RP COP014: The Design of Radiochemical Laboratories

VERSION CONTROL	
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1. Introduction

As with any laboratories in which toxic material is being stored, handled or disposed of, radiochemical laboratories need to meet certain standards and provide certain specialist facilities to assist in the safe use of radioactive material. This Code of Practice describes what is required for University laboratories handling open radioactive material. It applies to the isotopes, activities and physical forms that are commonly used in the University. What is classed as "commonly used" can be found by reference to the Generic Radiation Risk Assessments, which are on the Health and Safety website.

The part of the guidance on facilities is taken, with very little alteration, from a paper issued by the Environment Agency (Radioactive Substances Act Guidance, Chapter 4 – Generic issues, "GUIDANCE ON STANDARDS FOR RADIOCHEMICAL LABORATORIES IN NON-NUCLEAR PREMISES", Environment Agency, December 2004). At the time of writing, the Scottish Environment Protection Agency has not issued any comparable guidance, but there would be no reason to expect any differences in such guidance.

The radioactive material may well also have chemical or biological toxicity. This Code of Practice does not include consideration of these matters, which will also need to be taken into account the overall lab design. Guidance can be found on the Health and Safety Department's website. Nor does it take into account the fire safety standards, which must be considered at the time of planning.

2. Design

Any design that meets normal modern standards for research laboratories should generally be adequate for the type of radiochemical work routinely carried out at the University. The design should however incorporate the following points.

- The need for physical segregation depends upon the number required of the various Designated Areas (i.e. designated for the purposes of the type of work with radioactive material that is anticipated in the labs.) as defined in the Ionising Radiations Regulations. It is important

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therefore that these matters are determined at an early stage in the design of new builds, taking into account any reasonably foreseeable future use and flexibility. Details of the University's arrangements for designation can be found in RP COP011.

- Controlled Areas must be physically separated. Supervised Areas need not be, so if open-plan laboratories are intended, they can incorporate one or more Supervised Areas. However, there is no prohibition on the physical separation of Supervised Areas; these can be designed as separate laboratories if required. What must not be allowed is one or more "radiation rooms" with the intention of undertaking all radiation work in these rooms. To do so would encourage unsafe working, a potential breach of the relevant safety regulations, and significant inflexibility in future use of the laboratories.
- If open-plan laboratories are intended, the laboratory shape and internal layout must allow for Supervised Areas to be located so as to meet the requirements of RP COP011. This means in particular that areas with adequate space can be demarcated away from transit routes. The location of plant, such as fume cupboards, must also be carefully thought out so that (a) access is available from the Supervised Areas and (b) access at the same time is not required by those working outside of the area – see Figure 1
- Internal separation walls need not necessarily extend the full height of a storey. They must be sufficient to clearly separate the two (or more) areas and prevent the risk of contamination extending from the one to the other.
- It is essential that the overall layout takes into account the movement of researchers in between Designated Areas and other labs, offices, etc. It must not be such as to require or even encourage the transit of persons who are not working in a radiation designated area through such an area – see Figure 2 below.

