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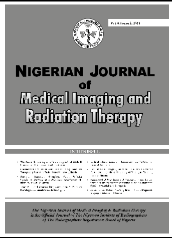

X-RAY SHIELDING EVALUATION AND REJECT FILMS ANALYSIS IN BINGHAM UNIVERSITY TEACHING HOSPITAL, JOS, PLATEAU STATE, NIGERIA.

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ABSTRACT

Introduction: The provision of adequate shielding is one of the methods of controlling exposure to x-rays. To ensure that adequate protection is afforded to both workers and members of the public, adequate shielding barrier is very important and essential to attenuate the intensity of x-rays to recommended and acceptable dose limits. The standard or general concept of provision of radiation shielding barrier for radiation installation begins with the designing of radiation shielding structures by a qualified expert (medical physicist or health physicist) to ensure that the required degree of protection is achieved [1].

Objective: To evaluate x-ray Shielding Evaluation and Reject Film Analysis in the general radiographic room of Bingham University Teaching Hospital, Jos.

Methodology: The evaluation was done using x-ray code called XRAYBARR. The code uses the total workload in the radiographic room, use factor, distances to the occupied area and the x-ray tube information to calculate the barrier thickness required. Imputing this information into the code model XRAYBARR [10], it presents the required shielding thickness (in mm and inches) and the details of the calculated unshielded and shielded primary, scatter and leakage dose generated by the x-ray tube.

Results: The results show that the workload distribution was spread between the operating potential of 35KVp to 100KVp in the radiographic room with most of the examinations carried out using operating potential of 60KVp. The results also showed that the shielding barrier thickness calculated from XRAYBARR was compared with the design dose limit and the design shielding barrier thickness were found to be adequate for both control and uncontrolled areas. This implies that the barrier thickness was found to be satisfactory. During this research, it was discovered that the Hospital is operating within the [1] standard and the protective measures. The ratio of the measured dose to the design dose was found to be less than1 (<1) except for window 1 and reception which is greater than 1. The ratio of the measured dose to the design was found to be less than <1 in the radiographic room indicating that the existing shielding in the radiographic room is adequate. The results of the study showed that the analysis of reject films for four years indicated that rejects films were mainly due to poor technique (31%) and poor processing (17%) as a result of unskillful technician

Conclusion: The study revealed that the existing shielding barrier of the hospital was adequate compared with the standard limit. However, there is a need for quality control and quality assurance policy to be put in place. Reject rates of films shows that film are wasted every year in the hospital.

INTRODUCTION

Over the past decades, radiography (x-ray) has become an important tool in medical diagnosis and therapy. It has been estimated that a third of half of crucial medical decisions depends on x-ray diagnosis, and the early diagnosis of some diseases depend completely on x-ray examination [2]. Radiography still remains the mainstay of medical imaging examination. Although individual patient dose in radiography is relatively low, its contribution to the collective dose is significant due to the frequent use of this examination. The collective dose associated with chest radiography is only about 18% in some western countries [1]. Optimization of image quality and patient dose still should be an important area worthy of study. However, if x-rays are not shielded such that they only interact with intended parts of the body, they are a potential health hazard to the workers, patients and members of the public [3] [4]. For image quality and patient safety, international and national bodies, such as international Atomic Energy Agency [5], European Commission (EC), National Radiological Protection Board (NRPB), (AAPM, et al), have addressed corresponding documents and diagnosis reference levels (CDRLs) or guidance levels based on experienced with film- screen radiography. It is important to reconsider the balance of image quality and patient dose and to re-evaluate local DRLs when digital techniques replace film-screen techniques. in as much as the radiography (x-ray) is important in most medical examinations, it has also been discovered to be harmful and dangerous to the patient and medical workers and neighbours to the radiological institution and hence adequate safety protection is needed to curtail the hazardous effects. The system of radiation protection that is used across Europe and worldwide is based on the recommendations of; the international Commission for Radiation protection [6]; and the International Commission on Radiation Units and Measurement (ICRU), The conceptual framework adopted by the ICRP in its publication ICRP 60 [7] is one of a system of radiological protection and builds on the system of dose limitation central to earlier ICRP documents such as ICRP 21 [7]. The ICRP system of radiation protection is based on three fundamental principles: justification, optimization and dose limitation. With the already existing radiology department of Bingham university Teaching Hospital, Jos and as a total quality assurance/control and total quality management program must be put in place, it is important and necessary that the shielding barrier provided is evaluated since the shielding design was not based on the National Council on Radiation Protection and Measurements (NCRP) recommendations [8] provides the widely accepted methodology for radiation shielding design. [8] has been reviewed and the new recommendation is contained in [9]. The estimation of the x-ray shielding in radiology department of Bingham university Hospital, Jos will be based on [1]. The aim of the study is to evaluate the shielding barrier thickness and reject films for the purpose of optimizing radiation protection in the radiology department of Bingham University Teaching Hospital, Jos, The specific objectives of this study are: To determine the total workload (w) and workload distribution for the general radiography room of the Hospital, To use the total workload (w) to estimate the shielding barrier thickness required and efficiency of the shielding barrier provided, To evaluate the quality assurance and quality control in the x -ray department of the hospital. To carry out reject films analysis and the cause.

