REVIEW OF THE DEVELOPMENT OF INCIDENTS DATABASES AND FEEDBACK MECHANISM: IRID, RELIR, EURAIDE AND RADEV

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1 Introduction

Technologies that make use of ionising radiations are widespread. They provide many benefits but, as with other technologies, the use of ionising radiations carries with it the potential for incidents and accidents. Their severity can vary from the trivial to the fatal and may involve substantial economic penalties. In order to minimise the number of incidents and their consequences it is important that there are mechanisms to learn the lessons from those that do occur.

This paper reviews the development of incident databases in the United Kingdom and France together with initiatives by the European Union (EU) and the International Atomic Energy Agency (IAEA) to improve feedback mechanisms. These initiatives necessarily cover a wide range of radiation uses. However it will be seen that a significant proportion of incidents and accidents relate to industrial radiography and that these initiatives provide mechanisms for 'learning the lesson'.

2 IRID

2.1 Objectives

In the UK in 1996, the National Radiological Protection Board (NRPB), the Health and Safety Executive (HSE) and the Environment Agency (the Agency) jointly established the Ionising Radiations Incident Database (IRID) and published its specifications[1]. The objectives of the database are

(a) to act as a national focus on ionising radiation incidents, primarily in the non-nuclear sector,
(b) through appropriate publications to provide feedback and guidance to users on preventing, or limiting the consequences of radiation accidents,
(c) to provide regulatory bodies, and others with advisory responsibilities, with analyses of data that help in assessing priorities in resource allocation.

2.2 Scope

The database is designed to cover radiological accidents and incidents involving actual or potential occupational and public exposure. It specifically includes near misses as there are often valuable lessons to be learned from such occurrences. Therefore in developing the database, it was felt more appropriate to use the word 'incident', as this has a wider meaning than 'accident'. The definition used for IRID is

> 'An ionising radiation incident is any unintended or ill-advised event, including events resulting from operator error, equipment failure, or the failure of management systems that warranted investigation.'

The database deals primarily with the non-nuclear sector, ie industry, research, teaching and medicine. It specifically excludes nuclear, transport and patient exposure incidents, as there are existing mechanisms for recording these sorts of event.

2.3 Confidentiality

Many organisations see the value of sharing information and learning the lesson, but if this is likely to bring them adverse publicity or increased scrutiny by the regulators, then they might be very cautious about contributing to the database. Therefore it was clear from the beginning that the confidentiality of information would be a major issue.

To address this problem, all information contained in the database is unattributable and confidential. Only the originator of the incident entry will know the names of the organisations or individuals concerned and all data are presented to NRPB in a format that provides anonymity. There will be some instances where, because of the affiliation of the contributor, NRPB may be aware of the organisation involved (but not the names of the

persons). For its part, NRPB undertakes not to divulge any such privileged information to a third party. HSE and the Agency are well aware of the natural wariness that potential contributors may have in respect of the involvement of regulatory bodies. Therefore they have given assurances that they will not seek to obtain further information from the other partners (or the contributing organisation if different) about any incident recorded on the database that was not reported to the regulators. This would not prevent HSE and the Agency following up incidents that are notified to them by other means, eg through statutory reporting requirements or complaints from employees or members of the public.

2.4 Format

The database consists of 24 fields, including a text field as summarised in Table 1 below. Each non-text-field contains either numerical data (eg dose in millisieverts) or one or more codes that categorise the incident.

TABLE 1 IRID fields

Field	Title	Field	Title
1	Case number	13	Occupation of worker(s)
2	Area	14	Type of equipment
3	Incident date	15	Nuclide(s) involved
4	Incident category	16	Activity
5	Exposure level	17	Kilovoltage of radiation generator
6	Site level	18	Cause of incident
7	Nature of incident	19	Contingency plans
8	Number exposed: occupational	20	RPA involvement
9	Number exposed: public	21	RPS involvement
10	Whole body dose(s)	22	Follow-up action (eg, improvements)
11	Extremity dose(s)	23	Date of entry in database
12	Internal organ dose(s)	24	Description: text field

2.5 Extent of coverage

Whilst the database and the reporting mechanisms came into existence in 1996 it was felt appropriate to 'seed' the database with past cases to provide an initial impetus. It was recognised that this could potentially provide some distortion to any analysis; however, the value of the feedback was considered to be overriding.

