



University of Wollongong

Mechanical Services Design Standards
Version 5 – 6 June 2013

VERSION CONTROL SYSTEM

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6. MECHANICAL SERVICES

The mechanical services comprise heating, ventilation and air conditioning (HVAC) systems and equipment including laboratory mechanical services, piped gases and process cooling. The mechanical services provide ventilation, heating and cooling to maintain space conditions and support services within the facilities.

The mechanical services will generally be designed and specified as:

- a. Space Cooling System
- b. Process Cooling System
- c. Heating System
- d. Ventilation System
- e. Compressed Air Systems
- f. Laboratory Services

HVAC services shall generally be monitored and controlled by the Building Monitoring and Control System. The BMCS currently used by UOW are the Siemens Apogee Insight System and Johnson Control System. (Refer to Building Monitoring and Control Design Standard).

The design of HVAC systems shall be energy efficient. The designer shall ensure business risk and OHS requirements are considered.

6.1 OVERVIEW

This design standard outlines the functional, installation and technical requirements for mechanical services at UOW.

The designer shall use these standards as the basis for the system design. However, it is incumbent upon the designer to ensure that the type and architecture of the mechanical services are suitable for the operational profile of the facility, are energy efficient and are capable of supplying space conditions and services within acceptable performance limits.

Where the design engineer considers that an alternate design philosophy is more appropriate than that specified in the design standard, the designer will advise the UOW Project Officer of the functional, performance or cost benefit that will be achieved through the implementation of the alternate design philosophy.

In determining the most appropriate systems architecture and equipment types for a particular installation, the designer shall consider the long term energy efficiency, maintenance implications, operational efficiency and life cycle costs as well as the initial capital costs.

6.2 DESIGN PROCESS

This section provides an overview of the design process. The process shall be followed to achieve UOW's desired outcomes.

