Radiation Monitoring Units: Planning and Operational Guidance

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This report from HPA Centre for Radiation, Chemical and Environmental Hazards reflects understanding and evaluation of the current scientific evidence as presented and referenced in this document.

EXECUTIVE SUMMARY

In the event of a radiation emergency, there may be a requirement to establish a Radiation Monitoring Unit (RMU) to undertake radiation monitoring of the public (population monitoring).

A RMU is used to determine levels of radioactive contamination in or on people and any subsequent requirement for decontamination. It will also inform decisions regarding the need for any medical interventions for persons contaminated with radioactive material.

This document is to aid emergency planners when producing specific plans for radiation monitoring units. It is provided in two distinct sections.

The first substantive section of the report (section 4) provides detailed information for emergency planners including information to inform the selection of suitable accommodation and equipment. A basic description of the process for people monitoring and data collection is also provided in this section since these may impact upon these early planning considerations.

The second substantive section of the report (section 5) focuses on the more detailed operational aspects of the RMU's lifecycle and begins with a structured discussion to aid decision regarding RMU activation. Preparation of a venue is discussed including layout of equipment at the venue, appropriate people flow and data capture systems. The section links to several appendices which contain systems of practices for key roles, data capture forms, pre-prepared information for the public, and guidance on specific monitoring techniques and monitoring strategies.

CONTENTS

1 INTRODUCTION

In the event of a radiation emergency, there may be a requirement to establish a Radiation Monitoring Unit (RMU) to undertake radiation monitoring of the public (population monitoring).

A Radiation Monitoring Unit (RMU) is used to determine levels of radioactive contamination in or on people and any subsequent requirement for decontamination. It will also inform decisions regarding the need for any medical interventions for persons contaminated with radioactive material. It should be noted here that radiation monitoring will not and can not detect if a person has been *exposed* to significant external radiation (although this document does introduce a methodology to help establish this), only if they are *contaminated* with radioactive material.

The purpose of this document is to aid emergency planners when producing plans for monitoring members of the public for radioactive contamination or assessing radiation exposure and to provide guidance on some operational aspects of this. When formulating RMU plans, this document should be considered in its entirety.

The document has two main sections. The first provides detailed information for emergency planners including information to inform the selection of suitable accommodation and equipment. The second focuses on the more detailed operational aspects of the RMU's lifecycle.

2 SCOPE

This document is intended to apply to any radiation emergency scenario where there is a need to undertake radiation monitoring of the public (population monitoring) and it is agreed by stakeholders that an RMU is the appropriate vehicle to perform this with. It is assumed that seriously injured persons would be dealt with either at hospital or the scene of an incident and would not attend the RMU.

It is intended that the basic principals of the document could be applied regardless of the supporting health or governmental structures.

This document does not cover radiation monitoring at the scene of an incident as this is the responsibility of other appropriate responders. Neither does it cover any clinical management of radiation induced symptoms or injuries.

This document can be used to plan for the establishment and operation of an RMU which may be required to monitor anywhere in the approximate range of 20 to 1,000 people per day.

3 GUIDANCE FOR DEVELOPING A LOCAL RMU PLAN

This section describes key steps to be taken and advice that may be considered when producing a local RMU plan. Planners must ensure that any RMU plan is commensurate with other plans derived for an area, including but not limited to; an off-site nuclear emergency plan (in place for any site subject to the REPPIR regulations), evacuee reception centre plans and mass evacuation plans.

3.1 Consultation with stakeholders

The following is a non-exhaustive list of organisations that planners may wish to consult with when producing their own RMU plan.

Health organisations

Local constabulary

Voluntary organisations

Water services supplier (for RMU venue)

Regulator for environmental issues

3.2 Accommodation for RMU

The NHS emergency planning guidance for radiation emergencies states that NHS emergency plans should clearly identify the potential locations of RMUs, the facilities to be provided and by whom they are to be provided. This guidance provides generic requirements considered to be necessary for the effective operation of an RMU. Local adaptation of these requirements may be necessary.

3.2.1 Location of RMU

The RMU should, where possible, be located at, or adjacent to, an evacuee reception centre established by the Local Authority which should itself be in a location which can be readily accessed by the relevant population and is not in an area subject to sheltering or evacuation. It may be necessary to identify several potential locations as an incident may preclude the use of a primary location.

An evacuee reception centre is a venue for receiving evacuees from an incident, providing food and temporary accommodation. An evacuee reception centre is the responsibility of the Local Authority and can be set up for a number of emergency scenarios. When identifying possible locations for an RMU,

consideration should be given to the transport of people to and from the RMU/ evacuee reception centre.

Evacuees should be monitored at the RMU and, if necessary, decontaminated, before entering the evacuee reception centre to avoid the potential for contaminating the evacuee reception centre.

The Local Authority should be consulted when selecting the RMU location as it is considered likely that they will be the providers of the venue.

A fire risk assessment of any potential venue must be carried out by a competent person. This is due to the change of use of the building. This assessment should identify fire precautions over and above existing precautions for the building[1].

Taking into consideration the requirements listed in this document, suggested buildings or establishments that could be used for an RMU may include:

- Sport centres.
- Schools.
- Warehouses.
- Village\community halls.
- Dedicated temporary structures (tented / inflatable)

The suitability of all prospective venues should be confirmed in advance.

3.2.2 Requirements of the facility

The following is an idealised list of attributes considered to be necessary for any RMU venue. Should a venue not meet all of these requirements, consideration should be given to how the suggested functions can otherwise be carried out.

- Be available to allow establishment of an RMU within a few hours of the requirement being identified or the activation of related plans (E.g. Off-site nuclear emergency plans)
- Have an area for people awaiting monitoring (indoor or outdoor under shelter).
- Have an area for external contamination measurements to be carried out.
- Have an area for internal contamination monitoring to be carried out.
- Have approximately 300 square meters of indoor space and approximately 300 square meters of outdoor space to be able to process approximately 1000 people per day.
- Have adequate and definable access and egress routes and points which can be controlled (for contamination control and in case of emergency evacuation) with separate entrance and exit.

- Have a segregated area to decontaminate people identified as contaminated (showers preferable), or an area where decontamination facilities can be rapidly created.
- Have a quiet area for recording and reporting information with communications equipment (ideally segregated from the monitoring and waiting areas of the RMU and with internet / telephone connectivity).
- Have a private area for counselling.
- Have adequate toilet facilities for staff and public. Separate toilets for pre and post monitoring.
- Have accommodations for people with disabilities.
- Have environmental control (against excessive heat or cold).
- Adequate number of landlines and mobile phone network coverage to allow both the public and staff to communicate.
- Have adequate mains sockets (several).
- Have storage for replacement clothing.
- Have storage for contaminated clothing and other contaminated items.
- Have staff welfare facilities.
- Have adequate power supply (power sockets in all rooms or provision to provide).

3.2.3 Venue layout

Figure 1 shows an idealised schematic of a building where an RMU could be established, note the building size shown is the minimum necessary for processing 1000 people.

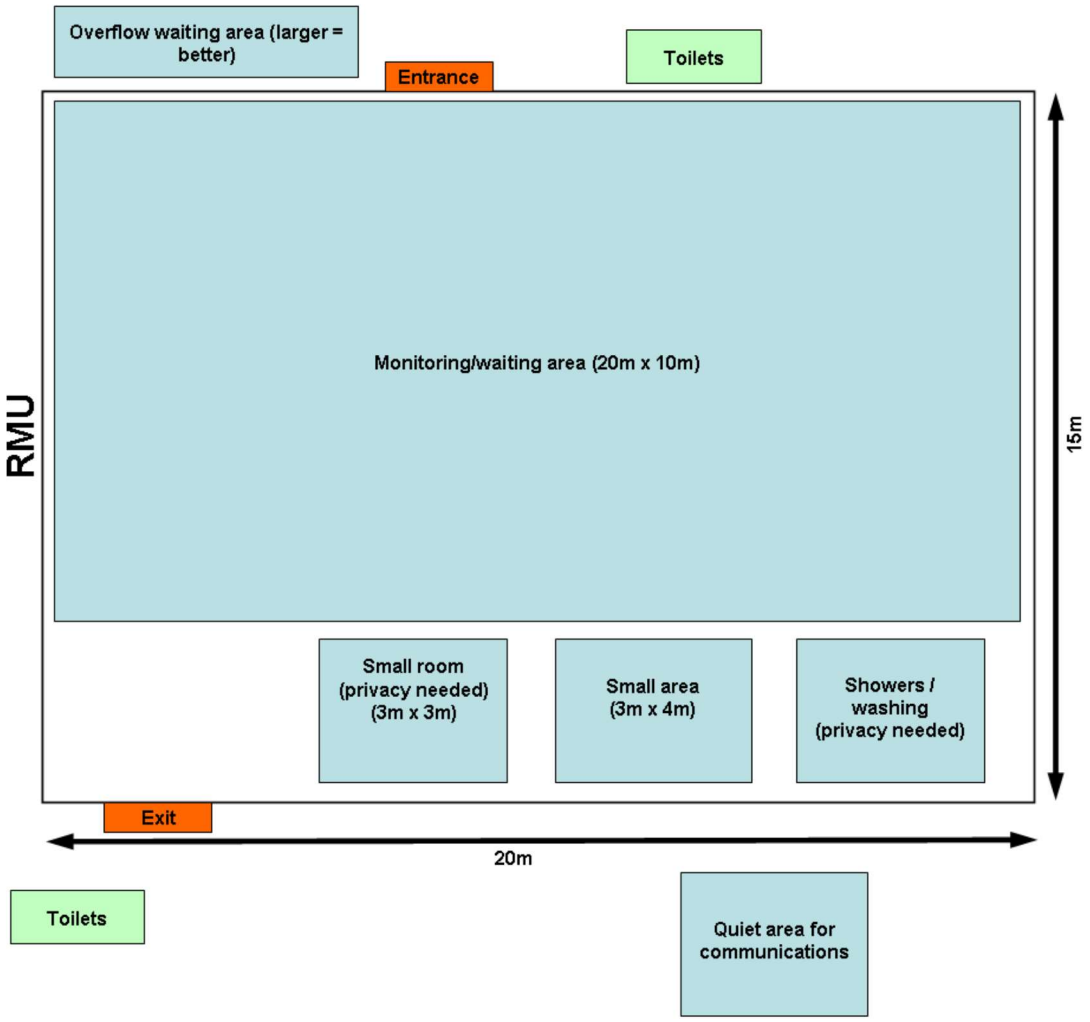


Figure 1. An idealised venue in which to locate an RMU.

3.3 Equipment

This section provides lists of suggested equipment necessary for the operation of an RMU. Consideration should be given to amount of equipment required relative to the numbers of people who may be required to go through the RMU for various scenarios. In addition to identifying stocks of this equipment considerations should also be given to methods of re-supply. In the course of writing a plan an assessment should be made of what equipment is already available to aid in RMU setup.

3.3.1 Equipment for controlling movement of people

- Warning signs (See Appendix A).
- Direction signs (See appendix A).
- Barrier tape.

- Barriers.
- Boards on which information/instructions can be displayed.

3.3.2 PPE for RMU staff

The body responsible for planning to establish an RMU should consider the following list of Personal Protective Equipment (PPE) in consultation with their appointed Radiation Protection Adviser (RPA).

It must be stressed that the following may not be necessary for all radiation scenarios:

- Respiratory protective equipment (must be suitable and fit tested).
- Disposable coveralls.
- Disposable laboratory gloves (nitrile are recommended in large, medium and small).
- Alarming personal dosimeter (measuring instantaneous dose rate as well as cumulative dose).
- Personal dosimeter (film badge or thermoluminescent dosimeter (TLD)).
- High visibility clothing.
- Overshoes.
- Hair cover (if not part of coverall).

3.3.3 Materials to prevent the spread of contamination

To prevent contamination of equipment, the venue and cross contamination of those being monitored the following coverings for articles, equipment and surfaces are suggested:

- 'Tacky' mats (disposable mats with an adhesive surface that removes contamination from the soles of shoes).
- Small and large polythene bags.
- Temporary coverings e.g. Polythene sheeting, kraft paper, wall paper.
- Vinyl sealing tape.

3.3.4 Monitoring equipment

This is the suggested equipment that could be used for detecting radiation and hence, the presence of radioactive material (see appendix T). Much of this equipment is specialist and needs care in its use and maintenance. Radiation monitoring instruments are to be provided by the attending RMU scientific staff.

It is recognised that not all of this equipment will be either available or needed. This is an ideal instrument list only:

- Portal monitors.
- Portable gamma spectrometry equipment.
- Gamma dose rate monitoring equipment.
- Personal alarming dosimeters (these should be capable of measuring instantaneous dose rate as well as cumulative dose).
- Alpha and Beta surface contamination monitors. Instruments capable of detecting both alpha and beta contamination could be used, but must be able to distinguish between alpha and beta contamination.
- X-ray and low energy gamma contamination monitors (NaI type instruments).
- Replacement batteries or charging units for rechargeable batteries used in monitoring equipment.
- Mains power extension leads.
- Equipment to take wipe samples and nose blow samples.
- Tissues.
- Plastic bags.
- Plastic bags to cover monitors (alpha contamination monitors must not be covered).
- Equipment necessary for the maintenance of instrumentation.
- '24 hr' urine sample collection bottles.

3.3.5 Decontamination equipment

To aid the removal of radioactive material, the following equipment is suggested:

- Moist towels or disposable wipes.
- Paper towels.
- Large plastic bags (a variety of sizes to hold clothing).
- Zipper-type bags for small personal items.
- Nylon tie wraps for closing bags.
- Adhesive labels.
- Soap (mild).
- Shampoo, including baby shampoo (no conditioner).

- Plastic sponges.
- Soft nail brushes.
- Towels.
- Replacement clothing of all sizes.
- Blankets or heaters for warmth. (Note: Heaters should not blow air across a potentially contaminated area.)
- Plastic shower caps.

3.3.6 Record forms

To capture appropriate data and to ensure identification of people within the RMU the following forms and equipment are suggested:

- Registration (see appendix B).
- External contamination survey report (see appendix B).
- Internal contamination report (see appendices C and D).
- Summary of actions and recommendations (see appendix E).
- Wrist band identifiers (if possible).
- Barcode generators and readers for labelling people and forms (if possible).

3.3.7 Stationary

General stationary as listed below will be required for day to day running of the RMU. Logbooks are recommended for recording decisions and actions and requests as in any part of an incident response.

- Notebooks.
- Pens and pencils.
- Marker pens.
- Sticky labels.
- Information/instruction leaflets.
- Logbooks.
- Calculators.

3.3.8 Communication

For effective command and control, communication with the coordinators of the incident response is essential. The following are suggested to ensure reliable communications:

- Mobile phones, landline telephone and facsimile machine, where these are not available: Satellite data terminal + 100m of cable (where possible).
- Computers (laptops) and internet connectivity for remote access data transfer (any computers or data storage devices must be encrypted).
- A reliable means of 2-way communication with the strategic \ tactical control centres.
- Photocopier or scanner.
- A loudhailer / PA system.

3.4 Staffing

There are several key roles within an RMU that should be filled with trained staff, some of whom must have specialist knowledge. A brief description of these roles is given below. Further detail of the suggested roles within the RMU is given in Section 4.4.

3.4.1 RMU manager (Senior Medical Physicist)

The RMU manager has devolved responsibility from the to manage the RMU.

3.4.2 Deputy RMU manager

The deputy RMU manager is responsible for supporting the RMU manager in discharging their responsibilities.

3.4.3 Radiation Protection Adviser (RPA)

A suitable RPA to provide advice to the RMU manager. The RMU manager may themselves be an RPA. In the event that an RPA is not available to attend the RMU a suitably experienced person (e.g. experienced medical physicist with suitable knowledge of contamination control) may be appointed to fulfil the RPA's functions. Arrangements for access to appropriate RPA advice over the phone should be made in this case.

