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Recommendations on Monitoring and Response Procedures for Radioactive Scrap Metal

Report of an International Group of Experts convened by the United Nations Economic Commission for Europe (UNECE)

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NOTE

Symbols of the United Nations documents are composed of capital letters combined with figures. Mention of such a symbol indicates a reference to a United Nations document.

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EXECUTIVE SUMMARY

Radioactive substances can become associated with scrap metal in various ways and if not discovered they can be incorporated into steel and non-ferrous metals through the melting process. This can cause health hazards to workers and to the public as well as environmental concerns and it can also have serious commercial implications. Numerous incidents have occurred in recent years involving the discovery of radioactive substances in scrap metal and, in some cases, in metal from the melting process. These incidents have proved to be very costly in relation to the recovery and clean-up operations required but also in terms of the potential loss of confidence of the industry in scrap metal as a resource. This has led the scrap metal industry to seek ways of managing the problem.

Shipments of scrap metal are monitored in most countries but at different points in the distribution chain and to different extents and efficiencies. As yet, only limited efforts towards unifying and harmonizing monitoring strategies and methods in the context of scrap metal have been made at the international level. For these reasons, the United Nations Economic Commission for Europe (UNECE) was requested to provide a consistent and harmonized approach for the prevention and detection of radioactive scrap metal and for appropriate response procedures. Radioactive scrap metal is defined here as radioactively contaminated scrap metal, activated scrap metal and scrap metal with radioactive source(s) or substances contained within it. It may include both radioactive substances that are subject to regulatory control and radioactive substances that are outside regulatory control. The work of the UNECE is complementary to that of other international organizations, in particular the International Atomic Energy Agency (IAEA) and the European Union (EU), in relation to their efforts to prevent the uncontrolled release of sealed radioactive sources and other radioactive material from regulatory control.

The present document, prepared by a group of Governmental and industry experts, provides recommendations and examples of good practice for prevention, detection and response in relation to radioactively contaminated scrap metal, activated scrap metal and scrap metal with radioactive source(s) or substances contained within it (referred to in this document as ‘radioactive scrap metal’). It identifies the roles and responsibilities of all concerned parties in Government and industry in helping to establish an effective collaborative and unified approach at the national level.

Governments and industry alike are encouraged to use the recommendations and examples of good practice contained in this document to develop strategies to effectively monitor scrap metal, metal products and associated waste and to respond to any discovery of radioactive material. This, in turn, should lead to better international harmonization of approaches and methods and, thereby, to more effective prevention, detection and response at the national level.

INTRODUCTION

Recycled scrap metal is increasingly used in metal production. In 2004, the worldwide consumption of scrap metal was of the order of 440 million tonnes out of which around 184 million tonnes were traded internationally [1]. In the case of steel, the proportion of steel products now made from scrap is more than one half. The rise in the importance of scrap metal as a resource has been paralleled by an increase in the frequency that radioactively contaminated scrap metal, activated scrap metal and scrap metal with radioactive source(s) or substances contained within it (hereafter referred to as 'radioactive scrap metal') is detected in scrap metal shipments. Scrap yards, steel works and non-ferrous metal smelters and refiners are increasingly detecting radioactive substances in incoming scrap metal as the result of losses, accidents or inadvertent disposal of radioactive material. In the United States of America alone, over 5,000 incidents were recorded in 2004 that involved various types of radioactive scrap metal. Of these, about 53% involved the detection of naturally occurring radioactive material (NORM), 7% were due to radium, and less than 5% were due to artificially produced radionuclides (for the other reported incidents, such information is not available) [2]. Some of this radioactive scrap metal has gone undetected and has been accidentally melted down or processed and thus entered the metal stream. Although much of the available data originate from developed countries the problem is also apparent in developing countries.

The detection of, and the response to, radioactive scrap metal is complicated by the fact that radioactive substances are ubiquitous in nature and, specifically, that metal ores contain radioactive elements. When low levels of radionuclides are detected in scrap metal it is sometimes difficult to determine whether the radionuclides are naturally occurring or have been added through human activities. Over the years, there have been national and international efforts aimed at defining levels of natural and artificial radionuclides in materials that are acceptable from a radiological health perspective, that is, levels so low as to have an insignificant health impact. The terms exclusion, exemption and clearance have been introduced in this context [3].

While the potential environmental and health risks of the incidents involving radioactive scrap metal are usually not very high due to the relatively low radiation levels involved, the economic and financial consequences of such incidents for the metal processing industry are always very serious. The detection of radioactive materials in processed metal almost always results in the closure of the involved facilities and usually requires expensive clean-up action. In addition, such incidents can lead to a loss of trust in the recycled metal industry and the associated products since consumers do not wish to have unnecessary radiation emanating from their purchases.

The frequency at which radioactive scrap metal is detected may be expected to continue to rise with the ever-increasing use of scrap to produce processed materials, the wider application of radiation monitoring procedures and the ever-increasing effectiveness of radiation detection equipment. Current efforts to control high-activity sealed radioactive sources are unlikely to change this trend in the near future since recovered and recycled scrap can be 40 years or more old.

Radioactive substances can also appear in other types of (non-metal) scrap but it is because of the scale of the metal recycle industry, the difficulties in detection caused by the radiation shielding of metal and the possibility of the radioactive substances being incorporated into the final recycled product that the radioactive scrap metal issue has become so important.

Considerable work has been undertaken in many countries and by international bodies, such as the International Atomic Energy Agency (IAEA) and the European Union (EU), on the control of radioactive sources and their safe transport [4, 5, 6]. In addition to efforts on regulatory control, the metal recycling and producing industries have organised themselves to reduce the probability that

radioactive material which has escaped regulatory control is introduced into the recycling process. They have introduced measures aimed at detecting radioactive scrap metal at the earliest possible stage in the recycling chain, but its detection is not an easy task. Even with the most sensitive and sophisticated equipment, radioactive scrap metal may be undetected and be introduced into the recycling process. As noted earlier, radioactive scrap metal is an issue in both developed and developing countries, but the developing countries are generally less well equipped and have a lesser capacity for dealing with the problem.

To date, there has been little published work at the international level aimed specifically at countering the problem of radioactive scrap metal although guidance is currently being developed by the IAEA and the EU. At the national level, the 'Protocol for Collaboration on the Radiation Monitoring of Metal Materials' adopted in 1999 in Spain by concerned industrial organizations and by the relevant parts of Government is an important model for action in this area [7]. The Protocol provides for a unified national scheme of collaboration between concerned industry and Government based on monitoring measures to prevent the inclusion of radioactive substances in the scrap recycling process and the management of the consequences of such events if they were to occur.

In 2001, the United Nations Economic Commission for Europe (UNECE), the European Commission (EC) and the International Atomic Energy Agency (IAEA) prepared a 'Report on the Improvement of the Management of Radiation Protection in the Recycling of Metal Scrap' [8] that recommended measures to avoid the introduction of radionuclides into the metal recycling stream.

In continuation of this work, the UNECE, with the support of the Government of the United States of America, prepared and circulated a questionnaire to ascertain the current state of the radiation monitoring of scrap metal worldwide. Following the evaluation of the information received, an international Group of Experts met in April 2004 under the auspices of the UNECE to discuss policies and experiences in the monitoring and interception of radioactive scrap metal and to explore ways and means to facilitate and secure the international trade and transport of scrap metal.

The proceedings of the Group of Experts meeting together with extensive documentation on national experiences are contained in a report published by the UNECE on 'Monitoring, Interception and Managing Radioactively Contaminated Scrap Metal'[9]. The Group of Experts identified ten issues as a common basis for possible future work and recommended that a permanent international dialogue should be maintained on these issues among Governments and private industries. In particular, the following concrete outputs were envisaged:

(a) Establishment of a voluntary international "Protocol" or "Recommendations" providing for a consistent and internationally harmonized approach to monitoring and response procedures;
(b) Establishment and maintenance of an Internet-based information exchange system open to all concerned parties;
(c) Compilation of training and capacity-building programmes.

The present document (hereafter referred to as "Recommendations") was developed in fulfilment of the first of these proposed initiatives. It was agreed upon after the second meeting of the Group of Experts on the Monitoring of Radioactive Scrap Metal held in June 2006 under the auspices of the UNECE.

The document provides a framework of recommendations and examples of good practice based, to the extent possible, on existing national, regional and international instruments and standards and on national experience. The document is intended to support States in developing their own national systems of monitoring and response while encouraging further cooperation, coordination and harmonization at the international level. It is also intended to facilitate international trade in, and the use of, scrap metal without compromising safety.

It is recognised that there are significant ongoing national and international programmes aimed at controlling high activity radioactive sealed sources and orphan sources including programmes for their detection at borders [4, 5]. The recommendations in this document go beyond these programmes and focus on detection and response in relation to radioactively contaminated scrap metal, activated scrap metal and scrap metal with radioactive sources or substances contained within it. The recommendations cover both radioactive substances that are subject to regulatory control and radioactive substances that are outside such control and should be seen as complementary to existing programmes.

I. GENERAL PROVISIONS

A. <u>Definitions</u> *(from IAEA Safety Glossary [10] unless otherwise stated)*

(a) **Clearance level:** A value, established by a regulatory body, and expressed in terms of activity concentration and/or activity, at or below which a source of radiation may be released from regulatory control.

(b) **Naturally Occurring Radioactive Material (NORM):** Material containing naturally occurring radionuclides. *(Defined for the purposes of this document).*

(c) **Orphan source:** A radioactive source which is not under regulatory control, either because it has never been under regulatory control, or because it has been abandoned, lost, misplaced, stolen or otherwise transferred without proper authorization [4].

(d) **Polluter Pays Principle:** The principle that the polluter *(i.e., owner of the source or radioactive material)* should bear the cost of pollution *(i.e., recovery, radioactive waste management and clean-up)*, with due regard to the public interest and without distorting international trade and investment [11].

(e) **Sealed radioactive source:** Radioactive material that is (i) permanently sealed in a capsule, or (ii) closely bonded and in a solid form whose structure is such as to prevent, under normal conditions of use, any dispersion of the radioactive material into the environment. *(Defined for the purposes of this document).*

(f) **Radiation dose:** A measure of the energy deposited by radiation in a target.

(g) **Radiation monitoring:** The measurement of dose or contamination for reasons related to the assessment or control of exposure to radiation or radioactive substances, and the interpretation of the results.