These 'historical data' fall into two groupings. Firstly there are incidents from the 1970s and 1980s that are of special interest or examples with important lessons to be learned. Most of these cases have been taken from NRPB records and have previously not been published. Indeed, it was this group of cases that had in part provided an incentive to pursue the development of IRID. This derived from the observation that the younger generation of qualified experts were either not aware of these incidents or had received accounts of the incidents that were distorted with time, often masking important lessons.

The second group of 'historical data' covered the period 1990–95 with all partners providing contributions. The choice of 1990 as the start point was partly influenced by the assessment that by this time the impact of the advent of the Ionising Radiations Regulations 1985[2] (IRR85) would largely have worked its way through the system and incidents could be taken as reflecting the effectiveness of the prevailing radiation protection culture in the country. Another consideration was the amount of effort required to make a retrospective trawl through files to extract incidents. It was therefore agreed that the partners would exercise their own judgement on what was readily available material, again recognising the implications for any kind of analyses.

During 1996 each partner set up reporting systems that encouraged staff to report incidents as they occurred. As with most new systems, IRID has experienced 'teething troubles' in getting the information about reporting to the correct people, familiarising them with the reporting procedures, and ensuring that all appropriate information is provided. Inevitably this has led to some under-reporting by the partners. Another relevant point is that a policy decision was taken to apply the *subjudicice* principle to those incidents that would be the subject of legal proceedings (typically a regulator taking a prosecution) and not to enter data on IRID until this process was complete. This can often be a lengthy process, typically between 6 and 18 months.

There is one other area of coverage that is worthy of mention, namely the 'near misses', ie incidents where things have gone wrong, there are lessons to be learned, but fortuitously the consequences were not severe.

Many of these, particularly in the research and medical sectors, would not normally come to the attention of one of the partners, and there is therefore scope for expanding the reporting network.

2.6 Feedback

Field 24 is a text field that follows the general format of description of incident, doses received, other actual or potential consequences eg, environmental or health, and lesson learned. The format was designed to be readily reproducible in reports and for subsequent use as training material. The first review of cases reported and operation of the database was published in 1999[3]. It covered 100 cases and Appendix A provides an example of a case report from the industrial radiography sector. For a number of the cases artists drawings of the circumstances of the incident were produced. The descriptions of the incidents and the drawings may be freely copied for use as training material or in published documents; providing an appropriate acknowledgement of IRID is included.

Cases from IRID have also become a regular feature of the European ALARA Newsletter. Again these were favourably received and prompted other members of the EAN to put forward for publication cases from their own country. This and feedback from the 2nd EAN Workshop (see Section 4) has prompted other countries to develop their own databases. The French example of RELIR is covered in Section 3.

2.7 Analysis

Any analysis of data from IRID has to be treated with a degree of caution, as the data set can by no means claim to be comprehensive, the timeframes for collection of data vary from partner to partner and the coverage across the sectors is unlikely to be uniform. Nevertheless some broad indication can be deduced. Table 2 shows the percentage of incidents with different types of equipment/uses. It can be seen that 29% of the incidents involve gamma radiography with X-ray radiography accounting for a further 10%.

TABLE 2 Type of equipment involved

Code		Number of incidents
01	Diagnostic X-ray	3
02	Veterinary X-ray	0
03	Teletherapy	0
04	Brachytherapy	1
05	Nuclear medicine (therapy and diagnostic)	1
06	Baggage inspection/security	4
07	Gamma radiography site	15
08	Gamma radiography facility (permanent)	14
09	X-ray radiography site	2
10	X-ray radiography facility (permanent)	8
11	Irradiation facilities (X, gamma, electron)	0
12	Thickness gauges	6
13	Level gauges	6
14	Density/moisture gauges	12
15	Analytical equipment	2
16	X-ray optics	1
17	Electron beam equipment	0
18	Unsealed radioactive materials (not covered elsewhere)	5
19	Smoke detectors	1
20	Consumer products	0
21	Static eliminators	2
22	Laboratory/calibration sealed sources	4
23	Yield monitors on agricultural equipment	0
24	Radioactive waste treatment plant	0
25	Environmental tracer work	0
26	Processing of ore and scrap materials	10
27	Other (specify in text description)	3

