Radiological Consequences Resulting from Accidents and Incidents Involving the Transport of Radioactive Materials in the UK – 2010 Review

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ABSTRACT

This report includes descriptions of thirty accidents and incidents involving the transport of radioactive materials from, to, or within the United Kingdom, which occurred in 2010. The number of events in 2010 was slightly less than reported in 2009 (33 events), and within the range of events that have occurred in the last five year period: 33 events in 2009, 39 events in 2008, 26 events in 2007, 29 events in 2006 and 16 events in 2005. Of the 30 events included in this review 8 involved irradiated nuclear fuel flasks (there were also 8 such events in 2009). In 2010 there were 4 events involving the discovery of radioactive material in shipments containing material which was thought to be non-radioactive. None of the events reported resulted in any significant radiation doses to workers or members of the public.

The details of these events have been entered into the RAdioactive Material Transport Event Database (RAMTED), which now contains information on 980 events that are known to have occurred since 1958. This includes an event which occurred in 2009, which was not previously reported.

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The following amendments have been made to this report since its first publication (August 2011)

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In section 4 page 9, text for event 2010012 is replaced by new text as this event is still under investigation. The text in section 5, 6 and Table 6 has been changed to reflect this.

EXECUTIVE SUMMARY

Up to half a million packages containing radioactive materials are transported to, from and within the United Kingdom every year. Accidents and incidents involving these shipments are rare. However, there is always the potential that such an event could lead to the release of the contents of a package or an increase in radiation level caused by damaged shielding and result in radiological consequences for transport workers. Such events could also lead to radiological consequences for the public. The UK Department for Transport (DfT) has supported work to compile, analyse and report accidents and incidents that occurred during the transport of radioactive materials. Annual reports have been produced since 1989 and this report for the year 2010 is the latest in the series. The details of these events are recorded in the RAdioactive Materials Transport Event Database (RAMTED), which is maintained by the Centre for Radiation, Chemical and Environmental Hazards of the Health Protection Agency (HPA-CRCE) on behalf of DfT. The database now contains information on 980 events that are known to have occurred since 1958.

This report includes descriptions of 30 accidents and incidents involving the transport of radioactive materials from, to, or within the United Kingdom, which occurred in 2010. The number of events in 2010 was slightly less than reported in 2009 (33 events), and within the range of events that have occurred in the last five year period: 33 events in 2009, 39 events in 2008, 26 events in 2007, 29 events in 2006 and 16 events in 2005. Of the 30 events included in this review 8 involved irradiated nuclear fuel flasks (there were 8 such events in 2009). In 2010 there were 4 events involving the discovery of radioactive material in shipments containing material that was thought to be non-radioactive. None of the events reported resulted in any significant radiation doses to workers or members of the public.

Almost all the events were of a similar type to those occurring in recent years. The 8 events involving irradiated fuel flasks were mainly due to minor errors in the preparation of the flask preparation or test procedure. Only one of these events involved the discovery of parts that were defective. These were relatively minor in terms of the overall safety of the flasks. However, it is essential that these flasks are maintained and operated to the highest quality standards.

CONTENTS

1 INTRODUCTION

Reviews of the accidents and incidents involving the transport of radioactive materials to, from and within the UK have been carried out for the years 1958 to 2008 (Gelder et al, 1986; Shaw et al, 1989; Hughes and Shaw, 1990-1999, 1996b; Hughes et al, 2001a, 2001b, 2006; Warner Jones et al, 2002a, 2002b; Warner Jones and Jones, 2004; Watson and Jones, 2004; Roberts et al, 2005; Hesketh et al, 2006; Hughes and Harvey, 2007; Harvey and Hughes, 2008, Harvey, 2009, Harvey, 2010). The objectives of those reviews were:

- to assess the radiological impact of such accidents and incidents on both workers and members of the public over the period of study;
- to comment on transport practices;
- to provide information pertinent to future legislation and codes of practice;
- to produce and maintain a database of events covering the period of study.

The initial reviews (Gelder et al, 1986; Shaw et al, 1989) were supplemented by annual analyses (Hughes and Shaw, 1990-1999; Hughes et al, 2001a, 2001b; Warner Jones et al, 2002a; Warner Jones and Jones, 2004; Watson and Jones, 2004; Roberts et al, 2005; Hesketh et al, 2006; Hughes and Harvey, 2007, Harvey and Hughes, 2008, Harvey, 2009, Harvey, 2010). A comprehensive review was carried out of events that occurred in the whole period from 1958 to 1994 using an improved event classification system (Hughes and Shaw, 1996b), which has been updated to include events up to and including 2004 (Hughes et al, 2006). The improved classification system was used to provide a summary and analysis of all events to 2000 that was presented at the Sixth International Conference on Radioactive Materials Transport (Warner Jones et al, 2002b).

Throughout this review accidents and incidents are collectively referred to as events. The information on these events is stored in the RAdioactive Materials Transport Event Database (RAMTED). In 2004, the database was reviewed and revised as the original version was approximately twenty years old and had many limitations compared to typical software and hardware specifications of today (Watson, 2004). The relational format of the current version of the database allows for more efficient recording of the details of an event. The classification systems were reviewed and, though only minor changes were made to the classifications, the change in the database structure now allows for an event to be more efficiently classified with a main category and subsidiary categories if appropriate.

This report describes the events reported during 2010 and analyses these events based on the revised classification system and the main event categories.

The Glossary (see Section 8) contains descriptions and definitions of a number of technical terms that are associated with the transport of radioactive materials.

2 DATA COLLECTION AND ANALYSIS

For this review, information on accidents and incidents has been mostly obtained from official files at the Department for Transport (DfT) (www.dft.gov.uk). Information was also obtained from other sources, such as the Civil Aviation Authority (CAA) (www.caa.co.uk), the Department of the Environment, Northern Ireland (www.doeni.gov.uk), the Scottish Environmental Protection Agency (SEPA) (www.sepa.org.uk) and from independent Radiation Protection Advisers (RPAs). Other sources of information for these annual reviews include events occasionally reported to the Environment Agency (EA), records of incidents reported under the National Arrangements for Incidents involving Radioactivity (NAIR) and incidents dealt with under RADSAFE. Under the NAIR scheme, the police attending an incident involving radioactive material can summon assistance from a health physics expert in the region. Only occasionally do these NAIR events directly involve the transport of radioactive materials. RADSAFE is a consortium of organisations that offer mutual assistance in the event of a transport accident involving radioactive materials belonging to a RADSAFE member and provides early advice and support to the emergency services.

2.1 Reporting of events and criteria

The transport of radioactive materials involves a number of activities, such as the preparation of the package by the consignor, its loading onto a vehicle, and finally its shipment carried out by carriers using various modes of transport. The shipment phase may involve a number of loading and unloading operations between different modes of transport before final delivery of the package to the consignee. The reported accidents and incidents included in these reviews come within the scope of these activities, for shipments and transhipments within the United Kingdom. Events involving shipments from the United Kingdom are also included if the event was as a result of a failing in the United Kingdom. However, events occurring on site, i.e. within the premises of consignors and consignees, are not included unless they are relevant to transport in public areas or if they originated from an incident that occurred during transit.

