AN OVERVIEW OF INDUSTRIAL RADIOGRAPHY ACCIDENTS IN INDIA DURING THE PERIOD 1987-1997

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Abstract

Use of gamma radiation sources for non-destructive testing of welds, castings and vital components in several industries in India has recorded a steep rise in the last three decades. There are over 1000 industrial gamma radiography exposure devices (IGRED) in over 400 institutions in the country. Most of these employ Co-60 and Ir-192 gamma sources. In spite of regulatory control and procedures there have been accidents with the IGREDs resulting in significant radiation exposures and in some cases, injuries to members of public and radiography personnel. This paper analyses the accidents which occurred in India during the ten year period of 1987-1997, management of such accidents, steps taken to avoid recurrence of these accidents based on the lessons learnt.

1. INTRODUCTION

NDT based on radiation technique is an indispensable tool and is widely used for inspection and quality control of vital components in various industries. Facilities for induction of trained manpower, ready availability of radiography equipment and sources and awareness of quality assurance requirements have added to the growth of radiation technique of NDT. There are about 400 institutions spread among private and public sector undertakings engaged in industrial gamma radiography throughout the country. Imported remote operated equipment in addition to indigenously fabricated equipments form the major support for use of iridium-192 and cobalt-60 sources. Even though the radiation safety record in industrial applications has been good, there have been some accidents/incidents in different applications. A radiation accident is different from accidents in other fields as the effects of radiation are not immediately felt. Because of this insidious nature, a radiation accident can lead to very serious consequences. The likelihood of occurrence of an accident in industrial radiography is fairly high, because majority of the radiography work is carried out in public domain, such as construction sites, workshop areas and inaccessible locations. The source activities used in industrial radiography are quite high, hence in the event of an accident, there is the possibility of very high doses, even up to lethal doses in certain cases. Though there are nearly 1000 radiography sources used in about 500 radiography sites in India, the accident rate is quite low and no fatal cases have been reported in industrial radiography field. This paper outlines and analyses the accidents in India in the last decade.

2. ANALYSIS OF ACCIDENTS

There have been 33 radiation accidents in this field during 1987-97 in India. Although most of them were of minor nature, a few of them resulted in radiation injuries to the exposed individuals. As far as a gamma radiography source is concerned, an accident can occur even when the source is not in use. The analysis shows that accidents have occurred in all the three main stages namely, storage, use and transport of radiography sources. Table 1 lists some of accidents which occurred in India during 1987-97.

Table-1 : Some Industrial Radiography Accidents in India During 1987-97

Period	Source / Equipment and Incident	Remark
Sep. 1987	292 GBq iridium-192 source assembly in lead pot stolen from storage room.	Recovered next day.
Dec. 1987	65 GBq iridium-192 source assembly in lead pot stolen from site.	Recovered after 3 months. Found buried under ground.
May. 1988	1.07 TBq iridium-192, TechOps-660 source housing. Guide tube was found damaged, as a heavy object had fallen on it during use.	It was rectified and the source assembly was brought back into its housing.
Jun. 1988	74 GBq iridium-192 source assembly was stolen along with lead pot from a site. It was left unattended.	Source assembly was recovered after three days from the site.
Jan. 1989	148 GBq iridium-192 source assembly attached to the manipulator rod was stolen during radiography operation from the site.	It was traced after five days from a scrap dealer's shop. Three persons were sent for CA test. Whole body dose : 50 - 260 mGy.
Mar. 1989	1.41 TBq iridium-192, Iriditron-520 source housing. The source assembly got detached and remained inside the guide tube.	It was retrieved into its housing.
Sep. 1989	880 GBq iridium-192, TechOps-660 source housing. The source assembly got stuck in the guide tube. The operator had difficulty in retrieving the assembly. He disconnected the source assembly and shook it violently with both hands.	Three fingers on the left hand and two fingers on the right hand had got exposed. The estimated dose to fingers was 8.8 Gy.
Feb. 1990	925 GBq iridium-192, TechOps-660 source housing. The source assembly got detached due to improper coupling and it remained in the guide tube.	It was retrieved back into its housing.
Feb. 1991	1.7 TBq iridium-192, Century SA source housing. The source assembly got stuck in the housing.	Plunger arms of the lock were found broken & the pieces were obstructing the source assembly movement. It was rectified.
Sep. 1991	60 GBq iridium-192, TechOps-660 source housing The source housing was stolen from the storage room.	It was found lying in a ditch outside the fence of the factory.

