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THE ROLE OF THE INTERNATIONAL ATOMIC ENERGY AGENCY IN RADIATION AND WASTE SAFETY

(Prepared by A.D. Wrixon and P. Ortiz-López, International Atomic Energy Agency)

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INTRODUCTION

Prime responsibility for safety rests with the employer or holder of a licence to operate a facility containing a radiation source of radioactive material. Nevertheless, practices in such facilities should be closely controlled by national regulatory bodies on the basis of national laws and regulations. At the same time, there is a substantial international dimension to radiation and waste safety, indeed to nuclear safety in general. There are benefits associated with international co-operation and collaboration involving the sharing of experience and knowledge and the development of consistent approaches, the latter being essential in order to facilitate legitimate international trade.

This Workshop is concerned with the issues associated with scrap metal that may in some way or other have been contaminated by radioactive material. This contamination may have arisen through natural processes; through the recycling of material that may have become contaminated during its use, for example in a nuclear reactor; as a consequence of an accident in a nuclear facility; or as a result of the loss of administrative control over a radioactive source. The issues associated with these situations are often quite different and it is therefore important to retain the distinction between them. However, all situations of residual contamination necessitate a recognition that the world's resources are limited and simple rejection of contamination, however low the level, may not be a sensible option.

Contaminated scrap metal may well move from one country to another and the presence of the contamination may not be recognized. It is therefore important that an international approach to the matter should be developed. The matter is not one simply of detection and removal. It involves prevention, amongst other things, of accidents and of loss of administrative control over radioactive materials and sources. It also involves definition of appropriate standards to avoid undue and expensive response to trivial levels. As this is a Workshop, the intention here is not to propose complete solutions but to indicate what the International Atomic Energy Agency (IAEA) is doing this area. This paper will begin by discussing the Agency's work on the development of radiation safety standards and then will focus on the problems associated with 'orphan sources', that is, those radiation sources that are not subject to control or over which

control has been lost for one reason or another. This will be complemented by presentations from other IAEA staff members.

As a point of principle, the IAEA actively seeks co-operation with other international bodies with similar interests. This is reflected in its work on standards, as indicated below. However, worthy of particular mention here is the fact that the IAEA and the World Customs Organization (WCO) have formalized their co-operation by signing a Memorandum of Understanding in May 1998. This is intended to strengthen global efforts against illicit trafficking in nuclear and other radioactive materials. The Memorandum covers aspects related to mutual consultation on policy and other issues; the exchange of information and documents; technical and financial co-operation; and technical meetings and missions. Training of those not normally concerned with radiation safety issues is a major component of the programme.

RADIATION SAFETY STANDARDS

The development of nuclear and radiation safety standards is a statutory function of the International Atomic Energy Agency (IAEA), which is unique in the United Nations system. The IAEA Statute expressly authorizes the Agency *'to establish standards of safety for protection of health and minimization of danger to life and property ... and to provide for the application of these standards ...'*. Work on the establishment of such safety standards began early in the life of the organization. The IAEA came into being on 29 July 1957: in 1961, the first edition of the *Regulations for the Safe Transport of Radioactive Material* was published; in 1962, the IAEA Board first approved Basic Safety Standards (BSS) for radiation protection. Since then revised versions of the Transport Regulations and the BSS have been produced, with the latest edition of both being published in 1996.

Both the BSS and the Transport Regulations are the basis for national regulations in a large number of countries and are reflected in the regulatory documents of the major international bodies. Such standards, although recommendatory in nature, have become a principal means of achieving harmonized safety approaches in the nuclear power field and in various applications of radiation and radioactive materials in medical, industrial and other fields.

The latest edition of the BSS entitled the *International Basic Safety Standards for Protection*

Against Ionizing Radiation and for the Safety of Radiation Sources [1] is the product of extensive global co-operation. The BSS are jointly established with five other organizations - the Food and Agriculture Organization, the International Labour Organization, the Nuclear Energy Agency of OECD, the Pan American Health Organization, and the World Health Organization, all of which have a major interest in radiation protection.

