

**Safety Reports Series**

**No. 84**

**Radiation Protection  
of Itinerant Workers**



**IAEA**

International Atomic Energy Agency

# IAEA SAFETY STANDARDS AND RELATED PUBLICATIONS

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RADIATION PROTECTION  
OF ITINERANT WORKERS

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# RADIATION PROTECTION OF ITINERANT WORKERS

INTERNATIONAL ATOMIC ENERGY AGENCY  
VIENNA, 2015

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## FOREWORD

The mechanisms and responsibilities for the control of radiation doses arising from occupational exposure are well established, and are described in Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards (IAEA Safety Standards Series No. GSR Part 3 (2014)) and in Occupational Radiation Protection (IAEA Safety Standards Series No. RS-G-1.1 (1999))<sup>1</sup>.

The objective of the IAEA's programme on occupational radiation protection is to promote an internationally harmonized approach to occupational radiation protection, through the development and application of standards and good practices for optimizing protection and safety, restricting exposures and implementing current radiation protection techniques in the workplace.

There are very specific management issues associated with the control of radiation exposure to one particular group of occupationally exposed workers. This group consists of workers who regularly carry out job assignments at a work location of an employer other than their own employer. They may either be exposed as a result of the use of ionizing radiation or radioactive materials by the management of the facility, or they may take into the facility their own source of ionizing radiation, with implications for potential exposure both for themselves and the employees of the management of the facility. These persons are referred to as 'itinerant workers'. For the purposes of this Safety Report, itinerant workers are occupationally exposed workers who work in supervised and/or controlled areas at a variety of (one or more) locations and are not employees of the management of the facility where they are working.

This Safety Report provides guidance on the application of the requirements of the IAEA Safety Standards Series No. GSR Part 3 (2014) to itinerant workers in a wide range of situations. It contains a compilation of information both on the issues associated with protection and safety for itinerant workers and approaches to resolution of those issues. While the cited issues may be covered comprehensively for workers in general, it was recognized that more specific guidance on the handling of these issues with regard to itinerant workers would be beneficial, especially as regards the interactions among the parties responsible for protection and safety.

Guidance on radiation protection for itinerant workers was initially drafted in 2002–2003. At that time, the full context of the protection and safety issues for itinerant workers was just emerging, and the means to resolve the issues were not yet mature.

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<sup>1</sup> A revision of this publication is in preparation.

This Safety Report takes into account the substantial changes in requirements and practices in occupational radiation protection that have occurred over the past decade. A substantial updating and supplementation of the draft began with a technical meeting in November 2011 and was completed in 2013.

The IAEA would like to express its gratitude for the contributions made by R.L. Doty. The IAEA officer responsible for this publication was J. Ma of the Division of Radiation, Transport and Waste Safety.

#### *EDITORIAL NOTE*

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# 1. INTRODUCTION

## 1.1. BACKGROUND

The establishment and continuing management of effective radiation protection and safety programmes are essential components in the control of radiation exposures of workers. The IAEA has developed extensive guidance for managers, radiation protection specialists and employers on the control of occupational exposure. The use of the guidance, together with observance of the relevant State legislation, will ensure that occupational radiation protection is optimized.

However, in many practices, there is a category of exposed workers who are not employees of the organization, who either work for contractors or are self-employed. These workers may not work with ionizing radiation sources themselves, but may be exposed to the sources of ionizing radiation at the facility. Alternatively, they may bring their own sources of radiation into the facility, thus creating an exposure pathway to the employees of the management of the facility as well as themselves. Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, IAEA Safety Standards Series No. GSR Part 3 (2014) (hereinafter referred to as GSR Part 3) [1] (paras 3.85–3.87) and Occupational Radiation Protection, IAEA Safety Standards Series No. RS-G-1.1 [2]<sup>1</sup> (paras 2.40 and 5.11) give some limited guidance on the procedures to follow when ‘itinerant’ workers are hired to carry out work. It is recognized, however, that further guidance needs to be given to specify where responsibility lies in these situations and the procedures to be followed. This guidance may also be appropriate for some employees on short term assignments with an employer.

The term ‘itinerant’ could be misinterpreted to imply that workers necessarily move from one work location to another in succession, with the workers necessarily taking job assignments that result in annual doses approaching dose limits or the jobs not being desirable for other reasons. In reality, many job assignments for itinerant workers are desirable, require highly trained personnel, result in accumulated doses which are well controlled and allow for longer term assignments at one location.

Alternative terminologies such as ‘transient’, ‘temporary’ or ‘migrant’ workers have similar connotations. ‘Outside’ worker is a term mainly used in Europe, and it is also used differently by the European Union than in this Safety

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<sup>1</sup> A revision of this publication is in preparation.

Report. A term such as ‘contracted’ workers may be confusing because permanent employees of an organization are sometimes said to be ‘under contract’.

The focus is on the set of workers who regularly carry out job assignments at a work location of an employer other than their own employer. The definition of ‘itinerant’ worker is provided in Section 2.

## 1.2. OBJECTIVE

This Safety Report addresses the radiation protection issues associated with the use of itinerant workers, and recommends managerial and practical arrangements that need to be in place if good practices are to be followed and radiation doses controlled adequately. The Safety Report focuses on the communication and cooperation among the relevant parties to establish a clear allocation of responsibilities and to ensure the protection and safety of itinerant workers.

The primary responsibility for the protection of workers lies with the management of the operating organization responsible for the facilities and activities that give rise to radiation risks; however, the employer of the worker (as well as the worker) also bear certain responsibilities. This Safety Report is intended to provide practical guidance for managers of itinerant workers, for managers who are responsible for the safety aspects associated with the use of contractors at a facility (with or without a radiation source) and for workers. This includes those managers directly responsible for radiation protection, such as radiation protection officers (RPOs) and radiation protection managers, and their staff. Equally important target audiences are those managers responsible for production or other aspects of the organization, such as the preparation of contracts. These persons may also be involved in the development and implementation of radiation protection programmes (RPPs) for the workers, both in-house and itinerant workers. This Safety Report is also useful for regulatory bodies in clarifying how the contracting parties comply with regulatory requirements with respect to the use of contractors and itinerant workers, including the identification of situations which may call for interaction between the contracting parties and the regulatory body.

## 1.3. SCOPE

This Safety Report applies to all sites and facilities (with or without a radiation source) in which itinerant workers are exposed to radiation in the course of their work, including general industrial facilities, nuclear fuel cycle

facilities, operations in the mining and processing of radioactive ores and other raw materials, oil and gas facilities, and well logging and medical radiation facilities (e.g. equipment engineers). Subjects covered include organizational and managerial responsibilities, contractor personnel competence, RPPs and training. Health care professionals (e.g. radiological medical practitioners and medical radiation technologists) may also meet the definition of itinerant workers, depending on their employment and work location arrangements. Specific guidance applicable to the situation of health care professionals in clinical and pseudo-clinical settings is being developed by the IAEA in a Safety Guide on radiation protection and safety in medical uses of ionizing radiation; therefore, the information concerning those situations in this Safety Report is limited.

The content of this Safety Report focuses on planned exposure situations. The likelihood that an itinerant worker would be asked to accrue dose in an emergency is small, but this request may be made of adequately trained and briefed workers. Thus, record keeping for such doses is mentioned in this Safety Report. The exposures of itinerant workers engaged in remedial actions are to be controlled for as those for planned exposure situations. For exposure to radon in the remedial action workplace, the above is true when reasonable efforts to control the activity concentration of radon below the reference level established by the regulatory body have not been successful [1].

#### 1.4. STRUCTURE

The definition of itinerant workers and the general issues associated with their use are presented in Section 2. Section 3 considers worker, managerial and organizational responsibilities, and discusses three types of situation that are likely to occur with itinerant workers. Section 4 describes a mechanism for ensuring the competence of itinerant workers, while Section 5 considers the development of appropriate RPPs. Specific issues associated with the use of itinerant workers in the nuclear industry, medicine, and in the mining and raw materials extraction and processing industries are discussed in Section 6. The mechanisms for the review and maintenance of arrangements for itinerant workers are addressed in Section 7.

Additional practical information, including examples of a checklist for guiding formulation of contractual arrangements for protection and safety, an individual radiation monitoring document (an IRMD, or ‘passbook’), a checklist for assessing the radiation safety performance of industrial radiographers, an example of an outline of a basic radiation protection training course, an individual access form for a nuclear facility and an example for assessing occupational exposure to NORM is given in the appendices.

## 2. MANAGEMENT OF RADIATION PROTECTION AND SAFETY

### 2.1. ITINERANT WORKERS

Itinerant workers, for the purposes of this Safety Report, are occupationally exposed workers who work in supervised and/or controlled areas at a variety of locations (one or more) and are not employees of the management of the facility where they are working. The itinerant workers may be self-employed or employed by a contractor (or similar legal entity) that provides services at other employers' facilities. Itinerant workers may be trainees, apprentices, students or research associates when their courses of study or work experience (overseen by their mentors in the contractor's organization) require their presence in supervised and/or controlled areas established at the facility.

In this Safety Report, the terms 'employer', 'management of the facility' (or 'site operator' or 'facility manager') and 'contractor' are used to describe various working arrangements.

The employer is a person or organization with recognized responsibilities, commitments and duties towards a worker in their employment (who may or may not be an itinerant worker, depending on the nature and location of the work) by virtue of a mutually agreed relationship [1].

The management of the facility, site operator or facility manager is the person, company, organization or body that manages and has primary control of a facility or site (with or without a radiation source) and the activities (involving or not involving radiation sources) undertaken at that facility, and will also be an employer.

The contractor is the person, company, organization or body that provides services under contract to a facility manager, and is also an employer. The employees of a contractor, when working in supervised and/or controlled areas at a facility not managed or under the primary control of the contractor, will fall within the definition of itinerant workers. In complex situations, a contractor may contract work to a subcontractor, whereupon the employees of both the contractor and subcontractor may be itinerant workers.

The registrant or licensee of the practice, or the person or organization under another form of regulatory control (e.g. notification alone), could be the facility manager or the contractor or both, depending on the circumstances. In some cases, neither the management of the facility nor the contractor may be under regulatory control regarding radiation exposure, but may wish to review (and possibly keep under review) the potential for occupational exposure and the reasonable feasibility of invoking specific protection measures or safety provisions.



In less formal language, both the management of the facility and the contractor are employers. The management of the facility has primary control of the facility, and the contractor provides services under contract to the facility management. The employees of that contractor (and any applicable subcontractor) fall within the definition of itinerant workers, when they are assigned work in supervised and/or controlled areas at a facility not managed or under the primary control of the contractor. If the contractor is a self-employed individual, that person is considered to be both an employer and an employee. Either the management of the facility or the contractor may be a registrant or licensee; in some cases described in this Safety Report, both or neither may be a registrant or licensee.

Owing to the fact that an employee of the contractor may work in facilities managed by other employers and by his or her own employer, an individual worker may be an itinerant worker for one period of exposure and not for the subsequent period of exposure. For example, a worker may be an itinerant worker for one week, then be a worker employed in the second week at a facility managed by their employer (so the worker is then an in-house or permanent worker), and then again be an itinerant worker for the third week, because the organization that operates the facility at which the worker is working for weeks 1 and 3 is not their employer.

A complicating factor can be that a worker may be employed by more than one employer at a time. However, it is virtually never the case that such a worker is both an in-house worker and an itinerant worker at the same facility at the same time. Another complicating factor can be that a worker may be the employee of a contractor but working at a single facility for a relatively long period of time (e.g. more than six months). Depending on the applicable State regulations, the definition of who is the worker's employer may be subject to change. For the purposes of this Safety Report, an itinerant worker is presumed to be employed by a contractor and not to become a de facto employee of the facility management even if they remain a contracted worker at a single facility for a lengthy period of time.

The radiation protection of an itinerant worker necessitates care and can be complicated by communication difficulties and remote supervision, but effective management is essential to identify and control risks due to radiation exposure. Examples of factors affecting multiple persons or organizations, for which job specific communications need to occur and appropriate agreements need to be reached, include the following:

- Definition of the responsibilities of the contractor (employer), the management of the facility and the worker, including responsibilities for dose tracking and control;

- Cooperation and information exchange between employers (of the itinerant worker and the facility management), with appropriate input from the worker, on the task(s) to be performed and the programmatic aspects of protection and safety to be applied;
- Training, health surveillance, safety culture and application of the requirements for protection and safety coherently with other requirements.

Additional discussion of communications between relevant parties and the development of appropriate contractual arrangements can be found in Section 3.

The percentage of itinerant workers in the general workforce appears to be increasing in recent years as employers of various types continue to evaluate the economics of using contracted services rather than services provided by their own (in-house) workers. Itinerant workers may be classified into two main types, in two different ways. First, the itinerant workers may be classified as follows:

- (a) Itinerant workers who reside in and work within the boundaries of the State in which the facility of their current work may be found; these are sometimes called domestic itinerant workers.
- (b) Itinerant workers who may travel from one State to another during a calendar year, and for whom their current work location may be outside of the State in which their employer is registered and/or from which each worker's individual radiological monitoring document (IRMD) was issued. They may maintain a permanent residence and may work at some frequency in that or another State. Sometimes these are called international, transboundary or cross-border itinerant workers.

When working at a given site in a State, there is basically no distinction between a domestic or international itinerant worker. The worker's employer and facility management will apply the dose limits of the State in which the facility is located and the other required protection and safety criteria of that State to the (domestic or international itinerant) workers equally. The radiation protection criteria are the same for the workers and are independent of the State of the worker or their employer.

A difference may appear in the work assignments that are made to an international itinerant worker as a result of either the highly specialized skills of that specific worker or the contractual agreements reached by the worker's employer and the management of the facility. These arrangements may place additional restrictions on the dose that may be accrued by an international itinerant worker, to maintain the worker's compliance with the dose limits of another State. (Such agreements are described in more detail in Section 3.1.1.)

Itinerant workers, regardless of whether they are domestic or international, are subject to restrictions on exposure, and protection and safety measures that are at least as good as those for the workers permanently at the facility (the in-house workers of the facility managers) (see para. 3.86(a) of GSR Part 3 [1]). There is, generally, no distinction made by the regulator between a permanent worker and an itinerant worker. Similarly, there is no distinction made between those workers regarding how protection and safety programmes are developed and applied.

There are two exceptions to the ‘no distinction’ policy just stated. The first exception is that trainees, apprentices and students 16 to 18 years of age are subject to an annual effective dose limit of 6 mSv/a [1]. A State may choose to extend the more restrictive annual effective dose limit to trainees, apprentices and students of a greater age. Consistent with GSR Part 3 citation above, the second exception is that a State may choose to impose a more restrictive annual effective dose limit (e.g. 15 mSv/a) to all itinerant workers over the age of 18, to reflect the specific needs of that State as regards itinerant workers.

A second means of classifying itinerant workers relates to whether the planned activities of the contractor and/or the management of the facility give rise to radiation risks. Such a classification scheme would include:

- (a) Itinerant workers who are exposed to radiation as a result of the facilities and activities of the management of the facility. In this case, the radiation source most likely continues to be located within the boundaries of the facility.
- (b) Itinerant workers who are exposed to radiation solely as a result of the facilities and activities of their employer (the self-employed individual or contractor providing services to the management of the facility). In this case, the radiation source is most likely mobile or semi-mobile, as it is likely to be transported from facility to facility. Note: Under some conventions, this category of worker may not be called an itinerant worker, because under those conventions, the facility would necessarily have legal responsibility for a radiation source and supervised and/or controlled areas accessed by contracted workers.

Examples of contracted workers who may meet the definition of itinerant workers and the types of work they perform include:

- Maintenance workers in the nuclear power industry. These workers are often employed by a contractor who provides maintenance services to the nuclear industry; the workers may be required to work at a facility, within supervised or controlled areas, during normal operations, shutdown or maintenance of a section of the plant, and may then move on to the next plant or power station.

- Quality assurance, in-service inspection and non-destructive examination or testing personnel in the nuclear power or other industries. These workers are often employed by a contractor who provides the named services to the industry; the workers are more likely to be located at the facility during periods when the facility is shut down.
- Maintenance and cleaning staff performing contracted services in general industry, who may be exposed to radiation from a wide range of applications.
- Contractors providing specialized services, for example, removal of scale and sediment from within pipes and vessels, the transport of radioactive wastes, or the loading or changing of radioactive sources at irradiation facilities.
- Contract workers in mining and mineral processing facilities, exposed to radiation risks arising from naturally occurring or artificial sources.
- Industrial radiography companies and self-employed industrial radiographers contracted to work at a facility (with or without a radiation source) operated by a management other than their own.
- Contracted personnel involved in the decommissioning of facilities of various types (e.g. industrial and military) and the cleanup of associated buildings and outside areas of radioactive materials.
- Workers performing contracted security screening using X ray generating machines or radioactive sources.
- Contracted researchers at accelerator facilities.
- Contracted medical equipment company personnel installing and servicing equipment.
- Medical staff — radiological medical practitioners, medical physicists, medical radiation technologists and other health care professionals with specific duties in relation to the medical uses of radiation and/or health surveillance — who provide contracted professional services in supervised and/or controlled areas in multiple hospitals or clinics (whether fixed or mobile). As noted in Section 1, specific guidance applicable to the situation of health care professionals in clinical and pseudo-clinical settings is being developed by the IAEA in a Safety Guide; therefore, the information concerning those situations in this Safety Report is limited.

Carers and friends and family members who voluntarily perform tasks such as escorting patients to and from medical services appointments (where radiation sources are used) are not considered to be within the scope of this Safety Report. Their protection and safety is considered to be solely the responsibility of the medical facility whose practices are giving rise to any radiation risk to the carers and friends and family members. Paragraph 3.153 of GSR Part 3 [1] may be reviewed for additional information.

Further, visitors to any facility, who do not perform work in supervised or controlled areas at that facility, are not considered to be within the scope of this Safety Report. Their protection and safety is considered to be the responsibility of the person or organization whose practices give rise to any radiation risks to visitors (even if the visitors perform ‘hands off’ observations of limited duration, but no physical work, in supervised or controlled areas at the facility). Paragraph 3.128 of GSR Part 3 [1] may be reviewed for additional information.

Some of these workers may have a well established work pattern, where they report for duty at no more than a few separate facilities over a relatively long period of time (e.g. months to years). Others have work patterns that are less well established, reporting for duty at what might be a lengthy list of facilities, often for relatively short periods of time at each facility (e.g. days to weeks).

## 2.2. GENERAL ISSUES ASSOCIATED WITH THE USE OF ITINERANT WORKERS

The issues associated with ensuring the protection and safety of itinerant workers (and, where appropriate, facility staff) are primarily those associated with managerial control, as a result of uncertainties over the allocation of responsibilities for worker protection arrangements. Difficulties may also arise with regard to exposure control over a period of time. An example of this is the use of itinerant workers at a nuclear power plant. These workers may receive relatively higher doses than some of their colleagues in a short period of time during plant maintenance programmes.

While the RPP of the plant will restrict the doses attributed to that plant to below a certain level, movement of itinerant workers from one plant to another may result in one or more individuals accumulating an annual dose approaching or even exceeding the annual individual dose limit.

This may be true even though none of the prospectively established dose constraints or the facility-specified allowable accumulated doses at the different plants was exceeded. (Sometimes, these facility-specified values are called ‘administrative dose targets’ or ‘administrative dose limits’ by registrants or licensees. The values are neither lower bound targets nor limits in most cases.)

This example of a potentially sizeable individual dose being accumulated across several facilities illustrates a difficulty that arises as a result of the possible uncertainty over who has overall responsibility for the individual monitoring of the workers and the application of dose constraints or allowable accumulated doses at one facility and accumulated annual dose across one or more facilities.

Another example illustrating the same difficulty would be itinerant workers who are exposed in multiple discrete periods at a few facilities (e.g. one facility in the morning, another in the afternoon and perhaps a third facility on one day per week).

The range of work carried out by itinerant workers makes it difficult to assign responsibilities explicitly, without first considering specific situations. These situations can range from those where most of the duties and responsibilities for protection and safety will naturally fall on the contractor (the employer of the itinerant workers) to those where the management of the facility will be required contractually to provide most of the necessary services for, or on behalf of, the itinerant workers. Within this range, three types of situation are most likely to occur:

- (a) The operation of a facility has the potential to cause exposure of not only the facility's permanent employees but also the employees of the contractor, which does not control a radiation source. In such a scenario, the manager of the facility is likely a registrant, licensee or under another form of regulatory control, and the contractor is an employer but not a registrant, licensee or under another form of regulatory control. For this Safety Report, 'another form of regulatory control' may imply facility practices either requiring notification alone or being exempted from some but not all of the requirements established in GSR Part 3 [1], as implemented by the government or regulatory body of the State in which the facility is located.
- (b) The contractor's employees bring the contractor's source of radiation to a facility which does not control a radiation source and, thus, the contractor's activities have the potential to cause exposure of not only its own employees but also the employees of the facility managers. In such a scenario, the contractor is likely a registrant, licensee or under another form of regulatory control, and the facility management is an employer but not a registrant, licensee or under another form of regulatory control.
- (c) Both the operation of the facility and the activities of the contractor have the potential to cause exposure of their own and each other's employees. In this scenario, both the management of the facility and the contractor are likely registrants, licensees or under another form of regulatory control.

There are both common issues and also specific issues that need to be addressed, and these situations are considered in Sections 3.2–3.4. Section 3.2 provides the most detailed guidance, addressing a situation where the contractor and its employees have limited or no experience working with ionizing radiation. The contents of that section may also provide guidance helpful in other situations.

### 2.3. MANAGEMENT FEATURES

There are several necessary management features generic to all practices for which the development and effective implementation of protection and safety programmes is appropriate. Notable examples, usually specified as being applicable to the registrant or licensee and, where applicable, to the employer (at a minimum, (a)–(d) apply to the employer), include the following:

- (a) A commitment to protection and safety at the highest management levels within the responsible organization(s).
- (b) Promotion and maintenance of a robust safety culture at all levels of the organization(s).
- (c) Consideration of means to improve human performance in development and implementation of RPPs.
- (d) Use of a graded approach “commensurate with the characteristics of the practice or the source within a practice, and with the likelihood and magnitude of exposures” [1].
- (e) Development by the organization(s) of systematic critical safety assessments of the facility or activity prior to operations, during operations and at the proposed closure of the facility or activity.
- (f) Ongoing evaluations of operations and operational occurrences, to provide input to protection and safety programme refinements. This will often include not only sharing of information on lessons within organizations but also across organizations.

All of these are attributes of a management system designed and implemented for the enhancement of protection and safety, and “able to demonstrate the effective fulfilment of the requirements for protection and safety” [1]. These topics are important to remember and will be referred to as the ‘specific topics’ addressed by this Safety Report. For guidance regarding these topics, see, for example, GSR Part 3 [1], the IAEA Safety Standards Series No. RS-G-1.1, Occupational Radiation Protection [2] and also publications developed for specific practices, such as the IAEA Safety Standards Series publications on Radiation Safety of Gamma, Electron and X Ray Irradiation Facilities [3], Safety of Radiation Generators and Sealed Radioactive Sources [4], and Radiation Safety in Industrial Radiography [5].

One other item is worthy of mention as a generic management responsibility. Radiation protection is most often only one element in making certain that overall worker (and public) health and safety is effectively maintained. An RPP is to be established and implemented in close cooperation with programmes such as industrial safety, industrial hygiene, fire safety, environmental safety and, where

appropriate, nuclear safety, such that all risks to workers and members of the public are appropriately addressed and final decisions reflect the optimal course of action. In GSR Part 3, this is referred to as “Applying the requirements for protection and safety coherently with other requirements, including requirements for operational performance, and coherently with guidelines for security” [1], even as actions are defined so as not to compromise protection and safety.

As stated above, there is a need to develop and implement coherent means of managing all risks which arise from conduct within a facility. This need may especially be seen with an example using the definitions of ‘itinerant worker’ and ‘facility’ used in this Safety Report. When the contractor brings a radiation source into a facility with otherwise minimal, if any, radiation risk, the contractor may bear primary responsibility for radiation protection and safety.

However, there remains the potential for interactions of risks among workers. Employees of the management of the facility may be exposed to some level of radiation risk, adding to the (non-radiological) risk profile to which they were previously exposed. Employees of the contractor may be exposed to types of non-radiological risk as they conduct their tasks at the facility, adding to the risk profile to which they would otherwise be exposed. Further, while perhaps unlikely, the calculated detriments associated with the risks may not be fully independent, in that there may be interactions between the risks, such that the total risk is greater than the additive risks from the several risk agents. An example may be thermal environments within the facility that may increase the volatility of radionuclides.

## 2.4. SUMMARY

The following statements are intended to summarize the information presented in this section and reiterate several key concepts described. They are to be interpreted within the context of the entire Safety Report and, specifically, Section 2:

- (1) Itinerant workers are occupationally exposed workers who work in supervised and/or controlled areas at a variety of (one or more) locations and are not employees of the management of the facility where they work. The itinerant workers may be self-employed or employed by a contractor (or similar legal entity) that provides services at other employers’ facilities. Itinerant workers may be trainees, apprentices, students or research associates when their courses of study or work experience (overseen by their mentors in the contractor’s organization) require their presence in supervised and/or controlled areas established at the facility.



- (2) A worker may not be an itinerant worker for one period of exposure but be an itinerant worker for the subsequent period of exposure. This would be true if the worker's employer has overall control of the facility in which the worker is performing tasks for the first period of exposure, but the worker's employer is providing contracted services at (and does not have overall control of) the facility in which the worker is performing tasks for the subsequent period of exposure.
- (3) Itinerant workers may be classified into two main types, in two different ways. First, the itinerant worker may be a domestic itinerant worker (residing and working within a single State) or an international itinerant worker. An international itinerant worker may travel from State to State during a calendar year, and the individual's current work location may be outside the State in which the individual's employer is registered and/or from which that worker's IRMD was issued.
- (4) The second means of classification relates to whether the planned activities of the contractor or the management of the facility give rise to radiation risks. Itinerant workers may be exposed to radiation as a result of activities of the management of the facility. Alternatively, the workers may be exposed to radiation as a result of their employer's activities. In some cases, both the management of the facility and the contractor undertake activities which give rise to radiation risks to the itinerant workers.
- (5) The registrant or licensee and, where applicable, the employer are to use a management system designed and implemented for the enhancement of protection and safety, and "able to demonstrate the effective fulfilment of the requirements for protection and safety" [1]. This is to include "Applying the requirements for protection and safety coherently with other requirements, including requirements for operational performance, and coherently with guidelines for security" [1].

### **3. RESPONSIBILITIES FOR ITINERANT WORKERS**

#### **3.1. GENERAL**

The main responsibility for radiation protection and safety of individuals lies with the person or organization responsible for facilities and activities that give rise to radiation risks. This corresponds, most often, to the registrant or licensee of specified activities. In some cases, application of the graded approach to protection and safety results in a finding that regulatory authorization

may not be applicable and, indeed, that little or no regulatory control may be necessary or achievable.

Specifically, in GSR Part 3 [1], the following statements are found regarding Requirement 4 on responsibilities for protection and safety:

“2.39. The person or organization responsible for any facility or activity that gives rise to radiation risks shall have the prime responsibility for protection and safety, which cannot be delegated.

“2.40. The principal parties responsible for protection and safety are:

- (a) Registrants or licensees, or the person or organization responsible for facilities and activities for which notification only is required;
- (b) Employers, in relation to occupational exposure;
- (c) Radiological medical practitioners, in relation to medical exposure;
- (d) Those persons or organizations designated to deal with emergency exposure situations or existing exposure situations.

“2.41 Other parties shall have specified responsibilities in relation to protection and safety. These other parties include:

- (a) Suppliers of sources, providers of equipment and software, and providers of consumer products;
- (b) Radiation protection officers;
- (c) Referring medical practitioners;
- (d) Medical physicists;
- (e) Medical radiation technologists;
- (f) Qualified experts or any other party to whom a principal party has assigned specific responsibilities;
- (g) Workers other than workers listed in (a)–(f) in this paragraph;
- (h) Ethics committees.”

These responsibilities of the principal parties include the appropriate establishment of protection and safety objectives, the documentation and implementation of a protection and safety programme, and the establishment of arrangements for consultation and cooperation among the employers whose employees may be exposed as a result of the activities of the management of the facility and/or contractor. These employers are also responsible for the health and safety of their own employees.

It follows that for the management of itinerant workers there will be overlapping responsibilities for the arrangement of radiation protection and safety matters between the facility management and the employer of the itinerant workers. The specific content of these joint responsibilities will be dependent on the type of work carried out, but will require consultation and cooperation, to the extent necessary, for compliance with the requirements for the safety of all workers at the facility. (See para. 3.85 of GSR Part 3 [1].)

Paragraph 3.86 of GSR Part 3 [1] provides additional commentary regarding the cooperation between an employer and a registrant or licensee. Specifically, that paragraph states:

“Cooperation between the employer and the registrant or licensee shall include, where appropriate:

- (a) The development and use of specific restrictions on exposure and other means of ensuring that the measures for protection and safety for workers who are engaged in work that involves or could involve a source that is not under the control of their employer are at least as good as those for employees of the registrant or licensee;
- (b) Specific assessments of the doses received by workers as specified in (a) above;
- (c) A clear allocation and documentation of the responsibilities of the employer and those of the registrant or licensee for protection and safety.”

The three items listed above remain appropriate relative to the discussion between the employer and any person or organization responsible for facilities and activities that give rise to radiation risks, even if regulatory authorization is not required. In such a case, the parties to the discussion ought to recall that measures for protection and safety are to be developed commensurate with the assessed radiation risk.

