



University of
St Andrews

Risk Assessment No 1 - Risk assessment for the Consent for the deliberate addition of radioactive substances in the production of products.

Ionising Radiations Regulations 2017

Document type	Procedure
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RISK ASSESSMENT Number 1 – Deliberate addition of radioactive substances in the production of products - IRR17

Name of Building and Room where work is to be carried out

Description of Work and Scope of the Assessment

This is for the deliberate incorporation of liquid unsealed radionuclides into biological chemicals as tracers for biological reactions. This will also include disposal of such radionuclides to drain. This includes the following radionuclides:

- 3H, 14C, 22Na, 32P, 33P, 35S, 45Ca, 51Cr and 125I
- Any others not on the above list require the prior approval of the URPO

This risk assessment has been carried out in accordance with the Ionising Radiations Regulations 2017 (IRR17) Approved Code of Practice (ACoP). This risk assessment only addresses the radiological risks associated with the type of operation detailed above.

Activity that can be stored and used

The quantity of radionuclides which can be stored within a Supervised Area is given below. If these quantities are exceeded, then the area must be designated a 'Controlled Area'.

STORAGE		USAGE	
Radionuclide	Supervised Area (MBq)	Supervised Area (MBq)	Teaching Laboratory (MBq)
3H	1000	100	20
14C	500	50	10
22Na	50	5	1
24Na	50	5	1
32P	50	5	1
35S	500	50	10
36Cl	50	5	1
45Ca	50	5	1
51Cr	500	50	10
59Fe	50	5	1
86Rb	50	5	1
125I	10	5	0.1

Who is at risk?

The worker, other workers in the laboratory, potentially trades staff (eg plumbers), cleaners. The samples will be very dilute when disposed to drain thus will provide minimal risk to exposed members of the public (eg Sewerage workers)

ACoP Paragraph 70 - Matters to be considered in an assessment, where relevant**70(a) - Nature of the radiation sources likely to be present**

The sources will be liquid unsealed radioactive sources where the radioactivity has been incorporated into another product. This product is then added to cell-based systems (or cell lysates) as a tracer to show the incorporation or metabolism of specific chemicals

70(b) - Estimated dose rates

No dose recorded on whole body dosimeters of greater than 0.05 mSv/2 months (it is noted that whole body dosimeters do not measure Tritium). Limits on total activity allowed in a laboratory and limit on an individual experiment in Appendix 16 of local rules ensure maximum dose per year must not exceed 0.5 mSv.

70(c) - Likelihood of contamination arising and being spread

The likelihood is small. Contamination monitoring is undertaken before and after labelling with the radionuclide

70(d) - Results of previous personal dosimetry and area monitoring

No dosimeter readings greater than 0.05 mSv/2 months for normal use of unsealed radioactive sources (it is noted that tritium dose will not be detected by whole body dosimeters). All area monitoring dose rates less than 2.5 μ Sv/h.

70(e) - Advice from manufacturers or suppliers about safe use and maintenance of equipment

Only authorised personnel and trained personnel will be allowed into the area where this work is undertaken. All workers must wear a whole body dosimeter badge when entering this area (except if using unsealed tritium sources as dosimeters do not measure this.)

70(f) - Engineering Controls, etc. In place or planned

The door to the fridge where stock solutions are kept is padlocked. Access to the room where radioactive stocks are kept and aliquoted is via a PIN lock on the door. Access to the laboratory or building where all such work is undertaken is on an electronic Fob lock or by a key.

All work with unsealed sources is undertaken behind an appropriate screen (Perspex for beta emitters and lead glass for gamma emitters). It is noted that Perspex screen are not necessary for work with tritium given the very low energy of the emissions.

Signage is prominently displayed on areas where radioactive work is undertaken

70(g) - Planned Systems of Work

Only trained workers who have passed the test on the University Radiation Protection Course are allowed into this area

70(h) - Estimated airborne and surface contamination levels

Details of specific dose rates from inhalation, ingestion and skin contamination can be seen through Work Instruction 4. It should be noted that skin contamination with ^{32}P can result in a significant dose. Thus if the experiment can be done with a lower energy emitter (eg ^{33}P) should be considered. It is vital that all workers using ^{32}P therefore work behind Perspex screen with a screen on the Gilson Pipette to try and stop any spillages landing on the person. The area and gloves and also laboratory coat should be constantly measured using Geiger Muller Probe contamination monitor. If there is any spillages these should be cleaned up immediately. The person should also use a finger dosimeter badge to measure the dose to the fingers over a 2 month period. It is also vital that all exposed areas of the skin are covered with appropriate PPE so that any spillages can be removed as quickly as possible.

