6. MECHANICAL SERVICES

General

6.1.00 In the health building context, mechanical services extend beyond the conventional 'HVAC' (heating, ventilating and air conditioning) to include the following:

- HVAC systems
- Medical gases systems
- Ancillary mechanical services and specialized equipment and services:
  - dental
  - sterilizers
  - steam generation systems
  - mortuary equipment
  - pneumatic transport systems
  - compressed air systems for industrial use
  - refrigeration plant (e.g. cool rooms)

Heating, Ventilation and Air Conditioning Systems

Performance Outcomes

6.2.00 PERFORMANCE OBJECTIVE

To provide mechanical services that deliver the expected levels of comfort and functionality using cost-effective solutions that achieve an optimal balance between capital, operating and maintenance costs over the life of the service.

6.2.05 OUTCOME STATEMENT

Achieve objectives through the use of energy efficient building and services design, low whole-of-life costs while meeting OH&S requirements and achieving occupant satisfaction with the internal environment.

Component	**Performance Outcomes**	**Performance Criteria**	**Measurement Mechanism**
Air conditioning energy usage	Minimise energy consumption	Energy input per square metre of air conditioned floor area per annum Whole Building 750 MJ/m^2 pa Clinical Areas 800 MJ/m^2 pa Administration 400 MJ/m^2 pa Wards 700 MJ/m^2 pa	Energy used in functional areas and the whole building
Energy used in functional areas and the whole building Air conditioning thermal load	Minimise thermal load on air conditioning system	Watts of refrigeration per square metre of air conditioned floor area (average for whole building) 120 Wr/m^2	

Component	Performance Outcomes	Performance Criteria	Measurement Mechanism
Occupant comfort	Occupant satisfaction with thermal conditions in occupied spaces	80% satisfaction rating	
Ventilation	Adequate quantities of outdoor air and exhaust air	In accordance with AS 1668.2	Actual quantities measured against AS 1668.2 requirements
Whole of life costs	Lowest system cost over it's operating life considering: capital cost; operating cost; and maintenance and replacement costs	Life cycle costing analysis	Life cycle costing analysis complying with AS 4536
Infection control	Prevent the spread of microbial contamination by the mechanical services systems	Systems complying with relevant codes and standards	Compliance with BCA, AS 1668.2, AS/NZS 3666 AS 1432, AS 4260

Note:
Energy targets shown above are for guidance only. Actual targets will need to take the following factors into consideration:

Climatic Zone	Different parts of the state have different climatic conditions which will affect air conditioning load estimation and plant selection. Main climatic elements are: • ambient dry bulb temperature • ambient wet bulb temperature • solar radiation • cloud cover • wind speed
Functional Areas	Different functional areas such as clinical and ward areas have different cooling loads and energy consumption
Operating Hours	Plant operating time will have a significant affect on energy consumption, ie, 12 or 24 hours.
Building Construction	Type of construction, ie, light-weight, heavy-weight, single storey, multi-storey, insulation, affects both plant capacity and energy consumption.
Orientation/ Fenestration	The angle and direction of the sun together with shading devices can significantly influence plant capacity and energy consumption.
Landscaping	For low rise buildings trees, plants and adjacent structures can shield buildings from wind and shade the building from the sun to reduce both plant capacity and energy consumption.

General

6.3.00 APPLICATION

This document applies to all HVAC systems in hospitals and includes:

- Air conditioning
- Heating
- Ventilation
- Piped services for heating and cooling systems.

For health building projects in New South Wales, this document provides a uniform basis for the selection of these systems and their equipment.

6.30.05 GLOSSARY OF TECHNICAL TERMS

A Glossary of Technical Terms is presented in Section 10, Appendix 1 of this document.

6.3.10 OBJECTIVES

A principal purpose of the Guidelines is to provide acceptable levels of comfort and functionality while creating more-cost effective solutions. The Guidelines emphasise the questioning of assumptions about the way in which these functions are achieved and place the onus on the design team to prove the decisions made in an objective, rather than subjective, manner. The Guidelines also emphasise the need to view the mechanical services from a whole life perspective and to take into consideration all associated costs including energy, maintenance and operating costs.

This document is intended to provide a standard for the provision of mechanical services in New South Wales hospitals and to provide, in a convenient form, data specific to hospital applications for use as a reference by designers and others involved in the health building process.

By bringing this data together in one place it is expected that it will replace much of the guesswork that often applies to the specific needs of health care facilities. For example, Section 13 Appendix 4 – Minimum Outdoor Airflow Rates, contains an expanded version of Table A l from AS 1668.2 giving outdoor air rates for a wider range of health care occupancies than in the original Standard. In addition the Guidelines provide a framework for reporting the design in a standardised format to simplify understanding of systems proposed and comparison between projects. They also emphasise the need to make critical decisions early in the design process and, through the Scheme Design report, provide a format for showing that the correct decisions have been made.

The emphasis in the Scheme Design report is on a systems approach as it is recognised that, at this stage, the design is not normally refined to a degree that permits analysis of components. Nevertheless it is expected that, at the scheme design stage, decisions that cannot easily be reversed later will be made. These would include system types, plant configuration, location of plant rooms, riser space, required ceiling heights and the like.

As these are decisions that have significant capital and operating cost implications, there is some emphasis given to timely decision making in the early stages of the project. Occasionally this may lead to the decisions being substantiated earlier than is commonly the case but the savings that flow from bringing such decisions forward more than outweigh the additional early effort.

6.3.20 BUILDING ENERGY MANUAL

Designers and users are urged to make use of the Building Energy Manual which provides extensive data about engineering services and is specifically aimed at applications in New South Wales. Reference to the manual is made at a number of points in this document.

6.3.25 STANDARDS AND CODES

Design requirements are to be in accordance with relevant Australian Standards, building codes and regulations. The list of applicable standards is provided in References and Further Reading of this document.

Infection Control

6.4.00 GENERAL

In addition to the comments made in 1.9.00 and Part D of the NSW HFGs - Infection Prevention and Control, mechanical services design principles shall comply with infection control requirements.

6.4.05 AIR HANDLING AND SUPPLY

Room pressurisation will frequently require air quantities in excess of the minimum scheduled in AS 1668.2, and this document.

Positive flow at adequate rates is preferred to the defining of pressure differentials between areas. In some circumstances, flow may be required only on opening of doors and the system shall have adequate flexibility to accommodate this requirement.

Provision shall be made to ensure adequate air supply with varying filter resistances in areas requiring high levels of airborne contaminant control. Typically this will be in Operating Rooms, Set-Up Rooms, Isolation Rooms and High Infection Risk Areas.

Rooms or booths specifically designed for sputum induction, aerosolized pentamidine treatments and other high-risk cough-inducing procedures shall be provided with local exhaust ventilation in addition to infection control requirements.

Fans in systems serving areas requiring airborne contaminant control shall be operated 24 hours per day to maintain airflow patterns from clean to less clean areas.

Energy conservation design shall not compromise infection control systems. The requirements of AS/NZS 4187 shall be maintained in respect of ambient conditions for sterile stock.

Provision of Cooling and Heating

6.5.00 INTRODUCTION

This document sets out the criteria for cooling and heating. Air conditioning is the most costly single building service currently provided in hospitals and refrigerated cooling is the second largest energy consumer after lighting. In this situation it is essential that air conditioning be only provided if no adequate alternative exists.

Until the mid 1970s it was not the practice in New South Wales to provide air conditioning to such areas as hospital inpatient units. Many examples can be cited where quite satisfactory comfort is achieved in older style buildings without the need for mechanical cooling. Factors that affected this were siting and orientation of the building, high ceilings, effective natural ventilation and heavy building mass. Similarly, there are many hospitals in the west of the State where evaporative cooling has provided adequate comfort for patients and staff for many years.

The change to deep plan buildings, modem, lighter-weight construction and community expectations have brought us to the point where air conditioning for comfort throughout the hospital has become the norm.

It must be recognised that with rare exceptions, the provision of air conditioning is not required by law and therefore is not mandatory. This document addresses the circumstances to be considered when deciding whether to air condition, evaporative cool or heat a space. The essential difference between these options lies in the degree of temperature humidity (and sometimes pressure) control that is achieved in the space served. It is the degree of control, or rather the extent to which the space goes outside acceptable limits, that dictates the choice of appropriate solution.

6.5.05 FACTORS INFLUENCING THE CHOICE OF COOLING AND HEATING

For capital and recurrent cost reasons it is preferred to limit the amount of air conditioning to those areas where it is essential for one of the reasons listed below. In areas where air conditioning is considered for 'comfort' purposes only, preference shall be given to the use of passive cooling techniques instead of air conditioning.