(h) **Radiation protection:** The protection of people from the effects of exposure to ionizing radiation, and the means for achieving this.

(i) **Radiation protection experts:** Persons who have been approved by national authorities as certified experts having had appropriate training and experience in operational radiation protection. *(Defined for the purposes of this document).*

(j) **Radioactive contamination:** Radioactive substances on surfaces, or within solids, liquids or gases (including the human body), where their presence is unintended or undesirable.

(k) **Radioactive material:** Material designated in national law or by a regulatory body as being subject to regulatory control because of its radioactivity.

(l) **Radioactive scrap metal:** This may comprise radioactively contaminated scrap metal, activated scrap metal and scrap metal with radioactive source(s) or substances contained within it. It may include both radioactive substances that are subject to regulatory control and radioactive substances that are outside regulatory control. *(Defined for the purposes of this document).*

(m) **Radioactive substance:** A substance which exhibits radioactivity.

(n) **Radioactive waste management:** All administrative and operational activities involved in the handling, pre-treatment, treatment, conditioning, transport, storage and disposal of radioactive waste.

(o) **Radioactivity:** The phenomenon whereby atoms undergo spontaneous random disintegration, usually accompanied by the emission of radiation.

(p) **Regulatory body:** An authority or a system of authorities designated by the Government of a State as having legal authority for conducting the regulatory process, including issuing authorizations, and thereby regulating nuclear, radiation, radioactive waste and transport safety.

(q) **Response level**: A radiation level above which outside radiation protection experts should be involved. *(Defined for the purposes of this document).*

Note: In this document the term 'radioactive material' as defined above, is used to denote material that is radioactive by regulatory definition. The term 'radioactive substance' is used to describe material that is radioactive in the physical sense and so it may be within regulatory control or outside of regulatory control. Similarly, the term 'radioactive scrap metal', as defined above, may include radioactive substances that are within regulatory control and radioactive substances that are outside regulatory control.

B. Objectives

This document is intended to support States in developing their own national systems of monitoring and response related to radioactive scrap metal and to encourage further cooperation, coordination and harmonization at the international level, thereby creating global confidence in the reliability, effectiveness and quality of monitoring and response.

The recommendations in this document are intended to assist Governments, industry and all concerned parties to counter the problem of radioactively contaminated scrap metal, activated scrap metal and scrap metal with radioactive source(s) or substances contained within it (termed 'radioactive scrap metal' in this document) by seeking to prevent its occurrence, by effectively monitoring metal shipments and facilities, and by intercepting and managing any radioactive scrap metal that is detected.

This document establishes a framework of recommendations and examples of good practice for this purpose based, to the extent possible, on existing national, regional and international documents and on national experience. It sets out the responsibilities of all concerned parties and the actions required of them to fulfil the objectives.

C. Scope

The recommendations in this document cover all metals used and traded nationally and internationally as part of the metal recycling industry.

The Recommendations are addressed to all parties concerned with the metal recycling industry, including demolition companies, scrap collectors, sellers of scrap metal, owners of scrap yards, owners of scrap metal processing facilities, buyers and traders in scrap metals, temporary storage companies, owners of metal works, the transporters of scrap metal, the departments of Government responsible for the control of incoming and outgoing shipments of scrap metal, e.g. Customs or border authorities, and the Governmental bodies responsible for safety, health and the environment in the context of radioactive material usage and transport.

The Recommendations address the prevention of the occurrence of radioactive scrap metal which may or may not have been under regulatory control, its detection and the prevention of associated radiological consequences through response actions, including the subsequent management of the material and of any radioactive waste produced.

The Recommendations are aimed mainly at facilitating national and international commerce in scrap metal and improving radiation protection; they are not concerned with national/State security aspects of radioactive sources, although the recommendations on monitoring for radioactive scrap metal may complement programmes aimed at detecting highly active sources and orphan sources.

The Recommendations are aimed at achieving at least a minimum standard of performance in prevention, detection and response in countries; they are not intended to supersede existing monitoring arrangements which may go beyond this minimum standard.

The Recommendations are not intended to place legal commitments on countries but, instead, to provide recommendations and examples of good practice which have been agreed upon by Governmental and industry experts in the field for application on a voluntary basis.

The application of the Recommendations in a country will depend on national administrative and commercial circumstances as well as on prevailing national legislation.

The Recommendations are intended to help prevent the introduction of discrete radiation sources and of improperly released activated and radioactively contaminated material into the recycling stream. This will help to achieve the protection of workers and the public and to minimise the detriment to commerce. The three main steps for achieving these aims are: **prevention, detection and response**. The Recommendations address each of these steps.

D. Guidance and international legal instruments

As yet, there are no international instruments that directly address the problem of radioactive scrap metal, however, the UNECE has considered the problem in two reports [8, 9]. The reports explore the nature and scale of the problem and the ways and means to manage the problem through national and international action. In addition, the problem has been addressed by the European Union and is the subject of a Council Resolution [12].

1. National actions

There are various national initiatives aimed at countering the problems associated with radioactive scrap metal but few are well documented. Two such initiatives are described below.

In Spain, the ‘Protocol for Collaboration on the Radiation Monitoring of Metal Materials’ has been adopted by the concerned industrial organizations and by the relevant parts of Government [7]. The Protocol provides for a unified national scheme of collaboration between concerned industry and Government based on monitoring measures to prevent the inclusion of radioactive substances in the scrap recycling process and the management of the consequences of such events if they were to occur. The Protocol establishes a register held at the Ministry of Industry and Energy to which companies can subscribe - thereby accepting the rights and obligations arising from registration.

In the United States of America, the National Council on Radiation Protection and Measurements (NCRP) has reviewed the problem of potentially radioactive scrap metal in a national context and discussed the commercial and health implications as well as the practical solutions [13].

2. Actions by industry

Some industry specifications exist for the quality of scrap metal [14, 15, 16] but these are all purely voluntary. As mentioned previously, in Spain the different operators work together under the Spanish Protocol [7] to minimize the risks to the metal industry and to the wider society from radioactive scrap metal. In other countries where there is no voluntary agreement or legislation in place, the largest scrap yards and metal works have installed and operate radiation detection equipment. Some importers in the United States for instance, have installed grapple-mounted detectors to intercept any radioactive materials from bulk cargoes. These installations are all voluntary and there is currently no federal- or state-required testing in the United States. In some countries there are legislative requirements that the larger scrap yards and metal works install and operate detection equipment. However, in general, the initial investment in the equipment and the ongoing costs of operation are borne in full by the industry.

In the United States, the Institute of Scrap Recycling Industries (ISRI) has an active Radioactive Materials Task Force and is currently revising the “Recommended Practice and Procedure concerning radioactivity in the scrap recycling process”. The Conference of Radiation Control Programme Directors, Inc. (CRCPD) has two task forces that deal with "Resource and Recovery of materials contaminated with radioactive materials", and "Orphaned Radiation Sources". The CRCPD is a non-profit organization consisting of radiation programme directors from all 50 states, and is attended by affiliate members from numerous federal agencies and industry. In this organization, federal and state agencies work together with industry to solve the difficult issues with radioactive scrap metal.

It is also practice to sell and buy scrap metal according to standards drawn up by international or national standards bodies. Where standards do not exist, industry scrap specifications will usually have been agreed between the industry trade associations representing sellers and buyers, and scrap metal is sold and bought on the basis of these documents. Some of these documents have clauses that require the seller to give some assurance that the scrap metal has been checked for radioactive contamination. For instance, in the German "General Terms of Metal Trading" [16] issued by the German Metal Traders Federation it is stated that “radioactively contaminated material is excluded from any delivery, even when this has not been specifically agreed between the parties and when the quality meets the contractual specifications in all other areas”. The European Scrap Specifications developed jointly by Eurofer and EFR [14] require that all scrap consignments are completely free of any radioactivity above ambient levels. However, it should be noted that care is needed concerning which specific clauses are acceptable to insurance companies.

3. International legal instruments and standards

The Basel Convention is the principal international legal instrument governing the control of the transboundary movement of hazardous waste and it places requirements and obligations on Contracting Parties wishing to move hazardous waste between countries [17]. It is concerned that “States should take necessary measures to ensure that the management of hazardous wastes and other wastes including their transboundary movement and disposal is consistent with the protection of human health and the environment whatever the place of disposal”.

Radioactive waste is excluded from the scope of the Basel Convention because it is part of another international convention, the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (the Joint Convention) [6], but the general principles of the Basel Convention are supported in the Joint Convention. These conventions are concerned, inter alia, with regularizing planned trade in hazardous material across borders. They declare the illicit movement of such material to be a criminal act but they do not address the inadvertent transfer of material - which is the main mechanism causing the appearance of radioactive material in scrap metal.

The problem of orphan sources is addressed in several international and regional documents. A voluntary Code of Conduct on the Safety and Security of Radioactive Sources [4] and guidance on its application for the import and export of radioactive sources [18] exist to encourage States to exercise control over radioactive sources. To date, eighty IAEA member States have advised that they are supporting the Code. A Directive of the Council of the European Union (EU) on the control of high activity sealed radioactive sources and orphan sources addresses essentially the same problem [5]. The control of disused radioactive sealed sources is the subject of Article 28 of the Joint Convention [6]. In addition to its efforts to control high activity sealed radioactive sources, the IAEA has for many years assisted its Member States in the collection, safe storage and disposal of all types of disused radioactive sources. These efforts are mainly concerned with attempting to prevent the uncontrolled release of radioactive material from the system of control established for radioactive material. However, for the present, the problem of uncontrolled release of radioactive material exists. It continues to be necessary, therefore, to monitor shipments crossing borders and also within countries. This need is recognized in the context of orphan sources both in the Code of Conduct [4] and in the EU Directive [5]. Documents relating specifically to the recovery and control of orphan radioactive sources in the metal recycling industry are currently under development at the IAEA.

In relation to the controlled release of material containing very low levels of radioactive material, an international Safety Standard has recently been published by the IAEA which establishes a set of levels of radionuclides, including radionuclides from NORM, for use in the practical application of the concepts of exclusion, exemption and clearance [19]. Clearance levels have also been defined in the European Commission's document Radiation Protection 122 [20]. Schemes for the clearance of such materials are applied in many countries using similar approaches to that described in the international documents. Details of a scheme used in the United Kingdom, which has been agreed by all parts of the nuclear industry have recently been published [21]. However, it should be noted that even the detection of very low levels of radiation (above normal background) emanating from a shipment may indicate a significant, but shielded, source of radiation. Therefore all detected radiation above background levels in shipments should be subject to further investigation.