Where the need for cooperation leads to an agreement on procedures to be followed, this is to be set down in writing. It is likely to be appropriate for such an agreement to form part of the formal contractual arrangement, particularly in large and/or complex contracting (and subcontracting) situations, for example, when the management of the facility specifically delineates a part of its facility to be handed over to a contractor to carry out some work, such as structure and/or system construction or decommissioning. This would ensure that each party clearly knows which of the legal demands on the employer it is specifically responsible for meeting. The detailed arrangements and identification of responsibilities will vary with the nature of the work and the relevant experience of the parties involved. The arrangements may also be important

in cases where international itinerant workers are to be used, to specify how any differences in regulations (or interpretations of regulations) between the relevant States are resolved.

In Section 3.1.1, the term ‘registrant or licensee’ is to be interpreted to include the possibility that the person or organization responsible for facilities and activities giving rise to radiation risks may not be a registrant or licensee but may otherwise be subject to regulatory control (as exemplified in Section 2.2) or may be assessing the potential for the reasonable application of one or more protection and safety measures even though such measures may not be required by regulations applicable to the facility.

### **3.1.1. Responsibilities of the registrant or licensee and responsibilities of the employer**

Requirement 21 of GSR Part 3 [1] describes the responsibilities of employers, registrants and licensees for the protection of workers:

“Employers, registrants and licensees shall be responsible for the protection of workers against occupational exposure. Employers, registrants and licensees shall ensure that protection and safety is optimized and that the dose limits for occupational exposure are not exceeded.” [1]

The registrant or licensee is to ensure that several conditions are met as the protection and safety programme is developed and finalized. Whether the registrant or licensee is the employer of the itinerant worker or the management of the facility, the following are to be true, and the registrant or licensee bears the primary responsibility to ensure that they are true:

- (a) There is equivalent protection and safety afforded to the (in-house or permanent) employees of the management of the facility and the itinerant workers of the contractor. If a subset of the ‘workers’ is by regulation or contractual agreement to be treated as members of the public, that subset (e.g. minors (aged 16 or 17) or apprentices) is to be afforded protection under the applicable dose limitations for members of the public.
- (b) Workers engaging in activities giving rise to radiation risks are medically fit for their assigned tasks, trained in the basics of radiation protection, and specifically trained and appropriately qualified for the tasks which they are to perform in the workplace environment they will encounter.

- (c) Applicable dose limits are known, and appropriate dose constraints and/or allowable accumulated doses (under the procedures of the facility operator) have been established for the activities giving rise to radiation risks. Constraints and/or facility-specified allowable accumulated doses for a planned work task are established via evaluation of the planned work consistent with the requirements for optimization of protection and safety. The previous occupational exposure history of workers is obtained for use in this process.
- (d) A work management system is in place to ensure the application of the requirements for optimization of protection and safety throughout implementation of the planned work. This is to include engagement of the workers in communications prior to job execution and as practicable during job execution, to identify and implement reasonable means of task refinement to reduce exposures.
- (e) Workers have the personal protective equipment necessary for their protection and safety.
- (f) Workers are provided individual (and/or workplace) exposure monitoring appropriate to their assigned tasks and workplace environment. This is to include, where appropriate, an integrating personal dosimeter and appropriate operational (active) dosimeter for the task and workplace, and an individual measurement programme to assess intakes of radionuclides.
- (g) Radiological data for the workers is recorded, and those data are provided to workers, employers, authorized health surveillance personnel and regulatory body personnel as necessary for their required actions.

As stated in the introductory paragraphs of Section 3.1, the employer of an occupationally exposed worker (whether an itinerant worker or a permanent employee of the management of the facility) is also a principal party with the registrant or licensee, in developing the appropriate protection and safety programme. The employer of the worker is to ensure:

- (a) Protection of the worker from unnecessary occupational exposure;
- (b) Compliance with the relevant requirements related to protection and safety;
- (c) Involvement of the worker in the optimization of protection and safety for that worker;
- (d) Facilitation of compliance by the worker with the protection and safety programme elements, including the notification of the worker of their obligations for their own protection and that of their co-workers.

The allocation of responsibilities for the duties mentioned above is subject to discussion between the contractor, the management of the facility and other relevant parties to the discussion (e.g. qualified experts). The relative input to such discussion depends on which party, if any, is a registrant, licensee or otherwise subject to regulatory control (e.g. notification regarding an intended activity), and which party has the greater knowledge and experience related to protection and safety as regards the tasks to be performed and/or the workplace environments in which the tasks are to be performed.

There are situations in which both the contractor and the management of the facility are registrants or licensees, for example, in the case of industrial radiography performed by the contractor on the site of a nuclear fuel cycle facility. For the situation where there is one registrant or licensee and one other employer whose employees have no or very little experience in work involving the potential for radiation exposure, the results of the discussion are likely to be weighted towards most of the responsibilities being borne by the registrant or licensee. The other employer is to participate at least sufficiently to become familiar with the topics of relevance to that employer's staff and to achieve a level of comfort that the finalized arrangements are as protective of the occupational health and safety of that employer's staff as for the staff of the registrant or licensee and as protective as applicable regulations require.

The purpose of such discussion among the relevant parties is to ensure clarity regarding roles and responsibilities for operational radiation protection, given the tasks being contracted. The roles and responsibilities are to be discussed and assigned via contractual agreements made prior to the start of work planning efforts or at least sufficiently in advance of work execution to allow for adequate implementation of assigned responsibilities. The agreements are to be clear regarding when the assigned responsibilities begin and end.

The topics described in the following subsections are likely to be those of most relevance regarding the development of contractual agreements addressing the use of itinerant workers at facilities, with the wording addressing the situation where the facility management is using radiation sources or undertaking practices that give rise to radiation risks.

### *3.1.1.1. Responsibility for providing basic training in radiation protection*

Who is responsible for providing (or ensuring the provision of) basic (general awareness) training regarding radiation protection to the itinerant worker? By when is the initial or latest refresher training<sup>2</sup> to have been completed and to what level of content (e.g. equivalent to that of the permanent staff of the facility)?

### *3.1.1.2. Responsibility for providing specific task related training*

Who is responsible for providing (or ensuring the provision of) specific task related training (and, if appropriate, providing documentation of qualification or certification)? By when is the initial or latest refresher training to have been completed and to what level of content? Task related training and/or facility specific training (see Section 3.1.1.3) are to include training on the safe management and security of high activity sources, when such sources will be present in the workplace.

### *3.1.1.3. Responsibility for providing facility specific training*

Who is responsible for providing (or ensuring the provision of) facility specific training necessary for the tasks to be performed in the facility workplace, in what time frame and to what level of content (e.g. equivalent to that of the permanent staff of the facility)? If the itinerant worker may need to wear respiratory protection equipment, the contractual agreement needs to include statements on acceptable means of confirming the worker's training on the wearing of respiratory protection equipment, fit testing for wearing devices available (allowed) at the facility, and the medical fitness of the worker for respirator use. For the training mentioned in Sections 3.1.1.1–3.1.1.3, agreement is also to be reached on responsibilities for any training to occur in languages other than that common for facility personnel, and how individuals trained in such languages can be effectively tested on their ability to understand notifications and warnings in the language common for facility personnel.

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<sup>2</sup> The 'refresher training' referred to in Sections 3.1.1.1 and 3.1.1.2 would need to be completed to meet the retraining content and the specifications of frequency of training for the State in which the facility is located.

#### *3.1.1.4. Responsibility for health surveillance and health services*

Who is responsible for health surveillance and health services for the itinerant worker, and by whom (and when) is the itinerant worker to have been declared medically fit for the planned work in the scheduled time frame? The health surveillance available to the itinerant worker needs to be arranged to be equivalent to that available for permanent staff of the facility responsible for the source. The responsibilities are to be established for medical follow-up in the unlikely case that an accrued dose exceeds the State's dose limit applicable at the facility or if a dose is received in an emergency (either >200 mSv or at the request of the worker as described in para. 4.19 of GSR Part 3 [1], or >100 mSv in a month as described in Ref. [6]).

#### *3.1.1.5. Responsibility for dose constraints and allowable doses*

What are the dose constraints and/or accumulated doses allowable under the procedures of the facility operator? Which are to be applied to the itinerant worker? Are they to be more strict than the State dose limits applicable at the facility and/or more strict (or, potentially, less strict), after appropriate prospective evaluation, than the dose constraints and/or accumulated doses that facility procedures allow for the permanent staff of the facility?

For the performance of similar work tasks, the dose constraints and/or the facility's allowable doses are, generally, to be the same for itinerant workers and permanent facility staff (that is, equivalent protection and safety is being offered). For work tasks that are not similar, prospective evaluation of the different tasks may result in the application of different dose constraints and/or allowable accumulated doses under the procedures of the facility operator. (It should be noted that such allowable accumulated doses may be a series of operator established levels of accumulated dose, which may be exceeded upon completion of facility specific evaluations and approvals for additional exposure of the worker.) This question may be more likely to arise for either international itinerant workers or for domestic itinerant workers whose speciality may be performance of activities that, even after optimization of protection and safety, lead to annual doses approaching the State's dose limits. For an international itinerant worker, the contractor may, for example, discuss with the facility management the application of dose constraints or facility-specified allowable accumulated doses that ensure the international itinerant worker stays below the annual dose limits (and is, thereby, more likely able to work in the near term) in the State in which



the employer is registered and/or in which the IRMD of the itinerant worker was issued.<sup>3</sup>

The dose constraints and/or allowable accumulated doses at the facility are, generally, to be established using the information from an assessment of doses anticipated to be received as a result of performance of the contracted tasks and potential exposures which could arise as a result of incidents or occurrences during task performance.

### *3.1.1.6. Responsibility with regard to the radiation protection programme*

Who is responsible for ensuring that the operational RPP, as executed, is in compliance with GSR Part 3 [1]? This would include arrangements for contractor supervision of the work at the facility workplace and the safety oversight roles of the contractor and/or facility supervision. The parties discussing contractual arrangements will recall that decision aiding techniques used during the initial process of optimization of protection and safety do not necessarily provide only one possible solution, so that discussion may lead to a mutually agreed plan which takes into account additional information provided during the discussions. While the registrant or licensee has primary responsibilities that cannot be delegated, when there is more than one registrant or licensee, responsibilities at the points of interface need to be clearly delineated.

Examples are ensuring proper placement of the boundary of a radiography controlled area in a nuclear fuel cycle facility, patrolling of that boundary to ensure no unauthorized persons enter, and transport of the radiography source through the nuclear fuel cycle facility. The work plan of the contractor is to be coherent (consistent) with the plan from the work management system

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<sup>3</sup> Compliance with dose limits and with the requirements for optimization of protection and safety is required in the State in which the facility is located (and the contracted work is being performed) and in the State where the employer of the itinerant work is registered. Those States may have different annual dose limits. In developing the contractual agreement between the management of the facility and the employer of the itinerant worker, the dose limits and the facility specified allowable accumulated doses to be maintained for the itinerant worker as the planned work is conducted, are to be discussed and agreed. If reasonably achievable for the planned work, the stricter of the State regulations may be arranged to apply as the facility-specified allowable accumulated dose (or potentially as a dose constraint) for the itinerant worker. If not reasonably achievable for the planned work, the itinerant worker and the employer of that worker need to evaluate the situation and either withdraw the affected worker from the contracting process or develop a proposal for further discussion with the facility management that considers the needs of the employer and the itinerant worker, and also a continuity of compliance with applicable regulations.

of the facility. Another topic for discussion would be any information provided by the worker (or the employer) about the worker's previous employment history that may affect the development of a protection and safety programme effective for that worker or others. Where appropriate for the planned work, roles and responsibilities for identifying emergency situations and implementing the appropriate response(s) are to be discussed.

#### *3.1.1.7. Responsibility for providing individual dose monitoring*

Who is responsible for providing (or ensuring the provision of), where appropriate, suitable official individual monitoring of external exposure of the workers (e.g. an integrating personal dosimeter) and, where appropriate, suitable operational individual monitoring (e.g. a personal alarming dosimeter or direct reading dosimeter)? If the results of workplace monitoring may be (or have to be) used for estimating doses to workers, the parties need to establish who is responsible for developing the dose estimates to be recorded. The frequency of processing any passive integrating personal dosimeter (e.g. film, thermoluminescent dosimeter or optically stimulated luminescent dosimeter) and the development of dose assessments from workplace monitoring are to be discussed, especially when international itinerant workers are involved. In some States, monthly processing of passive dosimeters (and/or monthly availability of updated results for the official dose record) is a standard practice, especially when a 12 month rolling average dose limit applies. In other States, processing of passive dosimeters (and/or availability of updated results for the official dose record) may occur less frequently (e.g. quarterly). The contractor and facility management need to mutually agree on the frequency of processing and records update or agree on an alternative approach (e.g. the contractor supplying an additional official individual monitor for more frequent processing). If a worker wears multiple individual monitors, perhaps from different dosimetry service providers approved by the regulatory body, mutual agreement is also to be reached on the process to initiate investigation of differences in results from the multiple monitors. For applicable situations, the discussion needs to include the development of mutually agreed provisions for workers to be placed into an individual measurement programme to determine whether intakes of radionuclides occurred and, if so, at what magnitude.

### *3.1.1.8. Responsibility for ensuring that results from individual monitoring are recorded*

Who is responsible for ensuring that individual monitoring (e.g. personal alarming dosimeter and/or individual measurement) results are placed, in a manner which is timely and preserves data integrity, into an individual worker's occupational exposure record, whether that is an IRMD or alternative individual dose record, and/or any appropriate electronic (or other) centralized database of workers' dose records? This is to include agreement on the means of timely and reliably forwarding official (and, when applicable, operational) monitoring results not available when the itinerant worker leaves the facility, and the means of timely and reliably updating of IRMDs and/or other record systems with those results. Facility management personnel, the itinerant workers, their employers, providers of the workers' health surveillance services and regulatory body personnel all have uses to make of dose data, consistent with giving due care and attention to the confidentiality of those data. Two such uses are ensuring: (i) that the individual workers remain in compliance with the annual dose limits established by the regulatory body (e.g. by employer and worker); and (ii) that appropriate investigations are undertaken (e.g. by facility management) if applicable dose constraints or allowable accumulated doses for the itinerant worker are closely approached or exceeded.

A checklist summarizing the information in this section is provided in Appendix I, initially focusing (in para. I.1) on a situation in which the management of the facility is using a radiation source or sources, and/or undertaking practices that give rise to radiation risks.

The material in Appendix I also describes (in para. I.2) additions to and differences in possible topics for the situation in which the contractor brings a source of radiation to a facility which otherwise would neither be using a source nor be undertaking practices which give rise to radiation risks. The management of the facility, the contractor and other responsible parties are encouraged to use this checklist as contractual arrangements are being discussed and finalized.

Some additional information which may be of use in the discussions and decision making among the relevant parties may be found in Appendix II.

There are two very specific situations which may also be discussed by the contractor, the facility management and other relevant parties. The first is not specific to the exposure of itinerant workers, but is a situation which may arise and for which a statement of guidance may be useful.

The first situation is where a woman notifies supervision that she is pregnant or that she is breast-feeding an infant. In such a case, the woman may be offered supplemental training regarding the risks of radiation exposure of the embryo/fetus or of a breastfed infant. She is also to be placed in a situation that limits the dose to the embryo/fetus or to the infant. It is recommended that the training records be updated to reflect any supplemental training given to the woman and that the dose records be updated to reflect the applicable dose limits and the estimated doses received for the applicable periods of exposure.

The second situation may apply directly to itinerant workers, depending on the restrictions on exposure of the itinerant workers mutually agreed by the contractor and the management of the facility. The topic for discussion is whether the itinerant workers (or a subset thereof) may receive either exposure as an emergency worker or via a specially authorized exposure.

In either case, the itinerant workers would have had to receive the applicable formal training and informal briefings relevant to the proposed work. In addition, the itinerant workers would be subject to the same process for volunteering and the same protection and safety programme as permanent employees of the facility for similar work. If such exposures may occur, the associated occupational exposure records are to clearly state the accrued doses separately for planned situations and for emergencies (or for specially authorized exposures), and are to cite reference to reports of relevant evaluations and/or investigations.

The formulation of contractual agreements may appear to be a very substantive effort, given the topics listed above. In some situations, where the contracted scope and/or the likelihood and magnitude of expected exposures are large, taking great care in defining responsibilities is warranted. This may also be true when the management of the facility and the contractor have not previously engaged in cooperative efforts.

The more limited the scope of the contracted work, the lower the likelihood and magnitude of expected exposures. The more frequently the contractor and site operator have worked together, the more likely it is that they will have relatively greater ease in developing mutually agreed contractual provisions. Of course, at any time, changes in work scope, work techniques, workplace environment or applicable regulations may lead to the need for re-evaluation of contractual agreements.

### **3.1.2. Responsibilities of the itinerant worker to the employer and the management of the facility**

The employer and the management of the facility have expectations of the itinerant worker, exclusive of those for technically competent performance of assigned tasks. Successful implementation of workers' obligations forms

an integral part of a programme for occupational health and safety for effective application of the standards as regards occupational health and safety.

The programme is developed for the benefit of each worker, and the active involvement of each worker in programme development and execution is relied upon to ensure that optimal results are achieved. In Requirement 22 of GSR Part 3 [1], the statement is made that: “Workers shall fulfil their obligations and carry out their duties for protection and safety.” A worker is to meet that requirement by:

- (a) Providing to the employer (and registrant or licensee, where appropriate) information on work history relevant to developing an effective protection and safety programme for the worker (and others);
- (b) Communicating perspectives on job specific radiation risks gained from education and training, and otherwise cooperating with regard to developing and executing an effective protection and safety programme;
- (c) Following applicable rules and procedures for protection and safety, including the proper use of monitoring and personal protective equipment as described in those rules and procedures;
- (d) Reporting to the supervisor identified circumstances jeopardizing protection and safety of the worker or others;
- (e) Abstaining from any wilful action that could put the worker or others in situations not in compliance with the requirements for protection and safety.

One factor that is to be considered regarding an itinerant worker relates to which organization or person is the individual’s employer. Some itinerant workers are self-employed and for them the situation is clear — they are their own employer. For some other itinerant workers, they work for one employer (other than themselves). That situation is also clear, in that both the fulfilment of duties of the employer and also the official and estimated operational doses accrued in known exposure time frames at known sites can be tracked with some level of ease.

Of course, the greater the number of facilities at which exposure has been received and/or the more complex the work pattern (e.g. recurring exposures at multiple facilities on daily or weekly bases), the more attention needs to be given by the worker and the employer to ensuring adequate control of total accumulated dose across exposure time frames.

There are also some itinerant workers who work for more than one employer within a 12 month (or shorter) period, often at a succession of work locations. For a specified work assignment at a specific facility in an established

time frame, an itinerant worker is almost certainly working for one employer having a contract with the management of the facility.

A short time (e.g. a few days or weeks) later, that same itinerant worker may be working for a different employer, likely performing a similar work assignment but at a different facility. This leads to the need to take care in tracking the employer, correlated to a time frame (start and end dates) of work for that employer and correlated to a time frame (start and end dates) of exposure monitoring (records of official and any operational monitoring for specified time frames).

One other situation that is encountered is the itinerant worker who works for two employers at the same time. This may occur, for example, when an employee at a facility where they receive exposure takes a vacation and chooses to work during that vacation period for another employer (and receives exposure during that period).

The record keeping is to show the overlapping periods of employment, with the employer of record for a work assignment correlated with the location at which an exposure was received and the results of the individual monitoring for that itinerant worker for that applicable exposure period. The worker bears a responsibility to inform the current employer of the relevant employment and dose history, to assist the employer (and the worker) in complying with applicable regulations and industry standards.

Another factor for the worker to consider is that maintenance of an up to date, accurate individual dose record makes it easier for the worker to become and remain employed. To that end, the worker needs to proactively communicate with the employer and other relevant parties to ensure their needs for dose recording and reporting are being met for the current work assignment and for known upcoming work assignments.

The worker also needs to take care that the record system is of sufficient quality to leave no impression that any previous employment involving exposure to radiation has been omitted, as the related investigation may delay their employability for the contracted work about to be performed.

Sections 3.2–3.4 provide supplemental information regarding arrangements to be made when itinerant workers (self-employed persons or the employees of a contractor) carry out work at a facility in three categories of situation. It is difficult to state which of these situations is the most complex or has the highest likelihood of resulting in a worker receiving unnecessary exposure.

In two of the situations, one of the principal parties (the facility management or contractor) may have little in-house knowledge or experience dealing with radiation protection and safety. In the third situation, both parties may have knowledge and experience with protection and safety, but coordination or integration of their protection programmes may require a high level of care;

that is: “Safety in these operations depends, in part, on cooperation between those responsible for radiation protection at the facility and those performing services” [3], in many cases using itinerant workers.

### 3.2. OCCUPATIONAL EXPOSURES ARISING FROM THE USE OF RADIATION BY THE MANAGEMENT OF THE FACILITY

In many types of work, a contractor’s employees or self-employed persons who do not have their own sources of radiation are required to enter an area of a facility where they may be exposed to ionizing radiation arising from the normal operation of the facility. Examples of such itinerant workers include maintenance and cleaning staff.

In some cases, the contractor (for the situation described in Section 3.2, sometimes called an outside undertaking) and its employees will have little or no experience working in radiation controlled areas, and they will have a limited knowledge of the regulatory requirements. One key item that the contractor needs to look for is the application of the same level of protection and safety for the itinerant workers as the management of the facility is applying for its own employees — that is the responsibility of the facility management as the registrant or licensee.

The contractual arrangement would ideally include this parity of treatment as part of the commitment of the management of the facility. (Applicable regulations for situations where the contracted workers do not enter the supervised and/or controlled areas established by the management of the facility may require that those workers have the same dose limits as members of the public.) The contractor may be wise to consider whether consultation with one or more qualified experts (Section 3.2.9) would provide helpful information to the contractor.

Most of Section 3.2 is intended to provide guidance to the contractor in evaluating the elements of protection and safety proposed by the management of the facility for itinerant workers and in developing a level of comfort that the finalized programme, reflecting appropriate input from the contractor, will be protective of the occupational health and safety of itinerant workers throughout the work.

Once the statement has been made by the facility management that there is to be parity of treatment for the itinerant workers and the workers employed by the facility management in supervised and/or controlled areas, it would be tempting for the facility management to further state that the occupational health and safety programme previously established for the employees of the facility management needs no change to accommodate the itinerant workers.

That temptation is to be avoided. If the tasks assigned to the itinerant workers can safely and effectively be performed within the bounds of the previously established programme, then no change is necessary. If, however, performance of the tasks assigned to the itinerant workers affects the assumptions and evaluations made in developing the previous occupational health and safety programme, then change may well be warranted. An objective of having the types of discussion described in Section 3.1 is to specify what types of change to the occupational health and safety (and, particularly, protection and safety) programme may be warranted.

### **3.2.1. Optimization of protection and safety**

GSR Part 3 [1] (para. 3.24) requires that for occupational exposure:

“all relevant factors are taken into account in a coherent way in the optimization of protection and safety to contribute to achieving the following objectives:

- (a) To determine measures for protection and safety that are optimized for the prevailing circumstances, with account taken of the available options for protection and safety as well as the nature, likelihood and magnitude of exposures;
- (b) To establish criteria, on the basis of the results of the optimization, for the restriction of the likelihood and magnitudes of exposures by means of measures for preventing accidents and for mitigating the consequences of those that do occur.”

This requirement for optimization of protection and safety applies to all types and levels of exposure, even at levels corresponding to well below the individual dose limits. Managers of large facilities may have established well reasoned investigation levels, job specific dose targets and/or dose constraints for their staff, and are likely to also apply these to the itinerant workers while they are working at the facility. These levels may be set significantly below State (statutory) dose limits.

For normal operations, optimization of protection and safety for itinerant workers will be achieved if working in accordance with local rules and procedures (see Section 3.2.3), which have been drafted by, or in cooperation with, the radiation protection staff of the management of the facility.

A detailed description of the optimization process and its application may be found in the IAEA’s Safety Reports Series, Optimization of Radiation Protection in the Control of Occupational Exposure [7]. As stated in Ref. [7]:



“The fundamental role of optimization is to bring about a state of thinking in everyone responsible for the control of radiation exposures, such that they are continuously asking themselves the question ‘Have I done everything that I reasonably can to reduce these radiation doses?’”

In part, “because optimization is largely a prospective operation, there is no such clear cut technical answer that does not require the application of judgement” [7]. Indeed, in a substantial number of situations and using a graded approach to risk assessment, qualitative analysis based on professional judgement will be adequate to specify the optimal level of protection achievable.

In more complex situations, the use of more structured approaches, identifying and comparing practicable protection options, may be needed. If an effective work management process is used, incorporating a multidisciplinary team perspective, the needs for dose reduction can often be achieved while simultaneously improving working conditions and increasing work task efficiency. For normal operations, well managed organizations use effective and efficient processes for work management executed by properly trained workers.

When the work to be performed is not part of the normal work performed in the facility, the process of optimization of protection and safety utilizes additional analysis of the particular jobs to be performed and relevant information from the contractor on worker competences and the proposed work plans.

If the contractor’s work includes non-standard operations, more attention is to be given to the prior analysis of doses potentially received. This analysis considers the various protection options, with the amount of detail in the analysis being commensurate with the anticipated level of accrued dose. The responsibility for the preparation of this analysis falls on the management of the facility because of its detailed knowledge of the work, but at the pre-tendering stage the tenderer needs to be involved in the decisions, possibly with the assistance of a qualified expert (see Section 3.2.9).

This is to ensure both that appropriate input for the contractor is requested and also that all relevant issues for radiation protection and safety are considered at that time. Again, the degree of effort involved in this preparation needs to be commensurate with the safety significance of the activities being assessed and on the maturity of the technologies and work techniques to be used.

In Section 3.1.1, the topics of both dose constraints and/or allowable accumulated doses under the procedures of the facility operating organization, and also execution of the operational RPP are mentioned, as items (e) and (f) in the list of topics to be discussed in developing contractual arrangements. On completion of the work, and possibly at stages during the contract, the actual doses being received by the itinerant workers ought to be compared with those predicted in the prior analysis, to provide information relevant to programme refinement.

Further information on the conduct of a prior radiological evaluation and safety assessment is given in Section 5.

### **3.2.2. Access to controlled areas**

GSR Part 3 [1] require areas to be classified as controlled in cases where specific measures for protection and safety are (or could be) needed to control exposures in day to day operations (or in limiting the likelihood and magnitude of exposures in anticipated operational occurrences and accident situations). Areas where such measures are not normally needed but where exposure conditions need to be kept under review are classified as supervised [1].

It follows that the management of the facility will classify some parts of the facility as controlled or supervised areas. Both types of area will be marked with suitable radiation warning notices, and access to controlled areas will be restricted by means of administrative procedures, such as work permits, and by physical barriers that could include locks or interlocks, the degree of restriction being commensurate with the likelihood and magnitude of the expected exposures and potential exposures.

The only persons permitted to enter a controlled area will be those who have received appropriate information and training on the risks of radiation exposure and on the procedures to follow while in the area. Suitable arrangements for the assessment of radiation doses will also need to be in place. Generally, there is no restriction on entry into supervised areas.

The classification of areas and the implications of classification are described in Ref. [2]. When itinerant workers are to be used to perform selected work assignments, a primary topic for discussion between the contractor and the management of the facility is whether the classification, location and/or size of any supervised and/or controlled area needs to be changed to safely perform the planned work.

### **3.2.3. Local rules and procedures**

The management of the facility is required to establish occupational protection and safety measures, including local rules and procedures that are appropriate for controlled areas. Access to the controlled areas will be permitted only for persons working in accordance with such local rules and procedures.

The local rules and procedures are to contain sufficient guidance necessary for protection and safety for workers while in the controlled area [1], and compliance would ensure that radiation doses are controlled in accordance with the requirements for optimization of protection and safety. They are to contain information on:

- (a) Procedures for work in the controlled area;
- (b) Values of any relevant investigation levels or job specific (or annual) dose estimates and/or constraints, and the procedure to be followed in the event of these being exceeded;
- (c) Any relevant personal protective equipment required (e.g. the use of protective clothing or respiratory protection devices);
- (d) Guidance on the actions to take in the event of an emergency.

A radiation work permit (RWP) may be prepared as one form of documenting radiation related portions of the local rules and procedures. A description of the contents of an RWP is provided in Section 3.4.2.

The contractor and its employees are required to observe the facility manager's relevant local rules and procedures. Such a requirement will often be imposed contractually. The local rules and procedures are likely to include the use of a pre-job briefing or similar communications forum, whereby contractor staff can provide input to enhance the facility staff's assessment of their work plans and also ask questions to promote an understanding of the risks of the job and the means being employed to eliminate, mitigate and/or balance those risks. In a situation where the contractors are from a different State from that of the facility management, consideration may need to be given to the provision of the local rules and procedures verbally and/or in writing in a language understood by the contracted personnel.

#### **3.2.4. Health surveillance**

Workers who intend to carry out work that involves or could involve occupational exposure to radiation are to be provided with appropriate health surveillance and health services [1]. GSR Part 3 [1] also require that where the source is not under the control of the employer, that the registrant or licensee responsible for the source draws up a health surveillance programme, in cooperation with the employer, with the programme being designed to assess the initial and continuing fitness of workers for their intended tasks.

The management of the facility will have procedures in place for the health surveillance of its own employees, and contractual arrangements ought to be developed to ensure that the contractor's employees are also provided with a similar level of surveillance.

Further information on health surveillance programmes is given in the IAEA's Safety Reports Series, Health Surveillance of Persons Occupationally Exposed to Ionizing Radiation: Guidance for Occupational Physicians [8].

### **3.2.5. Individual monitoring**

The management of the facility will have arrangements in place for the assessment of doses for its own employees, and it is important that appropriate arrangements are also made for the assessment of the doses of a contractor's employees. These may involve the facility manager providing the contractor with suitable dosimeters and then assessing them at the completion of the work, or they may require the contractor to arrange for suitable individual dosimetry for the itinerant workers. The arrangements to be followed need to be specified in the contractual arrangements between the facility and the contractor. If not specified by the contract, the employer of the itinerant workers may wish to obtain further advice on the need for individual monitoring from a qualified expert (see Section 3.2.9).

