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REPUBLIC OF NAMIBIA

MINISTRY OF HEALTH AND SOCIAL SERVICES

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TITLE: INSPECTION OF CONVENTIONAL DIAGNOSTIC X-RAY FACILITIES

ABSTRACT
TITLE: Inspection of conventional diagnostic x-ray facilities in Namibia
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Introduction

The National Radiation Protection Services (NRPS) is the competent unit responsible for the regulation of all activities involving ionising radiation. The enabling legal framework for this function is the Hazardous Substance Ordinance of 1974 and the National Radiation Protection Policy of 1994. The enabling legislation is expected to be replaced by the Atomic Energy and National Radiation Protection Act in the 2009/10 financial year. The inspection mainly consists of the x-ray-unit optimal performance and the general radiation safety provisions.

Method

The inspection is performed using a checklist which lists the general radiation provision such as radiation warning light, shielding, protective clothing etc. Then different tests for the x-ray unit were performed which are: kVp accuracy and reproducible test, the beam quality, beam collimation and alignment and the radiation dose output. The RMI 241 meter was used to measure the kVp and the Rad check was used to measure the radiation output and the half-value layer. The beam alignment and collimation was done using the collimator and beam alignment tools.

Results

For the purpose of compliance and enforcement 53 out of 57 conventional diagnostic x-ray facilities were inspected during March 2008 and April 2009, which mount to 92% coverage. 26% of the facilities failed the kVp test, while radiation warning lights followed with 20%. In most cases the radiation leakage and half value layer were within the recommend limits.

Conclusion

As a result of the inspection performed recommendations were issued to the management of the facility in order to implement corrective measures and 6 facilities that were inspected and not authorized carried out the corrective actions recommended. The division is thus recommended to improve its enforcement mechanism.

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1. Introduction

The National Radiation Protection Services (NRPS) is the competent unit responsible for the regulation of all activities involving ionising radiation. The enabling legal framework for this function is the Hazardous Substance Ordinance of 1974 and the National Radiation Protection Policy of 1994. The primary role of the NRPS is to ensure exposure to ionising radiation is controlled and monitored in workplaces, environment and living places. This is achieved mainly through regular inspection and authorization of facilities utilising or producing sources of ionising radiation and radioactive material. The enabling legislation is expected to be replaced by the Atomic Energy and National Radiation Protection Act in the 2009/10 financial year.

The inspection mainly consists of the x-ray-unit optimal performance and the general radiation safety provisions.

2. Method and apparatus

The inspection complies of the following test.

2.1 The Kilovoltage (kVp) accuracy test

Image quality and patient dose are dependent on any variation in the generator kilovoltage (kV) of the x-ray set. Therefore an accurate kV calibration is required.
A non-invasive tube voltage check over the whole used kV-range is performed with the RMI 240 multi-function meter (Figure 2.1).

Firstly the RMI meter was set at 100 cm from x-ray tube focus, and was centered using the laser. 20 mAs was set on the machine control panel. The kVp was then measured from 50-125 kVp in increment of 10. At every set kVp, the measured kVp was recorded. The percentage difference between the set and measured kVp was calculated and should be within ± 5%.

Figure 1: RMI Multi functional meter

2.2 The kVp reproducibility test

This test checks that the kVp will stay the same from exposure to exposure.

The set up is the same as above, but at a fixed kVp of 70. Five exposures were recorded and the coefficient of variation (CoV) which is the standard deviation/mean of the 5 readings was recorded. The CoV must be less than 2%.

2.3 Tube Output Measurement

This test checks that the radiation output [mGy/mAs] remains constant as the mA is varied. For this test the dose Victoreen Rad check meter was used (Figure 2.2).