The 1962 version of the BSS included the statement that *'The Agency's basic safety standards ... will be based, to the extent possible, on the recommendations of the International Commission on Radiological Protection (ICRP)'*. That principle has continued to be adopted through the successive revisions of the BSS. The current version was prompted by and is based on the 1990 recommendations of the ICRP [2]. Because these recommendations marked a significant development in the approach to radiation protection, the IAEA decided against a straightforward revision of its earlier standards and instead embarked on a completely new type of document.

By 1998, the IAEA in co-operation with its Member States had developed and issued more than 200 standards of safety in the Agency's *Safety Series* publications. They cover the fields of nuclear safety and radiation safety, including radioactive waste safety, and radioactive material transport safety. Since the preparation of the revised BSS, those concerned with radiation safety have been going through a process of review and revision. They are now being issued under a hierarchical structure in a new IAEA Safety Standards Series of publications. This hierarchy of safety standards comprises *Safety Fundamentals, Safety Requirements* and *Safety Guides.*

The *Safety Fundamentals* are essentially the policy documents which define basic objectives, concepts and principles. They provide no technical detail. On the other hand, the *Safety Requirements*, such as the BSS, deal with the basic requirements that must be met in order to ensure the safety of particular activities. They are governed by the basic objectives, concepts and principles of the *Safety Fundamentals*. They are written in a regulatory style such that Member States could adopt them into their national regulations as such. The *Safety Guides* contain recommendations based on international experience regarding measures to ensure that the *Safety Requirements* are met.

All of the documents are developed under a uniform preparation process which involve their review by advisory committees. That concerned with radiation safety is the Radiation Safety

Standards Advisory Committee (RASSAC). Priority has been given in the RASSAC programme of work to the completion of guidance under the BSS. Topics recently or currently being considered are the development of guidance on

- the safety of radiation sources,
- the prevention, detection and response to illicit trafficking in radioactive materials,
- application of the concepts of exclusion, exemption and clearance.

The last is also of interest to the sister advisory committee, the Waste Safety Standards Advisory Committee (WASSAC). The last two are the subject of separate presentations at this Workshop.

APPLICATION OF STANDARDS

The IAEA has an extensive programme concerned with provision for the application of safety standards. They include providing direct safety-related assistance to Member States, fostering exchange of safety-related information, promoting education and training in safety areas, rendering services on request to States and co-ordinating safety-related research and development projects.

Reports on safety and protection in nuclear activities are issued in the IAEA *Safety Report* Series, as informal publications. *Safety Reports* may describe good practice and give practical examples and detailed methods that can be used to meet safety requirements. Other reports that deal with safety issues are the *Technical Reports* Series and the Radiological *Assessment Report* Series. The IAEA also issues reports on radiological accidents, including dissemination of lessons learned, and an number of other types of publication on special topics.

Technical co-operation activities include a Model Project on 'Upgrading Radiation and Waste Safety Infrastructure', which involved 52 IAEA Member States. Participating countries are working together with the IAEA to address deficiencies and achieve an adequate system for the regulatory control of radiation sources as is foreseen in the Preamble to the BSS.

CONVENTIONS

The international dimension of nuclear safety was spotlighted when the Chernobyl accident in

1986 made it clear that a 'nuclear accident anywhere is an accident everywhere'. In the following years, Member States expressed an increasing interest in developing legally binding international instruments. Most of the instruments are in the form of Conventions, which are binding agreements between States. These have come to play a crucial role in improving nuclear, radiation and waste safety. They include the Conventions on Early Notification of a Nuclear Accident [3] and Assistance in Case of Nuclear Accident or Radiological Emergency [4]. The former applies in the event of any accident that has resulted or is likely to result in a release of radioactive material that may be of significance to another State. The latter provides for co-operation and prompt assistance in the event of a nuclear accident or radiological emergency.

The Assistance Convention was first invoked in 1987 in connection with the radiological accident in Goiania, Brazil [5]. In the following years, assistance was given to several Member States to cope with radiological emergencies, most recently, Estonia [6], Georgia, Turkey and Peru.

Other Conventions include the Convention on Nuclear Safety, the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [7] and the Convention on the Physical Protection of Nuclear Material [8]. The last of these prescribes the levels at which nuclear material is to be protected while in international transport. It requires each party to the Convention not to permit the export or import of such material unless it is satisfied that the nuclear material will be protected. Other provisions apply to nuclear materials while in domestic use and storage. It also requires parties to co-operate in the recovery and protection of stolen nuclear material.