E. Origins of radioactive scrap metal

Radioactive scrap metal can occur in a number of different ways. Some of the main origins are listed below:

(a) **Demolition or decommissioning of industrial facilities processing raw materials containing naturally occurring radionuclides**. These industries include phosphate ore processing and oil and gas recovery and processing. The pipes and metal vessels from such facilities are sometimes lined with significant deposits of naturally occurring radionuclides and they may, on occasions, be mistakenly collected as scrap metal.

(b) **Decommissioning of nuclear installations (such as nuclear power plants and other nuclear fuel cycle facilities) and other facilities.** This can produce significant amounts of various metals. A fraction of this material is radioactively activated or contaminated and is normally decontaminated or disposed of as radioactive waste but, on occasions, it may be mistakenly released for recycling. Material from decommissioning or demolition containing artificial or naturally occurring radionuclides at levels below the regulatory clearance level may be released with the approval of regulatory authorities for possible recycling.

(c) **Loss of sources.** Sealed radioactive sources are sometimes lost or mislaid. They may be collected as scrap metal, often with the sealed sources still housed within their protective containers. Industrial radiography sources are used for testing welds on pipework and may be lost in the field. The loss of radioactive sources used in medicine sometimes occurs through poor accounting.

(d) **Demolition of facilities in which radioactive sources have been used**. Radioactive sources are used for many purposes in medicine (e.g., radiotherapy, diagnostic applications), research (e.g., for experimental irradiation of materials or biological specimens) and industry (e.g., level gauging, product irradiators). If such sources are not removed from facilities prior to demolition then there is a risk that they may become part of the scrap metal taken from the premises.

(e) **Incorporation of old radioactive devices into scrap.** Items such as timepieces and compasses covered with radioluminous paint, lightning rods, thoriated lenses, etc. may be collected as scrap. They may have never been subject to regulatory control.

The events most likely to give rise to radioactive scrap metal are inadvertent industrial mishaps, carelessness in the management of radiation sources and other radioactive material, errors in source accounting etc.; they are less likely to be concerned with the illicit trafficking of high activity radioactive sources.

F. Recommendations on responsibilities and coordination

1. Responsibilities

1.1 National responsibilities

There are a number of stages in the scrap metal processing chain and at each stage it is possible to identify persons with specific responsibilities in relation to preventing or monitoring for the presence of radioactive scrap metal. They include the owner of radioactive sources, the seller of scrap metal, and the buyer of scrap metal.

The owner of radioactive sources or material could be the owner of a nuclear power plant, industrial premises, a research institution or a hospital in which radioactive sources or material are used or produced. The owner of the radioactive sources or material is the person formally authorized in national legislation to use and take care of the radioactive sources or material. The seller of the scrap metal could be the owner of the premises being demolished, the company carrying out the demolition, a trading company in scrap metal, etc. The buyer of the scrap metal could be the owner of a scrap yard, a processing facility or a melting works or a scrap metal trading company. In addition, there are persons between the seller and the buyer with responsibilities in relation to the shipment of scrap metal, such as Customs or border officials and shipment carriers.

Specific Recommendations - National Responsibilities

1. **The owner of radioactive sources or material** has obligations under national legislation to keep radioactive sources and material safe and secure while they are in use and for arranging their safe storage, transport or disposal after their period of use. In the event of a radioactive source or material being lost or removed from control, the source or material owner should remain responsible.

2. **The seller of the scrap metal** (who is usually the consignor for the shipment) is usually responsible to the buyer of the scrap metal, by contractual obligation or by national regulations, to provide a product free of added radionuclides. If the seller is so contractually or legally bound, the seller should arrange for radiation monitoring to be performed on the scrap metal at the point of origin and to provide a certificate indicating the results of that monitoring. An example of a certificate of shipment monitoring is attached as Annex I. The seller should provide appropriate training of involved staff.

3. **The carrier (or carriers) of the scrap metal** could be held responsible for the material being carried, for example, in circumstances where the owner of the shipment is not known. In this and similar situations, the carrier should either monitor the shipment for radiation, or request a certificate from the seller (i.e. the consignor) of the scrap metal that the load has been appropriately monitored (see Annex I).

4. **National Customs or border authorities** should be concerned to prevent the import or export of unauthorized and potentially hazardous material and should therefore provide for the radiation monitoring of incoming and outgoing shipments of metal scrap at key border points. They should also provide appropriate training of involved staff.

5. **The buyer of the scrap metal** (e.g. the owner of the scrap yard, the processing facility or the melting works) should be sure that the material received is free of added radioactive substance. It is therefore in the buyer's interest to require a certificate indicating that the shipment has been monitored by the seller and, in addition, to arrange for monitoring of the scrap metal as it enters and leaves the premises of the scrap yard, processing facility or melting plant. The buyer should provide appropriate training of involved staff.

6. **The national regulatory body** is responsible under national legislation and regulations for the licensing and regulation of radioactive sources and radioactive material and of facilities for their radioactive waste management.
   The regulatory body also has responsibilities related to ensuring the safety of workers, the public and the environment in the event of radioactive sources or other radioactive material becoming lost or misplaced (for example, in scrap metal). In some countries, these responsibilities may be shared between different national authorities, for example, Government departments dealing with safety, health, and the environment.

   The relevant national regulatory body or bodies should therefore promulgate appropriate regulations and provide guidance and advice on:
   - procedures to ensure safety in the event of the discovery of radioactive scrap metal, and
   - the safe storage, transport and disposal of radioactive scrap metal.

7. **The seller, the buyer and the national Customs or border authorities** should institute agreements with **national organizations with expertise in radiation monitoring and radiation protection** (or these arrangements may be established by the State):
   - on the provision of advice and training on the detection of radionuclides in scrap metal or metal product and on response procedures; and
   - on the provision of assistance in the event of incidents involving radioactive material in scrap metal, processed metal or product waste producing radiation levels requiring expert response as described in Section II.C.

   The seller, the buyer and the national Customs or border authorities should also be aware of the identity of the relevant national regulatory body (or bodies) so that the regulatory body can be quickly informed in the event of such an incident.

8. **The national competent authority responsible for the safety of the transport of radioactive material** should:
   - provide advice on the requirements for the safe transport of recovered radioactive sources, radioactive material, radioactively contaminated scrap metal or product and of any resulting radioactive waste;
   - issue special authorizations, as needed, for the safe transport of the recovered material or radioactively contaminated scrap metal or product and of any radioactive waste; and
   - facilitate the return of radioactive scrap metal and of any radioactive waste across national boundaries, where this is appropriate.

9. **The national organization responsible for radioactive waste management** should, when required, provide arrangements for the safe processing and storage or disposal of the radioactive material resulting from any incident involving radioactive scrap metal, metal product or production waste.

It is noted that while responsibilities can be attributed at different levels, as indicated above, there will be circumstances in which the allocation of responsibilities is not clearly established. This is most evident when the owner of the radioactive source or material or the seller cannot be discovered or located. In the event of the detection of radioactive scrap metal, contaminated metal product or production waste, this can cause severe difficulties in financing the necessary radioactive waste management or clean-up operations. This is discussed further in Section 3.

1.2 International responsibilities

As discussed in Section D, international and regional instruments such as the Joint Convention and the EU Directive [6, 5] place legal obligations on States to control and safely manage radioactive sources and disused radioactive sources but to date there are no international instruments related directly to the management of the inadvertent transfer of radioactive substances in scrap metal.

2. Coordination

A distinction may be made between situations involving radioactive scrap metal due to events within the country and due to trade with other countries. In general, the responsibilities and financial liabilities are easier to allocate when the source owner, the seller and the buyer of the scrap metal are all within the same country. When imported material is discovered to be radioactive scrap metal, determining the source owner and/or scrap metal seller can be a problem. In addition, the involvement

of more than one national legal and regulatory system can complicate the issue. Finally, the allocation of responsibilities and the recovery of the costs of radioactive waste management and clean-up are likely to be more difficult.

2.1 National coordination

National laws and regulations apply with respect to the loss of control of radioactive sources and the national regulatory body is empowered to take action in relation to the owner of the radioactive sources.

Specific Recommendation - National Coordination

Government ministries, Governmental authorities (safety and Customs or border authorities), agencies competent in radiation protection, transport and waste management and the industry (the metal scrap recycling industry and metal works) should cooperate in resolving problems associated with radioactive scrap metal and products. They should aim to establish a unified national approach with positive incentives and relief measures for all concerned. The example of Spain in this context provides a good model [7]. Annex II shows an example of the possible contents of a unified national collaborative scheme.

2.2 International coordination

By coordinated action, the Governments and industries of States can together contribute to improving the effectiveness of the detection of radioactive scrap metal and of measures in response to its discovery.

Specific Recommendations - International Coordination

1. **States** should:
   - promote cooperation between Customs or border authorities in relation to monitoring at borders, for example, by two neighbouring States sharing monitoring facilities, thereby reducing monitoring needs;
   - promote cooperation between involved States' regulatory bodies in the management of incidents involving radioactive scrap metal.

2. **The metal recycling industry** should promote cooperation between the industries in different States in providing advance warning of potential problems with scrap metal shipments.

3. **States and the metal recycling industry** should encourage industries and Customs or border authorities in neighbouring States to work towards the harmonization of methods and procedures used for detection, thereby increasing confidence that shipments have been effectively monitored for the presence of radiation.

3. Costs and financing

To the extent possible, the costs due to loss of revenues because of delays, unavailability of facilities, clean-up operations and radioactive waste management should be allocated on the basis of the 'polluter pays' principle [11]. Application of this principle implies that the original owner of the radioactive material found in the scrap metal is responsible for the recovery, transport, storage and waste management costs and for the costs associated with any clean-up operations required.

The 'polluter pays' principle should be incorporated into the contract between the seller and the buyer of scrap metal such that the costs associated with the management and disposal of any radioactive material found in a scrap metal shipment and any clean-up costs are covered by the seller if the original owner of the radioactive material cannot be found.