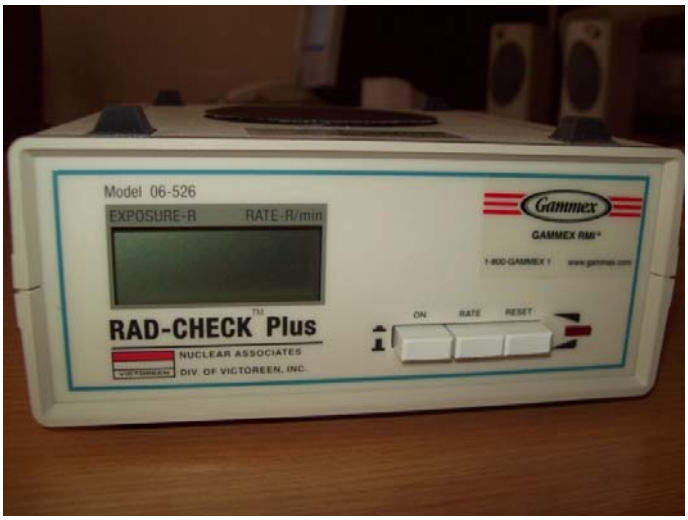

Figure 2.2: Victoreen Rad check meter

The Victoreen meter was placed at distance of 75cm from the tube focus. Some lead vinyl was placed under the detector to standardize backscatter. The kVp was fixed at 70, while the mAs was varied from 20 -100 mAs, in increments of 10.
At every mAs setting the radiation dose was recorded. For each exposure, the radiation dose / mAs was calculated. The maximum and minimum value of dose/mAs was identified and the following was calculated (max-min)/ (max+min). This should be less then 0.1

2.4 Half Value Layer (HVL) Measurement

The half-value layer measures the quality of the x-ray beam. The apparatus used are the Aluminum (Al) attenuator set, Victoreen meter and lead vinyl.

The meter was placed at 75cm from the tube focus on the lead vinyl to standardize back scatter. The kVp was set at 80 and fixed mAs of 50mAs. The x-ray beam was collimated to the size of the meter. Three exposures were recorded taking the dose. After a 1mm of Al was added to the beam, and the dose was measured. Al attenuator ware added and the dose recorded until the dose has fallen to below 50% of the initial unattenuated value.

A graph with the dose against the aluminum attenuator thickness was plotted. From the graph, the thickness of Al required to reduce the unattenuatted dose by 50% is the Half Value layer.

2.5 Beam Collimation

The following apparatus were used: beam alignment tool (Figure 2.3), collimator tool (Figure 2.4), cassette and film.

Figure 2.3 Beam alignment tool

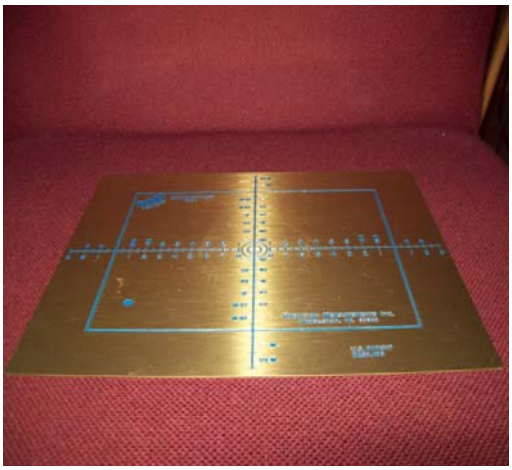

Figure 2.4: Collimator tool

The collimator tool was placed at a distance of 100cm from the tube focus with a cassette underneath it. The beam alignment tool was then placed at the center on the collimator tool. The collimator shutters were adjusted so that the edges of the light field coincide with the rectangular outline on the collimator tool. Then the cassette was exposed.
If the x-ray field falls just within the image of the rectangular frame there is good alignment. If an edge of the x-ray field falls on the first spot, ± 1cm, on either side of the line it shows that the edges of the x-ray field are misaligned by 1%.

2.6 Other inspection parameters

Apart from the equipment performance an inspection checklist is used to check other component of radiation protection, these include:

- Leaking at the entrance door and control panel
- Radiation warning light
- Local rules of the department including radiation warning notices
- Protective clothing
- Monitoring of the radiation workers
- And the departments quality assurance program
- Public protection
- Medical exposure

3 Results

For the purpose of compliance and enforcement 53 out of 57 diagnostic x-ray facilities were inspected. Figure 3.1 (below) indicates the total number of facilities inspected and authorized.

