ANNEX A

Incident Case Histories

A1

Unsealed Radioactive Material

Contents

IRID Case Number: 0001/92	**Category: D.1.1**
Equipment: Unsealed radioactive materials	**Nature: Localised exposure**

A researcher working in a laboratory used for handling unsealed radioactive materials was manually dispensing, in a fume cupboard, a routine delivery of what he believed to be 74 MBq phosphorus-32. When the stock solution was removed from its shielding the portable radiation monitor placed in the fume cupboard by the researcher went off scale; he expected this because the monitor could only measure the much lower dose rates of diluted material. It was then switched off. The appropriate beta shielding was used for the activity concerned. The containers to which the material was dispensed were placed behind Perspex shielding and the monitor switched back on. The expected drop in beta dose rate was not observed and the Radiation Protection Supervisor was contacted.

Investigations revealed that the activity that was delivered was in fact 1000 times more than was ordered, invoiced for, and that stated on the package. A packaging note did, however, state the correct activity but was not noticed.

Although a few spots of contamination, up to 480 Bq cm^{-2}, were found on a laboratory coat, significant levels of contamination were limited to the fume cupboard. The researcher's film badge recorded a penetrating radiation dose of 0.04 mSv. An investigation and reconstruction concluded that any intake of activity had been negligible but that his fingers had received doses of the order of 120 mSv.

Lessons

1. A radiation dose rate monitor capable of measuring all expected dose rates should always be used.
2. Whenever any radioactive source is purchased and received on the premises all paperwork must be examined in order to ensure that the activity and nuclide delivered are as expected. If there is any doubt or conflicting information is given, further advice should be sought. For unsealed radioactive materials a radiation monitor should be used in order to ensure that the associated dose rates are as expected for the quantity and type of material concerned.
3. Suppliers of radioactive materials must continually ensure that all quality assurance procedures are effective.

IRID Case Number: 0004/92	**Category: C.1.1**
Equipment: Unsealed radioactive materials	**Nature: Contaminated premises/ equipment**

A company was using a sealed chamber for examining the porosity of various materials. The materials were contained in metal sample tubes with rubber bungs on the ends and the gas used within the chamber was 1.3 GBq of krypton-85. During a radiation survey by the company's Radiation Protection Adviser, beta dose rates of between 1 and 2 mSv h^{-1} were detected on the surface of the bungs. There was a significant degree of handling of the sample tubes and bungs during the re-loading operations (up to 500 tubes per day).

It was concluded that the krypton-85 gas was diffusing through the rubber bungs giving rise to dose rates to the skin of those handling the bungs. The use of an alternative type of bung was subsequently instituted.

Dose

The skin dose to the fingers was estimated to be 0.2 mSv per day.

Lessons

1 Radiation monitoring of equipment incorporating radioactive substances must be carried out in a detailed manner on a regular basis.

2 Krypton-85 gas can diffuse through some types of rubber.

IRID Case Number: 0001/93	**Category: C.1.1**
Equipment: Unsealed radioactive materials	**Nature: Contaminated premises/ equipment**

Radioactivity was detected by sensitive radiation monitoring equipment on a consignment of scrap stainless steel pipes when they were delivered to a recycling works. Some of the pipes had been cut into shorter lengths. The pipes were subsequently found to be contaminated, mainly internally, by a thin layer of radioactive scale, which is likely to have accumulated inside them during mineral extraction or processing by the previous owners. Scale is formed when minerals containing natural uranium or thorium are pumped or processed in water-based slurry. Contamination was also found in the storage area. Dose rates around the pipes were generally less than 5 µSv h^{-1}, although up to 500 µSv h^{-1} was measured. The consignment was promptly shipped back to the suppliers.

Doses

The majority of radiation doses will have occurred during cutting and storage of the pipes. External doses were probably insignificant but employees of the consignor may have received internal doses as high as 2.5 mSv (based on estimated air concentrations and working times) if they cut the pipes without appropriate precautions.

Lessons

1 The installation of sensitive radiation monitoring equipment at recycling works can avert the spread of significant contamination from radioactive sources accidentally included in consignments of scrap metal. Since decontamination is always likely to be extremely expensive all companies involved with the recycling of metals should consider the benefits of installed radiation detectors to monitor feedstocks.

2 Continuous effort must be made by recycling works to attempt to ensure that either all materials delivered to a works have no significant radioactive content or that the works are fully advised and prepared to accept these materials.

IRID incident 0006/94: an unused building was being cleared by a contractor when a metal cabinet toppled over breaking its contents. The contractor was contaminated with liquid radioactive materials, which had not been stored in a secure manner

IRID Case Number: 0006/94	**Category: B.1.2**
Equipment: Unsealed radioactive materials	**Nature: Contaminated premises/ equipment**

A locked metal cabinet was found in a store room in a building that had been disused for a number of years and recently occupied by its new owners. The cabinet was being manually relocated when a bottle within the cabinet toppled over and was broken, spilling its contents. A liquid seeped from the cabinet, which when forced open revealed 4 × 1.5 litre intact Winchester bottles containing organic liquid and the remains of a broken 2.5 litre Winchester. A large empty plastic drum was also inside the cabinet. All were labelled with tape bearing the legend ‘radioactive material’.

