SECTION 20: LABORATORY DESIGN

CONTENTS

20.1 INTRODUCTION

20.1.1 General Scope Overview

This section of the Design Standards sets out the design principles and the University's minimum requirements for the design and specification of laboratories.

The project consultant is required to produce their own design and specifications which incorporates the requirements set out in this and other sections of the University's Design Standards. The design documentation is not to reference this design standard.

This section of the Design Standards is to be read in conjunction with all other sections of the University's Design Standards. The following sections are specifically highlighted :

- Section 2 - Health and Safety.
- Section 3 - Sustainable Design.
- Section 5 – Internal and External Building Elements
- Section 6 - Hydraulic Services.
- Section 7 - Electrical Services.
- Section 8 - Mechanical Services.
- Section 12 - Acoustic, Vibration and EMI.
- Section 16 - Laboratory Freezers and Refrigerators.

20.2 GENERAL REQUIREMENTS

20.2.1 Compliance & Regulatory Requirements

The design of all laboratory spaces shall strictly comply with the current versions / amendment of all relevant Australian and International standards, codes and regulations which include, but are not limited to:

Laboratory Design

- AS/NZS 2982 Laboratory design and construction
- AS/NZS 2243 Safety in laboratories
    - AS 2243.1 Part 1: Planning and operational aspects
    - AS 2243.2 Part 2: Chemical aspects and storage
    - AS/NZS 2243.3 Part 3: Microbiology aspects and containment facilities
    - AS/NZS 2243.4 Part 4: Ionizing radiations
    - AS/NZS 2243.5 Part 5: Non-ionizing radiations - Electromagnetic, sound and ultrasound
    - AS/NZS 2243.6 Part 6: Plant and equipment aspects
    - AS/NZS 2243.8 Part 8: Fume cupboards
    - AS/NZS 2243.9 Part 9: Recirculating fume cupboards

Controlled Environments & Hazardous Substances

- AS 1940 - The Storage and Handling of Flammable and Combustible Liquids.
- AS 2252 – Controlled environments.
    - AS 2252.2 Part 2 Biological Safety Cabinet Class II – Design

  - AS 2252.3 Part 3 Biological Safety Cabinet Class III – Design
  - AS 2252.4 Part 4 Biological Safety Cabinets Class I & Class II - Installation and use
  - AS 2252.5 Part 5 Cytoxic Drug Safety Cabinets
  - AS 2252.6 Part 6 Clean Workstations
- AS 2507 The storage and handling of agricultural and veterinary chemicals
- AS 2714 Storage and handling of organic peroxides
- AS 3780 The storage and handling of corrosive substances
- AS 4775 Emergency eyewash and shower equipment
- AS/NZS 1596 The storage and handling of LP Gas.
- AS/NZS 2022 Anhydrous ammonia – Storage and handling
- AS/NZS 3816 Management of clinical and related wastes
- AS/NZS 4586 Slip resistance classification of new pedestrian surface materials
- AS/NZS 5601 Gas installation
- AS/NZS 60079 (Series) Explosive atmospheres

Biosecurity Material

- The Department of Agriculture, Fisheries and Forestry (DAFF) – Commonwealth Biosecurity Act 2015.
- Requirements for approved arrangements class 5: biosecurity containment level 1 (BC1) Facilities and Approved Arrangement for Biosecurity containment level 1 (BC1) informative text.
- Approved Arrangement - Biosecurity Containment Level 2 (BC2) Conditions and Approved arrangement 5.2 - Biosecurity containment level 2 (BC2) Informative Text.
- Approved Arrangements For 5.3 – Biosecurity containment level 3 (BC3) Requirements
- Approved Arrangements For 5.4 – Biosecurity containment level 4 (BC4) Requirements

Genetically Modified Organisms (Office of Gene Technology Regulator - OGTR)

- The Department of Health and Aged Care - The Office of the Gene Technology Regulator (OGTR) - Commonwealth Gene Technology Act 2000.
- Guidelines for the certification of physical containment facilities

Animal Ethics

- Animal Ethics Committee - Prevention of Cruelty to Animals Act 1986.
- NHMRC - Australian Code of Practice for the Care and Use of Animals for Scientific Purposes.
- Scientific Procedures Premises Licence

