HHAngus

“There is no magic in doing a good job. It just takes knowledge, determination, good staff, and interesting clients.”

Don L. Angus, P.Eng., H.H. Angus
Past President

2011 Canadian Consulting Engineering Awards

Royal Jubilee Hospital Patient Care Centre

May 2, 2011

HHAngus

Contents

HHAngus

Project Overview

The largest LEED Gold hospital in Canada, the Royal Jubilee Patient Care Centre (PCC) is a Public Private Partnership (P3) project between the Vancouver Island Health Authority (VIHA) and the ISL Health Consortium. H.H.Angus was a critical part of the Consortium, providing the mechanical, electrical, vertical transportation, and specialty lighting for the project. It was constructed on the Royal Jubilee Campus, one of two main healthcare facilities servicing Vancouver Island, to meet the growing demands of state-of-the-art healthcare.

As a P3, this project's complexity increases significantly. Not only does the design of all systems have to reach the requirements and objectives of the client, but these designs have to be flexible and be ready for changes in the next 30 years. Design considerations need to include the operations and maintenance. The 'best' design to leave a legacy for the hospital is not necessarily the most practical design for the maintainability in the next 3 decades.

The project included three main components. The first and second being the construction of a new 8-storey building providing 500 inpatient beds and to relocate critical programs to a newer and more technically-advanced facility, which in turn created a need for the third, which was to upgrade the boiler/chiller plant systems to meet the needs of the new building.

The Vancouver Island Health Authority had many objectives for the Patient Care Centre leading to an innovative design both in the technical and social aspects. The plan for the PCC is to be forward-looking - a facility that can accommodate current and future needs for patients and staff. This has to be done by being flexible and enhancing the quality of care provided to the patients, especially the to the elderly, and by improving the working environment and processes for staff. Another critical objective is to support and encourage staff recruitment and retention.

While it is important that the new building is to be patient- and staff-focused, it is also equally important that it is to be sustainable and flexible, and to be environmentally-friendly. The above combination maximizes efficiency and minimizes costs.

The design of the mechanical and electrical systems in the Patient Care Centre represents a key priority of the ISL consortium's "health led" approach. It demonstrates the commitment to providing VIHA with a new facility that encompasses an outstanding health environment, is patient- and staff- focused and embodies the highest technical and energy efficiency standards. It is a significant factor in achieving the three goals that VIHA has identified as being central to the success of the new facility.

Elder-friendly design

The patient friendly non-glare lighting solution provides a healing atmosphere. Ease of access to lighting control and nurse call assistance from the patient bed, enabling a sense of control of one's own environment for the patient. Lighting fixtures specified minimizes the collection of dust and is easily cleaned thus contributing to infection prevention and control, and a reduction in hospital-acquired infections

Where applicable, equipment and devices that can easily be cleaned, such as nurse call cords, will be selected to assist in infection prevention, contributing to a reduction in hospital acquired infections.

Systems provided such as CCTV and Patient Wandering increases patient safety and security, systems provided in patient bedrooms such as Entertainment TV, and Nurse Call for ease of access to assistance makes the patient stay more comfortable.

The ventilation system includes operable windows to allow for natural ventilation in patient rooms. Mechanical equipment and systems are designed to minimize sound and vibration, transmission between spaces, contributing to improved sleep and helping to reduce noise-related stress in patients. They are also designed according to infection prevention and control guidelines, contributing to a reduction in hospital-acquired infections. Barrier-free fixtures deliver a high degree of accessibility.

Magnet hospital

Mechanical systems provide consistent environmental conditions and high quality indoor air, contributing to a comfortable indoor environment for staff. Incorporation of sound attenuation and vibration isolation measures lead to low sound levels in the building, creating a pleasant and productive workplace. Fixtures are procured specifically for their ease of use and ease to clean.

Lighting provides a non-glare working environment with illumination levels sufficient for the task, contributing to a comfortable working environment for staff. Devices and fixtures are easy to use and easy to clean, designed with the users in mind.

The structured cabling system and network enables the use of a variety of communication devices; these devices enhances the staff work environment, enabling them to provide a higher level of direct patient care. Systems provided such as CCTV and Staff Duress increase staff safety and well being.

Pacific Green (Sustainable)

Mechanical systems are there to provide a healthy building that benefits patients and staff, conserve energy, and have a positive environmental impact. Most notably, 100% fresh air ventilation is a main focus of the design to deliver high quality indoor air and to remove contaminants. Through the lifecycle plan, equipment was procured to be durable to maximise lifecycle and minimize the waste of resources. Energy-efficient systems were designed to reduce total energy consumption of the building. With that design, low-flow plumbing fixtures were used reduce water use.

Energy-efficient lighting systems are installed to reduce total energy consumption of the building. Some innovative solutions such as toggle switches are implemented in specific areas for specialized uses to reduce energy-use, while still maintaining the integrity and codes of the design. Site lighting and perimeter lighting design eliminates light trespass from the site and improve night sky access. Metering systems provide energy consumption history to ensure energy targets are met.

In keeping with the site lighting design initiatives to reduce light pollution, CCTV camera equipment selected provide quality images at the reduced available light levels, thus maintaining the security of the site while eliminating light trespass from the site and improving night sky access.

The largest LEED Gold hospital in Canada, the Royal Jubilee Patient Care Centre (PCC) is a Public Private Partnership (P3) project between the Vancouver Island Health Authority (VIHA) and the ISL Health Consortium. H.H.Angus was a critical part of the Consortium, providing the mechanical, electrical, vertical transportation, and specialty lighting for the project. It was constructed on the Royal Jubilee Campus, one of two main healthcare facilities servicing Vancouver Island, to meet the growing demands of state-of-the-art healthcare.

The project included three main components. The first and second being the construction of a new building providing 500 inpatient beds and to relocate critical programs to a newer and more technically-advanced facility, which in turn created a need for the third, which were to upgrade the boiler and chiller plant systems to meet the needs of the new building.

The Vancouver Island Health Authority had many objectives for the Patient Care Centre leading to an innovative design both in the technical and social aspects. The plan for the PCC is to be forward-looking - a facility that can accommodate current and future needs for patients and staff. This has to be done by being flexible and enhancing the quality of care provided to the patients, especially the to the elderly, and by improving the working environment and processes for staff. Another critical objective is to support and encourage staff recruitment and retention.

While it is important that the new building is to be patient- and staff-focused, it is also equally important that it is to be sustainable and flexible, and to be environmentally-friendly. The above combination maximizes efficiency and minimizes costs.