3.4.4 Radiation Protection Supervisor (RPS)

One or more members of staff will have responsibilities for the supervision of operational radiation protection measures within specific areas of the RMU under the guidance of the RPA. RPS duties will be additional duties for a selected staff member rather than an individual role.

3.4.5 Personal monitoring team leaders

There may be a number of personal monitoring team leaders working under the direction of the RMU manager.

These may include:

- Portal monitoring team
- Handheld monitoring team
- Internal contamination monitoring team

Team leaders may also be appointed as radiation protection supervisors for an area. The personal monitoring team leaders have responsibility for implementing parts of the monitoring strategy as directed by the RMU manager.

3.4.6 Monitoring staff

These staff will be responsible for performing monitoring tasks as required. This can involve handheld equipment or portal monitors or whole body monitors.

3.4.7 Medical practitioner

During the planning stage consideration should be given to the deployment of a medical practitioner to the RMU. A clinician may be considered if a need for METREPOL (Medical Treatment Protocols for Radiation Accident) is identified during RMU activation (see appendices G and J).

District/community nursing support may be considered as a possible alternative/supplement to a GP in case a GP is not available. Clinical staff attending must be able to cope with any (reasonably) likely medical incident and also be able to prescribe emergency drugs including insulin.

3.4.8 Receiving staff

These staff will be responsible for marshalling the public at the entrance to the RMU and ensuring they move to the appropriate place for monitoring. These staff will also give out information sheets if instructed (such as those in the appendices) to people whilst queuing and answer basic questions as appropriate.

3.4.9 Decontamination staff

These staff will be responsible for the removal of contamination from people at the RMU in accordance with the guidance detailed in section 4.5. The decontamination team may need to perform their own handheld monitoring to evaluate the success of any decontamination carried out.

3.4.10 Registry staff

These staff will be responsible for the collection of personal information as required. Staff must be computer literate as database entry may be required. These staff should be trained in or have guidance provided on Caldicott requirements[2]. They should also have good keyboard skills.

3.4.11 Public liaison staff

At the discretion of the RMU manager suitable staff may need to be allocated to provide support to members of the public.

3.4.12 Security staff

Arrangements should be made with the local constabulary in the planning stage to have a police presence at the RMU.

3.5 Staff numbers

Table 1. shows estimated staffing numbers for an RMU with a throughput of 20, 500 or 1000 people per day and do not include staffing for breaks or shift changes. These numbers are based upon experience from exercises.

		Number of people expected for monitoring /day		
		20 people	500 people	1000 people
Standard roles for all RMUs	Generic Roles	RMU manager (1) Registry staff (1)	RMU manager (1) Deputy RMU manager (1) Security staff (1) Receiving staff (2) Registry staff (4) Public liaison staff (1)	RMU manager (1) Deputy RMU manager (1) security staff(2) Receiving staff (3) Registry staff (6) Public liaison staff (2)
	Decontamination Staff	(2)	(3)	(5)
	Internal monitoring		Internal monitoring 1 team (2 people)	Internal monitoring 2 teams (4 people)
	RPA	(1)	(1)	(1)
	and			
Either of	Portal monitoring	1 team (2 people per team)	3 teams (2 people per team – 6 total)	4 teams (2 people per team – 8 total)
	or			
	Handheld monitoring	1 team (2 people per team)	6 teams (2 people per team - 12 total)	8 teams (2 people per team - 16 total)

Table 1. An estimate of staff numbers required for the operation of an RMU with varying monitoring capacities. (One shift only, staffing for breaks is not included. Note that portal monitoring and handheld monitoring staffing are exclusive. These staff numbers are a best estimate only.)

3.6 Methods of measurement

Where the incident has released radionuclides which would be difficult to detect via their photon emissions, then it is likely that only external contamination monitoring with hand-held detectors will be effective (depending on radionuclide). If the release contains radionuclides with associated photon emissions of energies greater than 200 keV then portal monitors can be used and internal contamination can also be quantified at the RMU. Monitoring at the RMU may identify people who need additional measurements which need to be carried out in laboratories. For some radionuclides bioassay samples (likely to be urine) will be needed; and some sampling could be initiated at the RMU (Blood samples are generally unlikely to be collected at an RMU).

In the event that the number of potentially contaminated people greatly exceeds the monitoring resource available, then the monitoring approach must be adapted to screen for people who are most contaminated first. Faster monitoring times, with consequential loss in monitoring sensitivity, and the setting of higher action level values should be considered.

Preferred monitoring methods for particular radionuclides can be found in appendix F.

3.6.1 Monitoring of external contamination levels on people

This type of monitoring is carried out using either walk-through portals or handheld equipment.

Results will enable decisions to be made on the need for external decontamination of people. Monitoring will enable people who could potentially have contamination levels high enough to cause early health effects to be identified quickly and directed for medical assessment. Results would also be used to prioritise people for internal contamination monitoring. The rapid initial screening will enable decisions to be made on which type of further monitoring, if any, would have to be carried out. This would be led by the use of action levels (see section 4.3.1).

3.6.2 Monitoring of internal contamination levels in people

This type of monitoring is carried out using: portable, transportable or handheld equipment.

Internal monitoring will usually follow for anyone identified as being externally contaminated, or for individuals identified as being at risk due to their proximity to an incident involving airborne radionuclides. It looks mainly for radioactive material in the lungs and the thyroid gland (in the case of radio-iodines). It will often be performed with more specialised equipment such as a portable Whole Body Monitor (pWBM) or with a transportable Whole Body Monitor (tWBM) such as that held by the HPA. Simpler handheld equipment may also be employed but it is likely to be less sensitive.

Internal monitoring will enable people who may have internal contamination levels high enough to cause early health effects, to be identified quickly and referred for medical assessment. This would be led by the use of action levels (see section 4.3.1).

3.6.3 Screening for Acute Radiation Syndromes (ARS)

Whilst not strictly monitoring, since the process involves objective assessments, questioning and possibly the taking of samples, this process may be followed for exceptional scenarios where people may have potentially received radiation doses high enough to induce ARS, with or without being contaminated with radioactive material.

If it is identified during the decision to activate the RMU (appendix J), screening for ARS can be carried out using the method described in appendix G. Screening should take place post contamination monitoring and if necessary post decontamination to avoid spreading any contamination and to reduce the period of exposure.

3.7 Collection of information

Records should be kept of all who are monitored, both those found to be contaminated and those found not to be.

These records may be used to contact people who require short-term medical follow up, or for purposes of long-term health monitoring. Occupationally exposed individuals should also be included.

As soon as a person enters the RMU they must become identifiable. This can be accomplished by various routes. It is recommended that each person is given a unique subject code either in the form of a number on a card or preferably via a barcoded tag. A copy of the subject code must be transferred to each form used in the monitoring / decontamination process. This will be used to tie monitoring results to personal details later on.

Collection of full personal details (registration) should come directly after the monitoring and decontamination functions of the RMU. This reduces contamination issues. It may take place within the RMU itself or within the reception centre (see figure 2). Note that detailed information collection may be carried out within the reception centre.

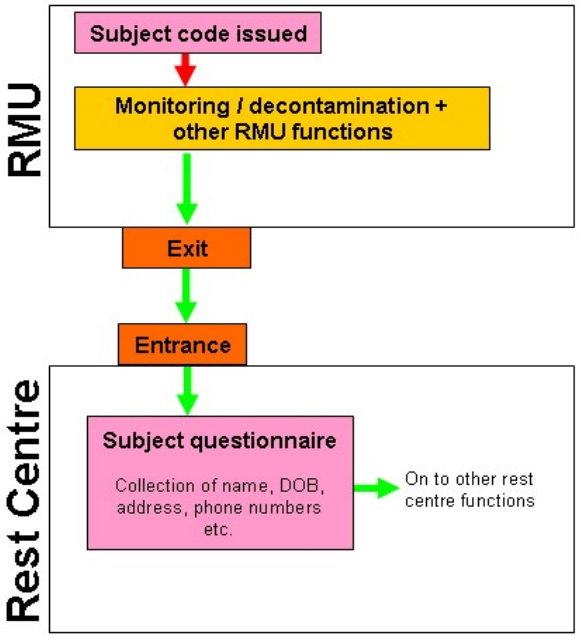


Figure 2. The flow of people from the RMU to the Reception Centre.

3.7.1 Barcoding

Barcoded patient wrist bands are an excellent means of identifying individuals presenting at an RMU for measurement. The barcode or unique number should be transferred to each form containing information referring to that individual, preferably, the wrist band will have several peel-off adhesive copies of the barcode.

These are pre-printed and plastic laminated and as such are tear resistant and impervious to liquids. A limited supply of suitable barcoded wrist bands may be provided by HPA. Planners may wish to contact HPA CRCE for advice on sourcing wristbands compatible with HPA data acquisition systems.

3.8 Data collection

There are two levels of data collection necessary which correspond to two groups of people:

1. Those with contamination below any action level.
2. Those with contamination above any action level and/or those screened for Acute Radiation Syndrome.

Group 1. Minimum basic personal information should be gathered including full-name, date of birth and postcode along with the null monitoring result. See forms in Appendix B.

Group 2. Collection of further information as detailed on the relevant forms (full address, location during incident etc.) to allow ease of medical follow up and estimation of dose. See forms in Appendix B-E.

3.8.1 Registration / result forms

It is strongly recommended that forms in appendices of this document should be used to ensure national consistency in data collection.

3.9 Reporting of information

The RMU manager should be the conduit of all data from the RMU to other stakeholders who have a legitimate requirement for the data. Timely and accurate information is required for both the individuals who have been monitored and for those directing the response to an incident. They have very different requirements and thought must be given to the processes involved before an RMU is set up.

3.9.1 Results for individual members of the public

Everyone monitored should receive information on the monitoring results obtained via the standard form in appendix E.

Pre-prepared information for those who are potentially contaminated is available in appendix H should this be required.

Appendix I contains pre-prepared information for those who have been found to be contaminated with radioactive material should this be required.

For those with large levels of contamination a full estimate of dose should be constructed and information on the health implications delivered by an appropriate specialist.

3.9.2 Results for those directing the incident response

Strategic levels in the incident response will require information on the numbers of people and the ranges of doses of those who have attended the RMU and a summary of the results recorded with no Person Identifiable Information (PII).

Results should be returned in a format appropriate and frequency as appropriate to the requirements of the response. This may be as frequent as every hour in the early stages of an incident.

3.9.3 Data protection

All data and information that identifies individuals (known as person-identifiable information, PII) should be treated as confidential and standard procedures for this type of information followed[2,3].

The RMU manager is responsible for ensuring that information is handled in the appropriate manner within the RMU.

3.10 Waste accumulation and disposal

RMU plans need to include consideration of the disposal of all waste that could be contaminated by radioactive materials. This would include all solids, liquids, washing effluents and clothing that could possibly have come into contact with radioactive material.

Early contact with the regulator for environmental issues is strongly recommended should an RMU be set up. The regulator can provide advice on situations where for example, no suitable permitting is in place, or where the extant authorisation does not cover the wastes involved. This will enable all radioactive wastes to be disposed of lawfully.

The regulator has statutory powers for regulating the storage and use of radioactive materials and the accumulation and disposal of radioactive wastes in accordance with the provisions of the Environmental Permitting Regulations (England and Wales) 2010[4]. In the event of an environmental incident, the regulator would be involved in approving accumulation and disposal of radioactive wastes whether by way of statutory authorisation or otherwise[5,8]

3.11 Training and exercising

In order to be successfully deployed, any plans produced relating to RMU operation should be exercised by staff that have undertaken appropriate training. The following are suggested to achieve this:

- Ensuring appropriate initial training and refresher training in RMU roles for staff who may be called upon to work within an RMU.
- Ensure that staff are provided with and trained in the use of appropriate PPE (if appropriate).
- Exercising the RMU plan at appropriate intervals.

4 RMU OPERATIONAL GUIDANCE

This section describes a best practice approach to the real time operation of an RMU. It covers key activities and roles and is not an exhaustive system of practices. The section should be used for the planning process in the development of system of practices. The system of practices contained within the annexes of this document can be used to form the basis of systems of practices for local plans.

4.1 Activation of the RMU

A clear and documented need for the RMU must be established before the activation of any RMU plan. This need may be established by agreement with stakeholders which will include as a minimum:

- Health services commissioning body
- HPA
- Local authority

A template for the discussion to ensure key points are covered can be found in appendix J.

If the need for an RMU is identified then this decision should be conveyed to the emergency services command structure for the incident (if there is one; e.g. police Gold).

4.2 Operational procedures

The following instructions outline some key requirements in setting up and running the RMU. Callout arrangements for staff are left to local procedures.

Each key role within the RMU is presented, setting out operational procedures for day to day running of the RMU (systems of practices are placed in the appendices). Where possible, actions to be taken when staff arrive and leave are included as well.

4.2.1 Preparation of the unit

The following steps are suggested:

- Clear the area to be used as far as reasonably practicable.

- Section off areas to be used for monitoring and other purposes. If necessary, use partition screens and tape barriers to create separate areas.
- Arrange the waiting area in a way that discourages unnecessary movement, perhaps by setting up a queue using tape barriers. Chairs may be provided but must be covered with polythene sheet, to be removed when the person leaves the waiting area.
- Place 'tacky mats' (disposable mats with an adhesive surface that removes contamination from the soles of shoes) at all entrances and exits to the area.
- Cover heavily used areas of the floor throughout the RMU (e.g. doorways) with heavy duty paper. The floor area between the monitoring area and the decontamination area must be covered. Tape all joins and repair any tears which may occur.
- Fix signs at the exit from the RMU prohibiting entry to unauthorised persons.
- Ensure RMU staff have appropriate PPE as necessary. See section 4.8.1.
- Each RMU staff member should ensure that they have been provided with the necessary equipment and supplies to carry out the task to which they are allocated.
- Access at most doors must be prevented and a one-way system used to prevent mixing of *clean* and *contaminated/potentially contaminated* people.
- Note should be made of a venue's acoustics. It may be difficult to brief people in the same room as monitoring is taking place. Consider placing news/information feeds with audio outside the main room or briefing area.

4.2.2 Setup and layout within the RMU

The generic flow diagrams provided in this section may be useful in planning the layout for specific RMU plans by showing the people and process flow involved.

The screening / monitoring process has four main components. These are:

Stage 1 Rapid screening to identify those in need of urgent decontamination.

Stage 2 More detailed external contamination screening / monitoring

Stage 3 Internal contamination monitoring

Stage 4 Recording and reporting of results (both to individual and to any monitoring result database). This includes the explanation of any result to the individual.

Figure 3. shows how these stages may be arranged and the pathways needed between them (See section 4.3 for detail on the decisions which direct the flow of people through the monitoring stages.). Figures 4. and 5. show this arrangement in operation during an exercise. Note the use of yellow tape, along with other materials that were to hand to create barriers. Figure 5. also shows the use of plastic ground cover by the stage 1 monitor where a heavily contaminated person would be redirected straight to decontamination. This monitoring station is completely covered in plastic bags to avoid direct contamination of the unit. Plastic covering is used close to the other monitoring stations to aid the removal of contamination near the monitors that could affect later measurements.

