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MECHANICAL CONTRACTORS

TECK ACUTE CARE CENTRE

(BC CHILDREN'S AND BC WOMEN'S HOSPITALS REDEVELOPMENT PROJECT)

PROJECT TEAM:

Construction Design-Build Manager:	**Affinity Partnerships / CWH Design-Build GP**
Architect:	**ZGF Architects & CEI Architecture**

MECHANICAL DESIGN-BUILD TEAM:

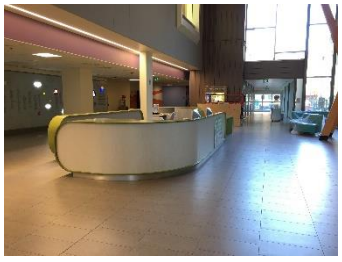
Mechanical Consultant:	**AEI | Affiliated Engineers, Inc**
Mechanical Contractor:	**Fred Welsh Ltd.**
Sheet Metal Contractor:	**Apollo Sheet Metal Ltd.**
Building Automation:	**ESC Automation**
Fire Protection:	**JCI / Tyco Integrated Fire & Security.**
Medical Gas Systems:	**Class 1 Medical Gas Systems**
Hemodialysis System:	**Baxter Renal**
Fuel Oil Systems:	**Western Oil Services**
Pipe and Duct Insulation:	**Aarc West Mechanical Insulation**
Balancing & Commissioning:	**KD Engineering Co.**

BCCW-TACC at a Glance:

The Teck Acute Care Centre project is an eight-storey, 640,000 square-feet expansion at the BC Children's and BC Women's Hospital Campus.

Following are the main project components:

- 231 Private Patient Rooms
- Emergency Department
- Medical Imaging Departments
- Neonatal Intensive Care Unit
- Pediatric Intensive Care Unit



- OR and Procedural Suites
- High-risk Labour and Delivery Suites
- Medical / Surgical In-patient Rooms
- Hematology / Oncology / Bone Marrow Transplant Department
- Renal Dialysis Department

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Mechanical Systems:

Following are the main mechanical systems serving the BCCW-TACC:

HVAC SYSTEMS

- Air Handling Units – (10) Units located on L5; 337,000LPS / 715,000CFM total airflow.
- Return Air Fans – (6) Units located on L5; 214,200LPS / 453,800CFM total airflow
- General and Specialized Exhaust Systems – 268,000LPS / 567,800CFM total airflow.
- (4) Air Cooled Chillers, 400 Tons each.
- (1) Water Cooled Heat Recovery Unit consisting of (5) modules 75 Tons each, providing the building process cooling loads.
- (2) Air Cooled Heat Recovery Units, 467KW Cooling / 515kW Heating capacity each, providing the first stage of heating when simultaneous heating and cooling loads exist.

- (2) Air Source Heat Pumps – (3) module and (5) module units, each module 30 Ton, providing the second stage of heating, recovering heat from the exhaust air leaving the building
- Energy Transfer Station (ETS) comprised of (2) Steam / District Heating Heat Exchanger Skid Units, each unit: 15,100kW / 51,500,000Btu/Hr. Heat Transfer 25,700kg/Hr. / 54,000lb/Hr. Steam Flow, 125PSI Steam Operating Pressure
- 340m / 1120ft of 10'' exterior direct buried District Heating piping system (Logstor EN253 System)
- Heat Exchangers - Building Heating, Process Heating, Domestic Hot Water, Hot Water Recirc and Domestic Water Pre-heat; 16,900kW total heat capacity.
- Back-up Steam Heat Exchangers for Building Heating and Domestic Water systems, 14,800kW total heat capacity
- Hydronic Systems: Heating, Process Heating, Chilled Water, Process Chilled Water, Steam and Condensate, District Hot Water, Radiant Floor Heating systems c/w a total of 1,250HP pumping capacity. Overall, approximately 68,000ft (13 miles) of installed hydronic piping systems.
- Total of 40 Tons of cooling for the elevator machine rooms.
- (64) Fan Coil Units serving critical areas, electrical and IMIT rooms; total of 250Tons cooling capacity.
- In-slab hydronic radiant heating systems for the Main Lobby and Patient Seclusion Room areas