The IAEA assists the process by facilitating agreements among Parties and providing a range of functions to the Parties once they agree on the undertakings. These functions include acting as Secretariat to meetings of Contracting Parties, maintaining records of national points of contact, and rendering services to State Parties on request.

BASIC SAFETY STANDARDS

These are divided into four distinct parts: Preamble; Principal Requirements; Appendices and Schedules. The Preamble explicitly states that the BSS are based on the presumption that an adequate infrastructure exists within the country. Such an infrastructure would include a

Regulatory Authority with adequate resources to deal with the safety and security of sources and have established independent regulatory authorities to authorize activities involving sources, inspect them, enforce safety requirements and, if necessary, to conduct intervention. They also assume that governments can provide, either directly or indirectly, essential support such as personal dosimetry services, information exchange mechanisms and personnel training.

It should perhaps be noted that these assumptions have proved not to be correct in many countries. Some States have no legislation and regulations and in others there are no independent regulatory authorities vested with the necessary powers to perform the work required of them. Furthermore, even when a formal regulatory system exists, it does not always have the necessary resources at its disposal.

Basic administrative requirements in the Principal Requirements Section include the application of a system of notification and authorization of sources. However, it is recognized that some exposures to radiation are unamenable to control and should therefore be excluded from the Standards. These are mainly due to radiation of natural origin, such as the radioactive material present in the earth's crust at normal levels of concentration. The BSS also recognizes that some practices involving the use of radiation sources present a trivial level of risk and should therefore be exempted from the full rigours of the requirements. In particular, the BSS defines total activities and activity concentrations below which practices may be exempted from the requirements. Clearance is also a concept used in the BSS to refer to sources and materials that have been within the regulatory system, but which have been treated or have reached a condition such that regulatory controls can be lifted. These matters are addressed in a separate paper.

The principal radiation protection requirements for practices, activities involving the use of radiation sources, follow those of ICRP. In particular, there are requirements that practices should be justified, the level of protection should be optimized and exposures should be subject to dose limits.

There is a *de facto* recognition by national authorities regarding the justification for many human activities involving exposure to radiation, such as the use of radiation for medical purposes. Other activities are generally deemed to be unjustified, such as the deliberate addition of radioactive substances to toys, foodstuffs, cosmetics. Although not totally explicit in the BSS,

the justification principle applies to the practice as a whole and not separately to its component parts, such as waste disposal. Decisions regarding which method should be used to dispose of radioactive waste are more related to the application of the optimization principle, which is in effect concerned with determining the 'best way' of carrying out the practice or fulfilling a particular objective. The 'best' will depend on all relevant factors being taken into account.

The BSS require those authorized to undertake practices to foster and maintain a safety culture, to establish a quality assurance programme, to assign responsibilities, etc. Proper management is the key and this requires people to be appropriately trained. All of these matters impinge on the safety and security of radiation sources.

Detailed requirements relating to the safety of sources are found in an Appendix to the BSS. These cover safety assessment, which has as an objective the identification of measures for improving protection and safety, design, the prevention of accidents and the mitigation of their consequences, the location and siting of sources, accountability and feedback of experience.

SAFETY GUIDES

The preparation of three Safety Guides is identified in the programme of radiation safety:

- Safety Guide on Prevention, Detection and Response to Illicit Trafficking in Radioactive Materials, co-sponsored by WCO and INTERPOL;
- Safety Guide on Application of the Concepts of Exclusion, Exemption and Clearance, co-sponsored by NEA/OECD;
- Safety Guide on the Extension of the Principles of Radiation Protection to Sources of Potential Exposure (The Safety of Radiation Sources).

SAFETY OF RADIATION SOURCES

Part of the programme on the safety of radiation sources specifically addresses their control. A technical document on developing national infrastructure for radiation protection has been published [8]. This will be complemented by a Safety Guide which will involve a quantitative approach to safety assessment, and documents on methodology for authorization and inspection of radiation sources, assessing the effectiveness of a national programme by peer reviews, and

methodology of investigation of accidents. In order to help Member States with the administrative control of the radiation sources, a software package, called Regulatory Authority Information System (RAIS) has been made available. The system contains proformas for data bases for the control of sources, authorizations, inspections, and dosimetry of workers and allows the Authority to keep track of each source.

