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ANALYSIS OF ACCIDENTS IN INDUSTRIAL GAMMAGRAPHY

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ABSTRACT

This study presents industrial gammagraphy accidents from 1967 to 2015, as a way to help the improvement of knowledge to radiation protection and the prevention of futures accidents, based on its common causes. It is based on a research in progress. The term radiation protection is applied to the concept of protection of people, worker or public, against the harmful effect of ionizing radiation. It is an important area and has to be in constant improvement to gain the society's trust. A way to make it possible is through studies of past accidents therefore, accidents reports are important. It is useful for creating a database with enough information to assist in accident management and prevention. This database also helps radiation practices to be more accepted by the community. From a public individual point of view, a practice with reliable statistics that shows low accident rates is more acceptable, even though some hazard might be present. The intent is gammagraphy's risks to be managed and reduced in the future, so the use of the technology might grow while public's acceptance increases and the magnitude of the perceived danger of the practice diminishes as seen through people's eyes.

1. INTRODUCTION

Industrial gammagraphy equipment uses radioactive materials, like isotopes of cobalt, iridium and cesium, as source of ionizing radiation to take radiographs of the interior of pieces or materials to control the quality of products and services in the industry. For instance, these radiographs can detect the presence of fractures inside a metallic piece that are unseen by other techniques of examination. It is a non-destructive testing where many types of components can be examined directly – no need to sampling and laboratory analysis, and without leaving any changes in the structure and composition of the component.

The activity of these sources are usually high enough to represent a threat to the health of workers and public individuals in case of accidental exposure of the sources by failure of equipment or operational errors.

This study presents a sample of occurrences during industrial radiological examinations, which have resulted in health effects to those involved in the deeds. Information found in the literature about gammagraphy accidents was collected and analyzed.

The study of past accidents is an important tool to better understand the causes of accidents, to prevent their occurrence and to lessen their consequences in the future. It is a way to learn making ionizing radiation safer to next generations, making it possible to extract benefits from its uses, while helping society to improve safety.

The causes of eighty-one events were classified and by comparison, it was possible to recognize common situations as, for example, sources that have stuck inside the equipment in an unshielded position, which resulted in the overexposure of workers. Another typical event is a source that fells out of the equipment and an individual pick it up and put in his pocket, damaging severely his leg. Although the main similarities might be the category of victims, once most gammagraphy accidents involve occupationally exposed individuals (OEI), they may frequently involve individuals of the public.

2. LEARNING THROUGH PAST ACCIDENTS

An accident is commonly caused by mutual sequences of actions or events. According to Sklet, [1] there is no common agreement about the term "*cause*" and the model used to investigate an accident may be different, depending on who will lead the investigation. However, a conclusion must cover three simple questions: 'What happened?', 'Why did it happened?' and 'What can be done to prevent it?'

It is important to reminder that there is no questions trying to find a culprit. A radiological accident investigation mainly tries to understand the inaccurate actions or practices for future correction hence, providing safer radiation practices to society.

The conclusion of this investigation should be archived as a report, as a way to create a database with vital information allowing the radiation protection area to learn and be increasingly safe and trustworthy.

During the selection of accidents for this study, it is possible to realize that some reports in the literature has not enough information and some of them has superficial cause, for example, there is reports that only attested that the accident was caused by worker, responding the question 'What happened?' and forgetting about the 'Why?'. Usually, a malpractice by a worker is a synonym of lack of knowledge or unfollowed protocol by the professional, but without a proper investigation or a proper report, it is easy to assume the answer to the unanswered question, but not accurate. For all matters, others factors could happen that lead the professional to be the cause of the event, as lack of attention, that not necessarily means ignorance, or even has a psychological condition, for example, stress.

Accident reports should be seen as way to improve radiation protection and to communicate with the public. If common people understand that, there is always enhancement in the radiation area, it will be easier to them to accept the practice.

In the next paragraphs, gammagraphy accidents are described, making it possible to see how some unanswered question may harm a better learning of the causes.

Gammagraphy is one of the methods of non-destructive-testing, utilized by industry to search for any discontinuity or density difference in metals and welding of airplanes, gas pipelines, cars, submarine and others fields of industry. It is performed using gamma rays (electromagnetic radiation) emitted by a radioactive material, a sealed radioactive source.

The sample of accidents in this paper has eighty events (Table 1), which, firstly, classifies the accidents by location (Figure 1). For a more comprehensive list of accidents, number of injured individuals and fatalities, and a more complete description of the events [2].