The normal transport of radioactive materials may give rise to small radiation doses to transport workers and in some circumstances members of the public might also receive very low doses. Conditions of transport that are intended to minimise these exposures are given in current national legislation and international agreements, which cover transport by road (UK Parliament, 2009; UNECE, 2007), rail (UK Parliament, 2009; OTIF, 2007), sea (UK Parliament, 1997a; MCA, 2006; IMO, 2006) and air (UK Parliament, 1994, 2007; ICAO, 2006). These conditions include, for example, the specification of segregation distances for packages during stowage. It may be noted that the most significant accidents and incidents that are included in this and previous reviews are those that give rise to increased radiation exposures during transport. In addition, events are included that had the potential for increased radiation exposures. Some events in this group may seem trivial, such as those involving administrative errors; however, experience has shown that in some circumstances such errors can have serious consequences. In practice, all but those reported events that are deemed to be trivial by the Department for Transport, are included in this review.

For transport by road in the United Kingdom, there are two sets of regulations, one for Great Britain (UK Parliament, 2009) and one for Northern Ireland (UK Parliament, 1997b).

For transport by road in Great Britain, the regulations (UK Parliament, 2009) require the driver of a vehicle transporting radioactive material to report a notifiable event to the police, fire brigade and consignor. A notifiable event (UK Parliament, 2009) means:

(i) a radiological emergency;

(ii) the theft or loss of the radioactive material being carried; or

(iii) an occurrence subject to report as construed in accordance with sub-section 1.8.5.3 (of reference UNECE, 2007). That sub-section includes the release of contents, or risk of loss of contents, environmental damage or personal injury.

Similar criteria are given for Northern Ireland.

Following this, the carrier must report the event to the police and if the driver has not already done so, the consignor and the Secretary of State for Transport. The notification of the latter is fulfilled by informing the Competent Authority that is the Dangerous Goods Division of DfT.

In practice, many other less serious events are reported voluntarily by consignors, carriers and consignees. Other types of events that are relevant to the transport of radioactive materials may also be reported by others, such as the police, suppliers and manufacturers. There have also been a few instances where members of the public have found lost packages and informed the emergency services.

Events involving undeclared radioactive material discovered in packages, or cargoes of scrap metal are included when they have involved illegal or unauthorised transport after the radioactive material has been discovered or where there is evidence that the radioactive material had been deliberately transported. For the purpose of this review, which is concerned with contraventions of the regulations in addition to incidents and accidents, similar considerations are applied to radioactive material discovered at ports and airports by installed radiation detectors. Where such intercepted material was known to be radioactive but was not being transported in accordance with the regulations, this is always recorded as an event.

Incidents involving the transport of dangerous goods by rail are subject to standard reporting procedures. This system can result in quite minor events being reported very efficiently. Each year during the transport of irradiated nuclear fuel (INF) flasks there are a number of incidents where the train has been stopped following the detection of overheated axles or brakes. The detectors activate at temperature levels that do not pose a threat to the integrity of the INF flask. However, on occasions the overheating can result in smoke production and fires in the axle or brake areas. The criterion for including such events in these reviews is whether smoke is apparent.

INF flasks are mainly loaded and unloaded underwater in ponds at nuclear power stations and reprocessing plants. The water in these ponds tends to be contaminated with radioactive material and this contamination may become attached to the flask surfaces. Before transport, the flasks are thoroughly cleaned and monitored. The level of non-fixed contamination by radionuclide must be below the regulatory limit of 4 Bq cm^{-2} for beta emitters and low toxicity alpha emitters and 0.4 Bq cm^{-2} for all other alpha emitters. In the past, operational quantities related to these values, termed derived working levels (DWL), were used. Events involving excess levels of contamination on INF flasks were included in previous reviews if at any point on the surface the level was 10 DWL or above.

As discussed in Harvey, 2009, changes in industry protocols mean that flask contamination is now reported directly in terms of its value in Bq cm^{-2} rather than DWL. Similar pessimistic assumptions are made when calculating the contamination in Bq cm^{-2} as were used in deriving DWL. Therefore, when contamination is reported post-shipment as being just over 4 Bq cm^{-2} the flask is unlikely to have actually been transported with contamination above the regulatory limit. A criterion of 20 Bq cm^{-2} (2 Bq cm^{-2} for alpha) has been applied to the calculated contamination level to separate those events where the regulatory limit is likely to have been exceeded (DfT, 2009).

Similarly to previous reviews this report does not include any events that may still be subject to legal proceedings at the time of publication. Any such events will be reported in later annual reviews.

A system known as the International Nuclear Event Scale (INES) (IAEA and NEA, 2001) has been established for rating events that occur in the nuclear industry, by the International Atomic Energy Agency (IAEA) and the Nuclear Energy Agency (NEA) of the Organisation for Economic Co-operation and Development (OECD). This system enables a rating, from Level 0 to Level 7, to be applied to an event to give a prompt and consistent indication of the severity of the event to the media and members of the public. Level 7 refers to the most severe type of accident and Level 0 refers to an event with no safety consequences. The INES scale has been extended to cover other events, including events involving the transport of radioactive materials. Significant events are reported to the IAEA from where the details are distributed and made publicly available. The United Kingdom, in common with most other countries, only reports events that are rated at Level 2 or above.

3 DATABASE OF REPORTED EVENTS

As mentioned in Section 1, details of the reported events have been entered into the RAdioactive Materials Transport Event Database (RAMTED). A comprehensive review of the events in the database was undertaken a few years ago (Hughes et al, 2006) and includes a description of the systems of reporting and scope of the types of events recorded in the database. Some of the information in the database is held in coded form to facilitate analysis. Descriptions of the information stored, including the coding system used to classify events, are given in Appendix A.

The database contained information on 949 events up to and including the events in 2009. The earliest reported events are from 1958. During the collection of information for this current review, details were obtained for 30 events in 2010 and for an additional event that occurred in 2009, which brings the total number in the database to 980. The collection of information for this review did not reveal any further events from previous years that were not in the database.

Table1 provides a summary of the main category code for the 30 events reported in 2010 and the additional event for 2009. The essential details of each event are briefly described in Section 4. Brief descriptions of these events are included in the database record of each event. Other details that are entered in the database record for each event are listed in Appendix A, including a broad description of the event as either an accident or incident that occurred during either the transport or handling phase (TI, TA, HI and HA). In addition, events where the main occurrence was radioactive contamination of external surfaces of intact packages, or conveyances, are recorded as category C.

In order to give a better description of the type of event, a classification system has been developed for the RAMTED database that gives more information than the broad descriptive categories noted above. This system enables events to be grouped into logical categories and facilitates analyses. The first four columns of Table 1 give, respectively, the event identifiers listed in Section 4, the material category code, the transport mode code and the package type. The definitions of the material category codes, the transport mode codes and the package type codes are given in Tables A3, A4 and A5 of Appendix A. The classification system covers a further three aspects: a descriptive classification, the effect of the event on the package and the level of radiological consequences. The descriptions of the codes used in this classification system are given in Tables A6, A7 and A8 of Appendix A. The classification codes are listed in the last three columns of Table1 for the 30 events reported in 2010.

The descriptive classification of the event, given in the fifth column of Table 1, specifies the nature of the event, following the descriptive structure set out in Table A6 in Appendix A. The first character of the code gives the general subject or area under which the event is categorised; that is, administrative (A), general shipment (S) or INF flask (F). Events involving INF flasks are separated from the other general shipments of radioactive materials for other nuclear, industrial and medical uses because of the special circumstances of INF flask movements. The identification of the second character of the code and following numbers are shown in the full coding system which is given in Table A6. The new database structure allows for events to be classified into a number of categories, as seen in Table 1, where some events have more than one entry in the fifth column. In these cases the event classifications are prioritised within the database and are listed in order of priority in Table 1.

The effect of the event on the package integrity, or the package deficiency, is allocated to 12 categories (D03 - D14), as set out in Table A7 in Appendix A. In addition category D01, ’No package’, applies to events in which the radioactive material is not within a package. Category D02 is for contaminated conveyances, with no package involvement.

