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MECHANICAL AND LAB GASES SERVICES

SCHEMATIC DESIGN REPORT

STEENSEN VARMING

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1 MECHANICAL SERVICES

1.1 GENERAL

The building will be a stand-alone facility, however it will abut an existing adjacent building.

Due to the specialised nature of the building and its specific functional requirements, the mechanical services systems generally will be provided to ensure suitable environments including close controlled conditions as well as the health and safety of the occupants/ research staff.

Current planning allows for centralised air handling plant, distributed air and water based equipment and a Central Energy Plant comprising chillers, boilers, pumps, heat rejection equipment housed in the roof plantrooms of this building.

The mechanical services for this building shall include the following systems:

- Air conditioning (cooling and heating) for comfort conditions in general laboratories, support spaces, offices, meeting rooms.
- Air conditioning (cooling, heating and humidity controls) for specific conditions in controlled environment rooms and animal holding areas.
- Air Handling systems.
- Chilled and heating water reticulation for HVAC.
- Special exhausts e.g. general laboratory, fume cupboards, PC2 containment, specific equipment, sterilizing equipment, flammable and chemical cabinets, chemical storage cupboards, kitchen and toilet exhaust systems.
- Cold rooms and freezer rooms.
- Sterilising and washing equipment.
- Building management system incorporating automatic controls for the mechanical services.
- Electrical works associated with the mechanical services.

Air handling system shall comprise a horizontal or vertical air handling / fan coil unit with chilled water and heating water coils, humidifiers (where required), high efficiency filters, variable volume boxes as necessary, insulated sheet metal ductwork, motorised outside air and return air dampers, chilled, and heating water pipework, BACnet controls grilles diffusers and flexible ducts.

1.1.1 Chilled and Heating Water Systems

Chilled and heating water will be made available from new roof top chillers and new boilers, consideration will also be given to the use of existing chiller and boiler plant within the adjacent building, spare capacirty of this existing plant is yet to be confirmed.

Insulated chilled and heating water pipes will be installed through the building to serve air handling plant on each level as well as roof top air handling plant.

Chilled water systems in the building shall be based on 6℃ - 12℃.

Heating water systems in the building shall be based on 71℃ - 82℃.

1.1.2 Mechanical Ventilation Systems

Provide all required exhaust systems each comprising: -

- Roof plant room fans
- Vertical exhaust duct riser.
- Horizontal branch ducts with fire dampers, grilles.
- The treatment of fume cupboard exhausts will need special attention when they pass through fire compartments to address compliance issues, a fire engineered approach shall be pursued.
- Exhaust fan positioned on the roof level shall require a wind study assessment to ensure the odours from these areas being served to not travel to neighbouring buildings
- Electrics and controls, etc.

Toilet spaces will be ventilated by the provision of supply air from the floor air handling plant and separate extract plant located at roof level. The extract duct riser for the toilets will be located in the service shaft between the toilet accommodation on the floors.

Internal corridors will be ventilated from the floor air handling plant.

Fire separation at each floor level will need to be provided at each compartment boundary where the duct passes from one compartment to the next.

1.1.3 Electrical System

Separate mechanical services control panel/s will be provided on each level of the building.
Each panel will house all the necessary switchgear and controls for equipment located within that floor.

1.1.4 Plantroom & Service Risers

Vertical service risers are required for the following:

- Chilled & Heating water pipes
- Electrical & Control Cables
- Toilet exhaust ducts
- Fume cupboards exhaust ducts
- Specific equipment exhaust ducts
- Sterilising equipment exhaust ducts
- Flammable and chemical cabinets exhaust ducts
- Tea room exhaust ducts
- General exhaust ducts
- Outside air supply and exhaust ducts
- Other piped services
- Stair pressurisation (if required)

1.2 NOISE AND VIBRATION

The mechanical services systems shall be designed to maintain noise and vibration within acceptable limits, incorporating recommendations from the Acoustic Consultant. Sound attenuators and other types acoustic treatment will be installed where necessary to achieve the appropriate noise levels as well as critical vibration requirements for specialist equipment.

1.3 OPERATION AND MAINTENANCE

The design of the mechanical services shall account for ongoing operation and maintenance. Feedback shall be sought from the client to ensure the maintenance needs of the systems shall be matched against the resources or alternatively assess benefits of outsourcing.

Maintenance access and risk to operations from disruption from leaks from overhead or decentralised equipment shall be considered.

Wherever possible air handling units shall be located in dedicated plantrooms to keep filtration, dehumidification, humidification, maintenance and monitoring remote. The investment in added plantroom space can provide major returns in reduced disruption to the occupied spaces. Where in ceiling fan coil units are used they shall be located such that access is from within circulation spaces and not from above work areas.

1.4 INTEGRATION WITH ARCHITECTURE

All efforts will be made to fully integrate all items of mechanical services plant with the architecture and landscape design. Air diffusion equipment shall be selected in conjunction with the architect to achieve this integration.

1.5 INDOOR AIR QUALITY

Indoor air quality or IAQ as it is widely known, covers and is affected by a number of issues including:

- Outside air and exhaust quantities
- Filtration of outside air
- Filtration of indoor air
- Building and fit out materials
- Temperature and humidity

The introduction of outside air has a major influence on the internal air quality and fluctuations in temperature and RH. It is intended that the project benefits from maximising outside air quantities to meet occupant's physiological requirements, dilution of internal contaminants and pressurisation of spaces and the building against the external environment.