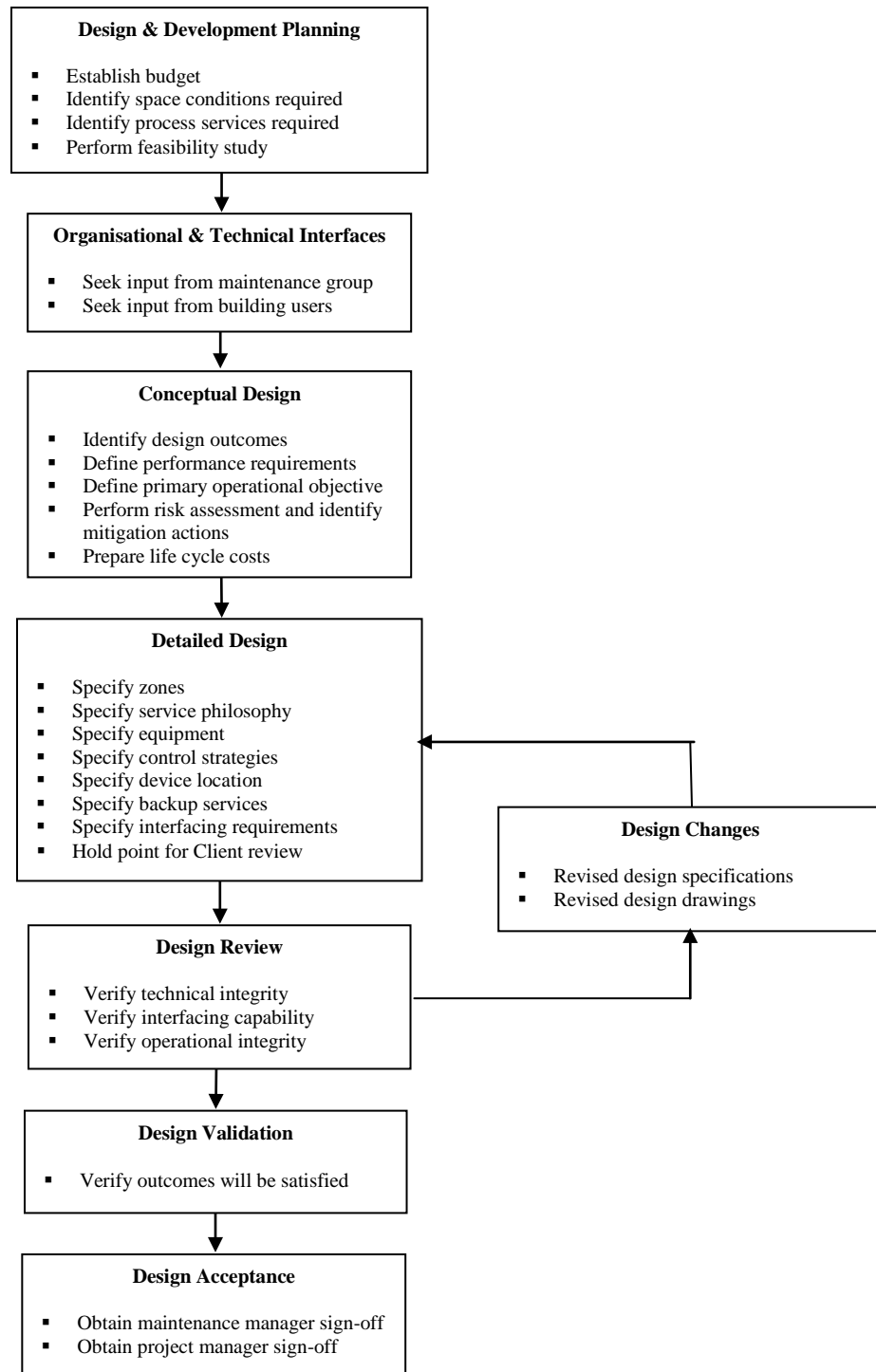


Figure 6.1 - Process Flow

6.3 FUNCTIONAL REQUIREMENTS

6.3.1 General

All areas shall be ventilated to meet BCA Requirements.

The requirement for HVAC services shall be assessed on the basis of compliance with relevant building codes and standards and the requirement for stable and comfortable space conditions. It is important that the provision of HVAC services be undertaken in a consistent manner across each campus. See performance standard at [6.5](#).

As a general guide, HVAC services shall be provided in the following areas:

- a. Research laboratories and specific areas nominated in a design brief, where a feasibility study has been performed and installation authorised by UOW Senior Executive;
- b. Offices occupied by the Chancellor, Vice-Chancellor and other senior nominated executive staff;
- c. Dedicated lecture theatres and computer laboratories.

The mechanical services design shall ensure the following:

- a. Appropriate space conditions for the operational usage of the facility;
- b. Energy efficiency;
- c. Efficient maintenance;
- d. Low life cycle costs;
- e. Retrofits and refurbishments are fully compatible with building.

The type and size of the equipment shall be designed to meet diversified demands. Redundancy shall only be specified where a risk analysis can support the additional needs and costs. Major plant items e.g. chillers, shall be selected in modular fashion to provide breakdown and servicing redundancy.

6.3.2 Cooling

The designer shall prepare heat load calculations and model the operational profile of the facility as the basis for the cooling system design and equipment selection.

Where the plant is to supply a facility that will be used continuously during business hours or continuously for periods of eight hours or more or where the plant is to supply a group of buildings, central cooling plant is a preferred option.

In all cases where central plant is specified, capacity for future expansion must be considered. This may involve allowing additional space in plant rooms for the installation of future plant and the capability to integrate the new plant and equipment with the original chilled water systems and control devices.

For all new installations and major refurbishment or plant replacement projects, the designer must undertake a life cycle analysis to determine the most appropriate option.

6.3.2.1 Central Chiller Plant

Chiller plant must be operationally efficient at both peak diversified and low loads. The designer shall prepare an assessment of low load conditions and submit to the UOW Project Officer for review. Refrigerant used shall be environmentally friendly.

The chilled water system shall be either a 'Primary or secondary' system as determined by operational requirements and environmental efficiencies.

The piping system shall generally be insulated copper pipes with copper runouts.

Waste heat recovery for Hot Water reticulation shall be considered as part of the design process.

Piping in plant rooms (where exposed to mechanical damage) or exposed shall be insulated and encased within steel or aluminium cladding (stainless steel if external).

6.3.2.2 Condenser Water System

A central condenser water system comprising cooling towers and pumps shall serve water cooled central refrigeration plant and the supplementary condenser water system where applicable.

Where appropriate, a supplementary condenser water system shall connect to the cooling tower via heat exchangers and pumps. Supply shall be reticulated to the floors via a single pipework riser distribution system, and terminated with isolating valves on each floor.