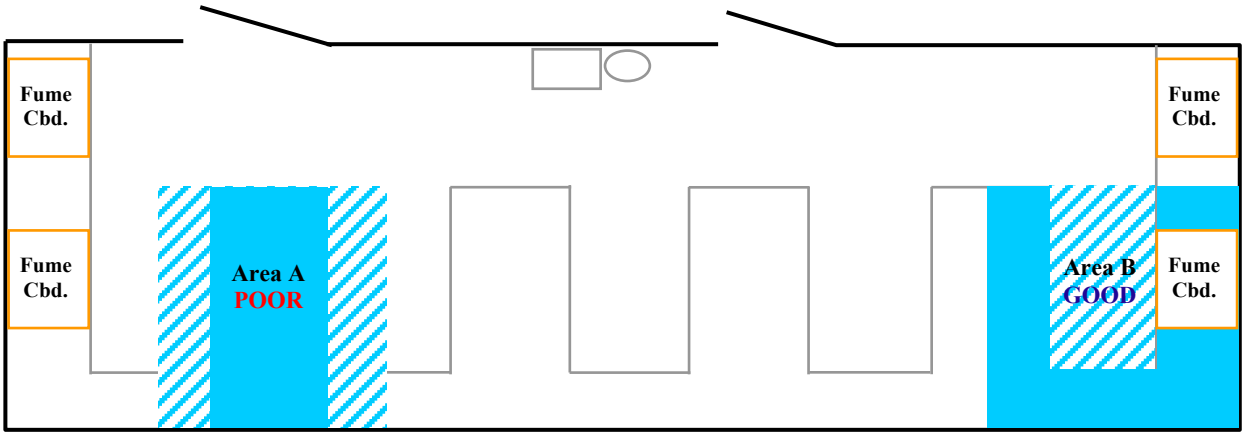

Figure 1 – Example of poor and good positioning of a Radiation Supervised Area in an open-plan laboratory. The solid blue shows the extent of the working areas, and the hatched blue the projected extent of the Supervised Areas. Area A is POOR, because it is difficult to exclude unauthorised

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persons from the area and to demarcate it, and they have no ready access to a Fume Cupboard. Area B is GOOD, because it is easy to exclude unauthorised persons and demarcate it, and there is exclusive use of a fume cupboard.

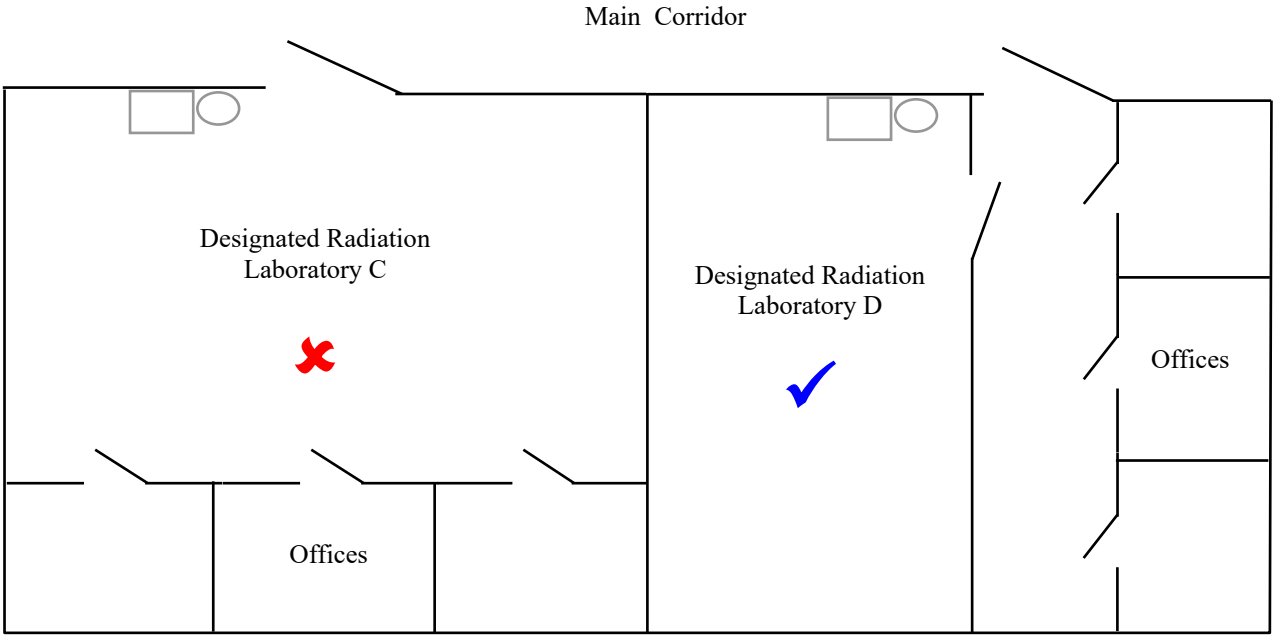

Figure 2 – Example of unacceptable and acceptable layouts of a Radiation Designated Area. Offices must not be designated radiation areas, and yet in Laboratory C persons would have to traverse a Designated Area to get to some offices. This is UNACCEPTABLE. In the case of Laboratory D, there is no need for anyone who is not intending to work in the laboratory to enter it.

