RPA INFORMATION SHEET NO 34

DESIGN SPECIFICATION FOR SUPERVISED AREA RADIATION & CATEGORY 2 BIO-CONTAINMENT LABORATORIES

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UNIVERSITY OF LEEDS

CENTENARY 1904-2004

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Document Title	**Design Specification for Supervised Area Radiation and Category 2 Bio-containment Laboratories**
Owner	I K Haslam (Radiation Protection Adviser)
Purpose	This document recognises three categories of science laboratory, **low-risk** general purpose labs that may be used for research and teaching, **medium-risk** specialist laboratories that must be designed and fitted out to specific criteria, and **high-risk** specialist laboratories in which dangerous pathogens or high activities of radionuclides may be handled. This document is a benchmark standard that harmonises the design and fittings used in **medium-risk** radiation and bio-containment laboratories.
Status	Open document, uncontrolled

Quality Assurance					
Version		Originator/ author	Checked	Approved	Date
1.1	Internal review	I K Haslam	A Cowling	XXXXX	XXXXX
1.2	Estates Services for comment	I K Haslam	A Kelly	XXXXX	19/11/03
1.3	Peer review	I K Haslam	A Cowling	XXXXX	26/03/04
2.0	Final version	I K Haslam	A Cowling	I K Haslam	16/06/04

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INTRODUCTION

Application of this Information Sheet

1) The purpose of this Information Sheet is to present the design standard that must be followed when designing new (or refurbishing) radiation or bio-containment laboratories. The standard applies to **Supervised Radiation Areas** where unsealed sources are used and **Category 2 Bio-containment Laboratories**. It does not apply to Controlled Radiation Areas or to Category 3 and 4 Bio-containment Labs[3].

2) It is a **legal requirement** that the customer, architects, project officer, design team etc. **seek the advice** of a suitably qualified[4] Radiation Protection Adviser[5] (RPA) or Biological Safety Officer[6] (BSO), as appropriate, from the **initial planning stage**. Moreover, the specialist advisers must be kept in touch with the project during its progress.

3) A laboratory may not be commissioned for use until a **Critical Examination** has been successfully carried out by a suitably qualified RPA, or a **Commissioning Survey** by the BSO, as appropriate.

4) The responsibility for legislative compliance with respect to the proper design, construction, installation and testing of radiation facilities lies with the 'radiation employer'[7], i.e. the Head of Academic Unit.

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[3] Controlled Radiation Areas and Category 3 & 4 Bio-containment Labs are for highly specialised work and are therefore considered on a case-by-case basis. Design of such facilities must involve consultation with specialist advisers.

[4] It is the responsibility of the customer to ensure the specialist advisers are suitably qualified. The Radiation Protection Adviser should be 'certificated' by a HSE approved certificating body such as RPA2000 and should be experienced in design work; the Biological Safety Officer should ideally be experienced and have a proven track record.

[5] Regulations 13, 31(2) and Schedule 5 of the Ionising Radiations regulations 1999 states that the RPA must be consulted about the prior examination of plans, design, installation and acceptance testing of radiation facilities…and the adequacy (and functioning) of control measures provided to restrict exposure. Additionally, paragraphs 68 to 118 and paragraphs 522 to 526 of the ACoP apply.

[6] Unlike the requirement for prior consultation with an RPA, there is no direct statutory requirement for prior consultation with a BSO when designing new facilities. The legal requirement for consultation with a BSO is instigated when risk assessments have been submitted for final approval by the local GMO (usually School level) Committee. However, if a facility has not been designed to an appropriate standard, authorisation for bio-containment work will not be forthcoming. Therefore, it is in best interests of all parties that a BSO is consulted in the early stages of laboratory design.

[7] A 'radiation employer' is defined in legislation as being the person who 'employs the uses of ionising radiation in an organisation'. The 'radiation employer' at the University of Leeds is the Vice-Chancellor for the University and the Head of Academic Unit (School, Department, Institute) for the organisational unit.

Objective

5) This design standard has been prepared with thought to the likely future needs and directions of research, and has harmonised thinking in the specialist safety disciplines (radiological protection and bio-safety) with a view to taking an enabling approach to multidisciplinary experimental work. A laboratory that is built to the standard given herein will satisfy the basic safety requirements for most types of medium to high-risk containment work likely to be carried out in the life, medical and environmental sciences.