The use of potable water for cooling tower requirements will be minimised wherever possible.

Cathodic protection of water cooled condenser vessels is required for all new installations. For condenser vessels over 500kW refrigeration capacity impressed current cathodic protection shall be required. For vessels less than 500kW sacrificial magnesium is satisfactory.

6.3.3 Heating

Heating shall be provided by natural gas-fired boilers with heating water reticulated to heating coils at air handlers and VAVs.

The use of electric heating shall be minimised. Electric heating may be considered for VAV zone re-heating where Life Cycle Costing illustrates it is appropriate.

The control strategies shall minimise conflicting heating and cooling demands and where practical, avoid reheat systems that waste energy through simultaneous cooling and heating.

6.3.4 Ventilation and Air Distribution

The ventilation systems shall be designed to complement the cooling and heating systems and deliver space conditions efficiently.

The planning of ventilation and air distribution zones shall be based on the operational activities performed in the areas and likelihood of changes in occupancy and heat loadings.

The use of outside air must meet BCA requirements and be energy efficient. CO₂ monitoring is to be used to improve energy efficiencies by controlling outside air quantities in theatres and wherever practical.

Air distribution to be designed to provide even, draught free air movement and to be readily amenable to modification to suit partitioning alterations. Air movement shall be between 0.1 and 0.25 m/s in occupied spaces measured 1.0 to 1.5m above floor level.

6.3.4.1 Air Handling Plant

The analysis of the operational profile of the building will determine whether a constant or variable volume air handling system is appropriate.

Thermo type supply grilles will only be considered when shown to be economical via life cycle analysis.

The plant shall be configured to operate on normal and economy cycles. In addition the use of night-purge shall be considered to minimise overall system energy consumption and improve space conditions.

Air distribution shall generally be via low-pressure sheet metal ductwork. Zoning, ductwork and controls shall be configured to allow future feasibility (e.g. office layout changes/additions) and to provide easy access for cleaning and maintenance in order to maintain indoor environment quality.

6.3.4.2 Exhaust Systems

Mechanical ventilation shall be provided for all toilets, cleaner rooms, showers, change rooms, stores, dark rooms, battery rooms, laboratories and other spaces as required by the relevant standard.

Where mechanical ventilation is required for new car parks, the carpark exhaust shall consider carbon monoxide monitoring to minimise fan energy during periods of low use by controlling variable speed fans.

Exhaust systems shall discharge vertically above the roof with adequate separation from fresh air intakes. Where practical separation of intakes and discharges shall be maximised and shall exceed minimum requirements as set out in AS 1668.2.

6.3.5 Control Strategies

Refer to Design Standards BMCS (Building Monitoring & Control Systems).

6.3.5.1 Zone Temperature Selection

In normal operation the air handling units shall be controlled by master sensors located in the respective zones.

All zone temperature sensors connected to the system shall be available for use as masters and the choice of masters shall be easily selectable by either the operator or automatically by the system. A master sensor shall be initialised for each zone.

The system shall be programmed to dynamically select the highest/lowest or average temperature sensor as the master. The system will allow for any specific sensor to be ignored as the master if readings are inconsistent or significantly dissimilar to the average temperature.

6.3.5.2 Digitally Controlled Air Volume

The mode of operation of digitally controlled air volume shall be set according to the mode of operation of the air-handling unit.

Space temperature selection for control of air handling unit operation shall be made from zone temperature sensors in the areas occupied after-hours.

Digitally controlled zone dampers shall vary the flow rate of conditioned air as required to maintain space temperature.

6.3.5.3 Air Handling Units - Temperature Control

The BMCS provides outside air cycles when the conditions are suitable. This mode is designated as "Economy Cycle" (EC).

The BMCS includes the provision of outside air temperature and humidity sensors to provide inputs to a calculation program to determine the outside air enthalpy.

The EC shall be enabled if outside air temperature/enthalpy is less than the programmed set point and the highest zone temperature is above the programmed set temperature.

The EC shall be disabled if outside air temperature/enthalpy is above programmed set point or the highest zone temperature is below the programmed set temperature.

To avoid possible oscillation of the EC cycle, the routine shall include an adjustable timer or differential, to ensure that the condition is stable and not transient prior to implementation of the cycle.

The operation of the unit's chiller shall be enabled or disabled according to programmed values of the highest master zone temperature or where another zone is considered more appropriate.

