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CFRA
CHIEF FIRE & RESCUE ADVISER

Fire and Rescue Service Operational Guidance

GRAs

generic risk assessments

GRA 5.5

Incidents involving radiation

Generic Risk Assessment 5.5

Incidents involving radiation

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SECTION 1

GRA 5.5 Radiation

Scope

This generic risk assessment examines the hazards, risks and control measures relating to Fire and Rescue Service personnel, the personnel of other agencies and members of the public when dealing with incidents involving radioactive materials.

Depending on the nature and scale of the operational incident a variety of significant hazards may be present. Fire and Rescue Services may need to consider the contents of other specific generic risk assessments in this series. You should therefore consider this generic risk assessment in conjunction with all other relevant assessments.

Incidents involving terrorist activity and deliberate release are covered in specific procedures (New Dimension/Chemical, biological, radiological, nuclear).

Fire and Rescue Services must conduct their own assessments and produce their own Safe Systems of Work (which include Standard Operating Procedures, training programmes, provision of equipment, levels of response etc.) within the context of integrated risk management plans, local conditions, knowledge and existing organisational arrangements.

Significant hazards and risks

The hazard to firefighters attending radiation incidents is irradiation or contamination from radioactive materials.

The hazards and level of risks that Fire and Rescue Service personnel face when attending incidents involving radioactive materials are dependant on the following:

Types of radiation

Radiation is the general term given to the process by which energy is transmitted away from an energy source. The term can equally be applied to heat, light, sound, microwave, radio or atomic sources of energy. This guidance is only concerned with the radiation arising from atomic sources as these uniquely have the property of causing ionisation when they interact with other substances and are often referred to as 'ionising radiations'.

Ionising radiation generally arises by one of two processes:

- radioactivity
- X-ray emission.

RADIOACTIVITY

This is the phenomenon by which unstable isotopes[1] of some atoms break down to form a more stable isotope of a different atom by expelling a small amount of matter from the nucleus (centre) of the unstable atom. Although there are several ways in which this can occur, by far the most dominant are by alpha emissions or by beta emissions. Shortly after an alpha or beta emission has occurred it is usually, but not always, followed by a gamma emission. Radioactive materials continue to undergo this process, often many millions of times per second until all the original unstable atoms have changed into the new stable atoms whereupon the radioactive material ceases to exist. Radioactivity cannot be destroyed other than by allowing it to decay away. The time taken for a radioactive source to reduce to half its original quantity is known as the half life. If a radioactive material is burned in a fire, the equivalent amount of radioactivity will still exist in the smoke and the ash.

X-RAY EMISSION

This occurs when electrons are accelerated by high voltages inside an evacuated tube and are allowed to collide with a target made from a heavy metal, usually tungsten. The energy associated with the colliding electron is transmitted to the tungsten target and stimulates the emission of an X-Ray from the target metal. Since X-rays can only be created through the application of a very high voltage, as soon as the electrical power is switched off, all X-ray emission ceases.

Radiological emergency incidents differ to other hazardous materials incidents in the following ways:

- firefighters generally have no experience with radiation emergencies as they are very rare
- even very low levels of radiation, that pose no significant risk, can be detected rapidly with simple, commonly available instruments
- radioactive materials can cause radiation exposure even when firefighters are not in contact with them
- the health effects resulting from radiation exposure may not appear for days, weeks or even years
- the public, media and firefighters often have an exaggerated fear of radiation.

[1] Isotopes are different forms of the same atom which are distinguished by having different numbers of neutrons in the nucleus but the same number of protons.

Characteristics and classification

When describing radioactive processes extremely large numbers and very small numbers are frequently discussed therefore it is necessary to be able to use multiples and sub multiples of the units used.

Commonly used multiple and sub multiples			
Fraction or multiple	**Number**	**Prefix**	**Symbol**
10^{-9}	0.000,000,001	nano-	n
10^{-6}	0.000,001	micro-	µ
10^{-3}	0.001	milli-	m
10^{0}	1		
10^{3}	1000	kilo-	k
10^{6}	1,000,000	mega-	M
10^{9}	1,000,000,000	giga-	G
10^{12}	1,000,000,000,000	tera	T
10^{15}	1,000,000,000,000,000	peta	P

As described above, there are in effect three types of radiation arising from radioactivity.

Types of radiation arising from radioactivity

Alpha radiation
Has the greatest ionising potential of the three types. However, partly because of this, it has very poor penetrating power. Typically, alpha radiation can only travel about 3 cm in air and is completely absorbed by very thin layers of other materials e.g. paper, layers of dead skin, or water droplets.

Beta radiation
Has moderate ionising power. The penetrating range of beta radiation in air is approximately 1 m. It is fully absorbed by relatively small thicknesses of metals and plastics (e.g. 1 cm thick Perspex)

Gamma radiation
Has the lowest ionising potential of the three types but by far the greatest penetrating power. Gamma radiation will travel many hundreds or even thousands of metres in air. It is capable of passing through solid materials such as brick, concrete and metals although it will be attenuated as it does so. The more matter it passes through, the more its intensity is reduced. For this reason, dense metals such as lead or steel are the most efficient at absorbing gamma radiation.