Vancouver Island Health Authority's Goals

The design of the mechanical and electrical systems in the Patient Care Centre represents a key priority of the ISL consortium's "health led" approach. It demonstrates the commitment to providing VIHA with a new facility that encompasses an outstanding health environment, is patient- and staff- focused and embodies the highest technical and energy efficiency standards. It is a significant factor in achieving the three goals that VIHA has identified as being central to the success of the new facility.

- Elder-friendly
- Magnet Hospital
- Pacific Green (Sustainable)

Mechanical Systems

The objective in the planning and design of the new Facility is to provide systems and equipment that will support the Patient Care Centre well into the 21st century, including improved infection control, ease of access for maintenance, convenience, efficiency of operations and energy efficiency.

Our design reflected high standards for all aspects of the facility, particularly those that have a direct impact on patient care such as air change rates, energy consumption and interior environmental conditions. Systems and equipment are designed to be reliable, efficient, safe and easily maintainable. Major pieces of equipment, are located indoors, and positioned to allow for regular servicing without the use of temporary apparatus.

Each mechanical system is designed to achieve the necessary clinical functionality in terms of services, infection control and internal environmental conditions, with appropriate resilience and redundancy.

Continuous involvement and input by Health Care Project Ltd (HCP - part of the ISL Health Consortium)'s Facilities Management Lead and the facilities management service providers has been a key input into the design of the systems and selection of the equipment. The comprehensive life cycle management and maintenance program has been considered right from the initial concepts so that whole life costs and plant/systems replacement are properly considered. Their role followed through construction and commissioning leading into occupancy to ensure maximum efficiency in the operations and maintenance of the facility.

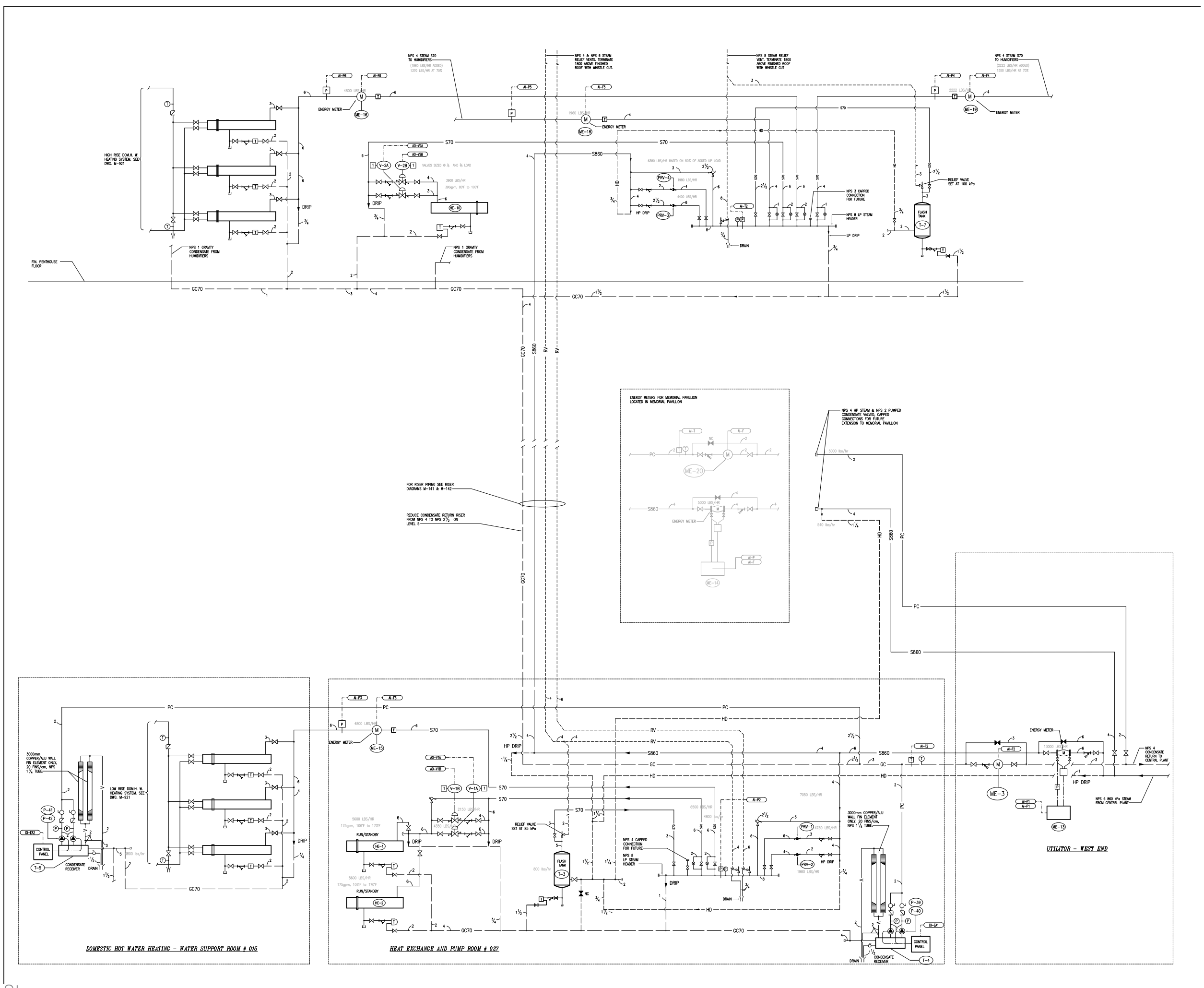
Main Energy Sources

A detailed analysis of options was conducted to evaluate the best solution with regards to the Central Plant for the PCC. The following factors were considered:

- Maximizing the potential value of the energy sources (exergy)
- Capital costs
- Operating and maintenance costs
- Reliability and redundancy
- Lifecycle requirements of the plant including equipment replacement
- Configuration of the RJH site and buildings
- Impact on planning and future expansion.