Owing to the complex nature of many of the incidents it is often not possible to identify a single cause and so persons supplying data to IRID can identify up to four codes that are likely to be the most significant cause/contributory factors to the incident. The published review of IRID cases identified a number of key messages

Ensure proper management systems are in place
Ensure the correct use of a radiation monitor
Maintain security of radioactive materials
Provide appropriate training
Be prepared for incidents: have contingency plans.

2.8 Future Developments

Maintaining the flow of incident reports from the partners is an ongoing challenge. The present arrangements depend heavily on coordinators in each partner organisation to drive and stimulate contributions, and when coordinators change job this can result in a hiatus in the flow of reports. To address this and improve access to the database a number of improvements are being taken forward

To expand the reporting network, approaches are being made to professional bodies and industry groupings.
To provide better access to the case studies, an IRID website will be established.
To improve the utility of the database and the ease of reporting, partner organisations will be supplied with electronic versions. Many regulators and radiation protection professionals now extensively use laptop computers on visits to users, both as an information source and as an "on the spot" reporting mechanism.

3 RELIR

3.1 Creation and Objectives

The Qualified Expert Group of the French Radiological Protection Society (SFRP) has recently created an arrangement known as Retours d'Expérience sur Les Incidents Radiologiques (RELIR), or in English, Feedback Experience on Radiological Incidents. This has been undertaken in collaboration with CEPN and

National Research and Safety Institute (INRS).
Office of Protection against Ionising Radiations (OPRI).
National Institute for Nuclear Sciences and Techneques (INSTN).
Curie Institute.

The objectives of RELIR are

to learn from feedback experiences to avoid new incidents.
to provide training centres and professional bodies with educational documents, giving lessons to be learned from specific examples of incidents.
to encourage exchange between health physicians, radiation protection professionals and non professionals.

3.2 Scope of RELIR

The scope of RELIR is broadly similar to IRID being focused on the non nuclear sectors and is given in Table 3.

TABLE 3 Activities covered by RELIR

Industrial	**Medical & Veterinary**
Non destructive testing	Radiology-conventional
Gauges	Interventional radiology
Sterilisation	Radiotherapy
Radioisotope production	Dental radiology
Polymerisation & surface treatment	Nuclear medicine
Crystallography	Brachytherapy
Electron beams	Veterinary radiography
Waste incinerators & storage	Veterinary research
Industrial research	Medical research
Radio-pharmaceuticals	
Education and Research	**Other domains**
Public research	Transport
Teaching	Lost sources
	Customs controls
	Civil security interventions

3.3 Operation and Management

The support of the various national bodies has been important in the creation of RELIR and will continue to be during operation. However an important aspect of the operation of RELIR is that it has been established under the auspices of the French professional body, SFRP, and will draw on two constituent networks for reporting incidents:

the qualified experts in the industrial and medical fields.
the medical physicians.

Anybody eg, employer, employee, consultant or incident witness, can propose that an incident be included. This proposal would be fed through and assessed by a radiation protection specialist for the activity sector, known as the "Moderator". It is envisaged that there would be about 20 Moderators. An Expert Committee, comprised of Moderators and representatives of the collaborating bodies (OPRI, Curie Institute, INRS, INSTN and CEPN) would then validate, or not, the case as a suitable input.

CEPN are providing the day to day management of RELIR and are constructing a website, http://RELIR.cepn.asso.fr/, that it is hoped will be available by the end of October 2001. By the end of the year it is hoped to populate the database with about 40 existing cases, most of which occurred in the 1990s.