The temperature and humidity of the outside air shall be monitored to assess the applicability of increasing the quantity for efficiency benefits at certain times. It is anticipated that the indoor air shall be monitored for levels of CO_2 to minimise outside air quantities when at inappropriate conditions from design levels to match fluctuating occupancy densities.

Outside air to the buildings critical areas shall be pre-conditioned by means of dedicated outside air AHUs. The benefits include improved control of internal conditions, maximise opportunities for low energy initiatives and tempering and economical operation.

Exhaust shall be provided to areas as required by the Australian Standards to control odours. Suitable exhaust air quantities shall be selected so as not to compromise the pressurisation of laboratory areas.

Air pollution includes outdoor-generated gaseous and particulate pollutants that infiltrate the building, as well as internally generated ones. Therefore, outside air shall be provided with both mechanical pre-filtration and secondary fine filtration when combined with the internal return air. Minimum filter performance shall meet ASHRAE recommendations; air cleaning shall be effective down to fine contamination particle sizes to avoid build up and cleaning problems. Filters shall be rated to ISO standards and be of the required F class rating.

It is anticipated that the building locality does not suffer from high pollution levels, and therefore atmospheric impurities such as NO_2, O_3 and SO_2 do not pose such a great threat to the functionality compared to dense urban or industrial locations. Hence, it is expected that carbon or activated alumina filters may not be required, however, they shall be allowed for in system set-up for future installation. These filters are expensive both initially and as an ongoing consumable/maintenance item and should only be included where a tangible threat to the occupants or building functionality is present. Initial and on-going monitoring should be instigated to determine this requirement.

Sensitive selection of building and fit-out materials will be required to minimise off-gassing that will impact on occupants and research. If it is judged that this will pose a problem and cannot be designed out, a more sophisticated active filtration system (gas-phase filtration as mentioned previously) will be assessed for incorporation.

Low levels of airborne pollutants can be achieved in many ways, including building design, filtration, maintenance and operations. A building is a complex, dynamic environment that affects the indoor level of airborne pollutants. Issues that will need to be considered by both the mechanical engineer and architect include:

- Outdoor pollutant load
- Occupant traffic and indoor activities
- Location of outside air intakes
- Location and type of air diffusion devices in spaces
- Ratio of outside to recirculated air when the building is open to staff, and when it is closed
- Particle and gaseous filter efficiency and filter maintenance
- Location and fit of filters in the air handling system

1.6 ENERGY

Operating a laboratory building is often costly, however it is necessary for the long-term functionality/ safety and quality of research.

In accordance with good practice it is intended that sensible and appropriate levels of technology and design are applied to reduce energy wastage and carbon dioxide emissions arising from the operation of the facility both for financial and environmental reasons without reducing the functional standards necessary. Also thorough commissioning to published Standards and post-construction fine-tuning of the mechanical services shall be implemented to reduce energy consumption with a "Soft Landing" approach suggested.

Within the briefing guidelines the following aims are deemed to be included:-

- HVAC systems to be adaptable to respond to a range of environmental standards which can vary depending on room/area function.

- Systems will, where appropriate, make use of free cooling and differing operating modes in response to external climatic conditions.

- Engineering systems to be reasonably adaptable to respond to changes in planning and the likely changes in use/ requirements of different research.

It is worth noting that in as much as the design can be developed to be efficient, the future operation and management of the building and its systems will have a huge bearing on energy consumption. To this end the design team shall liaise closely with the Client to assist to check that all design features are clearly understood and systems properly handed over for successful operation of the systems.

1.7 RELIABILITY

The susceptibility of research activities to departures from the optimal environmental conditions varies greatly. Most activities (other than where safety is paramount) can tolerate several hours of lost conditions without major damage, but some are at risk even with brief losses of control. A number of factors affect the reliability of the installed systems and the maintenance of internal environmental conditions, which have all been considered to some degree in producing the design to date

Stability in the internal environment by use of passive techniques and the building fabric have been discussed and assessed in principal and modelled in an initial form. However, a more detailed analysis will be required in future design stages.

Pumps shall be configured for duty and stand-by, with new pipework systems configured to allow a reasonable amount of maintenance to take place without system shut down.

Laboratories and other sensitive areas have individual local air handling units (AHU) and investigations into standby power for fans and controls etc shall take place.

The animal holding facility will be considered for standby air handling units which will automatically be switched on in the event of a duty unit failing.

Owing to budget constraints and efficient space planning requirements, it will not be possible to provide full n+1 redundancy for all items of new central plant serving the extended facility (note that for the purpose of this report, n+1 redundancy is defined as having the ability to lose the largest capacity item of equipment on a particular system and still be able to cover peak loads).

Steensen Varming will endeavour to provide the most cost efficient solution in terms of new central plant whilst ensuring appropriate redundancy is provided.

It is suggested that inclusion of a load shedding strategy to facilitate the maximum effectiveness of plant redundancy, in the event of a plant failure, so that operational building services systems will wherever possible give priority to critical spaces in order to maintain internal environmental conditions.