In all cases, it is essential that the worker complies with any requirements of local rules or procedures to wear individual dosimetry in a particular area and to participate in designated individual measurement protocols.

Detailed information on the assessment of doses and monitoring programmes may be found in the IAEA Safety Standards Series publications, Assessment of Occupational Exposure Due to Intakes of Radionuclides [9], and Assessment of Occupational Exposure Due to External Sources of Radiation [10]. Generally, workers are provided with integrating personal dosimeters if the prior radiological evaluation assesses that annual dose may potentially exceed a small fraction (often 10%) of the applicable dose limit. Generally, workers are provided with (active) operational dosimeters if the prior radiological evaluation assesses that supplemental dosimetry is appropriate for controlling exposure of the individual during a specific work task or on a day to day basis (e.g. in areas where exposure rates are, or potentially may be, variable). Specific to the topic of itinerant workers in industries such as the extraction and processing of raw materials, the selection process for an appropriate individual monitor needs to consider especially the mechanical strength and dust tightness of the dosimeter. The ability of the dosimeter to perform adequately in the anticipated ranges of temperature, humidity, atmospheric flammability and vibration of the workplace(s) of the itinerant workers is also of importance. Key to any effective individual monitoring programme is the reliable capability to unambiguously link the dosimeter (and the associated occupational exposure record) with an individual worker.

### **3.2.6. Maintaining records**

The registrant/licensee and the employer are required by GSR Part 3 [1] to maintain occupational exposure records for each worker for whom assessment of occupational exposure is required. These records are to include information

on doses, exposures and intakes at or above the pre-established recording levels and also the data upon which the dose assessments are based. (For internal exposure, the relevant data would include the assessed time and pattern of intake, and also calculated retention or excretion values.) Each worker is to be provided access to their own occupational exposure records. The State's regulatory body for the facility and the supervisor of a worker's health surveillance programme are also to have access to the occupational exposure records of the worker. If the work is being carried out under dosimetry arrangements made by the management of the facility, then the facility management is to provide the worker's employer (and any new employer) with the relevant dose records it possesses, giving due care and attention to maintaining the confidentiality of records [1].

Each of the individuals and/or organizations mentioned above has valid use for access to the occupational exposure records. One use is demonstrating compliance with legal requirements (e.g. dose limits). Others are providing means to assess and/or confirm the effectiveness of the process of optimization of protection and safety, to evaluate trends in exposure over time or across workplaces, and to provide data for radiation research studies, all of which may provide valuable information to be used in the refinement of the RPP. The role of the employer of the itinerant worker is not to be understated regarding assessment of doses to the itinerant worker and provision for the health and safety of the itinerant worker.

For the records to be of optimal use, records of doses exceeding the pre-established recording levels for effective and/or equivalent dose are to be included in the occupational exposure record. The pre-established recording levels are to be at least low enough both to comply with the applicable State regulations and also to enable tracking of doses (for the applicable period of monitoring, e.g. one month or from activities at a facility) exceeding a small fraction (under evaluation for specific guidance, but for example 5–10%) of the applicable annual dose limits for the occupationally exposed worker. If monitoring occurred but results did not reach the relevant recording level, the optimal occupational exposure record is to include a statement regarding whether: (i) there was no unrecorded result above the (stated) recording level; and (ii) there was a measurement made. One convention that may be adopted for values below the relevant recording level is to enter a zero (or 'not detectable (ND)') for the measurement result, with a statement in the record that a zero (or 'ND') entry implies that a measurement was made but that any associated dose was below the stated recording level.

An optimal occupational exposure record also includes any notional doses (above the relevant recording level) assigned to the individual via assessment of available information when the individual monitor results are, for some reason, lost or invalid, with reference to the basis for that dose assignment. A similar

concept would apply for reportable assessed dose to a portion of the skin due to contamination of the skin which was subsequently cleaned off. A primary objective of the record keeping system is to ensure that results are able to be reconstructed when necessary. That does not imply that all the records for such reconstruction appear within the occupational exposure record system, but that there is appropriate linkage to other record systems that together would allow for dose reconstruction if that were found to be necessary.

Especially when international itinerant workers are involved, the recording and reporting of occupational exposure can be complex. Regulations in various States are not necessarily fully developed or are not necessarily fully consistent from State to State as regards what forms of dose records are acceptable from another State, who is authorized to send or receive such records, and/or what means of transmission may be used. Some practices are, to a degree, common but not necessarily universal, such as the use of an IRMD carried by a worker. Even then, differences exist from State to State. The contractual arrangement between the employer and the management of the facility can address at least some of those differences and assist in developing a practicable system of dose recording and reporting. (See also Section 3.2.8 regarding records of occupational exposure.)

For each itinerant worker, an up to date record of health surveillance is also to be available. Allocation of responsibilities for health surveillance and medical follow-up is mentioned in Section 3.1.1 as item (b) in the list of topics to discuss in developing contractual arrangements. It is the responsibility of the employer of the itinerant worker to make sure that the worker's record of health surveillance is updated in a timely manner.

### **3.2.7. Information required by the contractor**

In deciding which of its employees are suited to work under a particular contract, and in discussing the development of final contractual arrangements, a contractor will need the following information from the management of the facility:

- (a) Details of any radiological risks and an estimate of the maximum radiation doses likely to be received by the contractor's employees during the contract;
- (b) Details of any additional training that will be needed and, therefore, needs to be provided either by the contractor or by the management of the facility;
- (c) Whether the itinerant workers need to wear individual dosimeters and/or participate in individual measurement protocols, and, if so, what arrangements are proposed;

- (d) Other information to enable appropriate input to, and a reasonable understanding of, the worker protection programme and the basis for its adequacy (e.g. proposed work procedures and/or protective clothing);
- (e) Details of non-radiological risks, such as anticipated or possible exposure to chemicals, dust and/or elevated workplace temperatures.

### **3.2.8. Information required by the management of the facility**

Before a contractor's employee is accepted into a facility to work in a controlled or supervised area, the management of the facility needs to obtain from the contractor specific information concerning the employee. If this information is immediately available, it will facilitate timely entry to the facility. This information includes:

- (a) Details of the appropriate qualifications of the employee (training, experience and certification);
- (b) Details of the employee's occupational dose history;
- (c) Relevant information on the employee's fitness for work and on the employee's work history that may affect the protection and safety programme developed for the worker.

Some itinerant workers may be assigned tasks to be completed at one facility within a period of days to weeks, and then those workers move to another facility to complete similar tasks in a similar time frame. Some other itinerant workers may, for example, be assigned tasks at one facility two days per week, a second facility two days per week, and yet another facility for one day per week. In this way, some itinerant workers may receive a dose at multiple facilities within a period of one year.

At each facility, the dose received may or may not be substantive; however, the accumulated dose across several facilities in one year (or five years, when relevant) may result in a total dose that may approach the applicable dose limits. That is one reason that keeping track of the doses of these workers, facility by facility and over relatively long time periods, is important. That is also a reason why thresholds for reporting doses received at a facility are not to exceed a small fraction (under evaluation for specific guidance, but for example 5–10%) of the applicable annual individual dose limits (and are to be low enough to comply with applicable State regulations).

As mentioned in Section 3.1.1 and Appendix I, contractual agreements between the management of the facility and the contractor are to address the allocation of responsibilities for individual monitoring and for record keeping and



record transfer. (In Section I.1.2 of Appendix I, see especially items (g) and (h) in the list of topics to discuss during the development of contractual arrangements.)

There are some States and some cooperatives of registrants and licensees who have developed (or are developing) and who maintain (or plan to maintain) data systems for individual records relating to protection and safety.

Whether those data systems were developed as centralized networks, dose registries or similar systems, the intent for itinerant workers was to collect relevant information on the identity of a worker, the results of health surveillance for that worker and the results of the measurements (or assessments) of reportable doses to the worker for a specified time frame, correlated to the facility at which the worker was occupationally exposed in that time frame and also to the employer of the worker for that time frame. (In some cases, records on completed training related to protection and safety are also included in the system.)

For workers engaged at multiple facilities within a calendar year, the intent was to be able to evaluate for work activity at each facility, the period covered by the work activity and the effective dose (and, where appropriate, equivalent dose and/or committed effective dose) to the individual worker for that period.

With that information in a data system, analyses may be facilitated for confirming compliance with applicable regulations and pointing to possible opportunities for dose reduction and/or other refinements of protection and safety programmes. Such systems may be of more use for analyses of exposures of domestic itinerant workers rather than international itinerant workers. That is because doses received within a State or a (likely State based) cooperative network of registrants and licensees are more likely to be available for analysis than doses received in several States, until the development of transboundary data sharing techniques becomes more advanced.

For the reasons described above, IRMDs may be used as a supplemental (or even primary) means of enabling information to be shared among facilities and, when appropriate, with the regulatory body.

One method for the provision of information to the management of the facility on the dose history and fitness for work of an itinerant worker is the use of an IRMD.

Such an IRMD is a requirement for Member States of the European Union [11], for those situations where a nation's data system for individual monitoring is not adequately protective for contracted workers, or where necessary to adequately track the doses to contracted workers crossing international boundaries. A revision of these requirements has recently been carried out by the European Union and is now part of the European Basic Safety Standards [12]. The Heads of the European Radiological Protection Competent Authorities are developing guidance on using IRMDs. A description of the IRMD, as it is being used in the European Union, is provided in Ref. [13].



Under this system, each itinerant worker applying for an IRMD is assessed regarding thresholds established by the State regulatory body (e.g. expectation of receiving an annual dose greater than a preselected value).

The itinerant worker meeting the State criteria would then hold an IRMD, issued by an organization authorized by the applicable (State) regulatory body, which contains a summary of the dose history.

That dose history most often consists of official dose results available on the date that the IRMD was issued and estimated doses received by the worker since that date (based on operational dosimetry and/or individual monitoring for intakes of radionuclides).

The IRMD also contains the dates of health reviews of the worker and a space for designated members of facility management (or the employer, depending on the agreed allocation of responsibilities) to enter estimated doses for the worker. The IRMDs are handed to the management of the facility for inspection when the worker arrives at the facility or, at least, prior to the commencement of work at the facility.

As the work evaluation is completed, a designated representative of the management of the facility (or the employer, depending on the agreed allocation of responsibilities) then enters an estimate of the dose received by the itinerant worker while on-site. This estimated dose may be based on the results of individual monitoring or on workplace monitoring and assessment, but the estimated dose provides a useful indication of the worker's dose for the next facility manager, in case the worker moves to another facility prior to the official record individual monitoring data being entered into the IRMD or its successor. It is the responsibility of the employer of the itinerant worker to ensure that the IRMD is kept up to date.

In most cases where the worker has moved from one State to another for their work assignment, official and estimated doses are accepted as being accurate, absent available information that the results are suspect or State regulations that do not allow for that choice. Their accuracy can be questioned, in which case information on the reliability of the official and/or operational individual monitoring may be requested and evaluated by the employer and/or the registrant or licensee (and regulatory body, where appropriate).

Additional description regarding an IRMD and an example of its content are given in Appendix II. Not all States use such a system or its equivalent. Some States may issue IRMDs using content differing in some aspects from the contents described in Appendix II.

As noted above, in some States, electronically based database systems are in use or are in development, which may facilitate provision of operational and official dose results (and other relevant data) to the appropriate parties for conduct of their duties and responsibilities. Some of these electronically based

systems are designed primarily for use by one industrial segment (e.g. nuclear power plants) and others for use by a regulatory body interested in data, both for all individuals receiving exposure in the State and for individuals to whom the electronic equivalent of the IRMD has been provided by the issuing authority of that State.

The data on an itinerant worker's occupational dose history on which a facility relies may be from a centralized system or dose registry, an IRMD such as a State issued document or a quality assured IRMD maintained by the (worker and) employer based on data reported to the (worker and) employer by dosimetry service providers and/or appropriate facility management. Without the details of an itinerant worker's occupational dose history, access to supervised and/or controlled areas for work may be denied.

It will also be appropriate for the management of the facility to carry out an assessment of the competence of the contractor's employees. This subject is discussed in Section 4.

Before work by a contractor at a facility is allowed to begin, the management of the facility also needs to obtain information from the contractor concerning any hazardous materials that the itinerant workers expect to bring to the facility and any non-radiological risks to the facility and its employees which may result from the efforts of the itinerant workers. This information is used in assessing the safety of the proposed work and in developing an optimal work management plan.

### **3.2.9. Qualified experts**

Registrants and licensees and also non-licensed contractors will find it appropriate to consult with qualified experts<sup>4</sup> on a wide range of issues. It is important that the contractor (and/or the management of the facility) considers whether it needs to consult with one or more qualified experts regarding the work to be undertaken, depending on the nature of the work and any contractual conditions. If the contractor wishes to consult with a qualified expert, it may seek guidance from the management of the facility and/or an independent source for suggestions on suitable persons. The following subjects are examples of those

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<sup>4</sup> A qualified expert is an individual who, by virtue of certification by appropriate boards or societies, professional licences or academic qualifications and experience, is duly recognized as having expertise in a relevant field of specialization, e.g. medical physics, radiation protection, occupational health, fire safety, quality management or any relevant engineering or safety specialty [1].

for which guidance may be required from a qualified expert as regards protection and safety:

- (a) The review of engineered controls related to protection and safety;
- (b) The formulation of suitable local rules and procedures;
- (c) Appropriate dosimetry arrangements;
- (d) The need for personal protective equipment;
- (e) The use of radiation monitoring equipment;
- (f) Record keeping;
- (g) Emergency procedures.

### **3.2.10. Supervision**

All work involving occupational exposure is required to be adequately supervised, and employers, registrants and licensees are required to take all reasonable steps to ensure that the local rules, procedures and other applicable measures for protection and safety are observed [1]. This is carried out by the direct line supervision of the workers and also via appointment of one or more employees as an RPO to provide a level of independent oversight for the protection and safety aspects of the work. The RPO is a “person technically competent in radiation protection matters relevant for a given type of practice who is designated by the registrant, licensee or employer to oversee the application of regulatory requirements” [1]. An RPO is to:

- (a) Have the appropriate level of knowledge and experience for effective supervision of the work;
- (b) “oversee the day to day implementation of the radiation protection programme and to carry out the duties required by the programme” [5];
- (c) Be able to supply close oversight of the work with ionizing radiation, preferably in a line management position that will allow close supervision, without necessarily being present at the work site all of the time.

The management of the facility may already have one or more RPOs in place, and may arrange for one of these to act as RPO for the contractor and its employees. Alternatively, the contractor will be required to appoint one of its own employees as RPO, and will then need to ensure that this person has sufficient training to carry out this function. This appointed RPO is to be acceptable to the management of the facility and is to be contractually requested to work closely with (and take guidance, where appropriate, from) a nominated member of the supervisory staff of the facility. The RPOs appointed by the facility management and contractor are to maintain the necessary degree of liaison. An RPO is to be

“given the authority to stop unsafe work and to interact effectively throughout the organization, especially with senior managers, to ensure that decisions that may affect radiation safety have high level support” [5].

The contractor and the management of the facility are to discuss the arrangements for supervision at the pre-contractual stage.

### 3.3. OCCUPATIONAL EXPOSURES ARISING FROM THE USE OF RADIATION BY THE CONTRACTOR

#### 3.3.1. Overview

Additional guidance is needed for situations in which an itinerant worker is required to take a source of ionizing radiation into an area of a facility where they will be exposed to little, if any, ionizing radiation arising from the operations of the facility, but will have the potential to cause exposure of the facility’s employees. There may be three such situations. First, the itinerant worker may access a facility under no regulatory controls due to ionizing radiation. Second, the itinerant worker may access a facility whose management has provided notification to the regulatory body alone because of an activity involving, at most, doses that are a small fraction of the applicable dose limits. Third, the worker may access a facility where the normal activities include radiation practices, for example the use of level and thickness gauges, but the contractor’s work would, in such instances, not require access to the associated supervised or controlled areas.

If facility employees directly support the work of the itinerant workers in the supervised and/or controlled areas established for the contractor’s work, representatives of the management of the facility are to look for the application of the same level of protection and safety to those facility staff as the contractor applies for its own employees (the itinerant workers). The contractual arrangement would ideally include this parity of treatment as part of the commitment of the contractor. (Applicable regulations for situations in which facility employees do not enter the supervised or controlled areas established by the itinerant workers may require that those facility employees have the same dose limits as members of the public.)

The management of the facility may be wise to consider whether consultation with one or more qualified experts (see Section 3.2.9) would provide helpful information to the facility management. The remainder of this section is intended to provide guidance to the management of the facility in evaluating the elements of protection and safety proposed by the contractor for the facility staff and in developing a level of comfort that the finalized programme, reflecting

appropriate input from the management of the facility, will be protective of the occupational health and safety of the facility staff. An illustration of a relatively complex situation will be used in providing this guidance.

A primary example regarding these situations relates to industrial radiography conducted at the facility. Consequently, the guidance below refers specifically to such work. Similar requirements and actions will apply to other activities, such as the provision of diagnostic X ray services at the facility for the periodic health surveillance of facility personnel or the performance of initial source loading operations in irradiation facilities — additionally, however, if unsealed radioactive materials are involved, for example in tracer studies, due regard has to be paid to the potential for surface and airborne contamination.

Industrial radiography involves the inspection of components (e.g. pipes and pressure vessels) to determine whether cracks or other defects are present. The source of ionizing radiation will almost always be a sealed (gamma) radiation source or an X ray generating device. (The use of neutron sources is quite rare.) The source of the radiation field will often be mobile (relatively easily transportable) and used outside of facilities designed specifically for the shielding of that source — that is, used within the operating facility as built. Whether or not the source is a gamma source or an X ray generator (or even a neutron source), strictly controlled procedures are required to be used. This will ensure that the radiography does not result in unplanned exposures to the radiographers using the source or to other persons at the facility.

An essential part of these procedures is the maintenance of a barrier at a suitable distance from the source, intended to prevent unauthorized entry into the controlled area within the barrier and to control exposures to individuals outside that barrier. This type of work is sometimes carried out in confined spaces or at night, and consideration may need to be given to the needs for additional protection measures, e.g. additional supervision or lighting. Detailed guidance on the safe control and operation of radiography equipment and facilities is given in Ref. [5].

### **3.3.2. Cooperation between employer and registrant or licensee**

The party with the overall responsibility for industrial radiography (and the associated protection and safety) is the person or organization authorized to carry out that radiography. For radiography work conducted in the field (that is, at the facility of another employer), the person or organization responsible for the premises where the radiography is being performed also bears responsibilities, that is, those of an employer. The duties and responsibilities of the contractor, the facility management and other relevant parties (e.g. an industrial radiographer who is an itinerant worker) need to be identified and agreed in writing. The

allocation of responsibilities in regard to the provision of individual dosimetry, health assessment arrangements, workplace monitoring arrangements and local rules are examples that need to be considered in the development of contractual arrangements. Section 3.1.1 and Appendix I provide additional information as regards topics to be considered in developing contractual arrangements. Appendix III provides additional information specifically on the control of industrial radiography.

Cooperation between the management of the facility and the contractor will enable the management of the facility to ensure the health and safety of its own employees where this might be affected by the contractor's work. Similarly, cooperation is needed so that the authorized radiography organization: (i) is not hindered in its ability to perform the radiography safely, in accordance with regulatory requirements; (ii) has the support it needs from facility staff in having a safe working environment for the radiographers (e.g. in coordinating with other work being performed at the facility); and (iii) has the information it needs to provide protection and safety for all workers who may be affected. The following paragraphs give additional advice concerning information to be obtained and actions that might be undertaken by the management of the facility.

Where the management of the facility has no direct in-house expertise regarding radiation protection and safety as related to industrial radiography, its involvement is essentially restricted to non-technical information gathering and communication regarding any non-radiological risks at the facility and the discussion of relevant facility rules and work plans which may affect the manner in which the work is to be performed. The management of the facility will need to place the onus on the contractor for cooperation on the more technical aspects of the work. However, the management of the facility needs to be able to satisfy itself, from information communicated by the contractor, that the contractor has made (and will be able to make throughout the work) adequate provision for achieving safe working conditions for both contractor and facility personnel, and for complying with regulatory requirements. In performing this evaluation of the protection and safety afforded to facility staff, the management of the facility may need the assistance of a qualified expert (see Section 3.2.9).

Before work is started, the management of the facility is to obtain from the contractor:

- (a) A telephone number at which the contractor can be contacted at any time in the event of an emergency.
- (b) The names and qualifications or certifications of the RPOs and/or the industrial radiographer(s) and assistant(s) who will be present during the work. If the RPO is not present at the facility, a radiographer with adequate

knowledge, training and experience is to be designated as the alternate RPO for the planned work.

- (c) The type of radiation generating device or radioactive source to be used, and the strength or activity of the device or source.
- (d) A copy of the contractor's local rules and procedures, including sufficient information about the proposed work and its control, including source storage and transport within the facility. If adequate local rules are not available, the contractor is not to be allowed to undertake radiography. One discussion point between the contractor and the management of the facility is to be the time frames during which access to the contractor's controlled area is not to be permitted by facility staff, and how the facility staff are to communicate to the contractor staff the need to halt radiographic operations to allow for entry by facility staff to address an emerging situation.
- (e) Where deemed necessary by facility management, the commitment of the contractor to communicate with the facility's operations control room prior to work execution, to ensure effective coordination of work activities in and near the radiography controlled area.

The management of the facility is also to ensure that the contractor implements the following protection and safety measures. Assurance in this case implies the satisfactory review, prior to commencement of the work, of the contractor's rules and procedures and/or the contractor's verbal briefing of facility management regarding those rules and procedures, preferably in addition to the performance of one or more safety assessments of the work (as described later in this section):

- (a) Designation of controlled areas and, where appropriate, supervised areas.
- (b) Placement of barriers to prevent access to controlled areas in which dose rates exceed predetermined levels.
- (c) Posting of sufficient warning notices.
- (d) Provision of warning signals (selected to be clear to staff at the facility) prior to and during the exposure(s).
- (e) Display of explanatory notices at access points.
- (f) Inspections of equipment and radiation monitors prior to (and after) use; replacement or repair of identified inoperable equipment prior to use.
- (g) Searching of the controlled area for the presence of unauthorized persons (anyone other than appropriate contractor personnel) before starting and during radiography exposures.
- (h) Patrolling of the barrier to prevent unauthorized access.

- (i) Use of a suitable, calibrated radiation monitor (e.g. a dose rate indicating device) in setting and/or verifying placement of the barrier and confirming expected dose rates after exposures.
- (j) Use of safe and secure storage facilities for the radiation source and/or X ray generating device. Agreement is to be reached regarding the control of keys to such storage facilities.
- (k) Formulation of emergency plans and timely notifications to contractor and facility staff of any incidents or circumstances that could reasonably result in higher than usual radiation doses and/or adversely affect the safety of facility staff.
- (l) Use of individual monitors, most frequently both an integrating personal dosimeter and a personal alarming or direct reading dosimeter (measuring dose and/or dose rate, and, for electronic devices, often with an audible and/or other alarm when preselected values are exceeded) and also, where appropriate, direct or indirect measurement for intakes of radionuclides. If a neutron source is used, the contractor may find it appropriate to consult a qualified expert to ensure selection of suitable individual monitors and radiation monitors. An occupational exposure record system, such as that described in Section 3.2.6, is also to be used.

Regarding the use of suitable radiation monitors, one item to consider is whether the proposed instrumentation is appropriate for measurement of pulsed X ray fields. Such capability is needed for situations when such fields are created by the X ray generator(s) to be used for radiographic operations. Another item to consider in workplace monitoring is the possibility that, near a point source (e.g. a radiography source) or collimated beam (as almost always used in radiography), a correction factor may need to be applied to avoid an underestimation of dose rate by the workplace monitoring instrument.

The management of the facility is to ensure that any of its employees who may be affected by the contractor's work have been given sufficient information about the proposed work. This would include people who may be in the vicinity of the work (but outside the radiography controlled area), security staff, management and people who could become involved in an emergency situation. (The management of the facility is also to inform the contractor about work of facility staff occurring at the same time as, and in the vicinity of, where the radiography is to occur.) The management of the facility is to ensure that if any facility operated radiation detection systems (e.g. some smoke detection systems) may be affected by the radiography operations, appropriate actions are taken prior to commencement of those radiography operations.



During the final stages of work planning and/or while work is in progress, it would be prudent for the management of the facility to arrange occasional, unannounced safety assessments to ensure that the contractor's (and the facility's) employees are observing the agreed, safe working practices. Employees of the facility or an independent third party could undertake these assessments.

Appendix III provides additional information about appropriate assessments of radiography operations. Facility management may also find it useful to refer to the protection and safety measures listed above as a guide to the development of an appropriate assessment process. Separate from these assessments, the contractor and/or the regulatory body may be expected to perform (announced and/or unannounced) assessments of the radiographers' performance at work, on the order of twice a year by each of those organizations.

### 3.4. OCCUPATIONAL EXPOSURE ARISING FROM THE USE OF RADIATION BY BOTH THE MANAGEMENT OF THE FACILITY AND THE CONTRACTOR

In some situations, an itinerant worker will need to take a source of ionizing radiation into an area of a facility in which they may also be exposed to ionizing radiation arising from the normal operation of the facility. Examples include industrial radiography performed by itinerant workers at a facility for processing raw materials containing elevated levels of naturally occurring radioactive material, non-destructive testing in a nuclear power plant, or the exchanging of a radioactive source at an irradiation facility.

In general, the guidance given in Sections 3.1–3.3 remains relevant. Additional matters that need to be noted are covered in the following paragraphs.

#### 3.4.1. Access to controlled areas

The itinerant worker may need to undertake work in areas in which there is either a significant ambient dose rate arising from the normal operation of the facility or the potential for relatively high dose rates if malfunctions of certain equipment or failures to follow safety procedures were to occur. The choice of an appropriate dose rate at which to erect barriers and signs needs to be discussed and agreed between the contractor and the management of the facility before work commences, consistent with applicable State regulations or regulatory guidance. Consideration may also need to be given to the timing of the proposed work, if changes in scheduling may reduce the magnitude of the radiation field(s) or the number(s) of workers in the work area(s), or modify other factors affecting radiation doses projected to be received.

### 3.4.2. Local rules and procedures

Work will have to be carried out not only in accordance with the contractor's local rules and procedures but also in accordance with the local rules and procedures for those sources associated with the facility. The contractor may, therefore, need to modify its planned local rules and procedures to incorporate certain aspects of the local rules and procedures of the facility. The contractor's local rules and procedures and those of facility management are to be written in such a mutually agreed way, so as to ensure that there are no conflicting requirements.

Most often, an RWP is developed to document protection and safety precautions to be implemented. The RWP is, generally, issued by the facility's RPO or radiation protection staff, but may be issued by a work planning organization in collaboration with the RPO or radiation protection staff. Applicable to the situation described in Section 3.4, the RWP would reflect the input of the itinerant workers, their employer and the permanent staff of the facility, both in identifying protection and safety measures and also in developing implementation plans to avoid conflicting requirements and to ensure that doses are controlled in accordance with the requirements for optimization of protection and safety. The RWP may include the following, where applicable, to the planned work [2]:

- (a) Dose rate maps of the working area, produced from a radiation survey made prior to the work or otherwise estimated; estimates of dose rates in the working area expected during the primary work steps; and locations expected to remain low dose rate areas as the work progresses.
- (b) Estimates of contamination levels in the working area, produced from a radiation survey made prior to the work or otherwise estimated; and estimates of contamination levels expected during the primary work steps.
- (c) Delineation of any additional radiation monitoring to be carried out before or during the work.
- (d) Estimates of individual and collective dose for the work, often for each primary work step.
- (e) Delineation of any additional dosimetry to be worn by the workers during the work or during specified work steps.
- (f) Delineation of protective equipment to be used during the work or during specified work steps.
- (g) Details of time or dose restrictions; and values of preselected levels (e.g. of dose rate, dose or contamination) requiring investigation if exceeded.

- (h) Instructions on when to contact the RPO and/or guidance on immediate actions to take if specified stop work criteria are met, preselected investigation levels are exceeded or when there is otherwise believed to be jeopardy of loss of control of the work as planned.

The local rules and procedures are likely to include the use of a pre-job briefing or similar communications forum, whereby the itinerant and other workers can provide input to enhance the assessment of the work plans and also ask questions to promote an understanding of the risks of the planned work and the means being implemented to eliminate, mitigate and/or balance those risks.

In the situation where the itinerant workers are from a different State from that of the facility management, consideration may need to be given to the provision of the local rules and procedures verbally and/or in writing in a language understood by the itinerant workers. Such communications relate to the GSR Part 3 requirement that workers “understand their responsibilities and can perform their duties competently, with appropriate judgement and in accordance with procedures” (para. 2.44 of GSR Part 3 [1]).

### **3.4.3. Training**

Special training for the itinerant workers may be required because of the potential for exposure due to sources under the control of the facility, even though the itinerant workers may already be trained in connection with their own use of radiation. Many facility managers, for example, require contract radiographers and their RPOs to be trained to a facility specified level.

### **3.4.4. Radiological instrumentation installed at the facility**

Consideration is to be given to the possible impacts of the contractor’s radiation source on any instrumentation that is affected by radiation and is installed at the facility. For example, the impact is to be addressed of the contractor’s source on some smoke detection systems, area gamma monitors and criticality incident detection systems, and the risk of unnecessary false alarms.

In the event that the reasonable possibility of such an incident is identified, appropriate corrective actions are to be taken. These could include the use of smaller sources or collimated radiation beams to minimize or localize exposure rates, or the deactivation of some instrumentation for a limited period.

The possibility may also exist for the radiation fields at the facility to affect the choice of radiation detection instrumentation used by the itinerant workers in performing their tasks. Alternatively, means to adjust for facility related exposure rates or energy spectrums may be needed.

