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"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

North Bay Regional Health Centre

May 3, 2011

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As the first LEED® building, it is clear that energy-efficiency is critical in the design. This was a key focus of the team from the start. Initial workshops were held to discuss and evaluate available options and approaches in order to arrive at the optimum systems for the facility. This environmental impact is significant to the community at large, as well as to the building industry as a whole.

When the project changed to the first Design, Build, Operate, the maintenance and operation issues were put into the spotlight for the Client. The facility was designed such that it would accommodate both current technologies as well as applications yet to be developed, without increasing operating costs.

What's a new facility without the people in it? A main focus was to enhance the environment and experience for the staff, the visitors, and the patients. This was achieved by putting the people first, and considering what the users would need in different situations, creating a complex design that is not difficult to use. This is not only to improve the quality of stay for patients and visitors, but also to increase staff recruitment and retention.

As the main healthcare facility in the entire region, it is crucial that operations can continue during construction. Any planned operational shutdowns had to be carefully phased in order to avoid service interruptions in key areas. Operational continuity after occupation was also a design imperative. Smaller, more remote cities and towns are particularly reliant on their hospitals, especially during times of adverse weather conditions, when northern locations can quickly become isolated. Reliability and redundancy must be considered beyond that covered in codes and standards.

The North Bay Regional Health Centre (NBRHC) is a partnership between the North Bay General Hospital and the Northeast Mental Health Centre. H.H. Angus and Associates Limited was engaged to undertake mechanical, electrical, vertical transportation and specialty lighting design in 2000. Piotrowski Consultants Limited was part of our team as designers of the mental health facility, as well as providing local knowledge and field review. Originally conceived as a conventional lump sum tender, it was the first project to be changed to build, finance and operate under the Infrastructure Ontario 'ReNew Ontario' initiative. Construction was completed in 2010 and on January 30th 2011, patients were moved into the facility.

The new three-storey NBRHC replaced two existing general hospitals and a separate mental health facility. The partnership is the first of its kind, between an acute hospital (NBGH) and a specialized mental health centre (NEMHC) and has been designed to provide a spectrum of health services for both physical and mental health care needs.

The NBRHC was constructed on a Greenfield site with a gross building area of 725,000 ft2 and includes a state-of-the-art full service acute care general hospital with 275 beds; a larger emergency department with 32 treatment stretchers to accommodate over 57,000 patients per year and a new ambulatory care centre to accommodate over 63,000 patient visits per year. The adjacent two-storey mental health and therapeutic support services centre includes 113 specialized mental health beds; client services mall, gymnasium, workshops and psychiatric offices; space for clinical and administrative work and improved outreach services for the community.

North Bay Regional Health Centre's Goals

The existing facilities had stood the test of time for many decades, and the expectation was that the new project would become a legacy building, serving many generations. The focus from the start was to build a robust facility that would be flexible and adaptable, reliable and cost-effective to operate. This approach would lead to some goals that North Bay had to serve its community. This facility is to improve community integration by amalgamating existing hospitals into a more community-based healthcare facility. It is to provide best-in-class care for patients, and at the same time improve staff's working environment for staff retention. Technology and flexibility for changing technology are also critical to the design. In the Build-

Finance-Operate model, it is important to not only design with legacy in mind, but also sustainability and longevity. It is important to ensure that the design will stand the test of time and be flexible for changes in technology without increasing operating costs in the future.

The design had to offer an improved patient experience, driven by several considerations: Patient expectations have changed over the past decade or so. They have become more engaged and informed, predominately through access to information on the internet. They are often active decision makers in the course of treatment they will accept. They have broader expectations regarding services and the treatments available. There is also a broader acceptance of the involvement of the family in a patient's care. As well, a shortage of family practitioners, particularly in more remote communities, has increased pressure on Hospital ERs and clinics.