ILLICIT TRAFFICKING

The effectiveness of a national infrastructure, as presupposed in the BSS, in exercising appropriate control over radiation sources, will depend on the commitment of all parties involved including the Regulatory Authority and those responsible for the radioactive sources. Nevertheless, whatever the level of commitment, a residual risk of loss of control over radioactive sources remains. Regulatory Authorities may also experience difficulties in identifying all radioactive sources that were produced in or have entered the country before the establishment of the infrastructure. The situation is however much more serious in those countries where an infrastructure has not been established or has only partly been established.

In addition, unexpected risks and hazards arise as a result of unauthorized receipt, possession, use, transfer or disposal of radiation sources. These activities, whether intended or not, with or without crossing of international borders, are considered as illicit trafficking.

Illicit trafficking is a symptom of a loss of control over radiation sources. Systems are in place at the borders of a number of countries for the detection of radioactive materials to prevent proliferation risks. Metallurgical scrapyards and recycling plants also have set up systems to detect the presence of radioactivity in material entering their premises. In recent years, many incidents have been detected involving illegal movement of nuclear materials and other radioactive sources across state borders. Often only small quantities of radioactive materials have been involved, the vast majority (about 95%) being small radioactive sources and non-sensitive nuclear materials (natural, depleted and low enriched uranium). There have however been a number of particularly serious events involving larger radioactive sources and the general apprehension is that the number of such cases will increase. The IAEA's programme on illicit trafficking in radioactive materials is the subject of a separate paper at this meeting. This will discuss the content of the Safety Guide on Prevention, Detection and Response to Illicit Trafficking in Radioactive Materials.

DIJON CONFERENCE

Interest in the safety and security of radioactive materials started with the possibility of illicit trafficking in nuclear materials. It was however recognized that more mundane failures in the safety and security of radioactive materials represent a substantial risk to human health. Incidents involving lost, abandoned or stolen sources continue to occur, some with serious consequences. Numerous incidents have occurred, particularly since 1992, involving the illegal movement of nuclear and other radioactive material across borders. The vast majority of cases detected involved very small quantities of radioactive material, but in some incidents, sources with high activity have been found. A particular problem is contamination of scrap due to careless or fraudulent disposal of industrial or medical radiation sources.

An International Conference on the Safety of Radiation Sources and the Security of Radioactive Materials was held at Dijon in September 1998. At this Conference, two distinct but interrelated subjects were addressed - the prevention of accidents involving radiation sources, and the prevention of theft or any unauthorized use of radioactive materials and the measures for detecting and responding to the illicit trafficking of these materials. The Conference was co-sponsored by the European Commission, International Criminal Police Organization, and the World Customs Organization.

A number of important conclusions arose out of this Conference. In particular, the following are noted:

- Radiation sources should not be allowed to drop out of the regulatory control system. This means that the regulatory authority must keep up-to-date records of those responsible for each source, monitor transfers of sources and track the fate of each source at the end of its useful life;
- Efforts should be made to find radiation sources that are not in the regulatory authority's inventory, because they were in the country before the inventory was established, or were never specifically licensed or were lost, abandoned or stolen;
- Because there are many 'orphan sources' throughout the world, efforts to improve the

detection of radioactive materials crossing national borders and moving within countries by carrying out radiation measurements and through intelligence-gathering should be intensified. Optimum detection techniques need to be developed, and confusion would be avoided if international agreement could be achieved on quantitative levels that would trigger investigations, for example, at border crossings.

RESOLUTION AND RESPONSE

The conclusions of the Dijon Conference were considered by the IAEA General Conference at its meeting in September 1998 and as a consequence a resolution relating to the matter was adopted. In this resolution, the General Conference - *inter alia* - encouraged all governments *'to take steps to ensure the existence within their territories of effective national systems of control for ensuring the safety of radiation sources and the security of radioactive materials'*, requested the Secretariat *'to prepare for the consideration of the Board of Governors a report on (i) how national systems for ensuring the safety of radiation sources and the security of radioactive materials can be operated at a high level of effectiveness and (ii) whether international undertakings concerned with the effective operation of such systems and attracting broad adherence could be formulated'* and requested the Director General to report to it at its next (1999) regular session on the implementation of that resolution.