(There are other nuclear processes which give rise to radioactive emissions but these are much less common and are therefore beyond the scope of this guidance)

When measuring radiation (alpha beta, gamma or X-ray) there are two properties which need to be classified, the activity (or strength) of the source and the dose (or amount) of ionising energy which is being absorbed by the body.

The modern unit of activity which has been adopted throughout Europe is the Becquerel (abbreviated as Bq). All radioactive sources found in the UK legally have to be measured in Becquerels. The Becquerel is however, an extremely small quantity (it is defined as 1 nuclear disintegration per second) and most sources will have activities of thousands, millions, billions or even trillions of Becquerels. This means that the usual SI multiples kilo, mega, giga, tera etc. are often encountered when recording the activity of a source. It should however be noted that an older unit, the Curie, is sometimes encountered particularly if the source originally came from the USA. Becquerels and Curies measure the same dimension in much the same way as centimetres and miles measure the same dimension but on a different scale and magnitude of measurement.

The modern unit for measuring the radiation dose received by a person that has been adopted throughout Europe is the Sievert (Sv). All personal dose (and dose rate) measurements legally have to be expressed as Sieverts. In contrast to the Becquerel, the Sievert is a very large unit, and the common SI sub multiples of milli and micro are commonly encountered.

Most hand held monitoring equipment measures the dose rate, which is the speed at which dose is being accumulated, although it is only the total dose received which is relevant as the cause of health problems.

A simple analogy which may assist firefighters in understanding the difference between Dose and Dose Rate is a journey in a car;

- the Dose, usually measured in millisieverts (mSv), a firefighter has received can be compared to how far you have travelled as shown on the car's odometer (miles)
- the Dose rate, usually measured in millisieverts per hour (mSv/hr), can be compared to how fast you are travelling at any given moment as shown on the car's speedometer (miles per hour).

Hazards

There are two principal hazards which arise from radioactivity, regardless of the type of radiation. These are:

- irradiation – which presents an external risk (i.e. from outside the body)
- contamination – which presents both an internal (i.e. inside the body) and possibly an external risk.

Irradiation

Irradiation is mainly a problem with materials which emit gamma radiation or from X-ray machines. Ionising energy is radiated out from the source and passes through a person's body. As it does so, some of the energy is absorbed by the body tissues and the ionising properties can cause chemical changes in human cells. This can lead to damage and possibly disease. The source material however, never enters the body but a “hazardous materials exposure” has occurred and a radiation dose will be received.

Radioactive contamination

Contamination is a potential problem with any radioactive material except electrically generated X-radiation. If a material which contains radioactive isotopes are in a form which is easily dispersed (i.e. dusts, powders, liquids, gases) the radioactive substance can become attached to the exterior of the body by direct contact or airborne dispersion (e.g. dust, spray, mist etc.). It may also enter the body through inhalation, ingestion or through an open cut or wound. In this sense, internal radioactive contamination poses much the same threat as any other chemical toxin or “hazardous materials exposure”. Once inside the body, alpha and beta emissions, which were not considered high risk in terms of external contamination, may produce damaging ionising radiation directly into the cells of the lymph system, blood and internal organs.

Sealed and unsealed sources

It is important for emergency responders to make a distinction between sealed (closed) sources of radioactivity and unsealed (open) sources of radioactivity.

- **Sealed sources** – A sealed source is a radioactive source that is encapsulated into a solid material, usually metal. The encapsulation is intended to prevent the escape of radioactive material while allowing the radioactive energy to pass through. Sealed sources are designed to withstand rough handling and elevated temperatures without releasing the radioactive material. Because the radioactive source substance is encapsulated or plated onto a surface, sealed sources do not present a contamination hazard under normal conditions, however, they can present an irradiation hazard.
- **Unsealed sources** – Unsealed sources consist of powders, liquids or sometimes gases which contain radioactive elements and which could easily be released from their containers through leaks and spillages and dispersed into the environment. The main hazard with unsealed sources is contamination although there may also be a significant irradiation hazard from the bulk material
- **Shielding** – Both sealed and unsealed sources are generally stored or transported in such a way that they are ‘shielded’ by solid materials, usually their containers. These prevent or limit irradiation hazards. If a source’s shielding is removed or damaged the radioactive hazards are increased.

Damage caused by radiation

The damage caused by radiation may be divided into two different categories

- deterministic
- stochastic (or probabilistic).

