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STATUS OF INDUSTRIAL RADIOGRAPHY PRACTICE IN GHANA

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ABSTRACT

Practice of Industrial Radiography in Ghana is regulated by the Radiation Protection Instrument LI 1559 of 1993.

A system of notification and authorization by licensing, safety and security inspections and worker radiation exposure monitoring to ensure adequate protection of staff and public has been established.

An overview of the training and certification of radiographers in radiation protection are highlighted.

INTRODUCTION

The importance of nuclear energy and its applications for peaceful purposes in Ghana has been recognised since the early 1960s. The first step was taken through the establishment of an Atomic Energy Commission by Act 204 of 1963 [1]. During the last four decades there has been a rapid growth in the use of radiation sources including sources used in industrial radiography. In view of this the Radiation Protection Board (RPB) was established in 1993 by the amendment of Act 204 with PNDC Law 308 [2] as the sole regulatory authority for the purposes of radiation protection and safety of radiation sources. The authority and functions of the RPB are prescribed in the radiation protection regulation LI 1559 of 1993 [3]. Under "Part II-CONTROL OF RADIATION SOURCES" of the regulations a national system of Notification, Authorization by Registration or Licensing, Safety Inspection and Enforcement for the control of radiation sources used in industrial radiography has been established. A national training scheme and minimum requirement for the qualification and certification of radiographers in radiation safety has also been instituted.

NOTIFICATION

Persons or institutions intending to carry out any industrial radiography practice either on-site or in shielded enclosure have the primary responsibility of notifying the RPB in writing according to prescribed procedure [4]. The RPB then proceeds with the assessment of the notification documentation.

A favourable assessment then indicates to the institution to request for application for Authorization by Registration or Licensing. Application scheme for authorization by registration or by licensing is similar but the requirements concerning the safety documentation are more stringent for licensing than by registration. A Radiation Protection and Safety Guide [5] have been developed to assist licensees to follow systematic procedures in notifying and applying for authorization.

AUTHORIZATION BY REGISTRATION OR LICENSING

The applicant then applies to the RPB using a prescribed application form [6]. Indications of applicant's own assessment of magnitude and likelihood of potential exposure due to radiography practice and all necessary steps for radiation protection and safety of equipment/source or installation for both workers and general public are to be documented on the form.

One of the important requirements on the application for authorization form is the identification of the Radiation Safety Officer (RSO) who has key responsibilities for supervision of protection and safety during the radiography process. He must be capable of providing some level of training to operators on the health risk from occupational exposure and the significance of their actions for radiation protection and safety. In this regard the appropriate personnel identified on the form is required to indicate his profession, training and experience in Industrial Radiography. In addition the following list of documents should accompany the authorization application form. These include:

(i) Personnel qualifications and certification

(ii) Work procedures and instructions

(iii) Radiation monitoring equipment, personal alarm dosimeters, protective remote handling equipment.

(iv) Safety equipment and tools, shielding container, radiation warning label & signs.

(v) Transport Instructions

(vi) Emergency plans and

(vii) Quality Assurance (QA) programme.

INSPECTION

Acceptance of application documentation after a review by RPB is followed by a pre-authorization inspection. Inspection is conducted at the facility (on-site or enclosed) in accordance with inspection procedures/protocol.

A report of the inspection noting all deficiencies is then submitted to the applicant. Registration or licensing is not issued until all corrective actions have been complied with.

The RPB conducts periodic inspections at the facility to ensure conditions and terms as stated in the authorisation are complied with. A safety Guide on Inspection [7] has also been developed to assist licensees in this regard.

A summary of current inventory of radiation sources used in Industrial Radiography is shown in Table I.

Table 1. Inventory of sources currently used in Industrial Radiography

No.	Installation	Radiation Source	Initial Activity/ KVp	Radiation Safety Officer (RSO)
1.	NNRI/NDT	Ir-192 X-ray	3.7TBq 300KV	Dr. K. Danso
2.	Motherwell Bridge	Ir-192	1.48TBq	Mr. James Martis
3.	Motherwell Bridge	Ir-192	1.813TBq	Mr. James Martis
4.	S. K. Engineering & Construction	Ir-192	3.8TBq	Mr. Lee Bu Yoel
5.	Tema Oil Refinery	Ir-192 Cs-137	37GBq 37GBq	Mr. F. B. Forson
6.	GhanaCylinder Manufacturing Co.	X-ray	220KV	Mr. K. Asmah

PERSONAL MONITORING

Personal monitoring of Operators and Radiation Safety Officers using TLDs are supplied and processed by the Occupational Radiological Laboratory of the RPB. Radiographers/Operators are legally responsible for wearing these TLDs during radiography. The annual collective, mean and maximum equivalent doses of operators engaged in Industrial Radiography in Ghana between 1993-2000 are listed in Table 2 below.