1.8 PLANT SIZING

Building fabric and solar loads will be assessed utilising very accurate and sophisticated dynamic thermal modelling software rather than conventional steady state calculation techniques. All systems shall be designed to be capable of responding to load fluctuations based on the combination of occupancy variations, outside air fluctuations in quantities and temperature/ humidity, process load shifts, solar load variations and atmospheric weather conditions (e.g.

temperature and humidity changes).

The other loads within the space are primarily from equipment, occupants and lights. The population load shall be based on the applicable occupancy profiles that need to be confirmed by the client. Therefore continual and close liaison with the client is important.

The plant space will be sized to allow for the potential future conversion of levels 2 and 3 to wet research laboratories.

1.9 VENTILATION AND AIR CONDITIONING STRATEGY

1.9.1 General

The ventilation to all laboratories needs to ensure that negative conditions of approximately 10Pa differential is maintained with respect to access corridors to ensure that all air movement is inwards into the rooms. The method of achieving this parameter can be simply by the mechanical adjustment of the extract air quantity in excess of the makeup air quantities at the time of commissioning. If the maintenance of the differential pressures is vital in terms of containment then automatic adjustment of the balance between supply/makeup air and the extract will be necessary by means of measurement of the differential pressures and making suitable adjustment of the extract air volumes.

The air distribution for the makeup air whether mechanical or passive needs to be carefully considered to ensure that there are no draughts that can cause disturbances of the inlet air paths into the fume cupboards. If there are any problems with draughts then the user faces possible loss of containment and the associated health risks that would entail. The use of linear slot diffusers should be confined to the areas of occupied areas of benching and if it is necessary to install inlets adjacent to fume cupboards then perforated plate faced diffusers should be considered due to their much lower face velocities for the air quantities.

The operation of a laboratory under normal conditions, without the open sash of the fume cupboard requiring the makeup air quantity to provide the necessary air changes, needs to be carefully considered. The experience indicates that a minimum of 12 air changes should be maintained during all occupied times. The final calculation of the air change volumes will depend entirely upon the control and offsetting of heat gains from solar, occupants and equipment. The build up used for design has been as follows:

- Equipment generally – 75 - 90w/m2 allowance (if exact details not known)
- Equipment in equipment rooms – 120 – 160 W/m2
- Lighting 10 – 15w/m2
- Solar – dependent upon aspect and orientation
- Occupancy – research 1 person/25m2

The following strategy for the mechanical services is proposed for the various elements of the building:

General – The ventilation and air conditioning equipment will be a combination of roof plant room air handling units on floor fan coil units and ventilation supply and exhaust fans.

Offices and open plan work spaces - These spaces will be treated with a VAV system of ventilation

and air conditioning. The VAV system will comprise a central air handling unit with branch supply air ducts to each floor and VAV boxes provided to each zone on each floor.
Where offices are remote from the main VAV system they will be provided with a local air conditioning unit. The local system may be in the form of a fan coil unit served with both heating and chilled water.

Laboratories - Each laboratory will be treated as separately ventilated spaces to allow for maximum control of contaminants and future flexibility. The system of air conditioning proposed will use air handling plant to maintain constant air change rates with variable outside air systems for makeup air for intermittent exhaust systems such as fume cupboards. The air conditioning air handling plant will be in the form of fan coil units located within the laboratory.

The main air handling units will have minimum outside air to meet the occupancy and general exhaust needs set also to maintain the laboratories under slightly negative pressure relative to the adjacent corridor and circulation spaces. These AHU's will be selected with 15% spare capacity to allow for future changes in cooling load demands.

The outside air makeup air systems will introduce variable quantities of outside air at approximately room temperature. This relatively high supply air temperature will allow a low grade cooling source to temper the air close to the required temperature. The control of the quantity of outside air will be via a VSD linked via the BMCS to the fume cupboard sash positions, this will allow the outside air quantity to approximate the exhaust flow rates but at the same time maintaining the laboratory under negative pressure.

Fume cupboard and other laboratory exhaust systems will be provided to meet the containment needs of the laboratory processes. Exhaust ducts will rise to the roof within the riser shafts and arranged in the centre of the building. Fans will be located at roof level with exhaust discharge locations three metres above the roof.

Specialised HVAC systems - Areas requiring specialised air conditioning systems and strict controlled environment are the animal holding areas and the PC2 containment areas.

The delivery of conditioned air to these rooms is also extremely important and close planning with the users and Architect will be required to ensure a satisfactory result.

Dedicated air handling units specifically designed for this type of application shall be used.

Animal Facilities – Generally the animal facilities shall be provided with separate ventilation systems delivering 100% outside air with full exhaust to atmosphere. The areas shall also be subject to and air change rate of ~16AC/hr. These areas shall be provided with both temperature and humidity control within tight tolerances 24hrs per day with built in redundancy of equipment and back-up power to maintain these conditions under a number of failure situations.

According to AS2243.3: 2002, the following approach to ventilation is required:

PC2 – A directional airflow (mechanical ventilation) to be maintained by extracting room air. Recirculation is permitted but not into areas outside the PC2 facility. Dedicated exhaust systems shall be provided for PC2 rooms.

1.10 AIR HANDLING SYSTEMS

This section addresses the building's air handling requirements in further detail. It has been a fundamental issue at this stage of the project to explore the appropriate use of energy efficient opportunities both passive and active. Some of these opportunities will need to be addressed later when the architectural and planning issues are developed further.