MATERIAL

The facilities used for this study includes; the general radiography room, X-RAYBARR, the x-ray machine (MINXRAY X-ray machine; model HF120/60HPPWV power plus mono- block type high frequency portable X-ray machine with serial number SXR-130-15-1.2 manufactured by SUPERIOR X-RAY COMPANY 1993)

METHODS

The total workload distribution for the studied room had earlier been surveyed over four calendar weeks (one month). The total workload per week was calculated using the equation $W_{tot} = NW_{norm}$. The exposure techniques for all patients were recorded by radiography staff for four weeks in Bingham University teaching Hospital. However, to calculate workload, for each patient the number of exposure and techniques including mAs and Kvp were recorded.

RESULTS

The results showed that large number of reject films were found mainly due to unskillful technicians in the radiology department of Bingham University Teaching Hospital. The analysis indicated that a total number of 1,084 films have been wasted for the past four years.

STATISTICAL TOOL

The X-RAYBARR calculation software was used to calculate the barrier thickness of the radiology department of Bingham University Teaching Hospital, Jos.

Table 1: 2014 Reject Film of different examinations

Type of examination	No of Reject	Poor Tech	Poor Processing	Machine	Fault	Wrong ID	Body Size	Fog	Over Penetration	Poor Penetration
Pelvis	40	10	4	0	2	0	4	10	5	5
Vertebra	55	10	9	0	8	0	10	10	5	3
Hand	20	5	5	0	2	0	3	2	2	1
Ankle	38	8	6	0	5	0	5	5	6	3
Tibia	26	10	10	0	1	0	3	2	1	0
Knee	32	15	5	0	2	0	5	3	1	1
Skull	12	4	3	0	0	0	3	1	1	0
Chest	23	2	4	0	4	5	3	2	1	2
Hib	11	3	4	0	3	0	0	1	0	0
Femur	16	2	5	0	2	0	0	1	5	1
Foot	19	9	4	0	2	0	1	2	1	0
Abdomen	10	2	2	0	1	0	1	2	1	1
Total	302	80	61	0	32	5	38	41	29	17