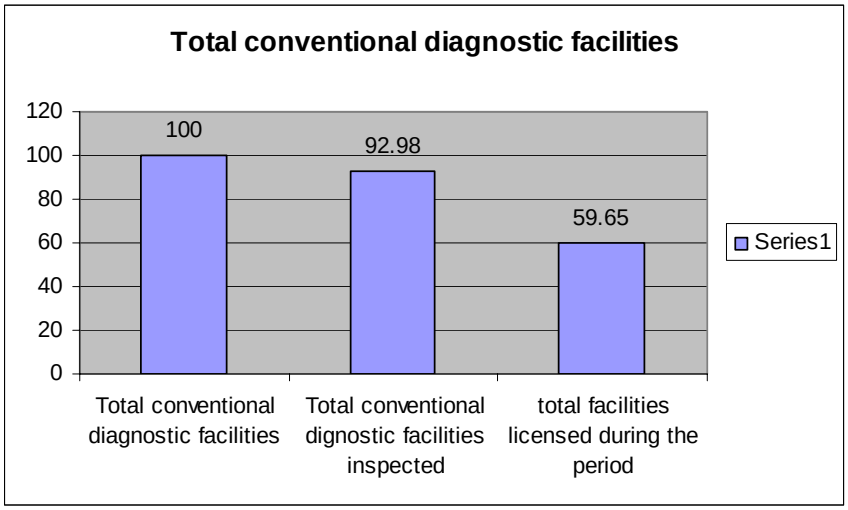

Figure 3.1: Total conventional diagnostic facilities

Figure 3.2 below shows that 26% of the facilities failed the kVp test, while radiation warning lights followed with 20%. In most cases the radiation leakage and half value layer were within the recommend limits.

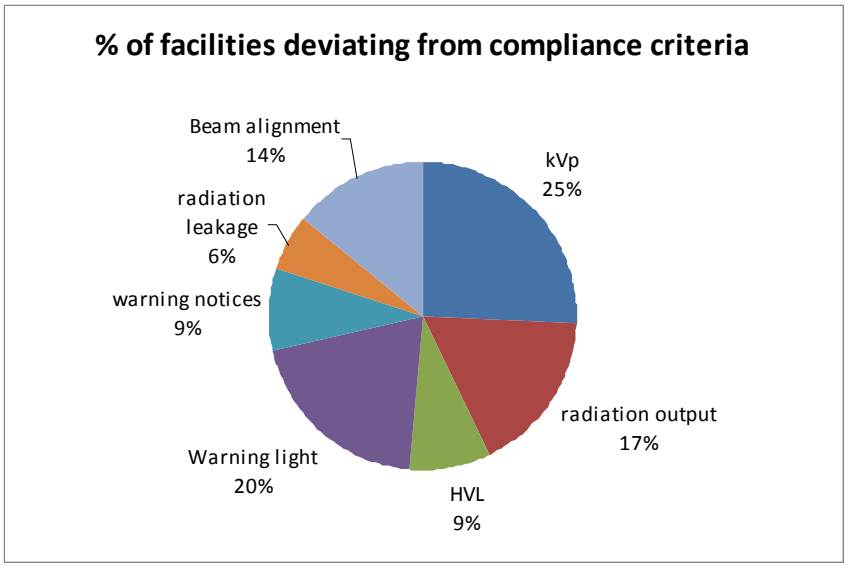

Figure 3.2: Percentage of facilities deviating from compliance criteria

4 Conclusion

The National Radiation Protection services have inspected 92% of all the conventional diagnostic x-ray facilities during the period April 2008 and March 2009.

As a result of the inspection performed recommendations were issued to the management of the facility in order to implement corrective measures and only 6 facilities that were inspected and not authorized carried out the corrective actions recommended. The division is thus recommended to improve its enforcement mechanism.