The ability to determine the appropriateness of these techniques will require the clarification of priorities and input from both the client and design team as issues such as initial costs, energy and operational costs, CO_2 emissions, user acceptance/education and architectural form are all relevant and integral to the solutions being developed.

Discussions have taken place within the design team to highlight the opportunities and their implications so that the principles can be implemented where and when appropriate during the following design development stages.

Mechanical ventilation systems will be provided to supply adequate outside air for occupants, control the environmental room conditions, pressurisation, air flow patterns and to provide make up air for general and specialist exhaust systems.

Air handling plant will employ air filters that provide the necessary quality of air for various functions. Air filters will be made accessible for cleaning and employ manometers with indication to ensure adequate frequency of cleaning or renewal.

All major air handling units serving non laboratory areas shall be fitted with full outside air economy cycles to take advantage of the free cooling effect during intermediate seasons, night-time and whenever ambient conditions are otherwise favourable.

Attenuators and acoustic treatment will be installed where necessary on all systems to achieve the appropriate noise levels as per advise provided by the Acoustic Consultant.

Air systems will be designed to be air tight in sheet metal ducts and AHU's. A review of the building fabric and ceiling details will be undertaken to ensure minimum leakage of air into or out of the building. Zoning of all air-conditioning systems shall acknowledge different dynamic loads and conditions likely to occur due to:

- External glazing and wall materials
- Roofs and suspended floors
- Educational and Research functions
- Internal heat gain from people, lights, equipment.

Pressure regimes will be designed to minimize any risks associated with contaminated air paths to/from other areas. Air will be distributed in the space in a way that minimizes draughts or major variations in conditions within the space and at a temperature differential acceptable to functionality and occupants. Air velocities can range between 0.1 m/s and 0.6 m/s depending on the actual temperature of the air without causing discomfort.

In specialist areas, air movement will be designed to ensure correct scavenging and capture velocities are met, as occupant safety and/or equipment/exhibit conditions are the determining factor.

Heat recovery measures, including run around coils, cross flow heat exchangers and thermal wheels will be assessed and incorporated into the system design where appropriate potential sources of heat recovery exist. The potential for heat recovery will be a function of system design and will be developed as the detailed design progresses.

1.11 HUMIDIFICATION AND DEHUMIDIFICATION

The humidification system shall be selected based on the quality of the humidification achieved, the close controllability provided by the system and the energy savings. Ultrasonic humidifiers achieve precise humidity control within spaces where very specific environmental criterion is required and have been employed with great success similar existing buildings. As the humidification process is adiabatic, substantial energy savings can be achieved over equivalent systems that require boiling of the feed water. In addition, low electrical demands and maintenance requirements reduce the cost of humidifying to below that of alternative adiabatic processes while still providing sensitive relative humidity control.

Other OHS and maintenance issues can also be designed out when appropriate maintenance regimes are applied, this will lead to a generally cleaner system. Systems shall be selected and designed to prevent standing pools of water and shall comply with the Australian Standards regarding microbial control.

Reverse osmosis (RO) water purification system shall serve ultrasonic humidifiers.

1.11.1 Ventilation Strategies

The ventilation to the building can be separated into the three main area types as follows:

- Laboratory supply and extract ventilation
- Specialist Support Area supply and extract ventilation
- Offices, support and write up area ventilation

Natural Ventilation – The building will require mechanical ventilation in many of its spaces, however, it is intended to explore the provision of suitably designed opportunities for natural ventilation to a number of areas (mainly in the form of mixed mode or hybrid systems that primarily rely on active systems but may allow for opening of sections of the facade to allow for access to natural ventilation if deemed preferential by certain occupants). Consideration of access to natural ventilation will be considered to areas such as offices, entrance spaces, and whilst it may not be deemed appropriate for reasons such as differences in personal preferences of occupants, dust control, maintenance of pressure regimes and the like – night purge cycles would still provide opportunities for maximising the passive performance of the building.

Mechanical Ventilation - A wide range of conditions will be realised in various spaces by mechanical ventilation where natural ventilation is not appropriate. Mechanical ventilation need not be energy intensive and it is the intention of the project to maximise use of intelligent low energy initiatives such as dessicant cooling and high efficiency fans to considerably reduce energy use whilst maintaining conditions and the core functional requirements of the building.

Laboratory Ventilation - The laboratory ventilation will provide the necessary extract ventilation to fume cupboards and all special extract ventilation provisions associated with the safe operation of the laboratories. Use of VAV fume cupboard extract can give significant savings, especially when combined with VAV supply and suitable controls. Fume hoods and special extract ventilation provisions will be constant volume services in order to maintain safe working environment for the users of the space. The fume cupboards will provide a constant sash air face velocity of at least 0.5 $m.s^{-1}$ regardless of the sash position. The constant velocity will be provided by control of the air volumes being extracted through the fume cupboard by controls associated with the local extract systems in the room.

The individual laboratories will be maintained at a negative pressure relative to their surroundings at a minimum of -10Pa at all times (with interconnecting doors closed) to ensure the surrounding areas do not become subject to fumes released in the laboratory whilst the laboratories are in use.