The Resolution was brought to the attention of Member States in a note verbale, in which the Secretariat recalled the BSS and that the Agency was ready to provide for the application of the BSS on request. In addition the Secretariat, with the help of senior experts, prepared a report, the conclusions of which were drawn to the attention of the Board of Governors at its March 1999 meeting. The detailed conclusions of the report are given in an Annex to this paper.

The Chairman's conclusion on the basis of the discussion at the Board meeting was that *'there was general support for the conclusions in the report prepared on the basis of advice from a group of senior experts'*. Comments were made by the Board on a number of the recommendations of the experts and a suggestion was made regarding the establishment of an international database for use in monitoring transfers of radiation sources. In particular, the Chairman urged the Secretariat to be cautious in implementing two particular recommendations. One was that States and international organizations should be requested to consider providing

radiation sources only to States that have an adequate infrastructure. The other was that States should be encouraged to consider installing monitoring systems at airports and seaports, at border crossings and at other locations where radiation sources may appear (such as scrap yards and recycling plants).

There was a particular comment on a recommendation that exploratory discussions be initiated by the Agency with a view to achieving an effective international undertaking by States in the area of the safety and security of radiation sources. While the Chairman stated that *'there was no opposition to the Director General's initiating exploratory discussions relating to an international undertaking, some members thought that to aim for an international convention would be too ambitious at the present time. They felt that it might be more feasible to aim for other types of instruments - for example, codes of practice/conduct.'*

Several members commented on the proposed action plan. Some wanted more information about it (particularly information about its financial implications) and called for prioritization of the activities envisaged. This action plan is currently being developed and will go before the Board at a meeting in September this year, before being submitted to the General Conference.

With these comments, it was decided that the action recommended in the cover note to the experts report should be implemented.

CONCLUSIONS

The IAEA has a major role in the establishment of safety standards. Such standards are intended to provide a harmonized approach throughout the world. The IAEA also provides support to States in the application of those standards, particularly through the establishment of appropriate infrastructures. Particular emphasis is being given at the present time to the safety of radiation sources and the security of radioactive materials. This is necessary in view of the significant number of radiological accidents that have been occurring throughout the world. Most of these accidents have involved one or more individuals being exposed to high levels of radiation. However, there is also the possibility that radioactive sources will finish up in scrap metal. Indeed, there have already been a number of instances where this has occurred. The IAEA also has a programme that is concerned with illicit trafficking in radioactive materials.

Residual activity in metal scrap may not be altogether avoided and there is a need for standards that define the maximum levels of contamination that should be permitted. Such levels should be based on there being trivial or insignificant radiological consequences.

The following actions are seen as high priority regarding the control over radiation sources and radioactive materials:

- alerting States to the issues associated with orphan sources,
- establishing or strengthening infrastructures for the control of radiation sources;
- provision of sufficient resources in the Regulatory Authority, including trained personnel, for control of radiation sources,
- installation of detection systems at appropriate locations,
- establishment of an action plan regarding the activities that should be pursued - these might include the identification and classification of those types of source that pose the greatest risk from the loss of control, strengthening training programmes, setting up databases of sources, and
- consideration of whether an international undertaking in this area would be useful in encouraging States to take the matter seriously, and if so, what form it might take.

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[6] INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Tammiku, IAEA, (1998).

[7] Convention on Safety of Spent Fuel Management and Safety of Radioactive Waste Management (1997).

[8] Convention on Physical Protection of Nuclear Material (1987).

ANNEX

Recommendations of the Senior Expert's Report

Governments should be made aware of the fact that, as a result of safety and security breaches and of serious safety and security deficiencies, severe - even fatal - accidents involving radiation sources have already occurred and are continuing to occur and that the absence or loss of control over radiation sources may pose a risk of significant radiation exposure and have serious health and economic consequences not only in the country in which a given radiation source was used but also in other countries.

Given the existence of orphan sources (i.e. radiation sources that either were never subject to regulatory control or were subject to regulatory control but have been abandoned, or lost, or misplaced, or stolen, or removed without authorization), States should be reminded of the risks presented by orphan sources and of the need to exercise strict control over radiation sources through appropriate infrastructures. The BSS and associated IAEA guidance, along with support programmes to help States implement the BSS, are suitable for the purpose of controlling radiation sources.