Table 2. Dose to Radiographers/Operators

Year	No. of Radiographers Monitored	Collective Dose (man-Sv)	Max Dose Equivalent (mSv)	Mean Dose Equivalent (mSv)
1993	6	3.44×10^{-3}	0.68	0.57
1994	2	7.20×10^{-4}	0.36	0.36
1995	14	1.18×10^{-2}	1.64	0.85
1996	12	2.78×10^{-3}	0.37	0.23
1997	10	2.15×10^{-3}	0.78	0.22
1998	-	-	-	-
1999	13	1.05×10^{-2}	2.91	0.81
2000	14	1.92×10^{-3}	1.55	1.37

The mean doses range from 0.22-1.37mSv per year. These shows that doses to operators in Ghana are rather low. Lack of data for 1998 was due to a breakdown in the monitoring service for that year.

ACCIDENT/INCIDENT AND LESSON TO BE LEARNED

So far the safety record with respect to safety and security of source used in Industrial Radiography has been good. However there has been an incident, which needs to be highlighted and lessons learned shared.

Incident: Stuck Ir-192 Source of Activity 3.2TBq

On the right of 2nd November 1999 a radiographer was performing a test on pipe welds with a 3.2 TBq source at Tema Oil Refinery (TOR). Two successful exposures were made. The development of the film indicated that the radiographic density was low. A decision was taken to increase the exposure time. During the third exposure when the source was being wound to the tip of the source guide the source got stuck in front of the radiographic device. The source could not be wound back into the device.

Response Actions

Lead sheets were dumped onto the device and the guide tube. This resulted in the reduction of the radiation dose rate in the vicinity of the device to less than 10uSv/h. The area was immediately cordoned off. The incident was then reported to the Radiation Safety Officer (RSO) who did a radiological impact assessment of the situation. The whole body dose to the radiographer during the response action was estimated to be 0.86mSv. There was no appropriate instrument to retrieve the source and retract it into the shielded device. The incident was reported to the Radiation Protection Board on 4th November 1999. IAEA was immediately informed who provided two experts with an equipment to retrieve the source. The radiographic device was then sent to South Africa for repairs.

Lessons to be Learned

The radiographer's response was very good and appropriate because he was well trained. The Radiation Safety Officer was well trained in making safety assessment under such circumstance. This has led to the development of comprehensive emergency response procedures of identified incident/accident scenarios as part of a National Radiological Emergency Response Plan. The only limitation at that time was the non-availability of the requisite retrieval equipment. Another vital lesson to be learnt was that the radiographic device was second-hand one refurbished from South Africa. The reason why the source got stuck could be due to inadequate maintenance of the moving parts of the device.

RADIATION PROTECTION TRAINING AND CERTIFICATION OF RADIOGRAPHERS AND OPERATORS

Formal training and certification of personnel in non-destructive testing (NDT) methods are performed by the National Nuclear Research Institute (NNRI) under its NDT section. Applicants for examination for certification in Radiation Protection at RPB must have been certified in Industrial Radiography by the NNRI.

RPB is responsible for the training and certification in radiation safety for personnel in Industrial Radiography It is therefore responsible for conducting training, qualifying and practical examination. Again a Safety Guide [8] on Qualification and Certification is available and this specifies a national scheme and minimum requirements for qualification and certification of Radiation Protection Personnel.

The scheme recognises two categories of radiation protection personnel in Industrial Radiography:

(a) Operators of radiation sources who actually perform exposures. These are holders of Level I and Level II NNRI certification [9] (equivalent to ISO 9712 Level 2 certification [10].)

(b) Radiation Safety Officer (RSO) who should be competent in developing and implementing a safety programme and capable of organizing training for operators. Such applicants are holders of Level III NNRI Certification [9] (equivalent to ISO 9712 Level 3 certification [10].)

Minimum Requirement

Operators and Radiation Safety Officer (RSO) seeking training in Radiation Protection are to possess with supporting documents, the following basic education as shown in table 3;

Table 3: Minimum Requirements of basic education

Category	Minimum Requirement
Operator	Secondary/Technical School Education
Radiation Safety Officer	Secondary/Technical School Education in science

Training

Training consists of both classroom and practical experience. Minimum duration of 40 hours for operators and 80 hours for Radiation Safety Officers (RSO).