- There must be adequate space for the intended work, including any reasonably foreseeable changes in usage or users. The design must take into consideration space for benches, sinks and hand basins, fume cupboards, refrigerators and freezers, storage for personal protective equipment, and storage for radioactive material and waste. This should include any reasonably foreseeable contingencies, such as a hold-up in waste disposal.
- The layout must minimise the need for moving radioactive material around, but allow for the possible use of shared facilities.
- The location of sinks needs consideration in order to meet the requirements on waste pipe design – see section 3.6.
- Conventional wall-mounted heating radiators, particularly the finned type, provide a large area for contamination, potentially where it cannot be detected. The type and location of radiators must therefore be considered. Radiators must not be located behind work benches.

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- There are no especial requirements for the lights and luminaires, provided that they are ceiling mounted.
- General dilution ventilation should be provided in all laboratories handling open radioactive material.
- Where airborne radioactive material has to be discharged to atmosphere, appropriate extract ventilation must be provided. In the majority of cases, a conventional fume cupboard discharging through an appropriately mounted stack should be used. For most new designs, it is probably best to assume that the laboratory will be used at some time for the discharge of material to the atmosphere, and install an appropriate number of suitable fume cupboards at the time of construction, rather than have to retrospectively fit later (Sometimes local extract ventilation is more appropriate, and this is likely to be identified after the initial design stage, such as when planning the work, or at the latest, when submitting the Proposed Scheme of Work form. Such systems should not be installed without prior reference to the University Radiation Protection Adviser.)
- Fume cupboards must meet the relevant requirements of BS 7258:1994 and BS EN 14175. Duct air velocities must be sufficient to prevent drop-out in the ducts. Discharge stacks design and location must meet current guidance and good practice.
- Normally, the extracted air must not be treated in any way, such as by filtration, prior to exhaust. If such treatment is required, perhaps for non-radiological reasons, the University Radiation Protection Adviser must be consulted.

If there is a need for a store for solid or organic liquid radioactive waste, the design should include the following considerations:

- The store should preferably be located in the same building as the waste-producing laboratories. It must not be located in a separate building where collecting the waste would involve its carriage along or across public roads.
- The store does not have to be exclusive to radioactive waste, subject to the following provisos:
    - if is shared with other waste, then the space used for radioactive waste must be demarcated by some physical barrier or enclosure;
    - the store must not be used for highly flammable or corrosive material, or highly flammable gases;
    - the various compartments of the store must be clearly labelled to show the contents and relevant hazards; and
    - all of the store must meet the security standards for the material with most stringent requirements.
- It should be large enough to accommodate the anticipated amount of waste, including contingencies.
- It must have a good degree of natural ventilation. If gaseous radioactive waste, or uranium or thorium or their daughters are to be stored, there might be a need for forced ventilation.
- There might be a need to consider shelving, allowing for the safe manual handling of the waste containers, and including a means to

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manipulate waste containers according to a storage decay system. The weights of the University's current waste containers are such that mechanical handling facilities are unlikely to be needed.
- For the University's current usage, no structural shielding is required.
- The store must not open out directly onto areas accessible to the general public. • It must be close to an access point for light goods vehicles.
- It must be secure. This might require a significant degree of physical security measures if it is near publicly accessible areas.
- Bunding is not necessary for the type and amount of waste normally produced by the University.

The design plans of the laboratories, any waste stores and relevant plant must be included in the building's CDM Safety File.

3. Facilities

3.1. Floors

The floor should be covered with an impervious surface such as a continuous sheet of PVC or linoleum at least 2.5 mm thick. The covering should be coved to the walls and any fixed island service units to a height of about 15 cm contiguous with the floor surface. All edges at the walls should be sealed or welded to prevent seepage of spilled materials. Joints between sheets are not recommended, but may be permitted if the joints are welded and inspected to ensure the absence of a seepage path for contamination. Any non-slip sealant material used to facilitate cleaning may be applied provided that spilled materials can be easily removed during the decontamination procedure. Generally, epoxy resin coatings are easily decontaminated. As an alternative to a sheet material covering (such as PVC), an epoxy resin coating may provide an acceptable finish on smooth concrete.

3.2. Walls and Ceilings

The walls should generally be smooth and either tiled, or painted with a hard gloss or high quality waterproof vinyl emulsion to facilitate cleaning. The surfaces should comply with the salient parts of BS 4247:Part 2. It may be worth tiling up to about shoulder height, especially behind sinks used for the disposal of aqueous radioactive waste, and using an appropriate paint above that. Joints should be sealed or filled with silicone type materials to facilitate cleaning (or removal in the event that decontamination cannot be achieved). Service penetrations in walls should be sealed.