Deterministic effects are those which occur at a relatively high dose and the severity of the effect is proportional to the dose. In all cases it is necessary to exceed a threshold dose before the effect is experienced at all. The most common effects in this category are skin reddening, hair loss, impaired fertility, lowered blood count, nausea, vomiting and diarrhoea. The threshold for detectable deterministic effects is about 100mSv. At this level no symptoms would be exhibited but tests on blood may start to show signs of damage. As dose levels increase the severity of effects and the rapidity of their onset increases. Doses above 5,000 millisieverts in a short period of time are life threatening.

Stochastic effects are those where the probability of experiencing the effect is proportional to the dose but the severity of the effect is independent of the dose. The most common effect in this category is cancer, The likelihood of contracting cancer increases with the dose but the severity of the disease is the same irrespective of the dose that caused it. Genetic effects are also believed to be stochastic although these have never been demonstrated in humans. As such it is assumed that any level of dose of radiation carries some risk and therefore all doses need to be kept as low as possible.

In summary, if the total dose is kept below 100 millisieverts, there will be no risk of any immediate effects such as skin reddening, hair loss, reduced fertility, nausea etc. However, the maximum annual dose to all radiation workers (male and female) is 20 mSv. There is an additional limit on females of reproductive capacity of 13 mSv in any three month period. The reason for this additional restriction is to protect a recently conceived foetus within a female who may be unaware of her pregnancy. In this sense it is not so much a restriction designed for the protection of females but is a restriction to protect a foetus.

Under the Ionising Radiation Regulations 1999 (IRR99), further restrictions apply to females who have announced they are pregnant or breast feeding but it is assumed that female firefighters would not be used in an emergency operational capacity once the pregnancy was declared (See Chapter 3 for further information).

NOTE:
All doses referred to in this document are whole body doses unless otherwise stated. The IRR99 allow for higher annual doses if the radiation is delivered only to localised parts of the body. However, this is a very specialised area of workplace safety and is beyond the scope of this guidance document.

Summary of whole body dose and effect		
Dose	**Effect**	**Comments**
5 Sieverts (5,000 mSv, or 5,000,000 µSv)	Probable lethal dose	Very dependent on rate of delivery and health of individual
3 Sieverts (3,000 mSv or 3,000,000 µSv)	Erythema (skin reddening)	May not appear for several days
3 Sieverts (3,000 mSv or 3,000,000 µSv)	Depilation (Hair loss)	Temporary between 3 and 7 Sv; permanent above 7 Sv
1 Sievert (1,000 mSv, or 1,000,000 µSv)	Threshold for radiation sickness	Dependent upon other factors e.g. health, rate of delivery, skin type etc
700 mSv (700,000 µSv)	Threshold for temporary sterility	Can be permanent at higher doses in excess of 3 Sv
100 mSv (100,000 µSv)	Chromosomal changes in blood cells detectable. Small increase in existing cancer risk	Minimum dose at which any physical changes can be detected. No noticeable effects by the person receiving the dose
5 mSv (5000 µSv)	Very small increase in overall cancer risk	No immediate observable effects
NOTE: This table is designed to give a general awareness of the order of magnitude required for various effects to be observed and should only be regarded as a very approximate guide. In practice there are likely to be many other factors which would influence the response to various levels of dose.		

Ionising Radiation Regulations 1999 (IRR99)

The Ionising Radiation Regulations are made under the Health and Safety at Work Act. They place a duty upon the employer (i.e. the Fire and Rescue Authority) to put in place systems to ensure that its employees are protected from excessive exposure to radiation. As part of the pre-planning procedure Fire and Rescue Services must have a written procedure stating how they will manage a radiation incident and stating how they intend to discharge their duties under the ionising radiations regulations. In particular the document must address the following points:

Dose Limits

The maximum annual dose to all radiation workers (male and female) is 20 mSv. Firefighters attending a radiation incident fall under the definition of a radiation worker. There is an additional limit on females of reproductive capacity of 13 mSv in any three month period. The reason for this additional restriction is to protect a recently conceived foetus within a woman who may be unaware of her pregnancy. In this sense it is not so much a restriction designed for the protection of females but is a restriction designed to protect a foetus.

Further restrictions apply to females who have announced they are pregnant or breast feeding but it is assumed that female firefighters would not be used in an emergency operational capacity once the pregnancy was declared.

Dose Constraints

The regulations stipulate that, where appropriate to do so at the planning stage, dose constraints are used to restrict exposure to radiation as far as is reasonably practicable. This dose constraint will usually be significantly lower than the legal dose limits. Fire and Rescue Services should consider any possible operations not involving situations immediately threatening to life where they may wish to impose a dose constraint below the legal annual limit. This could possibly be the case at a protracted incident or if it was considered possible that crews may have to attend more than one radiation incident within a 12 month period.

