacceptable [3]. However in most of cases the problem was rectified by the maintenance personnel of the research team. The x-ray beam in some units also showed the central ray is more than 3 degrees away from the perpendicular although they are few units misalign to that extent (see table 1) In some Hospitals, the faulty beam alignment and collimation devices were dismantled and radiograph were done without it which pose unnecessary exposure to the patients.

About **50%** equipment tested **for kV calibration** showed unacceptable errors ranging from 4kV to 20kV. For example *Sumve hospital in Mwanza region* showed a kV error of +20kV well above the acceptable error of -+ 4kVp [3].

Some equipments showed variation above the acceptable errors in the timer tests. e.g. at Muhimbili medical centres SIEMENS HELIOPHOS 4, set time was 1.00 sec, recorded time was 1.689 sec an error of 0.689 sec. Erroneous timing reading may be caused by wave form problems, for example, pulses of different height, too low radiation intensity or low peak intensity at the beginning of exposure and faulty timing circuit. It is suggested the error be limited to +-5% or 2msec, which ever is large [3].

Most of these units are very old and no any preventive maintenance being done. This facilitated the deterioration and bad performances. In some equipment the selection of some exposure techniques were not possible due to bad contact at KVp or mA selection contacts plates. The contacts plates were burnt. Some of these equipment were being operated by unqualified persons which lead to bad and carelessness handling. This is justified by the findings that 11 X-ray tubes for the mobile/portable diagnostic X-ray units were out of order. The damage which mostly might be occurred during moving from one room to another doing radiograph.

The break systems for the X-ray tube movement and positioning is common problem recorded. Some radiographers use wooden bars to support and positioning the tube during taking radiograph. This is dangerous, it may cause both physical injuries accidental radiation overexposure to the patients.

Table. 1 Results of quality control performance for various X-Ray units

Quality control test	ACCEPTANCE		Total units tested
	YES	NO	
Kilovoltage	11	11	22
Timer	14	5	19
Beam alignment & collimation	11	5	16
Leakage tests	2	0	2

3.1 Leakage test,

The results were below 0.5mSv/hour at 1m and are as shown below, see table 2. Both X-ray units complied with safety requirement. [2]

Table. 2; Leakage measurements obtained in the horizontal plane of X-ray tube.

Direction about the tube position	Philips X-ray unit,(Model Medio 50CP)	Shimadzu circlex P 13C
West	0.28 +- 0.04 mGy/hour	0.33 +- 0.04 mGy/hour
East	0.36 +- 0.08 mGy/hour	0.22 +- 0.03 mGy/hour
North	0.19 +- 0.01 mGy/hour	0.19 +- 0.01 mGy/hour
South	0.11 +- 0.01 mGy/hour	+- 0.04 mGy/hour

4. Conclusion

The prevention of accidents involving apparatus that generates ionizing radiation basically entails all aspects related to quality assurance, preventive maintenance, corrective maintenance as well as safe and proper operation of the apparatus hence requirement for skilled and qualified operating and maintenance staff. Establishment of co-ordination between personnel who perform

QC procedures and service agents who are supposed to perform the corrective maintenance is vital. It should be noted that QC, PM and repairs are integral procedures in that way complementary to radiation protection procedures. During the installation of these equipment, the initial quality control compliance tests should be done with periodical tests and corrective measures thereafter. It should be taken as mandatory for manufacturers to establish the servicing agents with necessary spare parts for their equipment. They can train some technicians from already established workshop/institutes in the country, who will be servicing agents. All manuals should be available to the users and service technicians. At present due to the problems pointed out earlier there is no follow up action on the QC results particularly, in corrective maintenance aspect.

In design aspect it is suggested that the manufacturers to include both **automatic and manual break systems** to the X-ray machine so that if one system fails other option can be used.

5. References:

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