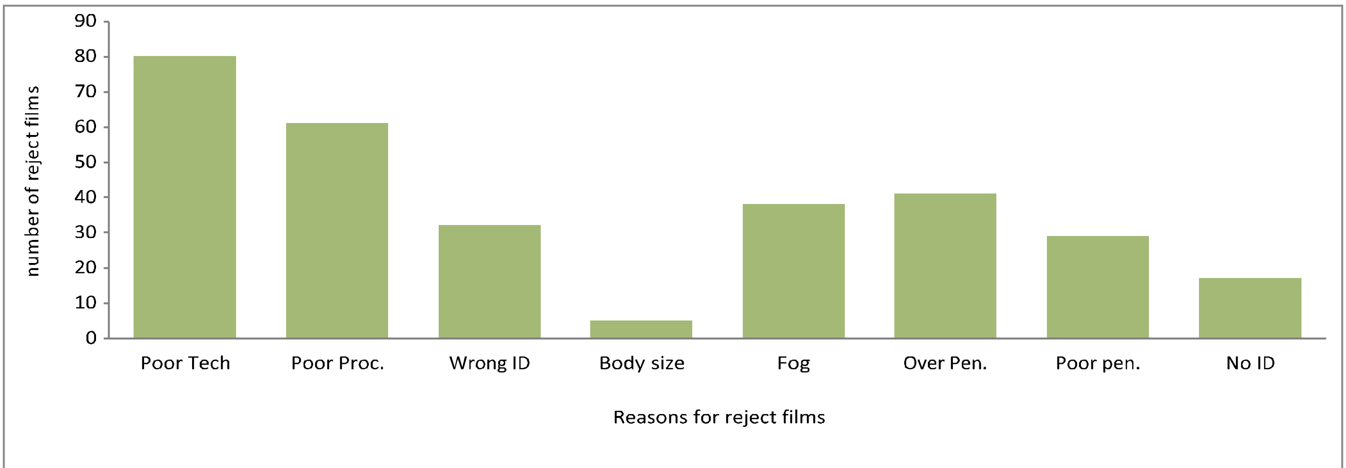

Figure 1 Reject Film for 2014

Table 2: 2015 Reject Film of different examinations

Type of examination	No of Reject	Poor Tech	Poor Processing	Machine	Fault	Wrong ID	Body Size	Fog	Over Penetration	Poor Penetration
Pelvis	35	10	5	0	10	0	5	3	1	1
Vertebra	15	6	2	0	2	0	1	2	2	0
Hand	20	3	3	0	2	0	3	6	3	0
Ankle	18	4	7	0	2	0	0	3	2	0
Tibia	26	8	4	0	0	0	2	5	6	1
Knee	22	9	1	0	2	0	3	4	3	0
Skull	32	6	7	0	0	4	7	4	2	2
Chest	22	17	1	0	0	0	0	2	1	1
Hib	40	10	6	0	2	3	4	10	4	1
Fermur	31	8	2	0	2	0	5	3	8	2
Foot	30	6	5	0	5	5	5	2	1	1
Abdomen	23	5	5	0	2	0	3	2	1	0

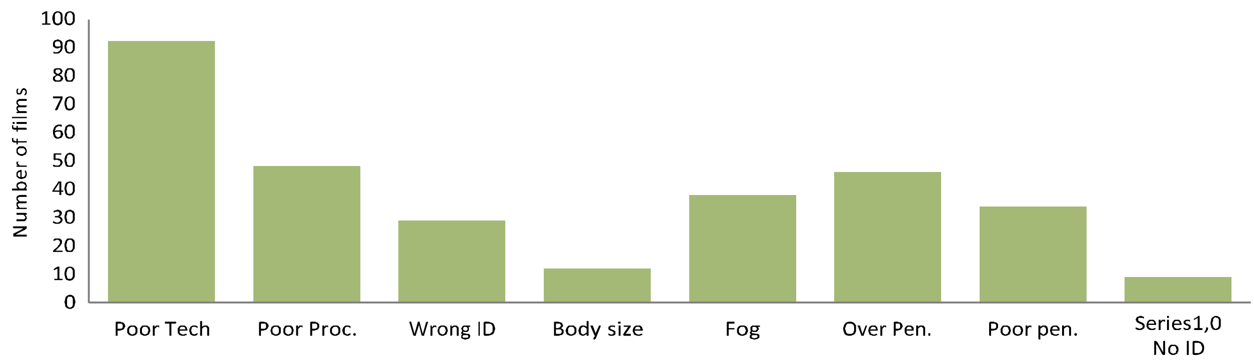

Figure 2 Reject Film for 2015

Table 3: 2016 Reject Film of different examinations

Type of examination	No of Reject	Poor Tech	Poor Processing	Machine	Fault	Wrong ID	Body Size	Fog	Over Penetration	Poor Penetration
Pelvis	15	5	4	0	1	0	0	2	2	1
Vertebra	31	11	7	0	3	0	1	4	5	0
Hand	25	5	1	0	0	0	0	0	6	3
Ankle	22	4	2	0	2	4	1	4	5	0
Tibia	17	5	3	0	0	0	0	0	6	3
Knee	11	5	1	0	0	0	0	2	3	0
Skull	22	12	3	0	0	0	0	0	5	2
Chest	60	15	5	0	3	5	8	11	8	5
Hib	8	1	2	0	2	0	0	2	1	0
Fermur	7	4	1	0	1	0	0	0	1	0
Foot	12	3	1	0	0	0	0	3	5	0
Abdomen	13	7	0	0	0	0	0	1	5	0
Total	243	77	30	0	12	9	10	28	52	14