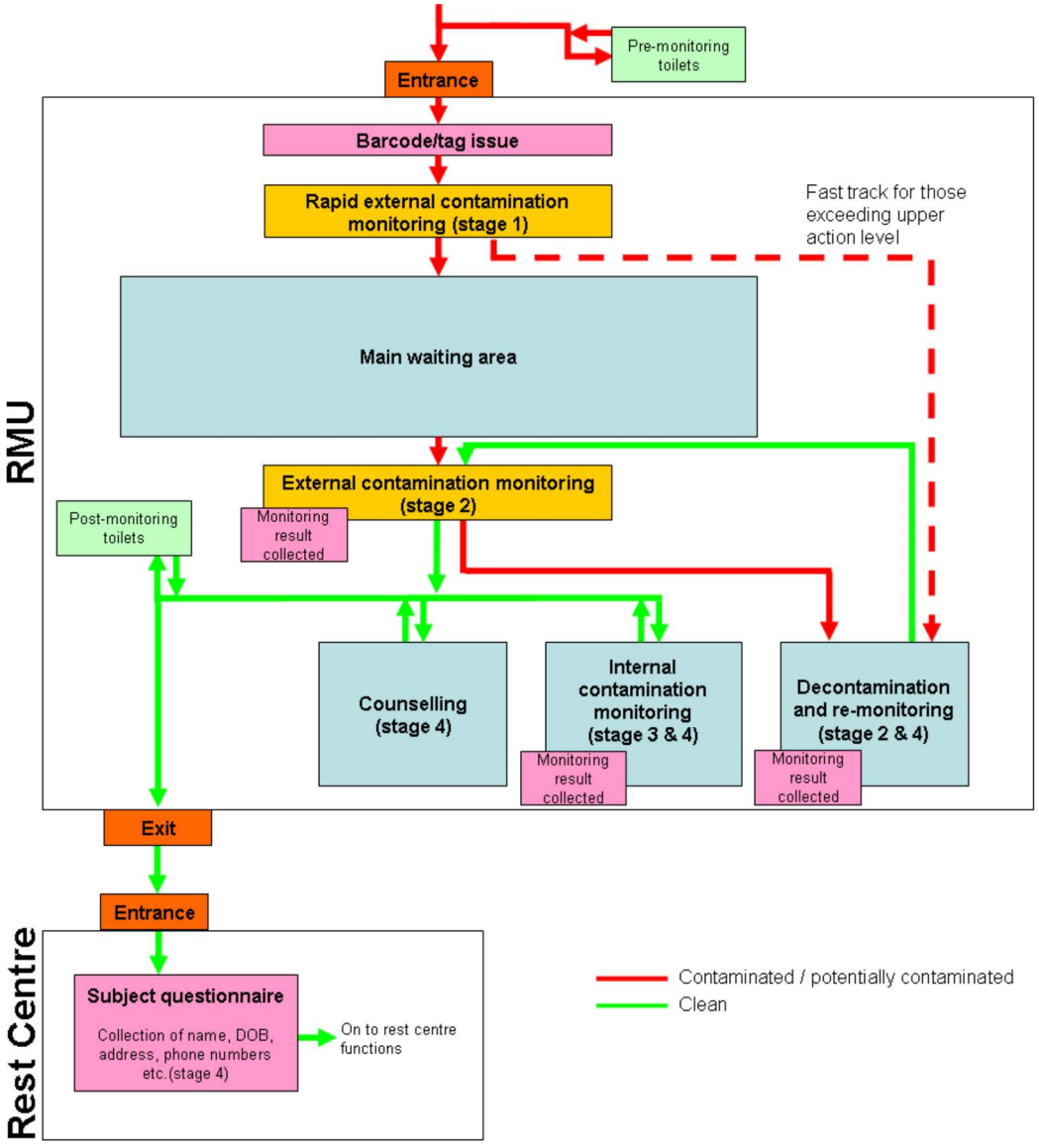


Figure 3. A generic RMU layout showing the areas needed and pathways between them.

Figure 4. An RMU being exercised. Stage 2 external monitoring with portals is shown here along with the main queuing area.

Figure 5. An RMU exercise showing first and second stage external monitoring (single portal on the left and multiple portals on the right respectively).

4.2.3 Toilet facilities

The public and staff should not be left without toilet facilities either before of after monitoring. Toilet facilities represent an area of potential cross contamination and so consideration should be given to their place in the RMU layout. There are two main ways to manage toilet facilities.

4.2.3.1 Separate toilet facilities

If the building has enough toilet blocks in suitable places then one can be designated as on the clean side (post-monitoring) and one on the dirty side (pre-monitoring) as in figure 3.

Separate toilet facilities with one set of toilets can also be achieved if the toilets are of a cubicle style. The men's could be designated as dirty side and the women's as clean (or visa versa), then both men's and women's changed to unisex.

4.2.3.2 Shared toilet facilities

Should only one toilet facility exist then it should be labelled as clean and regularly monitored. Provision should be made for temporary coverings.

4.3 Systems of practices for key roles

Systems of practices for key roles can be found in the annexes to this document, as listed in table 2. They are presented as best practice approaches to fulfilling the requirements of the role.

Role	Annexe
RMU manager	K
Deputy RMU manager	L
Monitoring Staff	M
RPA	N
Radiation Protection Supervisor (RPS)	O
Receiving staff	P
Registry staff	Q
Decontamination staff	R

Table 2. Annexes in which systems of practices may be found.

Figure 8. shows the limited management / advice structure for typical RMU operation. Note the RPA links giving advice to all aspects of RMU operation.

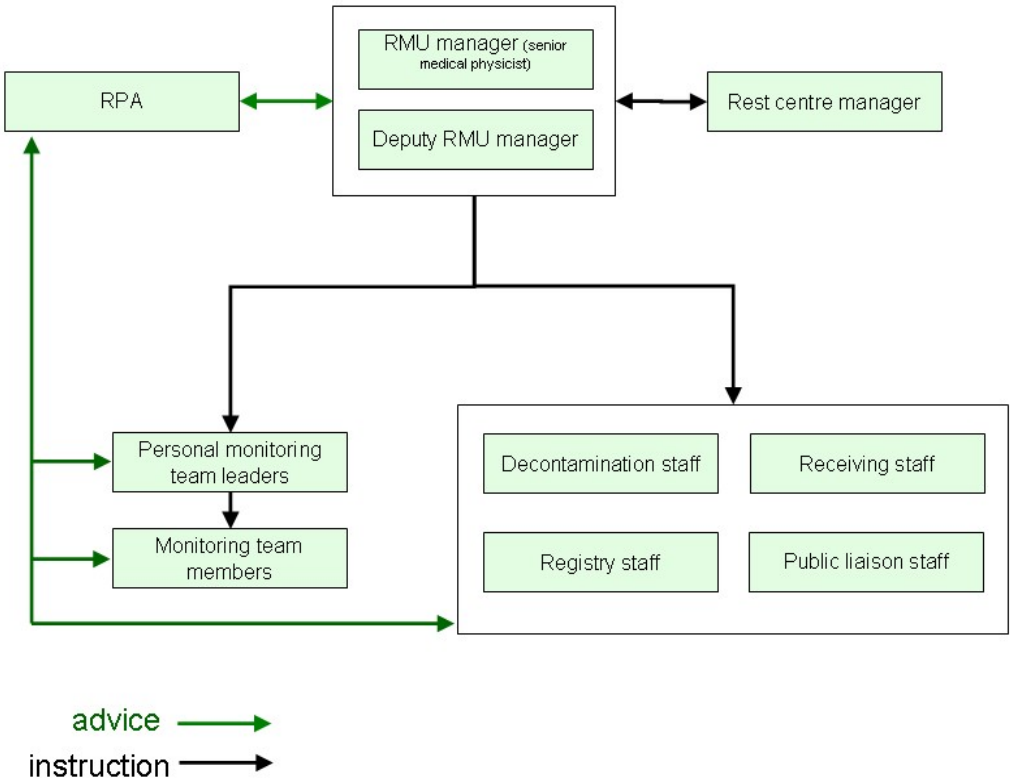


Figure 8. A schematic detailing the staffing structure within the RMU.

4.4 Radiation monitoring and screening for the public

Any monitoring strategy adopted should aim to identify, and where appropriate decontaminate, those at risk expeditiously.

Monitoring of people affected by emergency countermeasures (evacuation, sheltering, distribution of stable iodine) should be given a higher priority than monitoring other groups within the general population, as these people have a higher probability of being contaminated.

4.4.1 Action levels

Action levels are scenario and nuclide specific. They will be provided by the HPA during response to any incident. Guidance on the application of these levels will also be provided by HPA CRCE.

Action levels should be specified for decontamination, referral for medical assessment, additional monitoring, provision of information to individuals and for inclusion in any long-term follow up monitoring.

Actions levels are directly related to dose, but are specified in terms of measured quantities so that direct comparisons with the results of measurements can be made. An Upper Action Level $\mathbf{AL_U}$ is associated with urgent actions, while a Lower Action Level $\mathbf{AL_L}$ is associated with actions which are less urgent.

At each stage of monitoring the measurement result **M** is compared to the $\mathbf{AL_U}$ and $\mathbf{AL_L}$. The result of this comparison defines which actions should be taken. See figure 6. for a flow diagram of how action levels determine courses of action within an RMU. Figure 6. correlates to the layout of stations shown in figure 3.

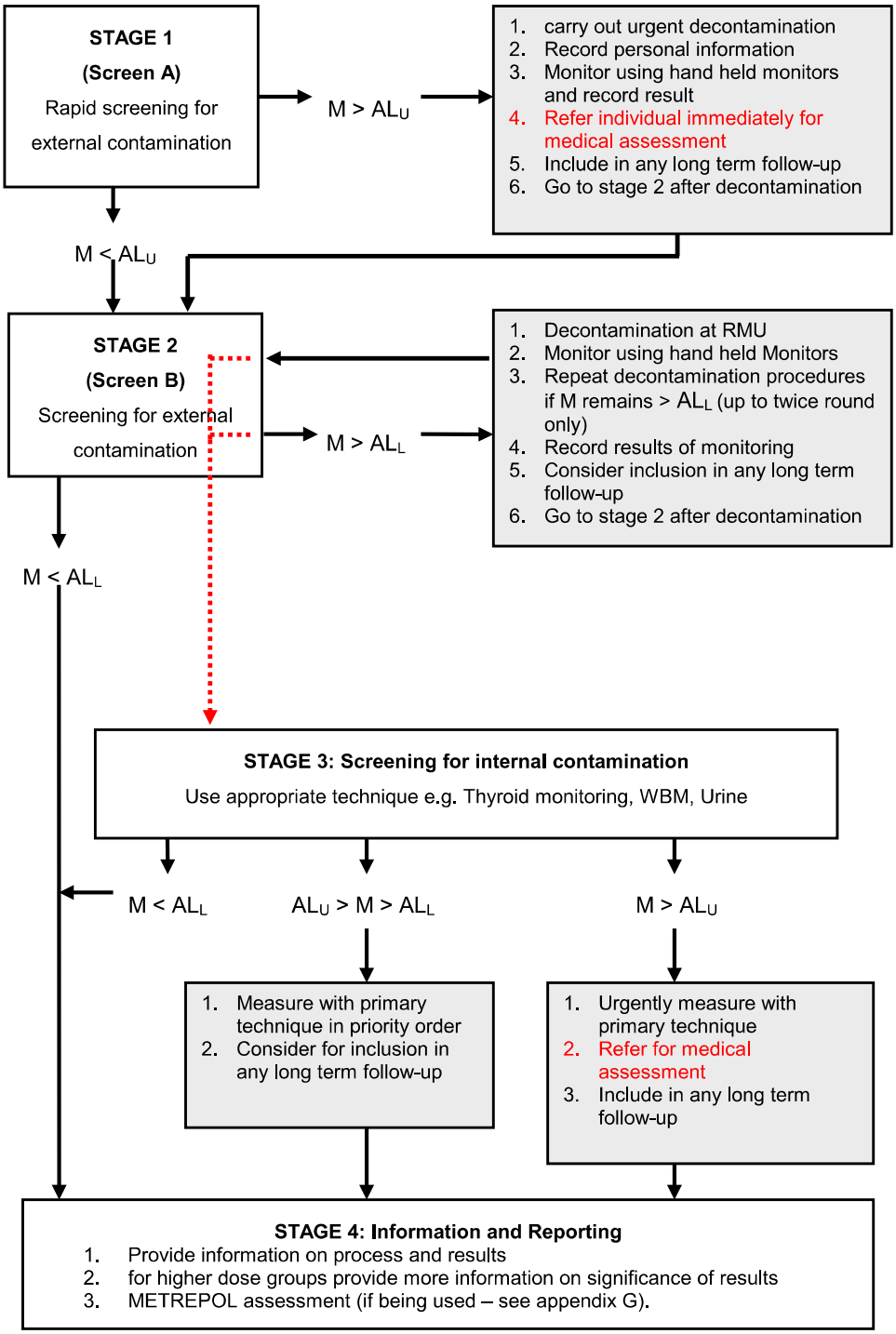


Figure 6. The decision tree for monitoring and decontamination processes within an RMU. M is the measurement value from monitoring, AL_L is the lower action level and AL_U is the upper action level.

4.4.2 Use of data collection forms

Data collection methodology is discussed earlier in section 3.7 collection of information. The practical capture of that data could utilise the forms held in the appendices B - E. To aid understanding of when these are to be used and of general data capture, Figure 7. highlights at what stage data is collected and on which forms.

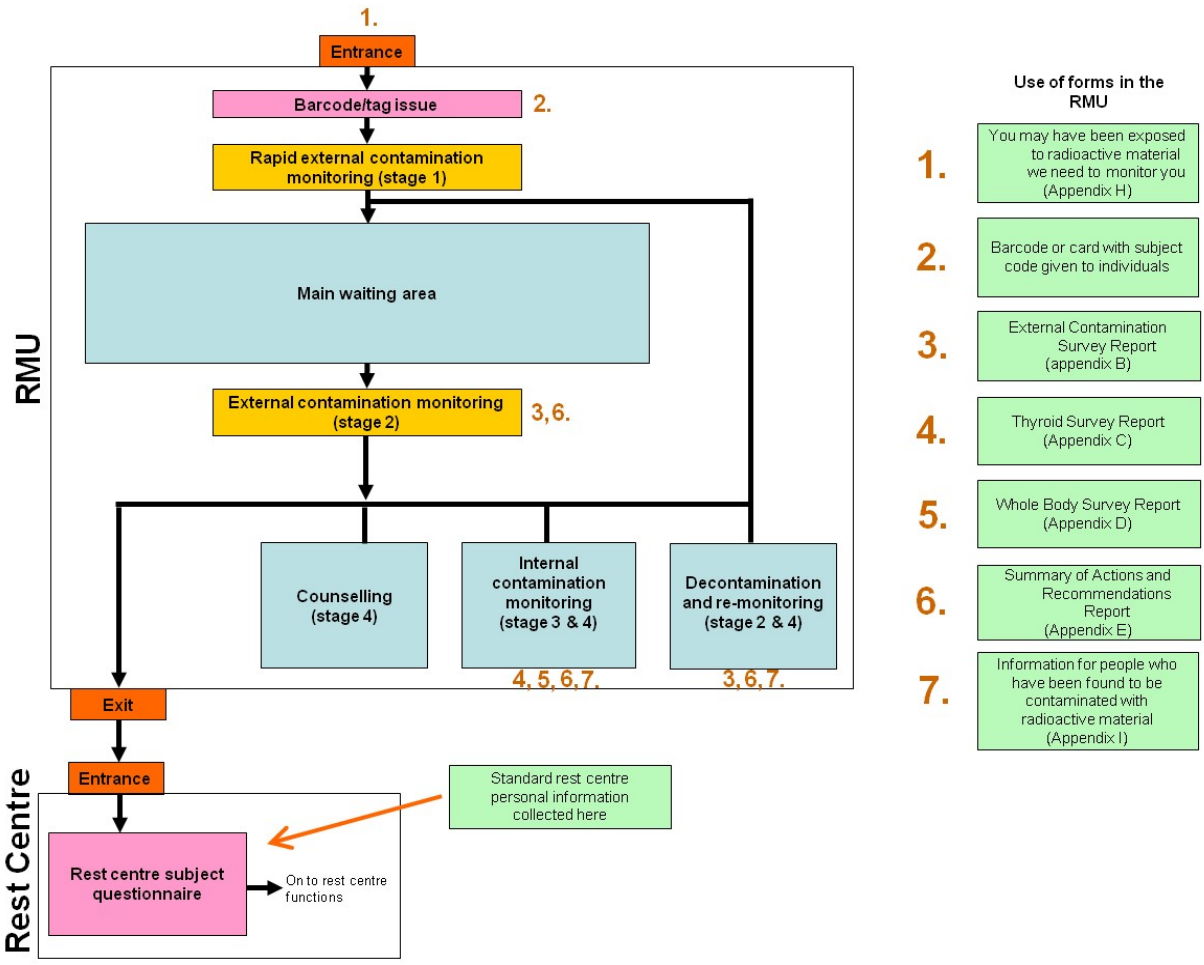


Figure 7. This simplified diagram shows the monitoring stages in the RMU and the forms that are associated with those stages (for the full people flow diagram see figure 3.).