It is recommended that a dose constraint of 5 mSv per incident is introduced at operational incidents. The reasons for this level of constraint are:

- it corresponds to the alarm setting on the Electronic Personal Dosemeters, supplied through the Fire and Rescue Service National Resilience project, which would naturally prompt staff to leave the Hazard Zone
- it is in line with dose reference levels used by the ambulance service
- it does not legally preclude female firefighters from entering the Hazard Zone as it is less than 13 mSv
- if a firefighter were to receive a dose in excess of one third of any formal dose limit (i.e. 1/3 of 20 mSv), the employer must conduct an investigation into the circumstances. This would equate to approximately 6 mSv for a whole body dose as measured by an EPD and by using 5 mSv as the dose constraint level this should avoid crossing this reporting threshold.

‘As Low As Reasonably Practicable’ (ALARP)

At all times, it is not simply sufficient to avoid exceeding dose constraints or dose limits, the Fire and Rescue Service must take active measures to ensure that all doses received are ‘As Low As Reasonably Practicable’ (ALARP). Dose limits are not aspirational, they are the last line of defence. In practical terms this means that if a task can be carried out in more than one way and one method is likely to result in lower radiation doses, this method must be used if reasonably practicable.

Emergency exposure

Although the preceding paragraphs are based upon the legal requirements under Ionising Radiation Regulations 99, there is an exception to these dose limits. Under the Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPIR) it is permissible to disapply the Ionising Radiation Regulations 99 dose limits at a licensed nuclear site or at an incident involving transport by rail if in doing so it might be possible to save life or maintain critical infrastructure.

In these instances it may be permissible for an informed volunteer to be exposed to a dose of up to 100 mSv[2]. The authorisation for the disapplication of dose limits (i.e. allowing emergency exposure to take place) must be given by an officer or manager within the Fire and Rescue Service who has received appropriate training.

The REPPIR state that employees of the emergency services who may receive emergency exposures should be pre-identified as part of the planning process. Fire and Rescue Services should liaise radiation risk operators or carriers, as appropriate, to obtain the expert advice needed to plan for emergency exposures.

Fire and Rescue Services that develop emergency exposure operational procedures which disapply the dose limits in Ionising Radiation Regulations should record specific risk assessments on this aspect of their plans. Even when operating under emergency exposure conditions the principles of ALARP should still be taken into consideration

Chemical, biological, radiological, nuclear (CBRN) incidents – Fire and Rescue Services should note that REPPIR applies to premises and transportation where a known source of certain strength exists. This is clearly not the case in a terrorist attack involving a radiation source at other premises. In this case therefore, the Ionising Radiation Regulations cannot legally be disapplied and the limitations in the regulations indicated above will apply.

However, this anomaly in law has been recognised and after consultation with the Nuclear Installations Inspectorate the following has been determined.

- "Terrorist incidents are not considered by the Health and Safety Executive to be applicable to either the Ionising Radiation Regulations 1999 (IRR99) or The Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPIR). However REPPIR does provide a good framework which can be used for planning and management of risk with regard to intervention at this type of incident".

Informed volunteer

An informed volunteer in terms of the application of REPPIR is a radiation worker who has agreed to receive an emergency exposure above the limits imposed by Ionising Radiation Regulations.

To be considered as an informed volunteer a firefighter should have received:

- appropriate training in the field of radiation protection
- suitable and sufficient information and instruction for them to know the risks to health created by exposure to ionising radiation and the precautions which should be taken

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[2] The figure of 100 mSv is not stipulated in the REPPIR, it has been arrived at through multi-agency collaboration. Where FRSs have licensed sites within their turn-out areas they should develop risk assessed emergency exposure procedures with site operators.

- a briefing on the risks and control measures associated with the specific emergency tasks in question.

> **NOTE**
> Informed volunteers should be asked to confirm their agreement to potentially receive an emergency exposure at this briefing.

The REPPIR also require that employers of informed volunteers:

- provide equipment that is necessary to restrict the exposure of informed volunteers to radiation
- identify, and appropriately train, managers/officers who are authorised, in the event of a radiation emergency, to permit informed volunteers to be subject to an emergency exposure
- make arrangements for medical surveillance by an appointed doctor or employment medical adviser to be carried out without delay in the event of a radiation emergency
- make arrangements with an approved dosimetry service for the assessment of doses during emergency exposures, and for the separate recording of such doses in dose records. Further information and the names of approved dosimetry service approved under REPPIR can be found on the Health and Safety Executive's website
- ensure that no employee under 18 years of age, no trainee under 18 years of age and no female employee who is pregnant or breast-feeding is subject to an emergency exposure.

Key control measures

Fire and Rescue Services should consider how they control the hazards and risks described above. A non-exhaustive list of key control measures are described below.

Pre-planning

Pre-planning is key to enhancing the safety of firefighters and others likely to be affected by FRS operations. Each Fire and Rescue Service's Integrated Risk Management Plan (IRMP) will set standards and identify the resources required to ensure safe systems of work are maintained.

Because of the nature of radioactive materials, careful pre-planning is essential to ensure that any incident will be dealt with in accordance with standard operational procedures and that personnel are aware of the risks. They also need to be aware of the protective measures that are provided by personal protective equipment and safe systems of work, and of any specialist advice that is available.