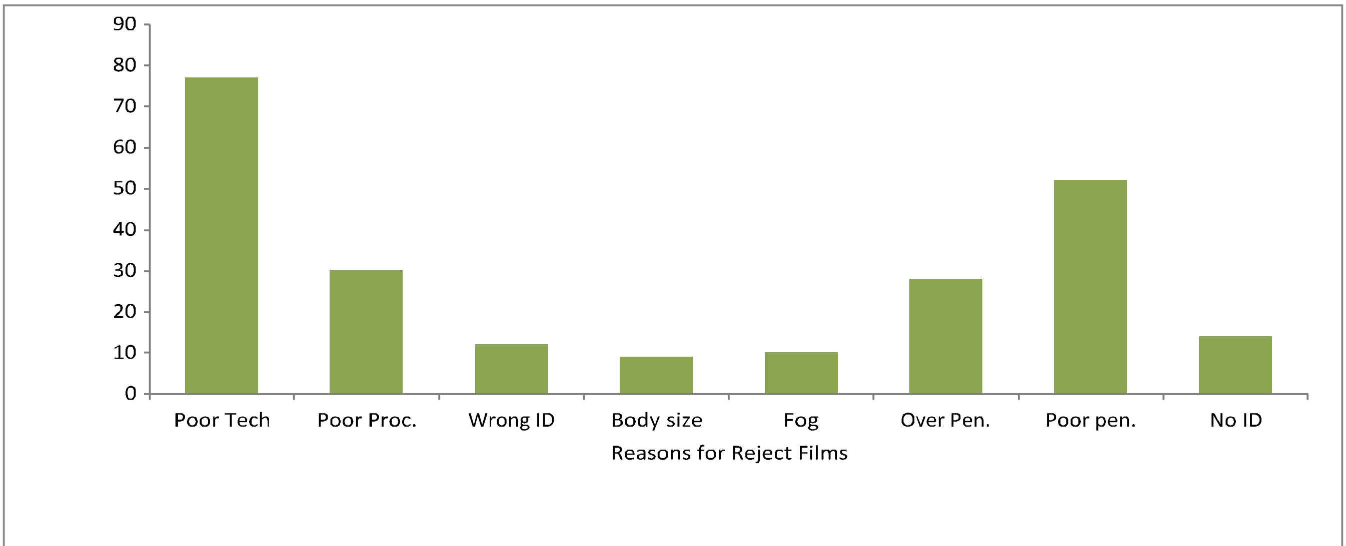

Figure 3 Reject Film for 2016

Table 4: 2017 Reject Film of different examinations

Type of examination	No of Reject	Poor Tech	Poor Processing	Machine	Fault	Wrong ID	Body Size	Fog	Over Penetration	Poor Penetration
Pelvis	20	10	4	0	2	0	0	2	1	1
Vertebra	25	11	4	0	2	0	0	2	5	1
Hand	10	3	3	0	0	0	0	1	3	0
Ankle	8	2	2	0	2	0	0	0	2	0
Tibia	16	5	2	0	0	0	2	3	4	0
Knee	12	3	2	0	1	0	0	3	3	0
Skull	22	11	3	0	0	0	2	3	3	0
Chest	68	27	8	0	2	5	14	10	2	0
Hib	10	4	2	0	0	0	0	4	0	0
Fermur	11	5	4	0	0	0	0	2	0	0
Foot	10	5	3	0	1	0	0	1	0	0
Abdomen	13	4	3	0	0	0	0	3	2	1