Safety

- Victoria Occupational Health and Safety Act 2004 (OH&S Act) and Occupational Health and Safety Regulations 2017 (OH&S regulations)

- National Occupational Health & Safety Commission: Storage and Handling of Workplace Dangerous Goods
- Hazardous Substances Compliance Code 2019
- Victorian Drugs, Poisons and Controlled Substances (Amendment) Regulations 1996
- Victorian Radiation Act 2005
- Victorian Radiation Regulations 2017
- Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) - Security of radioactive sources

Refer all current amendments and latest versions. This list is for information only, it is the responsibility of the design team to fully investigate all necessary codes, regulations and guidelines which will apply to the laboratory design based on project requirements.

20.3 LABORATORY SPACE TYPOLOGIES

20.3.1 Wet laboratories

A wet laboratory deals with the spaces used for teaching and learning or research activities with a technical or scientific experimental function, and may involve the use of hazardous materials, organisms and flammable substances that will require appropriate containment. Such work may include teaching, research, quality control, testing or analysis. These activities may require the usage of chemicals, including dangerous goods, hazardous substances, electrical or radiation hazards, pathogens, GMOs, quarantine or biosecurity materials or work processes which could also be hazardous.

Wet laboratories may include work in areas such as:

- Biomedical Sciences
- Biosciences
- Chemistry
- Earth and environmental sciences
- Engineering sciences (such as Chemical, Electrical, Environmental, Mechatronics Engineering Systems)
- Health sciences
- Life sciences
- Materials sciences
- Medical imaging
- Microbiological sciences
- Medical research
- Physics
- Veterinary sciences

Where there is risk posed by microorganisms all work carried out within the laboratory or facility will require the ‘laboratory design brief’ to meet various Physical Containment (PC) levels which will impact the planning, design, services and necessary adjacent support spaces for the laboratory.

PC1 is the minimum containment standard required for any wet laboratory space. Higher physical containment levels such as PC2, PC3 and PC4 are only required when specifically nominated in the brief.

The scope of this section covers the design of laboratories of physical containment classification PC1 and PC2. Refer below for other specialist laboratories that are not covered within this section.

20.3.2 Dry Laboratories

Dry laboratories are general purpose spaces for practical teaching, learning and research. Dry laboratories generally do not require wet plumbing fixtures, however on occasions may require a single plumbed service point for general use, preferably located adjacent to entry/exit point for hand washing and occasionally (if required) for safety shower and eyewash fixtures.

Compared to a wet laboratory, the space typically has minimal services, a lesser exposure to dangerous goods or hazardous materials and may contain extensive equipment (mainly instruments, electronics, computers, equipment, robotics etc).

20.3.3 Specialist Hazard Laboratories

Specialist hazard laboratories are areas within laboratories (or whole laboratory facilities) in which particularly hazardous substances are used or specific hazardous processes are required which necessitate the requirement to conform with specific standards and legislation in their design and operation. The standards and legislation relating to these special hazard laboratories will be over and above the listed regulatory requirements.

The scope of this section does not cover these specialist hazard laboratories. The University will engage specialist experienced design consultants with the required expertise to design these specialist laboratories. These may include:

- High Risk Microbiological physical containment laboratories (PC3 or PC4)
- High Risk Biosecurity containment laboratories (BC2, BC3 or BC4)
- Facilities requiring enhanced physical security to handle Security Sensitive Biological Agents (SSBAs)
- Animal facilities
- Plant houses
- Aquatic containment facilities
- Invertebrate containment facilities
- Cytotoxic chemicals
- Cleanroom laboratories
- Radiological laboratories
- Nanotechnology laboratories
- Imaging suites

20.4 LABORATORY DESIGN BRIEF

20.4.1 Consultation

The laboratory design brief shall be developed with the University and its appointed stakeholders including end laboratory user representatives, key stakeholders and the University's maintenance, engineering, facilities and OH&S Services teams to deliver the return brief, design, specifications and project outcomes.

20.4.2 Content

The laboratory design brief shall clearly define the functional and operational requirements for the laboratory design. This brief shall address as a minimum, the information outlined in AS/NZS 2982 Appendix A 'The Planning Brief'. The following briefing requirements may also be considered in formulating the brief.