It is assumed that no radiation dose is entirely free from risk, therefore planning for any incident that may involve radiation should have the objective of restricting dose levels to 'as low as reasonably practicable' (ALARP).

Each Fire and Rescue Service should assess the hazards and risks in their area relating to this generic risk assessment and site-specific plans should be considered for locations where there are significant known radiation risks. This assessment should include other Fire and Rescue Service's areas where 'cross-border' arrangements make this appropriate.

Such contingency plans should include:

- levels of response
- relevant standard operating procedures (SOPs)
- tactical considerations including rendezvous points (RVPs)
- appliance marshalling areas and access points
- on-site Emergency Plans and information packs.

Pre-planning is underpinned by information gathering, much of which will be gained through inspections or visits by Fire and Rescue Service staff. For example, those covered by section 7(2)d of the *Fire and Rescue Services Act 2004*.

Information relating to all registered users of radioactivity within their local authority area is sent to Fire and Rescue Services from the Environment Agency via the *Radioactive Substances Act 1993* (since April 2010 the *Environmental Permitting Regulations 2010* in England and Wales). All Fire and Rescue Services should use this valuable source of information to compile a register of all users of radioactivity within their jurisdiction. This should include:

- nature of radioactive material
- source strength
- location of source
- fixed or portable source/transportable.

Information should also be gathered and used to review safe systems of work, etc from sources both within and outside the Fire and Rescue Service, including:

- fire safety audits
- incident de-briefs
- health and safety events
- local authorities
- local resilience forum.

Involving others in pre-planning is an effective way to build good working relations with partner agencies and other interested parties, such as site owners.

Fire and Rescue Services will need to consider the levels of multi-agency liaison and advice that are required to resolve all foreseeable incidents involving radioactive materials within their areas.

Organisations that can provide positive benefits in this regard will include:

- nuclear energy providers
- emergency planning departments
- environmental health departments
- the Environment Agency
- the police
- the ambulance service
- the Health and Safety Executive
- highways agencies (if incident is mobile)
- specialist advice through National Arrangements for Incidents involving Radioactivity (NAIR) and RADSAFE
- the Health Protection Agency Radiation Protection Division
- the UK Government Decontamination Service (for maintaining a list of commercial companies who will quote for post clean-up operations)
- Fire Service scientific advisers.

Fire and Rescue Services should ensure systems are in place to record and regularly review risk information and to ensure that new risks are identified and recorded as soon as practicable.

Fire and Rescue Services must ensure that the information gathered is treated as confidential, unless disclosure is made in the course of duty or is required for legal reasons.

Fire and Rescue Services should consider the benefits of using consistent systems and formats to record information from all sources. Consideration should also be given to how timely access will be provided to information to support operational decision-making.

Information needs and the capacity of Fire and Rescue Service staff to assimilate information will vary, in proportion to the nature and size of the incident and what stage the operational response has reached. Arrangements need to be flexible and may be based on more than one system.

Training

When formulating a training strategy Fire and Rescue Services should consider the following points:

- Fire and Rescue Services must ensure their personnel are adequately trained to deal with the hazards and risks associated with incidents involving radioactive materials
- the level and nature of training undertaken should be shaped by informed assessment of operational and individual needs in accordance with the Fire and Rescue Service guidance on the integrated personal development system, national occupational standards and any internal training plan
- training and development should follow the principles set out in national guidance documents
- training and development programmes should generally be structured so that they move from simple to more complex tasks and from lower to higher levels of risk
- training and development will typically cover standard operational procedures as well as ensuring knowledge and understanding of equipment and the associated skills that will be required to use it
- training and development programmes should consider the need for appropriate levels of assessment and provide for continuous professional development to ensure maintenance of skills and to update personnel whenever there are changes to procedure, equipment etc.

Training outcomes should be evaluated to ensure that the training provided is effective, current and it meets defined operational needs as determined by the Fire and Rescue Service Integrated Risk Management Plan.

Primary control measures for all types of radiation

The following points should be considered when attempting to plan a safe system of work

DOSE LIMITATION

"Dose limitation period" is defined, as appropriate, a calendar year or the period of five consecutive calendar years (Ionising Radiation Regulations 1999).

Risks, and therefore the potential dose, should be reduced to a level that can be considered "As Low As is Reasonably Practicable" (ALARP). This will be achieved by:

Operational key principle

Radiation Dose Control Measures – Where it is known that the only radiation at an incident is from a sealed source (i.e. there is no contamination risk) protection will depend upon a combination of **TIME, DISTANCE and SHIELDING**

TIME – the shorter the duration of exposure the smaller the accumulated dose

DISTANCE – the greater the distance from the source of radiation the lower the dose rate

NOTE:
Inverse square relationship (e.g. doubling the distance from a radiation source quarters the dose received)

SHIELDING – in general the higher the density and greater the thickness of the shielding, the better the protection.