National systems of control for ensuring the safety and security of radiation sources should be established or strengthened where necessary in order to meet the assumption, made in the Preamble to the BSS, that in each State there already exist legislation and regulations, a regulatory authority empowered to authorize and inspect regulated activities and to enforce the legislation and regulations, sufficient resources, and adequate numbers of trained personnel.

The requirements of the BSS relating to notification and authorization apply to all radiation sources, unless the associated exposures have been excluded from the BSS because they are unamenable to control or because the practice involving the source has been exempted from the requirements on the grounds of the triviality of the dose. Although any loss of control over radiation sources covered by the BSS requirements should be regarded as unsatisfactory, loss of control over only some of them is likely to lead to serious injury to persons. It is important, therefore, to limit the focus to those sources which, if they became "orphan", could pose a major risk. This calls for a categorization of the sources in use. There are as yet no internationally

agreed categorization criteria, however, and it is suggested that the IAEA attempt to establish such criteria with some urgency.

The IAEA's Model Project on "Upgrading Radiation Protection Infrastructure" is leading to progress in the development of national systems that comply with the administrative requirements of the BSS. It should be complemented by systematic peer reviews of the effectiveness of regulatory programmes.

National requirements whereby authorized users must promptly report to the regulatory authority any case of a missing source should be put in place, and information on all missing sources should be kept in a database by the regulatory authority. The establishment of international databases on missing and found sources would facilitate the tracking of orphan sources. The information in such databases would need to be provided by national authorities or points of contact.

Education in radiation protection should be encouraged, and it should be complemented with practice-specific training. In this connection, it may be useful to have national systems for the authorization of workers operating radiation equipment or radiation sources that can cause significant exposures and of other staff with responsibilities related to protection and safety. Although considerable effort has been invested in regional centres for the provision of education in radiation protection, and a large number of persons have been educated at such centres, staff turnover and the increasing need for new staff created by the establishment of regulatory authorities call for intensified education activities.

Education programmes for medical personnel should include training designed to ensure that they recognize radiation injuries and apply the correct procedures.

States and international organizations should be requested to refrain from providing radiation sources to States that do not have an adequate infrastructure.

Some accidents result from lack of security when sources that are in use are placed into temporary storage. Other accidents result from lack of security when sources that are no longer needed are placed into long-term storage. In the latter case, the risk can be significantly reduced by requirements to include a provision for the disposal of the source in the application for authorization of the practice in which the source is to be used and by a national strategy and systems to deal with spent sources. States without provisions for the storage or disposal of spent sources should be requested to authorize the import only of sources whose manufacturers agree

to take them back when they are no longer required. As to existing spent sources, or sources that are in use without there being a strategy for their disposal, States should be encouraged to develop national strategies for dealing with spent sources and international assistance should be intensified in that connection.

States should be encouraged to install monitoring systems at airports and seaports, at border crossings and at other locations where radiation sources may appear (such as metal scrap yards and recycling plants). Strategies, including staff training and the provision of equipment. should be developed for responding to cases where radiation sources are detected at such locations. States should bear in mind that the loss of control over a source in one country may have transboundary consequences and may necessitate international information exchange and co-operation.

Consideration should be given to making sources used for defence purposes subject to control either by the civilian authorities or by a body that passes all necessary information to the civilian authorities, particularly in the event of the loss of a radiation source.

The IAEA should strengthen the mechanisms used by it in providing for the application of the BSS (particularly education and training, the fostering of information exchange and the rendering of technical assistance). The IAEA should also consider providing guidance with regard to search, detection and recovery actions, including guidance with regard to technical and personal protection measures. In addition, the IAEA should be prepared, upon request, to help with recovery actions itself and through the provision of outside expert services.

There may be a need for an effective international undertaking in the area of the safety and security of radiation sources. Such an international undertaking might take the form of a convention, a protocol or some other type of operational instrument. Whatever its form, it should provide for a clear determination by and attract the broad adherence of States. The IAEA is strongly encouraged to initiate exploratory discussions for achieving such an international undertaking.