20.4.3 Facility Wide Requirements

Overview	• Purpose of laboratory: teaching or research • Laboratory Function • Intended Occupancy • Hours of Operation
Containment Level and Certification Requirements	• Physical containment classification level and description of functional operations that may give rise to risk group items, infectious materials, and air borne contaminants.
Hazards	• Detailed description of potential hazards associated with the work to be carried out.
Controlled Environments & Hazardous Substances	• Quantities, volumes and classification of chemicals and hazardous substances in use and being stored in the facility, including storage cabinets for flammable liquids, corrosives, toxic substances or other substances. • Controlled environment requirements (eg. biological safety cabinets, fume cupboards, laminar flow cabinets etc) • Nominate regulatory over lays and relevant Australian Standards (refer above)
Biosecurity Controls or Quarantine Controls	• Description of any biosecurity or quarantine controls • Nominate regulatory overlays and relevant Australian Standards (refer above)
Animals	• Description of any processes involving laboratory animals • Nominate ethics and regulatory overlays and relevant Australian Standards (refer above)
Workflows	• Workflows for people, laboratory processes, materials, consumables, hazardous materials, and waste streams.
Waste	• Waste management and disposal strategy • Waste that will be produced and its intended disposal strategy
Safety	• Crime Prevention Through Environmental Design (CEPTED), safety and surveillance • Occupational health and safety provisions.
Sustainability	• Any environmental, sustainability or life cycle parameters for the operations.

Universal Access	• Universal Access Requirements for People with disabilities (PWD)
Flexibility and Expansions	• Degree of flexibility required • The degree of future flexibility, adaptability, expansion, and future proofing provisions (eg. pandemic responses). • Surge capacity requirements • Future expansion requirements • Strategies for surge events (eg.) pandemic responses

20.4.4 Room Requirements

Room requirements will be determined by equipment, process and required clearances. Extensive consultation with end users must occur.

Size	• Room dimensional criteria including width, depth and height
Functional Relationships	• Significant room adjacencies and relationships
Room Fabrication	• Insulation or shielding requirements • Acoustic and vibration controls • Room specific fire rating
Furniture	• Furniture and fittings (eg laboratory benches, cupboards, sinks, shelving systems etc.) • Storage requirements
Equipment	• A list of relevant equipment and instrumentation being installed, or intended to be used in the future, and any operational characteristics
Finishes	• Preferred finishes considering durability, resilience and life cycle and replacement strategy.
Services	Services requirements and environmental including: • Temperature and humidity controls • Air filtration • Room specific containment/clean room pressurisation requirements • Air change rates • Fume extraction or exhaust requirements • Lighting • Power (general, cleaners, special purpose, essential, UPS) and communications, • Security and access controls, • Reticulated gaseous services • Liquid waste (Chemical / Biological / Radiation/ Toxic) • Sinks and specialised water (eg. RO)

	• Audio visual requirements • Uninterrupted power systems requirements • Laboratory gases, high purity or ultra-high purity gases • Cryogenic storage • Laboratory gas detection • Earthing and grounding requirements • Static electricity control • Fire protection • Emergency shower and eye wash facilities

20.4.5 Equipment Requirements

Equipment requirements will be determined by the laboratory work and process to be performed. Equipment briefing requirements may include,

Equipment size and weight	• Servicing and maintenance clearance requirements • Clearances and minimum room dimensions
Operational requirements	• Special environment requirements • Special requirements in relation to loads, vibrations, noise, temperature, radiation
Services	• Alarms and monitoring • Back up power requirements • Risks associated with the use of the equipment

20.4.6 Format

The laboratory design brief may come in the form of a written list of briefing requirements covering the above considerations and a comprehensive set of Room Data Sheets prepared for each of the proposed laboratory spaces.

A return brief is to be provided by the design consultant team to confirm the briefing requirements, finalised Room Data Sheets (where required) and describe the project scope. It is to demonstrate to the University that the proposed design solutions meet the requirements of the brief and satisfies all compliance aspects.

20.5 GENERAL LABORATORY DESIGN REQUIREMENTS

20.5.1 Laboratory overall building or facility design parameters

A holistic approach to the design of the laboratory spaces is necessary for efficient and flexible planning of the laboratory environments. This needs to consider a whole of building design approach to the laboratories as much as the design of the laboratory spaces.