4 EURAIDE

4.1 Background and Objectives

A presentation on IRID was made at the 2nd European ALARA Network Workshop, "Good Radiation Practices in Industry and Research" held at NRPB in November 1999. One of the conclusions of that meeting was that feedback from radiation accidents and incidents was considered to be one of the most important areas for future development. The meeting made recommendations to the European Union for initiatives[4] which have given rise to a Pilot Study for the creation of a European Union Radiation Accident and Incident Data Exchange (EURAIDE) system. The objectives of the study are

(i) facilitating the establishment of national radiation accident and incident database where there are none and to encourage the compatibility of such databases,
(ii) establishing a European network to exchange radiological protection feedback from accidents and incidents,
(iii) establishing summary reports of relevant accidents and incidents with the aim of identifying lessons to be learned, so that they can be used in radiation protection training programs,
(iv) upgrading the radiological safety in the countries applying to join the EU, by integrating them into the above efficient feedback exchange system.

4.2 Structure of the Pilot Study

NRPB is the lead contractor for the study and is being supported by CEPN (France) and BfS (Germany) as subcontractors. Additional input is also being provided by CSN (Spain). The components of the work programme are

(i) The first stage of the Pilot Study would be to review the existing national mechanisms for capturing data on incidents, their formats and how this data is used.

(ii) In the light of the results from point 1, options for mechanisms to gather the data in a coherent way will be identified. This will involve

- assessing the various means currently in place to categorise accidents and incidents. Possible options for harmonising these categorisations will be identified.
- proposing criteria and mechanisms that may be used to select accidents and incident information that is of particular value for feedback. Use will be made of existing case studies to demonstrate the issues involved.
- to maximise the benefit from the feedback, this needs to be available in national languages, so that it can be used in worker training. The optimisation of this process will be considered.

(iii) The work in point 2 will allow the development of proposals on how to harmonise the content and format of case studies and the various presentation aspects, including different media formats, ie, hard copy, website and electronic training media.

Having identified a range of options for the technical details of data that could be gathered, categorised and formatted, it will then be necessary to develop ways of organising and managing the feedback in an ongoing way. Within these arrangements it will be necessary to include Quality Assurance elements. In particular the study will address the following:-

- organisations to be involved in each country. For each country one organisation will be identified as the most likely lead organisation together with others that could contribute or particularly benefit from access. In essence a Network could be established.
- the project will require a Steering Committee and options for the structure of this will be proposed. This will draw on the experience from the EAN.
- The output from the Pilot Study will be a series of recommendations and options for the technical specifications of EURAIDE, and its management and operating modes.

The Pilot Study is scheduled for completion by June 2002.

4.3 Further Developments

The full project will need to further develop these elements and identify the preferred options. To be successful the contributing organisations from the Member States and prospective Member States must feel comfortable with the arrangements and be able to commit themselves to support EURAIDE. There will undoubtedly be many issues and details to be resolved. Therefore as part of the full project it is envisaged that there would be two Workshops separated by a year to cover these issues.

- the first Workshop would present the results of the Pilot Study and specifically propose a way forward. This will raise issues and details that need resolving.
- in conjunction with the Radiation Protection Unit, there would be ongoing dialogue to resolve the above.
- this would result in a revised proposal for EURAIDE and its implementation to be put to a second workshop.

5 RADEV

5.1 Background

Over the last decade or so IAEA, with the cooperation of Member States has published a series of accident investigations reports[5-13] in order to provide feedback and identify lessons to be learned. These have tended to cover the most serious accidents, usually with fatal consequences. In addition a publication was produced

covering the lessons to be learned from a number of industrial radiography accidents[14]. IAEA recognised that there was need for a feedback mechanism that had a broader coverage, with which IAEA could provide a world-wide focal point for such information. IAEA therefore started to develop a RADiation EVent (RADEV) database.