Some forms are used more than once and will need to be transferred along with the individual through the process. If a computerised system is being used for data collection then the External Contamination Survey report form may become obsolete and the Summary Of Actions form may be printed automatically for many of those monitored.

4.5 People management

The management of people attending the RMU falls largely to providing adequate instruction and information to those people.

If possible, communications and educational materials should be provided in appropriate languages for the demographic. Visual signs on what to do and where to go may reach a wider audience than language, examples may be found in appendices A, H and I.

As far as practical, ensure cultural or religious factors that may affect the population monitoring process are taken into account.

Before the RMU is operational, any evacuees or other public at the RMU should not be allowed into the venue to prevent contamination of the venue. Consideration must be given to the welfare of these persons before the venue opens.

4.5.1 Prevention and treatment of psychological consequences

Guidance is available: NHS Emergency Planning Guidance on psychosocial care for people affected by disasters and major incidents[8].

4.5.2 Information for those who have been monitored

As with any examination of a health nature, people should be provided with information to allow them an understanding of what any result means. It is an essential part of including the public fully in the process.

As the public leave the RMU they should each have a **Summary of actions and recommendations form** (appendix E). This details in plain language what actions, if any, they should take.

There are two categories of result: no contamination present and contamination present:

No contamination present

The vast majority of people at the RMU are unlikely to have contamination above any action level and so will not enter into consultation with RMU staff regarding a radiation dose received.

Contamination present

The scientific staff at the RMU performing monitoring will be able to give initial advice on any positive contamination result. Further advice would be given by appropriate medical staff outside of the RMU.

4.6 Decontamination

Radioactive contamination in this context can be defined as unwanted radioactive material inside the body or on the body (internal or external contamination respectively). Decontamination is any procedure which removes this. It should be noted that external contamination is more easily removed than internal contamination and the following applies exclusively to external contamination. Any internal decontamination procedures would be performed at

the direction of medical staff following an assessment of the nature of any internal contamination.

In order of importance the decontamination strategy should incorporate:

1. Decontamination of those who are contaminated at a level which could result in significant health effects for that individual.

2. Decontamination of people who are contaminated at lower levels.

Generally, those who are contaminated are unlikely to pose a significant health hazard to others.

Monitoring of people affected by emergency countermeasures (evacuation, sheltering, administration of stable iodine) should be given a higher priority than monitoring other groups within the general population as these people have a higher probability of being contaminated.

For those who are externally contaminated, there are three corresponding strategies to follow:

1. Decontamination of small numbers of people - Strategy

If the number of people requiring decontamination is less than around 100, the following procedure should be used, as this is likely to be more effective than procedures which do not use showering. The SOP for this strategy may be found in appendix R2.

2. Decontamination of larger numbers numbers of people – Strategy.

These decontamination procedures should be used when the number of people requiring decontamination exceeds the capabilities of the procedure for decontamination of small numbers of people. The SOP for this strategy may be found in appendix R3.

3. Self decontamination at home - Strategy

If the number of people requiring decontamination, or a lack of decontamination facilities at the RMU, would mean decontamination would be delayed by more than 2 hours, uninjured people with a low priority for decontamination can be encouraged to go home and self-decontaminate. If possible transport should be provided to reduce the spread of contamination. The SOP for this strategy may be found in appendix R4.

4.6.1 Requirements before decontamination can take place

Decontamination should not be slowed down due to the lack of resources to monitor decontamination effectiveness.

1. Ideally replacement clothing should be available in sufficient quantities before decontamination can commence. Where doses sufficient to produce deterministic effects are possible, decontamination is urgent and should not be delayed. Modesty robes or similar should be provided if replacement clothing is not immediately available. Where only limited supplies are available,

decontamination priority should be given to children and those with the highest levels of external contamination.

2. A one-way system should be established so that people in need of decontamination do not come into contact with those people who have been decontaminated. Areas for decontamination must have separate entrance and exit points.

3. Warm water should be used in showers. Cold water can be used if the air temperature is above 20 °C, or medical advice has been given that the risk from hypothermia is negligible.

4. If the contaminated area is limited, showers may only serve to spread the contamination and make it more difficult for staff to assist the individual. Spot decontamination can be more effective in this case.

5. While decontamination is taking place it will be necessary to:

- Keep families together.
- Where possible respect cultural and gender differences.
- Assist people with disabilities and/or medical problems.
- Answer questions relating to radiological protection.

6. Personnel carrying out decontamination procedures must wear appropriate PPE.

7. If possible, clothing should not be removed over the head.

8. Move potentially contaminated items to a secure store at regular intervals. Any contaminated items should be labelled with the estimated activity and nuclide (if known) and the date of measurement to aid waste disposal.

9. The effectiveness of people decontamination must be confirmed by monitoring. The number of people monitored to confirm effectiveness will depend on availability of monitoring resources.

4.6.2 Personal belongings

At no time should an individual's identification (driving licences, passports etc), keys, mobile phones, jewellery, money, or credit cards be collected. People can try to wash these things as they wash themselves, or the items can be bagged and taken through decontamination with them. All contaminated clothing collected before the washing process should be bagged and labelled with the estimated activity and nuclide (if known), the date of measurement to aid waste sentencing and the identification number or barcode of the individual to whom the clothing belongs. Note that in certain cases the police may wish to retain items as evidence.

4.6.3 When to stop external decontamination efforts

The goal of whole body external decontamination is to decrease external contamination to a level of no more than two times background. However, external decontamination procedures should be stopped after 2 decontamination cycles, even when the second survey shows that external contamination is higher than 2 times background radiation. This is to lower the risk of skin damage. In any case, external decontamination efforts should not continue if signs of skin irritation appear.

Complete decontamination of the skin should not be seen as something to be achieved at all costs.

Aggressive and/or vigorous decontamination procedures should be avoided, since they damage the skin barrier and increase the risk of internal contamination.

4.6.4 Contamination control within decontamination area

Staff carrying out decontamination procedures must be monitored for contamination every hour along with the facilities themselves.

If contamination is found on clothing it should be changed for clean clothing.

If contamination is found on the skin, then staff must go through the decontamination procedure in the same manner as any member of the public.

Possible spread of contamination can be minimised by relatively simple measures, these will greatly simplify subsequent monitoring and decontamination procedures:

Work surfaces, etc. in the designated area can be protected by plastic sheeting, heavy duty paper, blankets or sheets. Standard plastic sheeting on floors is not recommended due to the slip hazard this presents when wet. Similar means can be used to minimise contamination of ambulances, stretchers and trolleys. A plentiful supply of paper towels and tissues should be available.

Entry to, and departure from the designated area should be strictly controlled. There should be facilities to allow such staff to change their footwear on leaving the designated area to prevent spreading contamination via contaminated footwear.

Ideally, no person or item should leave the decontamination area until monitoring and decontamination has been carried out to an acceptable level.

4.7 Health and safety at the RMU

All employers who provide staff to work at an RMU should have a suitable and sufficient risk assessment in place to cover that work.

In addition to general H&S requirements the following are relevant to radiation protection at the RMU.

4.7.1 PPE (Personal Protective Equipment)

No staff member who has not been trained in the use of personal protective equipment should be placed in a position where they are required to use it.

It must be noted that whilst an RPA will be designated for the RMU, each employer with teams deployed at the RMU is responsible for the safety of their own staff, including consultation with their own appointed RPA, appointing Radiation Protection Supervisors and providing PPE. Employers are also required to cooperate to provide any relevant information for the protection of staff.

As a general guide however, staff should be dressed in disposable coveralls, gloves and overshoes (as shown in figure 9). A consistent approach should be used and similar levels of PPE agreed upon for all staff at the RMU.

Waterproof aprons should be worn by staff that are expected to wash skin or wash out wounds etc. There is likely to be no need for facemasks unless specifically advised by the appointed RPA. Such advice will consider whether facemasks are required and the type to be used. Moreover, facemasks should only be used which have been fit tested and passed as suitable for any individual expected to wear one. Consideration to the concern that the use of facemasks may raise within the public should be taken into account as the public will not have them.

Figure 9. Tyvek coveralls, overshoes and gloves appropriate for most scenarios.

4.7.2 Risks to RMU staff from ionising radiation

It is unlikely that there will be any significant risks to staff from direct radiation emanating from a contaminated patient. Certain radioactive materials present a long-term health hazard if inhaled or ingested, however the doses from direct radiation are likely to be so small that it is not necessary to wear clothing designed to shield operators from radiation sources, e.g. radiography lead aprons. Careful handling procedures will minimise contamination of staff, the area and equipment.

4.7.3 Actions to prevent spread of contamination via RMU staff

Any staff members who have handled contaminated patients or materials should be monitored and, if necessary, decontaminated before leaving the designated area.

Staff must be warned not to eat, drink or smoke until monitoring and decontamination has been carried out.

4.7.4 Working with contaminated people

The presence of radioactive material, in any quantity, on people should not prevent trained personnel wearing PPE from monitoring them.

It is possible that contamination alone, without physical injury or a significant dose from external radiation would be sufficient to cause deterministic effects in the casualty, but is unlikely to cause adverse effects on health for other people.

4.7.5 Control of surface contamination

Initial screening should take place in an area with replaceable surfaces (e.g. paper/plastic sheeting on areas likely to become contaminated).

Monitoring equipment should be protected from contamination by placing monitors within plastic bags, however, contamination monitor detector windows should not be covered as a rule. Checks on battery status, background count rates and general condition for all of the monitoring instruments in use should be made frequently.

The RPA appointed at the RMU, or an appropriate RMU representative, should be kept informed of any radioactive material discovered. Conversely, if external contamination on people is not found, then contamination control measures should be relaxed in order to minimise unnecessary alarm in members of the public.

If external contamination is found on persons being monitored, then a member of staff should be allocated to the task of monitoring and controlling contamination of the RMU. Heavily used areas should be regularly monitored, with particular attention paid to “tacky” mats, floors and seating. “Tacky” mats and polythene covers should be replaced regularly in accordance with policies and procedures predetermined in consultation with the RPA.

Discarded clothing should itself be monitored, and if it cannot be deemed as uncontaminated, it should be put in plastic bags and held in a separate, designated area pending cleaning or disposal. Any discarded items placed in plastic bags for disposal should be labelled with the estimated activity and nuclide (if known), the date of measurement to aid waste sentencing and the identification number or barcode of the individual to whom the clothing belongs.

If people require the use of the toilets they should, if possible, be monitored first and allowed to use the local facilities.

4.7.6 RMU specific non-radiation hazards

The RMU manager should perform regular visual checks of the whole RMU to identify any obvious standard health and safety issues. The RMU manager should have received appropriate training in identifying standard health and safety hazards in the workplace.

4.7.7 Staffing breaks

The RMU manager has responsibility for ensuring appropriate breaks are taken during work. Staff numbers should be judged accordingly to allow for this to take place. Certain jobs can be intensive and will need more frequent breaks.

4.8 Follow-up monitoring

The HPA, in consultation with other stakeholders, will develop criteria to decide if follow-up monitoring is required along with the format of any such monitoring programme.

4.9 Ambulance attendance at an RMU

Should any person at an RMU require the attendance of an ambulance and subsequent transfer of that person to hospital, monitoring staff at the RMU should perform a survey of the casualty and complete the casualty handover form in appendix U. Completing this will greatly ease the transfer of the patient both to the attending ambulance and to the hospital.

4.10 Decommissioning

At an appropriate time the decision will be taken to close the RMU, the RMU Manager will be responsible for planning and carrying out decommissioning of the unit with advice from the RMU RPA.

5 REFERENCES

1. Stationary Office, The Regulatory Reform (Fire Safety) Order 2005, Statutory Instrument No. 1541. (2005)

2. Department of Health, The Caldicott committee, Report on the review of patient-identifiable information. 1997.

3. Stationery Office, Data Protection Act 1998. c.29. (1998).

4. Stationary Office, Environmental Permitting (England and Wales) Regulations. 2010, Statutory Instrument No. 675. (2010).

5. DEFRA, The Hazardous Waste (England and Wales) Regulations 2005. Statutory Instrument. No 894. (2005).

6. DEFRA, Strategic national guidance, The safe management of wastes arising following a Chemical, Biological, Radiological or Nuclear (CBRN) incident. Department for Environment, Food and Rural Affairs. 2008.

7. Department of Health, NHS emergency planning guidance, Planning for the psychosocial and mental health care of people affected by major incidents and disasters: Interim national strategic guidance. 2009.

The authors recommend the following references as useful for wider reading on the topic of radiation monitoring for the public. Thematic ideas and processes from these texts influenced the creation of the current document.

6 BIBLIOGRAPHY

Rojas-Palma C, *et al.* TMT Handbook, Triage, Monitoring and Treatment of people exposed to ionising radiation following a malevolent act, first edition (SCK.CEN, NRPA, HPA, STUK, WHO, Enviros, CLOR). 2009.

Centers for Disease Control and Prevention, Population monitoring in radiation emergencies – a guide for state and local public health planners, (Radiation Studies Branch, Division of Environmental Hazards and Health Effects, National Center for Environmental Health). 2007.

CRCPD, Handbook for responding to a radiological dispersal device, Publication 06-6. 2006.

Home Office, The Decontamination of People Exposed to Chemical, Biological or Nuclear (CBRN) Substances or Material, Second edition. 2004.

Crown, The Civil Contingencies Act 2004 (Contingency Planning) Regulations 2005, Statutory Instrument 2005 No. 2042. (2004).

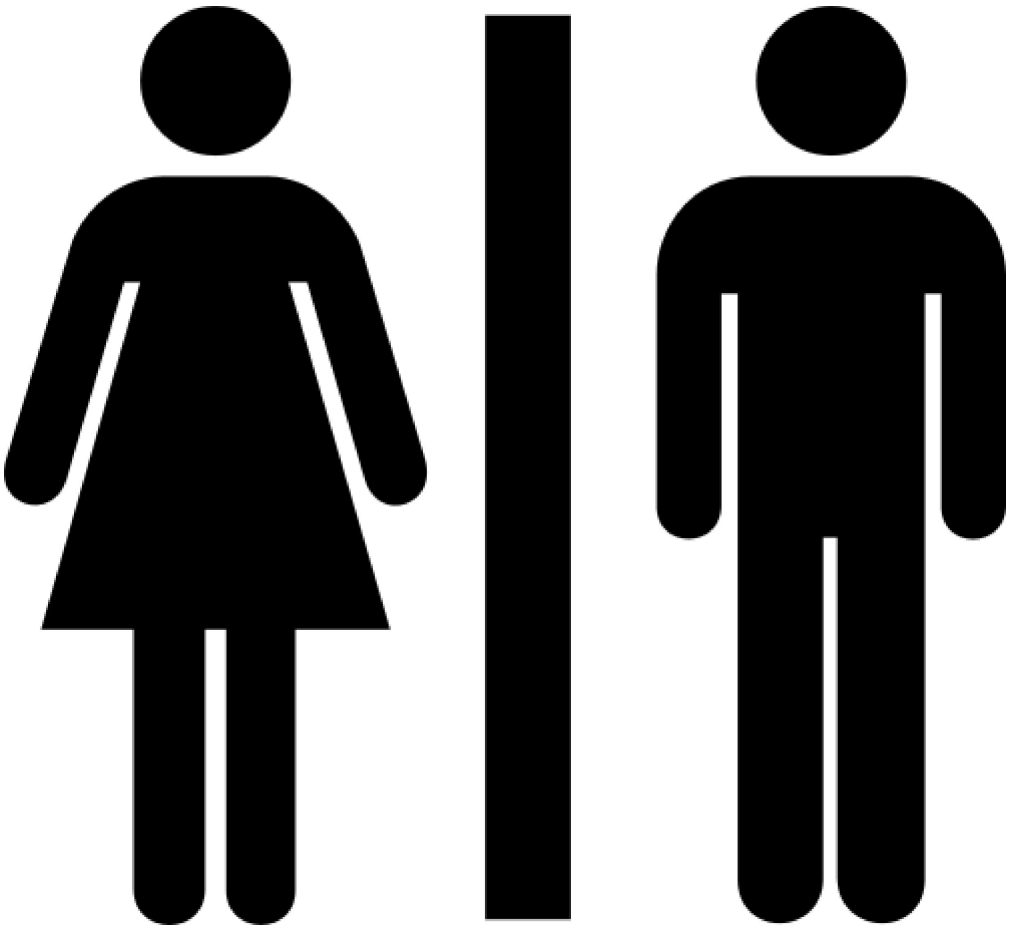
IAEA, Generic procedures for medical response during a nuclear or radiological emergency. 2005.