Each laboratory will have a direct supply air input to provide a percentage of the extract air volume with there is an option to provide less air through the central system and draw a proportion being transferred by ducts from the adjacent areas unless these areas are naturally ventilated – the design to date is flexible enough to accommodate either approach depending on further detailed analysis, however indications to date suggest that utilizing air from suitable adjacent spaces is preferential to utilizing "virgin" air. Any transfer ducts will incorporate pressure stabilizers set to provide the necessary pressure differential within the individual laboratory in response to the variations in extract volumes from the fume cupboards. All control dampers would be selected to be compatible with regards to reaction/ drive times etc. Supply air distribution shall be configured to minimize air flow disruption and be via laminar flow outlets and the like.

1.11.2 Fume Cupboard Exhaust

Fume cupboards exhausts will be discharged at roof level using a dedicated roof top exhaust fan for each fume cupboard. The discharge point will be a minimum 3 metres above the roof of the building and will meet the requirements of AS1668.2 regarding separation distances from outside air intakes and openable windows.

Issues that will have to be carefully considered are proximity of new and existing outside air intakes, noise generated by the fans and safe access for maintenance.

Since all of the laboratory spaces will be air conditioned sash operated exhaust air volume flow rate control will be considered together with the option of using fan local inlet by pass. The duct discharge point shall be arranged to ensure that the discharge velocity is maintained at not less than 15m/s.

Exhaust ducts shall be contained inside a vertical riser shaft and arranged so that inspections of the ducts can be achieved, ducts shall include fire collars where they pass through the shaft walls.

An enclosed plantroom will be provided at the top floor of the building with fans arranged for ease of access and exhaust duct distribution.

1.12 FUME CUPBOARD DESIGN STANDARDS

The design standards to be considered are as follows:

- Australian Standard AS/NZS 2243-8 Safety in Laboratories – Part 8: Fume Cupboards.
- British Standard BS7258 Fume Cupboards, Laboratory.
- ASHRAE Handbook Section HVAC Systems and Applications.

The various standards are considered in detail as below:

1.13 MAKE UP AIR OPTIONS

The air distribution for the makeup air whether mechanical or passive needs to be carefully considered to ensure that there are no draughts that can cause disturbances of the inlet air paths into the fume cupboards. If there are any problems with draughts then the user faces possible loss of containment and the associated health risks that would entail.

There are 5 options to provide make up air to the laboratories for the fume cupboard exhaust.

Option 1 – Direct from outside - this is the simplest and lowest cost but with no control on the room environment.

Option 2 – Outside air connected to room A/C unit - is simple system with some degree of comfort control but would require a specially made room A/C unit due to high volume flow rate of outside air to be treated to supply air conditions to cater for the internal heat load.

Option 3 – Pre-treated by outside air A/C unit – this can provide proper control of room environments at higher cost and spatial requirements.

Option 4 – From central outside air A/C unit - is similar to option 3 but with better opportunity for energy saving via the use of heat recovery heating coil and variable volume flow.

Option 5 – From central outside air A/C unit and connected to Room A/C unit – this is a variant of option 4 with better temperature control but difficult to apply if the number of fume cupboards is high within the laboratory.

For research laboratories, close control of the environment is important and hence it is recommended to use option 4.

1.14 BRU VENTILATION

Air quality within macro (room) and micro (cage) environments of laboratory animal facilities is essential for the health and welfare of humans and animals, and the integrity of the studies being conducted. It is well-known that biological responses are influenced by both genetic heritage and the environment. At the optimum environmental condition, not only does the laboratory animal experience a state of well-being, the researcher obtains reliable and repeatable experimental results from the animal.

Current ventilation guidelines are based largely on anthropomorphic views as opposed to scientifically defined animal needs. Limited research has been conducted to determine macro and microenvironment relationships in animal research facilities in regard to ventilation rates, room air distribution, supply relative humidity and temperature, and other factors required to maintain acceptable and uniform cage environments. Most research has focused only on room conditions.

Laboratory animal ventilation should balance air quality, animal comfort, and energy efficiency to provide cage environments that optimize animal welfare and research efficiency. Conditions that optimize animal welfare automatically tend to improve research efficiency because good conditions minimize unintended stress factors on the animals. Additionally, the laboratory animal ventilation system should provide a healthy and pleasant environment for researchers and animal caretakers.

On the subject of ventilation, the most commonly accepted sources of performance criteria for research animal facility ventilation systems are:

- the Guide for the Care and Use of Laboratory Animals, Institute of Laboratory Animal Resources (1996)
- ASHRAE Handbook
- AS/NZS 2243.3:2002 – *Safety in laboratories - Microbiological aspects and containment facilities*
- Australian Code of Practice for the Care and Use of Animals for Scientific Purposes
- Quarantine Approved Premises Criteria 5.2 for Quarantine Containment Level 2 (QC2) Facilities
- Office of the Gene Technology Regulator Guidelines for the Physical Containment 1 (PC1) Facilities and Physical Containment 2 (PC2) Facilities.