The unit's call for cooling shall be turned on and off according to the reading from its thermostat sensor.

6.3.5.4 After-Hours Operation

After-hours operation shall be initiated manually by local push-button (extension time BMCS adjustable and local indication light).

6.3.5.5 Ventilation and Exhaust Fans

Ventilation fans shall be started and stopped by the BMCS in accordance with independent time schedules or interlocked with other systems as appropriate.

6.3.5.6 Air Filter Operation

The BMCS shall monitor the status of air filters via air filter differential pressure devices (generally for all air filters over 250 L/S).

6.3.5.7 Fire Mode Operations

Air conditioning and ventilation system operation in fire mode will be documented in the operations and maintenance manual.

6.3.6 Fume Cupboards

Where fume cupboards are required the design engineer shall, in conjunction with the UOW Project Engineer and users, determine the type, proposed uses and operational profile.

The University wishes to standardise the construction, controls and regular maintenance and certification of fume cupboards. Preferred manufacturers of fume cupboards are:

Conditionaire or Dynaflow

Non-standard equipment, types or alternative manufacturers can be considered subject to life cycle costings and risk assessment on parts supply, software back-up, experience in industry, size of company, and demonstrated ability in servicing and maintenance agreements of third party fume cupboards. UOW approval will be required for any alternatives.

Fume cupboards and associated exhaust systems shall comply with AS 2430. Following installation fume cupboards shall be provided with NATA certification in accordance with AS 2243.8. This shall form part of the fume cupboard commissioning.

Design considerations to be taken into account in the specification of fume cupboards and the associated support system, include:

- i. Material selections, including appropriate tray material for chemical resistance.
- ii. Safety performance in relation to ignitability, spread of flame, heat involved and smoke developed in the event of a fire.
- iii. Appropriate width (1,800mm, 1,500mm, etc.)
- iv. Provisions including water, sinks, piped gases, power and access ports.
- v. Make-up air: Determine with UOW Project Officer and users appropriate make-up air diversity where multiple fume cupboards are within single enclosures.

6.3.7 Fire Mode Operation

Where required, HVAC systems that are required to operate in Fire or Smoke Control Mode shall do so independently of the BMCS in accordance with the relevant installation standards.

For HVAC plant which is shut down in building fire alarm conditions, the plant shall auto reset (unless the specific building operational requirements dictate a manual reset). The BMCS shall monitor the status of fire alarm trips and operation only.

6.3.8 Process Cooling

Where process cooling is required in nominated laboratories or research areas, the design engineer, in conjunction with the UOW Project Engineer and users, will determine the specific requirements and operational details.

The design engineer shall consider and verify the following:

- i. Process cooling loops shall be designed in a reverse return configuration to minimise pressure variations and the need for commissioning.
- ii. Most scientific equipment that requires process cooling requires stable and low pressure flows, oversized pipework, buffer vessels and designs which minimise static head should be considered (e.g. pumps at low point, open circuit buffer vessels).
- iii. Process cooling circuits will be sized with significant diversity – agreed with UOW Project Engineer.
- iv. Process cooling circuit water quality is an important factor, design system components (pipework, pumps, vessels, etc.) to operate with tap water (without added water treatment).

6.3.9 Piped Gases

Where piped gases are required in nominated laboratories or research areas, the design engineer, in conjunction with the UOW Project Engineer and users, will determine the specific requirements and operational details.

The design engineer shall consider and verify the following:

- i. Types of gases?
- ii. Volume of gas usage – is bottle, dewar or bulk storage required?
- iii. Future flexibility/distribution within building?
- iv. Impact of dangerous gases – leakage for distribution system into the building (rooms, return air paths, etc). Are gas detector/warning/shut—off systems required?
- v. Outlet gas quality.

6.3.10 Telecommunication Space Cooling

For all telecommunication spaces reference should be made to the current 'University of Wollongong – Specification for Voice and Data' requirements details on cooling loads and standards.

Cooling plant, where required, for telecommunication spaces shall generally be independent from Central Cooling Plant due to the 24/7 nature of the load. In some instances, e.g. Lab Buildings which also have 24/7 loads, the central cooling plant may be utilised.

6.4 STANDARDS

The mechanical design must comply with the BCA, relevant and latest versions of AS, codes and Federal and NSW Government environmental initiatives.