The organic liquid was understood to have seeped on to the hands and forearms (but not the clothing) of the two men involved with moving the cabinet. They subsequently washed these affected areas and contacted a Radiation Protection Adviser. Radiation monitoring revealed no residual contamination on the two men but the cabinet, some stacked metal shelving, the floor and a wallboard were contaminated by the spill.

The original owners of the building were traced and contacted. Inspection of the original owners’ records and the bottle labelling suggested that each bottle contained a few tens of kilobecquerels of carbon-14 in toluene (liquid scintillation cocktail). The carbon-14 content was later confirmed by analysis of the liquids by liquid scintillation counting.

The area was decontaminated and the cabinet, its contents and all waste arising from the clean-up operation were taken by the original owners for storage and subsequent disposal. This incident arose due to the poor record keeping and accountancy of radioactive materials by the original owners’ when they vacated the buildings. It was fortunate that higher activities or more radiotoxic materials were not involved and significant radiation doses were not incurred.

Doses

The activity of carbon-14 released in the spill (37 kBq) was 250 times lower than the annual limit on intake (ALI) which for carbon-14 is approximately 9000 kBq. It was therefore concluded that an uptake of even a significant fraction of the activity released would not result in a significant dose to the two men involved.

Lessons

1. All radioactive materials must be fully accounted for at all times and regular physical checks made to ensure that the records are correct. Any loss of these materials should be immediately obvious from the records so that an investigation can be carried out without delay.
2. Whenever an area that is used for the handling or storage of radioactive materials is vacated, a thorough search, and contamination monitoring if appropriate, should always be carried out in order to verify that all radioactive contents have been removed.

IRID Case Number: 0013/95	**Category: D.3.1**
Equipment: Unsealed radioactive materials	**Nature: Contamination of persons (internal)**

A laboratory technician working in a university was attempting to decant some caesium chloride solution from a standard vial. The stock in the vial was old and had been redundant for some time. The department had decided to dispose of it over a number of months as required by its authorisation under the Radioactive Substances Act 1993. The activity contained in the vial was 150 MBq and the work was being carried out in a controlled area. The technician used lead bricks to shield the gamma radiation from the vial and was aware of the need to maintain a good working distance from the vial. However, the work was not being done in the fume cupboard normally prescribed for such work but was done on a nearby bench.

The vial was capped with a rubber septum and hence the researcher used a pressure relief needle to relieve any pressure build up in the vial. However, when this was attempted the needle entered too far and penetrated the liquid. This resulted in an unexpected release of liquid from the vial, which had become slightly pressurised. Since the work had not been carried out in a fume cupboard the researcher's face was exposed to the resulting spray of liquid.

Possible contributing factors to the incident were the considerable age of the vial, the rubber septum of which had hardened, and that prior to the work commencing the vial had been left in the sun for some time.

Dose

A few days after the incident the university arranged for the technician to undergo whole body monitoring in order to estimate the activity of caesium taken into the body. It was estimated from the results of the monitoring that the technician had received a committed dose of 140 mSv.

Lessons

1 This case highlights the importance of following any specific precautionary procedures which have been identified for a particular job. Had the work been carried out as prescribed in a fume cupboard it is likely that the technician would have received an insignificant dose from the release.

2 A significant contributory factor in this incident was the age of the vial, which led to the hardening of the rubber septum, and may partly have been the cause of the pressure build up within the vial. It is generally bad practice to keep stocks of unsealed radioactive material, or sealed sources, which have become redundant. The condition of sources and their containment can only deteriorate over time leading to increased potential for incidents. When sources are no longer required they should be disposed of as soon as practicable.

IRID Case Number: 0008/97	**Category: A.1.1**
Equipment: Unsealed radioactive materials	**Nature: Other**

A company carrying out laboratory-based biological research with unsealed radioactive materials received a quantity of phosphorus-33 from the manufacturers. Phosphorus-33 is a relatively low energy beta emitter with a half-life of 25.3 days. Upon receipt of the material the company's standard procedures are to check all labelling and paperwork supplied with the package and then, using a radiation monitor in a controlled environment, attempt to estimate the activity of radioactive material received. Immediately prior to this procedure being carried out, the Radiation Protection Supervisor noticed that the colour of the solution was somewhat darker than usual. Radiation dose rates at the surface of the vial were found to be approximately 20 times the usual reading of 0.5 μSv h^{-1} for the 9.25 MBq of phosphorus ordered and stated on the documentation. The RPS refrained from giving the solution to the researcher and contacted the manufacturer.

Following an investigation by the manufacturer, it was later reported that the solution had originated from a factory that was closing down for a period and, in the rush to close the production lines, it appeared that the solution had not been fully defrosted from the frozen stock supply. Due to the presence of ice crystals, the solution had not therefore been fully diluted prior to dispensing into vials. This was the reason for the increased dose rates and darker colour of the solution.

A replacement stock was delivered and the erroneous stock disposed of by the company following a period of decay.

Doses

Due to the detailed procedures used by the receiving company, the error was identified before work began with the solution. No doses were therefore received.

Lessons

1. All companies receiving radioactive materials should have in place formal procedures for checking all documentation supplied and estimating the activity of the radioactive material received prior to the material being put into normal use. Errors do occur and resulting activities and dose rates can be many orders of magnitude higher than expected.
2. The delivery of the wrong quantity of radioactivity is a reasonably foreseeable incident and contingency plans should be available to deal with it.