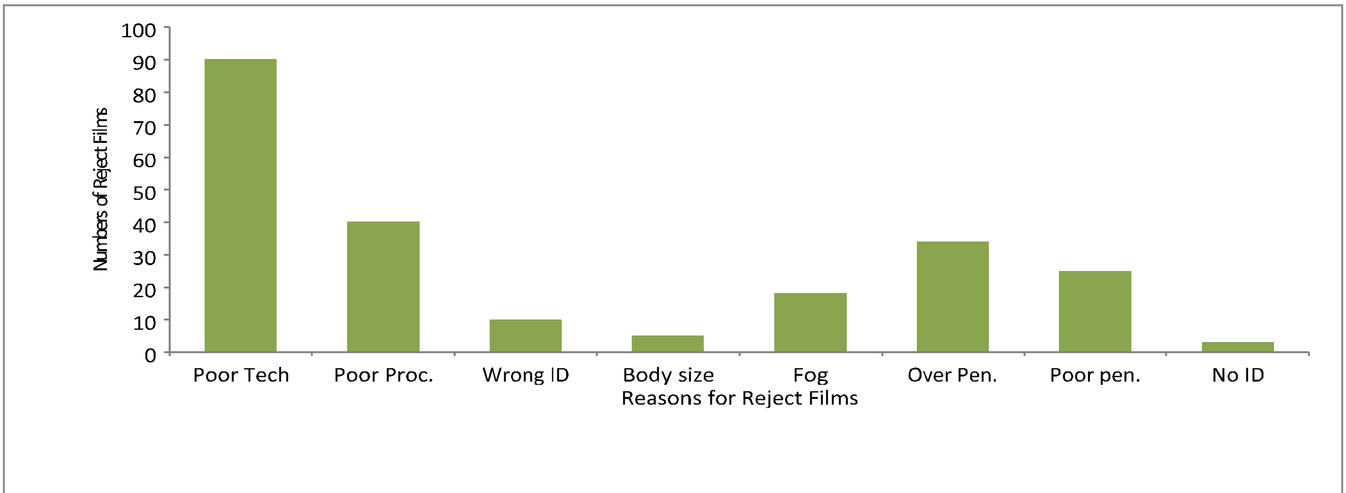

Figure 4 Reject Film for 2017

Table 5: PERCENTAGES OF REJECT FILMS FOR FOUR YEARS

Year	Poor Tech	Poor Processing	Wrong ID	Body size	Fog	Over Penetration	Poor Penetration	No ID
2014	26	20	11	2	12	13	10	6
2015	30	16	9	4	12	15	11	3
2016	33	13	5	4	4	12	23	6
2017	40	40	18	5	2	8	15	1

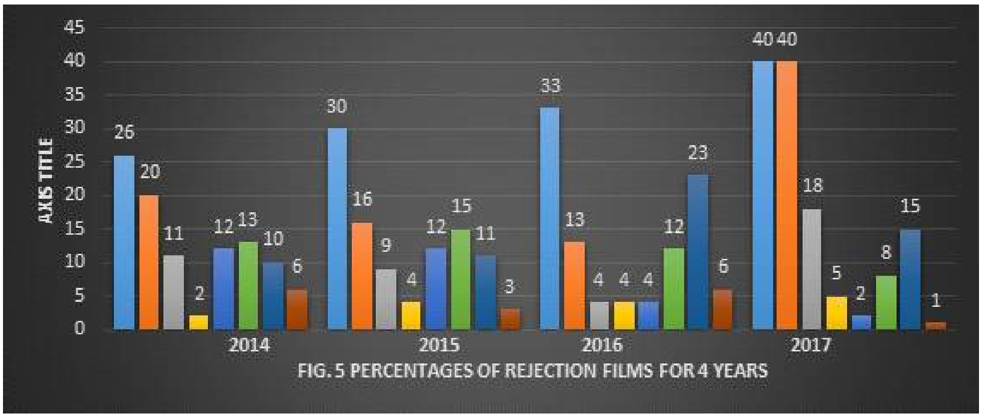

FIG. 5 PERCENTAGES OF REJECTION FILMS FOR 4 YEARS

Table 6: shielded occupancy-weighted dose per week calculated and the shielding barrier thickness required calculated from X-RAYBARR for the general Radiography room of Bingham University teaching Hospital Jos

Position	dpri (M)	dSec (m)	Dleak (m)	T	U	Scattering angle	Calculated dose mSv/week in unshielded dose			occupancy-weighted	
							Primary	Scatter	Leakage	Shielded dose (total)	Barrier of lead (mm)
Console	14.80	17.00	14.80	0.35	1.00	75^0	0.09981	1.622E-4	6.591E-5	0.1000	0.1633
Toilet	18.50	22.50	18.50	0.35	0.68	120^0	0.01915	9.844E-6	8.3885E-4	0.0230	0.3779
Darkroom	24.00	26.00	24.00	0.35	0.50	135^0	0.0986	3.078E-4	1.081E-3	0.0999	0.0533
Window1	18.50	22.50	18.50	0.10	0.50	155^0	0.0889	3.385E-4	2.908E-5	0.0189	0.0376
Window2	14.00	17.00	14.00	0.15	0.50	175^0	0.09972	2.195E-4	4.7674-5	0.0999	0.02754
Door 1	10.00	12.00	10.00	0.60	0.50	120^0	0.09966	1.503E-5	2.916E-4	0.0997	0.1767
Door 2	11.00	14.00	11.00	1.00	0.5	75^0	0.09957	1.331E-5	3.993E-4	0.0999	0.2586
Reception	20.50	26.00	20.50	0.50	0.50	120^0	0.01679	9.964E-6	3.417E-3	0.0177	0.2335
Office	18.00	20.00	18.00	0.37	0.50	75^0	0.09957	1.331E-5	3.993E-4	0.09999	0.2586
Wall	15.00	18.00	15.00	0.50	0.50	90^0	0.09966	3.659E-5	2.695E-4	0.09997	0.1597