UOW OHS064 OH&S Consideration for Design.

6.5 MINIMUM PERFORMANCE STANDARDS

6.5.1 External Design Data

For all general areas (offices, teaching spaces, lecture theatres and laboratories) the outdoor design condition shall be:

Summer: 29.6°C db/23°C wb
Winter: 7.8°C db

For critical areas (such as IT server rooms) the outdoor design condition shall be:

Summer: 35°C db/28°C wb
Winter: 4.0°C db

Note: **All** critical areas must be agreed with the UOW Project Engineer.

For selection of air cooled and evaporated heat rejection plant the outdoor condition shall be:

Summer: 32°C db/23°C wb

6.5.2 Internal Design Requirements

The UOW philosophy is to provide winter and summer comfort conditions in all general air conditioned areas. The UOW changes operational set points between winter/summer to minimise yearly energy consumption.

General area set points are:

Summer: 24°C db/60% RU
Winter: 21°C db

Control balance/band of $\pm 1^\circ\text{C}$.

Relative humidity is a non-controlled design condition.

The design criteria are therefore:

Summer: 24°C db/60% RU
Winter: 21°C db

Specialist areas such as server rooms, laboratories and the like may require more rigid design conditions – these shall be agreed on a project basis with the UOW Project Engineer.

6.5.3 Internal Heat Gains

The design engineer shall determine internal heat gains on project requirements, generally:

People: Determined from furniture/seating layouts and 70w sensible/60w latent per person.

Lighting: Actual lighting load.

Equipment: Determined from space usage, generally:

| | |
|------------------------|-----------|
| Office | 15w/sqm |
| Lecture | 15w/sqm |
| Computer Lab | 250 w/sqm |
| Teaching | 15 w/sqm |
| Breakout/Meeting Rooms | 500w |

6.5.4 Miscellaneous Design Requirements

6.5.4.1 Central Plant Diversity

In addition to building thermal/solar diversity, central plant will be sized with operational diversity, generally:

| | |
|----------------|-----|
| Office Space | 80% |
| Teaching Space | 70% |

To be confirmed with UOW Project Officer.

6.5.4.2 Outside Air

7.5 l/s/person minimum.

6.5.4.3 Infiltration

System designed for positive pressure to minimise infiltration.

6.5.4.4 Air Filtration

Filters will meet the following performance to AS1324.2 at installed face velocity to a final resistance of 125Pa

No. 1 Dust Test – 20% minimum efficiency

No. 4 Dust Test – 85% minimum efficiency.

6.5.4.5 Vibration (from Mechanical Equipment)

AS 2625.

6.5.4.6 Air Condition Zoning

Generally air condition zoning shall be sized as:

Office Spaces Max 100m²
Teaching Spaces individual

Agree with UOW Project Officer.

6.5.4.7 Acoustic

AS 2107 recommended levels (all building services operating).

6.6 INSTALLATION GUIDELINES

6.6.1 Plant & Equipment

Plant location shall be determined by the proximity to areas being serviced, available space and provisions for access for maintenance over the life of the equipment. It is important that maintenance and servicing can be performed during normal working hours without disrupting UOW normal building operations.

Central plant shall be installed in plant rooms and distributed plant shall be installed in low traffic areas and non student areas that offer suitable mechanical protection.

Where equipment must be installed above ceilings, access and noise must be considered to ensure that the minimum performance standards will be maintained. Where plant is located in ceiling space then consideration shall be given to installing associated filters on return grilles and at fresh air intakes to simplify service requirements. All filters shall be readily accessible and removable for cleaning.

Plant is not to be installed in locations that will impact on the visual ascetics of the University. Approval for plant location must be obtained from the UOW Project Officer.

Plant mounted on roofs shall be positioned on a HVAC support system (e.g. big foot system).

6.6.2 Piping

Pipe installation shall ensure that all piping is secure and mechanically protected.

Pipe systems shall be arranged with bends and offsets so the system has sufficient flexibility to absorb thermal expansion and vibration of connected equipment without causing excessive stresses in the piping or connected equipment as required by AS 4041.

Expansion loops and/or bends shall be used in preference to flexible bellows or other types of flexible pipe fittings. Minimise the number of joints by using the longest practical lengths of pipe.