- Response vehicles should approach the incident from the upwind direction wherever possible as a precaution. This is essential if it is believed that there has been a significant release of contamination from an unsealed source of radiation
- Initially response vehicles should be parked a safe distance from the incident
- The table below gives generic initial cordon distances based on the guidance given by the International Atomic Energy Agency (IAEA) in the *Manual for First Responders to a Radiological Emergency*. This manual provides practical guidance for those responding within the first few hours of a radiological emergency. It does not address the response to emergencies involving facilities or operations for which specific emergency arrangements should have been developed. Further information can be found at: www.iaea.org

Radiation Incidents – Generic Initial Cordons	
Outside buildings	
Unshielded or damaged potentially dangerous source	45 metres around
Major spill from a potentially dangerous source	100 metres around
Fire, explosion or fumes involving a potentially dangerous source	300 metres radius
Suspected bomb (exploded or unexploded)	400 metres radius or more to protect against an explosion
Inside buildings	
Damage, loss of shielding or spill of a potentially dangerous source	Affected and adjacent areas (including the floor above and below)
Fire or other event that can spread a potentially dangerous source materials throughout the building (e.g. through the ventilation system)	Entire building and outside distances detailed above

> **NOTE:**
>
> **ALARP**
>
> At all times, it is not sufficient to avoid exceeding dose constraints or dose limits, the Fire and Rescue Service must take active measures to ensure that all doses received are 'As Low As Reasonably Practicable' (ALARP).

PERSONAL HYGIENE

Smoking, drinking or eating must not be allowed in the risk area. Arrangements should be put in place for rehydration requirements for personnel involved in operational activities.

Command and control

The Incident Commander (IC) should follow the principles of the current national incident command system. Prior to committing personnel into any hazard area, the IC must take account of the actual information about the incident that is available to make operational decisions in what are recognised as sometimes dangerous, fast moving and emotionally charged environments.

A thorough safety brief prior to deployment of personnel within the hazard zone must be carried out.

The Incident Commander will be guided by a number of factors, including:

- the nature of incident
- the quantity and nature of the source
- resources
- whether all persons are accounted for
- non-radioactive additional hazards
- advice from site personnel
- advice and guidance from the Fire and Rescue Service Hazardous Materials Officer
- advice and guidance from the Radiation Protection Supervisor/Adviser
- fire risk inspection information
- protection against radiation
- decontamination requirements.

Safety Officer(s)

The early appointment of one or more Safety Officer(s) will help ensure that risks are either eliminated or reduced to an acceptable level.

A safety decision-making model should be used to brief Safety Officers regarding the nature of the incident, the allocated task and prevailing hazards and risks. The Incident Commander should confirm that the Safety Officer understands:

- their role and area of responsibility
- allocated tasks
- lines of communication.

Those undertaking the Safety Officer role should:

- be guided by the Fire and Rescue Service Hazardous Materials Officer
- be competent to perform the role
- ensure personnel are wearing appropriate personal protective equipment
- wear a personal dosimeter
- monitor the physical condition of personnel and any accumulated dose, and the general or specific safety conditions at the incident, in accordance with their brief
- take any urgent corrective action required to ensure safety of personnel
- update the Incident Commander or senior safety officer regarding any change in circumstances
- not be engaged in any other aspect of operations, unless this is required to deal with a risk critical situation.

A Safety Officer can be of any operational role, but the complexity of the task, size of the incident and scope of responsibility should be considered by the Incident Commander when determining the supervisory level required.

Safety Officers should wear nationally recognised identification to indicate they are undertaking the 'Safety Officer' role.

Fire and Rescue Services should ensure that sufficient and appropriate training and other measures (such as aide-memoires) are in place and available to support those staff liable to undertake this role.

Personal protective equipment (PPE)

Fire and Rescue Services must ensure that any personal protective equipment provided is fit for purpose and meets all required safety standards. When choosing suitable protective garments, the standard of clothing worn beneath the specialist personal protective equipment should also be taken into account. Consideration should also be given to the selection of suitable sizes and gender specific requirements of personal protective equipment.

Personal protective equipment should also take account of the need for rescuers to be visible against the operational background including night working and for the Incident Commander and other managerial and functional roles (defined in the national incident command system) to be distinguishable.

All personnel must use appropriate levels of service provided personal protective equipment and respiratory protective equipment as determined by the safe system of work.

It is important to remember that personal protective equipment is low on the hierarchy of control measures, and although it is provided for protection against contamination and internal exposure to radiation and for ease of decontamination, it does not protect against external gamma radiation.

Additional equipment

Where there is a radiological hazard specialist personnel such as an on-site Health Physicist or Radiation Protection Supervisors/Advisors can be responsible for the radiological protection, provision of instruments, protective clothing and decontamination of Fire and Rescue Service personnel. Site personnel can be used for carrying out these duties.

Equipment has now been provided through the New Dimensions programme and issued to each Fire and Rescue Service Detection, Identification and Monitoring (DIM) team. This equipment includes:

- Rados RDS 200 universal survey meters (RDS 200)
- Exploranium
- Thermo Fisher electronic personal dosimeters (EPD).