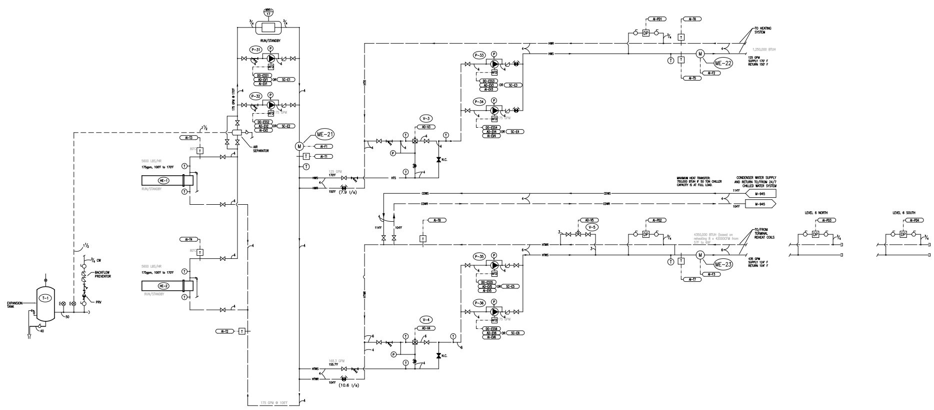
The main energy source for the PCC building is electricity, and steam directly and indirectly via steam from the existing Energy Centre. Steam to Water Heat Exchangers (HEX) are used to generate hot water for heating, while electrically powered air handling units for cooling and ventilation are utilized. Steam from the Central Plant is used to provide humidification and heating to the building.

Hot water is generated using steam to water HEX for building heating and semi instantaneous heaters for potable water. Chilled water is supplied by the Central Plant, which uses high efficiency centrifugal chillers. Heat removed form the IT based cooling loads is used to supplement the heating system. These efficiencies reduce the new Patient Care Centre's energy costs and are used towards achievement of LEED® Gold certification.



Steam

Cooling & Heating



Heating

Cooling of the occupied spaces in the facility is provided through the air supply system. Chilled water cooling coils in the air handling units will operate when the outdoor air is not cool enough. Cooling of the Main Computer Room, on-floor Communication Rooms, and Main Electrical Room is accomplished using chilled water fan coils.

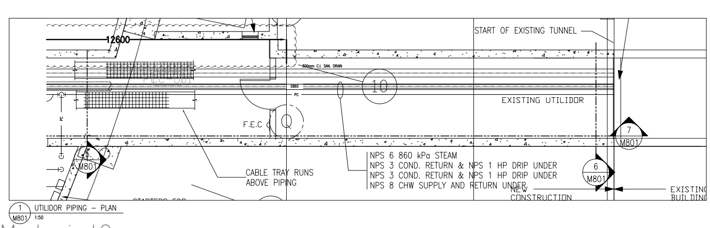
A variable flow primary circuit makes hot water available at appropriate temperatures for the different uses. The temperature of the circuit will be adjusted in response to system demand, but is kept as cool as possible to maximize efficiency.

The perimeter heating system for the building consists of ceiling mounted radiant panels along the perimeter of the building. This system avoids intruding into floor space and provides planning flexibility by leaving the outside wall free of heating elements. Radiant panels are ideal for use in a health care environment as they do not provide a location for dust or dirt to collect. The water temperature will be varied with outside air temperature through a separate pumped loop so that heat supplied to the occupied spaces in proportion to the transmission heat loss through the building envelope. The perimeter heating system is connected to the building's emergency power system so that in the event of a power failure, Patient Rooms will continue to be heated.

In addition to the hot water based perimeter radiant ceiling panel, the Burn Unit beds will have electric radiant ceiling panels above the patient bed, with in-room temperature control.

24/7 Cooling System

The relatively temperate climate of Victoria reduces the cooling load for the Patient Care Centre. Solar gains can account for a large proportion of building cooling, and they have been reduced with careful consideration of glazing area, glass types and shading devices. The annual cooling load is reduced by the use of operable windows, and with so much of the building space having direct access to the perimeter, the potential for passive cooling is high. The ability to use 100% outdoor air in all of the ventilation systems limits the need for mechanical cooling in these systems to only the hours that outdoor temperature exceeds 15°C; this substantially reduces the load.



Mechanical Spaces

By far the largest load is generated by the ventilation system, occurring during warmer weather. The other cooling load is a by-product of the electrical energy used to power the Main Computer Room, the on-floor Communication Rooms and the building electrical systems. This load is much smaller, and while it varies day to day, it is a factor twenty-four hours a day, seven days a week. Cooling to the air handling units serving the building is provided by the Central Plant. Two way control valves on the cooling coils modulate chilled water flow to maintain supply air conditions. The 24/7 load is met with small chillers, capable of operating year-round. The chilled water distribution is interconnected with common headers, but is configured to allow it to function with the rest of the system turned off, as it will be for much of the year. Heat rejection from this load goes into the building's heating system.

Steam Connection

A maximum of 5900 kg/h (13,000 lbs/h) of steam at a pressure of 860kPa (125 psig) is provided by the existing Energy Centre. Steam pressure is reduced to 70 kPa (10 psig) and distributed to the steam humidifiers in the air handling units and to the heat exchangers. The height of the building enables much of the condensate to drain back to the existing Central Plant by gravity, as an energy-saving feature. Dual-pump packages are utilized where pumping is required. A high pressure drip line parallels the high pressure steam line.

Ventilation

Room terminal units (supply and exhaust) use direct digital controls (DDC) linked to on floor panels. Feedback from the terminal units are used to optimize space conditions and air handling unit operation. The Patient Room supply terminal units are linked to operable windows. In the event a window is opened to permit natural ventilation, the damper on the supply terminal box will close, while the exhaust terminal box will continue to operate in order to provide natural ventilation while still maintaining the minimum required air change rate. Room terminal units also have the ability to interface with lighting systems and occupancy sensors where provided to ramp up or down the ventilation rate. Feedback from terminal units are used to optimize space conditions and air handling unit operation.

Environmental conditions throughout the facility are monitored via the Building Automation System. Adjustments to the system can be made at the BAS to meet individual room occupants preferred conditions.

Air Handling Systems.

Air handling systems can contribute to superior infection control as well as provide a comfortable and productive interior environment for both patients and staff. A 100% fresh air system was designed as it provides high indoor air quality with the benefit of reduced potential for recirculation of airborne pathogens. It also provides enhanced flexibility for future changes in occupancy which might otherwise require extensive ventilation revisions.

All supply and exhaust air are fully ducted to and from the space being served. Providing 100% outside air benefits all occupants of the building by ensuring a constant supply of fresh air. This enhances the indoor air quality in the building, remove odors, and contribute not only to the comfort and well-being of occupants, but also to improved infection control measures by considerably reducing the potential for re-circulating airborne pathogens throughout the facility.