APPENDIX A Posters and signs for the RMU

Please do not

Eat
Drink
or Smoke

before monitoring
or within the RMU



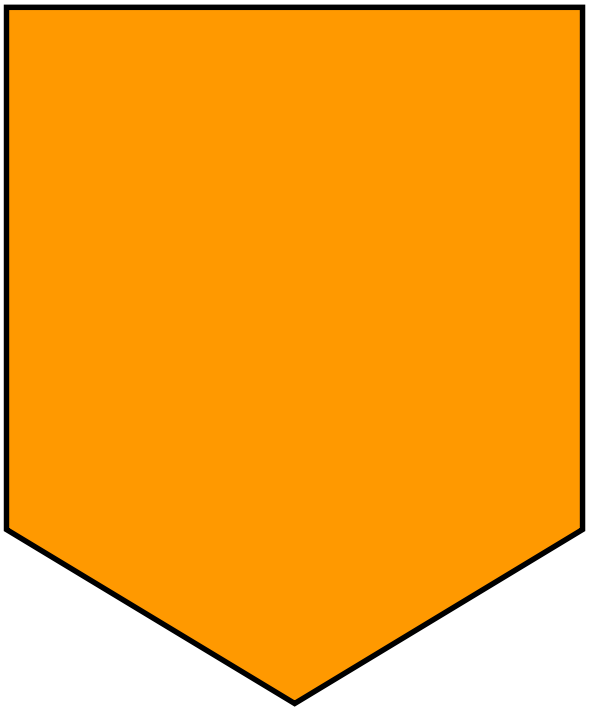
Unisex toilets

Male toilets

Female toilets

No entry

Please queue here to be monitored



Radioactive Contaminated articles

Turn off mobile phones

APPENDIX B External contamination survey report

Person ID Code (or attach bar code):

Complete only if personal data is not being collected later in RMU / reception centre

Forename(s): _____ Sex: M F

Family Name: _____

Postcode: _____

D.O.B. _____

Date of measurement before decontamination:_____/_____/_____

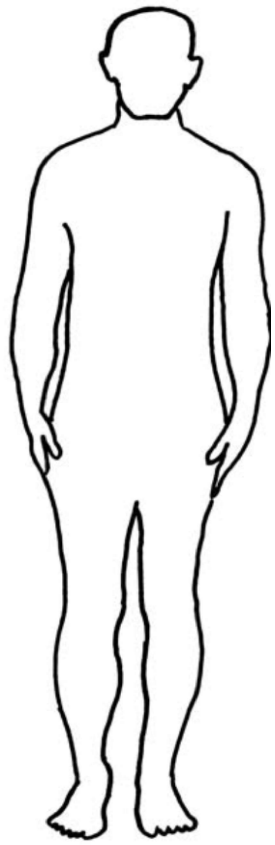
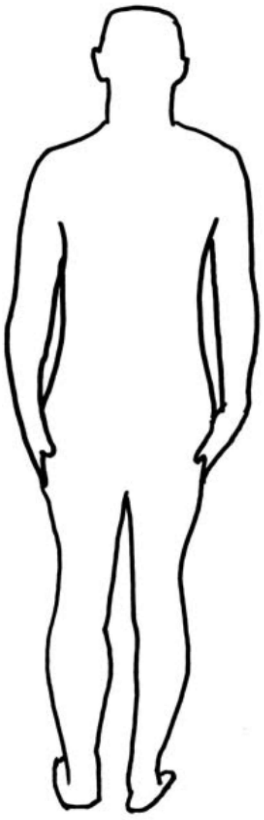
Time of measurement:_____

Instrument type: _____ Model: _____S/N _____

Background reading (cps): _____ Detector active surface: _____ [cm^2]

Conversion Factor (cps/Bq cm^{-2}) _____

Reading from person, for portal monitors (cps) _____ Portal Monitor Model:_____

Front	Count rates before and after decontamination	Back
	**Before**_____**cps** **After**_____**cps**	
	Before_____**cps** **After**_____**cps**	
	Before_____**cps** **After**_____**cps**	
	Before_____**cps** **After**_____**cps**	
	Before_____**cps** **After**_____**cps**	
	Before_____**cps** **After**_____**cps**	
	Before_____**cps** **After**_____**cps**	
	Before_____**cps** **After**_____**cps**	
	Before_____**cps** **After**_____**cps**	
	Before_____**cps** **After**_____**cps**	
	Before_____**cps** **After**_____**cps**	
	Before_____**cps** **After**_____**cps**	

Remarks: Indicate count rate readings in the centre of the diagram. Indicate location of the readings by arrows and circle/shade areas of contamination. Only record readings greater than background.

If positive result, location at time of incident:_____
_____

Decontamination procedures performed: Yes No provide more details as follows:
If "Yes" details of decontamination procedures (use additional pages if needed, note any contaminated belongings bagged)_____
_____
_____
_____

Date of measurement after decontamination:_____/_____/_____

Time of measurement:_____

Instrument type: _____ Model: _____

Background reading (cps): _____ Detector active surface: _____ [cm^2]
Conversion Factor (cps/Bq cm^{-2}) _____
Reading from person, for portal monitors (cps) _____ Portal Monitor Model:_____

Surveyed by:
Organisation:

APPENDIX C Thyroid survey report

Unique Person Code (or attach bar code):

Age: _____

Date of exposure: _____/_____/_____ Time of exposure: _____

Intake pathway (if known): Inhalation Ingestion Skin absorption Wound

Stable iodine taken: . Yes . No
If Yes, time of administration (HH:MM) _____
Date of administration (dd/mm/yy) _____
Date of measurement: _____/_____/_____ Time of measurement: _____

Results of measurement

Instrument type: _____ Model: _____S/N _____
Distance from neck to detector: 0 / 10 cm
Average environmental background count rate (cps): _____
Average gross subject thyroid count rate (cps): _____
Average body background count rate (cps): _____
Net subject thyroid count rate (cps): _____
Radionuclide: I-125 / I-131
Activity (Bq): _____
Committed effective dose, if calculated (mSv): _____

Results of gamma-ray spectrometry measurement

Radionuclide	Measured Value (Bq)	Committed Effective Dose (mSv), if calculated

Action Levels (tick one option)
Activity above Upper Action Level Y
Activity between Lower and Upper Action Level Y
Activity below Lower Action Level Y
Activity not detected Y

Name: _____
Organisation: _____
Date:

APPENDIX D Whole body survey report

Unique Person Code (or attach bar code):

Date of exposure: _____/_____/_____ Time of exposure: _____

Intake pathway (if known): Inhalation Ingestion Skin absorption

Wound

Person externally decontaminated: Y N

Date of measurement: _____/_____/_____ Time of measurement: _____

Results of measurement

Instrument type: _____ Model: _____S/N _____
Average subject gross count rate (cps): _____
Average person background count rate (cps):_____
Net subject count rate (cps): _____
Activity (Bq): _____
Committed effective dose, if calculated (mSv): _____

Results of gamma-ray spectrometry measurement

Radionuclide	Measured Value [Bq]	Committed Effective Dose [mSv] if calculated

Action Levels (tick one option)

Activity above Upper Action Level Y
Activity between Lower and Upper Action Level Y
Activity below Lower Action Level Y
Activity not detected Y

Name: _____
Organisation: _____
Date:

APPENDIX E Summary of actions and recommendations report

To be retained by the person monitored (copy to be held by issuer).

Name of issuing Organisation: _____

Address of issuing Organisation: _____

Subject Code:

Name of person measured: _____

Address: _____

You have been measured for radioactive contamination:
(Delete paragraphs not applicable)

1. Monitoring has been carried out, and no radioactive contamination has been detected. No further action is required.

2. Monitoring has been carried out. A small amount of radioactive contamination has been detected on your skin or clothing. You are advised to return home, place the clothes you are wearing in a polythene bag and keep them, and take a bath or shower. No further action is required.

3. Monitoring has been carried out. A small amount of radioactive contamination has been detected on your skin or clothing. You should have already been offered facilities to wash, and to change your clothing, in order to remove this material. No further action is required.

4. Monitoring has been carried out. A small amount of radioactive contamination has been detected on your skin or clothing. You should have already been offered facilities to wash, and to change your clothing, in order to remove this material. Further assessment is needed and you will be contacted with appointment details.

5. Monitoring has been carried out and has shown that you may have swallowed or inhaled small amounts of radioactive material. Further assessment is needed and you will be contacted with appointment details.

Other information:

If you have any concerns or wish to discuss this matter further, please contact your GP.

Signed: .....

Name:_____

APPENDIX F Preferred monitoring methods for particular radionuclides

Assessment of external contamination levels can be made with hand-held instruments or portal monitors (if a gamma-ray emitting radionuclide is involved).

In most cases, assessment of intakes of radionuclides may be achieved by body activity measurements (direct bioassay), urine monitoring or faecal monitoring (indirect bioassay), or a combination of these techniques. The choice of measurement technique will be determined primarily by the radiation emitted by the radionuclide and its daughter products. Faecal monitoring would only be considered if absolutely necessary and could only be used for a few individuals.

A monitoring strategy which details the methods of choice will be produced by the HPA in consultation with other health organisation staff and the Scientific and Technical Advisory Cell.

Choice of monitoring technique for internalised radionuclides

Experience and research have shown the best methods for measuring levels of internalised radionuclides. Table 3 shows these methods for some radionuclides of interest. This table is included for reference, the HPA will advise as part of the monitoring strategy which methods will be employed.

Individual Monitoring Methods for Selected Radionuclides

The primary monitoring method is the method that is expected to provide the most reliable assessment of internal dose. The measurement is likely to be carried out in a laboratory. For most radionuclides, more rapid measurements can be carried out in the field, although these will in general be less accurate. Such measurements are of most use for triage purposes, and are referred to here as *rapid screening methods*.

Radionuclide (absorption type)[1]		Radiation type emitted	Rapid screening method	Primary monitoring method
Tritium	^{3}H	β	None	Urine
Manganese-54 (F)	^{54}Mn	γ (EC)	Whole body (rapid)	Whole body[4]
Cobalt-60	^{60}Co	β, γ	Whole body (rapid)	Lung[5]
Strontium-90	^{90}Sr	β	Nose blow/nasal swab[6]	Urine
Selenium-75	^{75}Se	γ (EC)	Whole body (rapid)	Whole body
Silver-110m	^{110}Ag	β, γ	Whole body (rapid)	Whole body
Cadmium-109	^{109}Cd	γ (EC)	Whole body (rapid) Nose blow/nasal swab	Whole body, urine
Iodine-131	^{131}I	β, γ	Thyroid (rapid)	Thyroid
Barium-133	^{133}Ba	γ (EC)	Whole body (rapid)	Whole body
Caesium-137	^{137}Cs	β, γ	Whole body (rapid)	Whole body
Europium-152	^{152}Eu	β, γ	Whole body (rapid)	Whole body
Europium-154	^{154}Eu	β, γ	Whole body (rapid)	Whole body
Iridium-192 (F)	^{192}Ir	β, γ	Whole body (rapid)	Whole body[4]
Polonium-210	^{210}Po	α	None	Urine
Radium-226	^{226}Ra	α	Nose blow/nasal swab	Lung [3,5], Urine
Thorium	Th	α, β, γ	Nose blow/nasal swab	Lung [3,5], Urine[7], Faeces [2]
Uranium	U	α, β, γ	Nose blow/nasal swab	Lung[5,8], Urine
Plutonium-238	^{238}Pu	α	Nose blow/nasal swab	Urine, Faeces [2] (Lung [3,5])
Plutonium-239	^{239}Pu	α	Nose blow/nasal swab	Urine, Faeces [2] (Lung [3,5])
Americium-241	^{241}Am	α, γ	Nose blow/nasal swab	Lung
Californium-252	^{252}Cf	α, n	Nose blow/nasal swab	Urine, Faeces [2] (Lung [3,5])

α – alpha emitter β – beta emitter γ – gamma emitter EC – electron capture

1. The Absorption Type (F, M or S) to which a chemical compound is assigned reflects the rate at which it is absorbed from the respiratory tract to the body fluids.

2. Faecal monitoring is unlikely to be suitable for large numbers of people.

3. Lung monitoring has very low sensitivity for these radionuclides. Nevertheless, the sensitivity is adequate for the detection of contamination levels that could result in deterministic effects.

4. Different primary monitoring methods are recommended for compounds of manganese and iridium other than those allocated to Absorption Type F

5. Intake by inhalation only.

6. Nose blow/nasal swab monitoring is not suitable for soluble compounds of ^{90}Sr.

7. Urine monitoring may not be suitable for all Absorption Types

8. Lung monitoring is unsuitable for Absorption Type F

Ref. TMT Handbook

Table 3. Monitoring methods for selected radionuclides of interest.

APPENDIX G METREPOL - Screening for acute radiation syndromes (ARS) at an RMU

Not all radiological emergency scenarios pose significant enough hazard to give rise to doses high enough to cause deterministic effects of radiation exposure. It is therefore necessary for responders to ascertain for any given situation whether or not the incident is capable of producing deterministic health effects. This would be done by appropriately knowledgeable individuals during the activation stage of an RMU which forms part of the activation procedure of appendix J.

Once it has been determined that there is a likelihood of exposure at levels sufficient to cause the potential for observable deterministic effects including ARS, then measures will need to be put into place to identify the population at risk so as to avoid overwhelming the resources available.

The first step in identifying the population at risk is to define exclusion criteria i.e. who will not be screened. Exclusion criteria will be produced by the Health Protection Agency on the basis of information available at the time.

It is probable that in situations where an RMU has been established and there is potential for exposures sufficient to cause deterministic effects, all people brought to an RMU will undergo screening for ARS and other deterministic effects. If a significant number of people are evacuated to an RMU or there are significant numbers of self presenting people then it may also be necessary to apply specific inclusion criteria at a reception point so as not to overwhelm the screening facilities available.

Once exclusion criteria have been identified they must be presented in such a way that allows them to be communicated to both the population at risk and those deemed not at risk.

Suitable screening method

A suitable screening method for ARS, in the application covered within this document, is one which can be implemented by a trained healthcare provider but which does not require a medically qualified doctor to be present at each screening. For this approach to be effective a simple scoring system should be used to classify the severity of symptoms. A recommended scoring system for use in the first 48 hours after exposure is the primary scoring method presented in a document produced by the European Group for Blood and Marrow Transplantation (EBMT) called the European approach for the medical management of mass radiation exposure. This document is available through the HPA and also available via the EMBT website:

www.ebmt.org/7directory/committees/nuclear%20accident%20docs/pocket_guide.pdf

This document is also reproduced in the European TMT Handbook (Triage, Monitoring and Treatment of people exposed to ionising radiation following a malevolent act; www.tmthandbook.org).

In addition to screening for symptoms of radiation exposure, blood samples should be obtained for full blood counts and chromosome dosimetry. Only suitably trained and experienced personnel should be used to obtain such samples and arrangements for the interim storage and onward transport of such samples should be made when planning for a response.