The ownership of any detected radioactive material should be clearly established, for example, by reference to the INCOTERMS (an international set of trade terms adopted by most countries defining exactly the responsibilities and liabilities of both the buyer and seller while the merchandise is in transit) in the contract between the seller and the buyer of the scrap metal. In particular, the time and location of any transfers of ownership should be clearly specified.

In cases where it is not possible to determine the original owner of the radioactive material or the seller of the scrap metal, the financial responsibility normally falls on the owner of the premises where the radioactive scrap metal or contaminated processed metal is discovered. Since this could place undue financial burdens on individual owners of premises, it is desirable for there to be arrangements established in the State to provide assistance in the radioactive waste management and disposal and for any clean-up operations needed in relation to radioactive material originating from unidentifiable suppliers. This can be achieved in various ways including a specific insurance policy, a special national fund, possibly established in national legislation or a collaborative approach between Government and industry. In the context of orphan sources, it is noted that Article 10 of the EU Directive [5] requires that Member States establish "a system of financial security ... or any other equivalent means to cover intervention costs relating to the recovery of orphan sources". Annex III gives some examples of national provisions that have been made to provide assistance in the management of the potential consequences associated with the discovery of radioactive scrap metal when the original owner cannot be found.

Specific Recommendations - Costs and financing

1. **The buyer of scrap metal** should ensure that a 'polluter pays' clause is contained in all contracts for the purchase of scrap metal.

2. **Government and industry** should establish arrangements to assist owners of premises at which radioactive scrap metal or contaminated processed metal has been discovered originating from unidentifiable suppliers, in the recovery operations, the management and disposal of any radioactive waste and any necessary clean-up operations.

II. FIELDS OF ACTION

A. Recommendations on prevention

1. Prevention of occurrence

In order to prevent the occurrence of events leading to radiation hazards to workers, the public and the environment, States should make arrangements for the safety of facilities and sources of ionizing radiation. Effective safety arrangements prevent the loss of control over sealed radioactive sources and radioactive material and reduce the likelihood of the appearance of radioactive material in scrap metal shipments.

An important first step in achieving this objective is to establish an appropriate legal and Governmental infrastructure for the safety of facilities and sources of ionizing radiation. This should include national arrangements for radiation protection, the safe management of radioactive waste and the safe transport of radioactive material. To assist States in creating such an infrastructure, the IAEA has published safety standards which cover the establishment of a legal framework and regulations, the establishment of a regulatory body and other actions to achieve effective control of facilities and activities involving radioactive sources and radioactive material [22, 23, 24].

In recognition of the particular problems associated with sealed radioactive sources and to ensure that sources within States' territories are safely managed and securely protected during their useful lives and at the end of their useful lives, an international Code of Conduct has been established [4]. It encourages States to institute means for ensuring that sealed radioactive sources are managed safely and securely. The EU Directive of 2003 places similar obligations on EU Member States [5].

Specific Recommendations - Prevention of occurrence

States should:

- have in place an effective national legislative and regulatory system of control over sealed radioactive sources and radioactive material. This should include a regulatory body to enforce the regulations established within this system;
- have appropriate facilities, arrangements and services for radiation protection available to persons who are authorized to manage radioactive sources;
- ensure that adequate arrangements are in place for the training of staff from the regulatory body, law enforcement agencies and emergency service organizations;
- establish a national register of radioactive sources (for details see reference [4]);
- ensure that source owners carry out regular checks to confirm that their inventory of radioactive sources is intact;
- promote awareness of the safety and security hazards associated with orphan sources;
- emphasize to sealed radioactive source designers, manufacturers, suppliers and users and those managing disused sources their responsibilities for the safety and security of the sources;
- ensure that the possession, remanufacturing or disposal of disused sealed radioactive sources takes place in a safe manner;
- provide arrangements for the safe management and disposal of radioactive waste.

2. Preparedness

Recognizing that the above arrangements are not always completely effective because of human error, neglect, and lack of proper training, etc. and that there is always a finite risk that radioactive scrap metal will be discovered, States should assess their own national situations. They should assess the likelihood that such problems could occur within their territories and their state of preparedness for such events. In this context, it is noted that the likelihood will vary considerably depending, inter alia, on the location of the country under consideration and the nature and extent of its metal industries. The likelihood assessment should include consideration of the following:

(a) the magnitude of the scrap metal recycling industry in the country, i.e. the number of scrap metal suppliers, collection facilities and metal processing facilities;
(b) the frequency of incoming scrap metal shipments from foreign countries and the sources of the scrap metal; and
(c) the history of the occurrence of national events involving the detection of radioactive scrap metal.

Plans to counteract the possible presence of radioactive scrap metal should be in place. They should include the provision of radiation detection capabilities at key locations in the State (Section II.B.), expertise to evaluate and respond to radiation alarms (Section II.C.), and the training of relevant personnel (Section III.A.).

The nature and extent of the plans and arrangements in a State should be proportional to the risk of the occurrence of radiation events involving scrap metal. They may, therefore, range from small scale monitoring in States with little or no scrap metal processing industries, e.g., monitoring checks at scrap metal suppliers‘ premises and at borders, to wide ranging monitoring in countries with large scale metal recycling industries, e.g. scrap metal collection yards, metal processing facilities and metal works and at borders. The level and extent of monitoring arrangements, of national expertise in radiation detection and event evaluation and of training programmes should be determined on the basis of the findings of the likelihood assessment.

Specific Recommendations - Preparedness

States should:

- assess the likelihood of the occurrence of events involving the presence of radioactive scrap metal within the State;
- review and, if necessary, improve national arrangements to counteract the possible presence of radioactive scrap metal. The extent of the arrangements should be proportional to the likelihood of event occurrence and the associated hazard; and
- as appropriate, and based on the likelihood assessment, require Customs or border organizations to install radiation monitors for the surveillance of scrap metal shipments at key border points and encourage owners of major scrap metal yards, processing facilities and melting plants to install equipment to monitor incoming shipments and outgoing metal products and waste.

B. Recommendations on detection

1. General aspects

The monitoring of scrap metal should be performed at key points during its movement from its origin to the processing or melting facility, that is:

(a) at the main points of origin of the scrap metal;
(b) at main borders and points of entry of the State or region; and
(c) at the entrances and exits to major scrap yards, processing facilities and melting plants (including the monitoring of metal products and production waste, e.g., slag and waste gases).

Monitoring, in this context, may take the form of 'administrative monitoring', to determine the likelihood that scrap metal shipments contain radioactive scrap metal; 'visual monitoring', to check for the presence of typical radiation warning signs and source housings; and 'radiation monitoring', to check radiation levels in the vicinity of the shipment.

It will be necessary to make judgements on the extent and location of the monitoring required in a State. A first priority should be given to providing monitoring at the scrap yards of the major sellers and at the major locations of other sources of scrap metal, e.g: at demolition sites where the presence of radioactive material is suspected. Next, monitoring should be provided at the border crossings through which scrap metal shipments pass with some regularity and at the larger of the scrap metal processing facilities and at melting plants. The judgements should be informed by knowledge of the previous history relating to the occurrence of radioactive scrap metal in shipments.

It is noted that, in some regions, the barriers at border crossings between States no longer exist, for example, in some parts of the European Union, and this means that there is monitoring only at the outer borders of the region. This may imply that greater reliance has to be placed on monitoring at the scrap metal recycling facilities within each State of the region.

Arrangements are already in place in many States to provide for monitoring [8, 9]. However, the monitoring and response schemes in use vary in their extent and nature from country to country and from facility to facility. As stated earlier, an important objective of these Recommendations is to assist countries in harmonizing monitoring and response arrangements in States and between States so that there is improved confidence in the reliability of the neighbouring States' arrangements. Neighbouring States should therefore exchange information about their national arrangements and, if necessary, seek to improve them using this document as a basis. The information exchanged should include, inter alia, the locations of border monitoring stations, the types and sensitivities of the systems employed, the monitoring procedures adopted including alarm levels, and response arrangements.

Specific Recommendations - Detection (General)

States should:

- ensure that monitoring is carried out at each of the key points of the scrap metal movement within the State. The monitoring should take the form of:
  - administrative monitoring, to determine the likelihood that scrap metal shipments contain radioactive scrap metal,
  - visual monitoring, to check for the presence of typical radiation warning signs and source housings, and
  - radiation monitoring, to check radiation levels in the vicinity of the shipment;
- exchange information on monitoring and response arrangement with neighbouring States as a means of improving international harmonization.

2. Administrative monitoring

Knowledge of the origin of the scrap metal, of the scrap metal supplier and the history of previous transactions can provide a first indication of whether there is a significant potential for radioactive scrap metal to be present in consignments. Incoming shipments to scrap yards, processing facilities and melting plants should, therefore, be reviewed in relation to these factors.

Specific Recommendations - Administrative Monitoring

Persons responsible for the reception and monitoring of the shipments should be alerted if the shipment:

- arrives without evidence of radiation monitoring having been performed before shipment or during shipment;
- is from a supplier with a previous history involving the supply of radioactive scrap metal; and
- is from a supplier not previously known to the recipient company or the regulatory authorities.

3. Visual monitoring

Scrap metal should be visually monitored during its handling at scrap yards, processing facilities, melting plants and at borders. Persons handling scrap should be trained to recognize the different types of radiation sources, source housings and radioactivity warning signs. Guidance on the different types of radiation sources and source housings is contained in an international catalogue produced by the IAEA [24].

Specific Recommendation - Visual Monitoring

Scrap yard, processing facility, melting plant and border personnel should be properly trained to visually recognize radioactivity warning signs and the different types of radiation sources and source housings.

4. Radiation monitoring

Where there is an identified risk or doubt concerning the possible presence of radioactive material in scrap metal shipments by road, rail, inland waterway and sea, the shipments should be checked for radiation using fixed (for example, portal, conveyor, or grapple monitors) or portable monitors. Annex IV provides more detail on the radiation monitoring of scrap metal shipments.

As noted earlier, even the detection of very low levels of radiation (above normal background) from a shipment may indicate a significant, but shielded, source of radiation. Therefore all detected radiation above background levels in shipments should be subject to further investigation.

For convenience in application, guidance on monitoring is given separately in the following paragraphs for owners of companies from which scrap metal shipments originate, Customs or border authorities, and owners of scrap yards, processing facilities and melting plants.

4.1 Radiation monitoring at the point of origin

Scrap metal shipments should be monitored for radiation at the main points of origin prior to their transportation.