A survey meter should be used in the first instance to set up the inner cordon. Entry into this area must be strictly controlled and all personnel entering must be wearing appropriate personal protective equipment and carry a personnel dosimeter.

Each team entering the restricted area should also have a survey meter with them for monitoring gamma radiation levels.

Health surveillance

Arrangements should be in place for effective health surveillance of all personnel who are suspected of being exposed to any radiation during an incident. This may be by means of an on-site specialist while the incident is still in progress.

Plans should be in place to provide for the monitoring and recording of radiation doses received, and for the dissemination of any relevant information.

Recording should be done either on-site, on return to the station or as soon as reasonably practicable. This should include a full safety briefing for personnel. There should subsequently be a process for the secure retention of dose records for up to 50 years.

Personnel should also be provided with follow-up monitoring by the Occupational Health Unit as necessary. This will enable more sensitive whole body monitoring or analysis of biological samples, such as urine etc. to be carried out.

Decontamination

Suitable decontamination may be required if exposed to unsealed sources. However, the use of safe undressing procedures is often more effective. The identification of a restricted area around the source and limitation of the number of personnel entering the restricted area must be actioned in line with national guidance published in 2003, *National Guidance Document for Fire Service Mass Decontamination*.

Post-incident

The following measures, as appropriate to the nature and scale of the incident, should be considered to help eliminate or remove risks after an incident:

- Any safety events: personal injuries, exposure to hazardous substances or near-misses should be recorded, investigated and reported in line with legislative requirements such as the *Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995*, etc
- Arrangements should be in place to either remove all contamination from personal protective equipment or to ensure its safe and appropriate disposal and to check that it maintains the agreed levels of integrity and protection for the wearer throughout its lifecycle.
- Occupational health support and surveillance follow-up
- Conduct a de-brief to identify and record any lessons learned from the incident. De-briefs will range in complexity and formality, proportionate to the scale of the incident and in line with individual Fire and Rescue Service's procedures
- Consider any changes required to safe systems of work, appliances or equipment in the light of any lessons learned from de-briefs or from safety events
- Consider the need to review existing information held on a premises or location, or the need to add a new premises or location into future pre-planning e.g. by adding to visit or inspection programme
- Staff should be supported and monitored to identify whether they are experiencing any adverse affects and to check whether they would benefit from accessing counselling and support services
- Consideration should be given to arranging for staff to make a contemporaneous written record of their actions. This information may be used to assist in any internal or external investigations or enquiries that follow any incident e.g. coroners court, public enquiry, etc.

Technical references	
1	**Ionising Radiation Regulations 1999 (IRR99)** Apply to a large range of workplaces where radioactive substances and electrical equipment emitting ionising radiation are used. They also apply to work with natural radiation, including work in which people are exposed to naturally occurring radon gas and its decay products. Any employer who undertakes work with ionising radiation must comply with IRR99. It requires employers to keep exposure to ionising radiations as low as reasonably practicable. Exposures must not exceed specified dose limits. Restriction of exposure should be achieved first by means of engineering control and design features. Where this is not reasonably practicable employers should introduce safe systems of work and only rely on the provision of personal protective equipment as a last resort. Further information can be found at: **http://www.hse.gov.uk/radiation/ionising/legalbase.htm**
2	**Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPIR)** REPPIR establishes a framework of emergency preparedness measures to ensure that members of the public are properly informed and prepared, in advance, about what to do in the unlikely event of a radiation emergency occurring, and provided with information if a radiation emergency actually occurs. A "radiation emergency" is an event that is likely to result in a member of the public receiving an effective dose of 5 mSv during the year immediately following the emergency. REPPIR do not replace existing nuclear site licence conditions but operators of licensed sites who comply with those conditions will satisfy equivalent provisions in REPPIR. REPPIR place legal duties on: (a) operators of premises where work with ionising radiation is carried out e.g. licensed nuclear sites, hospitals, universities, ports, airports, factories (b) people who transport radioactive substances through a public place (but not those using standard forms of transport such as road, rail, inland waterway, sea, air, or through a pipeline) (c) all local authorities, not just those who have REPPIR operators within their boundaries, and (d) the employers of people who intervene in a radiation emergency, such as the FRSs. Further information can be found at: **http://www.hse.gov.uk/radiation/ionising/reppir.htm**

