30 Years Learning from Radiological Accidents.

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Abstract. The summary of the radiological accidents from 1957 to 1997 occurred in Mexico is showed, including the analysis in terms of practice, and consequences. The study tries to establish the radiological knowledge of the people involved in the accident, their attitude to the safety, and retrospective review to the light of 30 years after. Nevertheless, due to the technological developments made to the equipment allow the use in a safe manner, so that the accident number has diminished in a important in a important quantity respect to the reported period, combined to the increased the radiological culture learned by the operation personnel in addition of qualification and awareness in this matter, at present is little probable that the mentioned accidents repeat now days with the same radiological affectations as those happened in the past.

1. Introduction

In Mexico the use of radiation form the nucleus begun in the fifty of the last century, such applications were in medicine and industry, with the installation of the first Cobalt -60 Teletherapy Unit and four companies of industrial radiography with Cobalt-60 and Cesium-137.

The national normative development was initiated on 1950. Nevertheless radiation protection standards come until 1979 when an institution devoted with a unique objective to respond a competent authority in the fields of nuclear safety and radiation protection.

The most of radiological accidents came from industrial radiography and begun at the same time of the use of radiation sources.

2. Accidents occurred from 1957 to 1997

The radiological accidents in the industrial and medical applications of radioactive materials begun in 1957, when one Cesium-137 source was theft, that it was recovered without any damage. The Commission (1) personnel recovery this source, in these type events was established a notification, in order, to support to the companies during the search and rescue activities, in the records form the Commission are the files with the causes, companies, sources involved, people names, doses and detriment. Therefore, the figures resulting from the analysis are 139 events, 94 in industrial radiography 11 in Nuclear Medicine, 9 in Research these are shown in the figure 1, and also the percentage of each practice.

About the consequences the results are a spectrum form no detriment to several dies and economical loss like Ciudad Juarez accident happened in 1985 with a 35 million of USA dollars. The most relevant events are summarized in figure 2.

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Table 1: Events record for practice and per year from 1957 to 1997

Year	Industrial Radiography	Nuclear Medicine	Telethe_ rapy	Brachithe_ rapy	Research	Miscellany
1957	1					
1958	1					
1961	1					
1962	2					
1963	1					
1964	2					
1966	2					
1967	1					
1969	1					
1970	2					
1971	2					
1973	2					
1976	1		1			1*
1977	3					
1978	8	1			1	
1979	6					
1980	13			1	1	1*
1981	5			3		
1982	5	1			1	1**
1983	4					
1984	4		1		1	1*,1**,1***
1985	4		1			
1986	2					2*,1****
1987	0					1**
1988	4					1**
1989	2	1		1		
1990	6	2	1	1		1****
1992	1	1				
1993	1	2			1	1**
1994	2	1				
1995	4	1			1	1*****
1996	0				1	1*****
1997	1	1			2	1*******
	94 (67.6%)	11(7.9%)	4(2.9%)	6(4.3%)	9(6.5%)	

* Tracer
** Well logging
*** Industrial Irradiators
**** Isotopes Production
***** Assembly of Smock Detectors
****** X Ray Analysers

Table 2: Summary of the relevant accidents

Year	Practice	Radionuclide	Activity	Cause	Dosis	Detriment
1961	Industrial Radiography	Co-60	370 GBq	Lost	880 Gy at gluteus	Recuperation
1962	Industrial Radiography	Co-60	185 GBq	Abandoned	Exposition of 2 children, 1 fetus and 3 adults	2 children, 1 fetus and 2 adults died and a man sterility
1964	Industrial Radiography	Cs-137	37 GBq	Lost and radioactivity leak	3 OEP with internal contamination	No
1970	Industrial Radiography	Co-60	111 GBq	No fence and signs	2 Non OEP 4.78 and 12.41 mSv ED	
1970	Industrial Radiography	Co-60	185 GBq	Lost	3 Non OEP One of them gluteus 533	The person recovered

					Gy, gonads 2.4 Gy and hands 35.4 Gy	
1971	Industrial Radiography	Co-60	185 GBq	Theft	Non OEP, the man robber the source 100- 2800 Gy, their wife and children were exposed to lower values	The man died 8 months after
1973	Industrial Radiography	Cs-137	185 GBq	During the transport the source was released from the container	Non OPE found the source, left gluteus 3000 Gy	Left gluteus and leg amputation
1977	Industrial Radiography	Ir-192		Source free In the guide pipe	OEP 423 Gy right y 186 left hand	Amputation of 4 fingers