For the type of work undertaken at the University, particular surfaces for the ceiling should be unnecessary.

3.3. Doors and Windows

Any wooden surfaces should be covered with plastic laminate material or painted with a good quality polyurethane gloss paint or varnish. All joints should be sealed. Windows should not be capable of opening where there is a

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risk of contamination splashing outwith the laboratory. Window shelves should not be larger than necessary, have no decorative rebates or the like, and not be inclined towards the window. It is preferable that any ancillary flat surface is inclined back towards the laboratory benches.

Security of radioactive material is important. Unless the building is considered to be sufficiently secure, the entrance doors to Controlled Area laboratories should be fitted with locks to ensure safe keeping. Where the Controlled Area is frequently used, a key pad lock might be appropriate. Supervised Areas and non-designated areas do not need locks on the laboratory doors, although secure storage of stock material is still required.

3.4. Benches

Working surfaces should be smooth, hard and non-absorbent and have necessary heat and chemical resistant properties. All gaps and joints should be sealed with a silicone type material. Depending on the type and quantity of radioactive materials used, account may need to be taken of the problems involved in decontaminating certain materials used for bench surfaces. For example: Corrian apparently binds iodine (e.g. I-125) in several chemical forms; Melamine fixes sodium ions (e.g. Na-22) under some conditions; stainless steels may bind phosphate (e.g. P-32) or chromium (e.g. Cr-51) firmly and may be very difficult to decontaminate.

There should be no gap in between the back of the bench and the wall, and the benchtops should be coved (up stand) against the wall. Joints should be sealed with a silicone type material. Rounded-edge benchtops should be used instead of lipped edges, since the latter provides another joint for potential contamination. However, if high activity material is being handled in liquid or fine dust form, or there is some reason why bench trays cannot be used, then preformed bench tops that have a raised front lip must be used.

Exposed wood, including under benches and under-bench cupboards, should be painted with a good quality hard gloss paint or polyurethane varnish or laminated. The use of wood surfaces should be avoided on all new laboratory designs.

3.5. Shelving

Shelving should be of a similar finish to benches, although there is a less concern of chemical attack. If the shelving is at a sufficiently low level that there is a risk of contamination by splashing, joints with the wall should also be sealed.

3.6. Other Laboratory Furniture

Any other laboratory furniture, such as seating, should be made of materials with a similar nature to the benches, i.e. with surfaces on which contamination is unlikely to become fixed, which are readily able to be monitored, and from which contamination is readily removable.

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3.7. Personal Protective Equipment

In the case of Controlled Areas there must be sufficient facilities for the storage of personal protective equipment. Normally, this will just mean lab coats. The accommodation should be adjacent to the entrance to the room and should include some spare capacity for visitors.

3.8. Waste Disposal Sinks and Drainage Pipes

Sinks for the disposal of radioactively contaminated aqueous liquid waste should be constructed of suitable material; for most applications, stainless steel is preferred. Where possible, combined sinks and draining boards should be used, with rounded front edges and coved (upstand) at the rear against walls. Ideally an easily decontaminable rear splash plate should extend a reasonable distance up the wall behind the sink. Side splash guards may also be useful. As noted above, phosphate ions may bind strongly on to stainless steel, and this may cause problems in laboratories where P-32 is used in quantity. (Similar problems may arise where old fashioned sinks have been sealed with putty or in hard water areas where a calcium phosphate layer may be precipitated in the sink). Borosilicate glass sanitary ware may be appropriate in some circumstances.

Taps should be fitted with handles that can be operated without being touched by the hand.

Small diameter U-shaped or bottle traps should be used, instead of large traps or catch pots, so as to avoid accumulations of radioactive sediments. .

The drain should be connected as directly as possible to the main foul water sewer leaving the premises. Holding tanks would normally not be required for the University's discharges of radioactive waste, and the discharge from sinks designated as used for radioactive liquid disposal should not be directed towards any existing holding tanks without prior reference to the University Radiation Protection Adviser. In the case of new build, the discharge route should be mapped and recorded for future reference.