The training syllabus includes;

- Basic radiation physics
- Nature of ã and x-rays and other types of radiation
- Concept of decay and half-life
- Dose, doserate and radioactivity
- Units of radiation measurement
- Detection and measurement of radiation
- Survey meter, TLD and Personal alarm dosemeters
- Controlling radiation dose using Shielding, Distance and Time Optimization and ALARA principle
- Inverse square law
- Biological effects of ionising radiation

Regulatory Knowledge

- National legislation for the control of radiation sources
- Regulations and Licensing Conditions for radiation Sources
- Regulations on Industrial Radiography practice in the area of packaging and transport of radiation sources and work safety.

In addition Operators and Radiation Safety Officers (RSO) are to document the following minimum duration of practical experience.

Table 4. Minimum requirement of practical experience

Category	Minimum Practical Experience
Operator	3 months
RSO	6 months

Certifying Examination

Certification examination consists of three parts;

- Written General [WG] with forty (40) multiple choice questions in 1 hour
- Written Specific [WS] with twenty (20) multiple choice and essay type questions in 1 hour.
- Practical [P] in 2 hours

Grading for Operator/Radiation Safety Officer (RSO) for certification is calculated as follows;

$$CG = WG.WF_1 + WS.WF_2 + P.WF_3$$

Where CG - Composite Grade
WG - Written general examination grade (%)
WS - Written specific examination grade (%)
P - Practical examination grade (%)
WF_1 - Weighting factor for WG
WF_2 - Weighting factor for WS
WF_3 - - Weighting factor for P

Weighting factors (WF) for the two categories of radiation protection personnel are as shown below:

Table 5. Weighting factors for different category of Radiation Protection Personnel

Category	Weighting factors for Different Categories		
	Written General [WF_1]	Written Specific [WF_2]	Practical [WF_3]
Operator	0.25	0.25	0.50
Radiation Safety Officer	0.30	0.30	0.40

Passing the examination for certification one should score a composite grade (CG) of 80% and the score for the individual papers should not be less than 70%. Certification to radiation protection awarded are valid for a period of five years.

RE-CERTIFICATION

Employer or Operator/Radiation Safety Officers (RSO) are expected normally to apply for renewal of certificate three months before the end of expiry date for personnel in continuous employment. The renewal consists of a refresher course followed by a test.

Personnel who interrupt radiography practice for a period of one year are obliged to apply for re-certification. Re-certification consists of repetition of the full programme of certification.

CONCLUSION

Regulatory control of practices in Industrial Radiography has been achieved in the country by means of a system of notification, inspection and authorization by registration or licensing.

A national scheme and minimum requirements for qualification of radiographers in radiation protection has also been established. It is that expected when emphasis is placed on well trained Operators and Radiation Safety Officers, radiation protection knowledge and rules, radiation safety culture on site and enclosed facility will be improved.

ACKNOWLEDGEMENT

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REFERENCE

1. Atomic Energy Commission Act 1963, Act 204, (Government of Ghana, Printing Department, Accra, Ghana) (1963).

2. Atomic Energy Commission Amendment Law, 1993 PNDC Law 308, (Ghana Publishing Corporation, Accra, Ghana) (1993).

3. Radiation Protection Instrument, 1993, LI 1559 (Ghana Publishing Corporation, Accra, Ghana) (1993.

4. RPB Form G2-1, Notification form.

5. Radiation Protection Board, Notification and Authorization by Registration or Licensing, Examination & Exclusion. Safety Guide No. GRPB-G2 (RPB, Accra, Ghana) (1995).

6. RPB Form 1A, Application for Authorization by Registration of Radioactive Material.

7. Radiation Protection Board. Inspection, Safety Guide No. GRPB-G4 (RPB, Accra, Ghana) (1995).

8. NNRIQA98. The National Nuclear Research Institute, Ghana Atomic Energy Commission, Quality Assurance Manual for Non-Destructive Testing/Evaluation (NDT/NDE) Personnel (1998).

9. ISO 9712, Non-Destructive Testing-Qualification and Certification of personnel (1992).

10. Radiation Protection Board. Qualification and Certification of Radiation Protection Personnel, Safety Guide No. GRPB-G1 (RPB, Accra, Ghana) (1995).