Application of screening method at an RMU

Screening for ARS should take place post contamination monitoring and if necessary post decontamination to avoid spreading any contamination and to reduce the period of exposure.

Some incident scenarios that could give rise to ARS and other deterministic effects may not involve contamination, such as exposure to a sealed radioactive source. However, RMU managers should be aware of the potential for contamination in such scenarios if sources become damaged or disrupted.

The following flow chart compliments the standard RMU process flowchart (figure 8. of the main document) should it be decided that screening for ARS is necessary by application of exclusion and inclusion criteria.

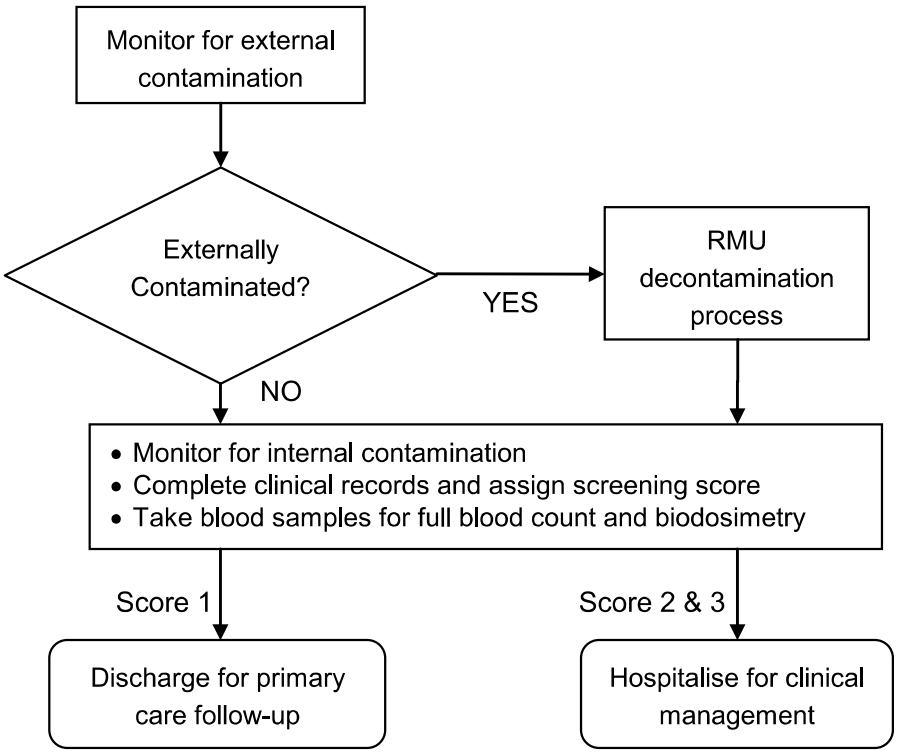


Figure G1. – ARS screening process in an RMU setting

Screening should occur in facilities designed to afford the individual being screened appropriate privacy. Records should be managed in accordance with the appropriate guidelines. Biological dosimetry methods other than full blood count are not presently developed sufficiently for use in the field.

Staffing and training

Staff to be used as assessors during the screening process should be suitably qualified in making objective assessments of the conditions stated in the screening method and are most likely to be sourced from the health services. Staff should also be suitably experienced in handling Medical In Confidence information. The number of staff required will vary depending on the nature of the incident and the number of people potentially affected. In an RMU setting, the number of screening 'posts' should equal the number of handheld monitoring stations so as not to create a 'bottleneck' in the throughput of people. Staff should be provided with suitable training in the use of the screening process and provided with a briefing on the environment and facility into which they would be deployed.

Dose reconstruction

It is possible that some incident scenarios will not result in any contamination and rapid onset of symptoms may not occur. Where a limited number of people have potentially been exposed and the nature of the exposure pathway is well characterised then a process of dose reconstruction may be required in order to assess the potential for later onset of symptoms of radiation exposure and estimate stochastic risks. Such dose reconstruction should be performed by specialists from the HPA.

Arrangements for care of those exposed

The type of care required for any individual exposed will be highly dependent on the level of their exposure, the severity of their symptoms and the nature of the exposure and injuries sustained. The flowchart in Figure G1. shows two care routes depending on the score awarded in the screening process. Those who do not score on the process or score 1 can be managed as outpatients using the local healthcare system. Those scoring 2 or 3 would be hospitalised for more detailed clinical assessment and care. Some of these, especially those scoring level 3, are likely to require treatment in specialist centres which have experience and expertise in dealing with effects of high level radiation exposure.

Plans should make provision for the passing of information obtained from the screening process to GPs and healthcare providers as well as provision for admitting patients to hospital whether it is at local or at a specialist centre.

APPENDIX H You may have been exposed to radioactive material so we need to monitor you

Welcome to the Radiation Monitoring Unit (RMU). Please follow all signs and instructions to aid staff in monitoring you in an efficient and timely manner.

Please wait in line in the queuing area. You will be called by a member of staff from the queuing area to be monitored.

Monitoring will be performed by professionals using a variety of measuring instruments. All of the methods used for radiation monitoring are passive, painless and non-invasive, as in the pictures shown above.

What if external contamination is found?

External contamination means that radioactive material has been discovered on your body (i.e. on skin or in hair etc.). If external contamination is detected, there may be a need for decontamination. Decontamination should be carried out as soon as possible, but does not require the same immediacy as with some chemical or biological contamination.

If only low levels of external contamination are detected, you may be instructed to return home and take decontamination measures. If you are instructed to do so, you should:

1. Remove clothing and seal in a plastic bag. Bags of clothing should be retained until you are provided with further information on disposal or laundering requirements.

2. Shower or bath thoroughly, but gently, washing both skin and hair. Hair conditioner should not be used as this may bind material to the hair.

3. Do not eat, drink or smoke until washing is complete.

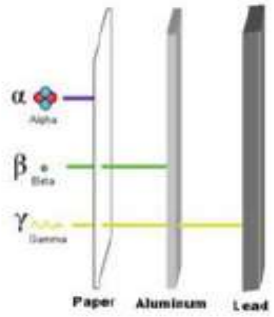
What if internal contamination is found?

Internal contamination means that radioactive material has been discovered inside your body (it has been inhaled or ingested). If you are found to have radioactive material inside your body, information will be provided to you on any measures to be taken in regards of further monitoring or medical follow up necessary.

APPENDIX I Information for people who have been found to be contaminated with radioactive material

Radiation and radioactivity

We cannot eliminate radiation from our environment. We can, however, reduce our risks by controlling our exposure to it. Understanding radiation and radioactivity will help you make informed decisions about your exposure



What is ionising radiation?

Ionising radiation is energy that travels in the form of waves (gamma or X-rays) or high speed particles (alpha and beta), and its penetrating properties are depicted on the left.

What is radioactivity?

Radioactive material spontaneously undergoes a change while sending out radiation as particles or waves

How are people exposed to radiation?

When we hear the words 'radiation exposure', we generally think of radiation from a source beaming out and striking the exterior of a body. However, radioactive particles can also become lodged inside the body and expose internal organs as the radionuclides decay. As a result, health physicists consider not only the type of radiation emitted from a source, but also the routes by which people are likely to come into contact with it. There are three main routes of exposure or exposure pathways:

- **Inhalation**. Exposure by the inhalation pathway occurs when people breathe radioactive materials into the lungs. The main concerns are radioactivity contaminated dust, smoke, or gaseous radionuclides.
- **Ingestion**. Exposure by the ingestion pathway occurs when someone swallows radioactive materials.
- **External exposure**. Exposure to radioactive sources/material outside your body. The level of concern for exposure to different kinds of radiation varies from "limited" for alpha particles since they cannot penetrate the outer layer of skin (but if you have any open wounds you may be at risk); "intermediate" concern for beta particles which can, in some cases, burn the skin or damage eyes. Greatest concern is for gamma radiation since gamma rays can travel long distances and penetrate the body.

What happens to ingested radioactive materials?

Ingested radionuclides can expose the entire digestive system. Some radionuclides can also be absorbed and expose the kidneys and other organs, as well as the bones. Radionuclides that are eliminated by the body fairly quickly are of limited concern.

What happens to inhaled radioactive materials?

Radioactive particles can lodge in the lungs and remain for a long time. As long as it remains and continues to decay, the exposure continues for radionuclides that decay slowly, the exposure continues over a very long time. Inhalation is of most concern for radionuclies that are alpha or beta particle emitters.

How Radiation Affects People

The term ‘radiation dose’ is used to describe the amount of energy absorbed by a material from ionising radiation passing through it. The most common measure of radiation dose to people is called effective dose, measured in units called sieverts. Effective dose takes account of the different sensitivities of organs in the body and the effects of different types of radiation. A sievert is a large dose of radiation and in most cases radiation dose will be given in microsieverts (μSv, one-millionth of a sievert) or millisieverts (mSv, one-thousandth of a sievert).

At low levels radiation causes no immediate perceptible damage to humans. However any exposure to radiation is considered to be capable of increasing the lifetime risk of cancer and of passing on hereditary illnesses to children. Individuals exposed to very high doses of radiation may receive burns to the skin, damage to the gastrointestinal, cardiovascular or nervous systems, and exceedingly high doses can cause death.

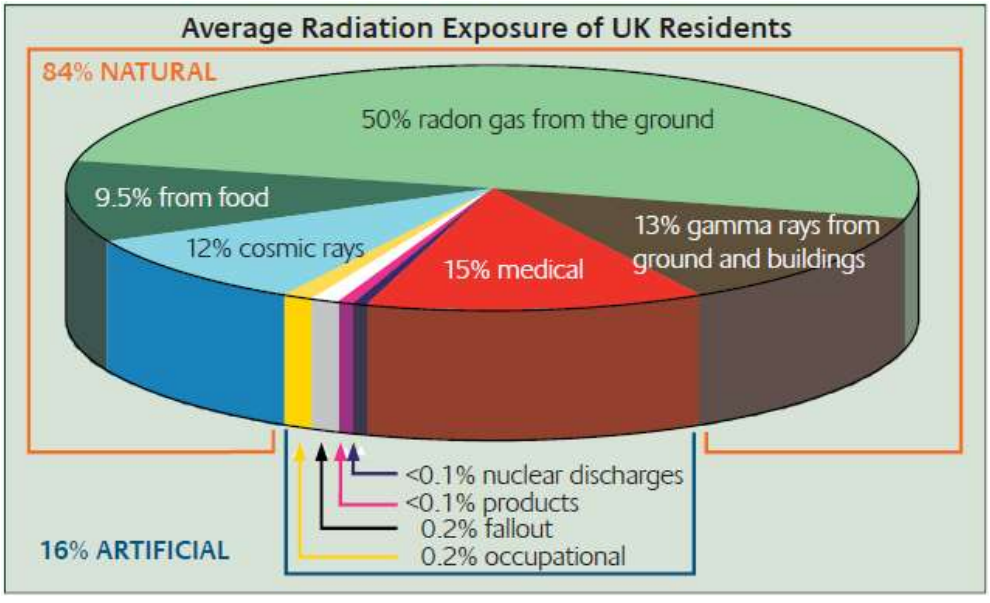
Radiation Exposures

Humans have always been exposed to low levels of radiation from natural sources. On average people in the UK receive an annual dose of 2.7 mSv. Natural sources make up 84% of this dose, with the remainder coming from a variety of artificial sources.

The natural radiation sources include gamma rays from the natural radioactivity in the earth and in building materials, the small amounts of natural radioactivity in food and drink, and cosmic rays which bombard the earth from space. However, by far the greatest contribution comes from breathing radon gas which is given off by natural radioactive materials in the earth.

Inhalation of radon leads to alpha particle irradiation of the lungs and has been shown to cause lung cancer.

Artificial (man made) sources are dominated by medical exposures All other artificial sources contribute in total less than 0.5% of the average annual exposure.



APPENDIX J Activation

Activation of an RMU should follow from a reasoned discussion along with a pre-identified need in emergency plans.

Below is an example of the type of discussion which may take place prior to any public monitoring programme. It should help inform decisions about whether a programme of monitoring is required and the nature of that programme.

J1 ACTIVATION

A clear and documented need for the RMU must be established before the activation of any RMU plan. This need may be established by agreement with stakeholders which will include as a minimum:

- Health services commissioning body
- HPA
- Local authority

This section provides suggested items for discussion when considering the requirement for establishing an RMU.

J2 SUGGESTED ITEMS FOR DISCUSSION

Have arrangements to monitor the public for radioactivity been initiated already – are they adequate?

What is known about the incident?

Is radiation suspected or confirmed?

Has the presence of radioactivity in the environment been confirmed?

Is knowledge of the incident in the public domain?

Is the incident one which is likely to lead to any exposure to the population?

Is there a likelihood of internal or external radiological contamination for people arising from the incident?

Has an appropriate radiation specific plan been invoked?

Have any public protection measures been put in place such as establishment of cordons or implementing of sheltering or evacuation?

Has any decontamination of members of the public started?

What radiological measurements are available from the emergency services and others?

Do we know how many people are or have been in the affected area?

Can the source of exposure be excluded from causing foreseeable deterministic health effects?

Is there a need to perform reassurance monitoring?

J3 WHAT SHOULD BE THE FORM AND SCALE OF MONITORING UNDERTAKEN AT THE RMU?

What are the objectives of the monitoring programme?

What are the groups to be targeted for monitoring?

What types of monitoring is appropriate for the given scenario? (external, internal, METREPOL (see appendix G))

J4 WHAT ACTIONS ARE NECESSARY TO INITIATE THE RMU?

Is Scientific and Technical Advice Cell (STAC) and Strategic Coordination Group (SCG) approval to proceed required?

Is an appropriate location available?

How will health and safety be managed at the RMU?

What resources are required to establish and maintain RMU operation?

APPENDIX K RMU Manager system of practices

On behalf of the health services commissioning body, the RMU manager has responsibility for:

- Establishing and decommissioning the RMU.
- The personal monitoring teams deployed to an RMU, or similar.
- Ensuring best use of the Personal Monitoring Teams within the RMU.
- Advising team leaders and strategic coordinating centre on any actions necessary to deliver the agreed Personal Monitoring Strategy.
- The health and safety of the teams deployed to the RMU.
- Ensuring an adequate data collection system is in place and that systems are in place for reporting data to subjects and the HPA.
- Ensuring that data protection and Caldicott principles are followed and that a suitable brief on how to achieve this is provided to relevant team leaders for onward cascade to other staff. (Note that clinical staff may be a good source of knowledge in Caldicott issues).
- Responsibility for all radiological matters within the RMU.
- Providing liaison with media at the RMU.
- Providing liaison with the regulator for environmental issues.

The RMU manager may delegate parts of their role as necessary.

APPENDIX L Deputy RMU manager system of practices

The Deputy RMU managers main role is to aid the RMU manager in performing their duties. As such they deputy would expect to be tasked by the RMU manager as appropriate.

The deputy RMU manager will also ensure the RMU is kept stocked with necessary consumables.

APPENDIX M Monitoring staff system of practices

This annexe contains detailed instructions for monitoring staff in order to standardise the complex processes involved in people monitoring. Procedures for the monitoring process rather than specific techniques are detailed since techniques are scenario dependant.

Monitoring staff must be familiar with monitoring techniques, the specific monitoring instruments and must use PPE as appropriate (see section 4.8.1 of main document). Monitoring staff are likely to be sourced from local medical physics personnel and staff from the Health Protection Agency. The nuclear industry may also provide assistance under the HPA's monitoring coordination arrangements or local planning arrangements.

Monitoring staff are responsible for:

- Carrying out the elements of the monitoring strategy as directed by the RMU Manager. It is important that all tasking is routed through the RMU Manager.
- Ensuring their monitoring locations follow the protocols for monitoring.
- The contamination control procedures agreed by the RPA.

M1 RESOURCES REQUIRED

All monitoring equipment should be brought to the RMU by the attending scientific staff and may include:

- Contamination monitors.
- Hand-held scintillation detector (NaI based or similar) for radioiodine in thyroid measurements if appropriate.
- Hand-held instruments for internal contamination monitoring.
- Portal monitors if appropriate.
- Protective clothing; paper coveralls or laboratory coats, disposable gloves and plastic overshoes.
- Materials for prevention of contamination e.g. plastic bags, vinyl tape, plastic sheeting.