Assessment of the laboratory design for a whole building configuration, or part of a building, may involve the refurbishment or adaptive reuse of existing building stock or a purpose-built new facility. The design of buildings to accommodate laboratory spaces needs to consider the following design parameters:

- NCC Building classification to accommodate a laboratory (Class 8).
- The condition of existing building structures, their structural adequacy and the requirement for infrastructure upgrades (eg. fire, services etc.) shall be reported on in an existing building assessment report.
- Adequacy of floor-to-floor heights to accommodate building services reticulation including seismic clearances and maintenance accessibility.
- A clear building services strategy for electrical, mechanical, hydraulic, fire, and reticulated services including flexibility for future provision of additional services and redundancy.
- Pathways for reticulation of mechanical exhausts and fume cupboard flues through dedicated riser space including flexibility for future provision of additional flues.
- Allowance for future flexibility and changes of use as the building and user needs change, for example future building reconfiguration or conversion of office workplace (BCA Class 5) into a Laboratory (BCA Class 8).
- Adequate loading and delivery access for large vehicles (eg. cryo vehicles, gas deliveries, waste collection etc.).
- Front of house circulation routes to the laboratories to facilitate laboratory access, collaboration and relationships to write-up and workplace.
- Back of house circulation routes through the building, including goods lifts for the delivery of consumables and equipment and the removal of waste streams
- Location and storage of hazardous substances and dangerous goods.
- Security control requirements,
- Laboratory ventilation systems and exhaust systems for airborne contaminants and safe discharge to the environment or proximity of adjacent properties.
- Assess power infrastructure to maintain essential power supply provisions to necessary laboratory equipment and critical research.
- Any hazardous areas zoning requirements that might apply to the space(s).
- Assess flood levels and mitigate risks to preserve critical research or critical building infrastructure (eg. Freezer farms, cryogenic stores, data stores, servers, substations, main switchboard etc.)
- Adequacy of facades, sun shading and building envelope to satisfy air leakage rates, maintaining thermal conditions and the exclusion of direct sunlight penetration into laboratory spaces where it can affect the work being undertaken (for example use of volatile chemicals or instruments that are sensitive to direct sunlight exposure).

20.5.2 Generic laboratory design principles

Laboratories typically incur substantial capital investment and significant operational costs. It is important to invest wisely in laboratory spaces that are well serviced, flexible, and with the knowledge that they will be appropriately utilised, they are safe workplaces, and directly satisfy the University's briefing requirements and compliance.

A flexible, adaptable and generic laboratory planning module provides the basis for nearly all scientific research and teaching environments. The planning module allows for a standardised approach that can be shared by multiple user groups, allowing flexible reconfiguration of laboratory group sizes over time.

The following key design principles form the key foundations for the design of laboratory spaces that are responsive to accommodating a diverse range of laboratory users, functional uses and can be applied in principle to both research and teaching laboratories:

1. Flexibility
2. Consistent zoning strategy
3. Modularity
4. Generic standardised planning
5. Sustainability

1. Flexibility

- Flexible laboratory spaces that are responsive to change.
- Highly adaptable and reconfigurable spaces to accommodate physical restructuring.
- Resilience to change and ability to cope with rapidly changing conditions including moving different equipment in and out, the ability to re-organise research laboratories as new technology, new techniques or new pathogens emerge, and minimising the risk of cross-contamination.
- A holistic approach offering shareability of operations, building support and connections between working laboratory floors, good lifts and basement service areas.
- The Physical Containment (PC) level is to be determined, PC1 is the minimum containment standard required for any wet laboratory space. PC1 spaces shall be designed as PC2 capable construction standard as a minimum for future proofing.
- Future proof provisions to permit future modifications such as new equipment, reticulated services, additional fume cupboards, future exhaust capability, spare plant space, accessible riser shaft zones, and provision for future penetrations in floor slabs. Review these provisions with the university and the end users to balance the needs of future provisioning with project priorities.