Table 1: Sample of Reported Gammagraphy Accidents

Year	Location	Source	Reported causes
1967	Russia, USSR[3]	Sc-45	
1969	Scotland, UK[4]	Ir-192	Trainee operating equipment without supervision
1969	Russia, USSR[3]	Ir-192	
1969	Russia, USSR[3]	Cs-137	
1970	Russia, USSR[3]	Co-60	
1975	Iraq[5]	Ir-192	
1976	England, UK[6]		Untrained worker and lack of control by regulator
1977	Pardubice, Czechoslovakia[5]	Ir-192	
1977	Zona del Oleoducto, Peru[5],[6]	Ir-192	Untrained workers; lack of supervision, authorization and equipment registration
1977	United Kingdom[5]	Ir-192	Worker manipulated a source
1977	New Jersey, USA[5]	Co-60	
1977	United Kingdom[5]	Ir-192	Worker held a source
1977	Buenos Aires, Argentina[6]		Source loosened from shielding
1978	Russia, USSR[3]	Ir-192	
1978	Russia, USSR[3]	Ir-192	
1978	Louisiana, USA[5]	Ir-192	
1978	Russia, USSR[3]	Ir-192	
1978	Louisiana, USA[5]	Ir-192	
1979	Czechoslovakia[5]	Ir-192	
1979	Montpelier, France[5]	Ir-192	
1979	Kirgyzstan, USSR[3]	Ir-192	
1980	Russia, USSR[5]	Ir-192	
1981	Buenos Aires, Argentina[5]	Ir-192	Source peeled off and got stuck in the power tube
1981	Oklahoma, USA[5]		
1982	Russia, USSR[3]	Ir-192	
1982	Russia, USSR[3]	Ir-192	
1982	Nigeria[5]	Ir-193	No authorization, untrained worker
1983	Ukraine, USSR[3]	Cs-137	
1983	Russia, USSR[3]	Ir-192	
1983	Russia, USSR[3]	Cs-137	
1983	Russia, USSR[3]	Ir-192	
1983	Bombay, India[5]	Ir-192	
1983	United Kingdom[5]		
1984	Russia, USSR[3]	Ir-192	
1984	Russia, USSR[3]	Ir-192	
1984	Mendoza, Argentina[5]	Ir-192	
1984	Tiszafured, Hungary[5]	Ir-192	
1985	Lithuania, USSR[5]	Ir-192	
1985	Yamuananager, India[5]	Ir-192	Violation of safety procedures associated with power failure

1985	Visakhapatnam, India[5]	Co-60	Violation of safe practices
1985	Texas, USA[7]		Source kept in a unshielded position
1985	Brazil[6]	Ir-192	
1985	Bahia, Brazil[6]		Lack of security in the source site; theft
1986	Russia, USSR[3]	Ir-192	
1988	Uzbekistan, USSR[3]	Ir-192	
1988	Sao Paulo, Brazil[6]	Ir-192	Broken cable of the source holder
1989	China[5]	Ir-192	
1989	Gujarat, India[5]	Ir-192	Failure of safety management and improper maintenance
1989	Transvaal, South Africa[5]	Ir-192	Radiographer was negligent in not attach the source properly and failure of portable monitor to register detached source
1989	India[5]	Ir-192	Stolen source
1989	Russia, USSR[3]	Ir-192	
1989	India[5]	Ir-192	Stolen source
1990	Russia, USSR[3]	Ir-192	
1977 1991	United Kingdom[5]	Ir-192	
1991	Arauco, Chile[6]	Ir-192	
1992	Riazan', Russia[3]	Ir-192	
1992	Axay, Kazakhstan[3]	Ir-192	
1992	Switzerland[5]	Ir-192	Source jammed
1993	India[5]	Ir-192	Source fell into the sea, not rescued
1994	India[5]	Ir-192	Source assembly got stuck
1994	Voronezh, Russia[3]	Ir-192	
1995	Pervouralsk, Russia[3]	Ir-192	
1995	Nizhny Novgorod, Russia[3]	Ir-192	
1996	Nizhny Novgorod, Russia[3]	Ir-192	
1997	Sao Paulo, Brazil[6]	Co-60	Trainee worked without supervision
1997	Italy[5]	Ir-192	Misconnection between the remote control cable and the source holder
1998	Texas, USA[8]	Ir-192	Trainee operating without supervision
2000	Illinois, USA[9]	Ir-192	Alarm-meter low battery made the worker believe that the source was shielded
2000	Russia [3]	Ir-192	
2001	Russia[3]	Ir-192	
2001	Salavat, Russia[3]	Ir-193	
2001	Baltimore, USA[9]	Ir-192	Worker not using safety equipment
2001	Georgia, USA[3]	Ir-192	
2002	Nizhny Novgorod, Russia[3]	Ir-192	
2002	Kentucky, USA[10]	Co-60	
2006	USA[11]	Ir-192	
2007	Tecnos, Spain[5]	Ir-192	Interlock access control system to the room was broken
2009	Jinju, Republic of Korea[5]	Ir-192	Survey meter was not deployed to working place and the worker did not wear a personal dosimeter as well as an alarm meter
2011	Texas, USA[12]	Ir-193	Worker removed a camera guide tube and may have tried to brushed the source with his hand while removing the tube