The radiological consequence of an event is allocated into one of four categories, which are set out in Table A8 in Appendix A. The 'None' category ('N' in Table 1) applies to events where there are no dose rates or contamination above that expected from normal transport, or where there is no evidence that individuals have received any dose. Events in which people received a small excess dose, but not at a level thought to be worth a detailed assessment are categorised in the 'Extremely low, not assessed' band ('E' in Table 1). Such doses may be received when a worker repackages a poorly packaged item. Events in which workers are exposed to radiation for a significant period and an assessment is carried out of their likely dose fall into either the 'Assessed, lower category' ('L' in Table 1) or the 'Assessed, upper category' band, depending on whether their effective dose exceeded 1 mSv, or an extremity dose exceeded 50 mSv.

Table 1. Summary list of events included in the 2010 review

Event ID (Section 4)	Material category (Table A3)	Transport mode (Table A4)	Package type (Table A5)	Event classification (Table A6)	Effect on package (Table A7)	Radiological consequence (Table A8)
Events occurred in 2010						
2010001	10	2	NR	AG241	3	N
2010002	0	2	A	AG241	3	N
2010003	4	1	BM	FP181	6	N
2010004	6	3	BFP	SC411 AG231	5	N
2010005	0	0	UK	SP221	4	N
2010006	8	12	A	AG111 AC111 AG221	3	N
2010007	7	0	A E	AG211	3	N
2010008	4	1	BMF	FP161	6	N
2010009	7	5	UK	SC511	4	N
2010010	10	2	NR	AG241	3	N
2010011	0	2	A	AG111 SC411	3	N
2010012	6	0	NR	AG211 SP141	13	L
2010013	4	1	BM	FP181	3	N
2010014	0	0	E	SP141 SP181	13	E
2010015	5	4	BM	FP141	3	N
2010016	4	1	BM	FP181	3	N
2010017	5	1	BM	FP181	4	N
2010018	0	2	BM	FP321	6	N
2010019	7	2	AP	SC711 AG231	10	E
2010020	0	0	UK	AG211 AG241	4	E

Table 1. Summary list of events included in the 2010 review

Event ID (Section 4)	Material category (Table A3)	Transport mode (Table A4)	Package type (Table A5)	Event classification (Table A6)	Effect on package (Table A7)	Radiological consequence (Table A8)
2010021	0	5	UK	AG211	3	N
2010022	5	1	BM	FP181	4	N
2010023	8	0	A	AP121 SC311 SC411	4	N
2010024	0	2	E	AP111 SP111	6	N
2010025	3	7	AF	AG211	4	N
2010026	0	0	UK	SP241	5	E
2010027	7	7	UK	SC511	4	N
2010028	7	5	AP	SC511	4	N
2010029	7	0	A	AP211	3	N
2010030	7	0	E	AG411	3	N
Events occurred in previous years						
2009033	2	3	IP2	AG221	3	N

4 EVENTS RECORDED FOR THIS REVIEW

Brief descriptions of the events reported in 2010 are listed below. The package types used are listed in Appendix A.

4.1 Events for 2010

January

2010001. During a security screening at a UK airport a consignment was found to contain a large quantity of smoke detectors which should have been classified as ‘Radioactive Material’ and transported in an excepted package. The consignment was not marked or labelled as containing dangerous goods and was not accompanied by a dangerous good transport document. An investigation carried out by an overseas authority found that although the shipper had received a license to ship the smoke detectors, it was unaware that there were additional dangerous goods requirements that needed to be met. The overseas authority reminded the shipper of the requirements to declare dangerous goods appropriately.

February

2010002. A consignment delivered to the consignee for servicing and re-calibration was found to contain undeclared radioactive material, which was transported in a Type A package, special form. The consignment had not been marked or labelled and was not accompanied by a dangerous goods transport document. The consignment was found to be incorrectly declared when the copy import documents from the importer were requested. The consignment was transported back to its origin in full compliance with the dangerous goods requirements. The incident was referred to the authorities in the country from which the consignment was sent for investigation.

2010003. A fuel flask transported from a nuclear power station to a nuclear site was found to have a lid valve bolt missing on arrival. The nuclear site in receipt of the flask confirmed that the lid was closed.

March

2010004. On arrival at an overseas nuclear company, a shipment of vitrified high level waste canisters travelling from the UK was found to be out of position within the holding channels of the transport flask. The error was thought to be due to an anomaly in the flask loading operator instructions.

2010005. A number of undelivered packages were found in a warehouse owned by a company which had gone into insolvency. Fourteen of these packages contained radioactive material, including seventeen sources (sixteen unsealed and one sealed). The packages contained the addresses of the consignees. The incident was handled by the Environment Agency, which used the event as a NAIR training exercise. The 16 open sources were collected by the Radiation Protection Adviser (RPA) of a local hospital for safe disposal. The sealed source was collected by the original consignee of the packages.

2010006. A lorry delivering a package containing radioactive material (radiography equipment), which had arrived at an airport from overseas, did not have the appropriate placards on the vehicle and the driver had received no awareness training. The carrier had failed to identify the package as containing radioactivity, as the package documents did not identify the package as containing radioactive material. However the package which contained a sealed source of ^{192}Ir in special form with a TI of 0.1 and an activity of 0.001TBq, was correctly labelled as a Type A package.

2010007. The RADSAFE response scheme was activated when a shipment of radioactive material, packaged in four Type A and one excepted packages was transported without the correct paper work. The packages were held by the carrier and returned to the consignor.

2010008. A nuclear plant received a fuel flask from a nuclear power station, with a pin hole leak, relating to a weld defect and not the flask body. There was concern that the contaminated water from the power station cooling ponds, might leak into the void spaces of the flask. A leak test was performed on all weld areas before the flask was allowed to be moved. It was finally concluded that the leak site was a weld on a cavity cover plate. The whole fleet of this type of flasks was investigated by the nuclear company owning the flasks, at a number of nuclear sites. The company issued an operation experience note to all stations to raise awareness and offer staff training on weld defects. A similar problem had occurred with a flask in 2003, and the company should have prevented this from occurring again. The nuclear company also requested an approval for modification to the use of flasks with weld defects on cavity plates at loading sites.

2010009. A vehicle carrying a technetium generator with an activity of 3.8 GBq was involved in a road traffic accident. The vehicle was hit by another car, but the package was not damaged. The police were informed and a RADSAFE event was declared.

2010010. During a security screening at a UK airport, a consignment was found to contain 46 smoke detectors which should have been classified as ‘Radioactive Material’, and transported in an excepted package. The consignment was not marked or labelled as containing dangerous goods and was not accompanied by a dangerous goods transport document. A letter was sent to the shipper and no further action from the Civil Aviation Authority was required.

April

2010011. During an unannounced audit by a foreign authority abroad, a unit load device (ULD) carrying radioactive material in a Type A package was inspected. The ULD was not volumetrically full and the dangerous goods were not secured using ropes or lashing. As a result of this event, all personnel involved with the loading of dangerous goods at the station of origin attended a dangerous goods lashing refresher course. A newsletter was also sent throughout the operator’s network advising of the incident and reminding all staff of the requirement to secure shipments during loading.

2010012. Some bags of low level radioactive waste were consigned from a nuclear site for landfill disposal. It is suspected that the levels of radioactivity in the bags would have necessitated their transport as radioactive material, packaged in a suitable container. The bags were later recovered and returned to the consignor in compliance with regulatory requirements. The circumstances of this event are still under investigation.

