Development of Guidelines for the Effective Management of Radiation Safety in the Field of Industrial Radiography in Morocco

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1. Introduction

Industrial radiography is a non-destructive method for detecting the presence of defects in materials by examining the structure of welds, castings and building components. Qualified personnel use sealed radioactive sources, emitting high-energy ionizing radiation, in certified exposure devices.

The licensing and inspection process feedback history of the Moroccan regulatory body exposes the difficulties of industrial radiography applicants to effectively manage radiation safety in their workplace [1]. Thus, guidelines need to be developed to guide operators in the effective management of radiation safety in their practices.

This paper consists of developing guidelines destined for industrial radiographers for the effective management of radiation safety in their workplace. IAEA radiation safety standards, international best practices as well as Korean regulatory control experience on industrial radiography are referred to for elaborating this paper.

2. Methods and Results

2.1. Literature overview

Industrial radiography operations are often performed under difficult working conditions, such as X-ray or Gamma ray shootings in confined spaces and cold, hot, or noisy environment [2,3]. Working under such unfavorable conditions can lead to operational situations in which the principle of maintaining the dose as low as reasonably achievable (ALARA) may be difficult to fulfill. Given those work conditions, it is challenging to prioritize radiation protection instructions and promote a radiological safety culture in the workplace to ensure that the safety of operators and the public goes first.

IAEA standards along with Euratom norms provide the principles for the effective management of radiation safety in the field of industrial radiography [4,5]. Related literature on radiation safety best practices highlights the crucial role of operators training and knowledge on radiation safety management to maintain the radiation dose of exposed workers and public members As Low As Reasonably Achievable (ALARA), and meet radiological safety requirements in an optimized manner.

2.2. Industrial radiography situation in Morocco

Table 1 shows the distribution of annual doses registered in Morocco from 1989 to 2018 among the operators of industrial radiography monitored by CNRP, (Centre National de Radioprotection), a government entity governed by the Health Ministry.

Table 1 - Distribution of Annual Doses in industrial Radiography in MOROCCO 1989-2018 [8].

Category	Number of workers	Class of dose (millisievert)							Collective dose (man. Sievert)
		< 0.2	0.2 - 1.0	1.0 - 6.0	6.0 - 15	15 - 20	20 - 50	> 50	
Gammagraphy	219	201	2	10	3	1	0	2	0.5
X. ray radiography	560	547	10	1	2	0	0	0	0.008

Industrial radiography activities present a negligible risk if they are safely carried out. However, experience shows that related incidents caused overexposure of workers to high doses, which has had serious consequences on their health, for example irradiation burns caused by high levels of irradiation when the sources are pulled out of their protective containers.

In the history of incidents in Morocco we can distinguish two categories of incidents:

- Incidents resulting from misuse or breakdown of the device.
- Loss or robbery of sources or transport incident [8].

2.3. Gaps identification

In Morocco provisions have been made for regulatory control over radiation sources. However, radiation safety regulation generally covers the overall activities involving the use of radiation. Efforts need to be put in to adjusting the application of safety regulations on different types of radiation utilization activities. This paper focuses particularly on industrial radiography.

On the other hand, it is often challenging for operators to develop an effective radiation protection manual, along with the radiation safety-related procedures and instructions according to regulatory requirements and international standards, due to

knowledge gaps and insufficient training in the field of radiological safety [1].

The radiation safety guidelines for industrial radiography are developed based on the IAEA standards, European norms EURATOM publications and international best practices for radiation safety that apply to the field of industrial radiography.

The existing regulatory control gaps over industrial radiography activities and the related radiation safety challenges are taken into account so those guidelines are adapted to the Moroccan radiation safety regulatory context and the existing pace of development of the activity in the country.

2.4. Results

The developed guidelines for industrial radiographers are as follow:

1) Industrial operators shall prior receive a certified training on the proper and safe usage of the relevant radiation apparatus for the inspection technique they perform. The training certificate shall be renewed every 8 years according to Moroccan relevant regulation.
2) An industrial radiography operation organization shall designate a radiation safety officer with a recognized certification and with defined roles and responsibilities in radiation safety management within the operating facility.
3) Industrial radiographers shall receive regular recorded and recognized training and knowledge refreshment on radiation safety management this training can be either provided by an approved third party or by the certified radiation safety officer designated by the operating organization.
4) In case radiographic inspection is to be conducted outside the designated control area within the facility, justifications for the need of our facility performance must be provided to the regulatory body explaining the technical difficulties or obstacles in moving the inspected object to the designed controlled area within the facility.
5) The operator shall establish and communicate to the competent authority the transport plan including the provision made for the safe and secure transport of Gammagraphy device holding the gamma-ray source from the location of origin to its destination, as well as the estimated time length of radiographic inspection performed outside the designated facility.
6) In case the radiographic inspection is performed in a location outside the designated control area within the licensed facility for more than 24 hours, the operator shall make arrangements for the safe and secure storage of the radiation source within a Bunker close by the location where radiographic inspection is taking place. The Bunker where the gamma-ray source is stored shall have enough physical barriers and delay functions to secure the radioactive source from potential human malicious actions (ex: theft, sabotage, unauthorized access, etc).
7) Operators shall establish an emergency plan containing the steps to take in case of a radiation safety event as well as a contingency plan for a security related incident for all possible situations: inside or outside the facility and during transport of the radiation source.
8) Operators shall be provided with relevant training on radiation safety and security of radioactive sources used in industrial Gammagraphy during transportation. Operators should be trained to be familiar with procedure to follow in case of an accident or incident related to radiation safety for instance (ex: overexposure), or security related incident (ex: theft, loss of radiation source, sabotage attempt).
9) The industrial inspection organization shall define work organization by defining the roles and responsibilities of industrial radiography actors, as well as work procedures and instructions that align with radiation safety requirements for different work situations, conditions, and for different work environments.
10) Operating organizations are requested to effectively manage their radiation safety-related documents for smooth and efficient communication and interaction with regulatory body, mainly during the licensing and inspection process.
11) Modifications of work procedures, controlled area, radiographic inspection stuff, transport vehicle, or any alteration having an impact either positive or negative radiation safety management system shall be notified to the regulatory body within 10 days after the modification.
12) Gamma ray sources for radiographic inspection shall be transported in a fully equipped vehicle according to radioactive sources transport vehicle safety norms, the vehicle should be prior approved by the regulatory body for suitability to transport radioactive sources. In case the radiographic inspection organization does not possess the appropriate vehicle, it can resort to the transport service of an approved third party, which provides the arranged vehicles for the transport of radioactive sources.
13) The operator shall establish and keep up to date a radiation safety manual that contains all the arrangements and provisions made by the license holder to manage radiation safety within the licensed facility to keep the radiation doses of workers and the public members below the regulatory limits.

3. Conclusions

The guidelines developed in this paper serve to fill up the radiation safety management gaps in industrial radiography, more particularly the training and information of radiographic inspection workers. The guidelines suggest increasing the frequency of inspections to further improve the regulatory control mechanisms over industrial radiography activities.

The guidelines may have a significant impact on improving radiation safety management performance of industrial radiographers, this results in reducing the workers' and the public exposure as low as reasonably achievable.

The effective implementation of those guidelines is a collaborative effort that will foster the contribution, commitment, and interaction of both involved parties, the regulatory body through the control mechanism, and the operators by following the guiding instructions.

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