An added impetus to this process was the rising number of 'orphan sources' – sources that had either never been under regulatory control or had fallen from a controlled environment eg, lost, stolen, misplaced, abandoned or otherwise transferred without proper authorisation. Global awareness of the magnitude and seriousness of the problem was raised in September 1998 at the first international conference on the 'Safety of Radiation Sources and the Security of Radioactive Material' held in Dijon, France. The conclusions of this conference were drawn to the attention of the IAEA Board of Governors at the General Conference. Subsequently, the IAEA Secretariat was requested to prepare and implement an *Action Plan* on the 'Safety of Radiation Sources and the Security of Radioactive Material'. The *Action Plan*, which was endorsed by the Board of Governors and the General Conference in 1999. It covers the following seven areas: regulatory infrastructures; management of disused sources; categorization of sources; response to abnormal events; information exchange; education and training; and international undertakings. One of the actions under 'Information Exchange' is for the IAEA secretariat to fully develop and maintain an international database on unusual radiation events (RADEV) and to make it available to Member States.

5.2 Overall Objectives of RADEV

RADEV includes many different types of events that have occurred outside the nuclear power programme. The overall objectives of RADEV are to:

(a) disseminate information on radiation events and feedback lessons learned that may help to prevent future accidents, or mitigate their consequences should they occur, and
(b) provide a tool to help Member States, the IAEA and other organizations to identify priorities in their radiation safety programme to facilitate the efficient allocation of resources.

In order to achieve these general objectives a centralized RADEV database is being established at IAEA's headquarters in Vienna to:

(a) provide a repository of information on accidents, near-misses and any other unusual events involving radiation sources not directly involved in the production of nuclear power or its fuel cycle;
(b) categorize events in a standardized manner to facilitate the search for events fitting particular profiles, the identification of causes and the lessons to be learned;
(c) provide a means to analyze trends in radiation events; and
(d) provide summary descriptions of events that can be used directly as training material.

RADEV is designed to capture lessons to be learned from radiation events and is not meant to be a real-time on-line database. There is a separate IAEA initiative concerned with developing a 24-hour reporting system for missing and found orphan sources.

5.3 Scope and Operation

The following events will be included in RADEV:
– events or potential events involving patients, workers or members of the public;
– events involving radiation sources which have been lost, found, stolen, or subject to unauthorized and inadvertent transfer/sale; and
– events that occurred during the transportation of sources that result or could have resulted in the loss or degradation of control of radiation sources.

The database has been designed to operate on a personal computer using Microsoft Access 97. Copies of the RADEV software will be provided to selected organizations within Member States for their own use and users will be requested to provide data to IAEA on a regular basis. IAEA will manage and operate the international RADEV database and act as the central focal point for all users. IAEA will publish regular summary reports from RADEV and will provide electronic updates of the data to participating organizations. Confidentiality will be maintained by IAEA at all times and details such as names of individuals, hospitals and factories will not be divulged.

5.4 Implementation

The RADEV project is being implemented in 3 phases:

Phase 1: Establishment of the database. IAEA will collect currently available details of radiation accidents and test the software.

Phase 2 : Limited international trials. IAEA will provide a working version of RADEV to several international and national organizations (including professional organizations in the medical field) for testing and evaluation. Feedback from the trials will be reviewed by IAEA and any necessary changes made to the software.

Phase 3: Distribution of RADEV. IAEA will collect data from participating organizations, compile international statistics and produce summary reports. Electronic copies of the summary reports and the updated database will be available to participating organizations.

The current status at time of writing is that Phase 2 is in progress.

5.5 Initial Statistics

To date 179 events have been recorded in RADEV. These are not representative of world-wide statistics, as they are simply some of the events known to IAEA. There are many more events to input, but it is felt that the currently available statistics would be of interest to a wide audience. It will be noticed that industrial radiography features in a significant number of events.