2010013. A fuel flask outer lid seal was found to be dislocated from the seal groove on arrival at a nuclear site. The seal was found to be within tolerance but with a circumference of approximately half an inch less than a previous batch.

2010014. Two full height ISO containers containing radioactive material were consigned to a scrap metal recycling facility as excepted packages. On arrival one of the ISO containers was measured giving a contact dose rate of 15 $\mu Sv\ h^{-1}$, which is higher than the value allowed for an excepted package. Also an additional item had been added to the second ISO container, which had not been included on the loading plan. An investigation was carried out by the consignee, as to why the loading plan had not been amended to account for the additional item.

May

2010015. A fuel flask arrived at a nuclear power station from a nuclear plant with a screw tightened to the incorrect torque. The screw secures the locking arrangement assay to the water level valve.

2010016. When a fuel flask was returned to the fuel handling plant at a nuclear site from a nuclear power station, it was discovered that two small brass plugs were missing from the lid valve. These plugs have no safety significance relating to the integrity of the fuel flask and are only in place to prevent contamination. This incident is being investigated by the nuclear company.

2010017. On arrival at a nuclear power station an empty fuel flask was found to have a water level valve clamp fitted in the wrong orientation, 180° from the correct alignment. The functionality of the clamp however remained the same, although not within operating manual specification. This event was similar to the one that occurred in August (2010022).

June

2010018. On inspection of a fuel flask liquid residue stains were found to be protruding from a weld which retains the radioactive warning label plate. This is a similar event to the one that occurred in March (2010008)

July

2010019. A fire occurred in an airport warehouse containing radioactive material. The Environment Agency and Health Protection Agency were involved because there was no guarantee that all the packages containing radioactive material were in a fire-proof store as the packages may have been in the process of being loaded. Packages which may have been outside the fire-proof store included sources of ^{131}I (41 GBq), ^{99}Mo/^{99m}Tc (654 GBq) and ^{111}In (320 MBq). The water run off to a bund was monitored and small levels of ^{131}I were detected. The consignor should have notified the location of stored material prior to trans-shipment. This indicated that there was a gap in the consignor's procedures. The radioactive material that caught fire and the damaged packages were returned to the consignor.

2010020. NAIR was invoked regarding a package found in a factory unit. Workers had opened a standard steel workshop cabinet that had recently been delivered after being purchased at an auction. The cabinet had a trefoil reading 'Radioactive Material Store' 'on the outside and a lead pot was found in a tin. An inspection of the package showed that the lead pot was labelled as a ^{137}Cs source (activity of 40 MBq in 1999). There was no outer packaging and no markings on the tin or the pot to indicate the content was radioactive. The dose rates measured on the tin and the lead pot were <0.2 μSv h^{-1} and <0.5 μSv h^{-1} respectively. No loose contamination was detected on the package or individuals who had found the item. There was a possible breach of regulations as the cabinet had been delivered from the auctioneers to the successful bidders without appropriate documentation. The source was recovered by a local police station and stored in a source cabinet where it is awaiting information regarding safe disposal by the Environment Agency or the local nuclear power station.

August

2010021. An empty package was incorrectly being transported as an excepted package (UN 2908) in a van with incomplete documentation. The driver had been advised as to what should appear in the documents for an excepted package, but had not been advised that he had to update his documents. He then realised that the documents for the shipment he had just made was non-compliant. He was required to update the documentation for the package.

2010022. When a fuel flask arrived at a nuclear power station it was found that the water level valve clamp was fitted incorrectly at the wrong orientation (ie at 180 degrees and not 270 degrees). This event was similar to that which occurred in May (2010017).

2010023. Two Type A packages were incorrectly consigned when they arrived at an airport from a company in the UK to be transported as air freight. The packages contained an Am-Be and a ^{137}Cs source, both in special form, for well-logging. The Type A boxes had no external locks or seals and were not secured within the overpacks and therefore were free to move. The overpack did not have a label and the TI was recorded at 0.1 but measured to be 0.4. The inadequacies were discovered by the RPA for Hazmat at the airport.

2010024. During security screening, at an airport in the UK, a jiffy bag containing radioactive material in an excepted package was found to be open upon arrival. The excepted package label was not the size specified by the IATA requirements and the bag had only been held closed with staples. The package was safely removed with no risk to staff or passengers. The operator investigated and established that the consignor was at fault. As the inner packages were not damaged, the consignment was re-packaged and forwarded to the consignee.

September

2010025. A nuclear fuel manufacturing company in the UK sent four boxes containing nuclear fuel to a nuclear power station. On arrival, staff at the nuclear power station discovered that two of the boxes were supposed to be transported at the beginning of October, while the two boxes which should have been sent in September remained at the consignor. All boxes were correctly labelled, but the consignor's certificate did not identify the serial numbers of the two packages correctly, indicating the amount of burnable poison in the fuel elements. This was a human error and the document did not match the fuel boxes which were consigned.

2010026. A radioactive source in a marked canister was discovered in the boot of a second hand car in a showroom, where it had been incorrectly disposed of. The NAIR respondent from a nearby nuclear power station was called. It was confirmed that the source contained 740 GBq of ^{137}Cs in a lead pot. The surface dose rate was measured at 1 μSv h^{-1}. The canister was double bagged and sealed and shipped to the local nuclear power station, in an excepted package, where it was stored awaiting onward disposal. A Radiation Protection company sealed the container in a Type A package to be transported for disposal.

October

No events.

November

2010027. A vehicle carrying low level radioactive generators was hit from behind by another vehicle at a roundabout. This was a very minor collision resulting in no injuries and no damage caused.

2010028. A van transporting a troxler nuclear density gauge was involved in a road traffic accident. The vehicle was damaged, but there was no damage to the troxler gauge. This was confirmed by checking that the dose rates were the same before and after the accident.

December

2010029. An audit for a borehole logging company found a number of non-compliances which resulted in a prohibition notice from DfT. The audit found an unidentified source container that had been used as a Type A container on a number of occasions. Since the container was not labelled the transport personnel were not aware of its radioactive contents. The borehole logging company corrected the problem and produced photographic evidence that they had correctly labelled the container so that it could be recognised as a Type A container, transporting radioactive material.

2010030. During a compliance inspection of a borehole logging company, it was found that twelve ^{241}Am sources were being transported in excepted packages instead of being transported in Type A packages as expected. On inspection it was found that the sources satisfied the excepted package criteria of a surface dose rate of less than 5 μSv h^{-1}. The source certificates confirmed that they were within the activities required by an excepted package (10^{-2} A_1 and 10^{-2} A_2).

4.2 Events for previous years

An event was reported to the Department for Transport in March 2009, but was still ongoing when the review for events occurred in 2009 was compiled (Harvey, 2010). This event has been included in the summary table for the current review (Table 1) and has been added to the RAMTED database but has not been considered in the discussion of events given in Section 5 or included in any of Tables 2 to 6 of this reports, as Section 5 and Tables 2 to 6 only refer to events which occurred in 2010. A brief description of the event is given below. It should be noted that there were no safety implications.

March 2009

2009033. An overseas company had made several shipments of nuclear fuel feedstock to another country calling into a UK port en-route. The packages containing the radioactive material remained on board the ship. The package design used for these shipments requires UK Competent Authority approval given on a shipment by shipment basis. A fault with the vessel caused the consignee to contact the DfT for permission to offload the packages in the UK as this was not allowed in the approval. It was then discovered that the approval document for that shipment had been forged. The shipment was impounded until DfT inspectors confirmed that it complied with the UK regulations; approval was then granted for transport to the intended consignee. Further investigation revealed that two other shipments had taken place with suspect UK approvals. The authorities in the consigning country investigated the incident and issued sanctions against the consignor and the individual involved. There was nothing that would have prevented the required UK approval being issued so the event had no safety implications.

