Experience Gained From Some Incidents Related to the Shipment of Radioactive Materials

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INTRODUCTION

The number of accidents occurring during shipment of dangerous materials in France varies between 200 and 250 each year. Those concerning radioactive materials represent one or two events per year. Six incidents or accidents recorded these last few years have been selected as particularly significant ; they include not only events on public highways but also events on nuclear sites relevant to transportation safety. These events are summarized in the next section together with corrective actions engaged after analysis of the causes of the events. Finally, more general conclusions drawn from these abnormal events are presented from the point of view of emergency preparedness.

ABNORMAL EVENTS RELATED TO RADIOACTIVE MATERIAL TRANSPORTATION SAFETY

Event No. 1

In a railway station, a locomotive struck a baggage trolley carrying several type A packages containing radioisotopes for medical applications. One of them, a technetium generator containing less than 0.015 TBq (0,4 Ci) of ^{99}Mo, was destroyed, whereas the others were dispersed without releasing their contents. The locomotive and the railway track were contaminated. The number of persons controlled was 291, 19 of which, mostly employees from the railway station, showed a detectable but unsignificant level of contamination. The railway traffic was stopped for 24 hours, the time necessary for personal from the French Atomic Energy Commission to decontaminate the railway track. This incident has not led to any demand for a revision of the regulations, safety having been insured due to the limited activity content of the packages. However, it has demonstrated the necessity of disposing of sufficient equipment to guarantee a rapid control of those persons likely to be affected by radioactive substances or who fear that such might be the case. The Central Service for Protection against Ionizing Radiations of the Ministry of Health is now equipped with trucks and a railroad car, each allowing the control of 12 persons at a time for a truck to 32 persons for the railroad car.

Sufficient decontamination means are also necessary to eliminate radioactivity rapidly from affected areas.

Event No. 2

This accident, the wreck of the Mont Louis cargo boat in the North Sea, involved 30 cylinders containing uranium hexafluoride with a ^{235}U isotopic content of less than one percent[1]. Controls of sea water were made by the French Atomic Energy Commission around the boat, which lay at a depth of 15 metres, and showed no leakage of UF_6. A decision was made by the consignor to recover the packages, an operation complicated by : the difficulty in gaining access there, the presence of stowage and several serious tempests. All containers were finally recovered in a tight condition except one into which 50 litres of sea water had leaked due to a 45-degree bend in the valve. Many other valves were found deformed, with no loss of their tightness, the valve-protecting covers having apparently not adequately fulfilled their role.

Because this accident was explained to authorities and to the media as presenting essentially a chemical hazard, safety authorities asked the French Atomic Energy Commission to verify the adequacy of the regulatory requirements concerning the subsidiary risk (corrosive and toxic) associated with uranium hexafluoride. This action has contributed to the establishment of AIEA guidance for the safe transportation of uranium hexafluoride[2] providing, in particular, criteria for the qualification of valve-protecting covers.

In addition, emergency packaging capable of receiving a damaged UF_6 cylinder has been acquired. Finally, a study aiming at the improvement of stowage equipment has been engaged with funds from the Europeen Community.

Event No. 3

This incident involved a type A package containing a 0.002 TBq (0.05 Ci) cobalt source during its shipment by road. The package arrived empty to the consignee. The cobalt source was subsequently found in the vehicle by an emergency squad from the Atomic Energy Commission. The investigation revealed that the package had not been securely closed, that no consignor's declaration had been established and that the driver of the truck had not warned the police after having discovered the opened package. The consignor has been requested by the competent authority to improve its control of shipment preparation. Actions have been taken by the carrier to improve the education of its drivers, especially as concerns emergency instructions in case of discovery of an opened package.

Event No. 4

A type B package in the process of being sent abroad fell from a height of 50 centimetres during handling in an airport. The package consisted in a irradiator containing a 3700 TBq (98000 Ci) cobalt source.

A thin external metallic shell designed to prevent contact with package surface was dented. Gamma dose measurements made by the airport security personal displayed no abnormal level. Therefore, the package was placed in a safe location before being carried back to the consignor for detailed controls, especially of internal mechanical pieces.

When the competent authority was informed about the incident, it appeared that it had not been notified of the shipment although the activity exceeded 1000 TBq. Moreover, the consignor was long in intervening : meanwhile, different parties proceeded to various and somewhat contradictory dose measurements so that the situation became rather confusing by the time a control was effected by the Central Service for Protection against Ionizing Radiations and by an emergency squad from the Atomic Energy Commission. The package was sent a few days later to its consignee, after verification and repair of the external metallic shell.

Following this incident, the consignor has been requested to improve its control of shipment preparation, specifically as regards notification of the competent authority. In addition, different measures have been taken by the consignor in order to improve its response to accident situations ; they include : a) the presence at all times of one person capable of informing or advising in case of an accident affecting a consignor's package and, if necessary, of causing an action plan to be launched under the consignor's responsability ; b) review, improvement and distribution of safety instructions to the carriers ; c) additional information on the packages themselves facilitating contacts with consignor and competent authority.

Event No. 5

During a control prior to loading an empty packaging designed for the shipment of iridium sources, it was found that the handle operating the packaging locking device did not correspond to the description in the approval certificate of the package design. The package design for this equipment had been modified several years previously to prevent errors when assembling the handle, which could have led to an accidental escape of a source outside the package (an incident of this type had occurred in a nuclear facility prior to the modification). All packagings had been modified according to the revised approval certificate except this one, let to a remote user who had been given the necessary instructions to perform the modification, not a complicated one, himself. The modification was never carried out, and the owner of the packaging did not verify whether the user had actually executed its instructions. Without the routine controls of the concerned packaging, a serious accident could have happened.