Pipework shall be installed to allow maximum space for installation, service and removal of other equipment. Obstructions, access openings, doors, manholes and the like shall be avoided. Connections shall be arranged to equipment to allow removal of the equipment. Valves shall be installed in logical groups where hand wheel and spindle clearance is available and access for operation and maintenance is convenient.

Measures shall be adopted to prevent entry of foreign material into pipe systems. Plastic or metal end caps shall be fitted to pipes prior to shipment from the manufacturer.

Piping on external walls shall be enclosed in ducting that does not impact on the building architecture and be approved by the UOW Project Officer.

To avoid water ingress with any installation of piping or electrical work through roofs, it is necessary that:

- All piping/electrical wiring must have a water loop and covering before entering roof.
- All piping with insulation needs to have insulation separated when entering roof.
- Roofing solutions, such as Top Hat Roof Penetration Systems, or equivalent, should be used where practical.

6.6.3 Fire Mode Operation

Air conditioning/ventilation system operation in fire mode will be documented in the operation and maintenance manual.

6.6.4 Split System

Split system will be installed so that they do not impact on the visual aesthetics of the University. Approval for location needs to be gained from UOW Project Officer.

6.6.5 Valves

Valves shall be installed for the safe and proper operation of the system. Valves shall be line sized unless noted otherwise. Valves shall be screwed or flanged to adjoining pipework as specified for the piping in the particular system. Valves shall be installed to allow maximum space for service and removal of valves and actuators.

6.6.5 Mechanical Services Switchboards

Mechanical Services Switchboards shall be:

- Constructed in accordance with AS 3439.1.
- Form is generally Form 2, major plant switchboards to consider Form 3B (e.g. chillers, pumps, etc. in central plant rooms).
- Protection IP52.
- All sections accessible by hinged doors.
- Minimum 25% space capacity in each section.
- Labelling shall be machine-engraved (10mm) or plastic laminate screw fixed.
- Metering (smart metering to UOW Standards).
- Off-Auto-On control switches and indicator light for all plant, facia mounted. Consider LED lights. Include lamp test facility.
- Include indicator lights for fire normal/trip conditions.
- Painted orange.

6.7 EQUIPMENT

The following equipment list contains the makes of preferred mechanical services equipment:

6.7.1 Package Units

Mitsubishi, APAC, Temperzone.

6.7.2 Split Systems

Daikin, Mitsubishi.

6.7.3 Chillers

Powerpax.

6.7.4 Cooling Tower

AquaCool or Baltimore Air Coil (BAC).

6.7.5 Hot Water heaters

Raypac.

6.7.6 Air Handling Units

Trane, Carrier, Air Design, York.

6.7.7 Fan Coil Units

Air Design, Carrier, Trane, York.

6.7.8 VAV Units

| Equipment | Type | Make | Model |
|-----------|-------------|-------|-------|
| VAV | Single Duct | Trane | DD15 |
| VAV | Single Duct | Trane | DD17 |
| VAV | Dual Duct | Trane | DD00 |
| VAV | Dual Duct | Trane | DD11 |
| VAV | Dual Duct | Trane | DD12 |

Table 6.2 – VAV Unit

6.7.9 Exhaust Fans

Fantech.

6.7.10 Control Equipment

Johnson Controls, Seimens.

6.8 WARRANTY

The designer shall ensure that all components are supplied with a minimum warranty period of 12 months for parts, installation and labour.

6.9 LIFE CYCLE COSTING

The designer shall prepare life cycle costing analysis as part of the conceptual design process. Due to the high cost of mechanical services and the significant difference in capital investment between centralised plant and distributed plant it is important that a full life cycle cost analysis be undertaken.

The period of financial interest should generally be twenty five years.

During this period, most distributed plant will need to be replaced and the life cycle analysis should not only take into consideration replacement costs but also additional considerations for architectural and civil building elements that may need to be disrupted for the replacement to occur.

These costs will include but are not limited to:

- Initial cost of system equipment
- System replacement costs
- Installation costs
- Maintenance costs
- Utility operation costs

Where the provision of HVAC systems can be cost justified through operational, maintenance or energy savings, the designer shall prepare a cost feasibility report containing the capital costs, life cycle costs, cost benefits, payback period and internal rate of return. The cost benefit will be supported by engineering calculations that are based on the specific equipment ratings, predicted load factors and operational times.

The University Project Officer will confirm requirements of the life cycle cost analysis.