Passive cooling techniques include:

- Proper siting and orientation of the building.
- Selective shading of windows to prevent solar penetration in summer but permit it in winter.
- Suitable building mass and insulation combinations.
- The use of natural ventilation.

In order to achieve this objective, there needs to be early involvement of the mechanical engineer in the design process and for the design team to have, as a high priority, minimisation of the amount of air conditioning while achieving a comfortable building.

6.5.10 CRITERIA

The following criteria have been applied in determining what type of mechanical system should be applied.

1. Statutory Requirements:
   Examples include WorkCover Authority regulations or Local Government Act (BCA) regulations. Such regulations relate only to the provision of mechanical ventilation and limits on temperatures. They do not prescribe air conditioning or any other means of achieving temperature control.

2. Patient Safety:
   Examples of such areas are Recovery, ICU, CCU and HDU. In these areas a controlled environment reduces stress on patients and permits observation of them with only limited bed covering.

3. Infection Control:
   In areas such as Post-Mortem Rooms and Operating Rooms, mechanical systems air conditioning provides a means for reducing the spread of airborne infectious organisms from one space to another.

4. Essential for Activity / Equipment: Examples include:
   - Pathology where stable conditions are required for consistent results.
   - Parts of Medical Imaging containing heat sensitive equipment.
   - Mainframe computers.

6.5.15 SUMMARY OF AREAS

The principal areas within a hospital have been divided into three categories on the basis of the permissible variation in temperature in the space concerned. It should be noted that these are not control tolerances but rather limits on the amount of time during which unacceptable conditions will occur:

Category 1:
Areas where temperatures must be kept within close limits most of the year to meet criteria 2, 3 and 4 in clause 6.5.10. Normally this would be achieved using refrigerated air conditioning and heating.

Category 2:
Areas where a wider range of temperatures is acceptable. In these areas, cooling and heating is provided for the comfort rather than safety of staff and patients. In these areas air conditioning is acceptable only when the design team is unable to achieve comfortable conditions by passive means. Heating would normally be provided in these areas.

Category 3:
Areas where the usage is such that an upper limit on temperature is not appropriate although

a lower limit (and therefore heating) is required for occupant comfort. Where it would cost more to provide separate systems for a single room or small group of rooms to comply with the above categories a system which combines different categories may be used.

6.5.20 CATEGORY 1

Redefine performance

Category 1 Areas:
- Emergency Department (whole unit)
- Cardiac Catheterisation rooms
- Coronary Care Unit
- Operating Suite
- Day Procedure Rooms
- Delivery Rooms
- Intensive Care Units (including Neonatal, Coronary etc.)
- Isolation rooms within inpatient units.
- Medical Imaging Rooms
- Mortuary/Post-Mortem Units
- Library (Only)
- Main Frame Computer Room
- Recovery
- Pharmacy Unit
- Pathology Unit
- Sterile Supply Unit
- Stores for temperature-sensitive goods.

6.5.25 CATEGORY 2

Where mechanical cooling is proposed, the design team shall demonstrate that they have examined the alternatives and explain why they are unable to apply passive cooling. Heating would normally be required in all instances.

Evaporative cooling should be restricted to locations west of the Great Dividing Range.

Category 2 Areas:
- Biomedical Engineering Unit
- Blood Donor Unit
- Dental Unit
- Main Entrance and Public Areas
- Medical Records Unit
- Occupational Therapy
- Offices (All units including offices in engineering, stores etc.)
- Outpatients
- Residential Accommodation
- Rehabilitation Units
- Physiotherapy
- Staff Cafeteria
- Tutorial/Meeting Rooms (All units)
- Waiting Areas (All units)
- Inpatient Units
- Nurseries
- Kitchen

6.5.30 CATEGORY 3 :

For Category 3 areas, temperature shall be above 20 ºC on all but 10 days per year. Normally heating will be required. For small rooms such as dirty utilities, toilets and en suites, where exhaust air is required, this condition may be deemed to be met if the make-up air is drawn from a space provided with some form of heating.

Evaporative cooling may be proposed for Category 3 areas provided it can maintain an inside temperature of less than 27 ºC throughout the year.

Category 3 Areas:
- Change / Locker Rooms
- Cleaner's Rooms
- Dirty Utility Rooms
- Disposal Rooms
- Engineering Unit
- Hydrotherapy Pool (Refer to 6.615 for special conditions)
- Hygiene Unit
- Linen Handling Unit
- Store Areas for non-temperature sensitive goods
- Toilets

Offices located in the above Category 3 areas are classified as Category 2.

Kitchens require special attention to deal with high internal heat load and fresh air rate for hoods.

Special cooling is required for plating areas and preparation areas for Cook-Chill Kitchens.

Evaporative cooling should be considered where climatic conditions are suitable Refer 6.6.55

Plant and Equipment

6.6.00 INTRODUCTION

The purpose of this document is to set out the methods and basis to be used when calculating heating and cooling loads for hospitals and when selecting the appropriate size of equipment.

The document does not present itself as a comprehensive document and designers are referred to the standard design guides such as ASHRAE [2] and AIRAH [7] for further design data and methods.

This document refers to the Building Energy Manual - NSW PWD to which designers should also refer.

The methods in this document are to be used for all air conditioning and heating load calculations.

Heating load calculations shall be based on the relevant sections of this document adjusted as set out in Mechanical Services, Air Conditioning Heating Load.

Innovative approaches to plant configuration may be proposed provided the life cycle cost advantage can be shown. These would include:

Heat Recovery Systems:
- Ice Storage
- Co-generation

Details of the systems, including life cycle costs, are to be included in the Scheme Design Report.

6.6.05 AIR CONDITIONING COOLING LOAD

Cooling load calculations shall be performed by computer software based on the data in Section 14, Appendix 5 of this document.

The software shall be a commercial package that has been validated by a recognised benchmarking test. The package shall have good technical support.

6.6.10 OUTDOOR DESIGN CONDITIONS

Outside design conditions shall be based on the most accurate climatic data available for the location of the proposed project.

Great care is required in selecting this data as two locations separated by only short distances can have markedly different climatic patterns. The consequence of error in selecting the most appropriate data can result in both excessive plant capacity and unnecessary capital cost. For example - using 24º C instead of 23ºC for wet bulb temperature can add 8% to a typical hospital cooling coil and central plant capacity.

Outside design conditions shall be selected as follows:

1. For the locations listed in AIRAH: Application Manual DA09a 'Load Estimation & Psychometrics' [2]

   For Operating Theatre plants use the 'Critical Process', 24 hour data if available for the location, otherwise use the 'Comfort or Non Critical' data with the dry bulb temperature increased by 2 ºC or the wet bulb by l ºC.

   For all other plants use the 'Comfort or Non Critical Process Installations' data.

2. For locations not listed in AIRAH, use data for the nearest listed location having similar climatic characteristics. Figure 15.12 of the Building Energy Manual [3] may be used as a guide in selecting a suitable location.

The data in reference [2] has been prepared by the Bureau of Meteorology (Computer data now available from Met Bureau) from their archives for hundreds of locations in Australia and as such it represents a significant increase in the accuracy of data compared with what was available previously. Data is also available directly from the Bureau of Meteorology.

6.6.15 INDOOR DESIGN CONDITIONS (ROOM DESIGN CONDITIONS)

TEMPERATURE AND HUMIDITY

Inside (room) design conditions are summarised in following Table. They are to be used for plant sizing purposes and do not imply that the plant is to be controlled to maintain the values stated nor do they represent recommended set points or tolerances for controls.

Area	Summer Design Dry Bulb ºC	Summer Design Relative Humidity %[3]	Winter Design Dry Bulb ºC
Operating Rooms	23	50	21
Category 1 Areas	24	50	20
Category 2 Areas	24	50	20
Other Areas	27	50	20
Hydrotherapy Pool[4]	Space conditions to comply with AS 3979		

NOTES

1. Special surgical procedures, such as paediatric and neurosurgical, may require other conditions between 15ºC and 25ºC. Design shall be based on other values only when there is a demonstrated clinic need.
2. Rooms housing heat sensitive equipment such as main frame computers, linear accelerators, MRI equipment and the like, shall have conditions according to the equipment manufacturer's recommendations.

3. Humidification shall not be provided except as required in Note 2. Humidity may be permitted to rise to 65% if appropriate to the design or operation of the systems.

4. These depend on pool water temperature and require that air temperature will be not more than 10 ºC lower than pool water temperature and relative humidity not more than 75%. Pool water may be in the range 28 to 35 ºC.