Drainage system materials should take into account the possible build up of contamination on surfaces. All drainpipe materials may retain specific radionuclides. The most generally useful type - vulcathene - fixes iodine very strongly - which may be significant where the radioiodines have to be disposed of through drains of this material. Pipes should be well supported along a suspended run, should be sloped down to prevent accumulations of radioactivity, and, where reasonably practicable, should not be hidden. If necessary, demountable panels should be fitted to allow access to any covered pipework.

All sinks used for disposal of liquid radioactive waste must be marked with the standard University sign:

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Figure 3 – The sign to be fitted next to sinks used for the disposal of aqueous radioactive waste

The drainage pipes from such sinks must be marked to indicate the possible presence of radioactive contamination up to a point at which their contents are diluted substantially with frequently-flowing, non-radioactive effluents. This is to alert maintenance staff and to prevent uncontrolled disposal of any contaminated pipes removed during maintenance work. Further information on this matter is given in the Radiation Protection Guidance Note GN010.

3.9. Wash Basins

Every laboratory used for open radioactive work must be provided with a wash hand basin. In the case of Controlled Areas this must be within the Area and next to the door. In the case of Supervised Areas and non-designated areas the wash basin does not have to be within the area, although it should be within the same room.

The wash basin should have hot and cold running water, and taps that can be operated without being touched by the hand. There should be soap and a paper towel dispenser adjacent to the basin. The waste pipes should meet the same standard as for waste disposal sinks.

The University's current use of radioactive material does not warrant an emergency shower.

3.10. Radioactive Storage Facilities (Including Waste)

There should be sufficient space in the laboratory for the safe and secure storage of all radioactive material. Unless the room itself provides adequate security, appliances in which the radioactive material is stored should be capable of being locked. There should also be adequate space for waste disposal bins in the laboratory. The University uses disposable bins for combustible solid and organic liquid waste, so no permanent bins need to be supplied, except where shielding is required. Some small-usage laboratories do not generate a large amount of solid radioactive waste and store all such waste in the laboratory pending collection and disposal.

Where waste stores are required, the following facilities are needed:

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- The store must be fitted out with smooth, impervious and easily washable floors and walls, up to a height above which splashing is not reasonably foreseeable.
- Racking or shelving might be needed to maximise the space available. Any such racking or shelving must meet the same standard as the floor and walls for decontamination. The design must take into account safe weight loading and any accompanying manual handling requirements.
- There must be a wash hand basin in or immediately adjacent to the store. The hand basin must have the same facilities as outlined in section 3.9 above.

3.11. Signage

The nature of the signage depends upon whether the laboratory is to be designated as a Controlled Area or Supervised Area, or will be non-designated. Details of this can be found in RP COP011. The appropriate sign is provided by the Radiation Protection Unit and must be attached as follows: Controlled Areas – on the entrance door to the room. Supervised Areas – at the entrance(s) to the area. Non-designated Area – not required.

It is assumed that these will be fitted by the users. Warning signs are not needed, and must not be fitted, on doors or partitions that do not lead immediately into a radiation designated area.

Signs are required on the waste disposal sinks and waste pipes, and these have been described in previous sections. All other warning signs in the laboratory would be fitted by the users, and information on this can be found in RP COP011 and RP COP006.

The ventilation ducts and air handling units for the fume cupboards must not normally be labelled in any way to indicate the presence of radioactive material. Labelling should only be necessary if air treatment devices, such as filters, have been installed. Such devices should have been the subject of consultation with the University RPA.

In the case of separate waste stores, designation would be most unlikely. These should therefore be labelled on the outside door to warn of the presence of radioactive material and to prohibit entry by unauthorised persons. This or another sign should also provide information on what department has responsibility for the store and who should be contacted in case of an emergency. An example of an appropriate sign is shown below.

4. Consultation and Further Information

This Code of Practice is intended to help those involved in the planning and construction or refurbishment of radiochemical laboratories, and further advice can be obtained from the University Radiation Protection Adviser at any time. However, it is not intended to replace the statutory requirement to consult the URPA. It is important that the URPA is contacted at the design stage of any plans to build or fit out any radiochemical laboratories.

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Figure 4 – The sign to be used on the door(s) to radioactive waste stores

For advice on any of the above topics please contact the Radiation Protection Unit, radiation@ed.ac.uk.

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