Surface contamination levels are measured using a Scintillation probe on a Mini Monitor and a Geiger-Muller probe on a Mini Monitor (or equivalent) before and after work is carried out (to ensure that all beta and gamma emitters can be identified). Where there is work with tritium, the surface will be swabbed and the swab counted in a liquid scintillation counter. A written record of contamination Monitoring is undertaken.

The background levels are approximately 5-10 counts per second on a 44A Scintillation Probe and about 0.5-1 counts per second on a Geiger Muller Probe. The background counts from liquid scintillation counter are obtained by putting in a blank swab and the sample counted (giving results in counts per minute)

Any levels 3x background counts would be deemed contamination and would require work to stop and local DRPS or depute to decontaminate the area and write an incident report. Any contamination levels greater than 40 counts per second above background would require the area to be evacuated and the University Radiation Protection Officer to be immediately called out to investigate and to decontaminate the area. A written incident report would be done.

70(i) - Effectiveness and suitability of PPE

Laboratory coat, disposable nitrile gloves and eye protection must be worn.

When working with ^{32}P extra long gloves must be worn to ensure that there is no potential for skin contamination. All gloves must be removed immediately that any contamination is identified on the gloves. Where contamination is from a spillage of ^{32}P , after the PPE has been removed and the skin washed till there is no evidence of contamination, the incident must be reported to DRPS and URPO

70(j) - Unrestricted access to high dose rates or significant contamination

Not allowed. Only trained and experienced workers (or inexperienced workers under close personal supervision by an experienced trained worker)

70(k) - Possible accident situations, their likelihood and severity

Foreseeable Unsealed Radioactive Source Incident	Actions Taken
Loss of source or theft of source	If it is suspected that there has been a loss of a radioactive source, you should double check the area to see if it can be found. If not you must notify the DRPS and URPO as soon as is reasonably practicable. A search will then be commenced for the source. If it cannot be immediately found then the matter has to be reported to Police Scotland, SEPA and HSE. This will be done by the URPO
Fire	In the event of a fire in a room with unsealed sources, evacuate the room (helping any injured person out of the room), activate the fire alarm to evacuate the building. Call the Fire Service on 999 or 112 and tell them there is a fire and that the fire is in a room with radioactive materials. Wait for the fire service to arrive and then give details of the incident. Notify the URPO and DRPS and Head of School about the fire as soon as possible.
Flood	If the flood can be easily stopped, it should be. If there is a flood in a room with unsealed radioactive sources, evacuate the room. Notify the URPO, DRPS and Building Safety Co-ordinator during normal working hours. Call Security and Response if out of hours.
Injured person - Person contaminated with radioactive materials	If there is an injured person, check that they are not contaminated (using a Geiger Muller probe contamination monitor and a scintillation probe contamination monitor). If they are not contaminated then they should be removed from the area. If they are contaminated, a judgement has to be used in terms of the risk of spread of contamination compared to the risk to the health of the individual. If they are contaminated take the injured person to an area as close to the incident. Then call for an Ambulance and notify them that the person may be contaminated with radioactive materials.

Foreseeable Unsealed Radioactive Source Incident	Actions Taken
Spillage of a small quantity of radioactive materials	Firstly put on appropriate Personal Protective equipment (disposable nitrile gloves, Laboratory coat, eye protection and if necessary disposable coveralls (and overshoe covers). The immediate area where there has been a spillage should be identified using contamination monitors. Absorbent material should be placed over any liquid spillage. The material should then be removed and disposed of in an appropriate contaminated material bin. The area should then be scrubbed using a detergent and disposable cloth. The area should be monitored with a Geiger Muller probe and Scintillation probe contamination monitors until there is no evidence of contamination. A written record of the levels of contamination found, the level of contamination after cleaning, the date and who undertook the work should be kept.
Spillage of a large quantity of radioactive materials	Firstly put on appropriate Personal Protective equipment (disposable nitrile gloves, Laboratory coat, eye protection and if necessary disposable coveralls (and overshoe covers). Check for personal contamination (see section 2.6.2). Check for contamination of hands, clothing, shoes and floor with a Geiger Muller Probe and a Scintillation contamination probe. If there is no personal contamination, you should leave the room and call the DRPS and URPO who will clean up the room. A written record of the decontamination will be kept and an investigation of the incident will be undertaken by the URPO
Arrival of a source which has contamination on the outside of the package	Firstly put on appropriate Personal Protective equipment (disposable nitrile gloves, Laboratory coat, eye protection and if necessary disposable coveralls (and overshoe covers). The DRPS or a depute will be the only person who can accept a package of radioactive materials. If the packaging is contaminated or the bottle is cracked and leaking then the area should be isolated and room locked. The URPO or URPA should be called to determine the actions to be taken. The supplier must be notified immediately as well as the transport courier to determine if their vehicles are contaminated.
Determination of exposure to dose	In the event of a potential exposure to a dose of radiation, the URPO will calculate the possible dose exposure. This will be compared to the whole body dosimeter reading and if available, a finger dosimeter reading.