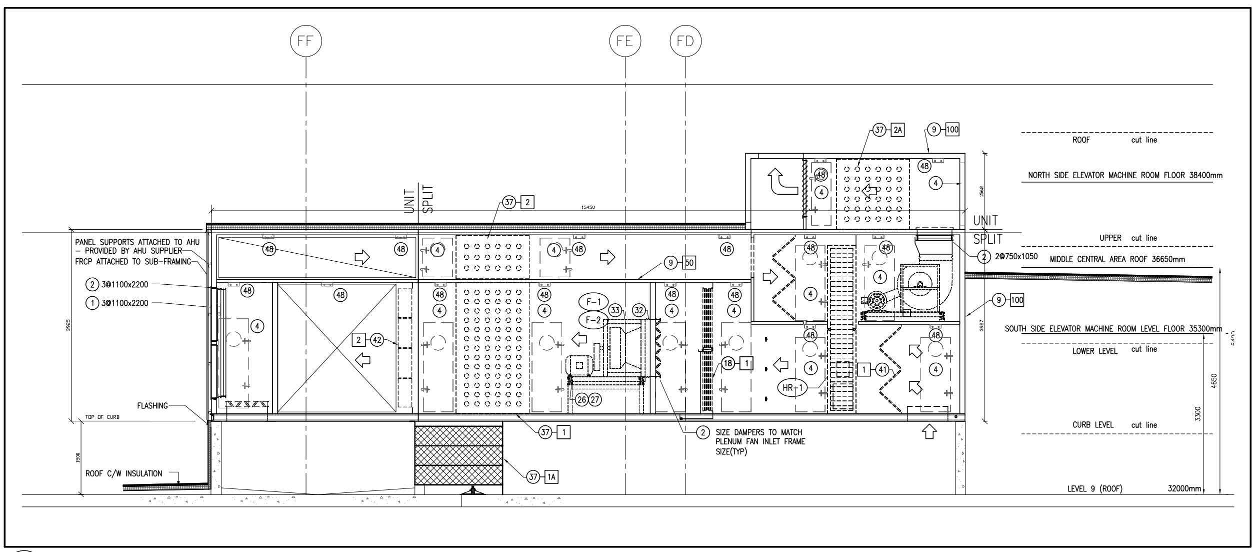
Service spaces including the main electrical room, boiler room, chiller room, mechanical penthouse and elevator machine rooms have independent ventilation systems using outdoor air. The main electrical room generates substantial heat which will be reclaimed by the cooling system when the heat is useful elsewhere in the building, and exhausted directly when it is not.

Each air handling unit has dual supply fans and dual exhaust fans. Both the supply and the exhaust fans have variable frequency drives. The enthalpy wheels for heat recovery provide an energy efficient means of delivering excellent air quality to all spaces. The enthalpy wheels have been selected based on their performance and reliability.

The units are sized at a lower velocity than industry standard to reduce the energy consumed by the fans. This is particularly effective as the friction drops as the square of the velocity combined with the fact that the units operate around the clock.

The air handling units are located in pairs, and the two units forming each pair have their supply ducts inter-connected upstream of the duct riser. Separate sanitary exhaust and general exhaust ducts are combined into a shared duct just before the air handling units in order to reclaim as much heat as possible from the exhaust air stream.

Careful consideration has been given to the location of fresh air intake and exhaust louvers. Locating all



2 SECTION
M982 1:50

Air Handling System

of the air handling equipment at the top of the building will ensure that the intakes are not accessible by the public, avoiding potential tampering or vandalism. The exhausts are away from the intakes to prevent recirculation, and away from the operable windows of the patient rooms.

Air Distribution

The air distribution systems for the hospital has pressure-independent terminal boxes which can supply either constant or variable air volume. In order to provide optimum controllability, each patient room is served by a pressure-independent, direct digital controlled (DDC), variable air volume (VAV) terminal unit with a multi row hot water reheat coil suitable for low temperature heating water. Distribution to each patient room goes from branch take-offs from the main duct run. The system provides operational flexibility and energy conservation by varying the air distribution to all areas based on load and occupancy requirements. The terminal box is located in the ceiling space of the patient room, above the entryway into the room, away from the patient bed, and on the other side of the privacy curtain from the patient.

Supply air is delivered to the room via a centrally located ceiling diffuser, with sanitary exhaust air transferred through the washroom at a constant rate; the balance of the general exhaust taken from a ceiling grille above the entryway of the room. This method of ventilation for all of the patient rooms is designed to provide superior air mixing and complete supply air coverage. Computational fluid dynamic (CFD) modelling of the typical Patient Room was conducted to compare various methods of air delivery. This design approach has been proven to provide excellent air distribution while also maintaining maximum patient comfort.

Separate sanitary exhaust and general exhaust ducts combine just before the air handling units in order to reclaim as much heat as possible from the exhaust air stream. The VAV terminal boxes on the supply and exhaust of the ventilation system for patient floors allow any wing of any patient floor to be isolated and converted to an isolation ward should a pandemic and/or disaster occur.

Plumbing

Domestic Hot Water Systems

The system is designed to distribute hot water at 49°C (120°F), which is energy efficient, and the copper-silver disinfection system will provide an environmentally-friendly, chemical-free method of preventing the growth and spread of Legionella bacteria. It offers many advantages over the alternatives such as high temperature disinfection, local mixing valves or shock chlorination. Copper-silver disinfection systems have proven very successful in test and actual installations on a number of hospitals.

Cisterns

An innovative design feature is the use of cisterns to reduce water consumption. Rain water is collected from the various points of the building: Penthouse roof, main roof over patient wings, green roofs, L2 south terrace , area drains on grade (capped line stubbed out for civil connection). Then the collected rain water is conveyed to three cisterns (two of which are connected to rain gardens).

Collected rain water is constantly pumped through the cistern to the rain garden or the green roof irrigation system. Overflow from the rain garden is drained back to the cisterns by gravity. This is a efficient way to use rain water as non-potable water for irrigation or recirculation of the rain garden.

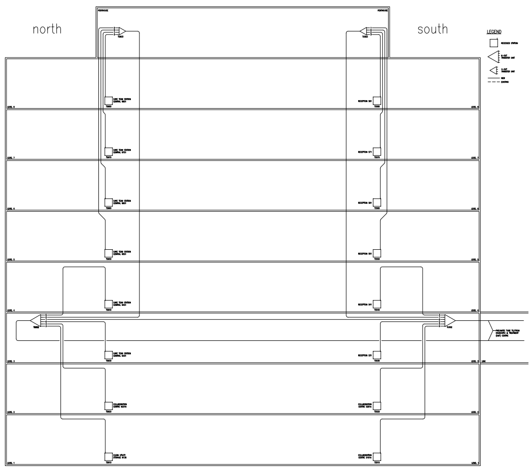
Plumbing Fixtures

Wall-hung waterless urinals, and low consumption urinals with electronic hands-free flush valves are used . Other plumbing fixtures are all low-flow and low-consumption. This type of fixture has the benefit of reducing water consumption and reducing energy consumption associated with hot water heating.

