STATUS OF INDUSTRIAL RADIOGRAPHY INCIDENTS DOSES DURING THE YEARS 2005-2009 IN IRAN

by

Seyed M. HOSSEINI POOYA [1, 2*], ***Tahereh OROUJI*** [1], ***Mansour JAFARIZADEH*** [1,3], ***Firoozeh NAZERI*** [1], ***Fatemeh YOOSEFI NEJAD*** [1], ***and Mohammad REZA DASHTIPOUR*** [1]

[1]National Radiation Protection Department, Iran Nuclear Regulatory Authority, Tehran, Iran
[2] Radiation Application Research School, Nuclear Science & Technology Research Institute, Tehran, Iran
[3] Agriculture, Medicine & Industry Research School, Nuclear Science & Technology Research Institute, Tehran, Iran

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The dose assessments of industrial radiographers who have been involved in radiation incidents in Iran during the years 2005-2009 are presented and discussed. All cases and events have been recognized by the regulatory body – National Radiation Protection Department of Iran as incidents based on the information declared by the Radiation Protection Officers. The registered dose values are in the range of 0 to 345 mSv.

Key words: industrial radiography, radiation incident, individual dose, dose distribution, regulatory body

INTRODUCTION

Among different kinds of radiation activities, the radiation risk of industrial radiography due to using bare sources (sources outside of the shield during the exposures) with high activities (up to 4.5 TBq), is so high that the related incidents should always be taken into consideration by the industrial radiography centres (IRC) and regulatory bodies [1]. The reasons for radiography incidents may be the carelessness of workers (*e. g*. not using safety equipments, not considering the requirements, …) and/or technical problems (*e. g*. source sticking in guide tube, radiation contamination of the shield surfaces, faults of radiometers, …) [2]. Hence the number of incidents in industrial radiography can be reduced as much as possible if the workers are adequately trained, the quality control (QC) and quality assurance (QA) programs are accomplished for all the instruments/equipments and the requirements are carefully observed. All these preventing actions, particularly the last one may be effective when they are performed with continuous inspections/supervisions by regulatory bodies.

One way to evaluate incidents status is the statistical data collection of incidents during several years. These data may clearly show the effectiveness of the regulatory body's tasks such as inspections, supervisions and enforcements in one country.

* Corresponding author; e-mail: mhosseini@aeoi.org.ir

The National Radiation Protection Department (NRPD) of Iran Nuclear Regulatory Authority (INRA) is in charge of the inspection and supervision of nearly 200 IRC in Iran. The statistical evaluation of incidents has been done at least every five years [3]. In this report, the incidents dose assessment of workers based on the statistical parameters are presented and discussed to investigate the effectiveness of the preventing actions during the period from 2005 to 2009 in Iran.

METHODS

The following procedures have been done to provide the basic data of this investigation:

- declaration of incidents to the NRPD by the IRC,
- submission of questionnaires to IRC by NRPD,
- immediate measurement of TL dosimeters of workers involved in the incidents [4], and
- evaluation and categorization of reasons for an incident based on the information provided through the questionnaires which includes:
  - source (type and its activity value),
  - date and time of the incident,
  - the registered dose value of the direct reading dosimeter,
  - explanation of the incident by the worker, and
  - explanation of the incident by the IRC (their RPO),

– interpretation and final reporting of the dose data, and
– recording of all above information for statistical evaluations.

The collective dose quantity and percentage of incidents have been used for comparison and assessment of the incidents status in each year. Also the dose distribution has been determined in the ranges according to the defined levels in basic radiation safety standard of Iran as: investigation level (4 mSv), average annual dose) over 5 years (20 mSv), maximum annual dose (50 mSv), and maximum total dose in 5 years (100 mSv) [5]. According to the provided information in questionnaires, the causes for incidents have been categorized in two groups: carelessness of workers during the sources handling and technical problems. The "carelessness" of workers means that the workers are qualified in radiation protection training course, but they have never applied it during the work. The examples of carelessness of workers are: not using the safety equipments during the exposes, handling the source in emergencies by hands and not using the alarm detectors during the exposes. The "technical problems" include all unpredicted technical reasons that lead to an incident for which no body in particular is responsible. Some examples of technical problems are: source sticking in guide tube or malfunctioning in locking systems, source assembly, connectors, drive cables, and radiometers.

RESULTS AND DISCUSSION

The percentage of workers involved in incidents (which equals to the ratio of number of workers involved in incidents and the total number of workers) as well as the percentage of incidents (which is the ratio of number of incidents to the total number of radiography centres) have been presented in tab. 1. The results show that in spite of increased number of workers and radiography centres during the years 2005 to 2009, both parameters have been decreased by a factor of around 2 to 1.2% and 6.4% values, respectively.