Legislative framework

6) This standard has been prepared with reference to the following legislation and guidance:

- Radioactive Substances Development Group. Environment Agency Guidance on Standards for Radiochemical Laboratories in Non-nuclear Premises. Environment Agency (1997).
- Health and Safety Commission. Work with Ionising Radiation (Ionising Radiations Regulations 1999[8], Approved Code of Practice and Guidance). HSE Books (2000). ISBN 0-7176-1746-7.
- International Commission on Radiological Protection. The Handling, Storage, Use and Disposal of Unsealed Radionuclides in Hospitals and Medical Research Establishments'. Annals of the ICRP **1** (2). Pergamon Press (1977). ISBN 0-08-021510-6.
- Association of University Radiation Protection Officers. AURPO Guidance on Working with Ionising Radiations in Research and Teaching. AURPO (2003 edition).
- Moseley, T. Contamination Control: Working with Unsealed Sources of Radioactive Material. University of Sheffield (2000)[9].
- The Advisory Committee on Dangerous Pathogens. The Management, Design and Operation of Microbiological Containment Laboratories. HSC (2001). ISBN 0-7176-2034-4).
- British Standard BS 3202-1. Laboratory Furniture and Fittings. British Standards Institute (1991).
- British Standard BS4247-2. Surface Materials for use in Radioactive Areas. Part 2: Guide to the Selection of Materials.

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[8] IRR99: Ionising Radiations Regulations 1999: SI 3232

[9] Educational video published by The University of Sheffield.

- The Radioactive Substances Act 1993.
- The Anti-Terrorism, Crime and Security Act 2001.

Overview

7) This design standard is in two parts, containing information relevant to both the Academic Unit and Estate Services, and information which is solely a matter for the Academic Unit, but which should be taken into consideration when assessing their needs.

8) The appendices to this report present typical layouts for radiation laboratories, and show the main features discussed in this design standard.

BASIC LABORATORY REQUIREMENTS
(MATTERS FOR THE ATTENTION OF BOTH THE ACADEMIC UNIT AND ESTATE SERVICES)

Floor coverings

9) 2.5 to 3mm continuous vinyl sheeting with a minimum number of welded joins, and which is coved to the walls to a height of 15cm. Where the flooring material is penetrated by screw holes, for example, sealant should be applied. It is recommended that the flooring should be coved up the legs of workbenches. All edges at the walls should be sealed or welded.

10) Great care should be taken if consideration is being given to non-slip floor coverings, as many of these surfaces are pervious and could retain spilt radioactivity or biological materials.

11) 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.

Walls and ceilings

12) Walls and ceilings should be smooth, intact and any areas of poor plasterwork should be made good. Any gaps sealed with a suitable hard bonding sealant.

13) The walls and ceilings should generally be smooth and painted with oil-based paints such as eggshell, hard gloss, or high quality waterproof vinyl emulsion to facilitate cleaning without

causing damage[10]. Painting with vinyl emulsion is not acceptable. The use of stippled surfaces or a paint finish applied to unplastered concrete blocks is not acceptable.

14) 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 and ceilings should be sealed and coved.

15) Suspended ceilings may potentially cause problems due to penetration of contamination[11].

Doors and Windows

16) Wooden surfaces should be covered with plastic laminate material or painted with a good quality polyurethane gloss paint or varnish.

17) A good level of security is essential for radiation and bio-containment labs[12], and therefore doors should usually be lockable to ensure safekeeping or to restrict access in the event of major spillage of the materials. Doors leading off public places and which are frequently opened may additionally be secured by use of a keypad lock[13]. For some sites, the user may provide a high level of security for a building as an alternative to securing an individual laboratory within a building.

18) Where opening windows are fitted, care should be taken that no persons will be affected by any release of radioactivity immediately outside. Open windows should not be used as intentional discharge routes.

19) Ground floor or accessible windows should be secured to prevent unauthorised entry.

20) Doors, door/window frames and glass panels must be sufficiently robust to deter forced entry if material that is scheduled under the Anti-Terrorism, Crime and Security Act 2001[14] is in use (i.e. the lock is of little use if the surroundings are weak).

21) Areas holding materials scheduled in the Anti-Terrorism Act will have to be fitted with

[10] A note of caution: many paints undergo chemical or physical reactions with certain radionuclides. A more important criterion may therefore be the ease with which the paint can be stripped off again rather than its cleaning properties. A known problem occurs with chloride ions, which may bind irremovably with painted surfaces.