Plumbing fixtures and fittings in the Mental Health Inpatient Units are of institutional quality, vandal resistant and designed to prevent undue harm or damage to the building and users. Toilets have concealed flush valves, with a special waste connection with cleanout to limit and remove blockages from the piping system. Faucets for lavatories and showers are single temperature metering push button type. Instead of a gooseneck faucet which presents a ligature risk, vandal resistant metering faucets are used for the staff hand wash sinks in Mental Health Patient Rooms. Secure Rooms have a stainless steel combination toilet/basin with rounded corners and rear access from outside the room, with water control shut-off from the nursing station, and a floor drain with self-priming trap inside the room.

Soiled Utility Rooms have a bedpan disposal unit, which provides capacity to discharge human waste. This system improves infection control by reducing the possibility of contact with human waste, and reducing the risk of contamination and infection from an improperly sanitized utensil.

HHAngus



M-171 Pneumatic Tube System

Pneumatic Tube System

The pneumatic tube system forms a key element in the internal transport system in an efficient hospital. The existing system contains two zones serving the PCC, with two separate connections to the existing system in the existing D&T building.

Noise Control Measures.

The mechanical systems are designed to minimize the generation of unwanted noise, reduce sound transmission between spaces, as well as to minimize sound transmission to the neighbouring community. Reducing sound levels in the facility serves to create a more peaceful environment, reducing stress levels in both patients and staff, and ensuring an elder-friendly environment.

Mechanical equipment is provided with spring hangers, flexible connections and vibration isolation to achieve this objective. Silencers are installed to maintain specified sound levels in occupied spaces. Fans are situated in an acoustically rated enclosure to control breakout noise. The fans are isolated internally on minimum 2" static deflection spring isolators. Internal silencers are used to control the sound levels before the air leaves the acoustic enclosure while reducing pressure drop and fan power. The 300 mm floor slab will provide adequate airborne sound insulation as well as an adequately stiff base for vibration isolation of the fans.

Redundancy Provisions

The reliability of a hospital's mechanical systems is a key consideration, and building in the appropriate degree of redundancy is paramount. Heating loops are provided with a pair of pumps each sized at 100% to enable the system to function to full capacity with one pump out of service.

Domestic hot water can be generated through steam heat exchangers fed from the existing Central Plant. Each of the three semi instantaneous heaters is sized for 50% of the load, and each contains two heat exchangers.

The Main Computer Room and IT /Communications riser rooms are considered the most critical spaces, and they provided with full equipment redundancy. Dual modular chillers each carry the base load, and will be further backed up by the main cooling plant. Both chilled water and condenser water sides have run and stand by pumps. Full redundancy is provided by the two cooling units in the main Computer Room.

Air handling units are connected in pairs on both the supply and exhaust to provide 100% redundancy for Class I spaces, and 75% redundancy for Class II and Class III spaces, allowing for the building to remain operational during scheduled or unscheduled shutdown of air handling equipment.

Infectious isolation rooms have run and standby exhaust fans sized for 100% design flow. The exhaust fans are connected to the building's emergency power system in order that design airflow can be maintained at all times.

The domestic water service have a cross-connection to the existing Campus system as well as inlet connections on the exterior of the building for connection to a tanker truck. Quadplex water booster pumps provide redundancy, and are connected to the building's emergency power system.

Storm and sanitary sump pits have twin compartments complete with duplex pumps connected to the building's emergency power system. Medical gas inlet connections are provided on the exterior face of the building. A sanitary sewer pump out connection is provided off of the main sanitary drain line, in the utilidor. The connection is extended up to grade on the north side of the utilidor for convenient connection to a sewage pump truck.

Energy Recovery Measures

The components of the heating and cooling systems are selected to minimize energy consumption and maximize efficiency under normal operating conditions. The heating water supplied to the terminal box reheat coils is the combined return water of the perimeter scheduled system and the domestic hot water systems. The heating system pumps uses adjustable frequency drives for maximum energy efficiency. In addition, the cascading approach results in a higher temperature differential so that less water has to be pumped for the same amount of heat.

The cooling water system chillers and pumps are equipped with variable speed drives. For maximum efficiency, the chillers are controlled by maintaining a constant return chilled water temperature, but are also capable of being controlled from the supply temperature should a constant low chilled water supply temperature be desired. Incorporation of a "smart" control system capable of evaluating the energy consumption of all of the components, and continuously adjusting the operating parameters is the key to achieving maximum efficiency.

The air handling units uses 100% outdoor air for free cooling as the first means of space cooling. They also incorporate total enthalpy heat wheels to recover both heat and humidity from the exhaust air and transfer it to the supply air. The heat wheels are very efficient operating at about 75% on both sensible and latent scales.

Infection Control Strategies:

The ventilation system can be used to isolate any unit and/or floor in the building to aid in infection control. VAV terminal boxes on the supply and exhaust of the ventilation system for spaces on patient floors allow the air volumes in any wing of any patient floor to be manipulated remotely. This provides the required isolation and conversion to an isolation ward should an internal or external pandemic and/or disaster occur. This would be accomplished by negatively pressurizing a wing relative to the rest of the floor.

Each side (East or West) of each Wing (North or South) forming a unit of 18 beds has a room or space which can be used as a vestibule in a pandemic situation, or which can be converted to a change area for staff to don personal protective equipment if the unit is isolated. Differential pressure sensors are located at the entrance to each unit to monitor pressurization.

The Burn Unit in its entirety will be positively pressurized relative to the rest of the patient floor, and within the Burn Unit itself, the patient rooms and the mister shower room will be positively pressurized relative to the corridor to protect vulnerable burn patients. A differential pressure sensor located at the entrance to the Burn Unit will provide confirmation of proper pressurization.

Electrical Systems

The electrical systems in the Patient Care Centre is a great complement to the mechanical systems. This is an advantage of having both the electrical and the mechanical teams under one roof in one team.

The Electrical Systems' key elements include reliable operation, low energy consumption, low environmental impact, ease of access for maintenance, convenient operation and at the same time be complementary to the architectural and structural designs.

Lighting

The design of the site lighting emphasizes safety and the creation of an environment that promotes a feeling of well-being. The goal is to achieve a pleasant ambiance along with a sense of security, to promote use of the space. The parking and pedestrian areas are provided with cut-off luminaires to prevent light trespass and unnecessary light spill into the sky.

Luminaires are utilized to provide the ambience of a residential space rather than an institution. Consideration is given to the needs of the occupant of the space, the visual tasks to be performed, the desired appearance of the space, energy and economic considerations and the maintenance of the space. To provide an atmosphere that is elderly-friendly, care is taken to ensure that even illumination with gradual change between adjacent spaces is provided.

To provide a low glare, even illumination of patient corridors and also in office spaces, recessed direct/indirect fluorescent luminaires are used. Compact fluorescent luminaires and LEDs are used where a "potlight" appearance is desired in areas such as Waiting Rooms, Public Spaces, etc.

In Conference and Meeting Rooms the space is provided with direct/indirect fluorescent lighting that minimizes glare issues and facilitate multi-level lighting scenarios. Lighting in the Med/Surg patient bedrooms include a wall-mounted, fluorescent, patient bed luminaire providing an indirect lighting system that is non-glare and comfortable to the patient. This approach provides both low level and general illumination, as well as illumination for reading.

A separate recessed ceiling-mounted, fluorescent luminaire is provided for patient examination. Luminaires in the Mental Health patient bedrooms are vandal-resistant types, but are still wall-mounted to provide more of a residential environment. Other areas in this part of the hospital are provided with vandal resistant or tamperproof luminaires for the safety of the patients and staff.

Egress lighting and exit light systems are provided throughout the facility. Exit signage utilizes LED lamps for energy efficiency and long lamp life.

Uplighting of landscaping is kept to a minimum. Landscape lighting utilizes in-ground luminaires. Architectural features are highlighted and the level of security enhanced through the use of wall mounted luminaires, strategically located. Bollards and smaller appropriately scaled poles/luminaires, along with step lights and in-ground luminaires, are used for the illumination of pedestrian areas.

To enhance the space while minimizing the impact on the environment, high efficiency metal halide and LED light sources are used. Lighting is photo-cell and timer controlled.

Lighting is designed to maximize energy efficiency consistent with the required functions. Individual local light switches are provided throughout for personal comfort and flexibility. In addition, the use of motion sensing switching and ambient light sensing are used in selected areas to minimize energy use and operating costs. Occupancy sensors utilizing passive infrared and ultrasonic technology are used to achieve motion sensing switching.

Additionally, because of the potential to cause confusion and disorientation amongst patients, particularly elderly and psychiatric patients, occupancy sensors are not used in patient or procedural rooms. Local switches are used in patient occupied spaces and bedrooms to give the patients control of their environment.

In every patient wing corridor there are normal powered 1x4 fluorescent ceiling luminaires and emergency powered fluorescent wall sconces. There is an interlocking system such that only one set of lights are on at any given time. During the day only the normal powered 1x4 fluorescent ceiling luminaires are on and the emergency powered fluorescent luminaires are off. During the night, the reverse occurs such that the emergency powered wall sconces are on and the ceiling normal powered 1x4 luminaires are off. In the event of a power failure, the emergency wall sconces will automatically turn on once the generators kick in regardless of the position at the time.

Interlocking the patient wing corridor lighting saves energy by preventing both sets of lights from being activated continuously. There are approximately 15 emergency wall sconces per patient wing with a total of 30 patient wings. Each wall sconce consumes 20W of power which amounts to a total building savings of approximately 9000W

Power Monitoring Systems

All branch circuit breakers feeding lighting loads are metered and displayed. The Modules/Display Units are interconnected to the central monitoring system, which is able to provide an historic record of lighting load consumption.

The central monitoring system is modularized and future changes to the power distribution can be easily updated in the monitoring system.

Standby and Uninterrupted Power Supply

The new facility is provided with a microprocessor-based, addressable, two stage, zoned, fully supervised fire detection alarm and emergency voice communication and paging system, Alarm signals are annunciated at the Authority's central monitoring centre located in the Parking Garage as well as the Central Alarm and Control Facility (CACF) within the PCC and is coded to indicate the source of origin of the alarm as the Patient Care Centre. Fire detection is provided by a system of intelligent addressable detectors located in patient corridors, patient bedrooms, stairwells, shafts etc.

Communications

The Communications systems feature reliable operation, flexibility, quality of service, convenience, and efficiency of operations.

A broad variety of communications, monitoring and computer systems have been installed, and more to be expected to be installed throughout the life of the building. The last few years have witnessed a truly explosive growth in demand for telecommunications and computing services in the Health Care sector. These include requests for advanced voice communication services, digital imaging, data communication services, video distribution services, and requirements for access to microwave and satellite communication facilities.

Structured Cabling

The structured cabling system is a network that seamlessly and efficiently connects data, voice, security, patient entertainment, video, nurse call and other low voltage applications. It consists of three (3) basic segments: Horizontal cabling, Backbone cabling (Intrabuilding backbone), and Campus cabling (Interbuilding backbone).

In order to maximize flexibility, a Distributed Backbone is deployed throughout the PCC. In a distributed backbone, horizontal cables terminate in Telecommunications Rooms and connect to the intrabuilding backbone, which in turn connects to the Main Computer Room (or main cross-connect). This offers greater flexibility for growth as it utilizes the horizontal cross-connect as a termination point.

Wireless Staff Communications

A wireless system provided to support wireless applications inside the facility. Intelligent wireless access points (APs) are mounted in the ceiling space and connected to the Power Over Ethernet (PoE) switch using Horizontal Unshielded Twisted Pair (UTP) cables routed through the ceiling wireway system. Intelligent Wireless Access Point units are strategically positioned throughout the facility to provide full coverage of the Patient Care Centre. To ensure reliability and uniform coverage to the entire facility the Intelligent Wireless Access Points automatically adjust RF signal levels.

This system provides full roaming (across radio standards, across AP and across IP subnets) using dynamic channel assignment, dynamic transmit power control, and dynamic load balancing.

Resiliency is provided between wireless switches and access points. Access Points are network-aware, ensuring that if one goes down, another one is available to dynamically plug up any coverage holes. A wireless network infrastructure is provided to support numerous security schemes simultaneously. Data Encryption, Secure Mobility, Device and User Authentication are supported, keeping traffic private in a mobile environment.

Through the structured cabling system and Local Area Network the wireless communications system interfaces to the Nurse Call, Fire Alarm, Security, Voice Mail, Dictation and Clinical Systems.

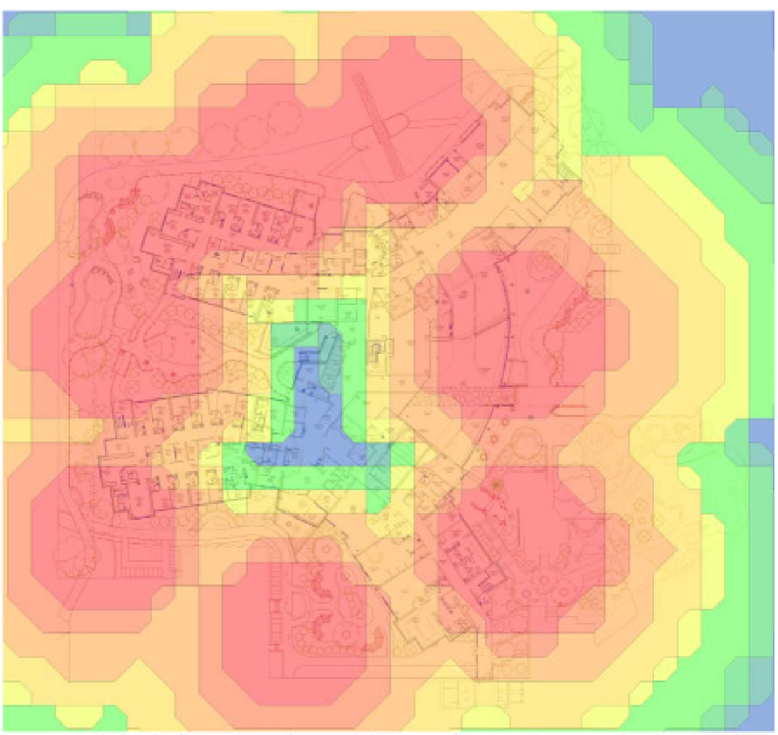


Figure 10, Level 1 (Outdoor) - An estimate of maximum data rate per location, with respect to the selected Signal-To-Noise threshold and the selected wireless network card receiver sensitivity values

1.0	2.0	5.5	6.0	9.0	11.0
12.0	18.0	24.0	36.0	48.0	54.0

Level 1 (Outdoor)-Data Rate

Security Systems

The Security Systems utilizes a fully Integrated Multimedia Security Management System (IMSMS), providing a scalable, open architecture client-server based security management solution, ideal for healthcare facilities, and utilizes state of the art technology. The Security Management System integrates the CCTV, Access Control, Intrusion Detection, Panic/Staff Duress (Code White), Patient Wandering and Incident Reporting System. The IMSMS workstations allow security personnel to monitor and control all security sub-systems from a single user interface. An event-monitoring screen displays all system events on a user programmable priority basis. Graphic based maps, customized for the facility incorporate icons representing doors, asset portals, alarm points, etc., giving the operator a dynamic visual reference when system events occur.

The Security System takes advantage of the integrated IT infrastructure utilizing the spaces, pathways, and the low-voltage communications backbone. This communications backbone was designed to serve all of the facility's systems, including not only security but fire protection, building management, and the audiovisual voice and data systems. The Systems integration enhances future flexibility where security information is no longer carried on a dedicated, point-to-point system, but instead shares the same media (cabling, etc.) used by other systems. All of these systems can be extended or rearranged concurrently. Since large, complex security systems often undergo extensive updates and renovations over a facility's lifetime, this approach will minimize costs over the longer term.

Patient Entertainment

A patient entertainment system provides a television signal to patient bedrooms, lounges, multi-purpose rooms, lobbies and other locations. The system provides patient entertainment and educational programs with technology that supports tele-health and two way video conferencing within the patient bedrooms.

Nurse Call Systems

The Inpatient Care Units are provided with a microprocessor-based audio-visual type nurse call system, to provide a means of communication between patient occupied spaces such as bedrooms and washrooms and nursing staff located either at nurses stations or carrying mobile wireless devices. To achieve mobile communication the nurse call system is interfaced with the wireless communication system. Master stations are interconnected to accommodate communications between different nursing units and patient care areas. Assignment of primary, secondary, and caregivers to each patient bed location are easily managed from the system master stations.

A nurse call patient bed station featuring nurse call, staff assist, code blue and an auxiliary input are provided at each patient bed location. An interface is provided to connect the nurse call feature at each bed to the bed jack at each bed location. This feature enables patients to activate the nurse call from the bedside rails of electric beds equipped with touch pads for this purpose. Patient bed stations are also provided with a call cord to provide patients easy access to place a call for assistance. For infection control purposes call cords are sealed and moulded from silicon with an antibacterial additive. The sealed call cord unit can be cleaned through dip sterilization. Patient calls are annunciated on corridor dome lights and zone lights, at the local nurse call master station, and on mobile devices of assigned caregivers. Activation of patient bedroom smoke detectors will be annunciated on the nurse call master stations and corridor dome lights as well as on the fire alarm system.

Code Blue

A centralized code blue (cardiac arrest) system is provided. Initiating stations are located in patient bedrooms and tub rooms. The system is integrated with the nurse call system and is annunciated on the nurse call console at each Team Care Station and Unit Clerk desk. Code blue calls are also annunciated on corridor and zone dome lights. The nurse call system interface with the wireless phone system will enable code blue calls to be sent directly to specified staff with wireless devices.

Code White

The proposed staff duress system is based on a wireless personal alarm transmitter. Once a personal alarm transmitter is activated the system is capable of identifying the actual point/room of activation via room/hallway mounted receiver units. The system provides a description of the device activated and location via an LCD screen and shall also provide an alert signal with an integral buzzer. In addition to the wireless personal alarm transmitters, all care team stations are provided with hard wired wall mounted panic alarm push buttons.

The wireless staff duress system is provided throughout the facility. Alarms are annunciated at the local care team station as well as at the PCC Security Desk and the main security office in the Parking Garage. The Code White system is fully integrated with the Integrated Multimedia Security Management System (IMSMS).

Patient Monitoring

A patient monitoring system enables care teams to view realtime physiologic data. The system infrastructure is provided throughout the facility utilizing servers connected to the structured cabling system. Authority supplied Access Points for Patient Monitoring are installed throughout two of the medical surgical floors of the Facility. The system is fully IP-based and connected to the local area network.

Patient Wandering and Equipment Tracking

The patient wandering and equipment tracking system is installed throughout the PCC. Ceiling mounted receivers are installed throughout the facility enabling the system to locate a patient or piece of equipment, provided with an RFID tag or band, to within 10 meters. In the event that a patient or piece of equipment identified with an RFID tag passes through an exterior door the system will identify the location of the event and the particular person or piece of equipment leaving.

Lifecycle

As a P3, this project's complexity increases significantly. Not only does the design of all systems have to reach the requirements and objectives of the client, but these designs have to be flexible and be ready for changes in the next 30 years. The Lifecycle Plan was developed in a manner to promote the value and use of building components and plant lifecycle cost analysis during the design, construction and operational phases of the project.

A key part of the development of the plan was to work very closely with the Plant Services Management providers Angus Consulting Management Limited (ACML) in all our value management and whole life cost exercises to ensure operational costs are minimised to provide the best value over the life of the building.

The plan was a critical tool which helped to achieve the following:

- Provision of an operations brief for each service, clearly identifying the methods and systems to be employed, together with any special space requirements to be incorporated
- Provision of a schedule of all fixed or loose specialist plant and equipment required in support of the services being provided
- Involvement in all design team meetings, ensuring that the initial brief and any changes and developments are incorporated into the evolving designs
- Review of the FM requirements at all design team meetings to ensure that the team can fully understand the method of operation such that the most effective / economic solutions can be developed
- Active and ongoing participation in the whole life cost analysis to establish the most cost effective choice of materials and plant, taking into account initial capital cost, maintainability, durability, interim maintenance and cleaning / replacement costs, together with the effect on financing charges.

By use of this holistic approach, we achieved the most operationally and economically efficient solution for the project as a whole and not one that is driven by initial capital cost alone.

LEED

The definition of sustainable design can vary widely but is generally accepted to be: the process of sustainable or healthy, high performance or green design involving a universal integrated approach to solving the needs of the built environment while conserving energy and natural resources and promoting community, history, and the environment for all time.

This LEED® Gold certified building has been carefully designed to support the vision for the project and to design and develop the Patient Care Centre (PCC) as the first Pacific Green hospital project notable for its architectural excellence, sensitivity to the needs wellness and healthy lifestyle of patients, staff and visitors. The PCC's innovative sustainable design heralds, to those who are serviced by the building throughout the region, the high standard to which hospitals will be built in the future. From the outset of design there has been a commitment to integrate the landscape and the building form to maximize the inherent benefits of the site specific geographic location on the hospital campus, in the North Jubilee Neighbhourhood and within the context of the City of Victoria.

The building's compact eight storey urban form cups around the heritage Pemberton Heritage Operating Theatre and creates a sheltered enclave and of intricate but highly structured indoor and outdoor spaces with a buffered micro climate that allow for patients, staff, visitors and volunteers an extensive array of places for social interaction, quiet contemplation, group therapy and recreational activities. It is a wellness setting featuring unique planting and landscape references to the diversity and inherent beauty of the local ecological environment, resulting in the highest and best use of the site while minimizing the building footprint, leaving as much open space as possible.

Green Healthcare Sustainable Principles are also reflected in the project. Building design and the construction practices used in this project reduces the amount of use of raw materials such as stone, gravel sand steel, virgin wood and plastics. In addition green planning, design, and construction operations and maintenance practices are chosen to positively affect the productivity of staff and patient outcomes. In accordance to the Green Healthcare Guidance Statement (2001) by ASHE building design and construction practice protects health on three scales:

1. immediate health of occupants
2. health of surrounding community
3. health of the global community and natural resources

This building takes many preventative health actions by improving environmental performance, therefore, the project works towards prevention of harm, a fundamental principle of healthcare. Through the selection of design features, mechanical systems and infrastructure, as well as material section and operations and maintenance practices.

The design and selection of heating and ventilating systems are based upon the choice of highly efficient components and the crafting of the urban form to minimize heating and cooling requirements throughout the year while providing patients choice and control over their own personal environments.

The Mechanical and Electrical engineering is a critical component as evidenced by the fact that many sustainable buildings in recent years have fallen well short of their energy targets. H H Angus brings a long history of proven energy efficient designs that also began in the late 1970's with the winning scheme in the Canadian Low Energy Building Design Awards and over 50 LEED accredited professionals.

Efforts are made to protect and enhance the air quality for both those constructing the building and those using the hospital as places of work and restoration of health.

Carbon Dioxide (CO_2) Monitoring

Low CO_2 levels provide building occupants improved air quality resulting in improved health and productivity and so the provision of CO_2 monitoring is especially important in hospitals. The heating and ventilation system is designed with CO_2 monitoring sensors that may be integrated into the building automation system and will visually inform the building operators when CO_2 readings reach high enough levels.

Green Building Education

A series of interpretive plaques are installed outlining the sustainable design features of the building. A brochure is also be produced for the use of walking tours and staff orientations.

Energy Management

Energy efficiency is one of the key components of a Pacific Green building. Fundamental to the development process has been the recognition that design is only the first step to energy efficiency, and in itself is no guarantee of success. The management of energy use over the life of the building is a key factor.

The design of the building has incorporated many energy saving features including:

- Building shape and orientation to control solar gain and maximize daylighting

- Building envelope with high performance windows and selective shading
- Air handling systems that track loads while maintaining code mandated minimum ventilation rates and recover the maximum energy from the exhaust air
- Efficient lighting with a high degree of user control
- Very efficient heating plant to make the best use of the high potential energy of natural gas
- An open protocol web based Building Automation System (BAS) linking all of the energy consuming components
- The planning for energy management included consideration of the following factors:
- The ability to monitor and record equipment performance and energy use through the BAS;
- Providing the tools to program the BAS to actively feedback performance to improve operation
- To anticipate events ahead of their occurrence with active monitoring
- Adaptability to incorporate new technologies to reduce energy cost and carbon emissions
- Designing the building for ease of maintenance to keep the systems optimized
- Consideration of the life cycle performance

The Building Automation System is a tool to assist operations personnel in controlling the environment for the full range of customers working in or visiting the facility. Through effective use, the BAS will provide improved occupant comfort, reduce energy consumption and allow for off-site monitoring by on call building personnel. Properly leveraged, it is a tool for maximizing customer satisfaction with the working environment. A BAS provides continuous monitoring of the physical environment within specific areas. This information enables the FM team to react to changes in environmental conditions before the customer detects them.

The building has a high degree of metering in order to provide for ongoing accountability of building energy and water consumption and performance. Short and long term trending of variables provide valuable feedback and benchmark information.

Our goal was to achieve maximum savings in operating costs with the implementation of a building optimization program including the use of energy resources. This encompasses a thorough and in depth analysis of all mechanical and electrical building systems to ensure maximum operating efficiencies.