2. Consistent zoning strategy

- A consistent planning arrangement for the laboratory compartment to all typical laboratory spaces. Where this applies to large laboratory facilities across multiple floors, a standardised approach to all floors is to be applied for consistency.
- An optimised planning arrangement of co-locating primary open plan laboratory modules clustered together with support laboratory modules that are accessed via a "ghost" corridor running through the primary laboratory, thus eliminating interconnecting corridors where possible.
- The primary laboratory space directly connects to a goods lift lobby via the "ghost' corridor.
- A consistent building services strategy to all typical laboratory floors
- The laboratory zoning strategy minimises cross-contamination risks.

3. Modularity

- The typical space planning for laboratories shall be based upon a generic approach that supports standardised modular laboratory systems for flexibility, consistency and interchangeability.
- A standard laboratory planning module based on a typical set out (a typical 34m^2 module being 3.4m x 10m). This modularity applies to both the primary open plan laboratory and the support laboratory module spaces. The length of the modules will vary according to site limitations or existing building configurations.

- The standard module dimensions accommodates compliant Australian Standard laboratory working space for aisle clearances, equipment clearances, biological safety cabinet and fume cupboard installation and use.
- Primary open laboratory areas and support spaces are interchangeable as required. This also allows the space to expand and contract as required in a multitude of combinations.
- Loose fit, modular furniture systems that are optimised and standardised to allow ease of reconfiguration and of interchangeability of the laboratory bench layouts.

4. Generic standardised planning

- A generic standardised planning arrangement within the modules allowing for changing functions to be conducted within.
- A loose fit, reconfigurable planning approach to the modules.
- The detailed design of each module allows the provision of adequate building services to cope with room rearrangement or re-purposing.
- The air handling systems allows a zoning strategy to allow adjustment of room environmental conditions.
- Movement pathways shall be checked for all large equipment to be manoeuvred to and from the loading/delivery areas to the final location within the laboratory.
- The spatial planning for the generic wet research laboratory space shall include, or have access to, all central support spaces required, such as; instrument and preparation labs, laboratory stores, sample stores, chemical stores, wash up, media prep, sterilisation facilities, waste storage and waste treatment facilities.
- Workplace and office accommodation shall not be within the laboratory boundary but should ideally be in close physical and visual proximity to the laboratories they serve. This proximity and visual connection enhances the human experience through improved collaboration and workflow efficiency.
- Write up areas are permitted within the laboratory boundary; however, these should be separated from areas where hazardous materials are stored or processes undertaken and should only be used on a temporary basis to support the scientific activities. These write up areas are to follow the same construction and design methodology as the remainder of the laboratory.
- Efficiency from shareability of common research platforms (for example microscopy, flow cytometry, histology, shareable instrumentation etc.).

5. Sustainability

Refer also to University Design Standards Section 3 - Sustainable Design. Relevant factors include:

- Occupant health and wellness.
- Optimised overall building performance.
- High performance building envelope.
- The whole of building design considers embodied energy, embodied carbon and operational carbon.
- Water consumption.
- Heat recovery systems.
- Energy efficiency.
- Facilities management and maintenance.

- Waste handling processes.
- Whole of life capital cost and operational cost.
- Indoor environment quality.

20.5.3 Wet teaching laboratory

In addition to the above generic laboratory design principles, the design of generic teaching laboratory space needs to consider the following design principles:

Flexibility

- Generic laboratory spaces that can be easily reconfigured for teaching a range of disciplines.
- Modular loose benches, equipment and furniture are preferred to built-in joinery wherever possible.

Student Entry and Exit Spaces

- Plan the entry zone to the laboratories to cater for the simultaneous entry of large number of student numbers. Space should allow for locker access, circulation, donning lab coats and waiting space.
- Provide adequate lockers for timetabled student cross-over use of the laboratory groups. Student swipe card access to lockers should be considered for efficiency of locker access.
- Plan the exit zone to the laboratories to cater for the simultaneous exit of large numbers of students. Space should allow for multiple hand washing facilities, storage of PPE, and waste bins.
- Allow adequate provision of break out space outside the laboratory to accommodate students at timetabled cross over intervals.

Movement and Travel

- Assess movement patterns of students in the laboratory aisles, between benches, equipment locations, and egress routes. Circulation space may exceed the minimum requirements in the Australian Standards to accommodate large cohorts.
- High usage equipment or controlled environment fixtures such as fume cupboards or biosafety cabinets, shall be located to minimise movements between student benches and equipment and minimise crossing of circulation routes.
- Trolley parking bays shall be distributed throughout the laboratory to keep circulation routes clear.