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Mechanical Systems

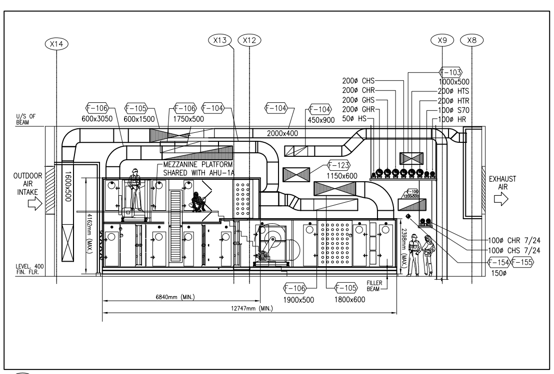
Air Handling System

The initial studies of system options led to a major departure from conventional design practice for the ventilation systems. The use of 100% outdoor air systems is not that uncommon in some areas of a hospital, but its use is normally limited to certain critical departments due to increased energy requirements. Our mechanical team's recommendation of expanded use of outdoor air systems presented considerable advantages to the hospital in improved infection control throughout the facility. H.H. Angus developed a design using 100% outdoor air systems with total enthalpy heat recovery wheels for 26 of the 28 air handling units which offsets most of the energy penalty. This is the very first time that this has been done in North America.

Another departure for standard practice was to combine the use of 100% outdoor air with a reduction in total air flow for the patient rooms. There were concerns that good environmental conditions could be maintained. In response, H.H. Angus constructed a mock patient room to verify airflow patterns for the air distribution system. This test provided added value to the client as proof of the design.

Reducing Air Volumes to patient rooms to four air changes per hour as a result of using 100% outside air also resulted in changes to the CSA Standard. The CSA standard of the time did not accommodate the design, but as a result of this project, CSA has updated its standards to include this approach which, in this facility, had the added benefit of reducing operating costs without increasing capital cost.

In addition to the enthalpy heat recovery wheels for the air handling units, adjustable frequency drives (AFDs) were also employed on the supply and exhaust fans in efforts to reduce the amount of energy consumed during peak and non-peak building operations. This is achieved through the use of a very extensive DDC system integrated to respond and react to different building and system conditions.



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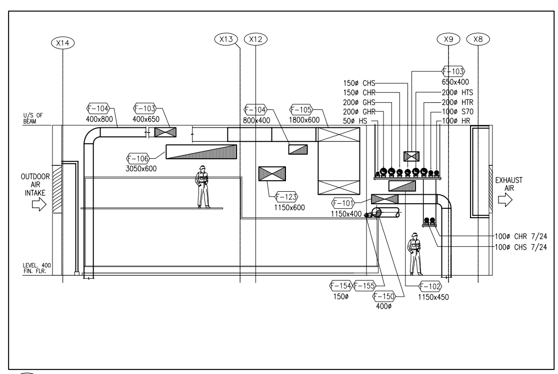

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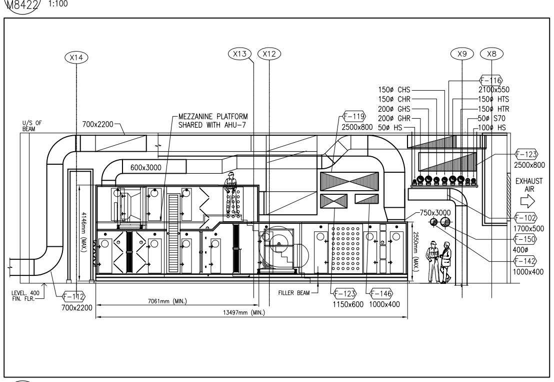

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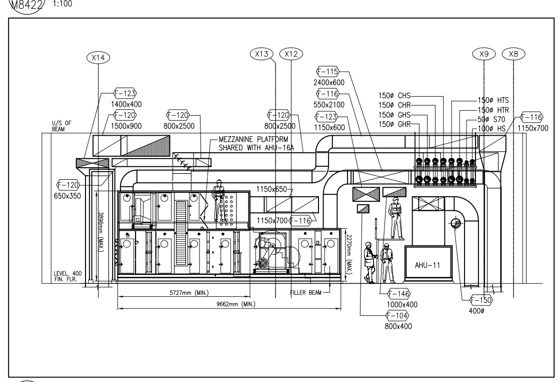

23 LEVEL 400 MECHANICAL ROOM SECTION – AHU 10
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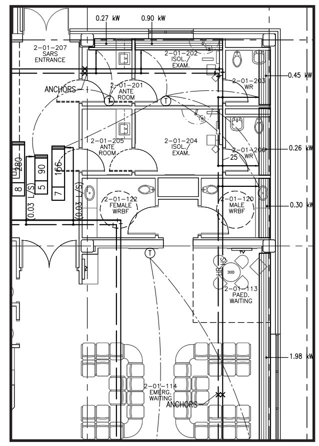
Cooling and Heating

To support the air handling systems, three high-efficiency centrifugal chillers utilized for chilled water generation have been installed. The produced chilled water is circulated through the air handling units to provide cooling and dehumidification as required to properly condition the air in efforts to promote a more comfortable patient and staff environment.

Although the air systems are the major consumers of chilled water, chilled water is also needed year round to cool spaces/equipment that have a high heat gain, such as fancoils used to cool computer and electrical rooms and specialty fridges/freezers. For this, a dedicated scroll chiller has been installed to service these constant loads.

To provide heating to the new buildings, a new high efficiency central heating plant with hot water and steam boilers has been added. The boilers installed under the project are low NOx, high efficiency high temperature hot water boilers capable of producing heating water to serve the air handling units, the internal loads as well as the perimeter loads.

The perimeter loads are dealt with using a radiant panel heating loop system. The radiant panels are located in the ceiling line of the room, against the exterior wall. The decision to use a radiant heating panel system was to deal with infection control and greenhouse area via slab heating system. In conjunction with this, the building envelope has been optimized to achieve better energy performance.



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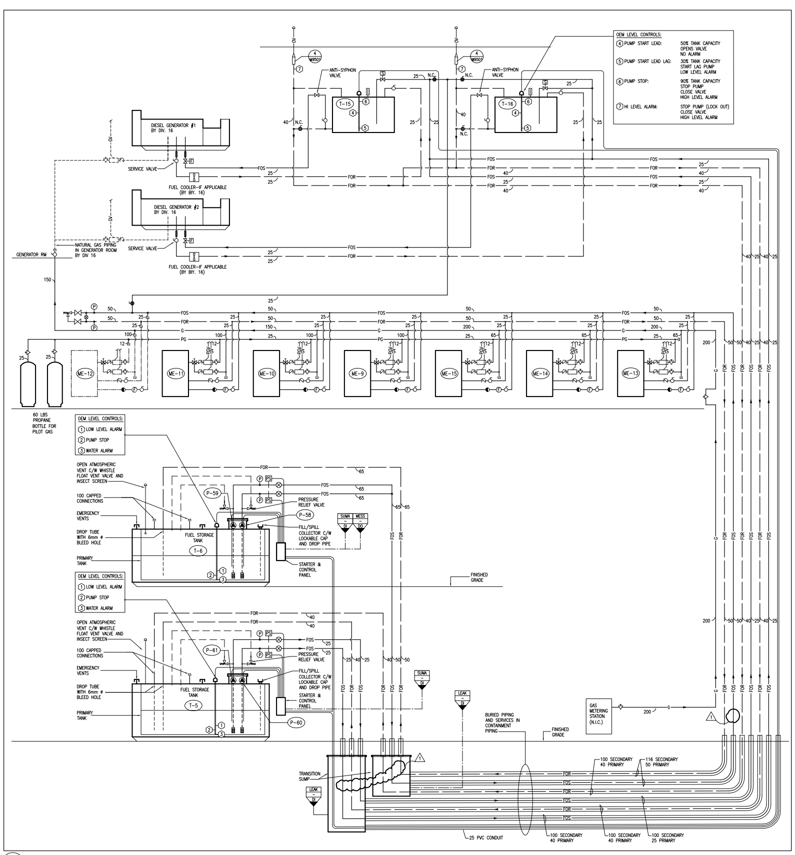
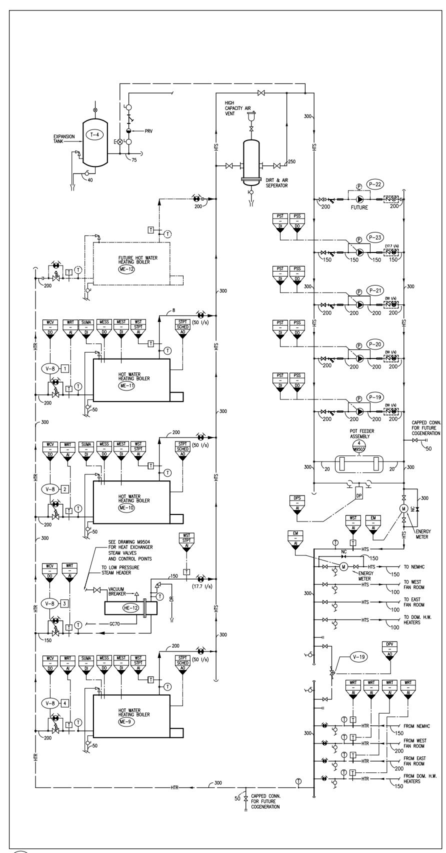


5 FUEL SYSTEM SCHEMATIC
M9501 N.T.S.



1 PRIMARY HOT WATER HEATING SYSTEM
M9501 N.T.S.

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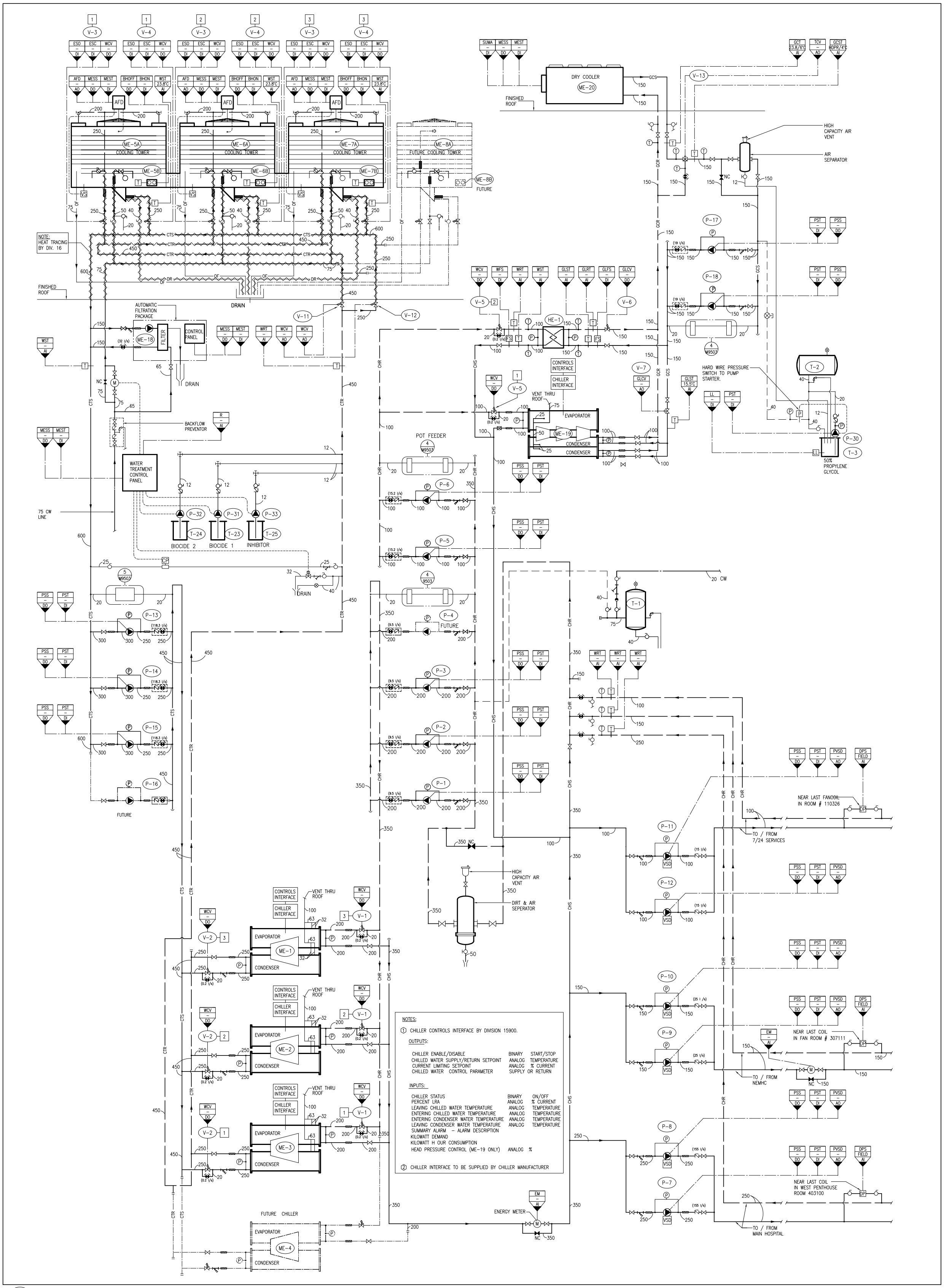
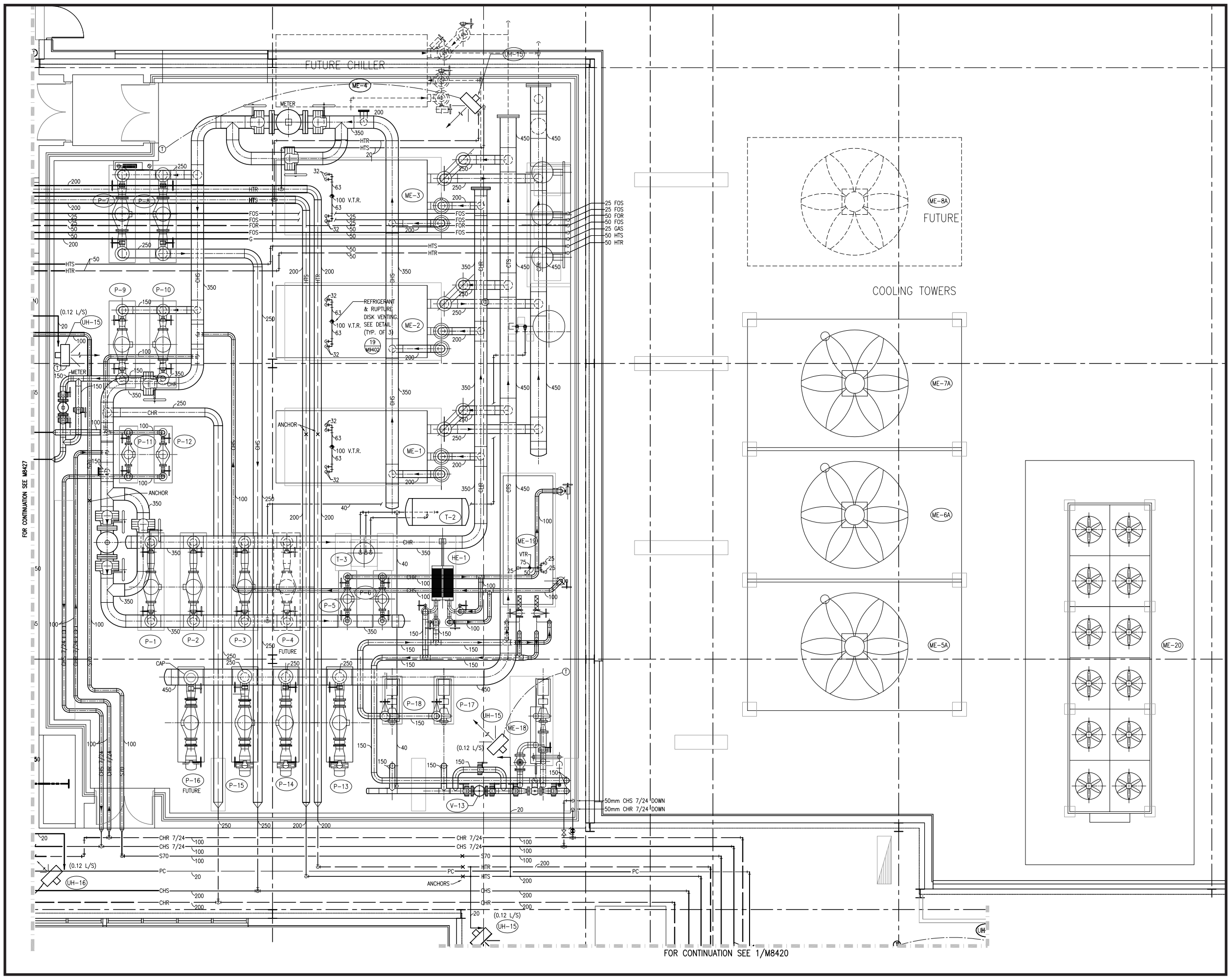
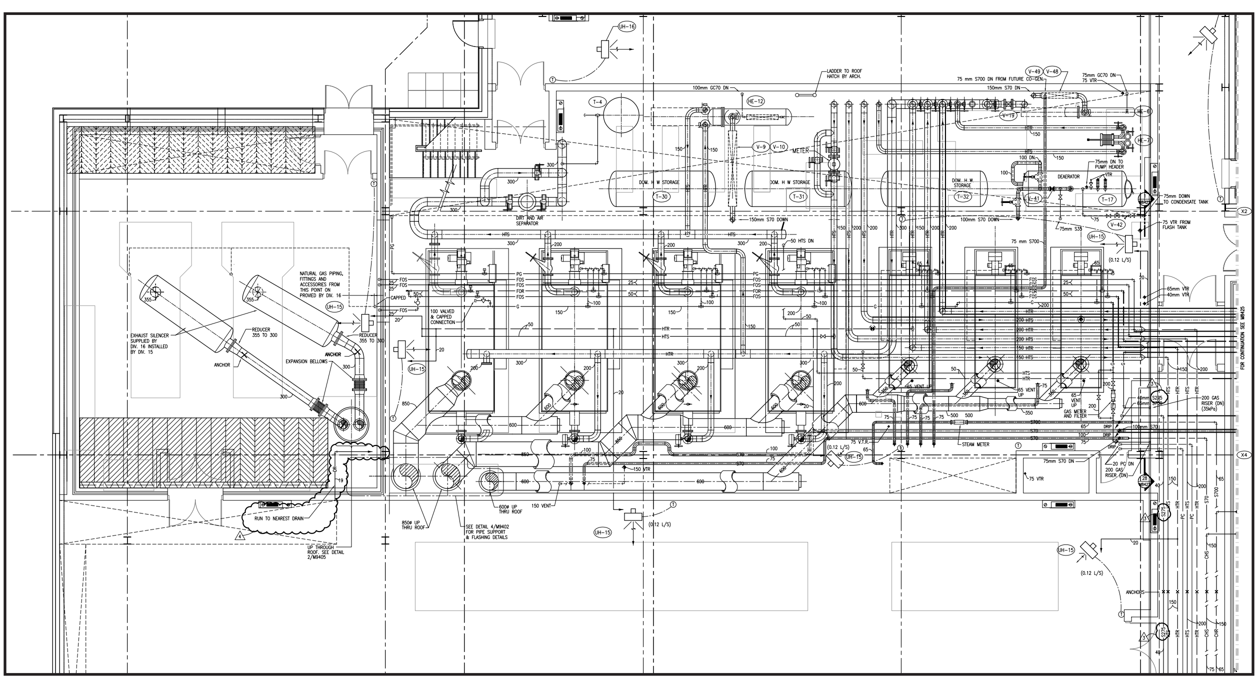


1 M9503 COOLING PLANT SCHEMATIC
N.T.S.


FUTURE CHILLER
COOLING TOWERS
FUTURE
FOR CONTINUATION SEE 1/M8420



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Electrical Systems

Back-up Power

The issue of continuity of operations is a critical one for a remote region served by only one hospital. Any prolonged service interruption due to power loss would require evacuation of patients to a distant facility, which would pose safety concerns for those individuals. In consideration of this, emergency power generation and reliability was a key design factor.

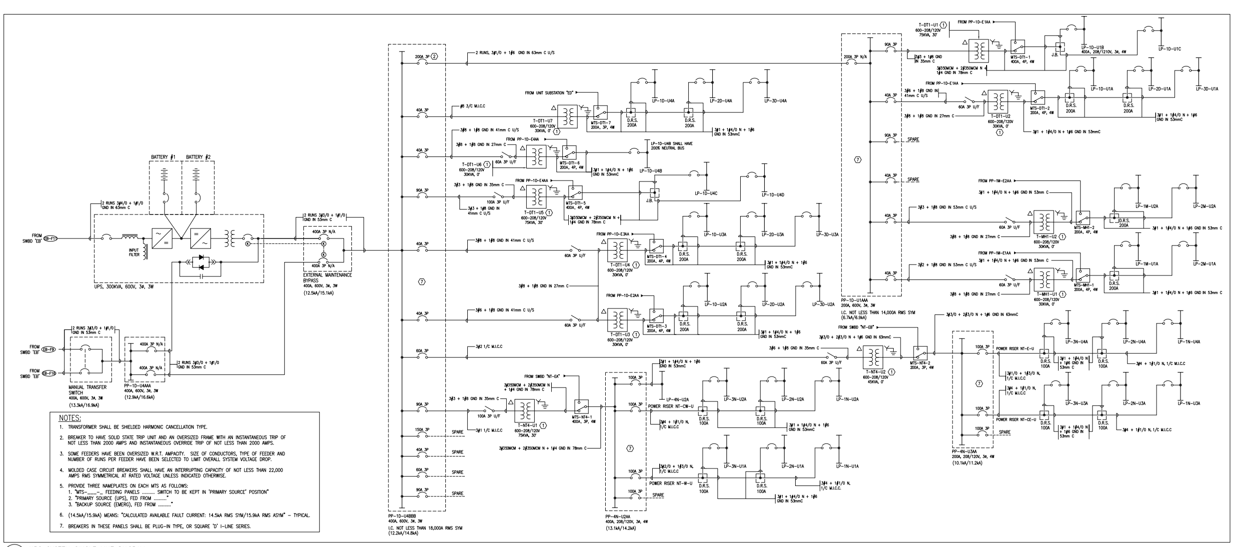
The emergency generators are a bi-fuel type that can use a combination of diesel fuel and natural gas. This was provided for two reasons:

- The use of natural gas reduces the operating cost of the generators.
- During an extended power outage, the generators will be able to run for a much longer period of time on the diesel fuel stored on site, provided the natural gas remains available.

Another major consideration was that the reliability of the emergency generators should not be reduced by the addition of equipment intended primarily to provide an economic benefit (a condition that typically occurs when co-gen equipment is used for emergency power). The bi-fuel system operates independently from the standard diesel fuel system on the generator and, should the natural gas supply fail or the bi-fuel system shut down, the engine inherently reverts to 100% diesel fuel operation with no appreciable reduction in system reliability.

The emergency generators are designed to allow for dispatch operation. This is operation when the utility power is available but the grid is experiencing a very high demand. Under dispatch operation the emergency generators can be remotely signaled to start and assume load, thus protecting the grid from overload or eliminating the need to purchase more expensive power from other provinces or the USA. This added complexity to the system in several ways:

The automatic transfer switches were changed to a type that allows for a ramp up and ramp down of the load so as not to subject the generators to unnecessary step loads and to protect the building loads from voltage disturbances.



1 E2106 UPS SYSTEM SINGLE LINE DIAGRAM N.T.S.

Additional controls and protection were required due to the extended paralleling of the generators with the utility grid. Further negotiations were required with North Bay Hydro. At this time, the dispatch operation is not enabled but it is expected to be enabled in the future when the need is more pressing and when the Hospital makes the necessary financial arrangements. The inclusion of the bi-fuel system on the generators reduces the operating cost of running the generators and this makes dispatch operation financially attractive.

Systems

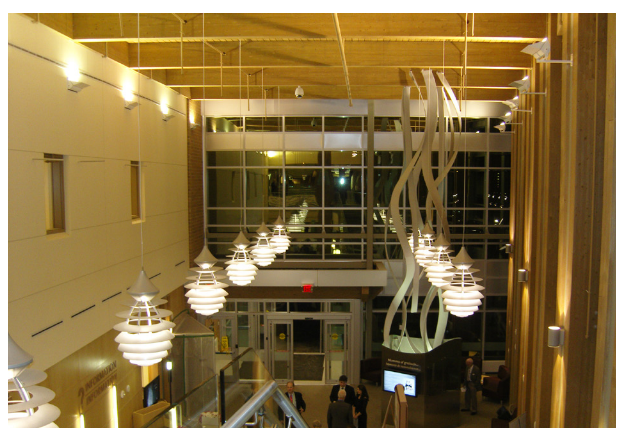
Specialized electrical systems features for the project included a centralized uninterrupted power system (UPS) and an integrated communications systems platform used for all building operations and healthcare applications.

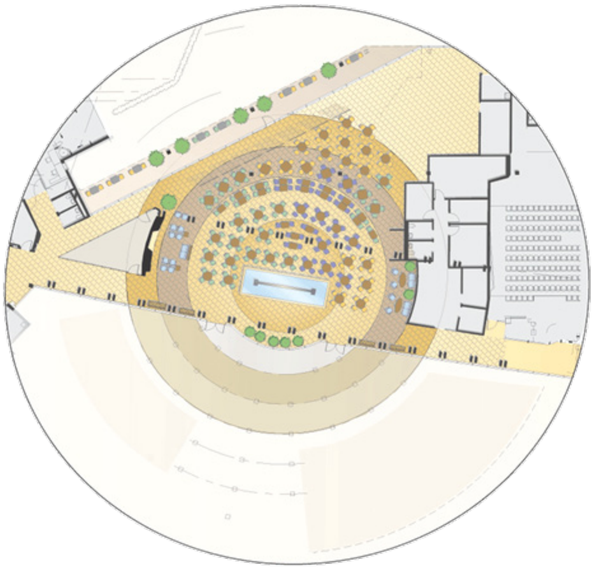
The "Street" floor plan posed challenges in providing adequate fire detection due to the height of the space, possible stratification of the air and smoke, possible future installation of signs, decorations, banners, etc, bright sunlight and possible minute vibrations in the structure, as well as difficulty in accessing devices for testing. The solution was to use an air sampling system that draws in air (and any smoke) from multiple locations at multiple levels. These air samples are then analyzed by a laser smoke detector located in accessible closets. The challenges were to design the system to provide adequate coverage as well as a short response time. Multiple systems were installed in order to keep the length of the sampling pipes short enough so that the sample transit time was within acceptable limits.

Lighting

Lighting played an important role in the design and feel of the hospital. Natural light was maximized with lighting illumination to enhance patient comfort and the healing process. The patient bedrooms use LED nightlights. These were pioneered by H.H. Angus on earlier projects in 2001/2 (now they are common). Typically patient nightlights use incandescent lamps. The use of the LED nightlights reduces the energy consumption but, more importantly, the long life of LED lamps significantly reduces maintenance and the device is less likely to be burnt out when the patient needs it.

The lighting was designed to strictly limit stray light in accordance with the LEED® criteria for a "dark night sky". This required the use of sharp cutoff luminaires carefully located to provide adequate illumination.





Community Plaza Plan

Cogeneration

Extensive studies were conducted to assess the feasibility of cogeneration. The generally favourable economics (advantage of floating rates of hydro energy costs and potential energy recovery from generators) combined with the added reliability made it an attractive proposition for the hospital; however, the capital dollars were not available at the time, however provisions were made throughout the design to allow this addition in the future.

Adding the cogeneration capacity to the emergency power capacity will allow the hospital to continue operations at close to normal capacity during unplanned power outages, a huge asset for clinical operations and patient safety.

Lifecycle

In the Build-Finance-Operate model, it is important to not only design with legacy in mind, but also sustainability and longevity. It is important to ensure that the design will stand the test of time and be flexible for changes in technology without increasing operating costs in the future. The design was done with this in mind since the beginning. Preventative maintenance is a consideration in the designs so that not only are they state-of-the-art, they are meant to be change over time with ease as technology improves, and maintained with ease.

LEED®

NBRHC was the first LEED® registered healthcare facility in Canada. It was registered with the US Green Building Council as it predated the Canadian Green Building Council. As a pioneer, this intensifies the already complex design.

The focus was to build a robust facility that would be flexible, adaptable, reliable and energy-efficient. The main challenge at the beginning was performing energy modeling as this type of software was not as developed as we know them now. Accepting the challenge, the design team succeeded in using the energy model to guide the design process to create an energy-efficient building, meeting all the LEED® standards.

H.H. Angus has over 50 LEED® Accredited Professionals.

Workshops evaluated different options and, through this process, led to the implementation of a number of technical innovations.

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Social and Economic Benefits

A modern, new hospital is very important for a city such as North Bay in Northern Ontario. Being the only acute health care centre

Serving a large area and 300 km from larger centres, such as Toronto or Ottawa, make it a very key part of the community.

Among the economic, social and environmental quality of life factors are:

- Spin-off of healthcare jobs and other suppliers. Job creation for an average of 250 workers on site daily. Local businesses to benefit through approximately $80 million of supply purchases
- $150 million salaries expected to have been paid during the construction phase
- Attraction for employment of new doctors and specialized staff to the hospital
- Enhanced ability of other employers to attract staff
- Higher level of medical care including remote telemedicine and telerobotic medical procedures
- Accommodation of cultural imperatives for bilingual and First Nations local population; for example, eight 'smudging rooms' were designed to have dedicated exhausts to accommodate religious and cultural ceremonies. These have dual function fire detection (smoke and heat). Normally this type of detector provides smoke detection for the earliest response; however, if a Sweet Grass ceremony were to be performed, the smoke detection function could be shut off and only heat detection would be provided in order to avoid nuisance alarms.
- Environmentally friendly design without major impact to natural and wildlife surroundings
- Design to conform LEED® certification standards
- Each hospital to retain governance and management of its services and ownership of its premises
- Maximized efficiency in hospital operations due to consolidation (three into one). Larger facility equipped to offer more services than the current two-site operation
- The hospital remains publicly owned, publicly controlled and publicly accountable

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