RADIATION SAFETY IN INDUSTRIAL RADIOGRAPHY: CURRENT WORK BY THE IAEA

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Abstract

The application of industrial radiography techniques is well established throughout the world and brings substantial benefits to society when used in a safe and controlled manner. The International Atomic Energy Agency (IAEA), in addition to facilitating the transference of such technology that utilises the constructive properties of ionizing radiation, has a statutory function to establish international standards of safety and to provide for their application.

As a direct consequence of the first International Conference on the 'Safety of Radiation Sources and the Security of Radioactive Material' held in 1998 in Dijon, France, IAEA prepared an 'Action Plan on the Safety of Radiation Sources and the Security of Radioactive Materials. The '*Action Plan*' was approved by the IAEA Board of Governors in September 1999; and in October 1999 the General Conference endorsed the Board's decision and urged the Secretariat to implement it. The *Action Plan* not only calls for the strengthening of existing systems for safety and security of radiation sources, but also develops new initiatives.

This paper presents those aspects of the *Action Plan* and other IAEA work relevant to radiation safety in industrial radiography, in particular: the Categorization of Sources; the Code of Conduct on the Safety and Security of Sources; Model Regulations for Industrial Radiography; a service for reviewing regulatory infrastructures; training modules for industrial radiography; international workshops on the safety and security of sources; a report of 'Lessons learned from accidents involving industrial radiography sources'; publication of accidents specifically involving industrial radiography sources; and a database of unusual radiation events (RADEV).

1. Introduction

One of IAEA's statutory functions is "*to establish or adopt … standards of safety of health and minimization of danger to life and property …, and to provide for the application of these standards …*". Of particular importance are the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (the BSS). [1].

Even though many governments have endorsed these international standards, the number of radiological accidents that have been reported worldwide implies that numerous radiation sources are not managed or regulated appropriately. Global awareness of the magnitude and seriousness of the problem was raised in 1998 at the first International Conference on the Safety of Radiation Sources and the Security of Radioactive Material held in Dijon, France, 14-18 September. The findings of the Dijon Conference were noted with interest by IAEA Member States at the General Conference later the same month.

Following a report to the Board of Governors, 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 primary purpose of this *Action Plan* is to enable the IAEA to develop and implement activities that will assist States in maintaining and, where necessary, improving the safety of radiation sources and the security of radioactive materials over their life cycle. The actions are grouped into seven areas, namely: Regulatory infrastructures; Management of disused sources; Categorization of sources; Response to abnormal events; Information exchange; Education and training; and International undertakings. More recently, an *International Conference of National Regulatory Authorities with Competence in the Safety of Radiation Sources and the Security of Radioactive Material,* was held in Buenos Aires from 11 to 15 December 2000 (the Buenos Aires Conference). The findings of his conference were reported to the Board of Governors in March 2001 and, as a result, the Action Plan has been updated.

This paper gives an overview of those aspects of the Action Plan of relevance to radiation safety in industrial radiography and, for completeness, reference is made to pertinent IAEA publications that were developed outside the Action Plan.

2. IAEA's Current Work Activities and Documents related to Radiation Safety in Industrial Radiography

Many factors need to be brought together to achieve an adequate level of radiation safety in industrial radiography. These factors range from the need for an appropriate and effective national legislative infrastructure with supporting radiation safety services, to ensuring that management and operators of radiation sources are trained, educated and are aware of the risks. The IAEA has developed, and is continuing to expand upon, a range of documents, training material and services to help its Member States achieve and maintain this adequate level of safety. These are summarised below, whilst Fig 1 gives a diagrammatic overview and shows how the various components are likely to be of interest to different audiences.

2.1 Categorization of Radiation Sources

There is a wide variety of devices containing radioactive sources, ranging from smoke detectors, which are intrinsically safe, to devices containing sources of high activity, such as those used in industrial radiography. Some of the latter have been responsible for serious radiological accidents. A categorization scheme for sources was therefore seen as an essential pre-requisite to establishing a graded approach to their management and control. Furthermore, it was envisaged that the categorisation scheme would be referred to

in the Code of Conduct (see below) and in the preparation of guidance on national strategies and programmes for the detection and location of orphan sources (see below). The current categorisation scheme [2] considers only radioactive sources and is based on the following attributes of the source: radiological properties, form of material, practice or activity, exposure scenarios and end-of-life considerations. The resulting categories, with examples, are:

Category 1 (high risk):	industrial radiography sources, teletherapy sources, irradiators;
Category 2 (medium risk):	brachytherapy sources (both high and low dose rate sources);
Category 3 (low risk):	fixed industrial gauges with lower-activity sources.