5. Control set points shall be selected to suit occupant preferences consistent with energy conservation.

6.6.20 TEMPERATURE DIFFERENCE WITHIN ROOMS

The temperature at 1.5 m above the floor in a room shall not vary by more than 1º C. The temperature difference between rooms on the same zone shall vary by not more than 3º C. The temperature difference between floor level and 1.5 m above the floor shall be not more than l.5º C. The temperature of the floor shall be within the range 19º C to 26º C.

Zoning of air handling plant shall be provided to the extent required to limit the temperature difference between rooms served by the same zone to a maximum of 3 degrees Celsius.

6.6.25 AVERAGE AIR VELOCITY IN THE ROOM

Average air velocity in the room shall be between 0.1 and 0.15 metres per second. Particular care with the design of air distribution is required in Operating Theatres and rooms where patients are on beds or trolleys such as Patient Bed Rooms, Recovery, Emergency and Critical Care. Under no circumstances shall the supply air rate be less than 4.5 ACHR in any room any time. It should be noted that this applies to minimum air quantities on variable air volume systems as well as to constant volume systems.

Evaporative cooling shall be designed to maintain acceptable indoor comfort conditions, based on heat stress index or similar criteria.

6.6.30 SOLAR GAIN THROUGH GLASS

For glazing that is not always fully shaded, the glazing system shall be selected and the air conditioning plant sized for an overall shade coefficient of not more than 0.6.

6.6.35 HEAT GAIN FROM LIGHTS AND EQUIPMENT

Heat gain from lights shall be calculated from the lighting designers' plans. (Refer Guideline Electrical Section -Lighting).

For preliminary calculations before the completion of the lighting design based on gross HPU areas, the following approximate values may be used. They are based on lighting levels in the Electrical Section.

Heat gain from electrically powered equipment shall be based on the actual equipment to be used within the space. Lacking specific information, the following may be used, based on gross HPU areas.

DEPARTMENT	LIGHTING W/m^2	POWER W/m^2
Medical/Surgical Wards	12	5
Orthopaedic	12	5
Paediatric	12	5
On-call accommodation	12	5
Rehabilitation	12	5
Allied health	12	5
Psychiatric	12	5
Psychogeriatric	12	5
Oncology	12	5
Bio-medical Engineering	12	10
Medical Imaging	12	10
Emergency	15	10
Medical Records	12	5
Pharmacy	12	10
Nuclear Medicine	12	10
Pathology	15	10
Blood Donor Unit	12	5
Medical Library	12	5
Day procedures	12	10
Operating Suite	25	40
Intensive Care Unit	15	10
Coronary Care Unit	15	10
Mortuary	10	5

Linen Handling	10	5
Regional store	8	2
Engineering & Maintenance	8	5
Kitchen	10	-
Staff Cafeteria	12	10
Education	8	5
Main Entrance & Foyer:	8	5
Admission/Discharge	12	15
General Administration	12	15
Staff Amenities	8	-

Additional allowances are required where equipment located in air conditioned space is heated by other means such as hot water or steam.

6.6.40 OUTDOOR AIR AND PEOPLE

Outdoor air shall be provided according to AS 1668 Part 2

The table in Section 15 Appendix 6 contains data from AS 1668 Part 2 with the addition of data on areas of hospitals not covered by the standard. Appendix MD shall be used as a supplement to Table Al of AS 1668 and be read in conjunction with the Standard.

It should be noted that AS 1668 Part 2 permits some concessions on outside air flow rate if filters of sufficiently high efficiency are installed. This use of such filters is permissible provided they are shown to be cost effective by life cycle cost analysis.

In areas where there are high people densities, the actual number of people in the space shall be used. It should be noted that values in AS 1668 for areas such as the Staff Cafeteria yield more people than is normal for such spaces in hospitals.

6.6.45 OTHER LOADS

Margins for other sources of cooling load including infiltration, duct heat gain, fan power and the like shall be calculated according to standard references [2], [7]

6.6.50 SAFETY MARGINS

Safety margins on cooling and heating load calculations shall be zero.

6.6.55 DIVERSITY

Where a central plant serves more than one air handling system, the capacity of the central plant shall be calculated based on the peak simultaneous load, not the sum of the individual loads. In addition, the following diversity factors shall be applied when calculating central cooling plant capacity.

Lighting:	0.90
Equipment:	0.85
People:	0.80

6.6.60 AIR CONDITIONING HEATING LOAD

Heating load calculation shall be based on the following:

Calculation method for heating load as part of air conditioning plant shall be performed using software according to Clause 6.6.05. Where heating only (i.e. non air conditioned) systems are involved, calculations may be according to Clause 6.6.05 or by manual methods in References [2] or [7], and clause 11.3.10.

- Zero solar gain. Outside design conditions for winter in Clause 6.6.10
- Inside design conditions for winter in Clause 6.6.15. Zero heat gain from lights. Zero heat gain from people.
- Outside air quantity calculated in Clause 6.6.40
- Other heating loads such as infiltration according to Clause 6.6.45
- Zero safety margins.

Zero 'Heat up' allowance. Instead provide control system to start heating plant before normal occupancy time to achieve acceptable inside conditions.

6.6.65 EVAPORATIVE COOLING

Evaporative cooling shall be designed to maintain inside dry bulb temperature less than 27º C. Calculation of cooling load and plant sizing shall be according to Sub Section 6.6 or alternatively by the use of computer software supplied by evaporative cooler manufacturers based on the bin temperature method.

6.6.70 DETERMINATION OF SPARE CAPACITY OF PLANT AND EQUIPMENT

GENERAL PROVISIONS

Except as provided below, all plant and equipment shall be sized as set out in the preceding sections to be equal to the load it serves with no additional capacity or duplication for 'safety margins', redundancy or the like. Diversity of load shall be considered when sizing plant that serves multiple systems - refer Clause 6.6.55

No additional capacity shall be provided for future loads unless the required capital for the future plant and/or building has been committed. Where extension of the system is planned, provision shall be made, as blanked valves, for future connection to the existing system but not as additional plant capacity.

6.6.75 SEGREGATION OF SYSTEMS

Air handling systems shall be segregated to permit individual departments to be shut down when not in use. In certain instances, availability can be increased by dividing the area served into separate air handling systems. An example of this is the splitting of the operating theatres so that each pair of theatres is handled by one air handling unit. In this case shutting down the air handling unit for maintenance and the like will still permit other theatres to be used.

6.6.80 NOISE LEVELS

Unless required otherwise by the Project Brief, the design interior noise shall be those in AS/NZS 2107 for 'Recommended Design Sound Level - Maximum'. For specification purposes NR (noise rating) values are preferred.

Convert dB(A) levels in AS/NZS 2107 to NR ratings by subtracting 5 dB(A) in each case. For example AS/NZS 2107 specifies 50 dB(A) for corridors so specification value for corridors would be NR 45.

6.6.85 STANDBY POWER OPERATION

Refer also to Guideline Electrical Services- Standby Power.

Selection of Mechanical Systems

6.7.00 INTRODUCTION

This document deals with selection of mechanical systems for space heating and cooling in hospitals. The procedure for determining whether cooling or heating of a space is to be provided is dealt with in Sub Section 6.3 -General.

Once that decision has been made, this Document sets out the criteria for deciding how it can be best achieved.

6.7.05 AIR HANDLING SYSTEMS

SYSTEM SEPARATION

In a large and complex project such as a hospital it is necessary to provide more air handling

systems than would be the case for a single use building such as an office block. Besides providing systems to meet the needs of separated buildings, fire mode operation and air conditioning zoning to match heat loads, separate air handling systems are required to meet the following requirements.

Varying occupancy times:
Some areas will nominally operate from 9.00 am to 5.00 pm and some will operate 24 hours a day. Some of the '9.00 am to 5.00 pm' areas such as Education may be in use weekends. Additional plants shall only be provided if it can be shown that the life cycle cost is lower than the alternative of operating plant for unoccupied areas out of hours.

Possible tenanting of departments (e.g. Pathology, Medical Imaging):
Separate plant for tenanted spaces shall only be provided if required under the structure of the proposed leases.

Duplication to provide redundancy:
A separate air handling unit is required for each pair of operating theatres.

Prevention of cross contamination:

Separate plant shall be provided for:
- Operating theatres - a separate air handling unit for each pair of operating theatres
- Mortuary
- Main Kitchen
- Where specifically required for isolation purposes. Refer other sections of this document.

Shut Down:

Systems shall be arranged to allow the closing down of whole units (eg ward units) at times of low occupancy.