5 DISCUSSION OF 2010 EVENTS

5.1 General

There were 30 events reported during 2010, including one event that is still under investigation at the time of publication.

The numbers of events in each of the descriptive classifications that occurred in 2010 are given in Table 2. Using primary classification in the three broad categories, 14 (46%) were administrative events, 8 (27%) general shipment events and 8 (27%) INF flask shipment events. The numbers of events in these three categories in the period 1958 to 2004, expressed as a percentage of the total, were 16%, 61% and 23%, respectively (Hughes et al, 2006). Nine events were given more than one event classification. Considering the primary event classifications only, the most numerous type of event involved 14 instances of administrative errors, ranging from insufficient worker training to incorrect shipment documents, four incidents occurred where the shipment was undeclared as being radioactive and one was a false alarm. In three other incidents the packages were incorrectly labelled. Of the eight non-INF shipment incidents, three were due to minor traffic collisions that did not involve fire and where the packages were undamaged; the remainder were single events involving insufficient tie-downs of package contents, a fire without any packages involved, an incorrect package type, packages sent to the incorrect destination and inappropriate disposal of low-level radioactive waste. Of the eight incidents involving INF flask shipments, the majority were due to minor flask preparation errors; the remainder were single incidents involving a defective water level valve, faulty test procedures and a flask found to be insufficiently decontaminated.

The number of events in 2010 was slightly less than in 2009. In the last five years, 33 events were reported in 2009, 39 events in 2008, 26 events in 2007, 29 events in 2006 and 16 events in 2005. The average annual number of recorded events during the period 1958 to 2004 was approximately 17 (Hughes et al, 2006), although in the first decade of that period events were probably under-reported. Over the past 20 years the annual number of events has fluctuated between 11 and 44 with an average of 26 events. The number of events in 2010 was therefore slightly higher than this long-term average, maybe as a result of the increased number of administrative errors and also the events involving INF flasks, also identified as being important in 2009 and 2008.

Table 3 shows an analysis of the events by material category. During 2010, there were 9 events (30%) involving transport of material which was in an undefined category. Of the remaining events, the largest group (7 events) involved the transport of medical and industrial radioisotopes. The percentage of events (23%) involving medical and industrial isotopes was lower than the annual average (47%) for events in the period 1958 to 2004 (Hughes et al, 2006). Eight events involved transport of INF flasks; four involved faulty flasks; one involved new fuel and three contained fuel residues. Two further events involved radiography sources and two involved consumer products.

Table 4 gives an analysis of the events by mode of transport: 6 events involved shipments by rail (20%), 7 by air (24%), 1 by sea (3%), 6 by road (20%), 1 by road and air (3%) and for 9 (30%) the model of transport was unknown. The proportion of sea events (3%) was lower than the long-term annual average (7%). For rail, the proportion of events in 2010 (20%) is lower than the long-term annual average (24%). The number of road and rail events in 2010 (12) is higher than the average annual number (approximately 10) during the period 1958 to 2004 (Hughes et al, 2006). The proportion of air events in 2010 (24%) is higher than the long-term annual average (13%).

Table 2. Numbers of 2010 events in each classification

Event classification	Event classification code (see Table A6)	First classification	Second classification	Third classification
Administrative	AC111	0	1	0
	AG111	2	0	0
	AG211	5	0	0
	AG221	0	0	1
	AG231	0	2	0
	AG241	3	1	0
	AG411	1	0	0
	AP111	1	0	0
	AP121	1	0	0
	AP211	1	0	0
Total		14	4	1
General (non-INF) Shipments	SC311	0	1	0
	SC411	1	1	1
	SC511	3	0	0
	SC711	1	0	0
	SP111	0	1	0
	SP141	1	1	0
	SP181	0	1	0
	SP221	1	0	0
	SP241	1	0	0
Total		8	5	1
INF Flask shipments	FP141	1	0	0
	FP161	1	0	0
	FP181	5	0	0
	FP321	1	0	0
Total		8	0	0

Table 3. Classification* of 2010 events by material category

Material		Administrative			General (non-INF) Shipments		INF Flask shipments			Percentage	
Code	Category	General	Conveyance	Package	Conveyance	Package	Conveyance	Package	Total	2010†	1958-2004
M00	Unknown	4	0	1	0	3	0	1	9	30	N/A‡
M01	Uranium ore concentrate	0	0	0	0	0	0	0	0	0	4
M02	Pre-fuel material	0	0	0	0	0	0	0	0	0	3
M03	New fuel	1	0	0	0	0	0	0	1	3	<1
M04	Irradiated fuel	0	0	0	0	0	0	4	4	13	13
M05	Residues	0	0	0	0	0	0	3	3	10	14
M06	Radioactive wastes	1	0	0	1	0	0	0	2	7	8
M07	Medical & industrial radioisotopes	2	0	1	4	0	0	0	7	23	47
M08	Radiography sources	1	0	1	0	0	0	0	2	7	10
M09	No radioactive material	0	0	0	0	0	0	0	0	0	<1
M10	Consumer products	2	0	0	0	0	0	0	2	7	1
M11	Other	0	0	0	0	0	0	0	0	0	<1
Total		11	0	3	5	3	0	8	30	100	100

Notes

*: First classifications only (see Table A6 for descriptions of event classifications).

†: With a sample size of 30 events, interpretation of these rounded percentages must be made with care. The total of 100% is of the unrounded values.

‡: This material category is a new addition to the database; no comparison can be made with previous data.

Table 4. Classification* of 2010 events by mode of transport

Mode of transport		Administrative			General (non-INF) Shipments		INF Flask shipments			Percentage	
Code	Category	General	Conveyance	Package	Conveyance	Package	Conveyance	Package	Total	2010†	1958-2004
V00	Unknown	4	0	2	0	3	0	0	9	30	N/A‡
V01	Rail	0	0	0	0	0	0	6	6	20	24
V02	Air	4	0	1	1	0	0	1	7	24	13
V03	Sea	0	0	0	1	0	0	0	1	3	7
V04	Road > 1.5 t (lorry)	0	0	0	0	0	0	1	1	3	15
V05	Road < 1.5 t (van)	1	0	0	2	0	0	0	3	10	13
V06	Road Car	0	0	0	0	0	0	0	0	0	3
V07	Road Unknown	1	0	0	1	0	0	0	2	7	<1
V08	Fork-lift truck	0	0	0	0	0	0	0	0	0	22
V09	Other	0	0	0	0	0	0	0	0	0	<1
V10	Road and sea	0	0	0	0	0	0	0	0	0	<1
V11	Road and rail	0	0	0	0	0	0	0	0	0	<1
V12	Road and air	1	0	0	0	0	0	0	1	3	<1
Total		11	0	3	5	3	0	8	30	100	100

Notes

*: First classifications only (see Table A6 for a description of event classifications).

†: With a sample size of 30 events, interpretation of these rounded percentages must be made with care. The total of 100% is of the unrounded values.

‡: This material category is a new addition to the database; no comparison can be made with previous data.

5.2 Effects on packages

Table 5 shows an analysis of the events in terms of the package condition. A list of types of packages considered in the database is given in Table A5; definitions of the codes used to identify package conditions are given in Table A7 of Appendix A. In 13 of the 30 events there was no damage or threat of damage to the packages involved. For 9 events there was no report of damage to the package or increase in dose rate, but there was a minor potential to cause damage. For 2 events there was no report of damage to the package or increase in dose rate, but there was a high potential to cause damage. For four events there was defective or poor condition of the package, but without increase in dose rate or loss of containment. One event involved a damaged package resulting in loss of containment; and two events involved improper packaging with no shielding or containment. One event involved two package types, hence the number of packages were 31 for 30 events.