1977	Industrial Radiography	Ir-192	2.24 TBq	Source free In the guide pipe	OEP Left hand 52 Gy and 35 mGy ED	Amputation of one finger
1978	Industrial Radiography	Ir-192	3.1 TBq	Source free in the guide pipe	OEP; 1.2 mSv ED, 67.2 Gy hand and 1800 for fingers	Amputationof 3 fingers
1978	Industrial Radiography	Ir-192	Unknown	The source get down on the floor	OEP; 30 Msv ED and 300mGy to hands and 31 Gy to fingers	Recuperation
1979	Industrial Radiography	Ir-192	1.66 TBq	Source free in the guide pipe	OEP; 1.2 Gy Ed, 12 Gy to gluteus and 36 Gy to hands	Recovery
1979	Industrial Radiography	Ir-192	444 GBq	Source free in the guide pipe	OEP; 670 mGy ED AND 1.66 Gy To hands	Recovery

1981	Brachitherapy	Ra-226	12 sources	A phycisian died and leaves the sources in a safe box	No	No
1985	Teletherapy	Co-60	15.3 TBq	Abandoned and sold to one scrap yard	Dozen OEP exposed, rebar and metallic products contaminated	Stereility of 2 people, doses For 6 people until several Gy, 35 million dollars .
1988	Well logging	Cs-137	45.5 GBq	The source was found on one road by a non OEP	3 non OEP, 74.7, 34.1, 30.7 and 12 mSv ED	No
1989	Brachitherapy	Ra-226	3 sources	Lost inner one hospital	No OEP; 120 mSv to one leg and 50mSv to gonads	No

1990	Industrial Radiography	Ir-192	740 GBq	The vehicle with the source were fired	No	No
1990	Teletherapy	Co-60		The source did not return to the safe position	3 OEP; 70, 26.46 and 93.72 mSv ED	No
1991	Radiopharma ceutical Production	I-131		The ventilation system went wrong	13 people with internal contamination	No
1995	Industrial Radiography	Ir- 192	3.9 TBq	The guide pipe fired	No	No
1995	Industrial Radiography	Ir192	629 GBq and 995 GBq	The ship with the sources get underwater	No	No
1995	Industrial Radiography	Ir-192	2.59 TBq	One Chase get underwater during the pas of a hurricane	No	No

1997	Analizers	Rayos X		3 No OEP were exposed during the reparation	Non determined	Dermatitis recuperation after 3 months
1997	Pharmaceutical production	I-131	21.09 GBq	The package was send to Mexico	No	No
1997	Industrial Radiography	Ir-192	64.75 GBq	Theft of the vehicle with the source	No	The source was recovered

3. Accident analysis

In a gross analysis of industrial radiography were found the initiating causes of the loss of source control or people exposition, that initiating causes are as follows:

Table 3 Initiating causes of accidents in industrial radiography

Theft/ lost	27
Cable failures	27
Security	13
Training	12
Traffic accident	3
Fence and signs	3
Container failures	3
Abandon	2
Meteorological phenomena	2
Manufacture	1
Others	1

The figures shown the failures of the directives to establish a coherent management of the radiation protection program and effective measures to radiation sources control. Because the industrial radiography practice had the higher data than the others practices the analysis will be made for it. From the table 2 it can observe that major impact in the detriment to the health was in the accidents of industrial radiography.

Therefore the authority actions were to establish a direct contact with the companies head for improve the radiation protection programs, including aspects such as, training, procedures, radiation detectors, tool for recover sources. The sanctions were of several types and some cases reach until the cancellation license.

The equipment is other important factor, such as, spare parts, refurbishment, maintenance, design changes and the oldest of the equipment from the developed countries to un-developed countries.

And the most important facto was and is the workers training based in the national regulations supported in the international recommendations, addressed to achieve the indoctrination on the radiation protection principles.

4. Development of the legal framework

January 26 1950
Law declare as national mineral reserves the uranium, thorium and the like substances from which is obtaining fissionable isotopes that could produce nuclear energy deposits.

This law didn´t define the competent authority responsible to apply it.

December 19 1955

Law that create the National Commission of Nuclear Energy CNEN with the responsibilities: promotion of the nuclear energy in pacific applications, uranium exploration, mining and milling and competent authority.

January 12 1972

Law that create the National Institute of Nuclear Energy INEN essentially with the same responsibilities like CNEN.

January 26 1979

Law that create the National Commission of Nuclear Safety and Safeguards CNSNS as competent authority in nuclear safety and radiation protection

February 4 1985

Law that clarify and confirm the responsibilities of the competent authority CNSNS

November 22 1988

CNSNS issue the General Regulation of Radiation Protection

1994

CNSNS begun the issue of radiation protection standards for specific subjects like; radiation detectors calibration, leak tests, control of contamination, radioactive wastes, intake annual limits, training,
Before of the law of 1979, the competent authority in order to establish conditions and rules for radiation protection, issued joint to the license the specific conditions on radiation protection and safety for each practice. These conditions gave to the authority a legal means to obligate to the users to improve the workers, public and environment radiation protection.

5. Conclusions

The pacific nuclear energy applications in the past needed learn from the radiological accidents for control the radiation sources in use in order to achieve that the benefits will be larger than the detriment.

6. References

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