The air conditioning system shall incorporate only sufficient separation of air handling systems to meet the needs defined above, and zoning for temperature control and smoke control.

6.7.10 ZONING

Zoning of air handling plant shall be provided.

Thermostats or temperature sensors shall be located in a representative area within the zone.

Zoning shall meet the tolerances of the internal design conditions for the particular category of environment selected.

6.7.15 MAINTENANCE

In selecting air handling system types, consideration shall be given to the cost and ease of maintaining the systems. This information and costs shall be incorporated in the Scheme Design Report.

Points to be considered include:

- All plant and components are to be in locations accessible for maintenance and with sufficient space to remove plant components. Access shall comply with Building Code of Australia and WorkCover Authority requirements.

- All plant shall be located so that it can be replaced and with a means of removal i.e. lifting beams, etc.

- Plant and components located over occupied areas shall be such that routine maintenance does not cause disruption to normal hospital activities. In this respect plant should not, for example, be located in ceilings over patient beds.

- System components shall be selected so that spare parts are readily available locally or within 24 hours.

- Selection of systems shall consider the level of maintenance expertise available on site and the level of technical expertise available to the hospital to operate and adjust the system.

- Preference shall be given to simple systems requiring simple maintenance and adjustment with extended periods between routine maintenance.

6.7.20 SELECTION OF SYSTEMS

There is a vast array of air handling systems and combinations of systems that can and have been used in hospital applications. The following provide guidance on their general suitability. It should be noted however that there are many smaller projects involving modification and extension to existing buildings where modification to an existing air handling system, while it may be less than ideal, can produce a far more cost effective solution than replacement with a new system. Should this path be chosen the users shall be advised if of compromises in performance that result.

Constant Volume Systems:

These are suitable for all areas of the hospital and are essential for areas where air flow and temperature control are critical such as operating theatres, mortuary, cytotoxic and aseptic rooms. Except in exceptional circumstances, do not employ re-heat methods to satisfy temperature zoning.

Variable Air Volume (VAV) Systems:

These are suitable for all areas in the hospital other than the special cases requiring constant volume systems. Because of the potential for low air flows at low load, VAV systems must have a means for setting a low limit on air flow (not less than six air changes per hour) either by control limit or by use of fan VAV boxes on centre zone.

Packaged Direct Expansion:

These include air and water cooled unitary style equipment and air cooled split systems. They are normally constant volume but subject to the technical limitations of direct expansion plant may also be used with VAV boxes. Air side performance can be expected to be the same as with other constant volume and VAV systems although attention is required to address the consequences associated with step changes in capacity due to compressor switching.

Of significance is the limited life of packaged direct expansion plant compared with chilled and/or heating water systems and this needs to be addressed in the life cycle cost analysis.

Fan Coil Unit Systems:

Fan coil unit systems served by chilled water with hot water or electric heating are an attractive solution for areas requiring special control or out of hours operation.

Such areas include isolation rooms, computer room and PABX rooms. While potentially suitable for patient rooms the high cost of associated pipe work and need for regular maintenance access make them a solution suitable in special rather than general applications.

Warm Air Furnaces:

Gas fired warm air furnaces provide a capital and energy cost effective means for heating areas where evaporative cooling or no cooling is required. They may be combined with evaporative cooling.

Evaporative Cooling:

Evaporative cooling is suitable for (Mechanical Services) Category 2 areas provided outside design conditions are suitable. They are of NO value east of the Great Dividing Range and require special attention to limit heating costs because of the large volumes of outside air used.

6.7.25 HUMIDIFIERS

Humidifiers are not generally required to be installed in health buildings unless for medical

reasons or for environmental control where 'high tech' equipment is installed and required by the manufacturer. Examples include operating rooms and computer rooms.

Where installed humidifiers shall provide a bacteria-free injection into the air stream.

6.7.30 COOLING SYSTEM

COOLING PLANT

Central cooling plant chiller sets shall be selected to ensure that in the event of failure of a compressor, adequate standby capacity is available for selected critical areas. Select chillers that maintain reliable, energy efficient low-load operation. Chiller plant shall be sized to provide efficient and stable part load operation.

6.7.35 COOLING TOWERS AND EVAPORATIVE CONDENSER SYSTEMS

Cooling tower and evaporative condenser systems shall be designed and installed in accordance with the Health (Legionella) Regulations and AS/NZS 3666.1 to AS/NZS 3666.3 - Air handling and water systems of buildings - Microbial Control. - Regulations under the NSW Public Health Act. Make allowance to keep part of the plant operating during the cleaning process.

Cooling towers and evaporative condensers shall include a side stream filter or cyclonic separator system to provide solids removals from the circulating water systems.

Evaporative cooling may be used for support areas where relief cooling only is required such as kitchens and workshops and some other non-critical areas, where suitable. Observe standards and codes for design as for air-conditioning

6.7.40 HEATING

SELECTION OF SYSTEM

All heating systems shall be thermostatically controlled. Heating systems with long thermal lag (e.g. most types of slab heating) shall only be used when no alternative is available and only when combined with a control system to hold space temperature within 2º C of the winter design value. Systems that rely on opening windows to compensate for over-heating are not acceptable. The surface temperature of heating equipment in occupied areas shall not exceed 50º C. Temperature of the floor shall be not more than l.5º C above the air temperature at 1.5m above the floor.

Open fires, portable heaters and unfluted gas heaters shall not be installed in patient areas.

6.7.45 ENERGY CONSIDERATIONS

Heating systems shall be selected having regard to the life cycle cost of the system. This shall include consideration of;

- Most suitable tariff structure;
- Availability of waste heat from heat recovery processes;
- Possibility of combining space heating reticulation with other; systems (eg domestic hot water)
- Energy sources available on site; and
- Suitability of the system for shut down in summer and when space is not in use (sterilising and domestic hot water should be segregated from space heating).

6.7.50 MAINTENANCE

The conditions set out in 6 .7.15 shall apply to heating systems

6.7.55 CENTRAL BOILER PLANT

Central boiler plant shall be unattended in accordance with WorkCover regulations.

6.7.60 DUPLICATION AND STANDBY BOILING PLANT

Duplicate boiler plant (multiple units equal to the total load) and standby plant (additional plant over and above that needed to meet the load) shall only be provided where needed to meet the availability requirements or to provide efficient and stable part load operation. Refer – Clause 6 .6.60.

6.7.65 BOILER PLANT MAINTENANCE

Similar considerations to those in Mechanical Services - Maintenance section, apply to central plant. While central plant reduces the number of system components, it usually means that they are large and require more complex control systems. Ensure, before proposing central plant, that adequate resource in terms of trained personnel and equipment are available on site to maintain and adjust systems. In order to effectively assess this, hospital policy regarding maintenance will have to be determined at the design stage. For example will the hospital have on site staff or will it rely on contractors?

Ventilation

6.8.00 Mechanical ventilation shall be provided to comply with AS 1668 Part 2 [5].

Outdoor Air

6.9.00 Outside air shall be provided according to AS 1668.2 1991 as adopted by the BCA. Note: AS 1668.2 2002 includes Health Care Facilities and should be used except where in conflict with BCA which refers to the 1991 edition.

In areas where there are high people densities, the actual number of people in the space shall be used. It should be noted that values in AS 1668 for areas such as the Staff Cafeteria yield more people than is normal for such spaces in hospitals.

Ensure that there is sufficient outdoor supply to provide make up for exhaust systems.

All ventilation systems shall be designed to control the high level of odours often generated within Health Care Facilities.

All bathroom and toilet exhaust systems shall be fully ducted and discharge to outside, not to common roof or ceiling space.

Variable volume supply air systems shall incorporate control devices to ensure minimum outdoor air supply to all areas is maintained at all times.

Regardless of whether the area is served via operable windows, forced fresh air shall be provided in accordance with this document to all air conditioned occupied spaces.

Sanitary compartments, Dirty Utility Rooms and similar spaces shall not be ventilated by a system which also serves areas such as Operating Rooms.

Ventilation systems for rooms where ethylene oxide (ETO) sterilizers are used and ETO stored shall be designed in accordance with the Occupational Health and Safety Section of this document. Upon loss of exhaust system airflow, an audible and visual alarm shall activate in the steriliser work area, and at a location that is continually staffed.

Exhaust Air

6.10.00 FAN SYSTEMS

Fan systems are highly recommended to be fitted with differential pressure switches, to

provide remote alarm indication of fan failure. This shall not apply to independent toilet exhaust systems serving single use toilet/shower or bath areas.