Table 5. Nature of package deficiency by type of package

Package deficiency or damage		Type of package (as specified or assumed)							
Code	Description	Excepted	A	BU	BM	BMF	IP2	Others	Total
D03	No damage or threat of damage to package	2	5	0	3	0	0	3	13
D04	No report of damage or increase in dose rate, but potential to cause damage to the package (lower category)	0	1	0	2	0	0	6	9
D05	No report of damage or increase in dose rate, but potential to cause damage to the package (upper category).	0	0	0	0	0	0	2	2
D06	Defective or poor condition, without increase in dose rate or loss of containment	1	0	0	2	1	0	0	4
D10	Damage with loss of containment	0	0	0	0	0	0	1	1
D13	Improper package with loss of shielding or containment – inappropriate contents	1	0	0	0	0	0	1	2
Total		4	6	0	7	1	0	13	31

5.3 Radiological consequences

Table 6 shows the likely radiological consequences for the events in 2010, analysed by material category. Table A8 in Appendix A provides a description of the categories for radiological consequences. Of the 30 events, 25 were categorised as ‘None’, indicating no radiological consequences for those events and 5 were categorised as ‘Extremely low, not assessed’. Within this latter category, three involved unknown material, one radioactive waste and one involved a medical or industrial radioisotope.

There were no events categorised as ‘Assessed, lower category’ involving effective doses below 1 mSv and there was none in the ‘Assessed, upper category’ involving effective doses above 1 mSv or extremity doses over 50 mSv.

Table 6. Radiological consequences by material category

Material		Radiological consequences				
Code	Category	None	Not assessed, extremely low	Assessed, lower category (< 1mSv)	Assessed, upper category (> 1mSv)	Total
M00	Unknown	6	3	0	0	9
M03	New fuel	1	0	0	0	1
M04	Irradiated fuel	4	0	0	0	4
M05	Residues (inc. discharged INF flasks)	3	0	0	0	3
M06	Radioactive wastes	1	1	0	0	2
M07	Medical and industrial radioisotopes	6	1	0	0	7
M08	Radiography sources	2	0	0	0	2
M10	Consumer products	2	0	0	0	2
Total		25	5	0	0	30

6 CONCLUSIONS

During 2010 there were 30 accidents and incidents, involving the transport of radioactive materials from, to, or within the United Kingdom and this report includes descriptions of each event. The number of events in 2010 was slightly less than reported in 2009 (33 events), and within the range of events that have occurred in the last five year period: 33 events in 2009, 39 events in 2008, 26 events in 2007, 29 events in 2006 and 16 events in 2005. The number of events in 2010 was slightly higher than the annual average over the past 20 years (26 events). This variation can be attributed to statistical fluctuation and is not indicative of any long-term trend. The events reported for 2010 are in general similar to those reported in recent years.

None of the events that occurred in 2010 resulted in any significant radiation doses to workers or members of the public. There were five events where it was reported that there was some increased exposure above that associated with routine transport but were considered too low to be assessed. One of these events involved an ISO container, another concerned packages held at a warehouse in which there was a fire, one involved transport of radioactive waste in the incorrect container and the remaining two involved sources found, in a cabinet purchased at auction and in the boot of a second hand car.

This report also provides details of an event reported to the Department for Transport in 2009, which was not included in the review for 2009 (Harvey, 2010). This event resulted in no radiological consequences to workers or members of the public.

The details of the 30 events occurred in 2010 and of the additional event occurred in 2009 described in this review have been added to the RAdioactive Materials Transport Event Database (RAMTED), bringing the total number of reported events since 1958 to 980.

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8 GLOSSARY

Term	Description
Absorbed Dose	Measured in Grays (Gy), it is the amount of energy absorbed per kilogram of matter, for example tissue, as a result of exposure to ionising radiation.
Activity	The number of radioactive decays per unit time in a given material. Normally measured in disintegrations per second (Bq).
AGR	Advanced Gas-cooled Reactor. Used in the UK's second generation of gas-cooled nuclear power stations.
Alpha emitter	A radionuclide that decays emitting an alpha particle.
Alpha particle	A particle emitted by a radionuclide consisting of two protons and two neutrons (i.e. the nucleus of a helium atom).
Beta emitter	A radionuclide that decays emitting a beta particle.
Beta particle	An electron or positron emitted by a radionuclide.
Category	Packages other than excepted packages and overpacks must be assigned to either category I-White, II-Yellow or III-Yellow, depending on the maximum dose rate at the surface and at 1 m from the surface and must be labelled accordingly.
Committed Effective Dose	A measure of the total lifetime radiation exposure of an individual from intakes of radioactive material. The effective dose received across the life-time of an individual (taken up to the age of 70 for members of the public), from an ingestion or inhalation of radionuclides.
Effective Dose	Measured in Sieverts (Sv), it is a measure of the overall exposure of an individual from ionising radiation. It is dependent on the absorbed dose, type of radiation and regions of the body affected. Since the Sievert is a large unit, doses are more commonly expressed in millisieverts (mSv) or microsieverts (µSv).
Effective dose rate (or Dose rate)	The rate at which effective dose from external radiation is received, measured in units of $Sv\ h^{-1}$, or $mSv\ h^{-1}$.
Flatrol	A type of rail wagon used to carry INF flasks.
Irradiated Nuclear Fuel (INF) Flask	A Type B package used to transport irradiated nuclear fuel (see packages).
Ionising Radiation	Radiation capable of breaking chemical bonds, causing ionisation and damage to biological tissue.
Label	Apart from excepted packages all packages must be labelled with a diamond shaped warning label which gives information on the contents of the package.
Low toxicity alpha emitters	Natural uranium, depleted uranium, natural thorium, ^{235}U, ^{238}U, ^{232}Th, ^{228}Th and ^{230}Th when contained in ores or physical and chemical concentrates; or alpha emitters with a half-life of less than 10 days.
Magnox	The first generation of the UK's gas-cooled nuclear power stations.
NAIR (National Arrangements for Incidents involving Radioactivity)	A scheme designed to provide assistance to the police when dealing with an incident which involves, or is suspected to involve, radioactive material.
NORM	Naturally Occurring Radioactive Material.
Nuclide	A species of atom characterised by a nucleus with a specific number of protons and neutrons.
Overpack	An enclosure such as a box or bag which is used by a consignor to transport a number of packages as a single unit.

Term	Description
Package	There are five main types of packages used to carry radioactive material: • Industrial Packages are industrial containers, such as drums, used to carry bulky low activity materials, or contaminated items. • Excepted packages are simple packages used to carry low activity materials and sources. They are mainly used to transport low activity diagnostic test materials to hospitals. • Type A packages are used to transport medium activity material such as medical or industrial isotopes. They must withstand normal conditions of transport including minor mishaps. • Type B packages are used to transport high activity sources and materials, such as Irradiated Nuclear Fuel (INF). They provide shielding from high radiation levels even under extreme circumstances. They must meet severe mechanical and thermal test requirements, which simulate accident conditions. • Type C packages are for the transport by air of greater quantities of radioactive material than is allowed to be transported by air in Type B packages. They must be designed to withstand very serious accidents such as aircraft crashes.
Radionuclide	A nuclide which spontaneously loses energy or disintegrates into another nuclide, resulting in the emission of ionising radiation.
RADSAFE	An emergency response plan operated by the main carriers of radioactive materials.
Special form radioactive material	An indispersible solid radioactive material or a sealed capsule containing radioactive material.
Transport Index (TI)	A number equal to the maximum dose rate, at 1 m from the surface of the package, overpack or freight container, measured in mSv h^{-1} multiplied by 100. This number is used to control radiation exposure from a group of packages during transport.