- (3) Steam Boilers, 982kW capacity each, for building humidification requirements.
- HVAC Ductwork: Supply Air, Return Air, General Exhaust, Garage Exhaust, Specialty systems - Isolation Exhaust, Fume Hood Exhaust, Wet Exhaust, c/w 2,709 Supply, Exhaust and Return Air Terminal Units.
- 500ft of 20'' SS Generator Exhaust Piping System

PLUMBING SYSTEMS

- Domestic Water, Non-potable Water, Lab and Dental Water, Sanitary and Storm, Decontamination Waste Systems
- (2) Concrete Domestic Water Storage Tanks, 76,000L capacity, providing 72 hours of building operation
- (1) 50,000L capacity Decontamination Storage Tank serving the decontamination showers
- (2) Concrete Sanitary / Black Water Storage Tanks providing on-site storage for 24 hours of full hospital operation.
- (2) Upper & Lower Zone Domestic Water Triplex Booster Pump Skids
- Domestic Hot Water, Hot Water Recirc and Preheat Heat Exchangers; 5,300kW total heat capacity

- (2) Chlorination Skid Units to maintain the potable domestic water quality in the storage tanks
- Back-up Steam / Domestic Hot Water and Recirc Heat Exchangers; 4,900kW total heat capacity
- (10) Sanitary and Storm Submersible Sump Pumps; 2,330GPM total flow
- 1,985 Plumbing Fixtures and over 500 drains
- Overall, approximately 95,000ft (18 miles) of installed pressure plumbing piping and over 83,000ft (16 miles) of drainage piping systems

MED GAS SYSTEMS

- Medical Oxygen System – 9,000 liquid liters main and 3,000 liquid liters secondary Oxygen Bulk Storage Tank. Includes a 20x20 automatic reserve manifold and additional 80 reserve cylinders
- Med Nitrogen – 2x2 Liquid Automatic Manifold with additional (11) back-up dry cylinders
- Med Nitrous Oxide – 3x3 Automatic Manifold
- CO2 – 3x3 Automatic Manifold
- Med Air – 372 SCFM Medical Air Compressor c/w 20x20 back-up Automatic Reserve Manifold
- Med Vacuum System – 360 SCFM Medical Vacuum Pump
- Anesthetic Gas Scavenging System – 198 SCFM Vacuum Pump
- Lab Compressed Air System – 61 SCFM Lab Air Compressor

- Dental Air Compressor – 5 SCFM Compressor Unit
- Dental Vacuum Pump – 10 SCFM Vacuum Pump Unit.
- Total of 96 Zone Valve Boxes serving over 6,000 medical outlets
- Approximately 102.000 ft (19 miles) of medical gas distribution piping

HEMODIALYSIS PURE WATER SYSTEM

- Central patient Hemodialysis Pure Water System c/w 10 point-of-use stations serving the L3 Renal Dialysis Department.
- A secondary “raw water” hemodialysis system with 28 point-of-use system was provided on L4 PICU Department to serve portable dialysis machines.

BUILDING AUTOMATION AND MANAGEMENT SYSTEM

- Standalone Delta Controls BAS System incorporating a Web Based front end.
- Approximately 20,000 physical I/O points.
- Approximately 3,500 Controllers.
- (70) Delta Controls HMI panels for CSA Class I Isolation Rooms
- BAS System integration to 3rd party systems such as:
  - Nurse Call Integration (automatically notifications for hospital staff when critical medical alarms are active)
  - PDCS System
  - Fire Alarm System Integration and Control, including:
    - Automatic Smoke Control System using the Supply/Return and Exhaust System via the BAS.
    - Automatic Smoke Sequencing for Stage 1 and Stage 2 Fire Alarm on a zone by zone basis.
    - Automatic floor smoke ventilation.
  - Electrical Metering System Integration
  - Lighting System Integration
- Fully Integrated Energy Dashboard System that allows the user to review hourly, daily, weekly, monthly and yearly consumption and demand.
  - Allows user to set energy targets and baselines for baseline comparisons.
  - Energy Reports are automatically emailed to client inbox on a user defined basis.
- Automatic Critical email alarming direct to client Helpdesk.
- Kaizen Analytics package:
  - Web based supervisory building analytics platform
  - Automated Fault Detection & Diagnostics (FDD) & Advanced Energy Analytics
  - Assists in continuous commissioning and report generation for client.
  - Reports building operational and tuning issues.
  - Provides additional trend views and assists in uncovering optimization opportunities.
  - Allows Measurement & Verification to be performed on implemented changes.
  - Allows commissioned BAS settings to be baselined and then tracked for any deviation.
  - Fully customizable reporting can be established to suit client needs.
  - Custom Energy Dashboard and reporting capabilities