In the event that certification is not provided for a shipment, **the assigned carrier** should request such a certificate from the owner of the shipment or arrange for the monitoring of the shipment to be performed, as described below.

Specific Recommendations - Radiation monitoring at the point of origin

Owners of companies from which scrap metal shipments originate should:

- ensure shipments are checked by administrative and visual means (Sections II.B.2. and II. B. 3.) for the possible presence of radioactive scrap metal;
- perform monitoring of shipments for radiation at the exit of the premises where scrap is collected;
- provide a certificate to accompany the scrap metal shipment as evidence that the shipment has been checked for the presence of radiation (see Annex I)
- ensure the effectiveness of the radiation monitors by appropriate quality assurance procedures to verify their ability to detect changes in radiation intensity;
- arrange for periodic calibration and testing of the detectors (at least annually) to ensure optimum performance;
- provide appropriate training in radiation monitoring and initial response procedures for the involved personnel;
- establish a response plan for action in the event of radioactive scrap metal being discovered (Section II.C.);
- make formal arrangements with a national organization with expertise in radiation monitoring and radiation protection:
  - to provide training of personnel in radiation detection and response procedures, and
  - to provide assistance in the event of a radiation incident involving the detection of radioactive scrap metal.

4.2 Radiation monitoring at borders

At key border points, arrangements should be made for the monitoring of scrap metal shipments; this includes seaports and land crossings. In this context, States may consider introducing appropriate administrative instructions and/or legislation requiring that incoming or outgoing scrap metal is monitored for radiation at borders or, in the case of the EU or other similar regions, at the borders of the region.

It is noted that radiation monitoring at borders is also carried out for the purpose of detecting the illicit trafficking of sources and for the detection of orphan sources [4, 5, 25] and that the monitoring of scrap metal shipments may be seen as a complementary activity.

Specific Recommendations- Radiation monitoring at borders

Customs or border authorities should:

- ensure that shipments of metal scrap are checked by administrative and visual means (Sections II.B.2. and II.B.3.);
- perform radiation monitoring at each major road and rail border crossing on shipments of scrap metal;
- ensure the effectiveness of the radiation monitors by appropriate quality assurance procedures to verify the ability to detect changes in radiation intensity;
- arrange for periodic calibration and testing of the detectors (at least annually) to ensure optimum performance;
- provide appropriate training in radiation monitoring and initial response procedures for Customs' officers likely to be involved in the monitoring of scrap metal shipments;
- establish a response plan for action in the event of radioactive material being discovered (Section II.C.); and
- make a formal arrangement with a national organization with expertise in radiation monitoring and radiation protection:
  - to provide training of personnel on radiation detection and response procedures, and
  - to provide assistance in the event of radiation incidents involving the detection of radioactive scrap metal.

4.3 Radiation monitoring at scrap yards, processing facilities and melting plants

Scrap metal should be monitored for radiation at the entrances and exits of all major scrap yards, processing facilities and melting plants and at any facility where there is a significant potential for radioactive scrap metal to be present in incoming shipments. Depending on the size of the facility this may be achieved by means of fixed portal monitors and/or hand-held monitors. In addition, in-plant monitoring of conveyors or within scrap grapples or dust collection systems may be used to supplement the other forms of monitoring.

Specific Recommendations - Radiation monitoring at scrap yards, processing facilities and melting plants

1. **Owners of major scrap yards, processing facilities and melting plants** should:
   - ensure incoming and outgoing shipments are checked by administrative and visual means (Sections II.B.2. and II.B.3.);
   - provide radiation monitors at the entrance/exit to the premises and, as appropriate, on conveyors and grapples. All entrances and exits should be monitored;
   - ensure the effectiveness of the radiation monitors by appropriate quality assurance procedures to verify the ability to detect changes in radiation intensity;
   - arrange for periodic calibration and testing of the detectors (at least annually) to ensure optimum performance;
   - provide appropriate training in radiation monitoring and initial response procedures for personnel likely to be involved in the monitoring of scrap metal shipments;
   - establish a response plan for action in the event of radioactive material being discovered (Section II.C.);
   - make a formal arrangement with a national organization with expertise in radiation monitoring and radiation protection to provide:
     - training of personnel on radiation detection and response procedures, and
     - assistance in the event of a radiation incident involving the detection of radioactive scrap metal; and
   - require that contracts for the supply of scrap metal include the condition that any costs associated with radioactive material discovered in shipments will be accepted by the seller unless the original owner of the radioactive source or material can be found.

2. **Owners of melting plants** should provide arrangements for the radiation monitoring of production waste systems, including monitoring of slag and dust collectors.

C. Recommendations on response

A response plan should exist at all locations where scrap metal, metal product or production waste is being monitored so that, in the event of sources or source housings being observed or elevated levels of radiation being detected in the scrap metal, in the processed metal, or the production waste, actions are clear and known in advance by operators and responsible organizations. Those involved should be appropriately trained in the implementation of the response plan.

1. Response to an alarm

If radiation is detected such that a radiation alarm in a monitor is triggered:

(a) The result should be checked and, if, after checking, the result is verified, the shipment should be immobilized, or in the case of metal processing, the process should be stopped. Access of personnel to the material should be limited to staff members of the facility trained in radiation monitoring and radiation protection.

(b) The staff members of the facility trained in radiation monitoring and radiation protection should carry out a preliminary investigation of the situation. If they find that the radiation level is less than a specified "Response Level" and if no radioactive contamination is detected, they should continue to investigate the situation. They should locate and isolate the radioactive substance so that it will not interfere with the operation of the radiation detection system.

(c) If, at the time of the preliminary investigation, the observed radiation levels exceed the "Response Level" or if radioactive contamination is detected in the vicinity, the external radiation protection experts (referred to in Section I.F.1.1.) should be promptly contacted. Similarly, they should be contacted if, during the preliminary investigation, any movement and rearrangement of the scrap metal produces radiation levels in excess of the "Response Level". The "Response Level" above which outside radiation protection experts should be involved should be set by the national regulatory body (Annex IV provides some examples of response levels set for this purpose).

The external radiation protection experts should:

(i) inspect the scrap metal shipment or the affected processed metal or production waste in detail until the part or parts containing the radioactive substance have been identified, taking due care to ensure that all persons involved are adequately protected from radiation during the inspection operation (that is, their exposures are kept as low as reasonably achievable with the restriction that doses to individuals are less than the dose constraints set by the national regulatory body [3]);
(ii) determine the radionuclides (and their approximate activities) contained in the unprocessed metal scrap in the shipment, the processed material, the melt or the production waste;
(iii) isolate the radioactive source or substance and place it in a safe location;
(iv) check to determine if any radioactive substances have been dispersed in the local area (by measurements to detect any surface contamination) and assess the likelihood of any other area being affected prior to the arrival of the shipment at the facility;
(v) draw up a report describing the actions taken, the results of the investigation and the steps taken to recover from the incident (an example reporting form is contained in Annex V).

(d) The regulatory body should be promptly notified of the event by the facility owner or manager or by the senior Customs or border official, if it is judged to be radiologically significant by the radiation protection experts according to State requirements or guidelines. The regulatory body should be provided with a copy of the report of the radiation protection experts.

(e) The recovered radioactive source or substance should be stored in a safe and secure location until arrangements have been made to safely dispose of it. In the event that the discovered radioactive substance is a sealed source, it is important to consult the national regulatory authority urgently on the best course of action for its management.

Specific Recommendations - Response to an alarm

1. **Members of staff of the facility trained in radiation monitoring and radiation protection,** should, when a radiation alarm in a monitor is triggered and the result has been checked and verified, carry out a preliminary investigation of the situation. If they find that the radiation level is **less than a specified "Response Level"** and if no radioactive contamination is detected, they should continue to investigate the situation. They should locate and isolate the radioactive substance so that it will not interfere with the operation of the radiation detection system.

2. **Owners or managers of the companies from which scrap metal shipments originate, Customs or border officials, owners or managers of scrap metal yards, processing facilities or melting plants** should, on being alerted by responsible staff of a verified radiation alarm with radiation levels **in excess of the "Response Level"** or of radioactive contamination being detected:
   - contact the external radiation protection experts to provide assistance in safely locating and removing the radioactive source or substance from the scrap metal, the melt or the production waste and/or determining the presence and extent of any radioactive contamination;
   - notify the regulatory body promptly (by telephone) if the event is judged by the radiation protection experts to be radiologically significant, and, subsequently, provide the regulatory body with the report of the radiation protection experts; and,
   - ensure that the recovered radioactive material is placed in a safe and secure location pending its disposal.

3. **The relevant national regulatory body** should:
   - provide guidance and advice on procedures to ensure safety in the event of radioactive material being discovered in scrap metal, metal product or waste; and,
   - authorize arrangements for the safe storage and disposal of radioactive sources and material, scrap metal, metal product or waste contaminated with radioactive material.

4. **The national competent authority for the safe transport of radioactive material** should:
   - provide advice on the requirements for the safe transportation of radioactive material, scrap metal, metal product or waste contaminated with radioactive material; and
   - issue special authorizations, as needed, for the safe transport of the recovered material, scrap metal, metal product or waste contaminated with radioactive material.
   - where possible, and in collaboration with competent authorities in neighbouring States, facilitate the return of radioactive scrap metal across national boundaries.

2. Management of detected radioactive material

Several options exist for the management of radioactive sources or material found in the scrap metal. It may be:

(a) returned to the last owner of the material, if this is possible, using arrangements approved by the regulatory body and the national competent authority for the safe transport of radioactive material (however, as stated in the Joint Convention and the Code of Conduct [6, 4], disused radioactive sources should not be exported to States not having the administrative capability, resources and regulatory structure needed to ensure that the source will be managed safely). In the event that radioactive sources or material are to be returned to another State, the national regulatory body should inform its counterpart regulatory body;

(b) treated as radioactive waste and transferred to a suitable waste repository or waste storage facility.

It will generally not be acceptable to leave radioactive sources or material at the facility or border crossing where they were detected unless the facility has been licensed by the appropriate regulatory body for storage of such material, as it may ultimately cause a hazard to persons and/or contaminate the local environment and, in addition, may interfere with the operation of the radiation detection system at the facility. Temporary storage may be allowed by the regulatory body if the proposed storage arrangements provide adequate radiation protection and security of the stored radioactive sources or material.