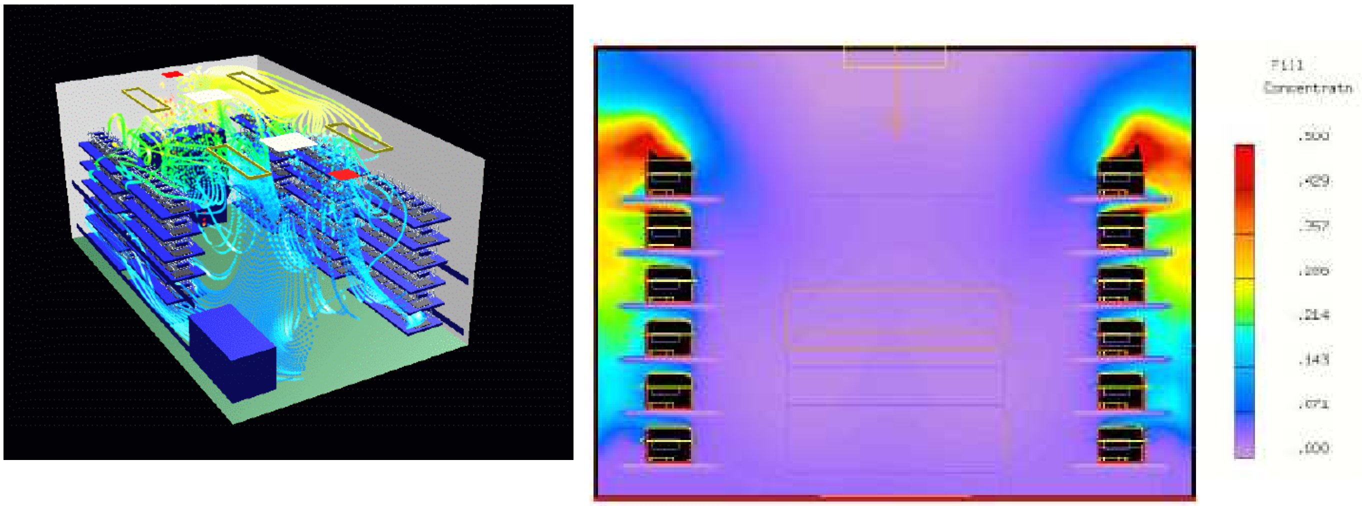


Figure – BRU holding cage ventilation system

Temperature and humidity will be controlled to ±2°C db/±5% RH with a standard system including humidification. The ventilation system will be designed to work in conjunction with any 'venti-rack', 'optimice' or similar animal holding systems. Each animal holding room shall be designed to PC2 standard and each room treated as an individual zone in terms of pressure control. Under this approach each room would require individual supply & exhaust provisions. Back-up systems for power and equipment will be integral to the design.

All inlets and outlets shall be vermin/ insect proof. There should be no cross ventilation between animal houses and non-animal areas (e.g. corridors, staff offices). It is important to address the odour control requirements within and external to the facility, it is expected that there will be facilities for carbon filtration to be installed in the discharge systems if deemed necessary. Where practicable, inlets to exhausts will be located at the level where the concentration of animal residue is highest. Where rooms are deemed to have a risk of discharging zoonotic pathogens, the exhaust air should be pre-filtered, then HEPA filtered, before being discharged. HEPA filtered supply air is required to the BRU and the level 4 tissue culture labs.

Exhaust ducts for effluent air should have removable half-chevron registers so that they can be maintained free of fur and other particulates. Local exhaust ventilation must be provided in procedure rooms to exhaust anaesthetic gases at the source of generation. Local exhaust ventilation should also be provided in areas where there is a high production of dusts, aerosols, etc (e.g. emptying feed bags, cleaning cages, handling sawdust). In some cases, e.g. handling sawdust, both exhaust ventilation and respiratory equipment may be required. All animal rooms will be able to be fumigated with formaldehyde or hydrogen peroxide.

General - The animal holding rooms shall be grouped and shall be ventilated and air conditioned with 100% outside air. The air shall be supplied via two air handling units, one operating as the duty unit and the other a standby unit. Changeover from one unit to the other shall be automatic.
Each air handling unit shall serve a number of animal holding rooms and each room shall be provided with its own temperature control via hot water re-heat coils. Humidity control shall be via a humidifier and chilled water coil common to all rooms.

Supply air - Air shall be supplied into the room via a perforated diffuser with a terminal hepa filter and a stainless steel insect screen provided over the face of the diffuser. The supply air flow rate shall maintain at least 12 air changes per hour within the room and shall be adjusted to provide 20Pa pressure differential between the animal holding room and the adjacent corridor. Animal holding rooms with open cages shall be provided with 16 air changes per hour.

Exhaust air - Each holding room shall be provided with an independent exhaust system and fan. The ductwork within the holding room shall be circular and exposed with a branch duct to serve each animal rack. The final branch connection onto the rack shall include a constant air flow regulating device and stainless steel insect screen. A flexible duct shall be used to connect the branch duct onto the rack suction ports.

Room Isolation - All ductwork entering and exiting the holding room shall be air tight sealed against the room structure. Each holding room shall include an air tight shut off damper installed into the supply air duct and exhaust duct and these shall be accessible from the mezzanine gantry above the holding rooms. The ductwork installed between these air tight dampers and the room outlets shall be fully welded circular stainless steel. All other ductwork shall be galvanised.

1.15 FIRE ENGINEERING CONSIDERATIONS

Mechanical services and in particular ventilation systems are essential to the safe occupation of laboratory buildings. Air movement, air pressures and exhaust systems ensure that personnel are protected from any toxic processes that they are working with. Shut down of many systems cannot be by automatic means since this can compromise the safety of personnel.

Any fire engineering that is undertaken for the building must recognise the importance of the ventilation systems and allow many systems to continue functioning during fire mode.