The owner of this series of packagings has been requested to improve its controls of the quality of maintenance operations, each packaging being accompanied by a form attesting the conformity of the packaging, after periodic maintenance or control, to the model described in the safety report.

Event No. 6

A truck-trailor carrying a 60 ton package containing 5 tons of spent fuel from a gas-cooled graphite reactor was advancing at low speed (less than 40 kilometres per hour) on the soft shoulder of a road. The trailor tipped progressively, causing the package to break its stowage, to turn on its side and to sink into soft soil to a depth of one meter. Because the conveyance was escorted and the accident location was only 10 kilometres from the reactor plant, controls of the dose level around the package were carried out very rapidly. Police, firemen and the army secured a zone several hundred meters across around the damaged conveyance, diverted the traffic from the road and, later, installed a radio-telephone liaison station. The package itself apparently suffered little damage (some of the cooling flanges were deformed) but the heat exchange surface with the atmosphere was somewhat reduced because the package was partially buried in soil. However, taking into account the actual decay heat of spent fuel, this question was not a cause for major concern. The main difficulty in terminating the accident was the long delay (more than one day) necessary to supply a mobile crane of a sufficient strength (350 tons) to handle the package and place it on a new truck-trailor.

This accident has highlighted the necessity, for reasons not only related to safety, such as public concern or pressure from the media, to improve the performances of plans ensuring the recovery and security of damaged packages. To this effect, the consignor, in conjunction with local authorities, has completed the inventory of high-capacity handling vehicles along all routes taken by spent fuel packages.

CONCLUSION

The events described above provide a realistic view of different types of the more plausible abnormal transportation conditions. These can be classified into two broad categories :

- the first one concerns situations involving low activity, or low specific activity, radioactive material packages : for example, technecium generators (event No. 1), non-fissile uranium hexafluoride packages (event No. 2), or low activity cobalt sources (event No. 3),

- the second one concerns situations involving high activity and/or fissile material packages : for example, high activity cobalt source packages (event No. 4), high activity iridium source packages (event No. 5), or spent fuel packages (event No. 6).

As concerns the first category, related to packages not designed to withstand severe accident conditions, the probability of a failure of the package is relatively high, but the consequences to the public or the environment cannot be serious because the limited radioactive content. However, these limits are based upon an impact model (in the Q-system[3]) which could, under certain circumstances, be questionable.

In particular, a major parameter, the delay during which individuals might be affected by a release of radioactive substances (see event No. 1 for example) or by a radioactive source (see event No. 2 for example), could be longer than the assumption made in the model. Therefore, the performances of the means devoted to cope with accidents involving type A or industrial packages are directly relevant to safety. The efficiency of the emergency system relies heavily upon trained and adequately equipped emergency squads based throughout the country and capable of being operational within a few hours after notification by the police or any other security representative. Such an organization exists in France ; it avails itself on the means of the French Atomic Energy Commission and of the Civil Security Department of the Ministry of Interior. Tasks assigned to these squads include : delimitation of contaminated areas, localization of radiation sources, control of access, decontamination, and evacuation of damaged packages and radioactive waste. Packagings in sufficient number and quality must be available for this purpose : they can be specialized packagings such as ones designed to receive damaged UF_6 cylinders or, on the contrary, multipurpose packagings.

The incidents recorded in this category have not been of such a nature as to throw doubt upon the adequacy of the regulations, except for the particular case of the subsidiary risk presented by uranium hexafluoride, which requires additional guidance.

In the second category of situations, involving strong packages, the probability of experiencing a failure of the package is quite low provided packages are properly maintained in conformity with the approved design (see event No. 5, for example). As in the examples described above (events No. 4 and No. 6), in most cases, the main problem after an accident will be to recover damaged but safe packages (air transportation accidents constitute, at the present time, a particular case in this regard ; this case is addressed in another paper to be presented in this meeting[4]). As explained in previous section, sufficient efforts must be made to ensure the adequacy and the availability of equipment to be used for the recovery of heavy packages in various environments. The responsibility for the recovery operations should be left to the consignor except in the unlikely case where a significant radioactive hazard would be present. The role of emergency squads in accidents involving type B and/or fissile packages is to verify the absence of radioactive hazard.

The incidents recorded in this category have not revealed a need for a revision of the regulations.

REFERENCES

1. Ringot, C., Devillers, C., Warniez, P. L'accident du Mont Louis et la sécurité nucléaire (IAEA-SM-286/182), Packaging and Transportation of Radioactive Materials (PATRAM' 86)

2. Technical Committee on Guidance for the Safe Transport of Uranium Hexafluoride (TC-587.2), Seventh Meeting of the Standing Advisory Group on the Safe Transport of Radioactive Material, Working Paper N°4, Vienna 10-14 April 1989

3. Explanatory Material for the AIEA Regulations for the Safe Transport of Radioactive Material (1985 Edition), Second Edition, IAEA Safety Guides, Safety Series No. 7, (1987)

4. Devillers, C., Ringot, C., Tomachewsky, E.G., Hubert, P., and Pagès, P., A Regulatory Approach to the Safe Transport of Plutonium by Air, PATRAM' 89.