SECTION 2

Summary of Generic Risk Assessment 5.5

Radiation

Task – Pre-incident

Ref. No.	Activity	Hazard	Risk	Persons at risk	Control measures
1	Dealing with incidents involving radiation	Inadequate preparedness for the incident type	Fatalities Serious injury Increase in risk of cancer	Operational personnel Members of the public	FRS should identify, risk assess, plan, train and adequately control all reasonably foreseeable types of operational incidents involving radiation FRS personnel to gather and record appropriate information FRS personnel to ensure that crews and supervisors are adequately trained and competent.
2	Approaching the incident	Windborne contamination	Inhalation of unsealed radioactive materials	Operational personnel	Standard operational procedures Incident Commander (IC) to establish appropriate Incident Command System (ICS) and risk assessment procedures. A service Safety Officer to be appointed All personnel under strict supervision of site officials Approach upwind Set up first aid point Seek specialist advice Liaison with on site specialist teams Use of monitoring and detection equipment

Ref. No.	Activity	Hazard	Risk	Persons at risk	Control measures
3	Approaching the rendezvous point	Exposure to radiation by irradiation and contamination	Excessive irradiation by gamma emitting radioactive source	Operational personnel	Standard mobilising procedures to established rendezvous points Any changes of procedure required would be notified by site manager via Fire Control to on-coming appliances All personnel receive instruction and information on the construction of the buildings and hazards to be encountered with radiological hazards in their Service area All personnel to be under strict supervision All personnel to don suitable PPE and breathing apparatus Use of radiation monitoring equipment Additional appliances and Special Units to be ordered on as necessary A Supervisory Officer and Hazmat Officer will attend Approach upwind Work only carried out under the supervision of site Safety Officers Cordon off area using inner and outer cordons, (hot and cold zone) Ambulance in attendance as required Restrict number of personnel to risk area Time Distance Shielding Welfare facilities.

Task – As the incident develops

Ref. No.	Activity	Hazard	Risk	Persons at risk	Control measures
4	Working at the scene Firefighting and rescue from radiological hazards	Exposure to radiation. Inhalation ingestion contamination.	Contamination Burns Irradiation Malignant disease	Operational personnel	All personnel receive instruction and information on the construction of the buildings and hazards to be encountered with radiological hazards in their Service area All personnel to be under strict supervision Advice and guidance from Hazmat Officer, RP Supervisor/Advisor All personnel to don suitable PPE and breathing apparatus Use of radiation monitoring equipment Additional appliances and Special Units to be ordered on as necessary A Supervisory Officer and Hazmat Officer will attend Approach upwind Work only carried out under the supervision of site Safety Officers Cordon off area using inner and outer cordons, (hot and cold zone) Ambulance in attendance as required Restrict number of personnel to risk area Time Distance Shielding Welfare facilities.

Ref. No.	Activity	Hazard	Risk	Persons at risk	Control measures
5	Decontamination/safe undressing procedure	Contamination of environment	Damage to the ecosystem and animal life	Ecosystem Animal life	Training Operational procedures Supervision Advice and guidance from Hazmat Officer and RP Supervisor/Advisor Equipment Incident Command GRA for decontamination Use of specialist monitoring equipment.
6	Dirty area	Insufficient decontamination of crew	Cross-contamination Radiation Absorption/ingestion/ inhalation	Operational personnel	Incident Command Training/instruction Operational procedures Supervision by Hazmat Officer, RP Supervisor/Advisor. Experience Specialist advice Use of specialist monitoring equipment.
7	Triage/first aid (assessment of injuries, dealing with persons involved in incident)	Trauma/psychological stress	Cross-contamination of radioactive material Absorption/ ingestion/ inhalation of radioactive materials	Operational personnel	Training Operational procedures Incident command Critical incident de-briefing.

Ref. No.	Activity	Hazard	Risk	Persons at risk	Control measures
8	Dressing and working in GTS	Rip/split suit, failure of breathing apparatus, emergency decontamination Communications and mobility difficulties and short duration CABA	Contamination by radioactive substance Absorption/ ingestion/ inhalation of dust/ debris/aerosol, vapour	Operational personnel	Training/instruction Operational procedures Supervision by Hazmat Officer PPE Experience Maintenance Incident Command
9	Clean area	Change in wind direction Overspray into clean area	Contamination by radioactive substance Inhalation/absorption/ ingestion/Inhalation of dust/debris/aerosol, vapour	Operational personnel	Incident Command Training/instruction Operational procedure Supervision by Hazmat Officer, RP Supervisor/Advisor PPE Use of specialist monitoring equipment Health monitoring
10	Handling equipment/ GTS after decontamination or safe undressing procedure	Poor decontamination	Cross-contamination by radioactive material Absorption/ingestion/ inhalation of dust/ debris/aerosol, vapour	Operational personnel	Incident command Training/instruction Operational procedures Supervision by Hazmat Officer, RP Supervisor/Advisor PPE Use of specialist monitoring equipment Health monitoring

Task – Post-incident

Ref. No.	Activity	Hazard	Risk	Persons at risk	Control measures
11	Site withdrawal procedures	Exposure to radio active materials	Cross-contamination	Operational personnel	Specialist decontamination needs – personnel and equipment requirements to be serviced Use of specialist monitoring equipment Recording of exposure and health monitoring for all personnel before leaving the site or as soon as reasonably practicable after the exposure.

Notes