FIRE PROTECTION SYSTEMS

- 325,000L post-disaster Fire Water Storage Tank
- Fire Pump Skid Package System
- (15) Preaction and Dry Pipe fire protection systems
- (17) Wet Pipe Systems
- (57) 2-1/2'' stairwell Standpipe Hose Valves
- Over 113,000 ft of steel pipe ranging from ¼'' to 8''
- Approximately 6,400 Sprinkler Heads

FUEL OIL SYSTEM

Serving the (2) L0 Emergency Generators:

- 65,000L Double-wall, below grade, Fuel Storage Tank
- (2) 4,000L Double-wall Fuel Day Tanks
- (2) Submersible Fuel Oil Pumps
- Fuel Oil Management and Pump Transfer Control System

PROJECT INFORMATION:

Schedule:

Phase 1 Construction Start Date:	JAN 2014
Phase 1 Completion / Service Commencement:	JUL 2017
Phase 1 Project Duration: 42 Months	
Phase 2 (Post Service Commencement Work) Start:	JUL 2017
Phase 2 (Post Service Commencement Work) Completion:	FEB 2018
Phase 2 Project Duration: 6 Months	

In accordance with the Project Agreement documents the original targeted completion dates for both Phase 1 and 2 of the project were achieved. The Service Commencement date was July 05, 2017.

Bidding, Design-Build Process & Financial Performance:

The BCCW TACC project was developed under the P3, Public-Private-Partnership model.
As the mechanical design-assist contractor, FWL provided valuable input during all stages of the project, from the pursuit phase to schematic design, design development and construction phases.

- During the initial pursuit phase FWL has worked closely with all members of the CWH design-build team providing design & costing input, value engineering options and ensuring compliance with the project documentation. FWL, part of the CWH team was selected as the Successful Proponent for the project.
- Following, FWL was involved in the design development and initial construction phases working with the design-build team and the Authority ensuring that the project compliance and financial targets are met.

- The early design-assist procurement allowed the team to be on site and start the construction process much earlier than in a traditional bid-build procurement model. This was critical for the success of the project and for meeting the targeted Service Commencement and completion dates.
- Full-Scale Mock-ups – FWL's involvement in providing the full-scale mock-ups of the patient care areas and working closely with the end users was an important avenue for gathering valuable clinical input during the design and construction phases.
- 3D / BIM Modeling Process – FWL participated extensively in the BIM modeling process which was an extremely important avenue for achieving a coordinated design, reduce conflicts and changes during construction and provide overall construction efficiencies and improved productivity.
- Coordination with the Facility Maintenance Team – Working closely with the Facility Maintenance Team during both design and construction phases was critical to ensure ease of maintenance and efficiencies are met.

The project financial targets were achieved.

Innovation & Improvements

Following are some notable innovations and improvements FWL was involved in that provided a financial benefit for the Project:

- Alternate Steam and Condensate connections for the Energy Transfer Station – FWL has worked on an alternate proposal for the 10'' steam and 6'' condensate tie-ins into the existing systems that provided both a financial and operational benefit for the project. Additionally, substantial re-work and operational impact in the existing steam plant was avoided.
- Alternate Piping for the L9 Chillers – FWL provided an alternate piping configuration for the level 9 roof Chillers which resulted in construction efficiencies.
- General Exhaust Heat Recovery Systems – FWL worked closely with the mechanical consulting team and equipment suppliers to provide an innovative solution for the general exhaust heat recovery system. Modular air-source heat pumps were installed in custom-built exhaust air plenums with multiple combination motorized dampers for an efficient and cost-effective method for recovering heat from exhaust air leaving the building.
- Implementation of the Kaizen Analytics package, a Web based supervisory building analytics platform that provides valuable input for the building operator.
  - Automated Fault Detection & Diagnostics (FDD) & Advanced Energy Analytics
  - Assists in continuous commissioning and report generation for client.
  - Reports building operational and tuning issues.
  - Provides additional trend views and assists in uncovering optimization opportunities.
  - Allows Measurement & Verification to be performed on implemented changes.
  - Allows commissioned BAS settings to be baselined and then tracked for any deviation.
  - Fully customizable reporting can be established to suit client needs.
  - Custom Energy Dashboard and reporting capabilities
- In order to achieve the strict noise criteria levels in the clinical spaces surrounding the emergency generator area FWL was involved in the design development and installation of an innovative solution for the generator exhaust support system using specialty type, high temperature resistant isolators and limit stops.

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Sustainable & Resilience Design and Construction

A significant aspect of the project was the mechanical systems energy efficiency.
This was achieved with the implementation of advanced heat-recovery devices to simultaneously optimize heating and cooling. Approximately 80% of the annual heating water and domestic hot water is provided through the heat recovery chiller and enhanced heat pump recovery system. The mechanical system consists of variable air volume air handling units with hot water reheating, which provides space conditioning and ventilation to a majority of the building. Premium-efficiency, air-cooled chillers and heat-recovery chillers provide cooling to air-handling units and process cooling loads in the building. The first stage of heating is provided by heat recovery chillers when simultaneous heating and cooling loads exist. The second stage of heating is provided by air-source heat pumps that recover heat from exhaust air leaving the building.

Another significant aspect of the project was the incorporation of resilience design principles and strategies that mitigate the consequences of potential natural disasters, pandemics, and other mass casualty events. Key post-disaster incorporated elements:

- N+1 level redundancy to ensure that systems remain operational in the event of equipment failure.
- On-site domestic water storage providing 72 hours of operation
- On-site sanitary storage capable of serving 24 hours of full operation
- Design flexibility for the ambulance canopy to convert into a mass-decontamination showers.
- Inclusion of six pandemic outbreak patient room pods
- Double occupancy ability in many patient rooms.
- Post-disaster emergency fill connection for domestic water, med oxygen and sanitary pump out.

Project has a LEED Gold targeted rating.

Project Challenges

- Early construction start, before finalized IFC drawings, required additional coordination to avoid re-work and changes during construction.
- On-time material procurement and deliveries were critical to ensure that the existing Hospital Campus is fully operational with minimal impact.
- Lifting and placement of air handling units on L5 mechanical room – required extensive coordination and planning between FWL and CWH. Total of (44) AHU sections with a total weight of 460,000lb was lifted over a period of (3) weeks.

- Lifting and placement of the air-cooled chillers on L9 roof required careful planning and coordination due to the limitations of construction site cranes.

- Managing a large construction team (mechanical team had over 240 workers at peak construction)
- The design and construction of the emergency generator muffler supporting system and associated exhaust piping system supports, expansion compensators and anchors did require a comprehensive multi-trade coordination (mechanical, structural, acoustical & vibration isolation, seismic) in order to achieve the prescribed noise and vibration criteria levels.

Other Specific Project Conditions

- *Site Cooperation* – Extensive communication, cooperation and coordination between all project stakeholders - the design-build team, the Authority, FMO and end-users was implemented throughout the design and construction of the project. The process included: design coordination meetings, user-group meetings, mock-up reviews, schematic design and design development compliance reviews, construction coordination meetings, BIM reviews, clash detection & resolution and final building systems testing and commissioning processes.
- *Material Management* – Efficient and on-time material management and procurement was a critical task of the project due to the extremely limited site space and working in operational hospital campus.
- *Safety Record*:
  - Total FWL worked hours: 270,500
  - With the implementation of the COR certified safety program and safe work practices and procedures FWL performed many critical tasks and only registered (1) day of lost time over the (48) months construction period.