APPENDIX A Information System Used in the RAdioactive Materials Transport Event Database (RAMTED)

The details of each event are stored in a computer database by the use of descriptive text and alphanumeric coding systems that are described in Table A1 below.

Table A1. Information on transport events recorded in the RAMTED database

Information	Description
Event ID	The events are numbered using a 7 digit identifier with the format YYYYXXX, where YYYY is the year of the event and XXX is a sequential figure.
Date	The date is recorded in the format DD/MM/YYYY
Source	Information regarding events is obtained from the following sources: Civil Aviation Authority, Dangerous Goods Division of the Department for Transport, Health Protection Agency Radiation Protection Division, National Arrangements for Incidents involving Radioactivity, Environment Agency, Health & Safety Executive and others. The source of the information is given for each event, together with the event identifier used by the source organisation.
Type of event	This coding gives the broad type of event, classified as occurring either during the moving phase of transport operations or during handling before or after movement. Furthermore, events occurring during either the moving or handling phases are categorised either as accidents or as incidents. Alternatively, events may be classified as contamination events. More information on the types of event is given in Table A2
Regional location of event	The location at which the event occurred is given, if known, together with a code assigning the location to one of a number of defined geographical regions.
Mode of transport	A code is given to identify the mode of transport for each event. Codes and their definitions are given in Table A4.
Category of material	A code is given to identify the type of material for each event. Codes and their definitions are given in Table A3
Consignor	The name and address of the company/organisation that despatched the shipment is given for each event, if known.
Consignee	The name and address of the destination company/organisation is given for each event, if known.
Carrier	The name and address of the carrier (and sub-carrier, if appropriate) is given for each event, if known.
Description of event	A brief description of the event is given in words.
Activity release	The activity, in TBq, of any radioactive material released into the environment is given for each event.
Worker doses	The maximum dose received by workers from an event is given in mSv, if known.
Public doses	The maximum dose received by the public from an event is given in mSv, if known.
INES ratings	The INES rating assigned to each event is given, if known.
INES Conditions	The INES rating is partly dependent on whether certain conditions applied to the event. A record is made of whether these conditions did apply for the event, if known.
Event implications	Implications such as worker or public safety implications, or environmental implications are given, if known.
Nuclear industry and airport events	It is recorded for each event if the event involved the nuclear industry or damage to a package at an airport, if known.
Emergency action	It is recorded for each event if emergency action was taken, if known.
Additional information	Any additional information, including photos if appropriate, is recorded for each event.
Description of packages	A description of each package is given, if known.
Package type	For each package, a package type is given, using the codes given in Table A5.

Table A1. Information on transport events recorded in the RAMTED database

Information	Description
Transport Index	For each package the Transport Index (TI) is given, if known (see Glossary for a definition of Transport Index).
Radionuclides	The radionuclides contained in each package are listed by their chemical symbol and mass number, with a record of whether or not each nuclide is a sealed source or a fission product.
Activity	The activity of each radionuclide is given, in TBq, if known.

Table A2. Codes used to identify types of events in the RAMTED database

Code	Definition	Description
TA	Transport accidents	A transport accident is defined as any event during the carriage of a consignment of radioactive material that causes damage to the consignment or significant damage to the conveyance so that the conveyance could not continue its journey.
TI	Transport incidents	A transport incident is defined as any event, other than an accident, occurring before or during the carriage of a consignment of radioactive material which caused, or might have caused, damage to or loss of the consignment or unforeseen radiation exposure of workers or members of the public.
HA	Handling accidents	A handling accident is defined as an event during the loading, trans-shipping, storing or unloading of a consignment of radioactive material and which caused damage to the consignment, eg a package falling from a fork-lift truck and subsequently being run over or a package being dropped owing to crane failure during handling.
HI	Handling incidents	A handling incident is defined as an event, other than an accident, during the loading, trans-shipping, storing or unloading of a consignment of radioactive material which caused, or could have caused, damage to or loss of the consignment or unforeseen exposure of workers or members of the public.
C	Contamination	A contamination event is defined as an event where radioactive contamination is found on the surface of the package or conveyance in excess of the regulatory limit.

Table A3. Codes used to identify the type of material of an event in the RAMTED database

Code	Definition
M00	Unknown
M01	Uranium ore concentrate (UOC)
M02	Pre-fuel material
M03	New fuel
M04	Irradiated fuel
M05	Residues including discharged nuclear fuel flasks
M06	Radioactive wastes
M07	Medical and industrial radioisotopes
M08	Radiography sources
M09	No radioactive material
M10	Consumer products
M11	Other

Table A4. Codes used to identify modes of transport of an event in the RAMTED database

Code	Definition
V00	Unknown
V01	Rail
V02	Air
V03	Sea
V04	Road – lorry > 1.5 t
V05	Road – van < 1.5 t
V06	Road – car
V07	Road – unknown
V08	Fork-lift truck
V09	Other (including crane)
V10	Road and sea
V11	Road and rail
V12	Road and air

Table A5. Codes used to identify the type of package in an event in the RAMTED database

Code	Definition
Type A Package Codes	
A	Type A
AP	Presumed to be Type A
AF	Type A, with fissile material
AFP	Presumed to be Type A, with fissile material
Type B Package Codes	
B	Type B
BP	Presumed to be Type B
BF	Type B, with fissile material
BFP	Presumed to be Type B, with fissile material
BM	Type B(M)
BMP	Presumed to be Type B(M)
BMF	Type B(M), with fissile material
BMFP	Presumed to be Type B(M), with fissile material
BU	Type B(U)
BUP	Presumed to be Type B(U)
BUF	Type B(U), with fissile material
BUFP	Presumed to be Type B(U), with fissile material
Type C Package Codes	
C	Type C
CP	Presumed to be Type C
CF	Type C, with fissile material
CFP	Presumed to be Type C, with fissile material
Excepted Package Codes	
E	Excepted

Table A5. Codes used to identify the type of package in an event in the RAMTED database

Code	Definition
EP	Presumed to be Excepted
Exempt Package Codes	
X	Exempt
XP	Presumed to be Exempt
Industrial Package Codes	
IP	Industrial Package, any type
IPP	Presumed to be an Industrial Package, any type
IPF	Industrial Package, any type, with fissile material
IPFP	Presumed to be an Industrial Package, any type, with fissile material
IP1	Industrial Package, Type 1 (IP-1)
IP1P	Presumed to be an Industrial Package, Type 1
IP1F	Industrial Package, Type 1, with fissile material
IP1FP	Presumed to be an Industrial Package, Type I, with fissile material
IP2	Industrial Package, Type 2 (IP-2)
IP2P	Presumed to be an Industrial Package, Type 2
IP2F	Industrial Package, Type 2, with fissile material
IP2FP	Presumed to be an Industrial Package, Type 2, with fissile material
IP3	Industrial Package, Type 3 (IP-3)
IP3P	Presumed to be an Industrial Package, Type 3
IP3F	Industrial Package, Type 3, with fissile material
IP3FP	Presumed to be an Industrial Package, Type 3, with fissile material
Other Codes	
CV	Contaminated conveyance only
NIL	No radioactive material carried
NR	Packaged item, but not in recognised package type
SC	Item carried within load of scrap
UK	Unknown packaging status
UPX	Unpackaged item, which should be packaged
UPY	Unpackaged item, which is OK to be unpackaged

A1 EVENT CLASSIFICATION SYSTEM

The analysis of the database of events is facilitated by the use of classification systems that define the description of the event, the type of package damage or deficiency and the extent of any radiological consequence. These three classification systems are set out in Tables A6, A7 and A8. Each event is characterised by the allocation of the alphanumeric codes shown in Table A6 and each package is characterised for damage or deficiency by the codes shown in Table A7. The radiological consequences of each event are characterised by the allocation of the codes shown in Table A8.