HPA-CRCE will advise on instrumentation suitable for a particular incident if required.

M2 OBJECTIVES

Work with the other Monitoring team staff to:

- Carry out monitoring of people using handheld monitors (appendix M5).

- Carry out monitoring of people using portal monitors (appendix M6).
- Carry out monitoring of people for radioiodine in thyroid using hand-held instruments (appendix M7).
- Carry out monitoring for internal contamination in the body using hand-held instruments (appendix M8).

In addition to the above, Monitoring Teams may be required to:

- Assist in setting up the RMU
- Maintain contamination control measures in the RMU.
- Assist in the decommissioning of the RMU.

M3 INITIAL ACTIONS FOR TEAM LEADERS - BEFORE ATTENDING THE RMU

If not already done, appoint team members. The number of monitoring staff required will have been agreed in the initial discussions with the RMU Manager. Note: the overall size of the team needs to reflect the effort needed in helping to set up the RMU and building in capacity for rest and meals.

A team leader has the following initial duties:

- Brief staff: to include known scenario to date, role(s) of team within RMU or similar and details of other Personal Monitoring teams to be deployed.
- If not already done, initiate the preparation of equipment to be taken to the RMU and appropriate transport.
- Brief staff on data protection matters including Caldicott.
- Consider health and safety information for team members.
- Ensure staff have appropriate contact details to contact each other and the RMU manager upon arrival.

M4 ON ARRIVAL AT THE RMU – ALL MONITORING STAFF

The following assumes the RMU is not yet in operation. If it is in operation, the order in which these actions are undertaken will need to be modified in the light of the specific

circumstances. In particular, the first 2 actions under “Setting up” will need to be implemented.

On arrival, staff are to assist in preparing the RMU (clearing furniture, covering floors, setting up areas for monitoring etc).

Before the RMU is operational, any evacuees or other public at the RMU should not be allowed into the venue to prevent contamination of the venue. Consideration must be given to the welfare of these persons before the venue opens.

- If the RMU is already in operation (potential for contamination to have been tracked in) put on PPE recommended by the RPA. The default PPE is coverall, overshoes and disposable gloves. If the RMU is not in operation, this action can be left until the last action before going operational.
- Ensure personal dosimeters are being worn.
- Put in place ‘tacky’ mats or other sacrificial coverings at key locations doorways and at monitoring stations.
- Ensure good background measurements are established and subtracted from all measurements accordingly.

The team leader should report to the RMU Manager and do the following:

- Agree location and function of monitoring staff.
- If a gatekeeper portal is not being used (stage 1 monitoring), ensure an alarming dose rate instrument is located at the RMU entrance to detect any large amounts of activity immediately should it be brought into the RMU (this is suitable for gamma emitting radionuclides only).
- In collaboration with RPA, agree clean and ‘dirty’ routes for individuals and items.
- Agree unique individual identification system to be used and associated documentation.
- Determine Action Levels to be used (see section 4.4.1 of main document).
- Obtain information on the arrangements for decontamination and dealing with contaminated clothing and other items.
- Agree unique individual identification system to be used and associated documentation.
- Brief staff on above.

M5 MONITORING WITH HANDHELD EQUIPMENT FOR EXTERNAL CONTAMINATION - COMMON INSTRUCTIONS

The following section details the actions common to monitoring with handheld equipment for external contamination for the three monitoring methods described in sections M5.1, M5.2, M5.3.

Handheld monitoring is generally performed by pairs of staff with the suggested roles and procedures listed below. Only one needs to be scientific staff (the operator), the other (recorder) transfers results to record forms:

- Operator :
    - Indicates when ready for the next individual.
    - Follows allocated monitoring procedure.
    - Confirms measurement made and recorded.
    - States to individual if “Above” any action level.
- Recorder:
    - Completes external contamination measurement report form (appendix B).
    - Directs individuals that are:
        - Above Upper Action Level for urgent decontamination and medical assessment. A detailed external contamination survey should be made after decontamination and decontamination procedures repeated if necessary.
        - Above Lower Action Level but below Upper Action Level for decontamination. A detailed external contamination survey should be made after decontamination and decontamination procedures repeated if necessary.
        - Below Lower Action Level to next stage or exit as appropriate.
    - Tells each person that they will be given an information sheet at the end (appendices E,H and I as required).
- The Team Leader will arrange periodic rotation of staff for rest breaks and meals.
- The RPA will advise on removal / change of PPE and routine contamination control checks.

There are three types of scan that can be performed depending upon the function of the team (stage 1 or 2 monitoring) and the demands placed upon the RMU. The RMU manager will advise the monitoring team leader as to which monitoring type should be used:

1. Rapid Scan
2. Standard Scan
3. Detailed Entire Body

These are detailed below in M6.1, M6.2 and M6.3 respectively.

M5.1 Monitoring of people for external contamination - rapid scan to Identify those who need urgent decontamination with handheld equipment

This procedure is only suitable for incidents involving gamma-emitting radionuclides.

This procedure is used to quickly identify those in need of urgent decontamination to avoid deterministic effects or large doses if some of the activity is ingested. This scan should take about 20 seconds.

Carry out this procedure as soon as possible on all affected people.

Using a large detection area instrument capable of detecting alpha, beta or gamma radiation, rapidly scan (in about 20 seconds) the body at a distance of about 30 cm, concentrating on head, hands, elbows, feet, buttocks.

If a predefined action level is exceeded then send the person immediately to the decontamination area first removing and bagging shoes if they are contaminated; overshoes should be provided.

Record measurements only if the action level is exceeded.

M5.2 Monitoring people for external contamination – standard scan with handheld equipment

This procedure is designed to detect radioactive material on areas which are most likely to be contaminated. This scan should take 1-2 minutes.

Use a suitable contamination monitor, suitable instruments will depend on the radionuclide.

Hold the survey meter probe about 2-5 cm (for alpha monitoring about 1 cm) away from the body.

Slowly move the probe at about 5 cm per second over the areas to be monitored. Do NOT touch any potentially contaminated surfaces.

Pause the probe for about five seconds at locations most likely to be contaminated and areas identified as contaminated.

Record measurements above background on attached form.

The following areas must be monitored:

- Start with the face, top and sides of head (pause at mouth and nose for approximately five seconds (high readings may indicate internal contamination).
- Front of the neck and shoulders.
- Right hand – palm and back (pause at palm for about five seconds).
- Left hand – palm and back (pause at palm for about five seconds).
- Back of the neck and shoulders.

Record measurements above background on External Contamination Survey Report form (Appendix B).

M5.3 Monitoring people for external contamination – detailed entire body scan with handheld equipment

This procedure is a careful and comprehensive scan of a person for external contamination. This scan should take about 5 minutes.

Use a suitable contamination monitor. Suitability will depend on the radionuclides involved.

Hold the survey meter probe about 1 cm away from the body.

Slowly move the probe at about 3- 5 cm per second over the areas to be monitored. Do NOT touch any potentially contaminated surfaces.

Person to be monitored should stand with their legs spread and arms extended, with palms facing forward.

A consistent procedure should be followed to ensure all the following areas of the body are monitored (see figure M1):

- Top and sides of head, face (pause at mouth and nose for approximately five seconds; high readings may indicate internal contamination).
- Front of the neck and shoulders.
- Down front of one arm (pause at palms for about five seconds) and back up the outside.
- Repeat for other arm.
- Across trunk working from shoulders downwards.
- Down front of one leg, over top of foot (pause for about five seconds) and back up the inside of the foot and leg.
- Repeat for other leg and foot.
- Back of head.
- Back of the neck and shoulders.

- Down back of one arm (pausing at elbow), and back up the inside.
- Side of trunk.
- Repeat for other arm and side of trunk.
- Across back working from shoulders downwards.
- Down back of one leg, monitor sole of shoe (pause for about five seconds) and back up the outside of the foot and leg.
- Repeat for other leg and foot.

Record measurements above background on External Contamination Survey Report form (Appendix B).

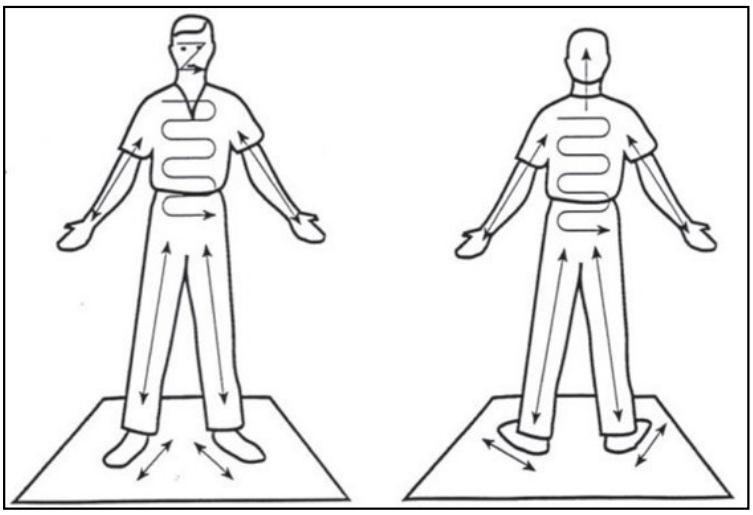


Figure M1. Procedure for entire body scan with handheld instruments.

M6 MONITORING WITH PORTAL EQUIPMENT FOR EXTERNAL CONTAMINATION

If portals are not already set up then see section M6.1.

Portal monitoring is generally performed by 3 staff with the suggested roles and procedures listed below. Only one needs to be scientific staff (the operator):

- The Front End Marshaller:
    - Regulates the flow of people and explains to each individual what to do when going through the portal; including
    - How long to reside in the Portal.
    - Not to touch the Portal.
- Operator:
    - Indicates when ready for next individual.
    - Confirms valid measurement made and recorded.
    - States to individual and Onward Director “Below” or “Above” .
- Onward Dispatcher directs individuals that are
    - “Below” to next stage or exit as appropriate.
    - “Above” to Decontamination.
    - Tells each that they will be given an information sheet at the end (appendices E, H and I as necessary).

The monitoring team leader should:

- Brief staff: to include known scenario to date, role(s) of team within RMU or similar and details of other Personal Monitoring teams to be deployed.
- Consider health and safety information for team members.
- Review any handouts that are to be given out to the public for appropriateness.
- Arrange periodic rotation of staff for rest breaks and meals.

Portal monitoring staff should:

- Try and avoid contact with those going through the system and any items they have with them.

- The RPA will advise on removal / change of PPE and routine contamination control checks.

M6.1 Setting up portal monitors

Perform the following to ready the portals for use:

- Assemble portals at assigned locations.
- Ensure a minimum 3m separation between Portals and flow routes of potentially contaminated individuals.
- Connect to PC data system if available.
- Get Portal to acquire Radiation Background.
- Confirm operational efficiency with “check-source”.
- Confirm operational parameters are available and known.
- Desired residence time in portal in seconds.
- Switch off alarms.
- Put in place “tacky” mats or other sacrificial coverings, particular on the Portal stand pad, as directed by the RPA.

M7 THYROID MONITORING WITH HAND-HELD EQUIPMENT

Thyroid monitoring with hand-held equipment is generally performed by 2 staff with the suggested roles and procedures listed below. Only one needs to be scientific staff (the operator):

- Operator:
    - Indicates when ready for next individual.
    - Follows procedure in section M9.6
    - Confirms measurement made and recorded.
    - States to individual if “Above” any action level.
- Recorder:
    - Completes thyroid measurement report form (appendix C).
    - Directs individuals that are:
        - Above Upper Action Level for more accurate measurements and medical assessment.

- Above Lower Action Level but below Upper Action Level for more accurate measurements.

- Below Lower Action Level to next stage or exit as appropriate.

- Tells each person that they will be given an information sheet at the end (appendices E, H and I as necessary).

The Team Leader will arrange periodic rotation of staff for rest breaks and meals.

The RPA will advise on removal / change of PPE and routine contamination control checks.

M7.1 Specific resources

- Hand-held scintillation detectors (e.g. NaI based). HPA-CRCE can advise on suitable instruments.

- Thin film to cover the instrument probe.

- Chair for the subject (if needed by the subject) covered in polythene sheet.

M7.2 Thyroid monitoring procedure

- Record the average environmental background count rate by holding the probe in the monitoring area, but not close to any people or objects and recording the average reading by observing for about 15 seconds. This measurement should be repeated as often as possible.

- For each subject record the average subject thyroid count rate with the subject standing or sitting, Hold the probe over the thyroid with the probe close to the skin but not touching (see figure M2).

- If the average thyroid count rate is less than twice the environmental background count rate. Then radioiodine has not been detected.

- If the average thyroid count rate is greater than or equal to twice the environmental background count rate, measure the average body background count rate. With the subject standing or sitting measure the count rate on the lower thigh, using the same instrument (see figure M3). The probe to skin distance should be the same as used for the thyroid measurement.

- If the average thyroid count rate is greater than or equal to the twice the average body background count rate then radioiodine has been

detected and the subject net count rate is the average subject thyroid count rate minus the average body background count rate.

- Complete thyroid measurement report form (appendix C).
- Compare the subject net thyroid count rate with the Upper Action Level and Lower Action Level, and direct individual as appropriate.

Figure M2. Measurement of radioiodine in the thyroid.

Figure M3. Measurement of body background.

M8 INTERNAL MONITORING WITH HAND-HELD EQUIPMENT

Internal monitoring with handheld equipment is generally performed by 2 staff with the suggested roles and procedures listed below. Only one needs to be scientific staff (the operator):

- Operator:
    - Indicates when ready for next individual.
    - Follows procedure in section M10.6.
    - Confirms measurement made and recorded.
    - States to individual if “Above” any action level.
- Recorder:
    - Completes whole body measurement report form (appendix D).
    - Directs individuals that are:
        - Above Upper Action Level for more accurate measurements and medical assessment.
        - Above Lower Action Level but below Upper Action Level for more accurate measurements.
        - Below Lower Action Level to next stage or exit as appropriate.
    - Tells each person that they will be given an information sheet at the end (appendices E, H and I as necessary).
- The Team Leader will arrange periodic rotation of staff for rest breaks and meals.
- The RPA will advise on removal / change of PPE and routine contamination control checks.

M8.1 Specific resources

- Hand-held scintillation detectors (E.g. NaI based). HPA-CRCE can advise on suitable instruments.
- Chair for the subject (if needed by the subject) covered in polythene sheet.

M8.2 Operation

M8.3 Monitoring procedure

- Record the average background count rate by holding the probe 30 cm from the chest of a person known not to be contaminated in the monitoring area. Record

the average reading by observing for about 15 seconds. This measurement should be repeated as often as possible.

- For each subject record the average subject count rate with the subject standing or sitting, Hold the probe approximately 30 cm from the centre of the chest.
- If the subject count rate is greater than or equal to twice the background count rate, then contamination has been detected. The subject net count is the average subject count rate minus the average background count rate. If the average subjects count rate is less than twice the background count rate then internal contamination has not been detected.
- Complete whole body measurement report form (appendix D).
- Compare the subject net count rate with the Upper Action Level and Lower Action Level, and direct individual as appropriate.

APPENDIX N RPA system of practices

The RPA will issue advice and ensure compliance with all relevant radiation protection legislation, including occupation exposure considerations and disposal of radioactive waste.

The RPA is responsible for providing advice on the following areas:

- Contamination control arrangements.
    - Any necessary links to those at the RMU carrying out decontamination of individuals and dealing with contaminated items and clothing.
    - Active waste management arrangements.
- Briefing staff on contamination control measures
- A suitable programme of monitoring and other measures to demonstrate the continued efficacy of the contamination control measures.
- Liaising with the Senior RPA from HPA.
- Briefing the Personal Monitoring Manager on relevant issues.
- Supporting the RMU manager in determining arrangements to decommission the RMU

Note: A resource compromised busy RMU runs the risk of changing the role of the RPA from advisor to implementer. Avoidance of this if at all possible should be specified.