6.10.05 SCAVENGING

Each space routinely used for administering inhalation anaesthesia and inhalation analgesia shall be served by a scavenging system to vent waste gases. If a vacuum system is used, the gas collecting system shall be arranged so that it does not disturb patients' respiratory systems. Gases from the scavenging systems shall be exhausted to the outside.

Anaesthesia evacuation systems may be combined with the room exhaust systems provided that the component used for anaesthesia gas scavenging exhausts directly to the outside and does not recirculate.

Scavenging systems are not required for areas where gases are used only occasionally such as emergency rooms and offices for outline dental work.

Acceptable concentrations of anaesthetising agents are unknown at this time. The absence of specific data makes it difficult to set specific standards. However, any scavenging system is highly recommended to be designed to remove as much of the gas as possible from the room environment.

It is assumed that anaesthetising equipment will be selected and maintained to minimise leakage and contamination of room air. (Refer also to the Occupational Health and Safety requirements in the Part C of the NSW HFGs (Health Facility Guidelines).

Life Cycle Costing

6.11.00 GENERAL REQUIREMENT

Refer to Section 12, Appendix 3 of this document.

Building Management and Control Systems

6.12.00 INTRODUCTION

The purpose of this Document is to set out the functions of a Building Management Control System (BMCS) and the standards to be applied.

This Document sets out proposals for achieving a system that gives sufficient information to enable the functions of the hospital to be carried out in a cost effective and efficient manner.

The provisions of this Document are to be applied to all new BMCS and to all extensions or enhancements of existing systems.

The BMCS should be an Open Building Control System using either Lon Mark, Lon Works, Modbus or BACnet standards with full interoperability.

Selection of a BMCS system shall be appropriate to the size, nature and location of the project.

Where economically possible, it is preferable to extend on an existing BMCS system on small to medium sized projects rather than to duplicate systems.

Alternatively systems should be selected for high level interface compatibility.
Where this is not possible, low level interface between systems may be considered to achieve a degree of system integration. This should always be considered a last choice.

Also, of significance is the degree of sophistication appropriate to the project and locations. Overly sophisticated systems requiring a high level of computer skills are not appropriate to remote locations. Also see clause 6 .13.05.

6.12.05 ALTERNATIVE TO CENTRAL CONTROL AND MONITORING

The cost of a BMCS is directly related to the number of controls or monitoring points. While the cost per point may be modest, it is inherent in BMCSs that the number of points escalates rapidly because when a decision is made to monitor or control one function that point is duplicated by as many times as the function occurs. For example, if a decision is made to monitor power consumed by each distribution board then the cost is represented not by one point or even the number of boards as each board has three phases per submain and two submains per board.

Typically for a 200 bed hospital there would be up to 20 distribution boards giving a total of 120 points.

Before adding a function to a central control and monitoring system, consider whether lower technology solutions would give an equivalent result. Examples are:

- use of time switches to control plant and lighting instead of central control,
- regular maintenance inspections of filters instead of filter pressure drop alarms,
- local electrical or electronic control of temperature instead of central control and monitoring, and
- manual switching of lighting by security staff rather than by a central system.

Required Functions of the BMCS

6.13.00 CRITERIA FOR SELECTION FUNCTIONS

Subject to the conditions set out below the following functions shall be provided by the BMCS system:

- plant control (temperature, humidity, pressure, etc.).
- optimum and scheduled start and stop of plant.
- electrical load shedding.
- outside air economy cycle control.
- alarm annunciation.
- data gathering and logging.

Given the high cost of providing BMCS, the limited life of the technology (currently about 10 years) and the larger volumes of information generated, the objective in installing a system is to include only those monitor and control points and functions that can be demonstrated to give cost effective control.

Typical functions would include:

Energy Management:
- energy metering from supplier including (as appropriate) KWH and KVA
- chiller and boiler kW output
- power to major submains. (The cut off between ‘major’ and ‘minor’ needs to be viewed by weighing the cost of monitoring against the benefits of allocating costs to departments and some other basis such as floor areas).
- data logging of plant run hours
- electrical load shedding
- emergency power mode operation.

Control:
- start and stop plant.
- Optimise plant operation to reduce energy consumption
- switch off lights and plant for areas not in use. Use of B.M.C.S. for this function is to be justified by economic comparison with alternatives (See 6 .12.05).
- chiller and boiler optimisation.
- temperature control (subject to need to have this centrally controlled).

Alarm Functions:
- fault alarms from critical items. Normally a common alarm for each item of plant will suffice.
- alarms from items of non-mechanical equipment such as blood refrigerators, body holding, kitchen cool rooms, medical gas plant, lifts, diesel generator etc. where fault condition could be life threatening or lead to major financial loss
- fire alarm indication with ability to allocate priorities.

Maintenance Functions:
- hours run log of plant items
- scheduled maintenance
- operating hours logging
- performance logging (eg temperature profiles)
- fault/alarm logging and analysis

6.13.05 OPERATOR TRAINING AND CAPACITY

It goes without saying that if the system is to be installed, it must be capable of being operated, adjusted and maintained. A modern direct digital control BMCS represents a high level of technical complexity and requires an equivalent level from mechanical contractor, operators and maintenance staff. It is essential that any system installed be capable of being understood and operated by hospital staff. They may be backed up by contractors, but if the system is too complex for the hospital staff, experience has shown that it will rapidly fall into disuse for all but the most basic functions.

The system must, as well as being suitable for the staff who will use and maintain it, be provided with technical back-up in the form of comprehensive, useable documentation and a formal training structure for initial and subsequent users.

6.13.10 MAINTENANCE ARRANGEMENT

Consideration should be given on large or complex BMCSs to incorporating a long term maintenance agreement into the installation contract. This arrangement has been common practice with lift contracts for many years and offers a commercial advantage to the purchaser if the maintenance costs are established at tender time. With the present state of BMCS technology it is probable that only the original supplier will be in a position to maintain the system. This makes the possibility of obtaining competitive tenders for maintenance unlikely after the initial installation contract is let.

Such a long-term contract needs to be carefully prepared. In addition to setting out requirements for maintenance of hardware, software upgrades and the like, it must also cover issues such as the training of new operators over the years, modification of software and extension of the system.

Controls – General

6.14.00 Provision shall be made to operate the air-conditioning system within the required temperature and humidity range. The range may need to be adjusted to suit local preference or medical needs when, for instance, elderly patients and babies may require higher temperature.

All adjustable controls such as thermostats are highly recommended to be provided with locking covers to prevent tampering.

All components such as temperature sensors within an occupied space shall be suitable for swab-down cleaning. (Not waterproof).

Building Construction

6.15.00 INTRODUCTION

At present there are no parameters dictating the thermal performance of building construction so that these vary greatly between projects. Issues such as the amount of glass, shading,

thermal mass and insulation have significant impact on both plant cost and operating cost.

The building shall be designed to meet acoustic performance requirement.

6.15.05 THERMAL PERFORMANCE

Thermal performance of buildings is to conform to ASHRAE Standard 90 – 1990.

6.15.10 BOILER, HEATING EQUIPMENT PLANTROOMS

Rooms containing heat producing equipment, such as boiler or heater rooms or laundries, shall be insulated and ventilated to prevent the floor surface above and/or the adjacent walls of occupied areas from exceeding a temperature of 6^{o}C above ambient room temperature.

6.15.15 NOISE AND ACOUSTIC ATTENUATION

Noise levels in any area shall not exceed the exposure standard established in the Occupational Health and Safety (Noise) Regulations. For the purposes of the regulations, the exposure standard means the eight (8) hour equivalent continuous sound pressure level of 85 dB(A) measured in A-weighted decibels referenced to 20 micro Pascals. Due consideration shall be given to the amplification of noise due to multiple sound sources to ensure the exposure standard is not exceeded.

Noise breakout from any plant areas shall not exceed the values for interior noise as determined in AS 2107 -'Acoustics - Recommended design sound levels and reverberation times for building interiors'.

Due consideration shall be given to exterior noise levels to prevent nuisance to the external environment by noise generated by plant.

Air Distribution System - Ductwork

6.16.00 INTRODUCTION

While other materials have been used over the years for ductwork, rectangular galvanised steel has consistently been shown to be more cost effective. This is largely due to the development of automatic sheet metal duct fabrication machines. Rigid circular ductwork is both less efficient in its space requirements and normally more expensive because of the high costs of fittings.

6.16.05 DUCT CONSTRUCTION

Duct Construction is to be in accordance with AS4254. Access for inspection and cleaning shall be provided in accordance with AS3666.

6.16.10 DUCT SIZING

Duct sizing is to be based on the recommended velocity and pressure drop ranges in ASHRAE 2001 Fundamentals.