Table A6. Classification of reported transport events

Area/Subject	Item	Sub-item		Description
A – Administrative (all packages)				
G – General	1 – Training	1	1	Insufficient worker training
	2 – Documents	1	1	Consignor's certificate incorrect or absent normally the "Dangerous goods transport document"
		2	1	Other shipment documents incorrect or absent, normally the "Instructions in Writing"
		3	1	Correct contents but wrongly described in documents
		4	1	Material undeclared as being radioactive
		5	1	Accounting error, ie apparent loss of package
	3 – Delivery	1	1	Administrative difficulty or error, returned to consignor or re-consigned
	4 – False alarm	1	1	Suspected incident but none found
C – Conveyance	1 – Placards	1	1	Correct vehicle placards not displayed
		1	2	Placards displayed but no sources carried
	2 – Excessive TI	1	1	Excessive TI on conveyance or in stowage hold
P – Package	1 – Labels	1	1	Insufficient or incorrect package labels
		1	2	Labels on empty package
		2	1	Incorrect TI on package label
		3	1	Incorrect radionuclide or activity on package label
	2 – Marking	1	1	Package type unmarked or wrongly marked
S – Shipments, general (not irradiated nuclear fuel flasks)				
C – Conveyance	1 – Load	1	1	Excessive load on conveyance
	2 – Mechanical	1	1	Faulty conveyance, or mechanical failure
	3 – Security	1	1	Locks or security devices: insecure, insufficient or defective
	4 – Tie-downs	1	1	Tie-downs or similar devices: insufficient or defective
	5 – Accidents	1	1	Collisions and other accidents, without fire
	6 – Accident/fire	1	1	Collisions and other accidents, with fire
	7 – Fire	1	1	Spontaneous fire on conveyance
	7 – Stowage	1	1	Inappropriate stowage conditions
P – Package	1 – Preparation	1	1	Poor standard of packaging or containment
		2	1	Incomplete package, insecure inner container
		3	1	Incomplete package, insufficient shielding
		4	1	Incorrect contents or package type
		5	1	Material in supposedly empty package
		6	1	Contamination inside package
		7	1	Contamination outside package
		8	1	Excessive dose rate
	2 – Loss/disposal	1	1	Stolen and recovered
		1	2	Stolen, not recovered
		2	1	Lost, found, temporary loss, wrong destination or wrong conveyance
		2	2	Lost, not recovered
		3	1	Lost at sea and recovered
		3	2	Lost at sea, not recovered
		4	1	Inappropriate disposal

Table A6. Classification of reported transport events

Area/Subject	Item	Sub-item		Description
		5	1	Radioactive material in scrap metal
P – Package	3 – Damage	1	1	Spontaneous mechanical failure of package, including leakage
		2	1	Deliberate damage or interference
		3	1	Damaged by falling from or within conveyance, or by falling object, or by external object
		4	1	Damaged during cargo handling
		5	1	Damaged due to broken or loose tie-downs
F – Irradiated nuclear fuel flasks				
C – Conveyance	1 – Flatrol/ HGV	1	1	Flatrol or HGV problem eg buffers, brakes, canopy not correct, including significant overheating of wheel or axle
	2 – Accident	1	1	Collision
		2	1	Derailment during low speed marshalling
		3	1	Inadvertent decoupling
		4	1	Fire on the conveyance
	3 – Contamination	1	1	Flatrol or HGV contaminated above regulatory limits.
		2	1	Fixed-contamination above 5 μSv h^{-1}
P – Package	1 – Preparation	1	1	Shock absorber damaged or unsatisfactory
		2	1	Tie-down bolts insufficient or defective
		3	1	Lid, defective or loose bolts
		3	2	Lid seal unapproved or obsolete
		4	1	Water level valve defective
		5	1	Discharged flask containing fuel rod, excessive deposit, or other incorrect contents
		6	1	Faulty test procedures
		7	1	Fuel not fully covered by water
		8	1	Other minor preparation error
	2 – Mechanical	1	1	Mishandled during loading or unloading
		2	1	Venting system or valve problem
	3 – Contamination	1	1	Contamination of surface above regulatory limits.
		2	1	Other: poor standard of decontamination

Table A7. Classification of package deficiency associated with the transport event

Deficiency Code	Deficiency	Examples/Comments
D01	No package	No package involved in event.
D02	Contaminated conveyance	Contaminated conveyance only with no package involved.
D03	No damage to package or threat of damage	Administrative errors and false alarms. Inadequate locks and security devices. Inappropriate or wrong contents. Obsolete lid seals.
D04	No report of damage or increase in dose rate, but potential to cause damage to the package. Lower category	Package temporarily lost or mislaid, or wrong destination, or put on wrong conveyance. Low speed derailments and collisions. Flatrol decoupling. Faulty conveyance or tie-downs.

Table A7. Classification of package deficiency associated with the transport event

Deficiency Code	Deficiency	Examples/Comments
D05	No report of damage or increase in dose rate, but potential to cause damage to the package. Upper category	Stolen source. Unretrieved lost package. Inappropriate disposal. Severe collision. Fire on the conveyance.
D06	Defective or poor condition, without increase in dose rate or loss of containment	Package of generally poor standard, corroded or other deterioration. Parts missing or mechanical defect.
D07	Minor damage without increase in dose rate or loss of containment	Damage to outer packaging: knocked, dropped or dented. Conveyance overturned.
D08	Severe damage without increase in dose rate or loss of containment	Severely damaged: crushed. Scorched by fire. Part of container, eg lid, knocked off.
D09	Damaged with increase in dose rate but without loss of containment	Increased dose rate outside package caused by damage or fire en route. Includes internal leakage and other mechanical failure. No loss of material outside package.
D10	Damaged with loss of containment	Leakage out of package caused by damage or fire en route. Includes material or source(s) released from package. Usually accompanied by some increase in dose rate.
D11	Contamination inside package	Unexpected contamination or other residual material found inside package.
D12	Contamination outside package	Fuel flask contamination above regulatory limits. Any other contamination above IAEA limits.
D13	Improper package with loss of shielding or containment – inappropriate contents	Activity unexpectedly high for package, leading to dose rates higher than expected.
D14	Improper package with loss of shielding or containment – inadequate shielding	Package shipped with poor, ineffective or damaged shielding, or source exposed en route.

Table A8. Radiological consequences resulting from transport events

Code	Definition	Circumstances
N	None	No dose rates or contamination above those expected during routine transport. No evidence of exposures having been received.
E	Extremely low, not assessed	Some increased exposure above that associated with routine transport but considered to be so low that an assessment was of little value.
L	Assessed and below 1 mSv*	Some increased exposure above that associated with routine transport and considered to be of a magnitude worth investigating, but found to be low.
U	Assessed and above 1 mSv* or exposure to significant contamination	Some increased exposure above that associated with routine transport and considered to be of a magnitude worth investigating. Some exposures found to be appreciable.

Note:

*: An effective dose of 1 mSv or an extremity dose of 50 mSv.