In the event of radioactive material having become dispersed at the facility where it was detected, the affected areas should be decontaminated and cleaned and the resulting material should be disposed of as radioactive waste. Such actions may require that metal processing operations be halted until the decontamination, cleanup and disposal activities are adequately completed, and radiation protection of personnel is ensured. Assistance in decontamination, cleanup and disposal should be available from the national organizations responsible for radiation protection and radioactive waste management.

In the event that radionuclides have been transferred into metal products and these products have been distributed from the manufacturing facility prior to detection of the contamination, it will be necessary to take actions to safely recover these manufactured products, transport them and appropriately store and/or dispose of them.

In all cases, when the recovered material is moved for return to its previous owner, to storage or for disposal at locations away from the site of its discovery, it must be transported as radioactive material in compliance with transport regulations for radioactive material. These exist both at the national level and at the international level. However, national and international transport regulations [26,27,28,29,30] are generally consistent with the internationally agreed transport regulations recommended by the IAEA [23] and the United Nations [31].

Specific Recommendations - Management of detected radioactive material

1. **The owner of the scrap metal yard, processing facility or melting plant or the Customs or border authority** should:
   - if possible, request the last owner of the shipment containing radioactive scrap metal to take it back, provided that this action is approved by the relevant national authorities and that the last owner is competent to safely manage the radioactive material on its return;
   - if this is not possible, contact the national organization responsible for radioactive waste management and request assistance in disposing of the radioactive material;
   - if there is radioactive contamination present on surfaces, request the assistance of the radiation protection experts and/or the national organization responsible for radioactive waste management to decontaminate the affected areas and to dispose of any radioactive waste produced in the decontamination operation;
   - ensure that any movement of radioactive material is done with the approval of the national competent authority for the safe transport of radioactive material.

2. **States** should:
   - have arrangements in place for the safe storage or disposal of radioactive material and waste;
   - have an authorized national body to manage such radioactive material and waste;
   - ensure regulations are in place, and are managed by a competent authority, to cover the safe transport of radioactive scrap metal or waste resulting from the disposition of radioactive scrap metal; and
   - to the extent possible, facilitate the return of radioactive scrap metal across borders.

3. Reporting

3.1 National reporting

As indicated in Section II.C.2, in the first instance, a report should be made by the owner of the facility at which the detection of radioactive material occurred (seller, Customs authority, buyer) or by the carrier to the national regulator - (i) promptly, by telephone or email, and (ii) later, in writing using a reporting format similar to that shown in Annex V.

Specific Recommendation– National reporting

Managers of scrap metal yards, processing facilities and melting plants, Customs or border officials, and carriers should promptly notify the responsible national authorities in the event of a radiation incident involving radioactive material in scrap metal, metal product or production waste.

3.2 International reporting

If the incident could have transboundary implications, as for example, in the case of the dispersal of radioactive material to atmosphere from a melting facility or the discovery of a widely exported batch of scrap or processed metal, the incident should be reported to the IAEA as soon as possible so that potentially affected States can be warned and can take protective action. Such an event, which may have potential radiological significance to another State, should be reported by the designated national authority (usually the national regulatory body) to the IAEA Incident and Emergency Centre (IEC). This is a legal requirement for States that are Contracting Parties to the Convention on Early Notification of a Nuclear Accident [32] but is recommended as an appropriate course of action for all States in these circumstances. For States of the European Union there is a similar reporting requirement within the European Union.

Specific Recommendation– International reporting

States should immediately report to the IAEA as well as to the potentially affected State or States any incident involving the dispersal of scrap metal containing radioactive material that may have transboundary implications.

III. ADDITIONAL PROVISIONS

A. Training

Specific Recommendations – Training

1. **Owners of companies from which scrap metal shipments originate, Customs or border authorities, owners of scrap metal yards, processing facilities and melting plants, and owners of scrap metal shipment companies** should provide appropriate training for the management and workers at border points or facilities where scrap metal, metal product or production waste containing radioactive substances may be found or processed, and for the staff of carriers involved in the shipment of scrap metals. Staff should be:
   - informed of the possibility that they may be confronted with scrap metal containing radioactive substances;
   - informed of the basic facts about ionizing radiation and its effects;
   - advised and trained in the visual detection of sealed radiation sources and their containers;
   - trained in the use of fixed and portable radiation detection equipment, as appropriate; and
   - trained in the action to be taken in the event of the detection or suspected detection of a radiation source or radioactive substance.

2. The training in radiation protection, monitoring and response should be provided by recognized **radiation protection experts.**

B. Information exchange

Reports and analyses of incidents involving radioactive scrap metal are valuable to the national and international scrap metal community as a means of learning from the experiences of others.

1. National level

The national authorities (regulatory body, Customs or border authority*)* should make available to the scrap metal industry, through the national registry of companies (if it exists), professional bodies, associations, unions, etc. information on incidents that have occurred involving radioactive scrap metal.

2. International level

An international internet-based information exchange system of radiation incidents affecting the scrap metal industry should be established for the benefit of the worldwide metal recycling community. It should include analysis of incidents and a summary of the lessons learned.

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ANNEXES TO THE RECOMMENDATIONS ON MONITORING AND RESPONSE PROCEDURES FOR RADIOACTIVE SCRAP METAL

Annex I

EXAMPLE CERTIFICATE OF SHIPMENT MONITORING

(to be part of the supplier's consignment documents)

It is desirable for the supplier of scrap metal to provide evidence, in the form of a certificate of shipment monitoring, for the benefit of the buyer that shipments of scrap metal have been monitored for radiation. This will often be a requirement within the contract between supplier and buyer. The monitoring should be done before the shipments leave the premises of the supplier and should be carried out by a reliable, qualified and independent organization/company. The qualified monitoring organization should provide the supplier with a certificate for each shipment that is monitored. An example certificate is shown below.

MONITORING STATION	
Location of monitoring station	
Name of organization/company and person conducting the monitoring	
Address	
Telephone	
Fax	
E-mail	
DETAILS OF LOAD	
Country of origin	
Origin of load - supplier of merchandise (*address, contact person and telephone)*	
Destination of load (*contact details of recipient)*	
Identification of load (*reference to transit documents being carried with the load)*	
Means of transport (*identify truck, ship, container, etc.)*	
Details of carrier (*contact details*)	
MEASUREMENTS	
Details of the monitoring equipment used	
Average values measured at 1 metre from the surface of the load (μSv/h)	
Maximum dose rate value in contact with the outer surface of the container, truck or wagon, in μSv/h (*identify position*)	
Background radiation value in the area, in μSv/h	
CERTIFICATION STATEMENT (*by person responsible for monitoring*) Certifying that the above values are a true record of the measurements made at the date of monitoring stated below.	
Official stamp of monitoring organization/company	
Date of monitoring of shipment	

N.B. No certification document should be provided for a load showing radiation levels significantly in excess of natural radiation background in the local area.

Annex II

EXAMPLE CONTENT OF A UNIFIED NATIONAL COLLABORATIVE SCHEME

A unified national collaborative scheme would provide benefits to all parties involved. The concerned industrial companies would benefit through a reduction of the likelihood that their products would be affected by radioactive material and also through the knowledge that, in the event of an incident, they could obtain help on response procedures and waste management through the national scheme. The national authorities would benefit from the scheme through the reduced likelihood of events leading to public radiation exposure and possible environmental damage and the evidence that they are fulfilling their mandates effectively.

The features of such a unified national collaborative scheme could be:

1. **National registry**
   A registry which individual companies would sign and thereby commit themselves to the national scheme. The registry would provide a means for determining the scale and scope of the monitoring network required. It would provide a clear overview of all the companies involved and, therefore, of the national situation.

2. **Harmonized detection measures**
   Agreed and harmonized measures and procedures for detecting radioactive materials at key stages and points in the metal recycling process. These would include regular checks by expert organizations on the effectiveness and efficiency of radiation detection equipment.

3. **Checks at key border points**
   Provision of arrangements by Governmental organizations (Customs or border authorities) at key border points to check imported and exported material for the presence of radiation.

4. **Assistance in response**
   Assistance by national expert organizations in responding to incidents involving the discovery of radioactive material.

5. **Assistance in management**
   Assistance by national expert organizations in the handling, management and disposal of any radioactive material discovered and the management of incidents involving the spread of radioactive contamination.

6. **Assistance in training**
   Assistance by national expert organizations in the training of involved staff.

7. **National support arrangements**
   Where it is not possible to determine the original owner of the radioactive material or the seller of the scrap metal, the financial responsibility would normally fall on the owner of the premises where the radioactive material is discovered. Since this could place undue burdens on individual owners of premises, it is desirable for there to be arrangements established in the country to assist in providing for the radioactive waste management and disposal and for any clean-up operations needed in relation to radioactive material originating from unidentifiable suppliers.

This example is based on the Spanish Protocol for Collaboration on the Radiation Monitoring of Metallic Materials [7] which provides a good example of a unified national approach to countering the problem of radioactive material appearing in scrap metal. It is an incentive scheme that involves all of the main concerned Governmental and industrial organizations.

Annex III

EXAMPLE NATIONAL ARRANGEMENTS TO SUPPORT RESPONSE TO THE DISCOVERY OF RADIOACTIVE SCRAP METAL

INTRODUCTION

Various types of national arrangements exist to manage and pay for events associated with the discovery of radioactive material in scrap metal shipments or in processed metal or process waste. They vary from schemes in which the Government takes whole or partial responsibility for the management and associated costs to schemes which rely on insurances taken out by the private companies. In almost all cases, the polluter pays principle is applied whenever it is possible.

Some examples are briefly described below. They are all of the former type, i.e. based essentially on the polluter pays principle backed by partial Governmental support.

BULGARIA

In Bulgaria, a system of nuclear control exists which extends to the scrap metal recycling industry.

For scrap metal, the first line of defence is the scrap metal delivery contact, i.e. the declaration provided by the suppliers (scrap metal owners) stating that according to their own measurements (performed with hand-held devices) the scrap is free of dangerous waste. The second line of defence consists of measurements performed by the big smelting companies by means of two pillars containing plastic-scintillation detectors.

If radioactive scrap metal is discovered, the scrap metal owner (national or foreign), is obliged to cover all expenses associated with the recovery and disposal of the material and any clean-up costs.

In the case of detection of radioactive scrap metal at the borders, the scrap is returned to the country of origin and the Nuclear Regulatory Agency (NRA) notifies the competent foreign authorities.