DISCUSSION ON SHIELDING EVALUATION

The results of calculated radiation levels inside the x-ray room beyond the barrier and the various shielding barrier thickness required to shield the diagnostic x-ray installation in Bingham University Teaching Hospital Jos was done using the program X-RAYBARR [10]

The results in table 6 show the unshielded and shielded dose per week and the thickness of shielding barrier required to reduce these doses to the design dose limit (p), for the general radiography room of Bingham University Teaching Hospital Jos. The shielding barrier thickness required in various position to reduce the unshielded radiation dose to the design dose limit of 0.02msv/week for uncontrolled areas ranges from 0.2335mm of lead at the reception to 0.0533mm of lead at the darkroom. The required lead shielding at the console position a controlled area is 0.1633mm of lead (design dose limit is o.1msv/week). The thickness of lead already in the walls of the general radiography room is 2mm while the lead glass at console position is also 2mm of lead. The analysis showed that the total workload has an average of 108 patients per week

DISCUSSION ON REJECT FILMS

The analysis of film reject in Bingham University Teaching Hospital for four years (i.e. 2014, 2015, 2016, 2017) in table 1, 2, 3 and 4 respectively, shows that, in in figure 1, poor techniques have the highest number (80) reject films and poor processing has (60) in the year 2014. Figure 2 shows that poor techniques record a highest number of reject films with no identification having the least number of reject films in 2015. Figure 3 shows that poor technique has the highest number of reject films with Body size having the least number of reject films in 2016. Figure 4 indicates that poor technique has the highest number of reject films with body size having the least number of reject films in 2017. From the analysis above, it's obvious that poor technique has the highest number of reject films in the four years. The percentages of film reject for four years in table 5 shows that Poor technique and poor processing has the highest percentages of 40% respectively while Fog and no identification factor have the least percentages of 2% and 1% respectively.

Figure 5 show the percentages of reject films in Bingham University Teaching Hospital for the four years indicates that poor techniques have the highest percentage (26%), Body size has the least percentage (2%), poor processing has 20%, over penetration has 13%, fog has 12%, poor penetration has 10% and no identification has about 6% of the total number of reject films in 2014. It also shows that, in 2015, poor technique has 30% of, 16% for poor processing, 15% for over penetration, 12% for fogging, 11% for poor penetration, 9% for wrong identification, 4% for body size and 3% for no identification respectively. Also, the figures show that in 2016, poor techniques have 33%, poor penetration 23%, poor processing 13%, over penetration 12%, no identification 6%, wrong identification 5%, fog has 4% and body size has 4% reject films respectively. In 2017, poor techniques have 40%, poor processing has 18%, fog 15%, over penetration 11%, body size 8%, under penetration 5%, wrong identification has 2% and 1% for no identification of reject films. The indicated that, total numbers of reject films for four years is 1,084 films in Bingham University Teaching Hospital, Jos. It indicated that large proportion of waste film was due to poor technique as a result of un-skillful technicians. The waste films imply unjustified dose to the patients through repeated exposures and unnecessary wastage of resources.

CONCLUSION

The reject film in Bingham University Teaching Hospital, Jos for the four (4) years was found mostly due to poor techniques. Out of the total number 1,084 of the reject films, poor technique has 339 of the reject film with a percentage of 31% and poor processing has a total number of 179 (17%). With this, it is an evident that poor technique and poor processing conditions (darkroom faults) forms the major problems lack of quality assurance in the radiology department. The results of the analysis also show that the ratio of the measured shielding barrier to the design dose was less than 1 (<1) for the radiographic room which indicates that the measured dose of the barriers was lower than the design dose limit.

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