6.16.15 DUCT DESIGN

Air handling duct systems shall be designed to be accessible for duct cleaning, generally by the provision of access panels.

Access panels shall be fitted at each reheat coil and fire and smoke damper to allow annual Essential Services inspection

6.16.20 Duct acoustic treatment and equipment such as fan coil units, conditioners and VAV boxes incorporating fibrous insulating materials shall not have fibres exposed to the airstream. Perforated facing shall have impervious linings.

Supply air ducting shall be designed and manufactured to prevent possible induction of

contaminated air.

6.16.25 DUCT INSULATION - GENERAL

The issue of whether or not ductwork needs thermal insulation and how thick it should be must be addressed on a job-by-job basis. Although it is a straight forward task to calculate the insulation thickness required, this is rarely done and 'rule of thumb' is applied. With the introduction of alternative materials this can no longer be relied upon and a critical appraisal of the need for insulation is required.

6.16.30 INSULATION THICKNESS

Insulation shall be provided for ductwork to achieve thermal and acoustic performance as follows;

- Air conditioning supply ducts in air conditioned spaces;
- Air conditioning supply ducts in non air conditioned spaces;
- Air conditioning return ducts in air conditioned space;
- Air conditioning return ducts in non air conditioned space; and
- Outside and exhaust ducts, intake plenums, air handling chambers.

6.16.35 GRILLES

Supply air and exhaust air grilles shall be made of non-corrodible material, for example, anodised aluminium section.

Grilles within an occupied space shall be suitable for swab-down cleaning. (Not waterproof).

In mental health patient bedrooms, ceiling-mounted air devices shall be of a secure type.

Air Filtration

6.17.00 FILTERS

The key to selection of filtration equipment is 'appropriate but not excessive'.
Modern dry media filters permit a wide range of media to be fitted to standard frames. Where possible, extended surface filters should be used as they prolong filter life, reduce maintenance costs and reduce energy use. This applies to low efficiency filters as much as to critical applications. This is an area where policy prescription is required as there is a tendency for users to request higher efficiency filters than the application would seem to demand.

Heating, ventilation and air-conditioning systems shall control the concentration of air-borne particulates in high risk areas to minimise the risk of infection by means of air pressure, flow control and air filtration. The level of control shall be proportional with the risk.

Filter frames shall be durable and dimensioned to provide an airtight fit with the enclosing ducting. All joints between filter segments and the enclosing ducting shall be fitted with a gasket or sealed to provide a positive seal against air leakage. A manometer is highly recommended to be installed across each filter.

6.17.05 FILTER EFFICIENCY

Additional roughing or pre-filters disposable dry media flat panels type F5 flat are highly recommended to be considered to reduce maintenance required for filters, when efficiency is higher than F7.

Filtration efficiency ratings are based on average efficiency according to AS 1324 - 'Air filters for use in general ventilation and air-conditioning' and AS 4260 – 'High efficiency particulate air (HEPA) filters – Classification, construction and performance'.

6.17.10 AIR FILTRATION SCHEDULE

AREA SERVED	PRE FILTER	MAIN FILTER	FINAL FILTER
Theatres	G4	F8	HEPA**
Category 1 Areas	G4	F8	-
Category 2 Areas	-	F5	-
Category 3 Areas	-	F5*	-

* AS 1668.2 - 2002 specifies filters for ducted supply air systems > 1500 L/s to be F4 filters to AS 1324.1. However, AS 1324.1 lists filters G1 to G4 then F5 to F9 i.e. no F4.

** HEPA filters are subject to Hot DOP testing to AS 4260.

Evaporative Cooling

6.18.00 INTRODUCTION

Evaporative cooling systems have a place in health care buildings. However, there are serious restrictions which must not be ignored.

Geographic Locations: Evaporative cooling is only suitable for hot, dry climates. Broken Hill is a good example. It is quite inappropriate for coastal areas east of the Great Dividing Range. Evaporative Cooling shall only be used west of the Great Dividing Range

Internal Loads: Evaporative cooling is not suitable for areas with high internal latent loads.

Zoning: Evaporative cooling must be applied only when all spaces have similar load profiles.

Relief: Evaporative cooling relies on moving large quantities of air, typically three to five times as much as for air conditioning. Adequately sized relief openings are required if the evaporative cooling system is to be effective.

Heating: Evaporative cooling systems can also be used for heating, but provision must be made for reducing outside air component if reasonable heating costs are to be achieved.

Access: In order to comply with ASNZS 3666, frequent access is required for maintenance inspection and testing. In the case of evaporative coolers mounted above the ground permanent WorkCover Authority approved access is required.

6 .18.05 EVAPORATIVE COOLING

Evaporative Cooling shall only be used west of the Great Dividing Range.

Plant Heat Rejection

6.19.00 VAPOUR COMPRESSION SYSTEM

The vast majority of air conditioning systems employ vapour compressor cycles. They are compact, relatively cheap to buy and have relatively low energy usage. Where possible the ‘waste’ heat rejection from such systems should be used for other functions. This is available either through reverse cycle package systems or by heat recovery from larger chillers. This heat rejection is normally the cheapest form of heating energy available, even on relatively small equipment.

Vapour compression systems should be of the heat recovery or reverse cycle type when economically justified on life cycle cost.

6.19.05 ABSORPTION SYSTEM

Absorption systems typically require five to seven times as much energy as vapour compression equipment. Even with very cheap sources of energy their cost effectiveness is

marginal. They cannot be expected to have a viable life cycle cost unless the heat energy used is 'waste' from some other essential, year round, process. This is never the case in hospitals although it may well be true in certain industrial applications.

Absorption Systems shall not be used unless as a part of total energy plant incorporating power generation.

Full life cycle with analysis is to be provided to substantiate the proposal

Exhaust System

6.20.00 EXHAUST VENTILATION

Exhaust systems shall be provided only when required by code or for life safety.

Systems intended for specific applications such as dissecting should be purpose designed to capture air as close to the source of contamination as possible.

FUNCTIONAL AREA REQUIREMENTS

Operating Suites (Category 1 Area)

6.21.00 SUPPLY AIR

Supply air to Operating Rooms shall be delivered at high level in a way that minimises turbulence and the recirculation of potentially contaminated room air, and provides the cleanest practical air supply over the operating table area. The directions of air flows within Operating Units shall always be from the Operating Room and Set-up Room, through immediately adjacent inner anterooms, Scrub-Up and Anaesthetic Rooms to the Entrance Foyer, Recovery, Changing and post operative Clean-up Rooms - from clean to less clean areas.

Graduated pressurisation relative to pressure in areas adjacent to the Operating Unit ranging from not less than 10 Pascal positive in the Operating Room/s to slightly positive pressure in areas like Entrance Foyer, Recovery and Change Rooms and slightly negative in Clean-up Room/s can be achieved by using carefully balanced supply air and exhaust air systems.

Airflow into the Operating Unit shall be by means of a distribution system that provides a flow of clean supply air over the operating area first then away. Entry of air shall be from the ceiling to deliver a downward air movement with a minimum velocity 0.2 m/s at the level of the operating table.

The barrier effect caused by air movement and not the actual pressure difference is important. As the pressure differentials are relatively small, the preferred method for setting up the air flow is for the total of return and exhaust air to be in the order of 150 l/s to 200 l/s less than supply air with all doors and openings closed. Different designs of Operating Rooms may require some variance in the bleed air quantity. Active control of the pressure difference is not necessary; however, supply air fans are required to be selected so as to maintain constant air quantity as filter resistance increases. This can be achieved by selecting good fan curve characteristics or controls measuring supply air quantity and controlling fan speed to maintain supply air quantity. Air not exhaust or spilled outward from high risk areas may be recycled as return air.

6.21.05 HUMIDITY

Room relative humidity shall be maintained within the range of 30% to 60% relative humidity (RH), except when flammable agents are used, in which case the requirement of AS 1169 (withdrawn) - 'Minimizing of combustion hazards arising from the medical use of flammable anaesthetic agents' – is to maintain relative humidity above 55%. Where humidifiers are used they shall be of the steam type. Limiting humidity range by cooling coil design is acceptable unless there is a specific surgical requirement to warrant precise control of humidity.

6.21.10 TEMPERATURE

The Operating Room temperature shall be adjustable to suit the requirements of the procedure in progress. The temperature adjustment range is highly recommended to be 16 degrees Celsius to 24 degrees Celsius. The proposed function of the room will determine what degree of adjustment is provided. (It is not intended that the system be able to achieve 16ºC on a design day as this will significantly oversize the plant)

To enable individual temperature, infection and odour control, each Operating Room or pair of Operating Rooms shall be served by a dedicated air-conditioning unit which may also serve that Operating Room's adjacent sterile support rooms.