Table 2 shows the incident dose distributions during the years 2005 to 2009 in the ranges based on the known dose levels. It can be seen that, most of the doses have been placed within the ranges of 0-4 mSv or 4 mSv-20 mSv in each year. On the other hand, there has been no observable trend in the incident mean dose and collective dose values during the five years. The quartile values (Q) of incident doses which have been presented in tab. 2 show that, although the number of incidents decreased in 2009, its $Q2$ and $Q3$ are larger than those of the other 4 years. It is the reason why, in spite of the decreased considerable number of incidents in the dose range of 4 mSv-20 mSv, this value for the range of 20 mSv-50 mSv in 2009 is still comparable with those of the other 4 years. Nevertheless all the Q values have been placed within the range of 0-20 mSv for all the five years and the dose values have been decreased.

The percentage of effective parameters in incidents has been presented in tab. 3. It can be seen that the carelessness of the workers against the technical problems remained lower in the period from 2006 to 2009. Also the percentages of incidents due to both factors have been reduced to zero in 2008 and 2009. It means that the training of workers has been effective, but the quality of the devices and the parts used for radiography activities should be reconsidered seriously.

CONCLUDING REMARKS

The results show that in spite of increased number of workers during the years 2005 to 2009, the percentage of incidents, workers involved in incidents and collective dose has been decreased by a factor of

Table 1. Number of industrial radiography incidents in Iran

Year	Number of workers involved in incidents	Total number of workers	Percentage of workers involved in incidents	Number of incidents	Total number of industrial radiography centres	Percentage of incidents
2005	35	1607	2.2%	17	116	14.7%
2006	43	1734	2.5%	23	143	16.1%
2007	27	1749	1.5%	13	154	8.4%
2008	43	1839	2.3%	19	170	11.2%
2009	23	1919	1.2%	12	187	6.4%

Table 2. The incident doses and their quartile values of industrial radiographers in Iran

Year	$Q1$ [mSv]	$Q2$ (=Median) [mSv]	$Q3$ [mSv]	Range [mSv]	Incident mean dose [mSv]	Collective dose [man-Sv]
2005	1.51	5.50	15.32	71.90	12.24	0.4
2006	0.80	3.10	7.03	318.00	18.10	0.8
2007	1.10	3.53	6.42	34.44	6.74	0.2
2008	1.80	3.20	8.74	345.70	16.54	0.7
2009	1.06	5.74	20.66	81.80	13.30	0.3

Table 3. The percentage of causing factors in industrial radiography incidents in Iran

Year	Technical	Worker	Both
2005	37%	83%	20%
2006	95%	13%	8%
2007	67%	37%	4%
2008	74%	26%	0%
2009	70%	30%	0%

around two and 0.3 man-Sv values, respectively. Also, the dose distribution due to incidents and quartile values show that, most of the doses have been placed within the range of 0 mSv-20 mSv.

Analyses of the causing factors in the incidents show that, the technical problems and/or carelessness of the workers have been the main reasons for the incidents in all these years. The percentage of factors due to the carelessness of the workers has as well been decreased significantly in comparison to that of technical factors. It can be concluded that the training of workers, inspection and enforcement conducted by the regulatory body have been effective, whereas the quality of devices and parts that are used for radiography activities should be reconsidered seriously.

Statistical analyses of the factors causing the incidents show the effectiveness of the training of workers and safety cultures as well as the regulatory body's activities such as inspections, supervisions, and enforcements. But the subjects of training of the workers should be revised in such a way that the workers have a real sense of the seriousness of radiation hazards during the incidents. However, the quality of devices and parts such as guide tubes, locking systems, source assembly, connectors, drive cables and radiometers which are used by the IRC should be considered as important problems. It means that the IRC need to establish the quality management system (QMS) as well as to perform QC/QA programs for their devices/equipments.

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Сеј̣ед М. ХОСЕИНИ ПУЈА, Тахерех ОРУЏИ, Мансур ЏАФАРИЗАДЕХ, Фирузех НАЗЕРИ, Фатемех ЈУСЕФИ НЕЏАД, Мохамад РЕЗА ДАШТИПУР

СТАЊЕ ДОЗА ПРИ ИНДУСТРИЈСКИМ РАДИОГРАФСКИМ ИНЦИДЕНТИМА У ИРАНУ, ОД 2005–2009. ГОДИНЕ

Приказане су и размотрене процене доза индустријских радиографа који су били укључени у радијационе инциденте у Ирану током 2005–2009. године. Регулаторно тело – Национална управа за заштиту од зрачења Ирана – све догађаје забележила је као инциденте пријављење од овлашћених службеника за заштиту од зрачења. Регистроване вредности доза су у подручју од 0 mSv до 345 mSv.

Кључне речи: индустријска радиографија, радијациони инцидент, индивидуална доза, расподела доза, регулаторно тело