### 3.5. CHECKLISTS

Information sheets and checklists are useful aids for exchanging information and assessing the adequacy of radiation protection arrangements. As an example, a list of protection and safety measures is given in Section 3.3.2. A checklist for the management of the facility with respect to industrial radiography contractors is given in Appendix III.

The checklist summarizes the radiation protection needs to be fulfilled and lists various points that need to be discussed and agreed between the management of the facility and the contractor prior to the initiation of radiography. The checklist also recommends that the facility management carry out an assessment during the radiography to evaluate the standard of protection, and lists subjects to be checked.

Appendix I may also be useful in exchanging information and developing an effective protection and safety programme.

### 3.6. SUMMARY

The following statements are intended to summarize the information presented in this section and reiterate several key concepts described in the section, as well as to direct attention to appropriate subsections of the text. They need to be interpreted within the context of the entire Safety Report and, specifically, Section 3:

- (1) The primary responsibility for protection and safety lies with the person or organization responsible for facilities and activities that give rise to radiation risks. This corresponds, most often, to the registrant or licensee of specified activities, but may be a person or organization otherwise subject to regulatory control or assessing the potential for application of one or more protection measures not required by regulations.
- (2) An employer is also a principal responsible party in relation to the occupational exposure of its workers and in relation to the overall health and safety of its workers.
- (3) Employers, registrants and licensees are to ensure that dose limits for occupational exposure are not exceeded and that protection and safety of the workers is optimized.
- (4) Cooperation is required between the employer and the registrant or licensee to develop and implement measures for protection and safety, for work involving a radiation source not under the control of the worker's employer, that are at least as good as those for employees of the registrant or licensee.

Involvement of the itinerant workers in the programme development and implementation process is warranted.

- (5) The cooperation is to include defining a clear allocation of responsibilities of the employer and the registrant or licensee for protection and safety. This allocation is to form a part of the contractual agreement or other approved agreement between the employer and the registrant or licensee. Section 3.1.1 and Appendix I provide a level of detail regarding different aspects of protection and safety to be addressed in the agreement.
- (6) To support the fulfilment of their responsibilities, the contractor is to provide needed information to the management of the facility, and the management of the facility is to provide needed information to the contractor, regardless of which employer is the registrant or licensee. Section 3 provides specificity to those informational needs. Example subsections of interest are Sections 3.2.7, 3.2.8 and 3.3.2.
- (7) The itinerant worker also has specified obligations to the employer(s) and registrant or licensee that are to be fulfilled, and has specified duties to carry out for protection and safety. Section 3.1.2 delineates those obligations and duties.
- (8) Either the contractor or the management of the facility or both may find it beneficial to use appropriate qualified experts when fulfilling their assigned responsibilities.
- (9) “Employers, as well as self-employed persons, and registrants and licensees shall be responsible for making arrangements for assessment of the occupational exposure of workers” (para. 3.99 of GSR Part 3 [1]). Those same responsible parties are also to “maintain records of occupational exposure...for every worker for whom assessment of occupational exposure is required” (para. 3.103 of GSR Part 3 [1]).
- (10) Use of an IRMD may be helpful in tracking the doses accumulated by itinerant workers as they move from facility to facility or from employer to employer. Section 3.2.8 and Appendix II provide a level of detail regarding IRMDs.
- (11) The development of agreed local rules and procedures for the conduct of the planned work is an important element of the protection and safety measures. Section 3.4.2 may be useful in its description of an RWP and one description of a pre-job briefing process may be useful in preparing workers for the near term execution of the planned work.

## **4. ENSURING THE COMPETENCE OF THE CONTRACTOR'S PERSONNEL**

### **4.1. CONSIDERATIONS**

The management of the facility is to ensure that contractors carrying out work at the facility are using personnel who are competent to carry out the work. A key factor to ensuring competence of contractor personnel is that they are suitably qualified before performing the work. Accordingly, competence of contractor personnel may need to be formally assessed and documented. This approach will be appropriate not only where the itinerant workers are potentially exposed to radiation sources under the control of the facility but also where the contractor is bringing a source of radiation into the facility and where there is the potential for the facility's employees, as well as the itinerant workers, to be exposed due to this source.

The assessment and documentation process may be performed by the contractor, using its knowledge of the background of its employees and the prerequisites for the competences of workers assigned to perform the planned work. The documentation may then be submitted to the management of the facility to confirm the results of the contractor's assessment.

### **4.2. ELEMENTS OF ENSURING COMPETENCE**

The assessment process is a structured process that evaluates the competence and qualification prerequisites necessary to accomplish the tasks assigned to the contractor and the actual competences and qualifications of the proposed workers for those tasks. Formal procedures or documentation are used to determine the needed competences (through education, initial and continuing training programmes, and work experience) and the qualification requirements for any job to be carried out by the contractors that can have protection and safety implications. Comparison is then made to the actual competences and qualifications of the worker candidates proposed by the contractor.

The level and detail of the assessment process will be dependent on the type of facility and the work to be carried out. Some itinerant workers will work in professions for which qualification or certification schemes are well established. Examples of such professions include radiological medical practitioners, medical physicists, medical radiation technologists and industrial radiographers.

Facility managers who intend to employ itinerant workers of this nature ought to be aware of the certification and qualification needed for this work and incorporate these into the assessment process. It may also be appropriate to specify these prerequisites for the workers in the contractual arrangements. (In this regard, in Section 3.1.1, items (a)–(c) of the list of topics to be discussed in developing contractual arrangements all relate to training and/or the demonstration of competence to perform assigned tasks.)

Workers in other professions and with other skills may not need special qualifications, and, in these circumstances, assessment of competence may be restricted to a review of curricula vitae, certificates, training records, references and reports of similar work carried out at other facilities.

Under certain circumstances, the management of the facility may wish to specify facility specific competence requirements to be fulfilled before the contractor is permitted to work at the facility. These requirements could include the competence to use appropriate respiratory protection. In these circumstances, the management of the facility may have to provide appropriate training and health services to ensure that these competences are met, or alternatively to be able to recommend where such competences may be developed. The satisfactory completion of the related training and other activities to obtain the required competence will be an input to the competence assessment process.

Contractors are to ensure that their employees are suitably qualified for the work to be carried out and are to submit details of each employee's qualifications to the management of the facility prior to commencing work at the facility.

Figure 1 illustrates a competence assessment process for contracted workers intending to perform radiation related work at a facility operated by an employer other than their own employer. To meet the definition of itinerant worker, the contracted worker needs to work in supervised and/or controlled areas of the facility, so that the answer to the question 'Does work involve exposure to ionizing radiation?' is 'yes'. Further information regarding the process of building and assessing competence in radiation protection can be found in Ref. [14].

## 4.3. GAP ANALYSIS

### 4.3.1. Overview

The assessment of contractor personnel competence will conclude either that the proposed itinerant workers are competent to carry out the job or that

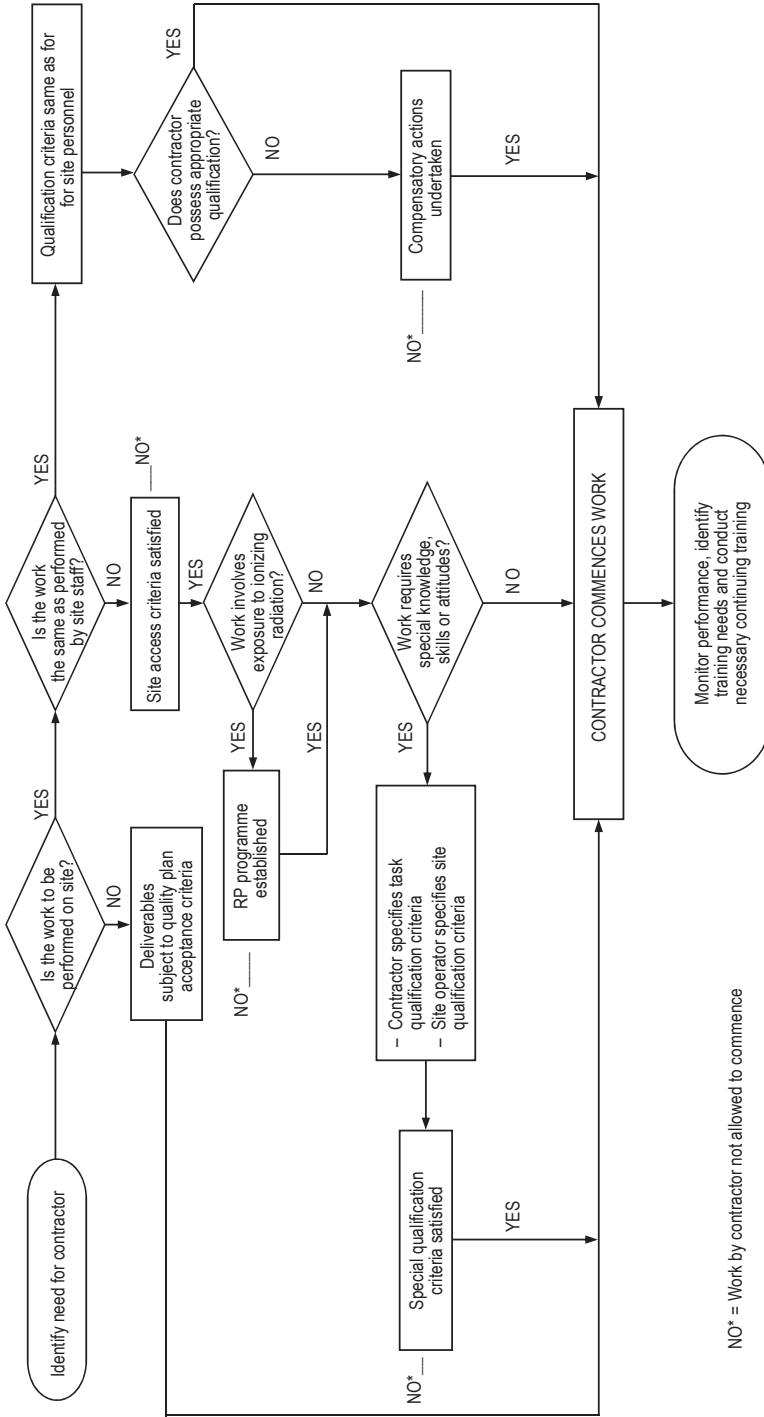


FIG. 1. Competence assessment process for contracted workers intending to perform radiation related work at a facility operated by an employer other than their own employer.



there are deficiencies in qualifications and/or experience. This analysis of actual qualifications and competence as compared with the desired qualifications and competence is called ‘gap analysis’. The use of the word ‘gap’ is intended to imply that limited shortfalls are anticipated, and it would be expected that any deficiencies identified would be remedied with reasonable resource allocations.

Clearly, if gaps do not exist, the itinerant workers are qualified and ready to perform the work at the facility. If deficiencies exist, the gap analysis becomes a ‘needs analysis’ and is the starting point for a systematic determination of compensatory actions.

#### **4.3.2. Compensatory actions**

It is not uncommon for gaps to be identified in the actual qualifications of contractor personnel as compared with the qualifications specified by the management of the facility. In this situation, it is necessary for compensatory actions to be taken before the contractor’s employees are allowed to work on those tasks for which gaps have been identified. The main characteristics of each particular situation need to be taken into consideration in order to specify the most appropriate compensatory action.

For training related compensatory actions, the required training is to be completed successfully before the contractor’s employees commence the work requiring the supplemental training. (In some cases, the management of the facility may be able to provide any necessary facility specific training.) The facility management and the contractor are also to liaise to close any other identified gaps.

The following additional management initiatives may also be implemented, via agreements between the management of the facility and the contractor, as compensatory measures:

- (a) Provision of supplemental direct supervision of the work by the contractor (or facility management) as one mechanism to compensate for a minor gap related to work experience;
- (b) Replacement of certain initially proposed contractor personnel with those having the appropriate competences and qualifications;
- (c) Documentation of additional education, training or experience;
- (d) Waivers of a stated prerequisite if deemed acceptable by the management of the facility in consultation with the contractor.

Compliance with regulatory requirements and the protection and safety programme for the workers have to be ensured with regard to the qualifications of the contracted personnel to be performing the work. Section 7.2 addresses reviews to ensure workers remain competent to perform their assigned tasks.

### **4.3.3. Extension of the gap analysis concept**

The gap analysis process, as described above, focuses on the assurance of competence and qualifications. That is not the only use of a gap analysis process. As a structured way of comparing the observed with the desired or needed attribute, gap analysis may be used with various programme attributes to identify deficiencies and to assist in developing strategies to eliminate those deficiencies. Using the radiography safety check described in Appendix III as an example, deficiencies in readiness to perform radiography safely may be identified via a gap analysis process. A strategy of remediation may then be designed by the contractor (in consultation with the management of the facility), specific remediation actions developed and implemented, and the outcomes of those actions used both to re-evaluate readiness for radiography work in the near term and also to improve initial planning for similar future work.

## **4.4. TRAINING**

Employers need to provide their employees with adequate information, instruction and training on the health risks arising from their occupational exposure and the procedures to follow for their protection and safety [1]. To quote briefly from para. 2.44 of GSR Part 3 [1], the relevant personnel are to have “appropriate education, training and qualification so that they understand their responsibilities and can perform their duties competently, with appropriate judgement and in accordance with procedures.” The nature and depth of this information and training will be dependent upon the type of work being undertaken and the level of education, training and knowledge of the workers.

Itinerant workers carrying out maintenance work in an area with no or minimal implications for protection and safety (e.g. painting or construction work in a supervised area) will require minimal knowledge of radiation protection and will only need to be provided with very basic information on any relevant precautions to be followed while at the facility. Conversely, workers required to carry out operations in controlled areas associated with complex tasks may need to be provided with training on topics such as access requirements, precautions to be taken, the use of personal protective equipment and procedural requirements.

Itinerant workers bringing sources into the facility will need to be adequately trained in the safe use of these sources. It is the responsibility of the employer of the itinerant worker to ensure that training is provided, but the management of the facility is also to be consulted by the contractor on the level and content of the training required for task performance in the facility workplace.

If the contractor has only limited experience working with radiation, the management of the facility may provide the contractor and its employees with the necessary information on protection and safety, including possible emergencies at the facility. This approach would be permissible if allowed by the regulations of the applicable State and if the assessed risks of the work to be carried out are sufficiently known and limited in magnitude (see Sections 3.1 and 3.2).

Depending on the circumstances, this information on protection and safety could be presented as formal training, notices, written instructions and/or potentially even verbal briefings. Most often, some level of formal training (coursework) is required. The other cited means of providing information to the relevant individuals are most often supplemental to formal training, but may often be used to enhance work planning and to ensure effective pre-job briefings take place just prior to the initiation of the planned work.

In other situations where the contractor has limited experience working with radiation, the contractor will be responsible for ensuring training is successfully completed, but the management of the facility will provide, before the work commences, information about the risks relevant to the actual task and workplace, and about any special training needed.

At a large establishment, the management of the facility may help to provide suitable training (in so far as it is relevant to the facility) either on behalf of the contractor or as a contractual requirement. This training is to be at a level similar to that which the management of the facility provides for its own employees.

The contractor is, in any case, to assess the training needs of its employees and to develop a training programme that provides both the appropriate level of training and information specific to the worker's job assignments and also, where appropriate, general radiation protection information [2]. In doing this, consideration needs to be given to the following:

- (a) The nature of the work to be carried out in the near future;
- (b) The potential for radiation exposure associated with this work;
- (c) The extent of training already provided and qualifications obtained;
- (d) Facility specific requirements at the facilities at which work will occur (e.g. entry procedures, personal protective equipment, emergency procedures);
- (e) Applicable State regulations or the directives of any applicable industry training standards group.

In assessing these factors, the contractor is to consult with the facility management and, as necessary, an appropriate qualified expert.

Several levels of training may need to be provided, depending on the nature of the work to be carried out. For example, only basic awareness training in radiation protection may be required for the majority of the workers. An example regarding the content of such a basic course is provided in Appendix IV.

More comprehensive training may be necessary for those staff who will act as RPOs or whose work at one or more facilities is expected to involve potential exposure to radiation that would result in a cumulative dose that is a significant fraction of the annual dose limit. As an example, industrial radiographers may receive initial theoretical and practical radiation protection training with a duration of the order of 40 h. The duration of the refresher theoretical and practical radiation protection training may be on the order of 20 h.

Further information on the level of training required for different types of work is given in the IAEA Safety Reports Series, Training in Radiation Protection and the Safe Use of Radiation Sources [15], which describes the use of a systematic approach for the development and implementation of training to achieve appropriate levels of competence by training participants.

Annex I of Ref. [15] contains a standard syllabus to meet training needs, so that staff acquire strong foundational knowledge about radiation protection and the safe use of radiation sources.

An example syllabus for initial training in radiation protection and safety for industrial radiographers is given in annex III (classroom training) and annex IV (on the job training) of Ref. [15]. A radiation protection training programme for industrial radiographers is also outlined in the IAEA's Safety Reports Series, Lessons Learned from Accidents in Industrial Radiography [16]. More recent mention of this topic and a list of additional publications on lessons may be found in Ref. [5].

Proposals for instruction of workers who are likely to be exposed to radiation or radioactive materials during their work in the mining and processing of raw materials are outlined in Ref. [17], as is instruction for the supervisors of those workers. Education of workers and supervision at irradiation facilities are outlined in Ref. [3].

Proposals for training courses for different groups of workers involved in work with ionizing radiation in the oil and gas industry are given in Ref. [18]. A detailed description regarding that same topic may be found in Ref. [19]. If the work of the contractor and itinerant workers relates more directly to diagnostic radiology or nuclear medicine, references outlining training and curricula for personnel in those specialties may be found in Refs [20, 21].

One additional means of enhancing the knowledge base of itinerant workers is also worthy of mention. Individuals in many work disciplines are members of professional societies which offer continuing education coursework or informational presentations (related to protection and safety) at society conferences or workshops. Some of those continuing education courses are organized as formal training for the participants, potentially meeting some refresher training requirements, while enhancing the level of the participant's knowledge.

Other courses or presentations are developed to provide information to attendees, without those attendees being eligible for formal continuing education credit. Itinerant workers (and their employers) need to take advantage of available opportunities to maintain and enhance their radiation protection knowledge.

#### 4.5. SUMMARY

The following statements are intended to summarize the information presented in this section and reiterate several key concepts described. They need to be interpreted within the context of the entire Safety Report and, specifically, Section 4:

- (1) Itinerant workers need to be suitably qualified before performing the work assigned to them. A structured assessment process is used to confirm the competence of the proposed workers to carry out the assigned work.
- (2) In the assessment process, comparison is made of the actual competences and qualifications of the workers proposed by the contractor with the needed competences (via education, training and/or experience) and qualifications for effectively, efficiently and safely carrying out the planned work.
- (3) The relevant personnel are to understand their responsibilities and be able to competently perform their duties, with appropriate judgement, in accordance with the local rules and procedures developed for the conduct of the planned work.
- (4) If deficiencies are found in the education, training, experience or qualifications of a proposed worker, then compensatory actions are to be undertaken to close the gap between the needed and actual competences and qualifications.
- (5) Training may be presented in the form of training courses, notices, written instructions and/or verbal briefings if found effective in meeting the objectives described in item (3) above.

- (6) There are references available (cited in Section 4) to provide useful guidance in both establishing needed competences and qualifications for selected work and also in providing training to ensure that those competences and qualifications may be met.

## **5. THE RADIATION PROTECTION PROGRAMME**

### **5.1. OBJECTIVES**

An RPP describes the management structures, policies, procedures and organizational arrangements to be applied and followed in a practice. The principal objectives of the RPP are, first, the determination of measures for protection and safety that are optimal for the circumstances, and second, the establishment of means for preventing accidents and for mitigating the consequences of those that do occur [1, 2]. In so doing, the factors relevant to the circumstances are to be taken into account in a deliberative manner.

The complex nature of the management and radiation protection arrangements associated with itinerant workers highlights the need for their work to be carried out in accordance with an effective RPP. This section describes the steps to follow in the development of suitable programmes for work carried out by itinerant workers.

### **5.2. PRIOR RADIOLOGICAL EVALUATION AND SAFETY ASSESSMENT**

The nature and content of an RPP will be very dependent on the type of work to be carried out and the doses potentially associated with that work. The first step towards the development of an RPP is to conduct a prior radiological evaluation of the practice, taking into account both realistically expected exposures and potential exposures [2].

The responsibility for the assessment will lie primarily with the registrant or licensee but also with the employer of the workers potentially exposed. It follows that for most work carried out by itinerant workers, the management of the facility and the employer of the itinerant workers (the contractor) need to collaborate in carrying out the assessment.

The registrant or licensee (or organization responsible for the source or practice that gives rise to radiation risks) is to bear the responsibility for drafting the evaluation and safety assessment, and for keeping it up to date. Other parties are to have specified responsibilities for protection and safety, including provision of input to the evaluation and safety assessment as their levels of knowledge and expertise allow.

The most complex situation arises when the contractor is also a registrant or licensee bringing a radiation source into a facility operated by a registrant or licensee because of the sources or activities occurring at that facility. (Examples may be industrial radiography to be performed by a contractor within or near supervised or controlled areas on the site of a nuclear fuel cycle facility or on the site of a facility extracting or processing raw materials containing naturally occurring radioactive material.)

The objective is to bring all of the relevant information together in a coherent manner, so that a systematic analysis, using graded approach methodologies, demonstrates that an adequate level of protection and safety can be ensured throughout the conduct of the proposed work, in compliance with applicable regulations and standards.

The assistance of a qualified expert may be useful in the preparation of a prior radiological evaluation and/or safety assessment, to provide additional assurance that the issues relevant to protection and safety are addressed.

The prior radiological evaluation needs to include [2], for all aspects of operations, the following three items:

- (a) An identification of the sources of routine and reasonably foreseeable potential exposures;
- (b) A realistic estimate of the relevant doses and probabilities;
- (c) An identification of the measures needed to optimize radiation protection [7].

For most situations, the prior radiological evaluation on which the RPP will be based is to be a collaborative effort by the management of the facility and the contractor. Use is to be made of the results of previous assessments of the same type of work in the facility, presuming they remain applicable. In addition, for a facility that uses radiation sources as part of its normal operations, the management of the facility will already have developed a prior radiological evaluation for its own operations and have completed the appropriate safety assessment.

For those cases where the contractor has its own sources of radiation, the contractor will already have developed a prior radiological evaluation and safety

assessment that is appropriate for at least most of the facilities at which the contractor is likely to work.

The safety assessment needs to be documented and reviewed, as necessary, to ensure that it remains appropriate for the work [1]. Lessons learned from recent operating experience are to be appropriately considered in determining the need for revision of previously completed evaluations and assessments.

An additional example of a situation for which additional review of the safety assessment is to be performed is a proposed significant modification to the facility or equipment, the relevant operating systems or circuits, or the relevant operating or maintenance procedures for those systems or circuits. Such a periodic or cause driven re-evaluation process may be part of the overall quality assurance programme developed to provide the management with additional confidence that an appropriate protection and safety programme remains in effect.

Additional guidance on the preparation of safety assessments may be found in Refs [22, 23].

The management of the facility and the contractor are to remain aware that the applicable regulatory body has specified its regulatory approach to the facility or activities based on information available to it that likely is the same as, or similar to, the content of a previously completed prior evaluation and safety assessment.

The proposed work of the contractor at the facility may potentially affect the prior evaluation or safety assessment, such that the assessed radiation risk increases to the degree that a different regulatory approach may apply. In such a case, the management of the facility and/or the contractor need to consult with the regulatory body.

Review by the regulatory body of the information prepared to reflect the proposed work may result, for example, in work that was previously exempt from regulation now requiring the use of a regulatory notification process, or work previously within the notification process now requiring a form of regulatory authorization. The change in regulatory approach might also occur if non-radiological risks to a worker's occupational health and safety would increase due to the proposed work.

In Section 6.4, situations are described that may result in the need to consult with the regulatory body when the proposed work is evaluated — for example, in a case where radium-rich scales or residues are to be removed that have accumulated more quickly than expected and at higher activity concentrations than expected.

The reverse situation is also possible. The proposed work of the contractor at the facility may potentially affect the prior evaluation or safety assessment, such that the assessed radiation risk decreases to a degree that a different regulatory approach may apply.



For example, the work assigned to the contractor may be construction of a system or installation of equipment which may reduce the magnitude of a source of radiation. In such a case, doses may be accrued by the itinerant workers in the near term to complete an assignment which will reduce doses to permanent workers of the facility management in the longer term, with a net benefit to collective and individual doses over time.

### 5.3. STRUCTURE AND CONTENT OF THE RADIATION PROTECTION PROGRAMME

The prior radiological evaluation and safety assessment will provide the basis for the nature and content of the RPP. The evaluation and assessment will, in many cases, result in a limited complexity of the RPP to be developed and implemented. For those situations where the planned work will be solely or primarily in supervised areas, applications of graded approach methodologies will lead to the development and implementation of an RPP with appropriately limited detail.

For those situations where the planned work will be in relatively low radiation fields and/or require only very limited occupancy within relatively low or moderate radiation fields, application of graded approach methodologies will also lead to the development and implementation of an RPP with appropriately limited detail.

Ensuring compliance with applicable dose limits (and constraints) and optimization of protection and safety remain key considerations, but for the above situations, achieving those requirements is likely to be accomplished with appropriate attention by facility and contractor management and the itinerant workers.

For those situations in which expected or possible radiation fields are relatively higher and where occupancy factors in such radiation fields are relatively higher, the facility and contractor management and the itinerant workers will need to provide relatively higher and fully focused attention to RPP development.

The numbers and complexity of protection and safety measures identified for implementation will be expected to be relatively higher to ensure optimization of protection and safety, and appropriate consideration of the prevention and mitigation of accidents. In those cases where non-radiological risks need to be addressed in conjunction with the radiological risks, the complexity of the RPP may also be relatively higher.

In developing an effective RPP, the contractual agreement between the management of the facility and the contractor will also be a useful reference. The following description focuses on developing an RPP for the situation in which doses anticipated or potentially received may be relatively high or multiple (radiological and non-radiological) risks exist to worker health and safety.

The same description applies to the situation where doses anticipated or potentially received may be relatively low, but the level of detail required within the RPP would also be relatively low. For itinerant workers, the basic structure of the RPP ought to document or reference, with an appropriate level of detail, the following subjects:

- (a) The assignment of responsibilities for protection and safety to different management levels, including the allocation of responsibilities to the management of the facility and the contractor;
- (b) The presence and extent of any controlled or supervised areas;
- (c) The local rules and procedures for workers to follow and for the supervision of work, including the system for accountability for source control and the use of protective equipment;
- (d) The names of the appropriate RPOs;
- (e) The arrangements for monitoring workers and the workplace, including, where appropriate, the use and maintenance of radiation dose rate or contamination monitoring instruments;
- (f) The system for recording and reporting the relevant information related to the control of exposures and the monitoring of individuals;
- (g) Any facility specific training requirements;
- (h) The plans to be implemented in the event of an incident or accident;
- (i) The health surveillance programme;
- (j) The methods for periodically reviewing and assessing the effectiveness of the RPP, including the methods for ensuring quality;
- (k) The integration of occupational radiation protection into a system which allocates resources for health and safety based on a rational balance between all risks.

As with the safety assessment, the registrant or licensee will have the primary responsibility for the RPP, but both the management of the facility and the contractor have specified responsibilities for the RPP. However, it is likely that one or the other will have superior knowledge of the subject and, hence, will take a lead role in its formulation and presentation for discussion between the facility management and the contractor.

In many circumstances, a suitable RPP will already exist, and may simply need to be modified to reflect the work of the contractor at the facility workplace. In a more complex situation, where both the site operator and contractor are registrants or licensees regarding the work to be performed and/or the location of that work, a collaborative effort will be needed to ensure that the relevant factors are adequately addressed in the RPP.

This can be illustrated by considering two examples. With work planned at a nuclear power plant, the management of the facility will have acquired extensive knowledge of the radiation risks associated with the operation and maintenance of the facility, will have carried out a comprehensive safety assessment for its own employees (and those of contractors foreseen to be used for assessed tasks), and will have established a comprehensive RPP.

In this instance, therefore, it may be appropriate for the management of the facility to communicate the relevant safety assessment information to the contractor, discuss work related circumstances and any identified concerns with the contractor, and draw up a simplified RPP for finalization with the contractor that covers the work of the contractor. (See also Section 3.2.)

An industrial radiography company working at a chemical plant will already have its own RPP for work at most facilities, but will need to liaise with the safety officer at the facility and provide them with appropriate information from the RPP. That information to be discussed will include the proposed management and supervision arrangements, and the procedures to be used in the protection of all employees at the facility. (See also Section 3.3.) Detailed guidance on the content of RPPs can be found in Ref. [2].

#### 5.4. RADIOLOGICAL RISK MANAGEMENT — ELEVATED RISKS

As mentioned earlier in this section, a graded approach to risk management is to be used, considering the relevant factors in a deliberative manner. For many situations, the radiation risks are relatively low or reasonably moderate, such that the wording of Sections 5.1–5.3 needs no amplification as regards the development of a protection and safety programme for itinerant workers. Work involving even higher levels of radiation risk may, however, present additional challenges for the facility management and the contractor as protection and safety measures are identified to optimize radiation protection.

The radiation protection staff of the facility and/or the contractor will wish to provide additional management oversight and resources when radiologically significant work is being planned and executed. That focus of resources will

begin when the work evaluation and/or assessment process identifies work where multiple diverse barriers are required to prevent the occurrence of events involving significant accessible radiation fields and/or the potential to exceed applicable individual dose limits or constraints.

Examples may be as follows: (i) known external radiation fields which may result in exceeding preselected values such as 10 mSv/h or 0.5 mSv for a single entry into the work area (or the equivalent for extremities or the lens of the eye); (ii) entry to areas subject to rapid increases in dose rate due to fixed or mobile sources (such as discrete radioactive particles); (iii) entry to areas where airborne radioactivity concentrations or estimated doses from inhalation are projected to exceed preselected thresholds; or (iv) entry to areas where contamination levels of alpha emitting materials or transuranic materials are projected to exceed preselected thresholds.