However, in the case of the discovery of an orphan source, including an orphan source in scrap metal, if it is not possible to find the owner of the source, the NRA assigns a legal person or responsible organization to deal with it and prescribes the conditions for the implementation of the assigned activities. In this case, the orphan source is declared as radioactive waste and becomes State property and all expenditures are covered by the specially created state Radioactive Waste Fund.

All radioactive materials are sent for storage at the radioactive waste repository operated by the State radioactive waste organization and the information is recorded by the NRA.

CROATIA

In Croatia, the appointed Government agency for radiation protection manages the situations in which radioactive material is discovered in shipments. On discovery of radioactive substances in a shipment from abroad, the shipment is sealed and returned to the border.

If the detected radioactive substance is from within the country, the radiation protection agency provides a safe and secure store for the radioactive substance or source. It then seeks to discover the owner of the radioactive source or material within the country. If the owner cannot be found it takes over the costs of management of the radioactive source or substance.

SPAIN

Within the terms of the Spanish Protocol for Collaboration on the Radiation Monitoring of Metallic Materials [7], the subscribing companies obtain advice, assistance and training from Governmental expert organizations related to the monitoring of scrap metal shipments or processed metal and appropriate response actions. In the event of radioactive substances being discovered in shipments or in processed metal, a well-defined scheme exists for the management of the radioactive substances involving all concerned Governmental agencies.

The costs of the management activities are to be borne by the subscribing companies unless they can be recovered from the "supplier or dispatcher". These costs are much higher for companies not subscribing to the Protocol. An exception is where the radioactive source or substance originates within the territory of Spain, in which case the costs are borne by the national organization responsible for radioactive waste management (ENRESA). The national regulatory body can claim back any costs of work it has performed from the subscribing company.

A Royal Decree 229/2006 on the control of sealed radioactive sources with high activity and orphan sources came into force in 2006. This is the national adaptation of European Union Directive 2003/122/EURATOM of 22 December 2003 on the control of sealed radioactive sources with high activity and orphan sources. Through this decree, which complements the Protocol, the necessary financial guarantees are established to remove orphan sources and to cover the costs of whatever incident such sources may cause (although the polluter pays principle is invoked wherever possible).

Annex IV

EXAMPLES OF MONITORING PROCEDURES USED FOR SCRAP METAL SHIPMENTS

In this annex, examples are provided of the procedures specified by the regulatory authorities of two countries (Belgium and Switzerland) for the radiation monitoring of scrap metal shipments. In addition, some guidance is extracted from an IAEA document on the procedures for monitoring shipments at borders. It should be noted that the IAEA document was developed mainly in the context of detecting orphan sources or the illicit trafficking of high activity radioactive sources at borders.

BELGIUM

Summary of the Belgian directive on the use of a portal monitor of radioactivity in the non nuclear sector

Each portal monitor must be registered with the Federal Agency for Nuclear Control. The portal monitor must be tested at least once a month. Maintenance and calibration must be carried out at least once a year. The threshold of the portal monitor must not exceed 5σ (where σ is the standard deviation of the background count rate). The speed of the vehicle passing through the portal monitor must be limited (typically to 10 km/h). The staff of the facility responsible for the operation of the detection equipment must have had proper training.

In case of the detection of radiation in excess of the threshold levels (portal monitor alarm level), the shipment may not be returned to the supplier except in the following cases:

- the supplier's facility is also equipped with a registered portal monitor
- the supplier is located abroad
- the supplier is an hospital with a nuclear authorization (for medical waste)

Even in these three cases, return is not allowed if the dose rate at the surface of the shipment is higher than 5 μSv/h. If the portal monitor threshold levels are exceeded (alarm level), the operator must measure the contact radiation dose rate at the surface of the shipment,

- If the radiation dose rate is greater than 5 μSv/h, the operator must call a radiation protection expert to handle the situation. *(This level is termed the Response Level in the main part of this document)*
- If the radiation dose rate is less than 5 μSv/h the operator may handle the situation alone.

A distinction is made between a homogeneous distribution of radioactivity over all the shipment (often characteristic of bulk NORM waste) and a localized distribution (characteristic of a source).

Homogeneous distribution: the shipment may be accepted if:

- the dose rate is less than a specified action level (approximately 3 times the background level)
- the origin of the anomaly is known (e.g. due to refractory bricks).

If one of these two conditions is not fulfilled, the shipment has to be put aside and a radiation protection expert must characterize the shipment (i.e. identify the radionuclides and measure their activities).

Localized distribution: The shipment is put aside on the site of the operator. Properly trained members of staff of the facility should then locate and isolate the radioactive source. They must wear appropriate protective clothing (gloves, overshoes, etc…)

During this operation, the trained staff members must continuously measure the radiation dose rate. If the dose rate (at the position of the person investigating) reaches a level higher than 20 μSv/h, the staff must stop the operation and a radiation protection expert must be called. Once the source has been isolated, it may be kept on the site of the operator in a drum placed in a closed room. The radiation

dose rate on the external face of this room may not exceed 1 µSv/h. The Federal Agency for Nuclear Control must be notified of any source detected. The sources discovered must be characterized by a radiation protection expert (identification of the radionuclides and measurement of their activities). Activity thresholds levels are defined for these sources. Below these levels no regulatory control is required.

SWITZERLAND

Minimum performance requirements for monitoring instruments used in Switzerland for detecting radioactive material in scrap metal

Basic requirements for measuring instruments

The instruments have to meet the following requirements:

- They have to give a consistent result within at most 30 seconds for each measuring point.
- If a measurement is repeated, the result should correspond within ± 5 % to the result of the preceding measurement. In order to achieve this objective the instrument has to be able to average over at least 1000 counts.
- The instrument should be able to detect gamma radiation with an energy between 60 keV and 1.33 MeV.
- The instrument should resist environmental conditions such as air humidity (up to 100 %), rain, and temperatures between -15°C to +40 °C. The display should be readable in the dark and in bright sunshine. The instrument has to be resistant to damage due to sharp objects.

In general, measurements are performed with hand-held instruments.

Procedure in practice

Before the measuring campaign starts a function control of the instrument has to be carried out.

The level of background has to be determined without the presence of the load (railway carriage, container, truck). The measured value is registered in the certificate and serves as reference value for the subsequent measurements of the load. Generally dose rates in the order of 0.1µSv/h are detected.

For each load a sufficient number of measurements are necessary. This means that measurements are performed at a distance of 20 cm of the side walls in sectors of 1 metre. Usually the measuring point is at a height of 1.8 metres above ground. If the content of the load is lower or variable, the height of the measuring point has to be adapted. In some cases (material from shredder, aluminium scrap) additional measurements are performed on the load. The maximum value of the measurements is noted in the certificate for each load.

During the measurements on the load, the dose rate is usually lower than the reference value due to shielding effects. If the value of the measurement at one point exceeds +5 % of the level of the reference value, the load cannot be released. The source has to be localized, removed and stored in a safe place on the premises. The regulatory authority has to be informed.

Response Level

If during the measurement the dose rate exceeds 20 µSv/h at a distance of 50 cm from the surface or object, the monitoring procedure has to be stopped and the area concerned has to be cordoned

off. The removal of the source must be performed by an emergency expert team under the control of the regulatory authority.

INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA)

(adapted from 'Detection of Radioactive Material at Borders', IAEA-TECDOC-1312, (2002))

I. Types of monitoring instrument

Instruments for detecting radioactive material at borders can be divided into three categories.

Pocket-type instruments are small, lightweight instruments used to detect the presence of radioactive material and to inform the user about radiation levels.

Hand-held instruments usually have greater sensitivity and can be used to detect, locate or (for some types of instrument) identify radioactive material. Such instruments may also be useful for making more accurate dose rate measurements in order to determine radiation safety requirements.

Fixed, installed, automatic instruments are designed to be used at checkpoints. Such instruments can provide high sensitivity monitoring of a continuous flow of vehicles whilst minimizing interference with the flow of traffic.

The specifications for pocket-type and hand-held instruments are set out in reference [4.1]. In the following, attention is focused on fixed, installed, automatic instruments.

II. Fixed, installed automatic instruments

A. Application

Modern, fixed, installed radiation monitors are designed to automatically detect the presence of radioactive material being transported in vehicles (i.e. road vehicles or railroad cars or railway wagons). The monitoring systems do this by measuring the radiation level taken while a vehicle occupies the detection area, and comparing this level to the background radiation level that is measured and updated while the detection area is unoccupied. Continuous measurement of the background radiation level and adjustment of the alarm threshold enables a constant, statistical false alarm rate to be maintained. It follows that suitable occupancy sensors are needed, so that the instrument knows when to monitor the vehicles as they pass through and when to monitor background radiation levels.

B. Installation and operation, calibration and testing

Fixed, installed radiation monitors are often known as portal monitors and typically consist of an array of detectors in one or two vertical pillars with associated electronics. Because instrument sensitivity is strongly dependent upon distance, it is important to get the vehicle as close as practically possible to the detector array. Therefore, highest effectiveness is achieved if the monitors are installed such that the vehicles are forced to pass close by, or between monitors. Careful consideration should, therefore, be given to selecting the optimum location to install fixed radiation portal monitors so they can be most effective.

The effectiveness of a fixed, installed instrument is also strongly dependent on its ability to measure the radiation intensity over the search area of interest. Therefore, when installing the monitor, it is important that the detector is positioned so that it has an unobstructed view of the search area. However, the instrument must also be protected from mechanical damage. Alarm indications should be

clearly visible to the persons manning the inspection point. Training in the appropriate response procedures is required for the persons responding to the alarms. Portal monitors need to be tested periodically to ensure optimum performance. Automatic portal monitors should be checked daily with small radioactive sources to verify they can detect radiation intensity increases.

The use of fixed, installed radiation monitors to detect radiation sources in vehicles is complicated by the inherent shielding of the vehicle structure and its components. While standard truck-bed monitors can be effective in detecting abnormal radiation levels in shipments of metals for recycling, they are much less effective in detecting radioactive material when that material is purposefully concealed.

As discussed earlier, the sensitivity of detectors is dependent upon the closeness of the detector and source as well as the slowness with which they pass each other. For large trucks, two pillars are required and the maximum recommended distance between pillars is 6 metres, dependent on the maximum width of the road vehicle to be scanned. It is important that barriers, which do not obstruct the view of the monitor, are installed to protect the monitor from being damaged by vehicles.