2012	Texas, USA[13]	Sc-45	Broken drive tube disconnected source pigtail and drive cable; also fail of procedures
2015	Kansas, USA[14]	Ir-192	Poor communication between two workers lead to the exposure of one of them

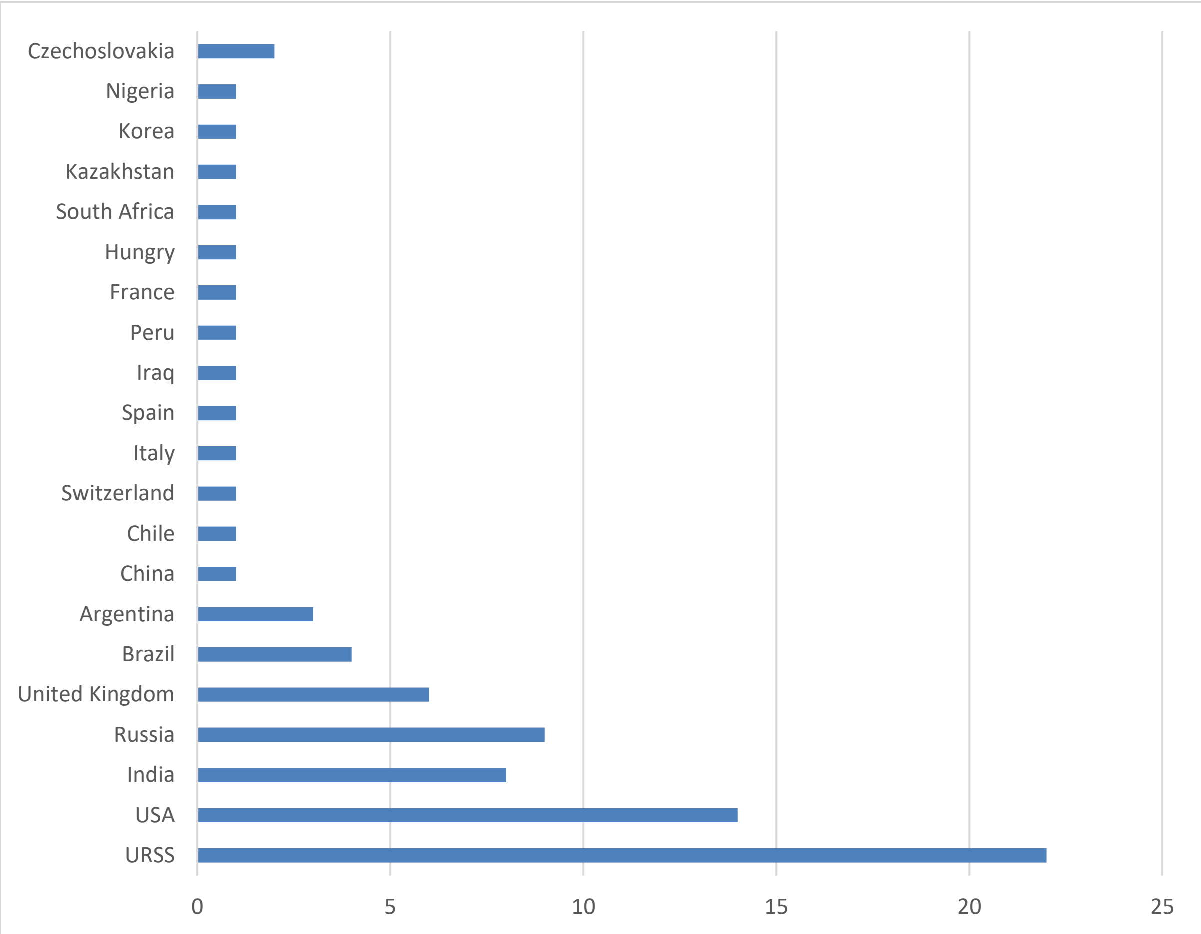

Figure 1 - **Number of accidents by country**

It is interesting to observe that countries with more reported cases are developed countries that have more demand and supply of gammagraphy services and have, possibly, more stringent regulations about notification of events.

The Table 1 also shows the important fact that many reports have no description of causes or even fail to identify the source. Fifty-one cases have not enough information to understand causes, resulting in a difficulty to elaborate measures to prevent accidents in the future. Proper reporting and registration of events are important to create a transparent communication where it is possible to get information without misunderstandings to allow making this kind of study.

3. CONCLUSIONS

During this research, it was difficult to obtain all information necessary to characterize all accidents. Many reports have limited description of causes and consequences, or even fail to identify the source.

It is possible to note that those responsible for the facilities have difficulty to controlling their sources, resulting in equipment malfunction, lack of appropriate personal training, failure in daily checking, loss of the sources, all them potentially resulting in serious accidents.

To make the ionizing radiation safer and to gain public trust, it is necessary to have enough information that can lead to better actions to prevent accidents and, consequently, to be trustworthy to public's eyes, in the future.

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