MEASUREMENT OF LEAD EQUIVALENT THICKNESS FOR IRRADIATION ROOM : AN ANALYSIS

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Abstract:

The Malaysian Ministry of Health (MOH) has established that the irradiation room must have a sufficient thickness of shielding to ensure that requirements for the purpose of radiation protection of patients, employees and the public are met. This paper presents a technique using americium-241 source to test and verify the integrity of the shielding thickness in term of lead equivalent for irradiation room at health clinics own by MOH. Results of measurement of 6 irradiation rooms conducted in 2014 were analyzed for this presentation. Technical comparison of the attenuation of gamma rays from Am-241 source through the walls of the irradiation room and pieces of lead were used to assess the lead equivalent thickness of the walls. Results showed that almost all the irradiation rooms tested meet the requirements of the Ministry of Health and is suitable for the installation of the intended diagnostic X-ray apparatus. Some specific positions such as door knobs and locks, electrical plug sockets were identified with potential to not met the required lead equivalent thickness hence may contribute to higher radiation exposure to workers and the public.

INTRODUCTION

X-ray is a potentially hazardous type of ionizing radiation used in hospitals to produce images of the body's internal organs for diagnostic purposes. The dedicated walls x-ray rooms within a hospital or imaging facility shall be of sufficient thickness to make sure that radiation doses outside the room do not exceed the limits for radiation workers or members of the public.

Table 1. The Guideline of the shielding at the door and wall for general & dental x-ray room (act 304)

Type of Irradiating apparatus	Thickness of Shielding at the door and wall
General X-ray	2.0 mm Pb eq
Dental X-ray	1.0 mm Pb eq

OBJECTIVE

A review of a technique using americium-241 source to test and verify the integrity of the shielding thickness in term of lead equivalent for general & dental X-ray room in three health clinics belonging to the MOH;

i) Klinik Kesihatan Changlun, Kedah
ii) Klinik Kesihatan Pengkalan Hulu, Perak
iii) Klinik Kesihatan Bt Minyak, Penang

Figure 1 : Lead equivalent testing equipment

Figure 2 : Testing procedure

MATERIALS AND METHOD

Figure 3: Klinik Kesihatan Bt Minyak, Penang

Test procedure used in this study was based on comparison of the penetration of radiation from Am-241 (7.4 GBq) radioactive sources on the protective barriers under test (wall, door, etc) with that as on piece of pure lead sheets. The lead equivalent measurements for the X-ray rooms were carried out at positions such as walls, doors, lead glass and weak point locations such as doorknobs, electrical sockets and switches, lead glass frame, pipelines and the door slits. The sealed sources of Am-241 emits gamma rays of 59 keV energy. This energy is suitable for testing a general radiography room which is designed typically for kilovoltages of up to 150 kV X-rays, but it is too penetrative for dental or mammography rooms which are meant for kV ranges of up to 90 and 35 respectively.

The fundamental relationship between incident radiation intensity of a narrow beam (Io), radiation intensity after shield (I), shielding material linear attenuation coefficient (μ) and its thickness (t) is given by the equation.

$$\ln (I/Io) = -\mu . t$$

A plot of (I/Io) on log scale versus t should produce a linear graph with a negative gradient equal to (μ).

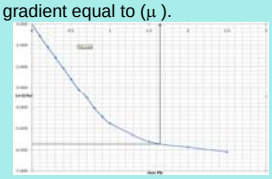

Figure 3: calibration curve

Figure 4 : Lead glass and door

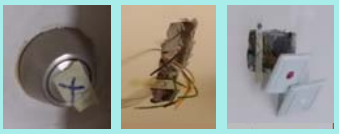

Figure 5 : Weak point positions

RESULT AND DISCUSSION

Table 2: The minimum lead equivalent thickness for general x-ray rooms according to the positions

	Minimum lead eq. (mm)					
Positions	Wall	Door	Lead Glass	Door Knob	Lead Glass Frame	Electrical Socket
Klinik Kesihatan Bt Minyak	>2.5	>2.5	>2.5	1.0	2.0	>2.5
Klinik Kesihatan Changlun	>2.5	>2.5	>2.5	>2.5	>2.5	>2.5
Klinik Kesihatan Pengkalan hulu	>2.5	>2.5	>2.5	1.3	>2.5	>2.5

Results showed that the radiation rooms meet the needs of the MOH. All positions are tested to meet manufacturer specifications and minimum specifications by the Ministry of Health of 2 mm Pb for general X-ray room and 1 mm for dental x-ray.

Table 3: The minimum lead equivalent thickness for dental x-ray rooms according to the positions

	Minimum lead eq. (mm)			
Positions	Wall	Door	Door Knob	Electrical Socket
Klinik Kesihatan Bt Minyak	1.1	>2.5	>2.5	>2.5
Klinik Kesihatan Changlun	2.4	>2.5	>2.5	>2.5
Klinik Kesihatan Pengkalan hulu	>2.5	>2.5	>2.5	>2.5

The door knob positions usually identified as the weak point in the x-ray rooms. The weak point positions (equivalent of Pb is less) for all irradiation rooms indicated they may contribute to higher radiation exposure to workers and the public. By taking into account that the primary beam is not directed towards the wall with the weak points, then the results are thus acceptable.

Lead is the most common material used for x-ray shielding because of its high density (11340kg/m^3). Normally the material used to construct the x-ray room walls are mixture of concrete and barium plaster. Besides density of the shielding materials, there are many other factors that require serious consideration before choosing of a shielding material . These factors include space availability (size of room), weight of the shielding material, cost of the material and its installation and availability of the material in local market.

CONCLUSION

All positions are tested to meet manufacturer specifications and minimum specifications by the MOH. However, this measurement is valid for positions that have been measured only. This lead equivalent test is very important in ensuring that the rooms are built to meet the needs of the MOH to ensure safety of all concern.

REFFERENCES

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