Foreseeable Unsealed Radioactive Source Incident	Actions Taken
<p>Failure of equipment leading to radioactive contamination of the equipment</p>	<p>The equipment must be taken out of service immediately, with a sign to inform people they must not use the equipment. The DRPS and the URPO should be notified of the spillage. If they believe the spillage is minor then the users can undertake the clean up. If it is a major radioactive spillage, then the DRPS or the URPO will undertake the clean up process.</p> <p>Firstly put on appropriate Personal Protective equipment (disposable nitrile gloves, Laboratory coat, eye protection and if necessary disposable coveralls (and overshoe covers)). The immediate area in the equipment where there has been a spillage should be identified using contamination monitors. Absorbent material should be placed over any liquid spillage. The material should then be removed by wiping down the equipment and disposed of in an appropriate contaminated material bin. The area should then be scrubbed using a suitable detergent (some detergents will cause damage to the equipment thus care must be taken when choosing the detergent) and disposable cloth. The area should be monitored with a Geiger Muller probe and Scintillation probe contamination monitors until there is no evidence of contamination. A written record of the levels of contamination found, the level of contamination after cleaning, the date and who undertook the work should be kept.</p>

70(l) - Consequences of failure of Control Measures including Systems of Work
See Table 1
70(m) - Steps taken to prevent accidents, or limit their consequences
See Table 1.

TABLE 1

Step	Who is Affected	Hazard		Initial Risk			Controls	Residual Risk		
		Description	Effect	SF	FF	R	List of Controls Required	SF	FF	R
1	DRPS or nominated depute	Stock bottle arriving broken or packaging contaminated	Possibility of raising risk of some form of cancer.	3	2	6	All new packages must be monitored by the DRPS or a trained nominated depute. A strict arrival procedure must be put in place such that stock solutions will not be available until the DRPS or nominated depute has monitored these.	2	1	2
2	Workers and DRPS (or depute) and RPO for cleaning up the spillage	Radiation dose received if a stock bottle of liquid radioactive materials is dropped on the floor and smashes	Possible risks of cancer	4	1	4	Only specialised staff who have received appropriate training in decontamination will undertake this task. All such staff will wear a dosimeter badge to show if they receive a dose. PPE worn will be disposable foot covers, disposable boiler suite, hair cover, eye protection and disposable nitrile gloves. The area will be evacuated after the incident and only the trained staff for decontamination. Appropriate decontamination processes will be used depending on the isotope and chemical material. All waste material will be immediately transferred to the central waste store for disposal. Area will be extensively monitored before being cleared. Record of contamination monitoring will be kept and recorded	3	1	3

3	Workers and also DRPS	Contamination of surfaces after aliquoting radioactive materials (eg bench, floor, door handle, fridge etc)	Possible risk of cancer	2	3	6	All staff undertaking such work must have completed and passed the University Radiation Protection Course. No unauthorised personnel will be in the room where aliquots are taken from stock bottles. All areas will be monitored for contamination before and after use. If any contamination found, the area will be evacuated and trained personnel who can undertake decontamination will be brought in (eg DRPS or a nominated depute). Any contaminated items which can be disposed of (eg tissues) will be put in the correct radioactive waste bin PPE to be worn will include laboratory coat, eye protection, disposable gloves and if contamination of flooring then disposable shoe covering	2	2	4
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4	Workers, DRPS and anybody repairing equipment	Contamination of surfaces if there is failure of equipment (for example a microfuge tube bursting etc)	Possible risk of cancer	3	2	6	The piece of equipment must be taken out of service immediately. The DRPS must be called (and if significant counts then the URPO must also be called) who will determine the level of contamination. Where it is feasible for the DRPS/URPO to decontaminate the equipment they will make every effort to do so. If it cannot be suitably decontaminated then the equipment must be disposed as radioactive waste. PPE - Wear laboratory coat, eye protection, disposable nitrile gloves, and if it is a large piece of equipment disposable boiler suit and disposable foot protection	2	1	2
5	Trades staff (eg Plumbers) who need access to specific areas	There may be a requirement for plumbers (for example) who need to deal with a blockage of a radioactive drain	Possible risk of cancer	3	3	9	No trades staff may open up a radioactive waste drain (as labelled with a radioactive trefoil) without appropriate measurements being undertaken by the local DRPS or URPO. All waste must be disposed of as radioactive waste by the department. Liquid waste from the drain must be disposed of via the unblocked drain.	2	1	2
6	Administrative Staff	Administrative staff must not have access without authorisation	No administrative staff	1	1	1	Signage on the door will say Only Authorised personnel can enter	1	1	1