6.21.15 EXHAUST ARRANGEMENTS

Exhaust registers shall be located so that the whole room is effectively scavenged, particularly at floor level. The consultant shall account for the adverse effect (turbulence) of the air flow pattern near the surgical field created by surgical lamps due to their shape, size location and the heat generated by the lamps. Operating Rooms for special procedures such as orthopaedic surgery, organ transplants or total joint replacement may require the provision of an Ultra Clean Air (UCA) system to suit their intended use.

6.21.20 Extraction of relief air and, if incorporated, return air shall be located at low to mid level. Supply air outlets shall be located directly above the operating table. Exhaust / relief air shall be extracted at least in two opposite corners of the operating room to remove anaesthetic gas leakages from the work area whilst ensuring good airflow through the room. Low level exhaust shall be extracted at 200 mm above floor level.
Low level exhaust and other provisions in accordance with AS 1169 (withdrawn), shall generally be provided where flammable anaesthetics are used. Where full provision is not made in accordance with AS 1169 (withdrawn), Operating Rooms shall have a notice, affixed as required, indication that flammable agents must not be used. Further, nitrous oxide shall not be used where low level exhaust is not provided and the range of surgical procedures undertaken in the Operating Room restricted accordingly

Operating rooms where lasers and diathermy equipment are being used shall have adequate suction / evacuation controls for the plume generated. Additionally, overdoor lights shall be included externally to the room indicating ‘Laser in Operation’

6.21.25 DESIGN REQUIREMENTS FOR UCA SYSTEMS

UCA systems shall provide sufficient filtered air moving in the correct direction to efficiently remove the bacteria dispersed by the operating team. The air flowing from the final filter shall contain not more than 0.5 Colony Forming Units per cubic metre of air (CFU/m3).

6.21.30 AIR FLOW

Down flow system: The air flow at one metre from the supply air outlet shall have a minimum average velocity of 0.35m/s and at working height, not less than 0.3m/s.

Cross flow system: The minimum average velocity shall be 0.4m/s measured one metre from the filter or diffuser face.

The siting of the return air grilles shall not cause short circuiting of the supply air. The control instrumentation shall include the indication of:

- Operating status such as 'in use' or 'not in use'
- Terminal filter pressure differential
- System Purging.

6.21.35 Where procedures such as organ transplants justify special designs, installation shall meet performance needs as determined by applicable Australian Standards. These special designs are highly recommended to be reviewed on a case by case basis.

Procedure, Recovery, Delivery and Dental Rooms (Category 1 Area)

6.22.00 Procedure Rooms in which the administration or aspiration of gaseous anaesthetics or analgesics are carried out, shall have adequate ventilation to ensure that the level of gaseous contamination does not rise above a maximum acceptable level. The utilization of a scavenge system is acceptable

Store rooms containing anaesthetic machines shall be ventilated to remove the build-up of nitrous oxide.

Bronchoscopy and Sputum Induction Units (Category 1 Area)

6.23.00 Supply air to Bronchoscopy and Sputum Induction Rooms shall be delivered at a high level in a way that minimises recirculation of potentially contaminated room air and provides the cleanest practical air supply over the procedure area. The directions of air flows within the Procedure Room shall always be from clean to less clean areas.

Total circulated air quantity shall not be less than 12 ACHR when the supply air filters are at their maximum pressure drop of which a minimum of 20% shall be outdoor air. Procedure Rooms and Recovery Rooms shall be maintained at a negative pressure in relation to adjacent areas.

Rooms or booths used for bronchoscopy, sputum Induction, aerosolized pentamidine treatments and other high risk cough-inducing procedures shall be provided with local exhaust ventilation.

Endoscopy Unit Cleaning Facilities (Category 1 Area)

6.24.00 Fully self-contained endoscope cleaning units shall be used to minimize the problems associated with glutaraldehyde fumes. Local exhaust systems shall be provided as necessary to suit the machine.

Fiberoptic endoscopes storage cupboards shall be mechanically vented with an exhaust system to remove glutaraldehyde residuals**.**

Sterile Supply Services (Category 1 Area)

6.25.00 Sterile Supply Services shall be air-conditioned with a minimum of 10 ACHR.

Air movement and ventilation shall achieve a positive airflow from clean to contaminated work areas. Ventilation rates shall be maintained when the zone is not occupied sufficient to ensure dilution rates are maintained.

Isolation Rooms (Category 1 Area)

6.26.00 INTRODUCTION

The two main classes of isolation rooms are:

- Negative pressure rooms for isolating patients capable of transmitting infection by airborne droplet nuclei (Class N) and
- Positive pressure rooms for isolating immuno-compromised patients, who are susceptible to infection (Class P).

6.26.05 GENERAL

Isolation rooms are to comply with the requirements of AS 1668.2.

The ventilation air flow rate shall be not less than 12 air changes per hour or 145 litres per sec, whichever is greater.

Both the supply and exhaust ventilation systems to isolation rooms shall be either separate independent systems for each room or shall incorporate controls to prevent the possibility of cross contamination in the event of a fan failure.
Provide pressure instrumentation, local alarms and monitor fan status.

Ensure that rooms are well sealed to enable the pressure differentials to be maintained.

6.26.10 INFECTIOUS ISOLATION ROOM (Negative Pressure – Class N)

Infectious isolation rooms shall be mechanically exhausted to atmosphere.

Air flow pattern shall be from the health care worker towards the patient with exhaust at low level.

Exhaust duct to be under negative pressure where it runs through the building.

6.26.15 PROTECTIVE ISOLATION ROOMS (Positive Pressure, Class P)

Consult with the health care facility planners for advice on the level of protection and air filtration required.

Pathology, Autopsy and Body Holding. (Category 1 Area)

6.27.00 Systems serving Pathology Areas shall be independent of other systems.

Exhaust from these areas shall be designed not to create any harmful effect to occupants or contamination or to any adjacent areas.

Supply air and exhaust serving autopsy and dissection areas shall be designed to protect personnel undertaking procedures and be discharged in a manner that will not contaminate any adjacent area or system.

Requirements for facilities that conduct autopsies include:

- Single pass air-conditioning utilising 100% exhaust of all air exhaust intakes arranged to provide maximum fume and odour removal with protection of personnel
- Operating the room at negative pressure in relation to adjacent areas
- If necessary, exhaust air to be filtered and odours removed with carbon filters
- Installation of down-draught or back-draught exhaust
- Exhaust system to suit the requirements of the specialist autopsy table.

Note: The above is for facilities which undertake regular autopsies.

Pharmacy – Additive and Cytotoxic Suites (Category 1 Area)

6.28.00 Laboratory and Dispensing Areas in Pharmacy shall be investigated for the necessity to control air flow and exhaust to avoid any possibility of contamination to any adjacent areas.

Cytotoxic Suites shall be designed and constructed in accordance with AS 2639 ‘Laminar flow cytotoxic drug safety cabinets – Installation and use’. The basic design shall be that of a Class 350 Cleanroom varied in accordance with the requirements of AS 2639.

Laboratories and Clean Rooms

6.29.00 Laboratory Areas and Dispensing Areas in Pharmacy shall be designed to comply with AS/NZS 2982.1 – Laboratory design and construction – General requirements, and AS/NZS 2243.8 – Safety in Laboratories – Fume cupboards.

Physical Containment (PC) laboratories shall be designed and constructed according to the requirements of the Genetic Manipulation Advisory Committee publication 'Guidelines for

Small Scale Genetic Manipulation Work' when any work involving genetic manipulation is undertaken.

Dark Rooms and Film Processing Areas

6.30.00 Air spill shall not occur from the Dark Room to adjacent spaces. Dark Room exhaust shall balance or exceed supply and shall be balanced considering equipment-connected exhaust systems. Note some X-ray processors installed through dark room walls have special pressure requirements.

Daylight processing equipment shall be provided with adequate local exhaust ventilation to prevent the uncontrolled escape of chemical emissions. Fumes or potentially contaminated air shall be exhausted to outside air and not recirculated.

Special ventilation requirements shall be dependent upon the type of film processor (automatic or manual) to be installed in Dark Room, Processing and Viewing Areas. Adequate ventilation is required to contain the uncontrolled spread of fumes from potentially harmful chemicals into occupied spaces.

Through-the-wall processors require local exhaust ventilation to each side of the wall. Most processors also require indirect connection of the drier fan discharge to an exhaust system, in addition to general room exhaust for fumes emitted from stored chemicals and the machine cleaning process. Ventilation shall be provided to film processors in accordance with the manufacturers' recommendations.