Sightlines and Supervisions

- Clear lines of sight across the laboratory so that AV technology can be viewed from all benches and so that all students can be adequately supervised.

Audio Visual Technology

- Employ camera and AV technology to ensure demonstrations can be viewed by all students in the laboratory. The main teaching laboratory bench layout is to be set out to maximise visibility over the benches to the audio-visual teaching displays.
- Distribute AV technology around the laboratory so that it is legible and accessible to all students, allow adequate ceiling heights for AV sight lines above heads.
- Employ AV technology that can be routed in small banks to suit to cohorts of different sizes and groupings in the laboratories to cater for a range of class sizes, facilitate smaller group work and offer multiple teaching sessions at one time is to be considered.

Storage

- Provide lockable storage space within the laboratory for equipment.

Services

- Provide adequate services at each bench for simultaneous large cohort work
- Provide adequate spacing between plugs to allow for a variety of plug shapes and sizes. Outlets too close together cannot be used simultaneously if the plugs are large or of unusual shape.
- Provision of adequate services is to be provided with the capacity to cope with future adaptability.
- Allow adequate ceiling space for the reticulation of laboratory services and consider maintenance access to ceiling services.
- Ensure that all services are provided with emergency isolation in clear and logical locations.

Emergency Provisions

- Emergency scenarios are to be assessed and reviewed with the University and the end users to locate emergency safety showers and eye wash stations appropriately to avoid interference with equipment, spillage at egress zones and maintaining safe egress pathways.

Wet teaching laboratory preparation & wash-up spaces

- Adequate preparation space shall be provided to service each teaching laboratory. Preparation space shall consider:
    - adequate benches with appropriate servicing for prep lab work
    - flexible central island benches for large cohort preparation
    - trolley parking within the prep space
    - storage and disposal of adequate volumes of chemicals and dangerous goods for large cohort work
    - storage of adequate volumes of consumables for large cohort work, consider high density medical compactus technology for efficiency
    - access to cold rooms and freezer rooms
    - access to wash-up and sterilisation facilities.
- Preparation spaces shall be adjacent to or have a direct relationship to the teaching laboratory to facilitate supervision and enable the prep staff to support teaching staff during laboratory teaching sessions.
- The Preparation areas should also have independent personnel access, so the teaching personnel and demonstrator's do not need to access the laboratory spaces through the same entry point as the students.
- Camera and AV technology shall be considered to so that prep staff are able to monitor the activities in the teaching lab and provide additional support and resources as required.
- The prep lab should have direct access to the goods lift or loading dock to facilitate cohort sized deliveries of consumables and supplies.
- The prep lab shall have direct adjacency to trolley parking
- The prep lab shall have direct back of house route to wash-up and sterilisation facilities, where these tasks are not done within the prep laboratory space.

- The prep lab shall have direct back of house route to waste disposal and collection facilities.

20.5.4 Laboratory building services

Refer also to the University's Design Standards for relevant building services sections.

20.5.5 Health and safety

Refer also to the University's Design Standards Section 2 - Health and Safety.

- A detailed laboratory risk assessment is to be undertaken and reviewed with the University.
- Dangerous Goods & Hazardous Zone Assessment Report - Engage specialist consultant services to assess dangerous goods, hazardous zones, handling, and risk assessments of the laboratory environment for the safe storage and usage of hazardous substances (noting that all laboratory spaces with a fume cupboard will have a Zone 2 hazardous area 300mm above the floor level). These may include specialist gases, cryogenic storage and use, dangerous goods, hazardous materials and substances, packaged goods etc.
- Hands free wash hand basin, hanging space for laboratory coats that prevent cross-contamination, waste bins for used laboratory coat and PPE storage areas shall be provided within the laboratory, near the exit.
- Safety showers and eye wash stations shall be provided in accordance with the relevant Australian Standards.
- Incorporate safety stations and chemical spill kits.
- Incorporate maintenance access zones as recommended by the equipment manufacturers that allows for safe and easily accessible servicing.
- The users of the laboratory spaces are to undergo induction training to meet compliance requirements.
- Waste management workflows are to be assessed for safe disposal procedures that avoids the risk of contamination.