Examples of the systems that would need to remain operating during fire mode are –

- Fume cupboards
- PC2 laboratories
- BRU
- Other special plant exhausts

1.16 CHILLED WATER SYSTEMS

Supply air handling units providing conditioned air will be equipped with cooling coils supplied from the centralised chilled water system (which will be made up of high efficiency electric refrigeration machines). The cooling coils will be designed and sized to offset heat gains and maintain the specified room temperature conditions as well as providing a de-humidification function.

Chilled water circuits will be closed circuits incorporating a pressurisation unit. Redundancy will be provided to support functions at peak design conditions to critical areas. The system shall be configured in a primary/ secondary decoupled arrangement to take full advantage of variable speed pumping efficiencies.

Proposed selection and configuration of machines will be appropriate to cover peak loads and minimum part loads efficiently and stability.

1.17 HEATING HOT WATER SYSTEMS

The building heating system predominantly relies on natural gas-fired Low Temperature Hot Water (LTHW) boiler plant that includes n+1 redundancy allowance.

It is intended to feed new, separate heating circuits each with duty/standby pump arrangements to serve constant temperature circuits to AHU and terminal heating coils.

There are few options concerning the use of gas fired LTHW boiler plant. The system will be designed to maximize system efficiencies as well as providing modularity to ensure standby capability and load matching capabilities.

1.18 HEAT REJECTION SYSTEMS

As water cooled systems are more energy efficient than air cooled alternatives and geothermal ground loop will not be sufficient for maximum load requirements, adiabatic coolers are proposed to serve the new facility.

Having taken account of the above issues, it is proposed that adiabatic coolers including n+1 redundancy provision are provided on the roof of the new facility.

Equipment location options will be developed with the architect to ensure that, as far as is practicable, the new towers will be positioned to minimise impact on roof lines.

1.19 CONTROL AND MONITORING SYSTEMS

The control and monitoring of the building services will be carried out by a BMS system utilising DDC techniques and will be installed to provide and integrate the following functions:-

- Control, optimum stop/start monitoring and data logging of the plant
- Monitoring and data logging of equipment failure alarms/faults
- Graphic displays of building systems status and performance

Electronic controls shall be used in preference to pneumatic control. To further ensure the accurate control on the indoor environment, some redundancy in pressure, temperature and humidity sensors shall be specified. Particular attention shall be paid to the location of sensors to achieve accurate control.

Separate verification recording and calibration devices, sensors and systems shall be incorporated if deemed suitable to assist in the management and validation of the system performance and maintenance of acceptable internal conditions for the certification body.

Trend logging facilities shall be provided to allow the tracking of system performance to enable the building operators to adjust the controls based on actual operating history.

It is intended that the new building BMS will be compatible with the Hospital system requirements with the potential to be monitored by a single system. This will simplify contractual maintenance issues and will remove complications arising with regard to differing communication protocols.

At present there is a lot of research and development being conducted into control system interoperability and interchange ability. The control system proposed will have to be linked to other systems such as fire etc. for emergency procedures and to gain benefits from use of common signals. The existing system already successfully incorporates this function and this therefore again supports the philosophy of extension to existing rather than provision of an entirely new system.

New plant and mechanical services will be provided with their own independent control and monitoring systems via intelligent stand alone outstations to enable the facility to be maintained with respect to temperatures and humidity and to incorporate safe emergency shutdown and start procedures.

1.20 STEAM STERILISERS

An autoclave will be provided for the purpose of sterilising equipment and materials in the animal holding facility. This autoclave will be electric operated
Autoclaves are required in –

- Two through unit in the BRU

1.21 WASHING EQUIPMENT

Washing equipment will be provided within the BRU to cater for cage, rack and bottle washing. A second washer will also be required to the shared wash up. These equipments will be electric heated and located between the dirty and clean side of the facility.

1.22 COLD ROOMS

Cold rooms will be provided for the storage of specimens and materials. The cold room refrigeration equipment shall be air cooled and located at roof level.
Cold rooms will be located –

- Workspace cold rooms, 4 degree C holding temp.

Each cold room will include a dial thermostat together with temperature monitoring, recording and high temperature alarms together with local door open alarm. Alarms and equipment failure will be monitored by the BMCS.

2 LABORATORY GASES

2.1 GENERAL

The location of plant and outlets will be coordinated with architectural planning and will take into consideration maintenance and operational requirements.

The reticulation of gases will be through grouped risers vertically to each floor and horizontally via ceiling spaces to serve laboratory benches, fume cupboards. It is proposed that a number of risers be provided to reduce horizontal runs and provide better zone isolation for any future modification and/or maintenance/repair work. Each department will be provided with an isolation valve box and alarm panel. Their locations will be determined in the detail planning of the departments. Lab Gas outlets will be specified to suit user requirements.

Centrally manifolded systems shall be provided as necessary as well as laboratory located cylinders that will be planned into the layouts and provided with securing brackets etc to suit.

2.2 LABORATORY VACUUM SYSTEM

2.2.1 General

Vacuum suction systems are used in laboratories to safely exhaust unwanted gases and substances and discharge them to a safe location. Vacuum suction systems will be installed at a central location.

Two types of laboratory vacuum suction are available, central vacuum pump system and local systems. The central vacuum suction system is more suited to teaching laboratories whereas the local suction systems are more suited to research laboratories.

We understand that all laboratories should be treated as research laboratories and hence the local units will be proposed.