As regards the protection of itinerant (and permanent facility) workers, the contractor's supervisory (and, where applicable, radiation protection) staff, the facility's supervisory (and, where applicable, radiation protection) staff and, where appropriate, the workers, need to focus collaborative efforts on the following factors:

- (a) Designation of a single management or supervisory point of contact by contractor and/or facility to manage the higher risk work; and clarity of the contractual arrangements and local work rules and procedures regarding roles and responsibilities of the task managers of the contractor and facility.
- (b) Awareness of job specific risks and their expected and potential magnitudes by planners and work crew personnel.
- (c) Decisions regarding any supplemental training that needs to be completed considering the identified risks.
- (d) Allocation of resources to identify any appropriate supplemental protection and safety measures during the work planning and work approval processes. For higher risk work, a 'challenge board' process may be useful, during which representatives of the contractor and facility from multiple disciplines review and constructively critique work plans as to their adequacy and optimization of protection and safety. Approval of work plans and procedures (including RWPs) by management at more senior levels may also be useful. Such an RWP would specify required controls, criteria requiring immediate cessation of work, and radiation protection monitoring. (See the description of RWP content in Section 3.4.2.) The process needs to recognize that the organization which is not the registrant or licensee (e.g. the contractor) will likely not be familiar with the procedures used by the registrant or licensee (e.g. the facility management) to ensure

higher levels of risk awareness and protection and safety controls for work of higher risk. That relative lack of knowledge needs to be addressed by the registrant or licensee providing additional briefings (to the non-registrant/licensee supervisory staff) on the desirability of using the available techniques for reducing the likelihood of human error by enhancing the numbers of disciplines and the experience levels of personnel represented in the work planning and approval processes.

- (e) Allocation of management and/or supervisory resources to pre-job briefings and to continuous oversight of task performance at the work location by the contractor and/or the facility staff, consistent with the warranted higher level of awareness and the need to perform higher risk complex and/or infrequently performed work. The process needs to recognize that the organization which is not the registrant or licensee (e.g. the contractor) will likely not be familiar with the procedures used by the registrant or licensee (e.g. facility management) to both reduce the likelihood of human error and also to provide enhanced means for detecting and correcting such errors. The description of the rationale for the enhanced pre-job briefings and supervisory oversight needs to be explained for the benefit of the non-registrant/licensee staff. Those procedures would include additional communication (between supervisors and craft workers) during pre-job briefings on risks and on risk control measures, including the need for the workers to adhere to the approved local rules and procedures. They would also include provisions for enhanced supervisory oversight of the adherence to local rules and procedures as the work is executed.
- (f) Establishment of a team under the auspices of the single point of contact for the work, to perform a post-job assessment of plans and results and, thereby, to specify lessons for the workers, the contractor and the facility.

## 5.5. SUMMARY

The following statements are intended to summarize the information presented in this section and to reiterate several key concepts described. They need to be interpreted within the context of the entire Safety Report and, specifically, Section 5:

- (1) The principal objectives of the RPP are, first, the determination of measures for protection and safety that are optimal for the circumstances, and second, the establishment of means for preventing accidents and for mitigating the consequences of those that do occur [1].

- (2) A prior radiological evaluation of the planned work is to be performed, primarily by the registrant or licensee, but in collaboration with the employer of the potentially exposed workers. The results of previous assessments of the same type of work may be used as a basis for the evaluation, if those results remain valid when considering any lessons learned from previous job evaluations and any modifications to the technology and techniques to be incorporated into the planned work.
- (3) The radiological evaluation needs to include: (i) an identification of the sources of routine and reasonably foreseeable potential exposures; (ii) a realistic estimate of the relevant doses and probabilities; and (iii) an identification of the measures needed to optimize radiation protection [7].
- (4) The RPP is to be developed based on the prior radiological evaluation and safety assessment, with the registrant or licensee taking the lead role in establishing the programme, but working in collaboration with the employer of the potentially exposed workers. The contractual agreement between the registrant or licensee and the employer will also be a useful reference in developing an RPP which addresses the responsibilities for, and the radiological controls on, the planned work
- (5) If the radiological risks of the planned work are relatively elevated, then elevated attention to the development of a comprehensive RPP is warranted. A principal means of developing an effective RPP is by reducing the possibility of human error or inadvertent action, and providing a means for detecting and correcting such an error if it occurs. To support the sound consideration of human factors, work with relatively elevated risk is most often: (i) managed by a single point of managerial contact; (ii) subject to multidisciplinary review and approval processes during work planning; and (iii) subject to enhanced pre-job briefings and to enhanced supervisory oversight during job performance.

## **6. ISSUES ASSOCIATED WITH SPECIFIC PRACTICES**

The previous sections describe, in general terms, the organizational and competence criteria associated with the use of itinerant workers. However, there are specific issues associated with the use of itinerant workers in some practices and these are considered in this section. The topical discussions in Section 6 are to be regarded as additions to (and not replacements for) the topical discussions

found in the other sections of this Safety Report; that is, development of a protection and safety programme using the guidance in Sections 1–5 and 7 will be made more effective by also considering the applicable discussions in this section.

## 6.1. NUCLEAR INDUSTRY

Comprehensive engineering controls backed up by detailed procedures used by trained and qualified personnel are required in the nuclear industry to control exposures adequately. High importance needs to be assigned to the practical aspects of optimization of protection and safety [7, 24]. The wording of this subsection primarily reflects the situation for nuclear power plants; this is because such plants tend to have some controlled areas with higher relative exposure rates than those of other facilities in the nuclear fuel cycle. A graded approach, as described in Requirement 6 of GSR Part 3 [1], is to be used for situations in which the magnitude and likelihood of exposures are lower.

### 6.1.1. Access to nuclear power plants

Doses that could be received by some workers in certain areas of the plant may be relatively higher than those received by their colleagues working elsewhere in the plant. It is, therefore, important that rigorous requirements are applied before itinerant workers are granted access to those areas and, potentially, even to the facility itself. Individual access into a nuclear power plant may require adherence to some or all of the following procedures:

- (a) The employer of the itinerant worker enters the following information on a facility access authorization form or otherwise ensures that the information is available to the facility personnel advising facility management regarding the granting of access to the facility:
  - (i) Individual information regarding the worker;
  - (ii) Contract reference;
  - (iii) Employer details;
  - (iv) Protection and safety training, and professional skill of the worker with relevant certificates (and dates acquired when requested);
  - (v) Expected duration of the worker's need for access to the facility;and sends the form to the representatives of the facility management for addition of the following information:
  - (vi) Description of the areas where access is permitted;

- (vii) Period of validity of the access permit to the facility and to supervised/controlled areas therein.

An example of a form to be used for this purpose is given in Appendix V. In the case of access to areas with relatively high (or potentially relatively high) exposure rates, as specified by the facility management, a specific authorization needs to be given to the worker. The access procedure for a nuclear power plant or other fuel cycle facility may take several days to process.

Depending on the type of facility and the specific conditions within the facility, a term such as ‘high dose rates’, as mentioned in the paragraph above, may imply different situations. Examples include:

- Substantial external radiation fields (e.g. >1 mSv/h);
- Areas subject to the presence of higher activity discrete radioactive particles;
- Areas where reportable intakes of commonly identified radionuclides may occur (e.g. tritium or <sup>137</sup>Cs);
- Areas where reportable intakes of less commonly identified radionuclides may occur (e.g. of transuranic radionuclides or other alpha emitting radionuclides).

The likelihood and the potential magnitude of exposures are to be considered for each of those situations relevant to the facility at which work is being planned.

- (b) On arrival of the itinerant worker at the plant, a check is made of all of the information in item (a), as well as:
  - (viii) The worker’s fitness for work;
  - (ix) The worker’s dose record over the current calendar year, the past 12 months and the past 60 months, unless not required by State regulations.
- (c) Specific training is provided on particular facility conditions and for actions required in the case of emergency occurrences.
- (d) A check is made of the compatibility of skills of the worker with the competences needed for performance of the work.
- (e) The worker has to justify their access to a controlled area by producing an RWP developed in accordance with the facility’s work management system.
- (f) An individual dose objective for the worker is established. Such an objective may be task based or time based, as appropriate for the work.



Special procedures may be adopted for workers on short term contracts, such as:

- (g) An individual dose objective calculated on a pro rata temporary basis.
- (h) Restricted or prohibited access to areas of relatively high (or potentially relatively high) levels of radiation as specified by the facility management.

The submission of an IRMD (Section 3.2.8) containing the relevant information regarding the worker (qualification, training, fitness for work) may be requested. Additional information and an example of an IRMD are given in Appendix II.

Some facilities may also use an electronic database containing similar information regarding numerous individuals as a primary aid to determining whether access to the facility and to the specific workplace within the facility is authorized. Use of an electronic dosimetric database, operated by the regulatory body of a State and/or by a consortium of key industrial registrants or licensees within that State, may allow near real time oversight of individual doses of itinerant workers in selected or in all industries within a State. Requirements with respect to access to workers' exposure records are specified in para. 3.106 of GSR Part 3 [1].

### **6.1.2. Specific training and procedures**

Itinerant workers at nuclear facilities have to face a variety of situations, owing to the facility specific nature of the working conditions and other factors. For tasks involving access to controlled areas, especially for those in which relatively high or potentially relatively high dose rates may reasonably be expected, the following special training (and/or briefing) and procedures are needed for itinerant workers:

- (a) A pre-work review, involving a detailed description of the work to be done, technical data, and dosimetric and environmental conditions;
- (b) A preliminary procedure to carry out the work, with an associated dose estimate;
- (c) Training of the workers on a mock-up or, where feasible, a representative simulation of the actual job site, or if necessary, a briefing using descriptors of the job site (e.g. photographs or videos);
- (d) Feedback on this training (or briefing where use of a mock-up or simulation is not reasonably feasible), including the exposure time, difficulties in carrying out some tasks, phases to be improved, specific tools to be developed, and the numbers or types of people simultaneously at the workplace;

- (e) Anticipation, to the extent possible, of breakdowns of tools or equipment and of other operational incidents — facilitating the formulation of corrective or contingency actions and the training (or briefing) of workers to carry out such actions in a manner that keeps doses as low as reasonably achievable;
- (f) Improvement of working procedures and of dose estimates when found appropriate;
- (g) Final training and/or briefing of workers in accordance with such improved procedures.

Lessons learned from operating experience at the facility and/or at other facilities are to be used in formulating the planned work (and contingency) procedures and the related training (and/or briefing) of the workers.

## 6.2. THE USE OF X RAY EQUIPMENT AND RADIATION SOURCES IN DIAGNOSTIC RADIOLOGY, INTERVENTIONAL RADIOLOGY, NUCLEAR MEDICINE AND RADIOTHERAPY

The use of X ray equipment for diagnostic and/or therapeutic purposes and the use of radioactive sources and accelerators for diagnosis or therapy are universal practices with the potential for relatively high doses to both workers and patients. (Exposure of patients is not within the scope of this Safety Report.) Interventional procedures using X rays are included among the topics to be considered in this section.

Broadly, there are three types of source that are used in the health care disciplines discussed in this section. They are: (i) devices exposing the patient to external beams of radiation, (ii) sealed sources placed in the body of the patient, and (iii) unsealed sources administered to the patient via intravenous injection, ingestion or inhalation.

As mentioned above, exposure of patients is not within the scope of this Safety Report; the information is provided to note that occupational exposures due to sources external to the body and sources that may be taken into the body can potentially occur in medical radiation facilities. For diagnostic purposes, sources emitting gamma or X rays are most often used. For therapeutic purposes, sources emitting gamma or X rays or charged particles, such as beta particles or protons, are most often used.

There are two primary types of employees in health care facilities who may meet the definition of itinerant workers. These two types will be dealt with separately.

### **6.2.1. Equipment engineers and maintenance technicians**

The first type of itinerant worker consists of equipment engineers and maintenance technicians servicing medical equipment which is a radiation source or is used together with a radiation source for health care purposes (e.g. the radiation detection systems used for a patient administered a radiopharmaceutical).

Such workers typically have one employer and may perform contracted services at a large number of facilities. They may perform preventive maintenance services on a periodic basis (e.g. one day every three months at a specific facility) and troubleshooting and/or corrective maintenance services as emergent equipment issues arise at a facility.

Sections 3.1–3.4 describe the arrangements needed to protect these itinerant workers. However, several additional comments may be appropriate regarding this type of itinerant worker.

First, the employer is often an equipment manufacturer or a vendor who sells and services a few types of equipment to health care facilities. That employer may be a registrant or licensee for the relevant radiation source or under regulatory control for sources used in servicing or calibrating such a source. If so, the employer is the responsible person or organization for performing the prior radiological evaluation and safety assessment for the services performed by its workers at representative facilities.

That employer is also to have developed procedures appropriate to the servicing of the equipment it handles. If the contractor is not selling, servicing or using radiation sources, but equipment used with such sources, it is the responsibility of the medical radiation facility authorized to use the source to perform the prior radiological evaluation and safety assessment, and to have developed the procedures for the workplace in which the equipment is used and serviced. Both the management of the medical facility and the employer of the worker will want to collaborate with the worker to ensure that compliance with the requirements for optimization of protection and safety will be met as the RPP is developed and executed.

Second, the manufacturer and/or vendor is to have developed the training required for the engineers and/or technicians to provide the services needed to maintain the equipment in good working order. Owing to the fact that the equipment is a radiation source or is used in conjunction with a radiation source, the training of the itinerant workers is to include basic training regarding radiation protection and additional classroom training (and probably on the job training) appropriate to the tasks which the individuals perform and the workplaces in which they perform those tasks. In some States, equipment engineers and maintenance technicians for sources used in medical radiation applications are to be licensed to perform their tasks.

Third, there is to be collaborative discussion between the contractor (often the manufacturer or vendor) and the management of the medical radiation facility to ensure that the needs of both parties are met, as the contracted services are performed and the equipment is returned for use in the care of patients.

The management of the medical facility will want to know that the contracted services are performed by appropriately qualified personnel using approved rules and procedures, and that those procedures are protective of both the itinerant workers and also the facility staff as the equipment servicing is performed. Both parties will want to know that there are no conflicting requirements between the local rules and procedures used by the medical facility and by the contractor, and that any notification requirements specified in local rules and procedures are known to all relevant personnel.

Related to the last point, the management of the medical facility may wish to confirm that the equipment servicing personnel is familiar with the clinical uses of the equipment, so that the personnel are aware which adjustments to features of the equipment may have radiation protection implications either for the staff of the health care facility or the patients.

Examples of required notifications to the users of the equipment for clinical purposes may be for (i) changes made to default settings of systems during the performance of the maintenance and (ii) changes to aspects of a system that affect the radiation characteristics of the source or the image quality of a system. There also needs to be agreement among the parties regarding the state of the equipment when the servicing is completed; for example, are (exposed or unexposed) film cassettes to be left in a film processing system after the system is serviced?

Classification of the areas in which servicing is performed is important, as are the procedures to ensure access control to those areas. Assurance is also needed that the system being serviced is under the control of the contractor and is not available to medical facility staff during the period of servicing.

For example, there may be the possibility of accidental exposure resulting from the temporary deactivation of a safety interlock during maintenance of a system (using a radiation source) by an itinerant worker. In such circumstances, adequate backup measures need to be in place to prevent the use of the system when the itinerant worker may potentially be exposed.

Clarity is to be ensured regarding the RPO(s) overseeing the contracted work, especially if the contractor is not a registrant or licensee; that is, the itinerant workers need to know whom to approach for radiation protection advice and/or if an operational event occurs that may have implications for protection and safety.

The final point to be mentioned is the development of the individual monitoring programme for the itinerant workers and the responsibility for calculating or tracking the total dose from work at the various facilities at which

the itinerant worker has been engaged. If the contractor (employer) is a registrant or licensee, the responsibility lies with that employer for ensuring the provision of appropriate individual monitoring (e.g. integrating personal dosimeter and, where appropriate, operational dosimeter and/or individual measurement) and for assessing the dose accrued by the itinerant worker at facilities and across facilities.

If the employer is not a registrant or licensee, the employer needs to discuss with the medical facility management the arrangements for appropriate individual and/or workplace monitoring and the timely availability of results for assessment by the employer (plus its workers and provider of health surveillance for those workers) and the registrant or licensee regarding compliance with regulations and appropriate refinements to the programme for optimization of protection and safety for the itinerant workers.

The employer retains a responsibility to assess the occupational exposure of its employees (the itinerant workers) and to maintain appropriate records of that exposure whether received at one or several facilities. The discussion in Section 6.2.2.1 on the advantages of having dosimetric results from each facility at which work is performed may also prove useful in developing the applicable RPPs for equipment engineers and maintenance technicians.

## **6.2.2. Health professionals**

The second category of employees who may meet the definition of an itinerant worker is a health professional, as it is a common practice for medical practitioners (including radiology specialists, dentists, cardiologists and other medical specialists), medical physicists and medical radiation technologists (and/or registered cardiovascular invasive specialists) to perform their professional services in several hospitals and clinics in a limited time period. Nurses may also be among the personnel that move from facility to facility.

The health professionals may be self-employed or employed by a corporation or similar legal entity and be doing contracted work at all facilities at which they are engaged. Alternatively, the radiological medical practitioners and staff may be employed by one hospital or hospital group and act as contracted personnel in other hospitals and clinics.

The health professionals may be utilizing their expertise in the supervised and/or controlled areas of a medical radiation facility which is a registrant or licensee (or otherwise under regulatory control). Alternatively, the contractor (employer of the health professionals) may be a registrant or licensee (or otherwise under regulatory control), with the health professionals using their expertise and medical radiation equipment and/or sources, under the control of the contractor, within a facility which may not otherwise control a source.

The situation may also arise where both the medical radiation facility and the contractor are registrants or licensees (or are otherwise under regulatory control). The situation may further arise in which the contractor is a registrant or licensee (or otherwise be under regulatory control) for health care operations, and the facility may be a registrant or licensee (or are otherwise under regulatory control) but not as a medical radiation facility or for health care operations.

Unlike many equipment engineers and maintenance technicians, health professionals may work in a relatively small number of facilities, using a well established pattern — for example, facility A on Mondays and Thursdays, and facility B on Tuesdays, Wednesdays and Fridays.

There are cases, however, where health professionals are engaged at numerous facilities, such as those health professionals that perform occupational health examinations using a mobile van moving from facility to facility over time. (Such a van may contain, for example, one or more X ray generating devices used for diagnostic tests such as X rays of the chest or teeth.)

Owing to the manner in which such mobile medical facilities operate, whether the facility on whose premises the van is parked is itself a registrant or licensee (or otherwise under regulatory control) for non-clinical activities, there are unlikely to be overlapping controlled areas and probably not overlapping supervised areas.

As mentioned in Sections 1.3 and 2.1, the IAEA is developing a Safety Guide which will address protection and safety for health professionals providing their services in clinical settings. That Safety Guide is also expected to address pseudo-clinical settings, such as those where the health professionals work with equipment designers and manufacturers (of sources and/or equipment) to test the features of medical radiation equipment and/or sources intended for later use in clinical settings.

That Safety Guide will address protection and safety for health professionals in a broad sense and so will address the case of a health professional as an itinerant worker. The relatively rapid changes occurring in the technologies (and the procedures) used by health professionals may benefit the health professionals, as improvements regarding optimization of protection and safety may be realized.

As the Safety Guide is not yet available, a limited amount of information regarding health professionals as itinerant workers is provided in Section 6.2.2.1. The information may be updated and/or superseded by the guidance on radiation safety in medicine when it becomes available.

For completeness, there are also uses of equipment, such as for diagnostic radiology, for example, in veterinary hospitals and clinics. Thus, itinerant workers, such as equipment engineers and maintenance technicians, may also perform their services in facilities for non-human patients. Potentially, there may be veterinarians and veterinary technicians who may also be itinerant workers

in veterinary hospitals and clinics. No additional information will be presented in this Safety Report on this subset of itinerant workers.

#### *6.2.2.1. Considerations regarding health professionals as itinerant workers*

Sections 3.1–3.4 apply to the work performed by health professionals when they meet the definition of being itinerant workers. Several additional comments may, however, be appropriate pending the publication of a Safety Guide on radiation safety in medicine by the IAEA.

First, health professionals have already received training in radiation protection in their initial pre-qualification training and will be working in accordance with similar procedures at each hospital or clinic where the appropriate source(s) and equipment are to be found.

In development of contractual arrangements between the management of the facility and the contractor, evidence of the appropriate certification or qualification of the health professionals is to be available for confirmatory review, to include appropriate confirmation that their education and training included coursework in radiation protection, sufficient for the professionals to perform their duties in a manner that gives due consideration to protection and safety.

It is also important that the professionals have received (or receive) specific training to familiarize them with any unique operational and/or safety related aspects of the equipment (X ray systems, accelerators, etc.) in the facilities in which they will be working.

An alternative situation that may arise is when the health professionals bring radiation generating machines or radioactive sources into the facility, such that the itinerant health professionals represent a registrant or licensee and the facility personnel may or may not represent a registrant or licensee because of activities otherwise occurring at the facility. In such a situation, Sections 3.3 or 3.4 may apply. In any case, maintaining the safety and security of the radiation sources is to be adequately addressed.

Second, when dose constraints and/or allowable doses are established for work at a facility, recognition is to be afforded to the fact that medical practitioners and their support staff may work in multiple facilities and with multiple radiation sources, so that a means to calculate or track the total radiation exposure of the individual is important in assessing compliance with annual dose limits and any annual dose constraint established by the State regulatory body or by the employer.

A dose constraint is by definition source related, so that the fact that the medical practitioners and support staff may be exposed to different sources at different facilities presents challenges in establishing an appropriate dose

constraint; this may also be true for establishing appropriate allowable doses under the procedures of a specific medical facility.

Establishment of constraints and/or facility specific allowable doses may be a topic of pre-contractual discussion between the management of the medical facility and the employer, especially where the medical facility is the registrant or licensee and the employer is not.

A primary issue to address for health care professionals working in multiple facilities is the adequacy of the individual monitoring (e.g. dosimetry) arrangements. The health professionals may, if exposed to sources in the conduct of their duties and consistent with the results of the prior radiological evaluations, be provided with dosimeters by their employer or by the registrant or licensee (if not one and the same, and dependent on the results of discussions between those two parties and any involved qualified experts) and are likely to wear those dosimeters at every location at which they work.

The practice of wearing one integrating personal dosimeter across facilities can create difficulties when a higher than expected radiation dose is recorded, as it may not be possible to determine in which hospital or clinic an unexpected dose was received and, thus, which employer is responsible for any investigation or corrective actions.

The existing situation may also be that the itinerant health professional performs their work at a facility where sources in addition to those used by the itinerant health professional are found. The emerging prudent practice is, therefore, to have the itinerant health professional wear a separate dosimeter at each workplace.

An alternative dosimetry arrangement that might be considered if consistent with State regulations and suitable for the circumstances of exposure, would entail the worker wearing a second, separate dosimeter at each employment location — perhaps an active operational dosimeter, such as a personal alarming dosimeter, with the results recorded for each facility.

The integrating personal dosimeter would likely be provided in that situation by the employer and be worn at all locations for primary record keeping purposes regarding total exposure for the monitoring period.

Notably, individual monitoring may include the use of devices such as extremity monitors for certain diagnostic or interventional radiographic and nuclear medicine procedures and/or monitoring of the lens of the eye for similar procedures. When unsealed sources are used within one or more facilities within which the health professionals provide a service, there are also topics to be addressed regarding the assessment of the potential for intakes of radionuclides by permanent facility staff and/or by the itinerant health professionals.



The prior evaluation of doses and the safety assessment need to lead to a decision on whether (and which) workers are to be placed into an individual measurement programme to determine whether measurable intakes occurred and, if so, to evaluate when and at what magnitude. Supplemental workplace monitoring may also be found to be appropriate.

The individual and workplace monitoring arrangements need consultation with all involved parties and need to be part of the contractual arrangement between the medical facility management and the contractor.

Adequacy of the arrangements can be achieved only when the health professionals, their employer and also other relevant parties (regulatory body, provider of the professionals' health surveillance, applicable registrants or licensees) are able to assess the professionals' continuing compliance with all of the applicable annual and other dose limits and associated requirements for their protection and safety. The employer retains a responsibility to assess the occupational exposure of its workers and to maintain appropriate records of that exposure, whether received at one or several facilities.

An additional topic for discussion between the medical facility management and the contractor is the set of local rules and procedures to be applied at the workplace. (This may include topics such as use of: (i) shielding between the source and the medical personnel; (ii) personal protective equipment; and (iii) prevention and detection techniques for contamination where unsealed sources are in use.)

Collaboration is needed to ensure that there are no conflicting requirements between the rules and procedures normally used at the facility, and the rules and procedures proposed by the contractor.

The use of other radiation sources near the workplace of the health professionals is to be discussed with the contractor, as there could be a need for the itinerant health professionals or the medical facility to adjust local rules and procedures to account for radiation or radioactive materials from the sources used by the other party.

If one of the two parties is a registrant or licensee for the activities of relevance and the other party is not, the primary responsibility for ensuring development of finalized rules and procedures, consistent with the needs of the health services being performed and the requirements for protection and safety, lies with the registrant or licensee. If both parties are registrants or licensees, mutually agreed rules and procedures are to be developed.

The employer of the health professionals and/or management of the medical radiation facility may find it prudent to arrange for occasional (perhaps jointly performed) safety assessments while clinical services are under way, taking due care not to interfere with those clinical services.

The assessments may both confirm that the agreed, safe working practices are being used and also identify possible occupational RPP refinements to better protect the health professionals. This would be consistent with ensuring compliance with requirements for optimization of protection and safety.

When the facility management is not a registrant or licensee for the health services performed by the itinerant health professionals, but at which facility health professionals may be engaged, the facility management (and/or their qualified expert) will wish to develop a level of assurance about the finalized protection and safety programme. This would ensure that the programme reflects appropriate input from the facility management, and is both compliant with applicable regulations and also protective of the occupational health and safety of the health professionals and facility staff throughout the period of health services performance.

Practical guidance regarding radiation protection and safety for selected medical situations may be found in Refs [20, 21].

### 6.3. MINING

Workplaces in mines, particularly underground mines, may exhibit elevated concentrations of radon in the air, and the inhalation of short lived radon progeny may lead to occupational exposures that need to be controlled. Exposures to short lived radon progeny in mines are highly dependent on the rates of radon entry into the mine air and on the degree of ventilation. Substantial exposures to radon and its short lived progeny can occur, even if the activity concentrations of naturally occurring radionuclides in the ore body are elevated only moderately.

Where radionuclide concentrations in the ore body are elevated significantly, such as in uranium or thorium mines, exposures to external gamma radiation and long lived alpha emitting (and, on rare occasions, beta emitting) radionuclides in dust may also need to be controlled. In situations in which scale accumulation from radium-rich water may occur, exposure of workers may be anticipated; the guidance in Section 6.4 regarding such situations may be helpful.

More detail regarding the exposure pathways and exposure reduction techniques in mining is given in IAEA Safety Standards Series No. RS-G-1.6, Occupational Radiation Protection in the Mining and Processing of Raw Materials [17].

The hiring of contractors, both short and long term, is commonplace in mines. The question of who is best placed to execute the agreed supervisory responsibilities for radiation protection measures (including training, health surveillance and the use of personal protective equipment) with respect

to itinerant workers depends very much on the nature of the contract work, which can vary widely, as illustrated by the following two examples:

- (a) In some mines, contractors are hired to carry out normal day to day mining operations that may be conducted on a large scale and continue for a long time. In such situations, it may be best to recognize that the primary responsibility for the management and control of radiation exposures of itinerant workers is that of the management of the mine, because it is responsible for the facilities and activities that give rise to radiation risks. The mine management will already need to have the necessary competence and infrastructure in place. The mine management and the contractor are to discuss their individual and joint responsibilities, and reach agreement for the establishment and implementation of the protection and safety programme.
- (b) Contractors may also be hired to carry out specialized, non-routine tasks that do not form part of the day to day operation of the mine, such as the installation and maintenance of structures and equipment in the mine, ore pass excavation and shaft sinking. Such tasks may sometimes involve higher exposure levels than those encountered during normal operations. It is possible, in such circumstances, that the contractor may be better positioned to assume additional responsibilities, in agreement with the management of the mine, for the protection of its employees and even those of the mine. That follows logically because of the specialized nature of the contractor's work and, because the contractor performs this work on a routine basis, it is likely to be more familiar with the particular radiological risks involved with that work. The contractor (employer) also has the advantage of being more easily able to keep track of its employees' radiation doses over long periods. On the other hand, the contractor's experience in carrying out such specialized work may have been gained mostly in situations where the radiation related risks were insignificant, in which case the responsibility for radiation protection may remain primarily with the management of the mine. The mine management would then have to familiarize itself with the radiation related risks associated with such specialized work, ensure appropriate work evaluation and safety assessment have been performed, and develop the appropriate protection and safety programme in consultation with the contractor.

Thus, for mining, it is important for the full range of options with respect to the assignment of operational responsibilities to be kept open. As a general rule, the operator of the mine is likely to be the registrant or licensee (or is otherwise

responsible for the activities that give risk to radiation risks) and, therefore, has lead responsibility for protection and safety.

The employer having the greater level of radiation protection competence and infrastructure for the tasks in question needs to provide the greater amount of technical input to the discussions between the management of the mine and the contractor.

As many workplaces in mines are remote and relatively inaccessible, supervision of work activities can be difficult, and close and sustained interaction between the management of the mine and the contractor is, therefore, particularly important.

In mining, and especially in underground mining, there needs to be close coordination with the individual who is assigned responsibility for ventilation systems (sometimes called the ventilation officer). Certainly, the exposures of workers are affected by overall and localized ventilation flows and dust control measures in the mine.