Since the sensitivity of the monitor is also strongly dependent on monitoring time, the instrument needs to be placed where the speed of the vehicle is controlled. Instruments vary in their capabilities, but it is recommended that the speed of the vehicle does not exceed 8 km/h and that the vehicle is not allowed to stop while passing through the monitor. It is recommended that the occupancy sensor is positioned so that it is only triggered when the monitoring system is occupied and not by other traffic in the vicinity.

C. Minimum performance recommendations

The instrument performance characteristics given here should be regarded as guidance only. The conditions given are not operational settings, but criteria against which performance tests can be made.

1. Sensitivity to gamma radiation

It is recommended that at a mean indication of 0.2 μSv/h, an alarm should be triggered when the dose rate is increased by 0.1 μSv/h for a period of 1 second. The probability of detecting this alarm condition should be 99.9%, i.e. no more than 10 failures in 10,000 exposures. This requirement should be fulfilled in a continuous radiation field, with the incident gamma radiation ranging from 60 keV to 1.33 MeV (tested with ^{241}Am, ^{137}Cs and ^{60}Co).

2. Search region

The volume in which efficiency of detection is maintained will vary according to the instrument. The following is a description of the geometrical region in which the performance characteristics for the given alarm levels should be applicable.
Truck monitor (two pillars):

(i) Vertical: 0.7 to 4 m;
(ii) Horizontal, parallel to the direction of movement: up to 3 m (6 m between the two pillars);
(iii) Speed up to 8 km/h.

3. False alarm rate

The false alarm rate during operation should be less than 1 per day for background dose rates of up to 0.2 μSv/h. If a high occupancy rate of say, 10,000 occupancies per day were expected, this would

mean ensuring not more than 1 false alarm in 10,000, for which the recommended testing requirement is not more than 4 false alarms in 40,000 occupancies.

4. Operational availability

Installed equipment should be available at least 99% of the time, i.e. less than 4 days out of service per year.

5. Environmental conditions

The system should be weather proofed and designed for outdoor operation. A desirable working temperature range would be –15°C to +45°C. However, this will be dependent on conditions at the installed location and lower temperatures down to –35°C may be necessary.

III. Investigation levels and instrument alarm settings

The nominal investigation level is defined here as that radiation level which is selected as the trigger for further investigation. This needs to be distinguished from the instrument alarm threshold. The instrument alarm threshold must be set considerably below the nominal investigation level chosen in order to allow for statistical variations. To achieve a 99.9% detection probability, assuming the idealized case of Gaussian distribution, the instrument threshold has to be set at least at 3σ (3 standard deviations) below the desired level.

A. Determination of an instrument alarm threshold

The selection of a particular investigation level means that the alarm threshold of a monitoring instrument has to be set appropriately. The alarm threshold can be expressed in terms of multiples of background, or as a multiple of the standard deviation of the background count rate. Since the relationship between background dose rate and its standard deviation depends on the detection sensitivity of the instrument and the actual value of the background, a generally applicable investigation level cannot be derived. Similarly, because of unknown factors such as the amount of shielding and the energy of the radiation, it is not possible to set an investigation level in order to detect a certain quantity of radioactivity. Therefore, it becomes reasonable to set the level at a value that is as sensitive as possible without causing too many false alarms.

On this basis, recommendations for an optimum investigation level can be derived from results obtained from the large scale pilot study on border monitoring systems conducted by the Austrian Research Centres and the IAEA [4.2].

A compromise must be reached in establishing a practical alarm threshold so that radioactive material being inadvertently moved can be detected yet provide an acceptably low nuisance alarm rate. For a false alarm rate of 1 in 10,000 the instrument alarm threshold must be set at least 4σ higher than average background for systems under Gaussian assumptions. Results from the ITRAP field tests [4.2] for truck monitoring indicate that an investigation level of at least 1.2 times natural background (at a normal background level of approximately 0.070μSv/h), is needed to meet the performance characteristics for the false alarm rate given earlier.

Specialist personnel involved in the selection and installation of this type of equipment are advised to consider these issues in the local context, and thereby satisfy themselves that appropriate instrument alarm settings have been made to achieve an investigation level that is practical under local conditions. Inevitably, once a unit has been in operation for a while some adjustments to the alarm settings will need to be made based on operational experience.

As discussed earlier, once an alarm has been signified the next tasks are to:

- verify that the alarm is caused by an actual increase in the radiation level;
- localize the source of the radiation, if present;
- identify the radioactive material and evaluate the situation.

IV. Verification of alarms

A. Types of alarm

1. False alarms

The normal, statistical fluctuations of the background radiation intensities can cause false alarms. They can also be caused by nearby radio-frequency interference, but this should not be a problem with modern, well-designed instruments.

2. Real alarms

The other category of alarms, real alarms are defined here as being ones that: (a) are caused by an actual increase in the radiation intensity; and (b) result from the inadvertent movement of radioactive material. Making the latter determination normally involves further evaluation of the situation.

B. Alarm verification by monitoring

Verifying an initial alarm usually involves repeating the measurement under the same conditions and/or using another instrument. A similar response is a good indication that there is a real increase in radiation levels.

1. Monitoring of vehicles

When the passage of a vehicle through a fixed installed radiation monitor triggers an alarm (as verified by repeated measurements), it will normally be necessary to remove the vehicle from the monitor for further investigation.

V. Radiological conditions and response levels

In general, the level of response needed for a real alarm will be dependent upon the radiological conditions found. Most situations encountered will involve little or no hazard and can be handled by non-radiation safety specialists. It is recommended that the response be upgraded to involve radiation protection experts if any of the following situations are found:

- radiation level greater than 0.1 mSv/h at a distance of 1 m from a surface or object;
- uncontrolled contamination indicated by loose, spilled or leaking radioactive material.

The value of 0.1 mSv/h at 1 m has been selected in view of the fact that this is the limit for legal transport of radioactive material as detailed in the IAEA 'Regulations for the Safe Transport of Radioactive Material', IAEA Safety Requirements No ST-1 [4.3].

References

[4.1] International Atomic Energy Agency, Detection of Radioactive Material at Borders, IAEA-TECDOC-1312, (2002).

[4.2] Austrian Research Centres Seibersdorf, Illicit Trafficking Radiation Detection Assessment Programme (ITRAP), Final Report, OEFZS-G-0002, Seibersdorf (2002).

[4.3] International Atomic Energy Agency, Regulations for the Safe Transport of Radioactive Material (2005 Edition), Safety Standards Series No. TS-R-1, IAEA, Vienna, (2005).

Annex V

EXAMPLE FORM FOR REPORTING DETECTED RADIOACTIVE MATERIAL IN SCRAP METAL

(adapted from Spanish Protocol for Collaboration on the Radiation Monitoring of Metallic Materials [7])

In the event of radiation levels being detected in shipments of scrap metal, in processed metal or product waste in excess of the threshold levels of the detection equipment, it is necessary to investigate and report the results of the investigation. The following is a typical form used for the purpose of reporting such investigations. The form, or national versions of it, will be required for notifying and reporting the event to the national regulatory body.

DETECTION OF RADIOACTIVE MATERIAL IN METAL SCRAP AT THE ENTRANCE TO THE INSTALLATION (*)

Date of detection:	
IDENTIFICATION OF INSTALLATION OR DETECTION LOCATION	
Detection location	
Address	
Contact person	
Telephone	
Fax	
E-mail	
DETAILS OF LOAD	
Country of origin	
Supplier of merchandise *(address, contact person and telephone)*	
Identification of load *(reference to transit documents being carried with the load)*	
Means of transport (*identify truck, ship, container, etc.*)	
PRELIMINARY INVESTIGATION DATA	
Average values measured by instrumentation *(wherever possible, attach monitoring record obtained from the equipment)*	
Environmental background radiation value in the area (in μSv/h)	
Area in which there is an increase in radiation levels over background levels	
Maximum measured dose rate in contact with the outer surface of the container, truck or wagon (in μSv/h) *(identify position)*	
Maximum dose rate measured in driver's cab (in μSv/h)	

(*) Initially the notification should be made with the information available. Any further information should be submitted as soon as it becomes available.

ACTIONS PERFORMED FOLLOWING DETECTION ***(Circle the appropriate reply)***		
Unloading and segregation from the rest of the load	YES	NO
Identification of material	YES	NO
Plastic coated	YES	NO
Shielded	YES	NO
Others (*please indicate*)		
IDENTIFICATION OF SEGREGATED MATERIAL		
Description of material *(contaminated parts, radioactive sources with or without shielding, radioactive lightning rods, ...)*		
Photographic information attached	YES	NO
Dimensions and weight		
Physical status *(intact, deteriorated, oxidized, corroded, ...)*		
Nature *(lead, steel, ceramic, brass, aluminium, ferroalloy, copper, ...)*		
Encapsulated source	YES	NO
Housed inside the shielding container	YES	NO
Labels, signs, plates, marks		
RADIOLOGICAL CHARACTERIZATION		
Measure of dose rate in contact	μSv/h	
Measure of dose rate at 1 metre	μSv/h	
Material contaminated superficially with β-γ emitters	Bq/cm^2	
Material contaminated superficially with α emitters	Bq/cm^2	
Radionuclide(s)		
Activity or concentration of activity	Bq,	Bq/g

DETECTION IN FINAL PRODUCTS AND PRODUCTION WASTE (*)

Date of detection:		
IDENTIFICATION INSTALLATION OR DETECTION LOCATION		
Detection location		
Address		
Contact person		
Telephone		
Fax		
E-mail		
IDENTIFICATION OF PROCESS AFFECTED BY THE RADIATION EVENT		
Affected product *(processed scrap, ingots, smoke dust, slag)*		
Description of event *(Briefly describe the event including time and location of detection, the instrumentation used and the radiological values obtained)*		
Parts of installation affected *(Identify the parts of the installation and/or vehicles with radiation levels in excess of the background levels for the area and take samples of all resulting products for subsequent analysis)*		
Shutdown of process phases affected *(If so, indicate date and time)*	YES	NO
Exit of materials from the installation *(If so, identify means of transport used and destination)*	YES	NO
Notification of Expert Radiation Protection Organization *(If so, indicate name, date and time of contact and initiation of activities)*	YES	NO

(*) The notification should be made initially with the information available at that moment. Any further information should be submitted as soon as it becomes available.