2.2.2 Local Systems

These can be bench top or under bench mounted units, i.e. one per bench or laboratory which is switched on only when vacuum suction is required.

These systems will each have an exhaust to be discharged; a common practice is to discharge them into fume cupboard exhausts stacks or dedicated exhaust systems.

Advantages

- The advantages of this system is that the risk of gas mixing producing a dangerous mixture is reduced since multiple laboratories will not be connecting into the system at the one time.
- If a system fails then it affects only one portion of the facility.

Disadvantages

- Maintenance of the suction systems may have to be from within the laboratory.
- Multiple discharges have to be arranged.

2.3 LABORATORY COMPRESSED AIR PLANT

2.3.1 Laboratory Air Compressor Plant

Two air compressors to AS 2896 shall be supplied as fully packaged, oil free, preferably of the rotary screw, inter-cooled, non lubricated type with proven laboratory service. The air dryers shall be integral to the unit. The unit shall be enclosed within a sound insulated enclosure. The compressors shall be of air cooled configuration. The plant will be provided with suitably sized air receiver plant.

2.4 NITROGEN BULK GAS STORAGE

There is a requirement to have bulk Nitrogen to serve the Cryogenic vapour phase storage vessels as well as house nitrogen gas to the laboratories. The decanting principles and procedures need to be discussed in more detail; however, the brief indicates that there will be a vacuum line from the N_2 storage tank to the vapour phase

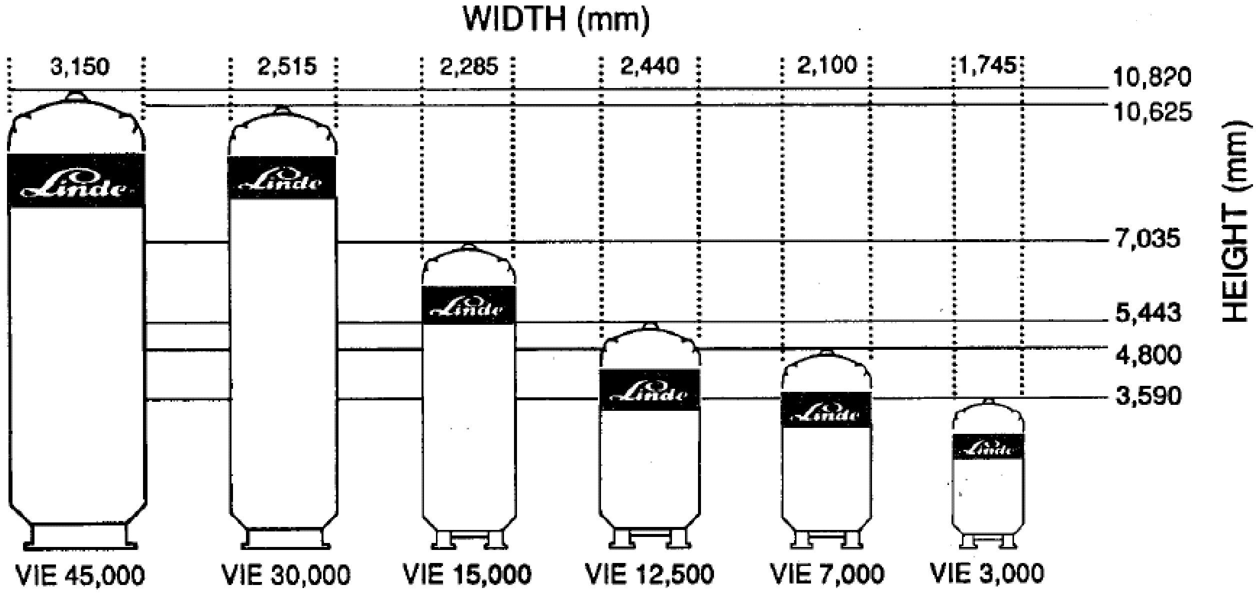
The bulk liquid gases are stored in dome ended cylindrical steel vessels. These vessels can be mounted vertically or horizontally. Vertical vessels are the preferred arrangement since they produce the lower no demand gas loss and are less likely to deliver contaminated gas. Vehicle delivery of these gases is generally by semi-trailer trucks.

Core Gas have provided the following details for their delivery vehicle –

Vehicle weight – 43 tonne
Vehicle turning circle – 30 metres

Deliveries are generally made early in the mornings, where noise is an issue, Core Gas would use a silencer on their gas delivery pump. Core Gas does not have the noise data for their delivery pump but state that with the silencer the problem of noise near a residence is overcome. We would recommend that the project acoustic engineer measures the noise level during a filling operation and we then decide if in fact noise will be an issue.

The final selection of an appropriate storage tank for these vessels will be dependent on the users' requirements. The following show typical approximate dimensions for the vertical cylinders. It is worth



mentioning that capacities of 1,000 Litres can be installed if 3,000 litres is too much.

2.5 CRYOGENIC BULK STORE VENTILATION

2.5.1 General

AS1894 is the code that deals with the storage requirements for bulk cryogenic gases. Bulk gas cryogenic vessels can be located indoors only when exhaustive investigation has shown that there is no suitable outdoor location. This would apply to cryogenic Nitrogen stores. (Oxygen and Nitrous Oxide bulk cryogenic vessels cannot under any circumstances be located indoors).