The primary ventilation system is an engineered control which has as one objective the reduction or maintenance of radionuclide activity concentrations in the work environment. As a supplemental measure, temporary engineered controls, such as portable or auxiliary ventilation, may be applied in localized areas during some routine and non-routine (e.g. maintenance) operations.

Collaboration between the ventilation officer and the RPO is warranted, especially regarding the development of training programmes related to ventilation and dust control, the use of any air purification systems, and the establishment of dust sampling and control programmes.

Both radiological and non-radiological risks are to be considered. The non-radiological risks, for example as related to the inhalation of silica and other particles, the presence of localized elevated temperatures or the potential flammability of the atmosphere in some localized workplaces, can be important. The development of local rules and procedures to be applied if the ventilation system fails to operate as planned or is taken out of service is also a worthy topic of discussion for the ventilation officer and the RPO.

A specific technical issue may warrant discussion by the mine operator and the contractor and then communication by appropriate personnel to the itinerant workers. These communications are more likely to be of importance if the contractor and its workers do not have substantial experience in mines or do not have experience regarding air sampling to determine exposures of workers. Specifically, the agreed method of air sampling needs to be described to the workers, along with the rationale for that choice, as appropriate. When airborne radioactive materials are to be measured, air quality measurement instruments are used.

Two types are used: stationary air samplers and personal air samplers. Stationary air samplers operate at a relatively higher flow rate (often about 20 L/min) at fixed locations in the workplace. Personal air samplers operate at a relatively lower flow rate (often about 2 L/min) and are worn on the body. A personal air sampler provides more reliable monitoring if the sampling head is positioned so that the sampled air is reasonably representative of the air breathed by the worker and when there are spatial and temporal variations in airborne activity concentrations.

There are practical difficulties in managing the use of personal air samplers by large numbers of workers at the same time. In some situations, workers are assigned to groups in which one or a few workers wear personal air samplers. That may lead to the further difficulty of ensuring that workers moving around in their workplaces somewhat independently of one another are representatively monitored. More information on monitoring in dusty workplace environments is presented in Section 6.4.

#### 6.4. EXTRACTION AND PROCESSING OF RAW MATERIALS

Most industries involved in the extraction and processing of raw materials, including the oil and gas industry and a wide range of mineral processing industries, rely to a greater or lesser extent on the use of radioactive materials and/or radiation generators in their day to day operations.

Sealed sources, often with very high activities, are used in measurement and control devices (e.g. gauges), within facilities and on occasion within product transfer pipelines. Use is made of industrial X ray or gamma ray equipment for testing the integrity of piping and pressure vessels. Unsealed radioactive materials are used as tracers in the oil and gas industry and in mineral processing facilities. Such uses of radioactive material and/or radiation generators are described in Section 3.3.1.

The primary responsibility for protection and safety lies with the person or organization responsible for facilities and activities that give rise to radiation risks. This corresponds, most often, to the registrant or licensee of the practice. The responsibilities include the establishment of arrangements for consultation and cooperation with other employers whose employees may be exposed as a result of the practices of the management of the facility and/or the contractor.

These other employers are also responsible for the health and safety of their own employees. The guidance found in previous sections of this Safety Report are useful both in defining the allocation of responsibilities between the management of the facility and the contractor, and in formulating appropriate contractual arrangements and protection and safety programmes.

There is an additional exposure pathway that applies to the extraction and processing of raw materials. The presence of minerals and mineral processing residues may result in exposure to naturally occurring radioactive material. For the purposes of this Safety Report, a material is classified as a naturally occurring radioactive material if, in any process material, the activity concentration of any radionuclide in the  $^{238}\text{U}$  or  $^{232}\text{Th}$  chain exceeds 1 Bq/g or if the activity concentration of  $^{40}\text{K}$  exceeds 10 Bq/g.

Such activity concentrations imply that the requirements for planned exposure situations apply, as established in GSR Part 3 [1]. The activity concentrations in many commercially extracted minerals do not reach the threshold value listed above for designation as naturally occurring radioactive material; therefore, radiation risks related to those minerals tend to be relatively low, and also the likelihood of any radiation related emergency situation is low.

The management of facilities extracting or processing such minerals are encouraged to confirm with the appropriate regulatory body that there are no applicable regulations or that a regulatory notification of proposed operations may be applicable (perhaps for non-radiological reasons).

Such a discussion may elicit a finding (though unlikely) that there are protection and safety measures which have been shown to be prudent and reasonably feasible for the relevant mineral industry in that State. In any case, the management of the facility may prudently perform its own evaluation of the reasonable feasibility of taking actions that may reduce risk to employees.

In section 3.1 of Ref. [23], industry sectors are identified in a roughly prioritized order in describing the need for assessment regarding the presence of radioactive substances and the development of protection and safety measures for work regarding minerals and raw materials. The sectors (in addition to uranium ore extraction and processing) are as follows:

- Extraction of rare earth elements [25];
- Production and use of thorium and its compounds;
- Production of niobium and ferro-niobium;
- Mining of ores other than uranium ore;
- Production of oil and gas [18];
- Manufacture of titanium dioxide pigments [26];
- The phosphate industry [26];
- The zircon and zirconia industries [27];
- Production of tin, copper, aluminium, zinc, lead, and iron and steel;
- Combustion of coal;
- Water treatment.

Tables 1 and 3 in section 3 of Ref. [23] provide more information regarding the materials and types of operation that may be of most relevance regarding the development of protection and safety programme elements in the appropriate situations.

Regarding the exposure pathway related to radionuclides of natural origin, the management of the facility and/or the employer of the itinerant workers need to take advantage of the generic and/or facility specific assessments that have previously been performed regarding doses potentially arising from extraction and processing facilities similar to those relevant to the planned activities.

The applicable State regulatory body will already have performed an assessment prior to reaching a decision regarding which types of facility and activity are to be authorized, subject to notification processes, or determined not to warrant regulatory requirements.

The listing cited above from Ref. [23] is also a result of an assessment methodology to specify which extraction and processing activities are likely to warrant protection and safety measures. Section 5 of Ref. [23] includes a description of an assessment methodology to assist regulatory bodies in reaching decisions regarding appropriate regulatory controls.

That methodology can also be used by the facility management, the contractor and/or their qualified expert(s) to perform a prior radiological evaluation for the facility and the activities being planned.

In certain situations described in Ref. [23], measurements of radon concentrations in air or activity concentrations for uranium and/or thorium decay series radionuclides in process materials may be needed to complete the assessment. Appendix VI provides brief examples of assessing the potential for planned activities to result in occupational doses that are more than a small fraction of annual dose limits.

If use of the assessment methodology, adapted for use by the facility management, the contractor and/or their qualified expert(s), leads to the conclusion that protection and safety measures are not warranted and/or reasonably feasible, then the remainder of this section is unlikely to be of relevance.

If use of the adapted assessment methodology leads to the conclusion that additional consideration of protection and safety measures is warranted, then the remainder of this section may be of assistance in defining the appropriate protection and safety programme.

Once assessment of proposed practices suggests that protection and safety measures are warranted, several references may be consulted to guide the development of the appropriate programmes. A primary example is IAEA Safety Standards Series No. RS-G-1.6, Occupational Radiation Protection in the Mining and Processing of Raw Materials [17]. For specific information related to several

industries involving naturally occurring radioactive material, Refs [18, 25–27] may be helpful.

Even water treatment facilities may, on occasion, be found to warrant protection and safety controls owing to radon inflows from groundwater and/or the buildup of radionuclides of natural origin in treatment vessels, such as those containing ion exchange resins.

In addition, even where there is little or no enhancement of radionuclide activity concentrations, the processing of raw materials often involves dusty operations (such as crushing and screening of raw materials), and these operations can give rise to occupational exposures from inhalation of dust that may be found to warrant control for both radiological and non-radiological reasons.

Work carried out close to large stockpiles of raw materials may also give rise to external gamma (and, in exceptional cases, beta) exposures that may be significant enough to require control. Areas in which solid and liquid process materials or wastes are treated or stored may also need to be assessed for appropriate protection and safety control measures.

The management of the facility (and its employees) and the contractor (and its employees) will need to be aware of the radiation protection implications of the work and the techniques that may be used to maintain exposures at levels which are as low as reasonably achievable.

The guidance of other sections of this Safety Report remains applicable. Specific to the work planned for an area with radioactive materials of natural origin, the management of the facility and the contractor are to discuss the radiation protection aspects of the work during the planning stage, with the expected result being an effectively designed RPP.

Commensurate with the foreseen risks via evaluation of the planned work, the relevant topics for discussion may include:

- The implications of risks posed by sealed sources, X ray generating machines and/or unsealed sources that may be in use or used at the facility, on work assigned to the contractor not in possession of or using such sources;
- The risks posed by operations resulting in airborne dust and, thereby, dust contaminated surfaces;
- The risks posed by radioactive scales, sludges or sediments in various parts of the plant;
- The risks posed by large stockpiles of raw materials;
- The presence of controlled or supervised areas;
- The procedures to be followed to reduce exposure;



- The use of appropriate personal protective equipment;
- Supervision of the work at the work site;
- Dose assessment and the maintenance of dose records;
- Waste management;
- Training and assurance of fitness for work;
- Actions to take if ventilation, dust control or other relevant control systems fail or are taken out of service.

The use of one or more qualified experts may be prudent for those situations in which protection and safety measures may be warranted and either the facility management or the contractor has limited knowledge and experience in developing effective RPPs.

Two examples may be illustrative of protection and safety measures and practical considerations likely to be applicable for extraction and processing facilities involving radioactive materials of natural origin. The first example relates to the inhalation of airborne dust particles commonly found associated with some activities within the facilities. The prior evaluation of doses and the safety assessment may result in findings regarding means of dose assessment for the individual worker (in addition to findings regarding means of controlling dust generation).

The findings may be that: (i) air sampling is the best way of assessing doses due to inhalation of radioactive materials and providing information for use in the process of optimization of protection and safety; and (ii) attention is to be given to the characterization of the airborne dust for purposes of assessing doses.

Taking each of those two items separately, air sampling provides input regarding the activity concentrations in the dust, which, combined with measured exposure times and assumptions about breathing rates, allows for the calculation of the activity breathed in by the individual. Characterization of the dust enables reasonable assumptions to be made regarding both the deposition of inhaled radionuclides in the respiratory system and the solubility or removal rate of the radionuclides from the respiratory system.

The air sampling is likely to be performed using personal air samplers worn on the lapel or on protective headgear to provide representative sampling of the material actually breathed by the worker. (See Section 6.3 for more information on stationary air samplers and personal air samplers.)

The characterization of the material is likely to be performed using instrumentation, such as a cascade impactor, to estimate airborne particle size distribution or to measure the respirable fraction of the airborne particles, and radiometric or other measurement devices to specify the activity concentration per unit mass of dust.

A second example, describing a scenario for which protection and safety measures, developed in accordance with the process of optimization of protection and safety, are likely to be warranted at some facilities, is that of cleaning out or demolition and removal of selected plant equipment.

The processing of raw materials can often result in the enhancement of the natural radionuclide concentrations present, and the selective deposition of certain radionuclides in the pipes and vessels within the plant. This can result in the buildup of radioactive scale with radionuclide activity concentrations that can, in some situations, reach several hundreds or thousands of becquerels per gram.

The buildup of scale or the formation of sediment in pipes and vessels may give rise to dose rates of up to tens of microsieverts per hour close to external surfaces, and access to the interior of the plant and its components may result in even higher dose rates and the potential for exposure via inhalation and ingestion when the radioactive scale or sediment is disturbed.

It is common practice in the chemical and oil industries to use contractors for specialized jobs such as high pressure water jet cleaning of the interior of vessels, and the demolition and removal of redundant parts of the plant. There is, therefore, the possibility of itinerant workers in these situations receiving dose rates that, if sustained, could give rise to annual doses approaching or exceeding applicable dose limits. As the length of contract at any one site may be much less than one year, it is particularly important to keep track of these workers' doses across work sites and over multiple exposure periods. Responsibilities and arrangements for achieving this dose tracking need to be clearly established and recorded.

Extensive use is indeed made of contractors in extraction and processing facilities. Depending on the types of work performed by a contractor and on the diversity of work experience of that contractor, a contractor may or may not have the specialist knowledge and infrastructure to be able to develop and execute a protection and safety programme for its workers. When the magnitude of radiation risk is limited at facilities intending to make use of a contractor, the management of the facility may not possess a great deal of specialist knowledge and expertise related to protection and safety in the presence of radionuclides of natural origin.

At other extraction and processing facilities, where amounts of radioactive material are present in larger quantities or at higher activity concentrations, the facility management is to possess the knowledge and infrastructure for effective protection and safety programme development and execution. As stated previously, the primary responsibility for the protection of workers lies with the operating management of the organization responsible for the facilities and activities that give rise to radiation risks.

Within the industry of extracting and processing minerals, as relates to naturally occurring radioactive material, this will be the management of the facility. The contractor (employer of the itinerant workers) will then also bear certain responsibilities. On occasion, where the radiation risks at the facility itself are minimal, a contractor with substantial experience related to naturally occurring radioactive material may agree with the management of the facility to bear additional responsibilities, with the management of the facility also bearing certain responsibilities. The management of the facility and the contractor are to develop a contractual arrangement by which the allocation of responsibilities becomes clear.

The management of the facility may also need to discuss with the contractor the non-radiological risks that may be present in the facility or specifically at the work site, to ensure the development of mutually agreed techniques for the management of those risks in a coherent manner with the radiation risks. The management of the facility will need to collaborate with the contractor in performing a prior evaluation of doses and in developing mutually agreed local rules and procedures.

In view of the nature of the work and the precautions to be taken, the itinerant workers will need to receive appropriate training in the risks of radiation exposure, pathways of exposure, the procedures to be followed to control and monitor exposure, and the duties of the RPO. The management of the facility may agree contractually to arrange this training on behalf of the contractor.

The nature of the specialist tasks involving exposure of itinerant workers due to naturally occurring radioactive material with relatively high activity concentrations is such that there may be significant opportunities for dose reduction using the process for optimization of protection and safety; that is, it may be possible to achieve substantial reductions in projected doses with relatively simple modifications to the work plan.

An example may be in the use of engineered controls (design changes) to reduce the buildup of scales, sludges and sediments or to facilitate maintenance work for removal of accumulated contaminants. Changes in the local rules and procedures for that type of work may also be found to reduce doses with a reasonable allocation of resources. Contractors and the management of the facility need to be alert to the possibility that application of the requirements for optimization of protection and safety may require a high level of management attention for specialized tasks involving itinerant workers.

As with mining, there needs to be close coordination with the individual who is assigned responsibility for ventilation systems at the extraction and processing facility. The exposures of workers are affected by overall and localized ventilation flows and dust control measures.

The primary ventilation system is an engineered control which has as one objective the reduction or maintenance of radionuclide activity concentrations in the work environment. As a supplemental measure, temporary engineered controls such as portable or auxiliary ventilation may be applied in localized areas during some routine and non-routine (e.g. maintenance) operations.

Collaboration between the ventilation officer and the RPO is warranted especially regarding the development of training programmes related to ventilation and dust control, the use of any air purification systems, and the establishment of dust sampling and control programmes.

At industrial facilities involving radioactive materials of natural origin, the inhalation of airborne dust particles containing radionuclides in the  $^{238}\text{U}$  or  $^{232}\text{Th}$  decay series also results in the inhalation of a matrix of non-radiological elements and compounds. The overall matrix of materials determines the solubility of the particles, affecting the magnitude of assessed dose. Notably, metal bearing ores and mineral sands are often resistant to many forms of chemical attack, meaning that the solubility of the matrixes is generally low.

At extraction and processing facilities, air (dust) sampling often results in measurement of dust mass concentration for the purposes of the industrial hygiene programme. Calculation of the intake of radionuclides is assessed using the measured dust mass concentration and knowledge of an activity concentration per unit mass of the dust particles (often that of the material being processed, but otherwise requiring radiometric or other analyses of the dust).

This type of situation is a reminder that both radiological and non-radiological risks are to be considered, as the non-radiological risks, for example, as related to the inhalation of silica and other particles, can be important.

## 6.5. SUMMARY

The following statements are intended to summarize the information presented in this section and reiterate several key concepts described. They need to be interpreted within the context of the entire Safety Report and, specifically, Section 6:

- (1) Work at nuclear fuel cycle facilities may be characterized as having the potential to result in doses approaching dose constraints and/or limits, and, in some cases, the potential for incidents or occurrences that might lead to dose consequences for workers. This leads to such facilities also being characterized as warranting engineering controls backed up by detailed procedures used by trained and qualified personnel. Collaborative arrangements between the facility management and the contractor may

focus especially on the adequacy of the training of itinerant workers, the development of effective work plans and RWPs, effective supervisory oversight of work in controlled areas, definition of lessons learned from ongoing and completed work, and dose tracking at the facility and across multiple facilities at which the itinerant workers may be engaged.

- (2) Work by equipment engineers and by maintenance technicians at a health care facility requires collaboration between the management of the facility and the contractor. The previous training of the itinerant workers may have focused on technical training to support task performance. Collaborative discussions may need to focus on the facility specific protection and safety measures and on the agreements to ensure a continuity of protection and safety as equipment is moved from clinical service to maintenance and back. Dose tracking arrangements are also of importance for the itinerant workers at the facility and across the multiple facilities at which the itinerant workers may be engaged.
- (3) Health care professionals may provide their services at hospitals and clinics not operated by their employer. The previous training of these professionals may have focused on achieving the best medical results. Collaborative discussions between the facility management and the contractor may need to focus both on achieving optimized protection and safety for all occupationally exposed workers at the facility and also on individual monitoring arrangements, to enable effective dose tracking at each hospital or clinic and across the multiple hospitals or clinics at which the health care professionals may provide their services. The IAEA is developing a medical Safety Guide on radiation safety in medicine, which is expected to provide comprehensive guidance for health care professionals.
- (4) The management of a mining facility may or may not be a registrant or licensee, but may be operating a facility which gives rise to radiation risks. An important early step for mines is completing an assessment for the presence of radioactive materials (at above background levels) and an evaluation of the reasonable feasibility of enacting protection and safety measures at the mine. Agreements need to be reached via collaborative discussions between the mine's management and the contractor when such measures are to be developed and implemented. In some cases, the experience of the contractor, although not a registrant or licensee, may be substantial in terms of work in mines with moderately elevated levels of radionuclides. The lessons learned from that experience need to be used, where appropriate, in the RPP. Close coordination with the mine's ventilation officer is warranted, as is the coherent consideration of both radiological and non-radiological risks in the workplace.

- (5) A facility for the extraction or processing of raw materials may or may not be a registrant or licensee, but may be operating a facility which gives rise to radiation risks. Such facilities may use sealed sources in measurement and control devices, radiation sources or radiation generating devices for inspection of materials and equipment, or unsealed sources as tracers or in other activities; the protection and safety measures for such sources and devices are described in Section 6.2.1. An additional source of possible importance in extraction and processing facilities is radionuclides of natural origin. An important early step is completing an assessment for the presence of naturally occurring radioactive material (at above background levels) and an evaluation of the reasonable feasibility of enacting protection and safety measures at the facility. Agreements need to be reached via collaborative discussions between facility management and the contractor when such measures are to be developed and implemented. In some cases, the experience of the contractor, although not a registrant or licensee, may be substantial in terms of workplaces with moderately elevated levels of radionuclides. The lessons learned from that experience need to be used, where appropriate, in the RPP. Initiatives for optimization of protection and safety may be of particular importance in areas that are dusty or where accumulated sediments, scales and sludges may be disturbed. Close coordination with the facility's ventilation officer is warranted, as is the coherent consideration of both radiological and non-radiological risks in the workplace.

## **7. PERIODIC REVIEW OF ARRANGEMENTS FOR ITINERANT WORKERS**

### **7.1. GENERAL**

The arrangements and procedures drawn up and put in place by the management of the facility, in consultation with the employer of the itinerant workers, need to be reviewed, when appropriate, to ensure that they remain appropriate and relevant to the work.

If the same itinerant workers are at the facility for a protracted period of time, it is important that their working practices are reviewed at appropriate intervals (periodically) to assess the level of compliance with the arrangements and procedures, and to identify any opportunities for improvement in the arrangements or procedures.

Likewise, when new itinerant workers are shortly to commence work under an existing contractual arrangement or an arrangement with a different contractor for similar work, the previously used arrangements and procedures are to be discussed by the management of the facility and the applicable contractor, affording the (event driven) opportunity to review their continued validity.

The lead organization for initiating the collaborative review lies with the registrant, licensee or organization responsible for the source or practice that gives rise to radiation risks (or as mutually agreed if both the facility management and the applicable contractor are registrants or licensees). In carrying out these reviews, account ought to be taken of the following:

- Changes in the working environment;
- Legislative and regulatory changes and revised industry standards;
- Modifications to working practices and/or technologies;
- Level of adherence to the previously used arrangements and procedures;
- Practicability of the previously used arrangements and procedures for safe, effective and efficient work performance;
- Adequacy of contingency plans and emergency plans;
- Changes in the understanding of contributors to risk in the workplace and effective means to eliminate, mitigate and/or balance those risks;
- The effectiveness of the previously used arrangements and procedures in maintaining doses as low as reasonably achievable;
- The need for changes to the radiological evaluation, the safety assessment for the planned work and/or the level of interaction with the regulatory body.

For many of the items listed, there may be lessons learned to consider, resulting from recent operating experience at the facility or at other facilities at which related work is or had been performed; that is, the collaborative review need not only address the rationale for the original arrangements and procedures, but also additional and/or recent experience which may suggest warranted changes to the arrangements and procedures.

The point on maintenance of doses as low as reasonably achievable is critical for protection and safety; the effective optimization of protection and safety for itinerant workers (and any affected employees of the management of the facility) is a principal objective of the arrangements and procedures.

In assessing the adequacy of the arrangements and procedures, the registrant or licensee may, therefore, wish to review the available records of occupational exposures for the itinerant workers while they were at the facility (and any affected workers of the management of the facility), and satisfy itself that they are appropriate to the type of work being undertaken.

If the management of the facility is the registrant or licensee, this review ought to be carried out in consultation with the employer of those itinerant workers (especially when an existing contract continues to apply for future work tasks) and, potentially, with advice from a suitable qualified expert.

If the contractor is the registrant or licensee, this review ought to be carried out in consultation with the management of the facility and, potentially, with advice from a suitable qualified expert. In performing such a review, due care is to be exercised regarding the confidentiality of dosimetry data for individual workers.

The outcome of the review will likely be a series of actions to be taken to rectify, improve and/or enhance the arrangements and procedures. These actions are to be implemented as soon as reasonably practicable and, preferably, before itinerant workers next perform the assessed tasks at the facility.

It is important that the proposed assessment findings are communicated to the affected workers and their employer(s) for their input and for incorporation into any revised contractual agreements and/or local rules and procedures.

Facility managers and contractors also need to review their internal arrangements and procedures at regular intervals. The scope of such a review is dependent on whether the organization has a radiation source under its control. In any case, as employers, the facility manager and contractor are responsible for overseeing the occupational health and safety of their employees, and in the context of radiation protection, managing the doses received by their employees. Thus, they are to have procedures in place, commensurate with the exposures and potential exposures of their employees, for the ongoing review of the dosimetry results of their employees.

As employers, they are also to review their internal arrangements for the health surveillance of their employees and procedures for maintenance of their own equipment relevant to the contracted tasks. If they have radiation sources under their control, they are also to review their procedures and records of the location, description, activity and form of each source for which the organization is responsible.

Additionally, to supplement the collaborative review described above, the topics listed in Sections 3.2 and 5.3 are to be considered, as are the management system elements in place to ensure the quality of the RPP.

Relative to management systems, and specifically to the maintenance of an effective quality management system, the registrant or licensee is to consider the desirability of participation in an applicable organization such as the Information System on Occupational Exposure<sup>5</sup> (for nuclear power facilities)

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<sup>5</sup> <http://www.iso-e-network.net/>



or the Information System on Occupational Exposure in Medicine, Industry and Research<sup>6</sup>.

Such participation would be expected to facilitate a better understanding regarding doses and dose tracking at similar facilities, the related aspects of dose control, and the identification of potential areas for protection and safety programme refinements.

## 7.2. REVIEW OF COMPETENCE OF PERSONNEL

The contractor is responsible for ensuring that its employees individually and/or as a group remain competent to carry out assigned work at the facility, and, hence, needs to carry out periodic reviews of the competence of staff. These reviews will focus on the following areas:

- Required professional qualifications;
- Legislative or regulatory changes affecting means of job performance or revised industry standards affecting means of job performance;
- Lessons learned from experience at the facility and at other facilities, including those on the adequacy and effectiveness of training of the worker(s);
- The dose history of the worker(s);
- The need for regular refresher training.

As part of the evaluation of experience at the local facility, the job performance of the worker(s) is also to be assessed. The description of the obligations and duties of a worker, as provided in Section 3.1.2, may be helpful in performing that assessment.

Lessons from problems encountered, and actions taken to resolve difficulties, may lead to the identification of the need for further competence training for one or more workers. Such training may be related to specific technical aspects of task performance or to support of the protection and safety culture of the contractor–facility management team.

Specifically regarding periodic refresher training on protection and safety, the following topics are to be addressed:

- Protection and safety issues;
- Legal and regulatory matters;

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<sup>6</sup> <http://www-ns.iaea.org/tech-areas/communication-networks/orpnet/isemir.asp?s=1&l=1>

- Workers' concerns about protection and safety matters;
- Lessons learned from experience gained locally and around the world;
- Specific needs for training [14].

The refresher training is to be provided at a frequency appropriate to ensure continuing competence for safe and effective job performance and continued compliance with applicable regulations.

### 7.3. SUMMARY

The following statements are intended to summarize the information presented in this section and to reiterate several key concepts described, as well as to direct attention to appropriate subsections of the text. They need to be interpreted within the context of the entire Safety Report and, specifically, Section 7:

- (1) Periodic and event driven reviews of arrangements and procedures used for itinerant workers are to be performed, with the lead organization for initiation of the reviews being the registrant or licensee, but in collaboration with the other principal parties and any selected qualified expert(s). Topics to be considered in reviewing mutually agreed arrangements and procedures are described in Section 7.1. The outcomes of the reviews will likely be a series of actions to be taken to rectify, improve and/or enhance the collaborative arrangements and procedures.
- (2) Facility managers and contractors are also to review their internal arrangements and procedures at regular intervals. The scope of such a review is dependent on whether the organization has a radiation source under its control and will focus on the demonstrated capabilities to carry out the responsibilities assigned to that organization for protection and safety. Section 7.1 provides additional information relative to such a review.
- (3) The contractor is responsible for ensuring that its employees remain competent to carry out their assigned duties and is then to carry out periodic reviews of the competence of the itinerant workers. Topics to be considered are described in Section 7.2. The need for additional technical training or training on support of a protection and safety culture may be one result from such a review.
- (4) Refresher training on protection and safety is to be given to workers at a frequency appropriate to ensuring continuing competence for safe and effective job performance and continued compliance with applicable regulations.

## Appendix I

### CONSIDERATIONS IN DEVELOPING PROTECTION AND SAFETY SPECIFICATIONS IN CONTRACTS BETWEEN FACILITY MANAGEMENT AND AN EMPLOYER OF ITINERANT WORKER(S)

Recommended users: contracting representative of the facility, RPO of the facility, contractor's representative, contractor's RPO, and qualified experts in protection and safety requested to be present by the facility or contractor management.

Purpose of discussion: to ensure clarity of, and mutual agreement, regarding roles and responsibilities for operational radiation protection, given the tasks being contracted.

#### I.1. SITUATION: CONTRACTOR WITHOUT A SOURCE, PLANNING TO WORK IN SUPERVISED AND/OR CONTROLLED AREAS AT A FACILITY HAVING A SOURCE OR USING PRACTICES GIVING RISE TO RADIATION RISKS

##### I.1.1 General considerations

- Equivalent protection and safety is afforded to the permanent employees of the facility and the itinerant worker(s) employed by the contractor.
- The protection and safety programme is at least sufficient to ensure continuing compliance with applicable regulations.
- Primary responsibility for radiation protection and safety lies with the organization responsible for facilities and activities that give rise to radiation risks; employers are also responsible for the health and safety of their own workers.

##### I.1.2. Topics of discussion

- (a) General awareness training in radiation protection:
  - (i) Responsibility for providing (or ensuring the provision of) basic or general awareness training regarding radiation protection to the itinerant workers, with that training meeting the requirements at least of the State in which the facility is located and of any applicable industry training standards group.

- (ii) Deadline by which that training (initial or latest refresher training) is to be completed. The refresher training listed in items (a) and (b) would need to meet the retraining content and frequency requirements at least for the State in which the facility is located and those of any applicable industry training standards group.
  - (iii) Content of that training (e.g. equivalent to that of the permanent staff of the facility).
- (b) Specific task related training:
- (i) Responsibility for providing (or ensuring the provision of) specific task related training to the itinerant workers (and, if appropriate, providing documentation of qualification or certification by the relevant certification provider and/or regulatory body).
  - (ii) Deadline by which that training (initial or latest refresher training) is to be completed.
  - (iii) Content of that training. Task related training and/or facility specific training (see item (c)) is to include training on the safe management and security of high activity sources, if such sources will be present in the workplace when the itinerant workers will be there.
- (c) Facility specific training for the tasks to be performed in the facility workplace:
- (i) Responsibility for providing (or ensuring the provision of) facility specific training necessary for the tasks to be performed by the itinerant workers in the facility workplace.
  - (ii) Deadline by which that training (initial or latest refresher training) is to be completed.
  - (iii) Content of that training (e.g. equivalent to that of the permanent staff of the facility).
- (d) Respiratory protection:
- (i) If the itinerant workers may need to wear respiratory protection equipment, then:
    - Means of confirming the training of the itinerant workers on the wearing of respiratory protection equipment;
    - Means of confirming completion of fit testing of the itinerant workers for wearing respiratory protection equipment available (allowed) at the facility;
    - Means of confirming the medical fitness of the itinerant workers for respirator use.
- (e) Language:
- (i) For items (a)–(d) above, responsibility for any training of itinerant workers to occur in a language different from that common for facility personnel.