If remote chemical mixing, reticulated chemical supply and silver reclaiming is utilised, the chemical mixing tank or silver reclaiming unit shall be contained within a ducted enclosure, connected to an exhaust system as described above.

Local exhaust ventilation shall be provided above sink units used in connection with the regular cleaning of X-ray processor equipment components.

Work areas and enclosures used in connection with the manual processing of x-ray film such as dental clinics, shall be provided with dilution ventilation and temperature controls to prevent the build up of fumes.

Vapour emissions from tundishes into which liquid photographic waste discharges shall be controlled.

Ducts that penetrate construction intended to protect against X-ray, magnetic, Radio Frequency Interference, or other radiation shall not impair the effectiveness of the shielding protection.

Podiatry, Prosthetics, Dental & Orthodontic Workshops

6.31.00 Fresh air, ventilation and air-conditioning systems shall be provided with a minimum supply air quantity of 20 litres per second per square metre of facility floor space.

Extraction shall be localised as close as practicable to the sources of contamination identified above.

Exhausts from this area shall be suitably filtered and discharged in a manner that will not contaminate any adjacent area or system.

Capture velocities at the point of localised extraction shall exceed 2 m/s.

Consideration is highly recommended to be given to acoustics to prevent noise nuisance.

Fume cupboards complying with AS/NZS 2243 - Safety in Laboratories - Fume cupboards, shall be installed in chemical mixing areas.

Linen Processing Areas

6.32.00 Air filtration, mechanical ventilation and air-conditioning systems servicing linen processing areas shall be designed to ensure appropriate lint and dust control.

Mechanical ventilation systems shall be designed to remove the heat generated by laundry drying processes utilising systems such as exhaust registers over the dryers or dryers ducted direct to outside air with lint collection provision on all exhaust discharges.

Provision shall be made for regular maintenance to prevent the excessive build up of lint which can be the source of a fire hazard.

Spot cooling with air-conditioned or evaporative cooled supply air is highly recommended to be considered to provide adequate operator comfort in laundries.

Linen Store Areas

6.33.00 Ventilation shall be provided in accordance with AS 1668.2 - Mechanical ventilation for acceptable indoor-air quality

Soiled linen rooms shall be exhausted through a dedicated exhaust system to reduce the risk of cross infection.

The Clean Linen Store shall be supplied with clean, filtered air. Air pressure shall be positive in respect to the rest of the Laundry.

Mental Health Units

6.34.00 Consideration shall be given to the type of heating and cooling units, ventilation outlets, and equipment installed in patient-occupied areas of Mental Health Units. Special purpose equipment designed for psychiatric or prison use shall be used to minimise opportunities for self harm. The following shall apply:

- All air grilles and diffusers shall be of a type that prohibits the insertion of foreign objects
- All exposed fasteners shall be tamper-resistant
- All convector or HVAC enclosures exposed in the room shall be constructed with rounded corners and shall have closures fastened with tamper-resistant screws
- HVAC equipment shall be of a type that minimises the need for maintenance within the room.

MEDICAL GASES

Introduction

6.35.00 The cost of medical gases within hospitals is proportional to the total number of points provided. The main area for cost reduction is in the number of gas points. Commissioning and sign-off is usually in the presence of senior anaesthetist of the hospital.

Medical Gases Outlets

6.36.00 Medical Gas outlets shall be minimised with requirements established at briefing stage.

Allowance shall be in accordance with the latest Health Facility Guidelines. Any departure from AS 2896 to be justified in terms of a demonstrated clinical service need.

Medical gas provisions to Critical Care Areas as defined in Section 2.0 DP13 shall be as follows for each patient bay:

- Two (2) oxygen
- Three (3) suction (one low, two high)

- One (1) medical air
- One (1) nitrous oxide if appropriate on clinical need.
- One (1) scavenging if appropriate

Suction

6.37.00 Two basic methods of producing suction are available. The first is to use a central vacuum pump and vacuum reticulation supply to all outlets. In this all discharges are centralised and filtered before entering the atmosphere.

The alternative system is venturi powered suction outlets in which compressed medical air is used as the energy source for producing the suction. Each outlet must be provided with a separate vent pipe discharging to atmosphere. Venturi suction outlets require frequent maintenance and use an expensive energy source (medical air).

In addition to the cost savings, the central vacuum system is more desirable from an infection control perspective as all discharges are filtered.

Suction shall be from central vacuum system. Comply with AS 2896.

Medical Air

6.38.00 With critical appraisal, many medical air outlets could be eliminated. The change from venturi suction and rationalisation of the number of points would see drastic reductions in the size and cost of central medical air plant.
Reticulation to patient care areas should be reduced to a minimum and only installed where a clinical service need can be demonstrated.

If medical air is to be produced on site the installation must comply with AS 2896.

Medical air supplied for life support systems must be maintained for medical use only.

Tool Gas

6.39.00

Comply with A.S 2896

Although high-pressure medical tool gas can be derived from compressors, the relatively low usage does not justify the high maintenance costs of these compressors. Bottled gas, located close to the theatres, offers the most economic and simple solution.

Refer to M15.5.2 Tool Gas

Tool gas shall be from bottled manifold located near the supply need.

Nitrous Oxide

6.40.00

Comply with A.S 2896

Savings in the provision of this gas largely relate to reduction in the number of outlets and reduction in reticulation costs by locating the manifolds close to the areas of use. It is not unusual to see hospitals where nitrous oxide manifolds are located adjacent to the oxygen store, when the main demand is in Maternity which is located at the opposite extreme of the hospital.

Nitrous Oxide, if required, shall be reticulated from a manifold located adjacent to the point of use.

When nitrous oxide is being used to provide sedation, an appropriate method for scavenging of expired gases shall be provided by connection of appropriate scavenging adaptors to the suction system. It is highly recommended that the risk of chronic exposure to nitrous oxide be

considered.

Reticulation

6.41.00 It is highly recommended that each medical gas outlet emanates from a central storage or generation point and is reticulated to outlets throughout the hospital.

Medical oxygen, compressed air and nitrous oxide multi-bottle storage manifolds shall be arranged in a 'Duty' and 'Reserve' configuration incorporating automatic change-over facility. It is highly recommended that:

- Each manifold include sufficient bottle storage to meet two days demand with additional bottles held in storage to meet three days or holiday period demand and
- All medical gas bottle manifolds are sited adjacent to each other in a location which facilitates ease of access for bottle delivery and pick-up.

The medical gases installation shall incorporate appropriate low and high pressure audible and visual alarms for each medical gas system and vacuum system respectively. The alarm system shall also be hard wired from the essential power supply if available, with status indication panels sited strategically throughout the hospital on a master and slave arrangement. The master panel shall be in a permanently manned location such as the Emergency Unit with slave panels sited in critical areas such as Operating Unit and Intensive Care Unit. Alternatively, an independent alarm panel can be provided for Operating Unit and Intensive Care Unit. These panels would sense pressures in gas pipelines serving each respective area by means of pressure switches located downstream of isolation valves.

Readily accessible isolation valves shall be provided in each main gas branch pipe to special areas such as Operating Unit and Intensive Care Unit. Valves shall be located in a wall-mounted dedicated valve box incorporating a clear Perspex cover and suitably labelled.

Patient rooms shall have oxygen and suction from a fully reticulated system. The minimum provision shall be an oxygen and suction point provided to each single bedroom and shared oxygen and suction points between two beds within multiple bedrooms.

An active aspirated gas scavenging system shall be provided where anaesthetic gases are administered. This requirement does not apply to areas where analgesic gases are administered and adequate ventilation is provided.

Vacuum (suction) systems utilising central vacuum is highly recommended to be reticulated to each point, except for suction scavenging points which will scavenge flammable anaesthetic gases or a high content of oxygen. These are highly recommended to utilise Venturi-suction with discharges as per requirements for suction pump discharges in AS 2896 - Medical gas systems - Installation and testing of non-flammable medical gas pipeline systems.

Venturi type suction systems shall not be used in rooms where infection control is required.

Ancillary Mechanical Service

6.42.00 Ancillary Mechanical Services could include the following additional services:

- Dental surgeries
- Sterilizers
- Steam generation systems
- Mortuary equipment
- Pneumatic transport systems
- Compressed air systems for industrial use
- Refrigeration plant (e.g. cool rooms)

Dental System

6.43.00 Dental compressed air shall be designed in accordance with AS 2866 (withdrawn). Dental suction shall be designed in accordance with AS 2686 (withdrawn).