[11] Suspended ceilings are not permitted in Category 3 laboratories.

[12] Radiation and bio-containment areas are viewed by MI5 (for biohazards) and the National Counter Terrorism & Security Office (for radiation targets) as being high risk, and so adequate security is required.

[13] Category 3 Laboratories should be fitted with a 'swipe card' locks; see also paragraph 21.

[14] The Anti-Terrorism Act applies to Category 3 laboratories and to those Category 2 laboratories within which agents listed in the Schedule are used.

computer recorded proximity locks; full compliance will be mandatory by 2007 (keypad locks will then no longer be acceptable).

Benches and Work surfaces

22) All work surfaces must be impervious to water and should offer a high degree of resistance to acids, alkalis, solvents, chelating agents, detergents and disinfectants. Care must be taken in the selection of surfaces as certain bench materials preferentially bind specific ions (e.g., Corian fixes iodine, laminates fix sodium, and stainless steel fixes phosphorous, chromium and calcium ions) and easily chipped surfaces may facilitate the incorporation of biological materials into the fabric of the bench.

23) A laboratory may be fitted with a mix of **'active'** workbenches where experimental materials are handled, and (flat-edged lower grade) **'support'** benches on which equipment is housed. The customer should give serious consideration to their needs in this respect. It is difficult and costly to convert support benching to active benching at a later date; having active benching throughout builds flexibility into the future uses of a laboratory.

Figure 1 Photograph showing a suitable lipped Corian® bench and integral sink

24) 'Active' work surfaces in Supervised Radiation Areas and in Bio-Containment Category 2 Labs should preferably be

- made of Corian[15] (or similar for radiation areas) or Trespa[16] (for bio-containment areas)[17],

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[15] Corian is a resin-based homogeneous material that is cast in a single piece (including backstand, lips and sink). The advantage is that it is seamless and highly resistant to wear and tear.

[16] Trespa is a solid laminate that is reasonably resistant to wear and tear, but which is produced in single sheets. Thus lengths, corners, backstand, lips need to be joined or bonded after fitting.

[17] The Radiation Protection Service is currently testing a new bench material called 'Capri'. This is similar to Corian, but significantly cheaper (~one-third the price). If trials go well the standard for both Supervised Areas and Bio-containment Laboratories will harmonise on Capri. Contact the RPA for details.

- 'lipped' (not dished) to retain spilt liquids[18] (Figure 1) in radiation work areas: lipped or ‘flat edged’ in bio-containment areas depending on how work is to be organised,

- have an integral or tight fitting sink for the disposal of aqueous radioactive waste and denatured biological materials, and,
- be fitted with integral back stands[19] that rise to a height of 10cm.

25) It is recommended that active benches are coloured to enable them to visually stand out from other work areas.

26) All gaps in benches, and between benches and walls, sinks, etc. must be sealed with a chemically resistant non-absorbent sealant; silicone and 'no nails' type sealants are particularly good.

27) For minor refurbishments and modifications it is acceptable to recycle older style laminated workbenches providing they can be retrospectively fitted with lipped edges and back stands. 'Trespa' is an acceptable material to use to create lipped edges providing it is firmly bonded onto the existing bench.

28) 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.

Waste Disposal Sinks and Drainage Pipes

29) Sinks for the disposal of radioactively contaminated aqueous liquid waste should be constructed of suitable material: for most applications, integral Corian® sinks are preferred for radiation work (Figure 1), although stainless steel is acceptable. Ideally, an easily cleanable rear splash plate should extend a reasonable distance up the wall behind the sink. Side splashguards may also be useful.

30) As noted previously, phosphate and calcium ions may bind strongly on to stainless steel, and this may cause problems in laboratories where ^{32}P is used in quantity. (Similar problems may

[18] Dished bench edges should not be used as 'new benching' as it presents an uneven bench surface.

[19] Backstands - are also known as covings or upstands.

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).

31) Simple U-bend traps should be used so that aqueous wastes are immediately flushed away and not 'retained' in the laboratory drainage system: large traps or catch pots must not be used.

32) The drain should be connected as directly as possible to the main foul water sewer leaving the premises. Catch pots and holding tanks are undesirable as they facilitate the accumulation of sediments, which may themselves become further contaminated, and are prone to holding chlorine-releasing disinfectants.

33) Drainage system materials should take into account the possible build up of contamination on surfaces.

34) The most generally useful type of drainpipe material for radiation laboratories is **'vulcathene'**. However, it must be borne in mind that all materials will absorb ions to a greater or lesser extent, for example, vulcathene tends to fix iodine very strongly[20], and this could prove to be significant where large quantities of radioiodine have to be disposed of through drains of this material. Borosilicate glass may be used as a drainpipe material in high-risk areas such as Controlled Radiation Areas; however, it is not greatly favoured because of its fragility and the difficulties in making good connections.

35) Pyrex waste lines are preferred in biological laboratories as 'slimy' blockages can be seen[21].

36) The discharge route should be mapped and recorded for future reference in case of maintenance on the system. Also, sinks and drainage systems used for the disposal of aqueous radioactive waste should be labelled with the ionising radiation symbol, up to a point at which their contents are diluted substantially with frequently - flowing, non-radioactive effluents. This is to alert maintenance staff and thus prevent unauthorised disposal of any contaminated pipes removed during maintenance work. Pipes should be well supported along a suspended run, should be down-sloped to prevent accumulations of radioactivity, and, where reasonably practicable, should be made accessible - for example by the use of demountable panels - and subject to periodic inspection so as to assure their integrity.

37) Biological materials are denatured prior to aqueous disposal, and so the issue of drainage is

[20] Prior to iodine work, vulcathene drainpipe runs can be pre-flushed with concentrated molasses, which lines the pipe and preferentially absorbs iodine ions.

not as great a concern as it is for radiation areas.

Hand-wash Basin

38) All Supervised Areas and Category 2 Laboratories must be provided with a handwash station comprising a suitable basin fitted with elbow or knee operated taps, liquid soap and paper towel dispensers[22], which must be sited near the exit to the laboratory.

39) A designated hand washbasin should be provided: it must never be used for the disposal of radioactive substances (other than traces from the washing of hands).

Changing Facilities and lobby's

40) As a minimum, somewhere to hang lab coats should be provided near the entrance to the facility. In many cases it is necessary to provide a lobby/changing area to the laboratory.

41) Whereas Category 3 laboratories must have lobbies, this is not necessarily the case for Category 2 and Supervised Radiation Area laboratories. The incorporation of lobbies into such laboratory suites will be dependant upon the nature of the work likely to be undertaken therein: specialist advice is required, and each proposal should be assessed by an appropriate specialist adviser from Safety Advisory Services.

Telephone

42) A telephone should be provided, ideally being sited close by the hand wash facilities in radiation areas and Category 2 laboratories.

Fume Cupboards, Ventilation and Containment

43) Careful thought should be given to the installation of fume cupboards and microbiological cabinets: in general, terms fume cupboards and microbiological cabinets are not compatible. Advice on the siting of microbiological safety cabinets is given in the ACDP publication 'The Management, Design and Operation of Microbiological safety cabinets'.

44) Dispensing or preparation of radioactive materials that may cause airborne contamination should be carried out under conditions to prevent dispersal of the substances, and fume

[21] Protein and other denatured biological media can provide a growth medium for contaminating organisms, with fungi and moulds being particularly problematic in tissue culture labs: disinfectants cease to be effective after a few hours.

[22] Knee or foot operated taps are required in Category 3 ACDP laboratories; elbow taps are acceptable in Category 2 laboratories.

cupboards have traditionally been installed in radiation laboratories for this reason. An acceptable alternative is to dispense radioactivity in a bench top 'Betacab®' (Figure 2).

45) It is acceptable to uses Class I - III Microbiological Safety Cabinets for dispensing radioactive materials, providing sufficient attention is given to the ease of radioactive decontamination.

46) Volatile radioactive materials should never be used in the open laboratory, only in appropriate externally ventilated or filtered containment such as a fume cupboard. Recirculating ventilation systems are inappropriate for volatile radioactive materials.

47) If a fume cupboard is to be used for containment when working with substantial quantities of a gamma emitting radionuclides then the plinth will need to installed that will support a considerable amount of lead shielding (possibly up to 1,000 kg). In addition, when handling gamma-emitting or energetic beta emitting radionuclides consideration should be given to lining the walls against which the fume cupboard is sited with 3mm lead.

48) Careful consideration should be given to laboratory ventilation and the provision for air change. Generally, airflow should move from less hazardous to more-hazardous areas of a laboratory before being extracted or discharged from the room. It should be noted that the balancing of an extract ventilation system having a number of ducts, dampers and inlet points, to achieve design airflow rates, requires considerable skill and expertise. Alterations to damper settings by unskilled operators are therefore generally to be deprecated.

49) Radiation and Category 2 laboratories must have either no pressure gradient between the laboratory and the corridor/outside area, or it must be held at constant negative pressure of 15 to 20 Pascals, i.e. inward airflow. What is strictly forbidden is for the room to become positively pressurised with respect to the surrounding areas. Air handling systems are not required for Category 2 laboratories, however, if air conditioning or forced ventilation is provided careful thought and expert advice are required.

Figure 2 Workstation comprising a beta cab and drip tray

50) When considering fume cupboards or cabinets for radiation areas, attention should be given

to both internal and external surfaces, which should be smooth, hard, non-absorbent and have the necessary heat and chemical resistant properties. Surfaces must also be easy to decontaminate (Figures 1 & 3).

Seating

51) Stools and chairs should be either non-upholstered or upholstered in non-absorbent material (Figure 3).

Write-up areas

52) Write-up areas are not permitted in radiation facilities, irrespective of the laboratory designation.

Power Supply

53) Electricity conduits, trunks and plug sockets should be wall mounted and set at a minimum height of 200 mm above the work surface (Figure 3).

54) Sockets should be a minimum of 300 mm from the nearest sink: the requirement used to be siting at a distance of 1500 mm, however this was revised as sinks no longer have to be earth-bonded, and pipes are changing to plastic.

55) Provision should be made for under-bench equipment such as refrigerators and freezers.

56) Sufficient sockets should be installed at suitable locations to power fridges, freezers, centrifuges, bench-top and freestanding equipment.

Figure 3 **Photograph showing a workstation sited on a Corian® bench, a suitable laboratory chair, the position of the electrical trunking, and a single sheet laminate floor covering coved to the walls**

Security Arrangements

57) Supervised Areas should be lockable, doors should preferably be self-locking and with keypad entry systems. See also paragraphs 16 to 21. If material scheduled under the anti-terrorism act is being handled then labs should be alarmed (the advice of an appropriate specialist adviser from Safety Advisory Services will be required).

LABORATORY EQUIPMENT AND ARRANGEMENTS FOR RADIATION WORK (MATTERS FOR THE ATTENTION OF ACADEMIC UNIT)

Storage and Waste Disposal

General storage

58) Adequate storage space should be available to keep essential equipment in order to minimise the cluttering of equipment near working areas, and reduce the risk of spreading contamination. It may be desirable to have an area set aside for the storage of equipment awaiting decontamination.

59) Storage cupboards should ideally be constructed of non-absorbent materials (Figure 4). Where wooden cupboards have to be re-used, they should be painted with a thick layer of gloss paint or varnish (see also paragraph 28).

Figure 4 Laminated under-bench storage cupboards mounted on castors to facilitate cleaning

Storage and the Anti Terrorism Act

60) Scheduled material must be stored in a locked freezer / refrigerator. If domestic appliances are used the door and hinges must be reinforced in some way as well as fitting padlocks and hasps.

Refrigerators and freezers

61) Refrigerators and freezers are commonly used for the storage of radioactive sources, biological materials, stock solutions and samples. All refrigerators/freezers[23] and the radioactive/biological materials within them, should be easily identified (labelled).

62) Refrigerators/freezers used to store Category 2 and 3 pathogens and bio-toxins must be kept locked at all times.

63) Refrigerators/freezers used to store radioactive materials should be lockable and kept locked unless they are under continual surveillance or sited in locked laboratories.

Waste storage and disposal

64) Waste disposal bins in the laboratory (used for storing hazardous wastes awaiting disposal) should be constructed of a material that is robust, and must provide an acceptable level of shielding[24]. The lid should be closed when not in use and the contents in the bag sealed or secured before removing them from the bin.

65) All sharps, bottles, tubes, etc should be placed in sharps containers to ensure safe handling of the materials. Bins located outside the control of the user must be secured to prevent misuse of the contents.

66) Adequate storage space (e.g. a bunker or storeroom) should be available for hazardous wastes, either inside or outside the laboratory. The storage space must be kept locked and may need to be under surveillance.

67) Biological and radiation waste must be secure at all times, and must never be left unattended (even for a moment) between the laboratory and the disposal area.

68) Biological waste must not be allowed to accumulate in autoclave areas, etc. Category 2 wastes (from concentrated cultures) must be autoclaved within the building (within the laboratory suite for Category 3 waste).

Space Allocation

69) As a guideline, a space allocation of approximately 24 m^3 per worker (which assuming a

[23] Refrigerators / freezers should be regularly defrosted. It should be noted that volatile radionuclides, in particular tritium, might accumulate in the ice: it is good practice for the user to check this periodically.

[24] If the waste contains hard beta emitters, the bins will need to be shielded by 1cm perspex, or lead if the waste contains gamma-emitting radionuclides.

ceiling height of 2500 mm, equates to approximately 9.5 m^2 per worker) is recommended for users of Supervised Areas and Category 2 Bio-containment Laboratories.

Hazard Warning Signs and Signals

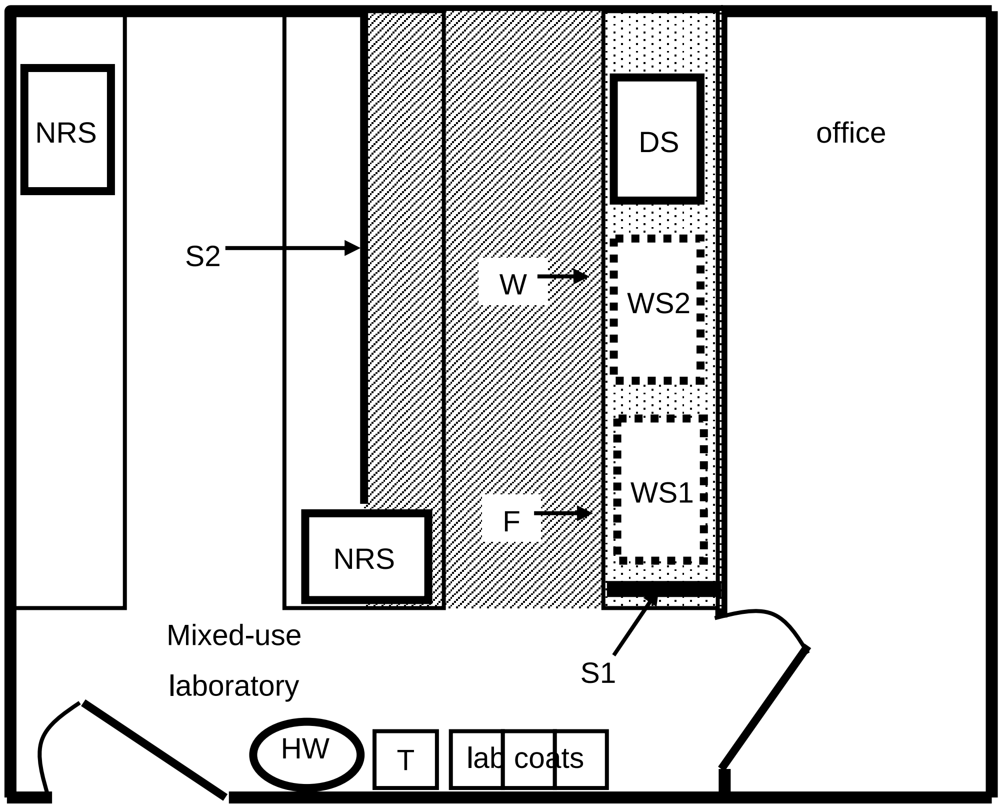
70) Clearly and legibly marked hazard warning signs must be posted on laboratory doors, cupboards, equipment, refrigerators, working areas, drainage pipes, sinks, storage facilities, sewers, exhausts as appropriate. All signs should comply with the requirement of the Health and safety (Safety Signs and Signals) Regulations 1996, i.e. signs should be clear, unambiguous, indicate the hazard and level of risk, and state where the hazard is to be located. The Radiation Protection Service usually provides labels and hazard warning notices during the course of a Critical Examination.

Radiation Workstations

71) Unsealed radioactive materials may only be handled on a ‘workstation’, therefore radiation laboratories should be designed with a mind for the number of workstations required therein. The workstation is delineated by taping an appropriate sized piece of Benchkote® (absorbent side uppermost) to an 'active' bench (see paragraph 24) using 'radioactive' labelled tape. A drip tray within which the work will be done is sited on the Benchkote®; the drip tray will be used in conjunction with disposable liners of absorbent paper (towels or Benchkote®).

72) Shielding will need to be used where appropriate to reduce radiation dose rates at all accessible points. This means that if two workstations are situated side-by-side, it is likely that a perspex screen will be needed between the workstations. Screens may also be needed at the ends of workbenches.

APPENDIX 1 GENERALISED LABORATORY LAYOUT SHOWING THE MAIN FEATURES OF A SUPERVISED RADIATION AREA INCORPORATED WITHIN A MULTI-PURPOSE LAB



Key

DS = designated sink for aqueous radioactive waste disposal.

NRS = sinks which must not be used for radiation work or radioactive waste disposal.

HW = hand washbasin, soap dispenser, paper towel holder.

WS = workstation.

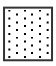
T = telephone.

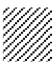
W = shielded radioactive waste storage bins, etc. beneath bench/sink adjacent to solid wall

F = fridge/freezer used for storing source, stocks, samples etc. beneath bench

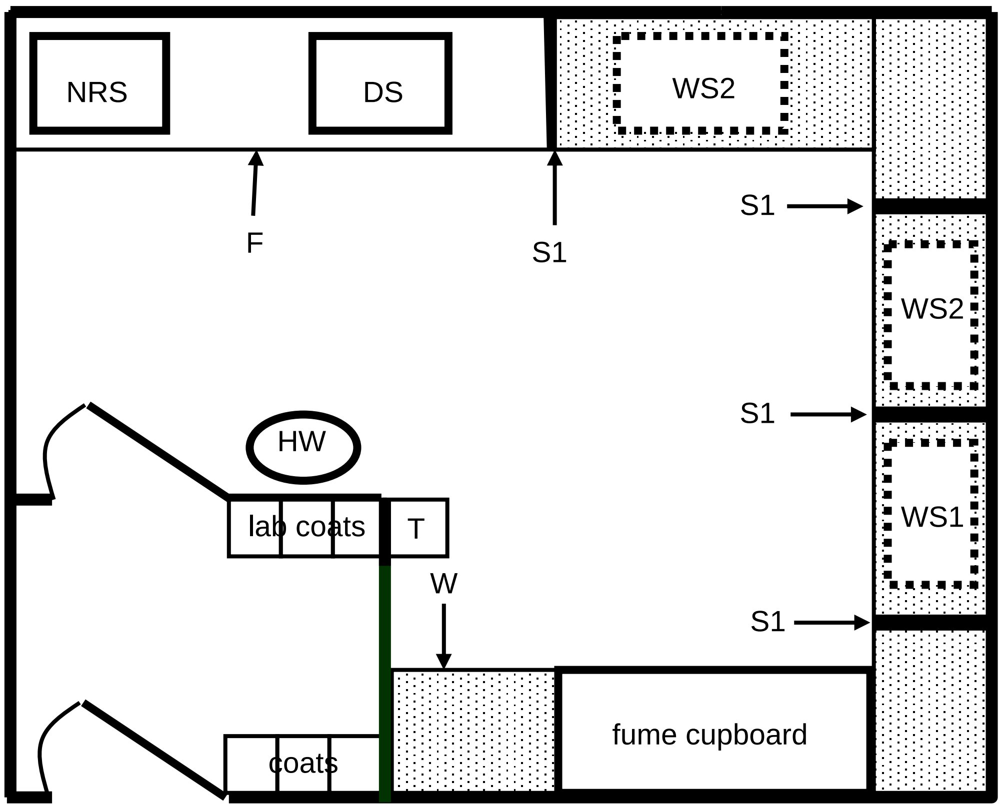
S1 = fixed 10mm thick perspex screen shield.

S2 = 3mm perspex/acrylic shield to partition island bench.

 = 'Corian' bench, lipped at exposed edges, edges adjoining walls combine integral backstand (15 cm high), integral designated sink.

 = section of lab to be designated as a Supervised Area.

APPENDIX 2 GENERALISED LABORATORY LAYOUT SHOWING THE MAIN FEATURES OF A SUPERVISED RADIATION AREA



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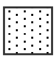
 = 'Corian' bench, lipped at exposed edges, edges adjoining walls combine integral backstand (15 cm high), integral designated sink.

APPENDIX 3 STAGES IN THE DESIGN PROCESS

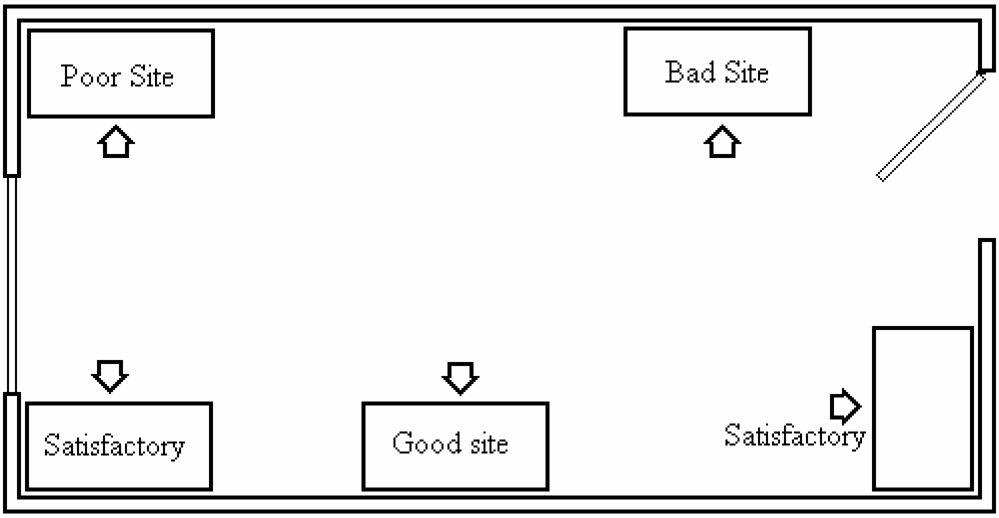
73) The design team, Estate Services and the Academic Unit should follow the following steps, in sequence, when designing and building/refurbishing Category 2 Laboratories and Supervised Radiation Areas. External designers and architects must be made aware of this 'sequence of events' at the time of the preliminary contractual negotiations.

- ☐ School → Determine usage and research needs, fittings, furniture, equipment, budget, etc. Make a rough plan of how the laboratory is envisaged - see Appendices 1 & 2.
- ☐ School → Discuss with Radiation Protection Adviser (RPA) and Biological Safety Officer (BSO).
- ☐ Estate Services / external designers & architects → To prepare / receive drawings.
- ☐ RPA/BSO → To undertake a Design Assessment.
- ☐ School, Estate Services, RPA/BSO, architects etc → To liaise.
- ☐ School, Estate Services, RPA/BSO, architects etc → To modify plans and design assessment.
- ☐ School, Estate Services, RPA/BSO, architects etc → Continual liaison, particularly over modifications to the plans.
- ☐ Estate Services → Construction works.
- ☐ School, Estate Services → Before hand-over, to agree that the final build has taken place according to specification, and also in compliance with this and other relevant documents.
- ☐ RPA/BSO → On completion of the construction works, but before hand-over, to undertake Critical Examination.
- ☐ Estate Services, School → Hand-over.

APPENDIX 4 COMMISSIONING MICROBIOLOGICAL SAFETY CABINETS

74) Cabinets must be tested to BSEN 12469 and the test must include a filter challenge and KI discus operator protection factor test. During the filter challenge, any external ductwork must be checked for integrity along its entire length. Likewise, with room extracts, where fitted, there must be no leaks between the room and the outside. It is strongly advised that an independent contractor be employed by the Academic Unit (i.e. not the installing contractor) to carry out these tests.

Figure 5 Optimum siting of safety cabinets



75) The diagram above (*adapted from Clarke, 1983*[25]) shows how the performance of similar Class 2 cabinets was affected by the position within the room. Ideally, cabinets must be positioned away from main thoroughfares, doors and windows where draughts can severely affect flow through the front aperture. It is essential to test cabinets immediately after installation to ensure that the operator protection factor is not compromised.

76) The difference in performance measured at the two left hand sites could not possibly have been anticipated simply by viewing the room layout. On the other hand, the good site would have been wholly predictable. This emphasises the point that where operator protection factors may be compromised by air currents or other activities within a room, marginally problematic sites can only be determined by performing the post installation tests. A mistake

[25] Clark, R.P. The performance, Installation, Testing and Limitations of Microbiological Safety Cabinets; H&H Scientific Consultants - ISBN 0141 7568.

inevitably leads to considerable additional expense. The only solution is to plan the laboratory logistics around the optimum cabinet site(s) and not the other way around.

77) The use of multiple cabinets in the same laboratory introduces a number of complications: expert advice should be sought at the earliest planning stage; the current ACDP guidance and Clark 1983 offer further advice on this subject.