- (ii) For items (a)–(d) above, responsibility for testing of itinerant workers on their abilities to understand notifications and warnings in the language common for facility personnel.
- (f) Health surveillance:
  - (i) Responsibility for health surveillance and health services for the itinerant workers (equivalent to those for the permanent staff of the facility).
  - (ii) Deadline for itinerant workers to have been declared medically fit for the planned work in the planned time frame.
  - (iii) Responsibility for medical follow-up if an individual's accrued dose exceeds the dose limit applicable at the facility or if an individual receives a dose in an emergency of >200 mSv, >100 mSv in a month or at the request of the itinerant worker.
- (g) Establishment of dose constraints and/or allowable accumulated doses under the procedures of the facility operating organization; assessments of doses:
  - (i) Responsibility for establishment of dose constraints and/or allowable accumulated doses under the procedures of the facility operating organization (thresholds established to initiate additional approval processes for further exposure of the worker) to be applied to the itinerant workers, using the information from statement (g(ii)) below and other relevant information (including, where applicable, the dose limits of the State in which the employer of the itinerant worker is registered and/or in which the IRMD of the itinerant worker was issued); constraints and/or allowable accumulated doses are, generally, to be equivalent to those of permanent facility staff for similar work tasks.
  - (ii) Responsibility for assessing doses anticipated to be received as a result of performing the tasks assigned to the itinerant workers; responsibility for assessing doses which could be received while performing the tasks assigned to the itinerant workers.
- (h) Operational RPP:
  - (i) Responsibility for ensuring that the operational RPP is in compliance with the BSS [1], considering relevant information provided by the contractor (and/or its workers) about previous employment that may affect the development of the operational protection and safety programme for the itinerant (and/or other) workers. Examples to consider may include effectiveness of access controls, local rules and procedures, and personal protective equipment.

- (ii) Responsibility of the contractor (and/or its workers) in developing an effective work plan, coherent with the work management system of the facility.
  - (iii) Responsibility for supervision of protection and safety at the facility workplace: roles of contractor supervision and safety oversight roles of contractor and/or facility supervision.
  - (iv) Responsibilities for developing an appropriate emergency plan and implementing that plan when conditions so warrant.
- (i) Individual monitoring:
- (i) Responsibility for providing (or ensuring the provision of) suitable individual monitoring of external exposure of the itinerant workers, to include, where appropriate, an integrating personal dosimeter and operational dosimeter.
  - (ii) Responsibility for assessment of dose when appropriate from the results of workplace monitoring.
  - (iii) Frequency of processing of integrating personal dosimeters and/or developing dose assessments from workplace monitoring.
  - (iv) If itinerant workers wear two or more personal dosimeters, agreement on the process(es) to initiate investigation of differences between the results.
  - (v) Responsibility for providing (or ensuring the provision of), where appropriate, individual measurement of itinerant workers for intakes of radionuclides.
- (j) Occupational exposure record:
- (i) Responsibility for ensuring that the results of individual monitoring (e.g. personal alarming dosimeter and/or individual measurement) are timely and reliably placed into an individual worker's occupational exposure record and any appropriate centralized database of workers' dose records; responsibility for agreeing on the frequency of updating of any appropriate electronic database(s) of workers' dose records for situations in which the itinerant workers are exposed for discrete periods extending over days or weeks.
  - (ii) Responsibility for timely and reliably forwarding official (and, when applicable, operational) results, received for an individual worker after that worker leaves the facility for work elsewhere, to the relevant parties; responsibility for timely and reliable updating of individual and centralized records with those official results.
  - (iii) Acknowledgement of responsibilities of the relevant parties for reviewing available data, to ensure, for each worker, continuing compliance with the applicable regulatory limits and the undertaking

of appropriate investigations if established investigation thresholds or facility-specified allowable accumulated doses are reached.

## I.2. SITUATION: FACILITY WITHOUT A SOURCE, WITH A CONTRACTOR PLANNING WORK WHICH USES A SOURCE OR IS A PRACTICE GIVING RISE TO RADIATION RISKS AT THAT FACILITY

### I.2.1. General considerations

- Permanent employees of the facility are provided with protection and safety commensurate with the radiation risks due to the practices of the contractor.
- The protection and safety programme is at least sufficient to ensure continuing compliance with applicable regulations.
- Primary responsibility for radiation protection and safety lies with the organization responsible for facilities and activities that give rise to radiation risks; employers are also responsible for the health and safety of their own workers.

### I.2.2. Topics of discussion (as additions to those described in Section I.1)

The contractor is, in this situation, the registrant or licensee or organization undertaking a practice which gives rise to radiation risks. That means that the contractor bears primary responsibility for developing and executing an effective protection and safety programme. The management of the facility is an employer with responsibility to provide for the occupational health and safety of its employees. It will also wish to ensure that the contracted organization is capable of performing the assigned tasks safely, effectively and efficiently.

The descriptions of discussion topics below are numbered in the same way as those in Section I.1, and are written to provide information on additional responsibilities to be addressed for the situation when the contractor uses the radiation source; that is, the descriptions below need to be regarded as additions to (and not replacements for) the topics listed in Section I.1:

- (a) Responsibility for providing (or ensuring the provision of) basic or general awareness training regarding radiation protection to facility staff who are assigned to work in the controlled and/or supervised areas established by the contractor. The numbers of such personnel are likely to be small. The content of the training needs to be equivalent to that provided to the contractor personnel. (See also item (g).)

- (b) Responsibility for providing (or ensuring the provision of) specific task related training to the facility staff who are assigned to work in the controlled and/or supervised areas established by the contractor for the purpose of assisting the contractor personnel in completing their assigned tasks. The likelihood of having non-zero numbers of such personnel when a source of radiation is exposed need to be very small. The content of the training needs to be commensurate with the duties of facility staff and needs to include a higher level of training in radiation protection if warranted by the duties of the facility staff. (See also item (g).)
- (c) (No substantive addition.)
- (d) The items within topic (d) apply to facility staff only in the unlikely situation that facility staff would be called upon to wear respiratory protection equipment in assisting the contractor personnel in completing their assigned tasks. (See also item (g).)
- (e) Responsibility for ensuring that the itinerant workers receive training appropriate to, and are supplied equipment for, placing notifications and warnings at required locations in the language common for facility personnel.
- (f) Responsibility for health surveillance and health services for facility staff who are assigned to work in the controlled and/or supervised areas established by the contractor. The services need to be equivalent to those for the itinerant workers. (See also item (g).)
- (g) Permanent facility staff need to be treated as members of the public, in the absence of a mutual agreement between the contractor and the management of the facility that a selected subset of facility employees (i.e. those assigned to work in the controlled and/or supervised areas established by the contractor) are to be treated as occupationally exposed workers. This would be based on an assessment of doses anticipated to be accrued as a result of facility staff's assistance to the contractor in completing the tasks assigned to the contractor. Compliance with applicable regulations is to be ensured. Further, this situation is likely to require or warrant consultation with the regulatory body.
- (h) (No substantive addition.)
- (i) Responsibility for providing (or ensuring the provision of) suitable individual monitoring and/or individual measurement, where appropriate, of the facility staff who are assigned to work in the controlled and/or supervised areas established by the contractor. The monitoring needs to be equivalent to that for the itinerant workers. (See also item (g).)



- (j) Responsibility for ensuring that results of individual monitoring of external exposures and/or individual measurement are timely and reliably entered into the individual's occupational exposure record and any appropriate centralized database of workers' dose records, for facility staff who are assigned to work in the controlled and/or supervised areas established by the contractor. The other elements mentioned in item (j) of Section I.1 also apply, with the wording modified as appropriate to reflect facility staff as compared to itinerant workers. (See also item (g).)

## Appendix II

### INDIVIDUAL RADIOLOGICAL MONITORING DOCUMENT

#### II.1. OBJECTIVES

- (a) Facilitate record keeping for individual workers who are likely to work at more than one facility (within a State or in different States) in a period of 12 months;
- (b) Facilitate the communication of relevant information directly from the worker and indirectly from the employer of the worker and from the management of a facility at which the worker was engaged to the management of a facility at which the worker will next be performing job tasks (and to a subsequent employer of the worker, if applicable);
- (c) Facilitate the access to relevant information by the worker, their employer and the individual responsible for the worker's health surveillance, regarding status upon leaving a facility (or while still engaged at a facility), as updated information is entered into the IRMD;
- (d) Facilitate the access to relevant information by the applicable regulatory body (or bodies) providing oversight of the efforts of the worker, employer and any registrant or licensee to maintain compliance with applicable regulations;
- (e) Supplement effectively the centralized State network(s) or State dose register(s) established by the applicable regulatory body (or bodies) in providing means to evaluate the levels of protection afforded to workers;
- (f) Ensure effective record keeping of the temporal gap between the end of the worker's task, the near real time availability of dose results from 'operational' individual monitoring and the availability of dose results from 'official' individual monitoring;
- (g) Give due consideration to the confidentiality of medical and dose results information specific to a worker.

#### II.2. KEY CONCEPTS

- (a) The content of the IRMD is designed to meet the varying arrangements for communicating individual monitoring results, as established by the regulatory bodies of the States in which the workers may be engaged.

- (b) The content of the IRMD is designed to satisfy the informational needs of the management of the facility, the employer of the worker and the worker, in developing an effective protection and safety programme for the worker while engaged at the facility.
- (c) Flexibility is to exist to allow for communicating the relevant information via electronic, paper based or a hybrid of electronic and paper based media. (This flexibility may no longer be needed when all relevant systems become electronic.)
- (d) The IRMD is issued to an individual and remains their personal property. The IRMD may be handed to the employer or facility for dose recording and updating, but it has to be given back to the worker when the worker moves from facility to facility or from one employer to another. The IRMD is not transferable to any other worker.
- (e) The worker is to have (no more than) one IRMD, and that IRMD is to include a unique identification code for that worker.
- (f) The IRMD is to bear unique coding to identify the individual worker, the organization of the State (regulatory body or other approved authority) issuing the IRMD and the specific IRMD issued to that individual worker. The IRMD is also to include either a validity period (if limited) and/or stated restrictions regarding when and where the document may be used. Placement of a sequence number on the IRMD by the issuing authority is appropriate if an IRMD is being replaced by a successor document.
- (g) Radiological data are to be reported in the units recommended by the International Commission on Radiation Units and Measurements (ICRU) and/or the International Commission on Radiological Protection (ICRP). For those States that have not yet completed the transition to those units, data for domestic itinerant workers may temporarily be based on their current systems of units (pending a timely completion of the transition), but data applicable to workers from those (many) States using ICRU/ICRP units are to be reported in ICRU/ICRP units.
- (h) The process of entering data into the IRMD is to be timely and reliable, governed by a management system which ensures the quality and traceability of the data to the monitoring result or assessment from which the data came. Individuals entering data into the IRMD are to have received training in dosimetry and/or quality control appropriate to their work assignments.
- (i) Data on doses exceeding pre-established recording levels are to be entered into the IRMD. Those pre-established recording levels are to be at least low enough to both comply with the applicable State regulations and to enable tracking of accrued dose (for the applicable monitoring period, e.g. one month or from activities at a facility) exceeding a small fraction

(e.g. 5–10%) of the applicable annual dose limits for the occupationally exposed worker. If monitoring occurred but results did not reach the relevant recording level, the optimal occupational exposure record is to include a statement regarding that (i) there was no unrecorded result above the (stated) recording level and (ii) there was a measurement made. Values below the relevant recording level may then be shown, for example, by entering a zero (or ‘ND’) for the measurement result, with a statement in the record that a zero (or ‘ND’) entry implies a measurement was made but that any associated dose was below the stated recording level.

- (j) The IRMD is to be written in the language(s) of the issuing State and at least one common language (e.g. English). This is due to the numbers of itinerant workers crossing international boundaries for their job assignments.

### II.3. CONTENTS AT ISSUANCE

- (a) Information on the worker’s identity, sufficient to uniquely identify the worker.
- (b) Information on the health surveillance of the worker, sufficient to determine whether the worker is fit for the tasks(s) to be performed, whether there are health based restrictions on the worker’s job assignments, the date of the worker’s last health assessment, the period of validity of the health assessment as indicated by the provider, and the responsible provider of the worker’s health surveillance.
- (c) Information on the employment of the worker, particularly on the worker’s employer for contracted work to be undertaken at the workplace(s) of contracting management. The information is to be sufficient to uniquely identify the worker’s employer (contractor) from other employers and the most recent specific date that the worker began employment with that employer. (Generally, the employer requests issuance of the IRMD for the worker from an issuing authority in the State in which the employer has offices overseeing the initial contract relevant to the worker. Subsequent employers would request any updated IRMD from that same issuing authority.)
- (d) The results of the individual monitoring of the worker:
  - (i) The official dose record available for the current calendar year, and for the previous 12 month period, as applicable. This is to include total effective dose; in the event of non-uniform exposure, equivalent dose(s) to the specified part(s) of the body; and for internally deposited radionuclides, committed effective dose. Supplemental means of assessing doses may need to be used to complete the evaluations

of cumulative accrued doses as compared to rolling 12 month dose limits. This is especially true if the itinerant worker was engaged within the last 12 months in tasks at facilities where individual monitors are processed and records are updated less frequently than monthly.

- (ii) Information on the official dose record would be available (presuming the completion of the processing of the monitors) for those workers, to assist in assessing doses for a 12 month period.
- (iii) The official dose record for the past five calendar years (not including the current year), as the records permit (from the IRMD, dosimetry service provider(s) and/or appropriate centralized dose registries). For each of those years, this is to include total effective dose; in the event of non-uniform exposure, equivalent dose(s) to the specified part(s) of the body; and for internally deposited radionuclides, committed effective dose.
- (iv) Contact information about the dosimetry service providers or other organizations providing these official results is recommended to be included.
- (v) [Optional] Dates of individual measurement for internally deposited radionuclides, with a listing of radionuclides identified and reference to the measured activities of each of those radionuclides and/or the methods used to assess committed dose.
- (vi) [Optional] Information on the basic radiation protection training (initial and refresher) and any advanced radiation protection training taken by the worker, including the date of completion of each course. Reference to outlines of course content is recommended.

#### II.4. CONTENTS TO BE UPDATED (BY THE EMPLOYER) BEFORE THE START OF A WORKER'S ASSIGNMENT AT A FACILITY

- (a) Changes regarding the fitness or health surveillance of the worker (from item (b) in Section II.3). If a female worker declares that she is pregnant or that she is breast-feeding an infant, this status needs to be noted as well as any special work conditions.
- (b) Changes regarding the employment of the worker, such as information on a new employer. The last date of employment with the previous employer is also to be entered, or if that employment has not ended, the last date of exposure under the auspices of that employer is to be entered. (See item (c) in Section II.3.)

- (c) Changes regarding official results of individual monitoring received by the employer and/or worker since the date of issuance of the IRMD (from item (d) in Section II.3).
- (d) Information on the facility at which the contracted work is to be performed, sufficient to uniquely identify the facility.
- (e) [Optional] Information on any facility specific training taken by the worker, and the date of completion of that training.

#### II.5. CONTENT TO BE UPDATED AFTER (AND DURING, WHEN APPLICABLE) THE END OF AN ASSIGNMENT OF A WORKER AT A FACILITY (BY THE RESPONSIBLE PARTY PER THE CONTRACTUAL AGREEMENT BETWEEN THE MANAGEMENT OF THE FACILITY AND THE EMPLOYER OF THE WORKER)

- (a) The period of time (start date and end date) of individual monitoring (to cover the time period over which assigned work tasks occurred).
- (b) An estimate of total effective dose received by the worker from individual monitoring for the period of exposure (i.e. official and/or supplemental operational dosimetry and individual measurement, linked to dates of monitoring covered by each type of result); in the event of non-uniform exposure, equivalent dose(s) to the specified part(s) of the body; and for internally deposited radionuclides, committed effective dose or estimate of the intake(s).

#### II.6. LIMITATIONS AND CONSIDERATIONS

- (a) Not all States issue IRMDs or their equivalent. Also, there may be States which issue IRMDs with a content that differs in some aspects from the content as described in this appendix.
- (b) State regulations are established to meet the needs of that State and they apply within that State. Regulations and specific protection and safety programme practices may differ between States, even when the regulations are intended to be consistent with regional and/or global standards developed in part to eliminate or minimize such differences and/or their practical effects.
- (c) State regulations and regulatory guidance are not always developed sufficiently to minimize the questions that arise regarding the acknowledgement of (official and/or supplemental operational) occupational dose records from another State, the transfer of such records

from one State to another, and the interpretation of terminology used in those records transferred from one State to another.

- (d) A practical example related to the item above is the question of a regulatory body's full acceptance of dosimetry results provided by a dosimetry service provider which is approved to provide services in another State but which is not on the list of approved providers in the State represented by that regulatory body. (The matter may not be addressed at all in a State's regulations.) This question arises with more frequency in considering the cross-border acceptability of the results from operational dosimeters used to estimate doses to workers pending the results from the integrating personal dosimeters most frequently used for official records of dose. If the results from operational dosimeters (e.g. electronic personal alarming dosimeters) are used for official records of dose in the State in which the dose was accrued, that also leads to a question of means to determine the acceptability of results in some other States. (This example is discussed in Sections 3.2.6 and 3.2.8.)
- (e) In some States issuing IRMDs, there is a section within the IRMD which provides information that may assist undertakings in other States to interpret the conditions that apply to the individual worker possessing the IRMD and/or to interpret its contents as issued.
- (f) Periods of validity may differ from State to State regarding health surveillance requirements and/or refresher training requirements. For example, the State issuing the IRMD (or the health surveillance provider for the worker) may require a medical examination of the worker once every two years, but the State in which the contracted work is to occur (or the health surveillance provider for workers at that facility) may require such an examination every year. Such a variance is to be resolved as the contractual arrangements are finalized and before the worker begins their job assignment at that facility. A similar example may be a variance in the required frequency of retraining in the basics of radiation protection. (There may also be variances in the content of required health examinations; for example, in one State, an X ray of the chest may be required as part of the examination, while in another State, it is not required.)
- (g) An IRMD may be inadvertently lost or damaged. The process for handling such a situation has likely been developed by the State authority issuing the IRMD.
- (h) A practical example of the reason for establishing a unique identifying number for the worker is as follows: A discussion arose between a State regulatory body and a licensee as they evaluated data on the distribution of doses to individuals and, specifically, as they reviewed the number of workers wearing integrating personal dosimeters. The issue was resolved

when it was determined that one of the parties was not using an available means of uniquely identifying the workers and tracking their accumulated doses. Those workers included a set of twins, having the same birth date, the same first name, the same surname and the same home address. The difference was in their middle names and in the unique numbers given to the two individuals under the State's social security system.

- (i) Care is to be taken to ensure that no more than one IRMD is issued to a single individual. The appropriate level of attention is especially important in the case of itinerant workers, because they or their employers may inadvertently request the issuance of passbooks in more than one State or by more than one issuing authority within a State.
- (j) Inclusion of a picture of the worker who is being issued the IRMD is prudent.

## II.7. EXAMPLE TEMPLATE FOR AN INDIVIDUAL RADIOLOGICAL MONITORING DOCUMENT

Sample templates are provided in Tables 1–10. States may modify the format or the contents of the templates to meet their needs. They need, however, to consider the possibility that the usability of the IRMD may be diminished (or be non-existent) in other States if the content is modified in a way that reduces the quantity or quality of the data contained in the IRMD. Another example of a template in use among nations of the European Union may be found in Ref. [13], as described by the Heads of the European Radiological Protection Competent Authorities. Tables 11 and 12 in the example template are optional tables which may be useful to one or more principal or other parties. Such table(s) would likely be separate from the IRMD issued to a worker, but may be used as part of an associated record keeping system for detailed data regarding the occupational exposure of a worker.

*Text cont. on p. 121.*



TABLE 1. SAMPLE TEMPLATE REGARDING GENERAL INFORMATION ON THE WORKER AND THE EMPLOYER

---

General information on the worker

---

*Worker*

Surname<sup>a</sup> .....

First name<sup>b</sup> .....

Sex (male/female) .....

Date of birth .....

Nationality .....

Home address .....

Telephone number .....

Email address .....

Unique identification number of worker .....

*Worker's employer at date of issuance*

Name .....

Address .....

Telephone number .....

Email address .....

*Signatures*

Worker .....

Employer stamp and/or signature .....

---

<sup>a</sup> Addition of a worker's second surname may, in some cases, be appropriate, to assist in clearly identifying the worker.

<sup>b</sup> Addition of a worker's middle name may, in some cases, be appropriate, to assist in clearly identifying the worker.

TABLE 2. SAMPLE TEMPLATE REGARDING INFORMATION ON THE ISSUING STATE AND AUTHORITY

---

|  |       |
|--|-------|
| Information on the issuing State and authority   |       |
| <hr/>  |       |
| State (and assigned country code, if applicable)   | ..... |
| Unique number assigned to individual radiological monitoring document, including any sequence number | ..... |
| Date of issuance of the document   | ..... |
| Expiration date of the document (if applicable)  | ..... |
| Authority issuing the document   | ..... |
| Address  | ..... |
| Telephone number   | ..... |
| Other means to contact the issuing authority   | ..... |
| Commentary (optional) on when/where the document may be used   | ..... |

---

**Note:** The addition of a logo or other means of visibly showing official endorsement of the individual radiological monitoring document may be appropriate, for example, by using the top space in the right column.

TABLE 3. SAMPLE TEMPLATE REGARDING INFORMATION ON THE CURRENT EMPLOYER

| Current employer |   |                                |                              |   |
|------------------|---|--------------------------------|------------------------------|---|
| Employer's name  | Employer's address, telephone number(s) and other contact information | Worker's employment start date | Worker's employment end date | Unique identification number for the employer |
| .....            | .....   | .....                          | .....                        | .....   |
| .....            | .....   | .....                          | .....                        | .....   |
| .....            | .....   | .....                          | .....                        | .....   |
| .....            | .....   | .....                          | .....                        | .....   |
| .....            | .....   | .....                          | .....                        | .....   |

TABLE 4. SAMPLE TEMPLATE REGARDING HEALTH SURVEILLANCE

| Health surveillance |   |  |                               |   |
|---------------------|---|--|-------------------------------|---|
| Date of examination | Result of examination (fit/not fit/subject to specified restrictions) | Restrictions on work with ionizing radiation | Expiration date of the result | Validation stamp and/or identifying number of the medical practitioner or approved health service |
| .....               | .....   | .....  | .....                         | .....   |
| .....               | .....   | .....  | .....                         | .....   |
| .....               | .....   | .....  | .....                         | .....   |
| .....               | .....   | .....  | .....                         | .....   |
| .....               | .....   | .....  | .....                         | .....   |

**Note:** This table is set up primarily to include the results of the initial (likely, pre-employment) examination and/or the periodic examinations for review of the health of the worker. If a special examination is performed because an annual dose limit is exceeded or if substantial exposure occurs to the worker in an emergency situation, or if an examination is performed owing to illness of the worker or the termination of employment of the worker, then the reason for the examination needs to be included in the table.

TABLE 5. SAMPLE TEMPLATE REGARDING THE OFFICIAL DOSE RECORD FOR THE PAST FIVE CALENDAR YEARS

---

Official dose record for the past five calendar years (excluding the current calendar year)

---

| Year  | Effective dose (mSv) | Committed effective dose from internally deposited radionuclides (mSv) | For non-uniform exposures: Equivalent dose to specific body location (mSv and associated location on the body) [repeat column as necessary to cover all such doses/locations] | Supplemental information regarding the provider of the results |
|-------|----------------------|--|---|--|
| ..... | .....                | .....  | .....   | .....  |
| ..... | .....                | .....  | .....   | .....  |
| ..... | .....                | .....  | .....   | .....  |
| ..... | .....                | .....  | .....   | .....  |
| ..... | .....                | .....  | .....   | .....  |

---

TABLE 6. SAMPLE TEMPLATE REGARDING THE OFFICIAL DOSE RECORD FOR THE CURRENT CALENDAR YEAR

Official dose record for the current calendar year (and for a 12 month period, if applicable)

| Period covered by the dose result (ddmmyyyy–ddmmyyyy) | Effective dose (mSv) | Committed effective dose from internally deposited radionuclides (mSv) | For non-uniform exposures: Equivalent dose to a specific body location (mSv and associated location on the body) [repeat column as necessary to cover all such doses/locations] | Supplemental information regarding the provider of the results |
|---|----------------------|--|---|--|
| .....   | .....                | .....  | .....   | .....  |
| .....   | .....                | .....  | .....   | .....  |
| .....   | .....                | .....  | .....   | .....  |
| .....   | .....                | .....  | .....   | .....  |
| .....   | .....                | .....  | .....   | .....  |

**Note 1:** The information entered on doses needs to be clearly indicated as being the dose per monitoring period or the cumulative dose for the year. If the individual radiological monitoring document is to be used by the worker for more than one year (validity period > 1 year), then the individual radiological monitoring document needs to be formatted to allow for the entry of official and operational dose records for each year of the period of validity of the individual radiological monitoring document.

**Note 2:** Some States use individual dose limits that apply on a rolling 12 month period. In those States, processes have been established to ensure the availability of dose results to support evaluation of cumulative accrued doses as compared to those limits. For the domestic itinerant workers of those States, the data need to be readily available for those evaluations. For international itinerant workers, the data need to be readily available for the months in which the itinerant workers work at the facilities in those States that use the rolling 12 month dose limits (and for those months in which they recently worked in facilities using monthly processing of individual monitors). For international itinerant workers recently working in facilities using less frequent processing of individual monitors, supplemental means of assessing doses may need to be used to complete the evaluations of cumulative accrued doses as compared to rolling 12 month dose limits. For itinerant workers engaged at facilities using less frequent processing of individual monitors in the previous calendar year, official dose records would be available (presuming the completion of the processing of the monitors) to assist in assessing doses for a 12 month period.

TABLE 7. SAMPLE TEMPLATE REGARDING THE ESTIMATED DOSE FROM OPERATIONAL DOSIMETRY

| Estimated dose from operational dosimetry  |   |                      |  |   |  |
|--|---|----------------------|--|---|--|
| Name, address and unique identifying number of the facility in which the work was undertaken | Period covered by the dose result (ddmmyyyy–ddmmyyyy) | Effective dose (mSv) | Committed effective dose from internally deposited radionuclides (mSv) | For non-uniform exposures: Equivalent dose to a specific body location (mSv and associated location on the body) [repeat column as necessary to cover all such doses/locations] | Supplemental information regarding the provider of the results |
| .....  | .....   | .....                | .....  | .....   | .....  |
| .....  | .....   | .....                | .....  | .....   | .....  |
| .....  | .....   | .....                | .....  | .....   | .....  |
| .....  | .....   | .....                | .....  | .....   | .....  |
| .....  | .....   | .....                | .....  | .....   | .....  |

**Note 1:** The effective dose column is intended to be (total) effective dose (that is, the sum of the personal dose equivalent from external exposure to photons and beta particles, the personal dose equivalent from external exposure to neutrons, and the committed effective dose from internally deposited radionuclides). If any rows of the effective dose column in the table only contain results for monitoring of external dose to neutrons or to photons/beta particles, then footnotes need to be added to the table to ensure clarity.

**Note 2:** The information entered in the table is intended to be a chronological listing of dose accrued at a facility for the listed monitoring period at that facility. No summation of doses from separate monitoring periods at a single facility or across facilities is intended within the table.

TABLE 8. SAMPLE TEMPLATE REGARDING RESULTS OF INDIVIDUAL MEASUREMENT OF INTERNALLY DEPOSITED RADIONUCLIDES

| [Optional table regarding] Results of individual measurement of internally deposited radionuclides |                    |  |  |                                |  |  |
|--|--------------------|--|--|--------------------------------|--|--|
| Date of measurement (ddmmyyyy)   | Measurement method | Radionuclides identified (exceeding minimum detectable levels) | Committed equivalent dose to a specified organ or tissue (mSv) | Committed effective dose (mSv) | Supplemental information regarding the provider of the results |  |
| .....  | .....              | .....  | .....  | .....                          | .....  |  |
| .....  | .....              | .....  | .....  | .....                          | .....  |  |
| .....  | .....              | .....  | .....  | .....                          | .....  |  |
| .....  | .....              | .....  | .....  | .....                          | .....  |  |
| .....  | .....              | .....  | .....  | .....                          | .....  |  |

**Note 1:** The ‘measurement method’ would include terminology such as ‘body counter’, ‘urine’ and ‘faeces’. The assessment of dose by evaluation of the results of personal and/or workplace air sampling is also used in some cases.

**Note 2:** It is a relatively common practice at some facilities (such as those in the nuclear fuel cycle) to perform an individual measurement (perhaps by using a screening technique to ensure awareness of any substantial deposition of radionuclides in the body) before the individual begins work on the site and again when the individual leaves the facility upon completion of their assignment at that facility.