7	Cleaners and trades staff	Cleaners and trades staff will only have access to these areas if the laboratory workers have produced a certificate of decontamination	No cleaners allowed in at any time unless authorised to do so, thus risk is very low	1	1	1	Signage on the door will say Only Authorised personnel can enter. Cleaners and trades staff will have access only if a certificate of no contamination is also posted on the door or have had appropriate training. The DRS must brief cleaners and trades staff on potential hazards in area when visiting for first time and answer any queries.	1	1	1
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Matrix of Risk Level						
Severity Factor (SF)						
Frequency Factor (FF)	Frequency Factor	Slightly Harmful (1)	Harmful (2)	Very Harmful (3)	Extremely Harmful (4)	
		Very Unlikely (1)	1	2	3	4
		Unlikely (2)	2	4	6	8
		Possible (3)	3	6	9	12
		Probable (4)	4	8	12	16
Risk (R) = Frequency factor (FF) x Severity of Harm (SF)						
Risk Rating (R)	Classification	Action Required				
1-2	Low	No additional controls				
3-4	Acceptable	Consider additional controls				
6-9	Moderate	Additional controls to be made				
12-16	High	Task must not be completed. Look for alternative method				

ACoP Paragraph 71 – Outcomes of the assessment

71(a) - Actions taken to keep exposures ALARP

All work must be risk assessed. Where it is possible to use non-radioactive labelled compounds, these will be used. If the work must use a radioactive tracer, then the isotope with the lowest energy should be used.

All work must be undertaken in an area marked out for radioactive work so that all workers know there is the potential for contamination.

Only trained personnel will be allowed to undertake this work.

There will be no unauthorised personnel in this area.

All work will be undertaken behind appropriate shielding (Perspex for beta emitters and leaded glass for gamma emitters).

PPE - all workers will wear a laboratory coat, disposable nitrile gloves and eye protection when handling radioactive materials. Those working with ^{32}P should wear extra long gloves to ensure there is no potential for skin contamination.

All waste will be disposed of in containers specifically for radioactive waste.

As a measure of exposure, all workers will wear radiation dosimeter badges to ensure that they have not accidentally been exposed to a significant radiation dose

71(b) - What Engineering Controls, Warning Signals and other Safety Systems are necessary

The door to the work area will say 'Only Authorised Entry'. Access to the main laboratories will be via a key or an electronic fob control. Access to the radioactive laboratories will be via an electronic fob lock or a PIN door lock. The fridge with stock solutions in them will be padlocked

71(c) - Whether PPE is appropriate and if so what type

Laboratory coat, disposable nitrile gloves and eye protection. Those working with 32P should wear extra long gloves to ensure there is no potential for skin contamination. Extra PPE will be required for decontamination and may include disposable boiler suit, disposable over shoes

71(d) - Dose Constraints

An investigation action level of 0.5 mSv/2months has been adopted.

71(e) - Protection of female employees

No special protection required. A separate specialised risk assessment will be undertaken for each expectant mother who wishes to continue working with radioactivity

71(f) - Investigation levels

An investigation action level of 0.5 mSv/2months has been adopted.

71(g) - Maintenance and testing schedules

There will be 2 yearly audit of laboratories

71(h) - Contingency Plans
As identified in Work Instruction 2.6.2
71(i) - Training needs
All staff entering the laboratories where radioactive is undertaken or working with unsealed radioactive sources must have passed the University Radiation Protection Course. All staff will also need specific induction training before using radioactivity. Inexperienced users will be closely supervised by an experienced worker.
71(j) - Designation of Controlled and Supervised Areas
There will be no area with an external dose greater than 2.5 μ Sv/h.
71(k) - Access restrictions and other precautions for designated areas
Access to the laboratories will be via a lock on the main entrance to the laboratories, a lock on the door to the radioactive stock laboratory and a lock on the fridge where stocks are maintained
71(l) - Designation of persons
Not required.
71(m) - Personal dosimetry
Whole body dosimeter badges issued to workers.
71(n) - Leak testing of radioactive sources
N/A
71(o) - Responsibilities of managers
Ensure that Local Rules are followed, and all staff are properly trained.
71(p) – Monitoring / auditing program to ensure compliance with IRR77
URPO to audit operations every two years with RPA



Assessor (sign):

Assessor: Dr Paul Szawlowski, University Radiation Protection
Officer and Deputy Director of Environmental, Health and
Safety Services

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v1.0	New Document	Approved	Dr Paul Szawlowski	12/07/2021