APPENDIX O Radiation Protection Supervisor (RPS) system of practices

The RPS role is a supervisory one. RPS duties are duties in addition to those already held by a member of the RMU staff.

The RPS should have authority with the staff they are supervising and a good understanding of the practices they are being asked to supervise.

- The RPS shall supervise the work of individual staff or work performed in a particular area in accordance with instructions provided by their employer.

APPENDIX P Receiving staff system of practices

Receiving staff will be the first RMU staff that RMU attendees are likely to come into contact with. Their role is to ease the transition of the public into the RMU and flow of the public through the RMU.

As directed, receiving staff may be responsible for:

- Giving appropriate directions to people at the entrance to the unit.
- Assigning each person a subject code (ID number) via barcode or numbered card. This number is used to identify the person uniquely and must be entered on all forms associated with the person which are used at the RMU.
- If a person is identified as someone who has been asked to evacuate or shelter, or who has been offered stable iodine, then that person should be sent immediately for the rapid screening measurement to the front of any queue at the RMU entrance.
- Sending people one at a time for stage 1 screening as requested by the monitoring staff.
- If required, for each person, pass on the report forms from one monitoring stage to the next as the individual being monitored moves.
- Do not step onto covered floor areas.
- Receiving staff members should at the end of their shift pass through the monitoring areas to be checked for contamination before leaving the unit.

APPENDIX Q Registry staff system of practices

Registry staff are to collect personal information as required by the RMU manager. The exact information required may be incident specific and depend upon the amount of information being collected in any reception centre attached to the RMU.

Generally, for each person the data collected will comprise at least: name, date of birth and home postcode.

The method of data collection may vary, with training in any specific system used locally to be provided by the supplier of the system. The simplest collection system will be using the External Contamination Report (Appendix B).

APPENDIX R Decontamination staff system of practices

The function of the Decontamination Team will be to supervise and assist people with decontamination procedures. For decontamination done very soon after the incident, this role may be performed by the emergency services. For decontamination at locations away from the incident, only simple techniques are needed so personnel are unlikely to require specific training.

If necessary, inform Decontamination Team members that concerns about their own radiation exposure resulting from cross contamination must not prevent people decontamination procedures from taking place.

R1 COMMON INSTRUCTIONS FOR DECONTAMINATION

Most external contamination (around 90 %) is usually removed with clothing and the remaining skin contamination is usually easily removed by washing. Normal saline solution or a mild detergent is generally sufficient. Mechanical and/or thermal trauma to the skin from the decontamination process should be avoided; it is better to use flushing and/or friction of cloth, sponge or soft brush, starting with a gentle stream of warm water.

Hair and nails can be difficult to decontaminate because particles may become lodged under the nails and become attached to the hair. Protein based shampoos with conditioners should be avoided since they coat the hair with a layer of protein and can fix contaminants in place (these are sometimes labelled as “volumising” shampoos).

Natural orifices need special attention because absorption of radioactive material is more rapid than through intact skin.

The decontamination facility should be established in an area with showering facilities, ideally with separate areas for males and females.

1. People awaiting decontamination should be advised not to eat, drink or smoke and keep hands away from mouth, until decontamination procedures are complete. If an individual needs to drink, the suggested method for consumption of liquid is by using straws and a bottle with a narrow opening.

2. While people are waiting for decontamination, they should be given moist wipes with instructions for washing the face and hands. Bags for disposal of used wipes must be provided.

3. Plastic bags for valuables (keys, wallet, prescription medicines etc.) must be provided for all people, before they are decontaminated. These should accompany the person throughout decontamination procedures and should be labelled to identify the owner.

4. A measurement form for each person must be completed (an example form that can be customised is provided in Appendix B). This should include a reference to any bags containing contaminated belongings of the person (and bag labelled with subject code).

5. Any bags containing contaminated items should be labelled with the estimated activity, the name of the radionuclide and the date of the measurement.

6. People undergoing decontamination procedures must be issued with information on where to get further information and instructions when released [appendices E, H and I as necessary].

7. If possible, a receipt should be issued for contaminated clothing.

R1.1 Solutions for skin washing

- Common soap and water.
- Mild detergent solution, low acidity (pH ~5) recommended.

  Non-soap emollient skin cleansers and water.

R1.2 Specific resources

See section 3.3.5 of main document.

R2 DECONTAMINATION OF SMALL NUMBERS OF PEOPLE

Provide each person with instructions to:

1. Remove all clothing and place it in a plastic bag, which should then be tagged and sealed.

2. Gently blow nose and wash out eyes and ears.

3. Shower thoroughly with warm (not scalding hot) water and soap, allowing the water to run away from the face. Wash hair, but do not use hair conditioner as this would fix the contamination to the hair.

4. Use the mechanical action of flowing water and/or a cloth, sponge or soft brush.

5. Avoid causing mechanical, chemical or thermal damage to the skin.

6. Change into clean clothing.

Then:

Re-monitor the person and identify those who may require further monitoring with the Whole Body Monitor. Wash out shower between people.

R3 DECONTAMINATION OF LARGER NUMBERS OF PEOPLE

Provide each person with instructions to:

1. Remove all clothing and place it in a plastic bag, which should then be tagged and sealed.

2. Gently blow nose.

3. Wash face and hands with water or a damp cloth.

4. Change into clean clothing.

5. Individuals with long hair may be issued with plastic shower caps (if available) to contain any contamination until decontamination at home is performed.

6. Follow procedure for decontamination at home when released

The bagged clothing is not likely to be heavily contaminated, but it may form a source of irradiation for the public. There may be a need for later contamination monitoring of the clothes. A course of action will need to be decided after the radiological assessment of the incident. It may be possible to return clothing to use after laundering, but it may also be necessary to treat it as radioactive waste.

R4 SELF DECONTAMINATION

If people self-evacuate or are allowed home, they can be provided with simple instruction to remove contamination from skin and clothing.

Guidance must be given to the relevant population through the media (television, newspapers, teletext, radio, or telephone/internet based healthcare service e.g. NHS Direct, on what to do and how to perform their own decontamination. This guidance should include the following:

- Explain that, like dirt, most contamination washes off with soap and water. They should be advised to act as if they were going home in clothes covered with mud and did not want to spread it into their homes; and provide instructions for them to:
    - Remove outer clothing at an outside doorway or if impractical behind the closed outer door
    - Remove clothing and place it in a plastic bag which should then be sealed and placed in a store, away from the living areas
    - Gently blow nose and wash out eyes and ears.

- Shower or bath thoroughly with warm (not scalding hot) water and soap, allowing the water to run away from the face. Wash hair but do not use hair conditioner as this will fix the contamination to the hair.
- Use the mechanical action of flowing water and/or a cloth, sponge or soft brush
- Avoid causing mechanical, chemical or thermal damage to the skin (e.g. scrubbing too hard)
- Change into clean clothing
- Wash out bath or shower
- Wash car if they drove home from the area of contamination
- Tune in to television or radio for further instructions.

The bagged clothing is not likely to be heavily contaminated, but it may form a source of irradiation for the public. There may be a need for later contamination monitoring of the clothing. A course of action will need to be decided after the radiological assessment of the incident. It may be possible to return clothing to use after laundering, but it may also be necessary to treat it as radioactive waste.

APPENDIX S Public liaison staff system of practices

Public liaison staff are appointed by the RMU manager as appropriate. The role of these staff is to answer questions related to the RMU, the monitoring process and to a limited degree the result of any monitoring.

They may be asked to disseminate handouts or specific instructions to those attending the RMU.

APPENDIX T Typical monitoring equipment

Organisations involved in monitoring are expected to bring their own instruments that they are familiar with and competent in using. These instruments should be appropriately calibrated and well maintained. Each instrument should be subject to a function check prior to use; battery and response to background.

The following sections detail typical instruments that might be used and for what situations they might be used along with annexes giving more information on the instruments method of use.

T1 HANDHELD MONITORS

Using the methods described in Appendix K, each monitoring team, using hand held instruments (see figure T1), could monitor up to about 20 people per hour. This approach should be considered if:

- Portal monitors are not available; or
- Alpha or beta contamination is present without the presence of gamma-emitting radionuclides suitable for detection with portals.

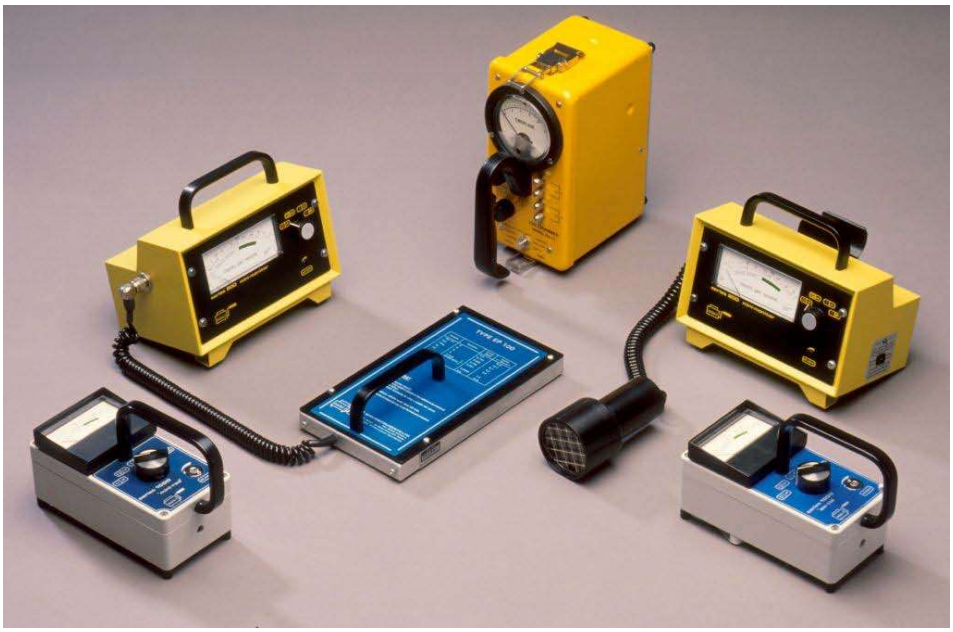


Figure T.1. Example handheld radiation monitors for external contamination monitoring/screening.

T2 PORTAL MONITORS

A portal monitor is a specialist item of monitoring equipment, potentially capable of monitoring more than 150 people per hour (see figure T2). It should be used, if available and suitable, to categorise potentially contaminated people when:

- The contamination includes nuclides which result in the emission of photons at an energy greater than 200keV.
- The number of potentially contaminated people requiring monitoring greatly exceeds other monitoring resources (either personnel or equipment); and/or
- High action level values are permissible (portal monitors are of limited sensitivity particularly at gamma energies below 200 keV).

Figure T2. An example portal monitor. The HPA currently have ten in total distributed amongst their centres.

T3 WHOLE BODY MONITORS

A Whole Body Monitor (WBM) is a specialist radiation monitor for detecting gamma emitting radionuclides within the body (see figures T3,T4,T5.). These usually have a spectrometry capability that will allow identification of which radionuclides are present.

Two types may be deployed to an RMU, the transportable Whole Body Monitor (tWBM) or portable Whole Body Monitors (pWBM). The tWBM is larger and more difficult to deploy, requiring the use of two trailers and a supply of liquid nitrogen. The pWBMs will readily fit in the boot of a car.

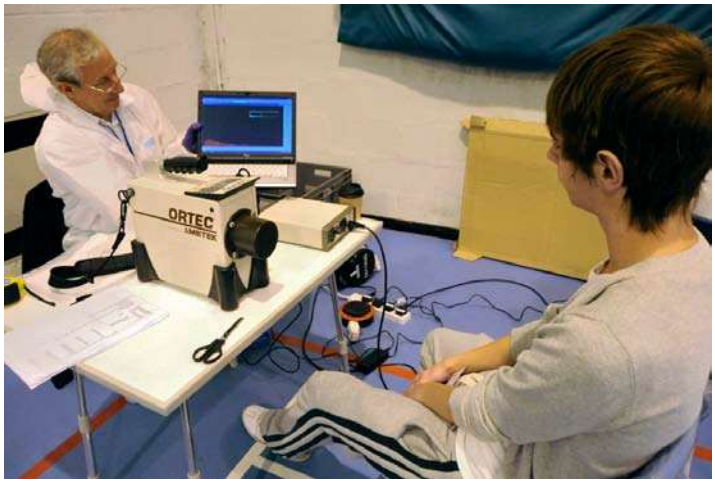


Figure T3. A portable Whole Body Monitor (pWBM) in use during an exercise. The model shown is an Ortec 'Detective'.

Figure T4. A transportable Whole Body Monitor (tWBM). In use during an exercise. This is a custom made instrument developed by the HPA.

Figure T5. The transportable Whole Body Monitor requires two trailers to deploy.

APPENDIX U Ambulance and hospital casualty handover form

CASUALTY MONITORING RESULTS FORM

CASUALTY CONTAMINATION STATUS		
Green	No radioactive contamination present	
Amber	Radioactive contamination has taken place but has been removed and is no longer externally detectable.	
Red	Radioactive contamination has been detected and remains by virtue of injury	

CONTACT TELEPHONE No

Casualty Family Name _____

Casualty Given Name _____

Date of Birth _____

Sex ☐ **M** ☐ **F**

Works Reference No. _____

Date of Event _____

Location of Event _____

Description of Event _____

_____

Name of Radioactive Substance _____

Type of Ionising Radiation ☐ **alpha** ☐ **beta** ☒ **gamma**

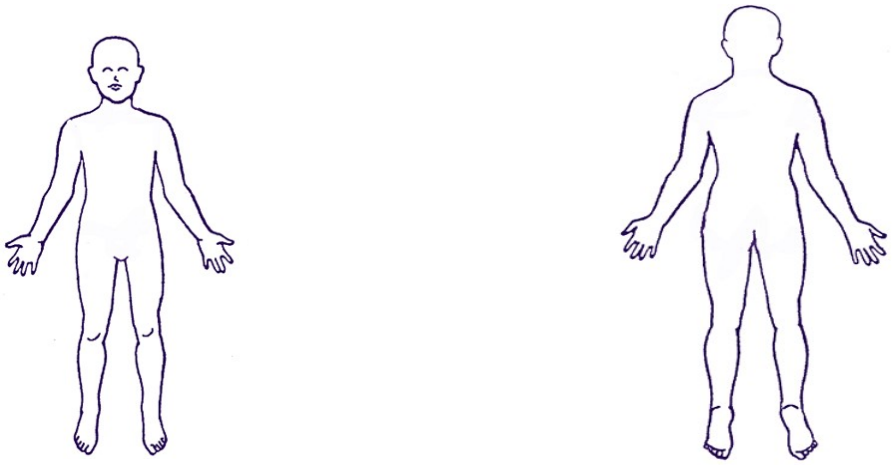
Time Decontamination Began _____

Time Decontamination Ended _____

Contaminated Clothing Removed ☐ **Y** ☐ **N**

SURFACE CONTAMINATION MONITORING OF CASUALTY

INDICATE AREAS OF CONTAMINATION ON THE CASUALTY BY MARKING THE BODY DIAGRAMS BELOW WITH A LETTER FROM ONE OF THE TABLES BELOW AND PLACE THE READING OBTAINED IN THE BOX BELOW THE LETTER. (The same letter can be used on the Body Diagrams where readings are found to have the same numeric value.)IF CASUALTY IS TO BE TRANSFERRED TO HOSPITAL RAM GENE SHOULD ALSO BE USED.



BODY LOCATION											
	A	B	C	D	E	F	G	H	I	J	K
RAM GENE c.p.s.											
Electra DP2 Bqcm^{-2}											
Wound Probe Bqcm^{-2}											
Mini Rad dose rate at 30 cm from casualty µSv/hr											

Decontamination carried out by: Sign: Print:

Monitoring carried out by: Sign: Print: