Laboratory Design Code of Practice

Reviews and Revisions

Date	Reason	Reviewer	Next review date	Approved by
21/06/2018	New Document	AJ Sampson	June 2019	E Pritchard
29/07/2019	Minor amendments, inclusion of energy efficiency considerations	A Swinburne	29/07/2021	E Pritchard
29/11/2019	Made code of practice. Change to document reference number	A Swinburne	21/06/2021	E Pritchard

Contents

1. Introduction

This document provides guidance on design standards of Laboratories. The aim is to provide a laboratory that is fit for purpose and provides an environment in which the range of activities defined by users can be carried out safely.

The design requirements for ALL Laboratories are given in Section 4. More specialist Laboratory requirements in addition to or instead of these, are given in Sections 5 and 6. Section 7 gives guidance to laboratory users. Where there are different requirements in multi-disciplinary laboratories, standards relating to the more stringent requirements should be used.

This list is not exhaustive, and alternatives or additional requirements may be needed where risk assessments indicates this is necessary.

This standard can be read in conjunction with NERC (Natural Environment Research Council) Guidance on the Design of Safe Laboratories:

http://www.nerc.ac.uk/about/policy/safety/procedures/guidance-laboratories/

References are also taken from CLEAPSS (Consortium of Local Education Authorities for the Provision of Science Services) G14: Designing and Planning Laboratories, found here: https://www.ase.org.uk/resources/lab-design/

All guidance points should be reviewed during the planning stage of laboratory design or redesign, and incorporated where the activity in the laboratory requires it.

2. Definitions

Laboratory: a room or space where scientific experiments or procedures are conducted using materials, equipment and/or substances that may present a hazard to health or the environment.

Hazard: any chemical, biological agent, genetically modified organism, radioactive source or equipment, laser, nanomaterial.

3. Responsibilities

Designers

Liaise with Faculty or Department Representatives, the Health and Safety Team, and any other competent party, throughout the design period, to design and provide laboratories that are fit for purpose. The design should be revisited at regular intervals to ensure all parties understand and agree to the scope.

Commission the laboratory to ensure any equipment or facilities supplied work properly.

Provide a formal handover of the laboratory to the identified faculty or department representative, including safety and operational information and documentation covering completed test and inspections and schedules for ongoing test and inspection regimes.

Act at all times in line with Northumbria University's CDM Guidance.

Faculty or Service Representative

Provide information on the range of activities that are expected to be carried out within the laboratory, types and numbers of equipment to be used and estimated maximum occupancy to designers.

Provide requirements from section 7 in line with the intended laboratory activities.

4. General Principles for all Laboratories

In all laboratories, there must be consideration of safe travel distances for evacuation, the final usage and the traffic routes of personnel through the laboratory and corridor areas between laboratories and to ensure safe passage through the working areas. Flexibility for future adaptation must be considered.

The minimum laboratory design requirements are:

Walls and Ceilings

- Walls should be coated with an easily cleanable covering which is resistant to liquids used in the lab.
- Joints, including those with permanently fixed benching and service penetrations, sealed at connections with suitable sealant.

Floors

- Floors should be covered with continuous sheet which is non-slip, impervious to water, resistant to acids, alkalis, solvents and disinfectants, and compatible with other lab chemicals, e.g. vinyl. Consideration should be given to the suitability of the material if cryogenic liquids will be handled in the lab. Include service voids if they could be contaminated.
- Cove walls, and piping or electrical passages through the floor, to a height of 150 mm, sealed at the top of the coving.
- Minimum of joints, but, where joints are unavoidable, they should be welded or sealed with silicone type material.
- Easy to clean; polished floors should be avoided.

Space and Location

- Minimum of 1200 mm passageway between benches, or 1700 mm passageway between back-to-back working benches.
- Work surface area for each worker must be more than 600 mm across and 600 mm deep (equates to 0.36 m^2 work area) excluding bench space for laboratory equipment.
- A minimum of 11 m^3 per person (where the ceiling is at least 3 m high, this equates to 3.7 m^2 floor space).
- Space should be provided for equipment, including PPE storage, bins, chemical storage, consumables storage, DSE, hand soap and towel dispensers, write-up areas, H&S/operational documentation, signage (fire, biological, radiation, laser, PPE, charts, eye wash), spill kits, fire extinguishers or blankets, display panels, emergency stop buttons, mobile eye wash bottles, fridges and freezers.
- Provide space for chemical storage away from exits if possible.
- Position LEV systems away from walkways where possible and avoid positions close to doorways. If not practical, testing is critical to assure that they are working effectively.
- Particle emitting equipment such as steam autoclaves and dishwashers should not be located directly beneath (smoke) fire detection sensors. Similarly, heat-generating equipment should not be located beneath heat fire detection sensors.
- Equipment weights should not exceed the floor loading.
- Suitable access should be provided to equipment for operation, maintenance and emergency response.

Fixtures and Furniture

- Furniture should be designed to resist corrosion from chemicals and constructed to allow ease of decontamination. There should be no wooden furniture.
- Worktops must be impervious and resistant to common laboratory solvents, reagents (e.g. acids and bases) and disinfectants, and not be overly light reflective.
- Benches should be capable of taking the maximum weight of equipment.
- Cupboards should be mobile or sealed against the floor.
- Handles on cupboards and drawers should be easy to clean and have no sharp edges.
- A telephone should be available, in a safe location, within a short travel distance e.g. in the corridor, adjacent to the lab entrance in case of emergencies.
- Doors should have vision panels in them except when activities specify otherwise, e.g. in dark rooms.
- Push plates should be provided on doors that open outwards.
- Door stops should be considered to prevent damage or harm.
- There should be provision for hanging coats and storing student's bags.
- Work surfaces must be an appropriate height to enable laboratory users to sit or stand comfortably whilst working. Height adjustable sections are recommended.

- Shelving should have the same surfaces as worktops. This does not apply to shelving within specifically designed chemical storage cabinets which will be a material appropriate for the cabinet.
- Shelves should be no more than 1800 mm from the floor to eliminate height access activities.
- Install sufficient electrical sockets to prevent the need for multi sockets.
- General use sockets should be mounted above bench level, in dado rails at least 150 mm above the bench surface and away from splash/wet areas and at least 30 cm horizontally from sinks.
- Appropriate locations for sockets for installed equipment e.g. under bench dishwashers, should be considered in the design. A switched fuse connection should be installed for appliances positioned beneath benches (e.g. fridges, dishwashers and washing machines).
- Electrical supplies to each laboratory should be protected by an earth-leakage circuit breaker, designed to BS 7671 (IET Wiring Regulations Seventeenth Edition).
- Electrical sockets, equipment and any other potential ignition source should be positioned outside of any zone identified during the area classification, unless rated for that zone.

Water

- Where there is a potable water supply, backflow contamination must be prevented using non-return valves, and maintaining a permanent air gap between waste water and the incoming supply.
- At least one separate hand wash sink should be provided with taps that allow for hands-free operation and positioned adjacent to an exit.
- The number, sizing and locations of sinks should be appropriate for the intended activities undertaken in the lab. As guidance, each laboratory should have at least one large sink (at least 300 x 200 mm, 150 mm deep) with a supply of hot and cold water and with grooved drainers for the purpose of washing equipment and glassware, if appropriate. Where possible the sink should be integral with the work top surface or sealed using an appropriate sealant.
- Sinks should be made of cast epoxy/fire clay and sized for the intention.
- Splash backs should be provided where there is a risk of water splashing on to experiments or electrical sockets, and extend at least 300mm up the wall behind the sink and sealed appropriate sealant.
- Consideration should be given to the design of the water taps to ensure they are appropriate for the intended use of the lab. As general guidance, taps should be of a non-rotatable, epoxy-coated, pillar design.
- Hot water for hand washing should be controlled to supply at 60°C.
- 'Not Drinking Water' signs should be positioned as close to relevant taps as possible.

- Drain pipes should be PVC/Vulcathene and pipework welded, with minimal numbers of mechanical fittings.
- Each sink's drain should be fitted with bottle traps, (mechanically coupled); the drain should have accessible rodding eyes for cleaning at intervals no more than 5 m, and be labelled at appropriate points.
- Each laboratory should have eye wash station facilities. A plumbed-in (Optiflex type) eyewash station, supplied with mains water is preferred, or space for saline eyewash bottles (2 x bottle design) if mains supply can't be achieved. Plumbed in systems should discharge water at a rate of 1.8 litres per minute at 30 psi for at least 15 minutes.
- Additional saline eyewash bottles may be required where risk assessment identifies this.
- A walk-in emergency shower should be provided if required by faculty's risk assessment. Emergency showers are typically not required, other than in laboratories where large volumes (typically 10s of litres at one time) of harmful materials are handled on a routine and frequent basis.

Ventilation and Gases

- CIBSE produce ventilation guides for various applications. There should be good ventilation, with at least 6 air changes per hour, with 5-10 litres per second per person depending on the processes, equipment and strenuous nature of the work. This requirement may be modified by the two statements below.
- Energy efficient strategies should be incorporated into laboratory designs. Where deemed acceptable on health and safety grounds, ventilation should reduce or stop when the lab is unoccupied. This should be via PIR or other presence detector, as well as BMS time controls. Temporary override should be provided within the labs
- Where possible, ventilation should incorporate Demand Based Control, reducing ventilation requirements in laboratories based on real time sensing of contaminates in the room environment. This approach can potentially reduce lab air change rates down safely to as low as 2 air changes per hour when the lab air is clean.
- Where appropriate, the room should have a minimum pressure difference of -8 to -10 Pa to the adjacent space. It is recognised it may be difficult in some older poorly sealed labs to achieve this where this applies additional rooms sealing work may be required.
- Each laboratory should have supply and extract air.
- Supply air should be conditioned and in a position to avoid draughts.
- Gases should be piped in from outside or be supplied internally from a generator.
- Where a laboratory uses a gas that poses an asphyxiation risk, a falling oxygen sensor should be installed with visual and audible alarms fitted outside the laboratory door and inside the laboratory to warn people to evacuate. The sensor should be close to a potential release point/work activity position, taking account the density of the gas.
- Where flammable or toxic gases are supplied, the laboratory should be fitted with detection and automatic isolation, alarm and signage, and linked to visual and audible alarms inside and outside the laboratory.

- Where possible, panels that allow gas concentrations to be read, should be placed outside the laboratory.
- Isolation valves should be fitted as close to the point where the gas enters the laboratory as possible.
- There should be a clearly labelled mechanical cut-off for each gas supply close to the point where it enters each laboratory. Automatic isolation should be considered where appropriate e.g. automatic cut off of flammable gases on fire alarm activation.
- Where flammable gases are supplied, an area classification should identify the zone type and extent. Area classification should recognise BS EN 60079-10-1 or HSL Quadvent methodology.
- Gas taps should be of the drop-lever/spring-loaded type and should be mounted such that they are easily visible and identifiable. Anti-rotation devices should be fitted.
- Pipework distribution lines should be welded where practicable. Where this is not possible, the use of twin ferruled compression fittings is acceptable. They must be manufactured by Swagelock, ham-let or Parker, no other alternatives will be accepted. . Pipework intended to run through risers, roof spaces or similarly enclosed areas should follow BCGA Codes of Practice.
- **Design of gas supplies and distribution should be in accordance with BCGA Codes of Practice. Ideally, the system should be rated for the highest pressure, or protected with a pressure relief valve or burst disc. Deviation from these should be justified in risk assessments.**

Local Exhaust Ventilation

- Local exhaust ventilation systems should follow HSE guidance document HSG 258.
- All new fume hoods purchased should be of an energy efficient design. The system should include V.A.V. controller with fast responsive modulating fume hood damper where practicable. A modern fume hoods design specification can run at reduced fume hood face velocities, providing improved energy efficient without reducing performance. A reduced fume hood maximum working sash height can provide significant energy-savings.
- Ducted fume cupboards, venting directly to the outside, should be provided in laboratories using hazardous substances that emit vapours or gases or where handling very small amounts of powders. The applicable standards for ducted fume hoods are those forming BS EN 14175.
- Where ducted fume hoods are not practical, ductless hoods may be used that vent into the laboratory, only where the filter is suitable for the vapours or gases being extracted. The applicable standard for recirculating fume hoods is BS 7989.
- For exposure control of larger quantities of hazardous powders, dusts or coloured fumes from ducted systems, extraction should include an appropriate filter.
- Ductwork for exhaust air must be separate from general building air supply and extract.
- Exhausts must not be located in the vicinity of air intakes or building openings and should reach at least 3 m above the highest part of the building.

- Ducting material needs to be compatible with substances being used e.g. for corrosive acids.
- Extraction systems should display flow rates or velocities and should produce audible alarms on low flow rates.

Temperature

- Temperatures in laboratories should be between 18-24°C.

Lighting

- Lighting should be suitable and sufficient for the laboratories intended purpose and may need to be individually specified, including localised task lighting and emergency lighting. CIBSE produce lighting guides for various applications. In general, average illumination at a bench surface should be at least 300 lux but does not need to exceed 500 lux.

Ergonomics

- It should not be necessary to access window openings, window blinds, alarm panels, emergency stops, operational controls or stored items from height, and all should be accessible without the need for stretching, squeezing between other equipment or ducking under equipment for example.
- There should be no storage at height i.e. storage should not be above 1.8 m.
- Where work at height is required, access platforms (fixed or mobile) should be in place.

Fire

- Fire door assemblies onto corridors should be a minimum of FD30s, certified to BS 476: Part 22 and installed to Build Regulations Approved Doc B. The compartment rating should be checked to ensure the correct door set is installed.
- Doors should be self-closing.
- Fire compartmentation must be maintained.
- Fire detection should be appropriate for the environment; smoke detection is not always suitable.
- Emergency lighting and signage must be installed.
- Fire detection should be linked to building fire alarms with sounders and light beacons.
- Fire dampers and thermal trips should be installed in ventilation systems at appropriate points.
- Each laboratory should contain at least one fire blanket and one extinguisher. The type and number of extinguishers will depend on the activities taking place in the laboratory. Foam, CO_2 or dry powder extinguishers are suitable where flammable liquids are used;

CO_2 cylinders should not be used for flammable metal (e.g. lithium, sodium) fires and only Class D extinguishers should be used; dry powder should not be used on strong alkalis or oxidisers.

- Fire-fighting equipment should be located near to exits.
- The need for additional extinguishers, blankets or automated fire suppression systems should be determined from the risk assessment of activities carried out in the laboratory e.g. when using pyrophoric and self-heating materials.

5. General Principles for Biological Laboratories

- Laboratories should be designed to containment level 2 other than where a higher containment level has been identified.
- Guidance on the microbiological laboratory design is given in the HSE document 'Management and operation of microbiological containment laboratories'.
- Access to Laboratory suites should be restricted to authorised personnel only.
- Applicable standards for microbiological safety cabinets are BS 5726 and BS EN 12469.
- Microbiological safety cabinets should not be installed within 3000 mm of an autoclave.
- Autoclaves for waste inactivation should be sited within the building, preferably in a room dedicated for waste treatment.
- Sterilisation autoclaves may be located in the same room if required or in an appropriate Laboratory with suitable ventilation.

6. General Principals for Ionising Radiation Laboratories

- Floor coverings should have minimum number of joins.
- Island format work benches or benches that are coved against walls should be used.
- Where the design of work surfaces is in an island format there should be a splash guard of non-absorbent, easy to clean material e.g. Perspex or stainless steel, around 300 mm, between the two sides to prevent cross contamination.
- All gaps should be sealed with appropriate sealant material or welded.
- Provision should be made to hang clean and dirty lab coats separately to avoid cross contamination.
- Wash-hand basin taps should be of a type that can be operated without being touched by hand (e.g. knee operated ones or ones utilising optical sensors).
- Walls and ceilings - painting with vinyl emulsion is not recommended. Acrylic emulsion provides a much harder more durable surface and for higher-grade labs oil-based paints, either in eggshell or gloss give a hard surface that is easily cleaned without surface damage.

- Sinks for the disposal of radioactively contaminated aqueous waste must be constructed of suitable material e.g. separately moulded epoxy resin sinks.
- A Perspex or stainless steel rear splash plate on disposal sinks should extend at least 300 mm up the wall behind the sink. Side splash guards, of a height of between 150mm height at up to 50mm from the sink edge, or 300 mm at up to 100 mm from the sink edge, should be installed to the side of the sink, where there is not at least 500 mm of drain board present.
- Drainage systems from disposal sinks should include a small diameter U-bend or small catch pot. Space should be allowed for a suitable container to be positioned directly underneath to contain any leaks.
- The drain from disposal sinks should be connected as directly as possible to the main foul water sewer with minimal pipe run exposed within the laboratory. The discharge route should be mapped and recorded for future reference in case of maintenance on the system and pipes should be labelled with the ionising radiation labelling at appropriate view points over its entire length, to the point it exits the building.
- Drainage pipes should be well-supported along a suspended run, down-sloped to prevent accumulations of radioactivity, made accessible by the use of demountable panels for periodic inspection or maintenance where practicable.
- A separate sink for washing and preparation purposes should be provided.
- There should be somewhere to hang lab coats near the entrance to the laboratory.
- Benches must be substantial enough to take the weight of any shielding or shielded pieces of equipment such as Liquid Scintillation Counters. Typically, lead shielding could require a load of ~100 kg over a 0.25 m^2 area of bench.
- Shielding to retain emissions inside rooms.
- Seating - stools and chairs should either be non-upholstered or upholstered in non-absorbent material.
- A designated area should be provided for the storage of equipment awaiting decontamination.
- The security of controlled areas should be agreed with the Radiation Protection Adviser.

7. User Considerations for Laboratories

Users should review planned work and future projects that could be carried out when designing a laboratory.

Spill Kits

- Where hazardous substances are being handled, spill kits are essential. They should also be in place where significant quantities of non-hazardous liquids or powders could be spilled and cause harm or damage.
- Spill kits should be selected for the type of substance and quantity that could be spilled.

- Spill kits should be located in accessible areas, be clearly identifiable (e.g. in yellow boxes or bags), and their location known by everyone.

Bins and Wastes

- Waste stream should be identified and bins/storage provided for all types of relevant waste that will be produced within the area and which enables waste disposal in accordance with the waste hierarchy.
- Consider if any items could be safely reused and provide storage for these e.g. Winchesters.
- Recycle where practical (non-contaminated cardboard, plastic, metals containers, glass).
- Use general waste bins for items that can't be recycled (all paper towels, non-contaminated items).
- Provide yellow bins for softs, sharps, animal, liquid or petri dishes that require autoclaving.
- Provide yellow bins for wastes that are contaminated with hazardous substances. Chemical wastes should not be disposed of via this route.
- Create storage provision for chemical wastes.
- Ensure all waste storage areas e.g. bins, are labelled with signage to remind users of the items that can and cannot be stored in the area/placed in the bin.

In addition to correct segregation of waste, ensure storage is safe to avoid reactions between wastes, to reduce fire risk (e.g. use of fire bins), and that the location of bins does not create a trip or egress hazard.

Services

- Consider space for and locations of services required e.g. electrical, gases, water.

Signage and Labelling

- Biological laboratories operating at Containment Level 2 should display the biohazard sign on all entry doors.
- Zoned areas identified during area classification should be marked. Floors or walls should be marked to show the extent of the zone if practical.
- HazMap drawings should show zoned areas and hazard locations.
- Laboratories handling radioactive sources should display the radioactive hazard sign.

Chemical Storage

- Suitable types and quantities of storage cupboards should be in place to accommodate storage of hazardous substances, where substances are stored in accordance with the segregation and hierarchy shown in Appendix 1.
- Cupboards should be fire rated for at least 30 minutes, with suitable internal bunding and should at least meet the design requires given in paragraph 189 of the Dangerous Substances and Explosive Atmospheres Regulations 2002 Approved Code of Practice and Guidance for flammable liquids.
- Chemicals should be stored below shoulder height.
- Storage should not be at laboratory exits.
- Chemical storage should be kept to a minimum, with no more than 50L of flammable liquids stored in any laboratory.

Equipment and Consumables Storage

- Utilise separate storerooms where possible and store only frequently used items in laboratories.

Equipment Use

- Where possible, the most energy efficient equipment should be chosen. When considering costs in procurement, this should include ten years of energy costs (and water costs where applicable) for the equipment as well as the initial capital cost (assume 17p/kWh).
- Where there are zoned areas identified in the laboratory, all equipment should be specified for use in that particular zone. No other equipment should be used in zoned areas.
- Fridges and freezers that store flammable liquids should be intrinsically safe, spark-free and rated accordingly.
- Consider the need for an Uninterruptable Power Supply (UPS) or electrical generator for critical electrical equipment such as -80°C freezers.
- Cylinders should not be used in laboratories without justification, risk assessment and approval from the Senior Technician.
- Consider the use of tacky mats to minimise spread of dusts and contamination.

PPE and RPE Storage

- Reusable PPE and RPE should be stored in locations that prevent contamination.
- Storage areas for PPE and RPE should be easy to access, and the correct PPE and RPE should be available.

Documentation

- Risk assessments, operating instructions, design limitations, service requirements, statutory testing (LEV systems, pressure vessels and their protective devices, steam autoclaves) should be retained in operational areas as needed.

Display Screen Equipment and Teaching Screens

- DSE equipment should be located so that access and use are not obstructed, and that users can sit or stand properly.
- Access and use of teaching screens should not be obstructed.

Mobile Eye Wash

- Separate eyewash bottles should be positioned in the laboratory where plumbed in systems are not practical or where deemed necessary by risk assessment.
- Bottles should be located at easily accessible places and as a general rule of thumb, be reachable within 10 seconds.
- Consider having one area for all emergency equipment e.g. close to fire-fighting equipment and call points if possible.

First Aid Kits

- Laboratories should have at least one first aid kit.
- Consideration should be given to the need for specific first aid equipment or accessories, in line with the work being carried out.

Electrical Sockets

- The number of electrical sockets should be sufficient for at least all of the equipment planned for use.
- Electrical sockets used for non-installed equipment should be above bench level.
- Multi socket extensions should not be used in laboratories.

HazMaps

- A laboratory drawing must be provided in a format that can be used by the laboratory occupants to indicate locations of any dangerous substances storage cabinets, cylinder storage, fire extinguishers, spill kits, etc. for incorporation into local and building emergency plans.

Security

- Restrict access to laboratories where there are health, safety or security concerns and where it is practical.

Appendix 1

Hazardous Chemical Storage – Minimum Segregation and Hierarchy

Oxidisers

Flammable

separate from

separate from

Corrosive Bases

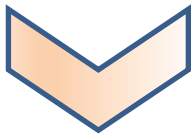
Corrosive Acids

Hydrofluoric Acid

Carcinogens, Mutagens, Reproductive Toxicity, Toxics

store with or separate from

Toxics



Harmful, Irritants

- Can be stored with toxics
- Store in line with operational needs