FIGURE 1 Distribution of events by general work sector

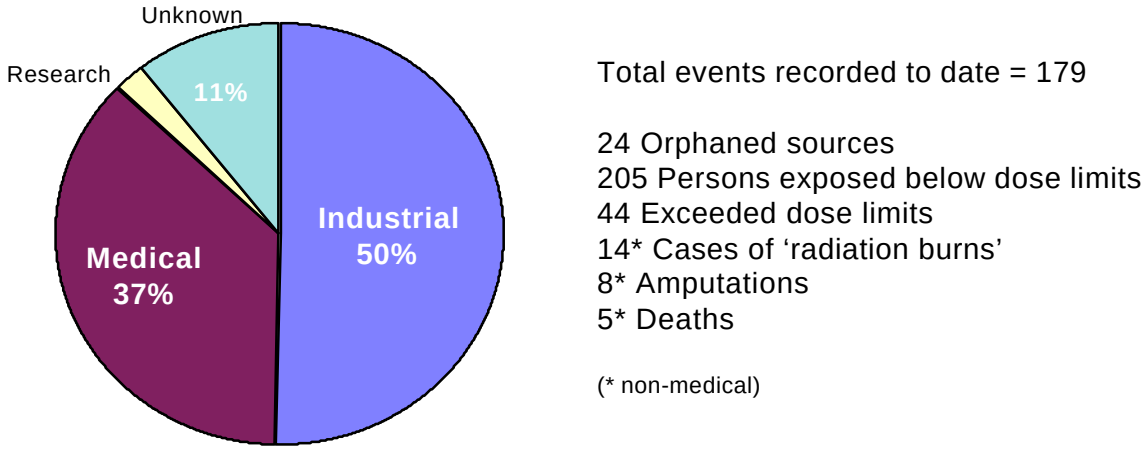


FIGURE 2 Number of industrial events by specific practice

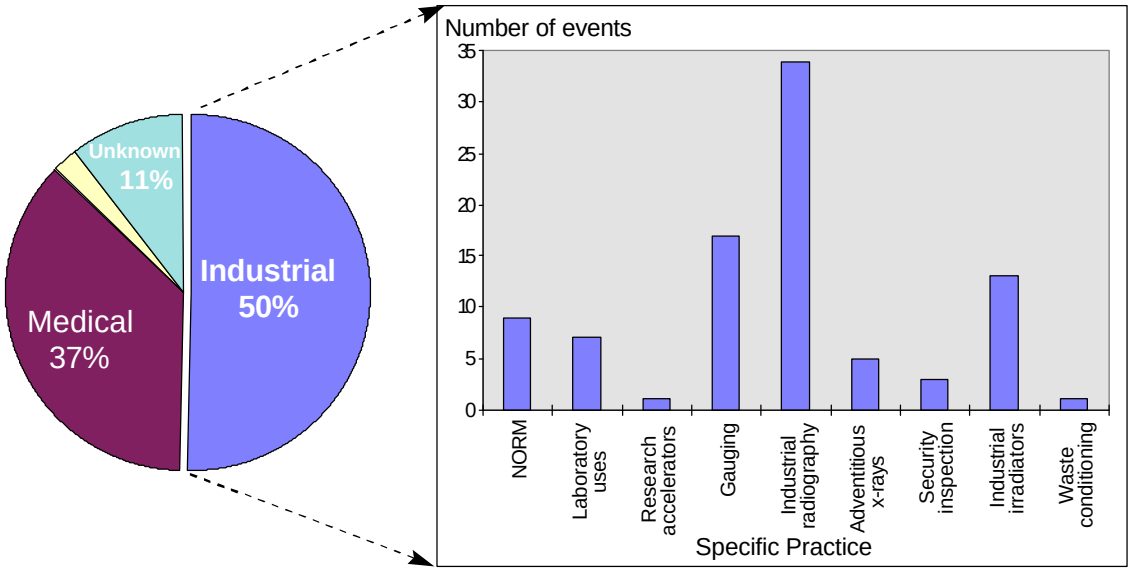
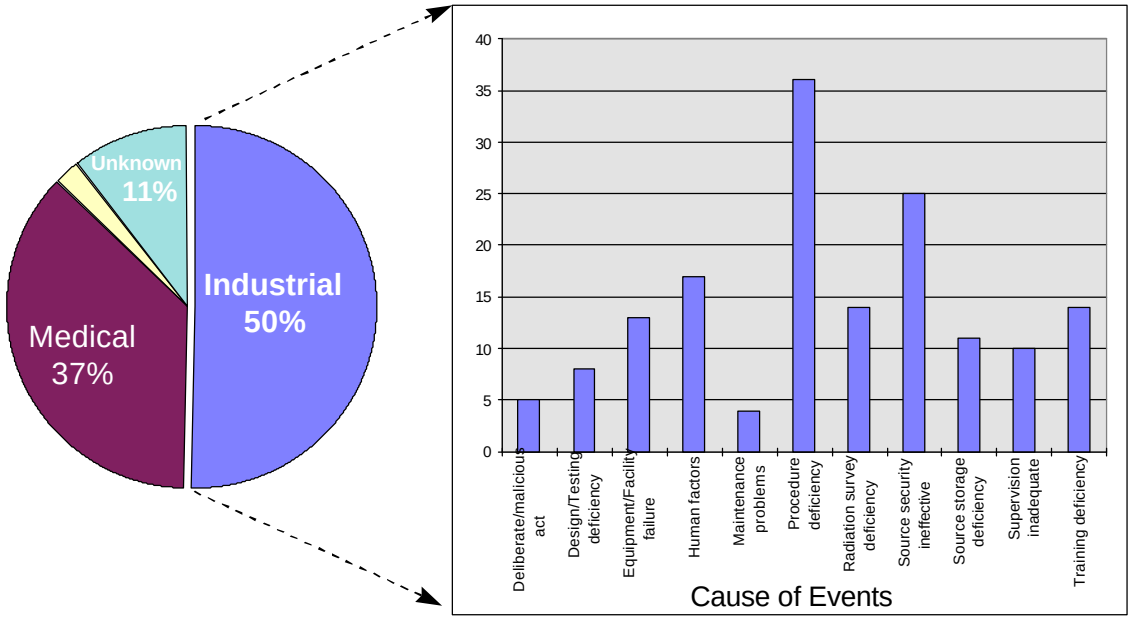