TABLE 9. SAMPLE TEMPLATE REGARDING BASIC TRAINING IN RADIATION PROTECTION

| [Optional table regarding] Basic training in radiation protection |                    |   |                               |  |  |  |
|---|--------------------|---|-------------------------------|--|--|--|
| Completion date<br>(ddmmyyyy)                                     | Number<br>of hours | Course title<br>(plus any descriptive comments) | Training company<br>or centre | Delegated<br>contact person or<br>the company/centre | Expiry date per training<br>company/centre<br>(ddmmyyyy) |  |
| .....   | .....              | .....   | .....                         | .....  | .....  |  |
| .....   | .....              | .....   | .....                         | .....  | .....  |  |
| .....   | .....              | .....   | .....                         | .....  | .....  |  |
| .....   | .....              | .....   | .....                         | .....  | .....  |  |
| .....   | .....              | .....   | .....                         | .....  | .....  |  |

TABLE 10. SAMPLE TEMPLATE REGARDING ADVANCED TRAINING IN RADIATION PROTECTION

---

[Optional table regarding] Training in radiation protection (exclusive of basic training)

---

| Completion date<br>(ddmmyyyy) | Number of hours | Course title<br>(plus any descriptive comments) | Training company or centre | Delegated contact person for the company/centre | Expiry date per training company/centre<br>(ddmmyyyy) |
|-------------------------------|-----------------|---|----------------------------|---|---|
| .....                         | .....           | .....   | .....                      | .....   | .....   |
| .....                         | .....           | .....   | .....                      | .....   | .....   |
| .....                         | .....           | .....   | .....                      | .....   | .....   |
| .....                         | .....           | .....   | .....                      | .....   | .....   |
| .....                         | .....           | .....   | .....                      | .....   | .....   |

---

**Note:** An example of the type of training that would be entered into this table would be a training course on wearing respiratory protection equipment.

TABLE 11. SAMPLE TEMPLATE REGARDING THE RESULTS OF DAILY PROCESSING OF DOSIMETERS OR MEASUREMENTS OF INTERNAL DEPOSITION OF RADIONUCLIDES

---

Measured or estimated dosimetry

---

Month: .....

Year: .....

Dose in past 12 months (mSv): .....

Dose in past 60 months (mSv): .....

Effective doses from daily processing or scheduled measurement (mSv):

| Date  | Site  | External | Internal |
|-------|-------|----------|----------|
| ..... | ..... | .....    | .....    |
| ..... | ..... | .....    | .....    |
| ..... | ..... | .....    | .....    |
| ..... | ..... | .....    | .....    |
| ..... | ..... | .....    | .....    |

Total effective dose (mSv): .....

---

TABLE 12. SAMPLE TEMPLATE REGARDING THE CONFIRMATION OF THE QUALIFICATION OF A WORKER TO UNDERTAKE A PLANNED WORK TASK

| Worker qualification confirmation |                                   |                           |                                       |                         |   |   |
|-----------------------------------|-----------------------------------|---------------------------|---------------------------------------|-------------------------|---|---|
| Nature                            | Certificate number, as applicable | Completion date (ddmmyyy) | Title (plus any descriptive comments) | Training company/centre | Delegated contact person for the company/centre | Expiry date per company/centre (ddmmyyyy) |
| .....                             | .....                             | .....                     | .....                                 | .....                   | .....   | .....                                     |
| .....                             | .....                             | .....                     | .....                                 | .....                   | .....   | .....                                     |
| .....                             | .....                             | .....                     | .....                                 | .....                   | .....   | .....                                     |
| .....                             | .....                             | .....                     | .....                                 | .....                   | .....   | .....                                     |
| .....                             | .....                             | .....                     | .....                                 | .....                   | .....   | .....                                     |

**Note:** Entries in the column headed 'Nature' would be terms such as 'industrial safety', 'quality assurance', 'safety culture', 'basic radiation worker training', 'plant access training (with facility specified)', 'industrial radiographer certification' and 'medical radiological technician certification'.

## Appendix III

### USE OF A CHECKLIST FOR ASSESSING PERFORMANCE OF CONTRACTED TASKS

*This information is for use by facility managers in respect of industrial radiography contractors who bring source(s) into their facility.*

Industrial radiography involves the inspection of components, for example, pipes, to determine whether cracks or other defects are present. The source of ionizing radiation will almost always be a sealed gamma radiation source or an X ray generating device. (A neutron source may, on occasion, be used.)

Strictly controlled procedures are required to ensure that the radiography does not result in unplanned exposures to the radiographers using the source(s) or to other persons at the facility.

An important part of these procedures is the positioning and maintenance of a barrier at a suitable distance from the radiation source. This is to ensure that no one other than the contractor's employees enters the 'controlled area' within the barrier and to facilitate control of exposures to individuals outside the barrier.

Another objective is to ensure that the contractor maintains full control over the source of ionizing radiation and that, for gamma or neutron radiography, the source is temporarily stored in a safe and secure manner, and is removed from the facility on completion of the work. Safe and secure storage of an X ray generating device is also warranted.

#### III.1. PRIOR TO THE COMMENCEMENT OF WORK

In order to fulfil the site operator's responsibilities, discussions are to be held with contractor personnel to ensure maintenance of the health and safety of the contractor employees and other persons at the facility. The following matters are to be discussed and relevant information exchanged.

First, it is to be confirmed whether the following information has been made available to the management of the facility:

- (a) Name and address of the contractor, and a 24 h telephone number at which the contractor can be reached (in case of an emergency). Confirmation of the contractor's regulatory authorization to do the type of work planned is also to be available.

- (b) Names of RPOs who will be at the facility and, if requested by the facility management, the name of the contractor's qualified expert. The functions of the RPO may be performed by a designated qualified industrial radiographer. If a properly qualified and designated RPO is not present at the facility, the work is not to be allowed to commence.
- (c) Type(s) of source(s) of ionizing radiation (e.g. X ray or gamma ray), activity or strength of the source(s), other relevant source ratings requested by the facility's management, and other requested equipment details.
- (d) Local rules and procedures to be used by the industrial radiographer(s) and assistant(s) for safe execution of the radiography, in compliance with applicable regulations. Agreements are to be available indicating that the contractor and the facility's management have determined that there is a clear and acceptable interface between the contractor's rules and procedures, and the work management system of the management of the facility. Agreement is to be reached on the means for the facility's management to request a halt to radiography operations, in order to address emerging situations at the facility. If adequate local rules and procedures are not available, the contractor is not to be allowed to undertake the radiography.
- (e) Where deemed necessary by the facility's management, the commitment of the contractor to communicate with the facility's operations control room prior to work execution, to ensure effective coordination of work activities in and near the radiography controlled area.

Second, it is to be confirmed that:

- (a) Appropriate notification of work, if any is required, has been or will be made by the authorized contractor to the regulatory body. This is applicable if the regulatory body has requested that notification occur on a case by case basis.
- (b) Barriers are being set at positions demarcating controlled areas where the dose rate is expected to equal pre-established dose rate reference levels consistent with regulatory requirements. Typical maximum permitted dose rates at the barriers, as specified by regulatory bodies, are in the range of 2.5–20  $\mu\text{Sv/h}$  [5]. The contractor and facility management are to determine whether that value includes the ambient background dose rate, consistent with any available regulatory guidance.
- (c) At least two suitable, calibrated dose rate monitors will be provided, one of which will be used after each exposure to confirm that the source of ionizing radiation has been made safe. If two operable monitors are not available, the work is not to be allowed to commence. (If multiple radioactive sources are to be in use, the minimum number of radiation

monitors is to be at least equal to the number of sources in use and, preferably, at least one per radiographer.)

- (d) At least one qualified industrial radiographer and either a second qualified industrial radiographer or a trained assistant radiographer will be carrying out the work. As stated previously, if the RPO is not present at the facility, a radiographer with adequate knowledge, training and experience is to have been designated by the contractor as the alternate RPO for the planned work.

Third, details are to be obtained of the working procedures that will be implemented in order to ensure safe work. In particular, the following is to be confirmed:

- (a) The approximate location and extent of the controlled area to be demarcated with barriers. Agreements regarding this controlled area are to be available to indicate acceptability to the facility management in regard to access restrictions for the period radiography operations are ongoing. Pre-job briefings are to include a description of the need for access restrictions for the period radiography operations are ongoing.
- (b) The type of barrier to be used and details of notices explaining the significance of the barriers and warning signs — it is to be confirmed that notices are placed at all probable points of access to the controlled area demarcated with barriers.
- (c) Warning signals to be used — clear and distinct signals are to be used when radiographic exposure is about to be made (usually an audible signal) and when radiation is being generated or a gamma source is exposed (often a visible warning). Agreements regarding the types of warnings are to be available, reflecting the results of discussions between the contractor and facility management, and indicating the actions to be taken to ensure that the warnings are clear to facility staff. If adequate measures to notify/warn staff about imminent or ongoing radiographic operations are not identified, the contractor is not to be allowed to commence (continue) the planned work.
- (d) Proposed means of giving the warnings and/or the locations of the above warnings, in particular that the warning throughout an exposure will be clearly visible at the following: (i) the position of the source of ionizing radiation within the radiography controlled area, to the satisfaction of the contractor RPO; (ii) the radiography control point, to the satisfaction of the contractor RPO; and (iii) all probable access points to the controlled area demarcated with barriers.

- (e) The controlled area demarcated with barriers is searched and unauthorized persons made to leave the radiography controlled area prior to the commencement of the work, and that the barrier will be kept under surveillance to prevent unauthorized persons from entering the area. Only the radiographer(s) and assistant(s), and RPO, where appropriate, are authorized to be within the radiography controlled area. Agreements between the contractor and the facility management regarding who patrols the radiography controlled area perimeter as a measure to prevent unauthorized entry into the controlled area are to be available.
- (f) Dose rates at barriers are checked during a test exposure (or at the first exposure) and whenever changes in the position of the source or localized shielding are made, such that exposure rates at the barrier may be changed. Barrier positions are to be altered, if necessary, to retain the pre-established (or lower) dose rate reference levels.
- (g) Checks are made by contractor staff of the radiography equipment to ensure usability as reasonably practicable. Testing of the radiation monitors for functionality is to be included in those checks. If issues of equipment operability are identified, the contractor is not to be allowed to commence work until replacement equipment is provided or repairs are made.
- (h) Facility operated radiation detection systems (e.g. some systems for smoke detection) expected to be affected during radiographic operations are taken out of service or alternative compensatory actions are taken by the facility management.
- (i) Integrating personal dosimeters are worn, in accordance with regulatory requirements, and agreements between the contractor and the facility management. Personal alarming dosimeters are useful as a supplement to passive dosimeters.

Fourth, it is to be confirmed that proposed source storage and transport arrangements/facilities are satisfactory:

- (a) Security of the source(s) of ionizing radiation and methods used to prevent unauthorized tampering with the equipment are to be confirmed. For X ray generating devices, keys are to be removed and/or the machine is to be otherwise safely disabled when not in use. Secured storage of the device is also warranted.



In the case of gamma radiography sources:

- (a) The source is to be kept securely, in accordance with regulatory requirements, in the contractor's vehicle or an agreed secure storage facility until the source is to be moved to the work location.
- (b) If the source is to remain at the facility overnight, a suitable secure, fireproof, dedicated source storage facility is to be provided. Agreement is to be reached between the contractor and the facility management regarding the arrangements for the control of the key(s) to the storage facility.
- (c) Transport of the source within the facility is to occur using paths agreed in discussion between the contractor and the facility management. The source is to be moved only in a locked exposure device with the keys removed, under constant surveillance by contractor and facility operating staff. Transport of radioactive materials into the facility and to another facility is outside the scope of this Safety Report; such transport is to be in compliance with the IAEA Regulations for the Safe Transport of Radioactive Material [28] or the equivalent applicable State regulations.

Fifth, it is to be confirmed, in writing, that arrangements have been made for actions to be implemented in the event of an accident, incident or occurrence (contingency or emergency plans). These details need to include a description of those circumstances that might reasonably be expected to lead to a possible incident condition.

The local rules and procedures are to include criteria, which, if met, are to result in the contractor's halting radiographic operations and ensuring that the source is put into a safe and secure configuration.

Equipment, instrumentation and diagnostic aids to implement the contingency or emergency plans are to be available on-site for use by the radiographers. Resumption of radiographic operations is not to occur unless the contractor and the facility management agree. (In some cases, the regulatory body may also need to concur with the resumption of radiographic operations.)

Notes:

- (1) The contractor is to have prepared local rules, and these need to cover the above points. A request for a copy of the relevant sections of the proposed local rules needs to satisfy the above matters. As noted previously, in the absence of adequate local rules, the contractor is not to be allowed to commence work at the facility.

- (2) Relevant employees and other persons, such as those who may be in the vicinity of the work (security staff, the work managers, other contractors at the facility, etc.), are to be informed of the radiographic operations and the precautions to be taken. These employees need to be instructed to comply with agreed arrangements and procedures for working safely. Work planned to take place in the immediate vicinity of the radiography controlled area is to be postponed until radiography has been completed. Alternatively, supplemental work management rules are to be put in place to ensure protection and safety of contractor and facility staff during the 'routine' radiographic operations and if an accident or incident were to occur.

### III.2. WHILE WORK IS IN PROGRESS

Safety checks are to be undertaken to ensure that the contractor's (and facility management's) employees are observing the agreed safe working practices. A suitable 'safety checklist' is shown in Table 13.

It is advisable that supplemental dose rate checks are made each time a gamma radiography operating session concludes. This can be done easily by comparing a measurement of the maximum dose rate close to the source container, made when it arrived at the facility, with another measurement — made in the same position — immediately before it leaves the work area and the facility. A significant difference between the two results might indicate that either:

- (a) The source has not been fully retracted to the safe position; or
- (b) The source has been lost and is still at the facility.

In either case, the contractor is to invoke its procedures and, as applicable, its emergency plans, to ensure that the source is placed in a safe and secure configuration while controlling exposures to its staff and the staff of the management of the facility. The facility's management will wish to be in close communication with the contractor personnel, to ensure that the potential for exposures to all personnel at the facility is being adequately assessed and managed.

### III.3. ALTERNATIVE RADIOGRAPHY LOCATION

The text in Sections III.1 and III.2 is written primarily for the case where radiography is performed on equipment in situ, that is, at its usual location in the

facility. In some cases, the equipment to be inspected may be moved by facility staff from its usual location to within a shielded enclosure within the facility.

While the enclosure may not have been designed with the intent of providing adequate shielding for control of exposures to personnel, the available shielding may meet the needs to ensure radiography operations can be performed safely. A related advantage to use of such a shielded space, if available, is to reduce the disruption to facility operations (and, potentially, to radiography) as radiography operations are prepared for and performed.

When use of an on-site space is proposed as a location for radiography, a key technical process is to use knowledge of the wall, floor and roof materials and thicknesses to determine whether the shielding is adequate for protection and safety purposes when the radiographer uses the originally planned source of radiation.

If the shielding is not adequate for that planned scenario, then (i) the shielding would need to be supplemented or (ii) the type and activity of the radiation source (or the type and strength of the X ray device) would need to be selected to enable radiography using the available shielding.

Given the practical difficulties of arranging for supplemental shielding, the choice of source adequate to perform the planned inspections safely within the available shielded enclosure is often important. If a radiation field adequate for high quality inspections cannot be ensured within the proposed enclosure, then use of the proposed enclosure may not be possible.

The text of Sections III.1 and III.2 of this appendix continues to apply when a shielded enclosure is to be used for radiography. Contractual and work planning questions that may also arise in discussions between the itinerant workers (or their employer) and the facility management are likely to focus on: (i) provision of adequate electrical services within and near the enclosure (to support lighting, radiation monitor operation, warning devices, etc.); and (ii) assurance of security regarding access to the radiography controlled area (e.g. keys to doors, presence and location of a security guard).

TABLE 13. SAMPLE TEMPLATE FOR A SAFETY CHECK OF SITE RADIOGRAPHY

---

Name of your company: \_\_\_\_\_ Address of site: \_\_\_\_\_

---

1. Contractor's name and address.....
2. Names of radiation protection officers on-site<sup>a</sup>.....
3. Name of contractor's qualified expert.....
4. (a) No. of contractors on-site.....  
(b) Are they all wearing dosimeters? YES/NO
5. (a) Are the local rules/emergency plans available? YES/NO<sup>b</sup>  
(b) Are the local rules/emergency plans acceptable? YES/NO<sup>b</sup>
6. If applicable, has the regulatory body been notified of the work? YES/NO
7. Source(s) of ionizing radiation; activity of each source.....
8. (a) Location of work.....  
(b) Number of exposures..... Planned..... Actual.....  
(c) Typical exposure time.....
9. Are two suitable operational dose rate monitors available? YES  
Is the necessary operable equipment available? YES/NO<sup>c</sup>
10. Source control confirmation (gamma radiography)

|  |  |
|--|--|
| <i>On arrival at site</i>                            | <i>On completion of work</i>                         |
| Maximum dose rate close to container..... $\mu$ Sv/h | Maximum dose rate close to container..... $\mu$ Sv/h |
| Are the two measurements similar? YES/NO             |  |

---

TABLE 13. SAMPLE TEMPLATE FOR A SAFETY CHECK OF SITE RADIOGRAPHY (cont.)

---

11. (a) Do all reasonable points of access to the radiography controlled area have a barrier, and is the barrier clearly visible? YES/NO

(b) Are the warning systems operating correctly? YES/NO<sup>d</sup>

*Note: test warning system before the start of radiography*

12. Confirm with the radiation protection officer the maximum dose rate at the barrier. The radiation protection officer needs to carry out (or have carried out) a test exposure and check (or have checked) the dose rate at the barriers before continuing with the work. Maximum dose rate at the barrier..... $\mu$ Sv/h

Signed.....

Date of safety check.....

Time safety check completed.....

---

<sup>a</sup> If a radiation protection officer is not present, do not allow work to proceed.

<sup>b</sup> If local rules are inadequate or are not available, do not allow work to proceed.

<sup>c</sup> If suitable radiation monitors and necessary operable equipment are not available, do not allow work to proceed.

<sup>d</sup> If the warning system is not operating correctly, do not allow work to proceed.

**Note:** Item 10 (and perhaps item 12) may need to be completed at a different time than the remainder of the items on the template. A separate safety check form is to be used in that situation, with the time of completion of item 10 (and/or item 12) annotated on the 'Time safety check completed' line. Any safety check items not assessed at the time item 10 (and/or item 12) is completed need to be annotated as 'N/A' (that is, not available) at the appropriate places on that safety check form.

**Caution:** When the source container or X ray generating machine has been moved into the radiography controlled area, the person undertaking the safety check is not to enter the radiography controlled area.

## **Appendix IV**

### **GENERAL AWARENESS TRAINING COURSE FOR ITINERANT WORKERS**

The main purpose of training is to provide essential knowledge, skills and attitudes for working with ionizing radiation. In order to become familiar with radiation risks, individuals who are occupationally exposed to ionizing radiation, or who may be exposed in the course of their work, need to receive adequate training in radiation protection.

This appendix gives an example of suitable course content for a general awareness course for itinerant workers. The content and, thereby, the duration of the training course may depend on the function of the itinerant worker, the likelihood and/or magnitude of the worker's radiation risks and the regulations of the applicable State (and the directives of any applicable industry training standards group).

Durations for basic health and safety coursework related to radiation may be in the range of 1–8 h or more. The instructors providing the training are to be knowledgeable about the topics they are presenting to the students. The organization providing the training may need to be authorized to do so by the applicable State regulatory body and by any applicable industry training standards group.

This basic training provides the foundation for additional training needed for some itinerant workers. Additional training would likely be required for the workers as they prepare for work assignments in specialized technical areas or in work locations with higher radiation (or non-radiation) risks — overall training needs are based on analyses of the competences required to perform specific tasks. See Section 4.4 for more information.

Retraining of individuals who continue as occupationally exposed workers is also prudent. The content and, thereby, the duration of the retraining course may depend on the function of the itinerant worker and on the likelihood and/or magnitude of the worker's radiation risk.

As for initial training, the content, duration and frequency of retraining may be specified by the applicable State regulatory body (and the directives of any applicable industry training standards group).

## IV.1. BASIC TRAINING

- Different types of radiation (alpha, beta, gamma, X ray, neutron) and sources of radiation.
- Radiological quantities and units.
- Radioactive decay.
- External and internal exposures; acute and chronic exposures.
- Effects on the human body (including risks of exposure of an embryo/fetus and breastfed children); stochastic and deterministic effects.
- Legal and regulatory requirements applicable to the employee:
  - Justification of the planned work;
  - Optimization of protection and safety;
  - Individual dose limits; dose constraints; action or investigation levels;
  - Fitness for work;
  - Certifications and qualifications.
- Specific rules for entering supervised and controlled areas, depending on:
  - Level of dose rates;
  - Level of contamination;
  - Radiation type (e.g. gamma or alpha).
- Equipment to measure radiation and contamination:
  - Individual monitoring equipment (e.g. passive dosimeter, active and/or direct reading dosimeter, measurement techniques for internal exposure); dose record systems;
  - Area monitoring equipment;
  - Contamination monitoring equipment.
- Protective (dose control) approaches:
  - Engineered control measures;
  - Work management; local rules and procedures;
  - Time, distance and shielding;
  - Source term reduction;
  - Personal protective equipment (e.g. protective clothing, respiratory protection systems);
  - Collective equipment (e.g. shielding, containment of sources);
  - Other systems (e.g. remote operated tools, decontamination).
- Behavioural approaches:
  - Individual behaviour;
  - Collective behaviour and safety culture;
  - Behaviour in case of emergency.

**Appendix V**

**INDIVIDUAL PROTECTION AND SAFETY RELATED ACCESS FORM  
FOR A NUCLEAR FACILITY**

TABLE 14. SAMPLE INDIVIDUAL ACCESS FORM

---

Worker's individual information

---

Surname .....  
First name .....  
Sex (male/female) .....  
Date of birth .....  
Nationality .....  
Home address .....  
Unique identification number of worker\* .....

---

Worker's employer

---

Name .....  
Address .....  
Telephone number .....  
Email address .....

---

Contract references

---

Contract owner .....  
Contract number .....

-----



TABLE 14. SAMPLE INDIVIDUAL ACCESS FORM (cont.)

---

Worker's professional information

---

*Work authorization*

Radiation protection .....  
 Safety .....  
 Quality .....

*Professional skills and certifications relevant to the contracted work*

.....  
 .....

*Health surveillance status*

Status of fitness for work  
 (fit, fit with restrictions or not fit) .....  
 Restrictions on work, if fit with restrictions .....  
 Fitness for work expiry date .....

---

Worker's dosimetry history as of ..... [insert date of worker's arrival]

---

Current (calendar) year .....  
 Previous 12 months .....

---

Previous 5 calendar years .....

Restrictions on controlled area access  
 due to dosimetry results or availability  
 of data on previous exposures .....

Restrictions on facility-specified  
 allowable dose due to dosimetry results  
 or contractual agreement .....

---

TABLE 14. SAMPLE INDIVIDUAL ACCESS FORM (cont.)

---

Authorized access

---

|                |                    |                  |
|----------------|--------------------|------------------|
| Area reference | From [insert date] | To [insert date] |
| .....          | .....              | .....            |
| .....          | .....              | .....            |

---

|           |        |          |  |                                     |
|-----------|--------|----------|--|-------------------------------------|
|           | Worker | Employer | Facility contract<br>and security<br>representatives | Facility<br>radiation<br>protection |
| Date      | .....  | .....    | .....  | .....                               |
| Signature | .....  | .....    | .....  | .....                               |

---

\* For example, a State identification number or social security system number for a domestic itinerant worker or a passport number for an international itinerant worker.

## Appendix VI

### ASSESSING POSSIBLE DOSES FROM EXPOSURE DUE TO NATURALLY OCCURRING RADIOACTIVE MATERIAL

*Note: The assessment process described in this appendix is based on information provided in Ref. [23], Assessing the Need for Radiation Protection Measures in Work Involving Minerals and Raw Materials, especially in sections 3 and 5, and in appendix III, regarding workers exposed to gamma radiation, and to radiation due to dust.*

The effective dose potentially received by an occupationally exposed worker owing to ambient gamma radiation fields and the inhalation of dust may be expected to be linearly proportional to the activity concentrations in the raw and processed materials of  $^{238}\text{U}$  and  $^{232}\text{Th}$  decay series radionuclides and/or the activity concentration of  $^{40}\text{K}$  in those materials.

In performing a prior radiological evaluation for planned work activities in extraction and processing facilities, it is then feasible to estimate occupational exposures given a level of knowledge about the characteristics of the materials to which the workers will be exposed.

There is also a dependence on the work situation, for example, regarding the number of hours over which a worker will be exposed to the materials on an annual or other relevant basis.

Once an estimated occupational dose is available, further attention to development of protection and safety measures may be given, on a prioritized or graded approach basis, to those scenarios for which doses are projected to be greater than a small fraction of the annual dose limits for an occupationally exposed worker.

Three generic circumstances of exposure may apply. They are as follows:

- (a) Large quantities of materials, such as those in large stockpiles or in ore bodies;
- (b) Small quantities of materials, such as mineral concentrates, scales and sludges;
- (c) Material that has been volatilized in a high temperature process — that is, furnace fume and precipitator dust.

The results of the process to estimate doses which may result from occupational exposure to gamma radiation and airborne dust, as a function of activity concentration in the relevant material, are summarized in Table 15, using rounded values for convenience.

TABLE 15. RELATIONSHIP BETWEEN PROJECTED ANNUAL DOSE AND ACTIVITY CONCENTRATION FOR OCCUPATIONAL EXPOSURE TO GAMMA RADIATION AND EXPOSURE TO RADIATION DUE TO AIRBORNE DUST [23]

| Category of material  | Example                           | Approximation of annual effective dose per unit activity concentration (mSv per Bq/g) |         |
|---|-----------------------------------|---|---------|
|   |                                   | Minimum   | Maximum |
| Large quantities of material  | Ore body, large stockpile         | 0.02  | 0.04    |
| Small quantities of material  | Mineral concentrate scale, sludge | 0.008   | 0.04    |
| Volatilized material with $^{210}\text{Pb}$ and $^{210}\text{Po}$ content | Furnace fume, precipitator dust   | 0.0006  | 0.003   |

**Note:** Activity concentration in the table above is to be interpreted as the highest activity concentration of the relevant individual radionuclides in the material concerned. For inhalation, dose calculations were performed using an inhalation rate for dust of 1 mg/h, an activity median aerodynamic diameter (AMAD) of 5  $\mu\text{m}$  and the slowest listed absorption class for the lung. For furnace dust, an AMAD of 1  $\mu\text{m}$  was used. (Using the highest applicable activity concentration and the assumptions used in this note suggests that the projected estimated annual dose is likely to be conservative compared to what might actually be measured using a monitoring programme developed for the facility as actually operated.)

Three examples may be illustrative of a means to use the information in Table 15 for selecting planned activities for which prioritized attention needs to be given towards developing reasonably feasible protection and safety measures. An example for each category of material, assuming the presence of  $^{238}\text{U}$  or  $^{232}\text{Th}$  series radionuclides, is given below:

- (a) A worker's job is projected to involve occasional presence near a large stockpile of raw material and frequent presence in a dusty atmosphere in the crushing and screening area at a facility processing a mineral with an activity concentration of 2 Bq/g. Exposure durations on the order of 400 h/a near the stockpile and 2000 h/a in a dusty atmosphere are assumed. Multiplying the 2 Bq/g activity concentration by the minimum (0.02 mSv per Bq/g) and maximum (0.4 mSv per Bq/g) dose factors in Table 15 for large quantities of material results in an estimated annual dose to the worker in the range of 0.04–0.8 mSv. Using the graded approach to developing protection and safety measures, the situation would not lead to prioritized investigation into the possibility of identifying a reasonably feasible protection measure.
- (b) A worker's job is projected to involve occasional presence near a small quantity of process scale and infrequent presence in a dusty atmosphere near that scale at a facility wherein the process scale has an activity concentration of 500 Bq/g. Exposure durations on the order of 400 h/a near the scale (external exposure) and 100 h/a in the dusty atmosphere are assumed. Multiplying the 500 Bq/g activity concentration by the minimum (0.008 mSv per Bq/g) and maximum (0.04 mSv per Bq/g) dose factors in Table 15 for small quantities of material, such as scale, results in an estimated annual dose to the worker in the range of 4–20 mSv. Using the graded approach to developing protection and safety measures, the situation would suggest that prioritized attention probably needs to be given to identifying protection measures to reduce the annual dose to a level which is as low as reasonably achievable.
- (c) A worker's job is projected to involve occasional presence in an area where furnace fume may be found and infrequent presence in the area where precipitator dust may be found, at a facility where  $^{210}\text{Pb}$  and  $^{210}\text{Po}$  with activity concentrations of 500 Bq/g may be measured in the furnace fume and precipitator dust. Exposure durations on the order of 600 h/a in the furnace area and 100 h/a in the precipitator area are assumed. Multiplying the 500 Bq/g activity concentration by the minimum (0.0006 mSv per Bq/g) and maximum (0.003 mSv per Bq/g) dose factors in Table 15 for volatilized material results in an estimated annual dose to the worker in the range of 0.3–1.5 mSv. Using the graded approach to developing protection and safety measures would not lead to prioritized investigation into the possibility of identifying a reasonably feasible protection measure.

As can be seen from the examples, the projected dose results are directly proportional to both the estimated activity concentration in the material to which the worker is exposed and also to the estimated duration of exposure in the relevant time period evaluated. In Ref. [23], typical activity concentrations are given for a wide variety of materials in extraction and processing.

Durations of exposure can be reasonably bounded by the number of hours the worker may be present in the relevant workplace within the facility in the relevant time period.

Usually, that number is less than 2000 h/a, especially given the time periods during the work day when the occupationally exposed worker is in office areas or in transit between workplaces, the availability of holiday and annual leave days, and so on.

In summary, for a planned activity for which reasonably projected annual doses are greater than the annual dose limit for a member of the general public (that is,  $>1$  mSv) or greater than a small fraction (e.g. 10%) of the annual dose limit (average of 20 mSv) for an occupationally exposed worker (therefore, for example,  $>2$  mSv), use of the graded approach and the requirements for optimization of protection and safety is likely to result in a finding that prioritized attention is to be given to the identification of reasonably feasible protection and safety measures for implementation, to reduce projected doses to levels which are as low as reasonably achievable.

The priority assigned would be lower for investigation of planned work activities to identify reasonably feasible protection measures when reasonably projected annual doses are less than 1–2 mSv. Confirmation of compliance with applicable regulations, perhaps via consultation with the applicable regulatory body, may be prudent to verify the adequacy of the prior radiological evaluation and approach planned for prioritization of further safety assessment regarding the planned work activities.

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