2.2 Code of Conduct on the Safety and Security of Radioactive Sources

Industrial radiography can be of an itinerant nature, with many companies now working abroad and facing problems in understanding the various national requirements for radiation safety. Furthermore, some companies have reported having problems in returning spent radiography sources to suppliers or disposing of them. The purpose of the Code of Conduct is to serve as guidance to States for the development and harmonization of policies, laws and regulations on the safety and security of radioactive sources. The Code was prepared by a team of technical and legal experts and the IAEA Board of Governors have invited Member States to consider, as appropriate, means of ensuring its wide application.

In particular, the Code of Conduct addresses the establishment of an adequate system of regulatory control from the production of radioactive sources to their final disposal, and a system for the restoration of such control if it has been lost. The Code recommends that States should give highest priority to those radioactive sources which pose the most significant risks, i.e. radioactive sources belonging to Category 1 of IAEA's "Categorization of Radiation Sources". The Code has been published in the 6 official languages of the IAEA i.e. English, Chinese, Spanish, French, Arabic, Russian [3].

2.3 Radiation Safety Regulatory Infrastructure Services (RSRI)

An appropriate level of regulatory control is necessary to ensure that industrial radiography is carried out in compliance with the relevant national and international standards. The RSRI service provides IAEA assistance to Member States in the establishment and maintenance of an appropriate national regulatory infrastructure to implement the BSS.

The service can be divided into two broad categories:

I. Assessment of the effectiveness of regulatory infrastructures for radiation safety. This will identify the weaknesses of national regulatory infrastructures and provide recommendations for improvement.

II. Assistance in the development of a regulatory infrastructure for radiation safety. This may be requested by a State as a result of the above mentioned assessment or be requested independently of such an assessment. This will provide advice on the organization and operation of a regulatory programme consistent with the BSS.

This service will be provided in accordance with established IAEA guidance. In general, it will involve missions to the State requesting the service.

2.4 National Strategies for Detecting and Locating Orphan Sources (in preparation)

Due to the nature and mobility of industrial radiography work, it is an unfortunate fact that many 'orphan sources' started out their life as industrial radiography sources. The purpose of the 'National Strategies' document is to provide advice to national authorities on how best to develop a strategy for regaining control over orphan sources. This in turn requires an understanding of the mechanisms by which control of these sources can be lost and their subsequent movement modalities. A review of experience to date indicates that sources get out of regulatory control mainly through:

- loss during use or in the case of mobile sources, whilst in transit;
- being abandoned, either deliberately or through lack of awareness;
- theft, either for the scrap value of the source or its container, or for illegal intent.

In addition it is recognised that many countries will have an "historic legacy" of sources that were in use before radiation protection infrastructures were put in place. Whether control has been lost or did not exist in the first place, there are some common routes for inadvertent movement of such sources within the public domain. International trade, particularly in scrap metal, provides the potential for orphan sources to cross borders and therefore the consequences may not be limited to the country of origin.

The document reviews the potential threat from these situations, the possible elements of a national strategy, parameters that may be relevant to the choice of elements and the priority given to them.

2.5 Regulatory Compliance

The following two documents have been developed to assist both regulators and users of industrial radiography sources.

2.5.1 Practice-Specific Model Regulations: Radiation Safety in Industrial Radiography (draft TECDOC)

This TECDOC specifies the minimum requirements for radiation protection and safety for industrial radiography used in non-destructive testing. It covers both industrial radiography performed inside shielded facilities that have engineering controls (fixed facilities) and sources used outside shielded facilities (site radiography). The TECDOC is to be published in the near future, with the intention of soliciting comments from national authorities, professional bodies, operating organizations, source/equipment manufacturers and relevant

International Organizations.

2.5.2 Safety assessment Plans for Authorization and Inspection of Radiation Sources

This TECDOC [4] provides administrative advice to facilitate the regulatory process governing authorization and inspection of radiation sources. It also covers the use of standard assessment/inspection plans and provides simplified plans and check lists for the more common, well established uses of radiation sources, including industrial radiography. The TECDOC can also be used by managers and Radiation Protection Officers (RPO) of industrial radiography companies for in-house auditing purposes to assess the adequacy of radiation safety within the company.

2.6 Radiation Safety Documents

2.6.1 Safety Guide on Occupational Radiation Protection

This Safety Guide [5] provides guidance on the control of occupational exposures. It is primarily aimed at regulatory authorities, but it is recognized that it may also be of use to employers, advisors, health and safety committees, and workers. The guide specifically address the technical and organizational aspects of the control of occupational exposures in situations of both normal and potential exposure. The following topics are covered in the guide: Framework for Occupational Radiation Protection; Dose Limitation; Optimization of Protection; Radiation Protection Programmes; Intervention in Emergencies; and Health Surveillance.