Period		Source / Equipment and Incident	Remark
Feb.	1993	85.1 GBq iridium-192 source assembly in a lead pot fell into sea, 90 m depth during use on an off-shore platform.	Not recovered, abandoned
May.	1993	267.8 GBq cobalt-60 source assembly got detached. It fell inside the enclosure.	It was picked up with CV tongs and put back into its housing.
Oct.	1993	1.6 TBq iridium-192, TechOps-660 source housing. The source housing was booked in brake van of a train. It was lost.	Not recovered.
Jan.	1994	1.67 TBq iridium-192, TechOps-660 source housing. The source assembly got stuck. An untrained person operated the source housing.	The untrained person got injury in his right hand thumb, index & middle fingers. CA test dose estimated was 0.38 Gy. Exposure to hand could be much higher
May.	1996	40 GBq iridium-192, TechOps-660 source housing. The source housing was stolen from the storage room.	It was recovered from a scrap dealer's shop.
Oct.	1996	1.0 TBq iridium-192, Teletron source housing. The source assembly got detached and fell from a height of 30 m and broke in two pieces.	Broken pieces were recovered and put back into the housing.
Jan.	1997	41 GBq iridium-192, Spec-2T source housing. The source housing was packed in a steel box and it was lost during transport in brake van of a train.	Recovered from the railway yard after two months.
Aug.	1997	592 GBq iridium-192, Roli-1 source housing. The source housing kept in storage room was washed away in flood.	Not recovered.
Sep.	1997	296 GBq iridium-192, Gammarid source housing. The source assembly got detached and got stuck at the exposure head.	It was put back into a lead pot.
Sep.	1997	2.07 TBq cobalt-60, TechOps-676 source housing. The source assembly got detached and remained in the guide tube inside a radiography enclosure.	It was retrieved back into its housing.

Among the possible accidents, loss of radiography source needs to be viewed seriously, because the source can reach the hands of members of public who are totally ignorant of the hazards associated with radiation sources. The lost source, if not traced quickly, can lead to very severe consequences. There were 16 cases of missing radiography source/equipment during 1987-97. Out of these, 8 sources could be traced. Out of these, 3 were cases of loss due to improper transport and the rest due to improper storage. One source assembly had fallen into the sea during use and in another case, the equipment along with source was washed away during flash flood. In all those cases where the source could not be traced, through extensive search and interrogation, prior to abandoning search operations, it was confirmed that the source had not reached the hands of members of the public or was not likely to result in significant radiation doses to any body. In all these cases, the chances of tracing the source became dim mainly due to delay in noticing / reporting the loss. From the analysis, it is very clear that improper storage or improper transport coupled with carelessness of the radiography personnel are the main reasons for the source loss. There were 17 such cases of accidents which occurred during 1987-97 while the radiography sources were in use.

Accidents and consequent radiation exposure / injury during use happen mainly because of the following reasons :

a) handling of sources by untrained persons,
b) use of defective equipment and/or its failure,
c) failure to use radiation survey meter.

In three incidents, some untrained operators/radiographers received radiation injuries. Fortunately, their whole body doses were not significantly high. However, the radiation injuries received by them were serious and needed prolonged treatment. As the activity of the sources used in these source housings are generally high, even a single accidental exposure can result in radiation injuries.

There were 13 cases of accidents involving decoupling/source stuck up during 1987-1997. In one case, the source assembly came out of the equipment, fell 30 metres below the level of operation and broke in two parts. In most of the cases, either the source housing was handled by uncertified operator or the certified radiographer had failed to verify the physical integrity of the coupling before driving the source out of the housing. The design of most of the remote operated source housings is such that the source cannot be pushed out of the source housing without proper coupling between the source assembly/pigtail and the drive cable. But, this safety feature is likely to fail either due to wear and tear or due to poor maintenance. Many such accidents could be easily avoided, if the personnel adopted proper work practice.

3. CONCLUSIONS

Radiation accidents, like other accidents do not occur but are caused. An analysis of these accidents clearly indicates that human error is the major cause for these accidents. Accidents occur mainly due to not adopting proper work practice and violating of safety rules at various stages. Proper maintenance of the equipment and accessories would not only ensure prolonged trouble-free operation, but would also minimize chances of occurrence of detachment of source assemblies. Based on our experience and analysis of accidents, some models of IGREDs were withdrawn from use and replaced by safer versions. In spite of all precautions and procedures, should the accident occur, early recognition and action would mitigate the consequences of the accident and minimize further damage. Utilization of trained personnel is very important for minimizing chances of accidents. Radiation safety depends crucially on the operators being aware of proper working procedure and this is achieved through appropriate

training. Thus the main concern of Regulatory Authority is the training and knowledge of the authorised personnel. Periodic refresher courses are conducted for trained personnel, so as to keep them in constant touch with the subject and also to update their knowledge. The Radiological Physics and Advisory Division of Bhabha Atomic Research Centre is associated in the conduct and coordination of radiation safety training programmes for users of radiation sources for more than 35 years.