FIGURE 3 Causes of events in industrial practices



6 Conclusions

It is clear that industrial radiography still accounts for a significant proportion of radiological incidents and that more could be done to learn the lessons from these incidents. This paper has covered some of the complementary initiatives (IRID, RELIR, EURAIDE and RADEV) that are designed to help in this process. It is hoped that

those present at this Workshop will be able to either encourage contributions to, and use of, these feedback mechanisms; or help develop complementary mechanisms.

7 References

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APPENDIX A

Example of Case Study from IRID

IRID Case Number: 0002/88	**Category: D.2.1**
Equipment: Gamma site radiography	**Nature: Damaged/defective equipment**

A two-man team was carrying out site radiography on a construction site using a 1.85 TBq iridium-192 gamma source in a remote exposure container. A set of three exposures had been completed before radiation monitoring by one of the radiographers revealed that the source had remained at the end of the guide tube after the final rewinding. At the end of each exposure, the end of the guide tube would have been repositioned and the films changed. The lead radiographer would have been very close to the source whilst repositioning the guide tube and changing the films. The contingency plan to recover the source was put into action by the radiographers. Both operators were wearing personal dosemeters but not alarm monitors.

Subsequent reconstruction of the incident indicated that the likely cause of events was that the source pigtail had not been connected to the wind-out cable by the radiographer and had simply been pushed to the end of the guide tube where it had remained for all three exposures. Connection of the wind-out equipment to the source container should not be possible in situations where the pigtail is not connected to the wind-out cable. With this particular wind-out equipment this was not the case, although the dimensions of the ball and shank were within the manufacturer's specifications for maintenance checks and both appeared to be in good condition.

Doses

Whole body doses were taken to be those recorded by personal dosemeters worn by the two radiographers. A reconstruction of the incident was carried out in order to estimate doses to the hands:

Lead radiographer	Whole body 43.3 mSv	Hands 200 mSv
Second radiographer	Whole body 2.9 mSv	Hands 2.7 mSv

Lessons

1 Radiation monitoring MUST be carried out after every exposure. Had this been carried out, doses would only have been received during implementation of the recovery exercise, and would have been significantly lower.
2 Care must always be taken when connecting the source pigtail to the wind-out cable and reliance should not be placed upon interlocking or similar mechanical mechanisms.
3 Personal alarm monitors should be worn during site radiography.
4 Routine maintenance must be carried out of all mechanical parts and interlocks.