2.6.2 Safety Report on Radiation Protection and Safety in Industrial Radiography

This IAEA Safety Report [6] summarizes good working practices in industrial radiography and provides technical advice on radiation protection and safety. It is aimed at regulatory authorities, operating organizations, workers, equipment manufacturers and client organization. The following topics are covered in the report: Organizational Responsibilities, Types of Exposure Devices; Design and Use of Shielded Facilities; Site Radiography Procedures; Storage, Movement and Transport of Radioactive Sources and Exposure devices; and Emergency Response Planning.

2.6.3 Practical Radiation Safety Manuals

There are several of these manuals which form a series of booklets on specific topics, including a ‘Manual on Shielded Enclosures’ [7] and a ‘Manual on Gamma Radiography’ [8]. The manuals contain basic radiation protection principles, of both a general nature and specific to the particular practice. They are primarily aimed at persons using radiation sources although they may also be of use to managers and regulators.

2.7 Training & Education

2.7.1 Training Module: Radiation Protection and Safety in Industrial Radiography

This comprehensive training module is aimed at users and RPO's in industrial radiography companies. The module includes: detailed syllabus; suggested timetable, lecture notes, presentations in MS PowerPoint, suggestions for practical exercises and group work, and example exam questions with model answers. The module is currently being tested and evaluated on IAEA national and regional training courses.

2.7.2 Regional Workshops on the Safety of Radiation Sources and Security of Radioactive Materials

These workshops provide a regional form for exchange of information on the safety and security of radiation sources. Three workshops have been held to date; in Vienna; Morocco and Thailand.

2.8 Dissemination of Lessons to be Learned

2.8.1 Accident Reports

IAEA has published, with the full support of the relevant Governments, several reports of serious radiological accidents. Two of these accidents involved industrial radiography sources [9, 10]. The reports outline the circumstances of the accidents, the medical consequences and summarise the lessons to be learned.

2.8.2 Safety Report: Lessons Learned from Accidents in Industrial Radiography

This report [11] reviews the primary causes of 43 accidents involving industrial radiography sources. Generic lessons to be learned are considered and ways to prevent future accidents are presented.

2.8.3 IAEA's Radiation Events Database (RADEV)

The overall objectives of RADEV are to:

- disseminate information on radiation events and feedback lessons learned that may help to prevent future accidents, or mitigate their consequences should they occur, and;
- 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:

- 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;
- 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;
- provide a means to analyze trends in radiation events;
- provide summary descriptions of events that can be used directly as training material.

RADEV has been developed in Microsoft ACCESS and is currently undergoing testing. The database will be made available to national authorities and professional organizations in 2002. Summaries of events, lessons to be learned and statistics will be published at regular intervals by IAEA.

3. Future development of the IAEA's Action Plan

The Conference held in Buenos Aires in December 2000 provided an opportunity to reflect on the effectiveness of the *Action Plan* and how it might evolve in order to address all the key issues. While many of the findings reinforced the activities already within the *Action Plan*, they also identified further actions that might have implications for it. These, in summary, are:

- consideration should be given to the possibility of establishing a universal system for the labelling of radiation sources. The trefoil symbol itself does not provide a clear warning of hazard and an additional warning label, in the local language, would seem necessary to make the hazard immediately clear. This recommendation has surfaced in some of the accident investigation reports, but never has been acted upon;
- whenever the management of disused sources is not possible within a country, the duty of the supplier to take back sources should be established at the time of purchase;
- Governments should ensure that arrangements are made between regulatory authorities and facility operators for the detection and future handling of orphan sources.
- events where individuals are exposed to radiation because of breaches in radiation source safety or security without malice aforethought should be clearly distinguished from events where there is a criminal intent of exposing people to harmful effects of radiation.

4. Conclusions

There are many components in the efforts to ensure the safety and security of radiation sources throughout the world. As discussed in this paper, the IAEA is contributing to some key aspects of these efforts. It is using its unique position in the international community to assist its Member States in bringing about the changes necessary to minimize the risks from the peaceful use of radioactive materials. However, improving the situation is a slow process and the IAEA's actions are only part of the solution. Regaining and maintaining control of sources ultimately relies on the determination and commitment of all concerned, particularly those responsible for the use of the sources.

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Fig.1 RADIATION SAFETY IN INDUSTRIAL RADIOGRAPHY: IAEA'S CURRENT WORK ACTIVITIES & DOCUMENTS