AME Group
Consulting Professional Engineers

Canadian Consulting Engineering Awards 2012

The Jim Pattison Centre of Excellence in Sustainable Building Technologies and Renewable Energy Conservation

Submitted by:
The AME Consulting Group Ltd.

ASSOCIATION OF CONSULTING ENGINEERING COMPANIES | CANADA
ASSOCIATION DES FIRMES D'INGÉNIEURS-CONSEILS | CANADA

CANADIAN CONSULTING engineer

PROJECT HIGHLIGHTS

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Introduction
The Jim Pattison Centre of Excellence for Sustainable Building Technologies and Renewable Energy Conservation at the Okanagan College Campus in Penticton BC, was conceived to meet the urgent need for tradespeople, site managers and construction workers who are skilled in the practices of sustainable building. The 73,000 ft^2 (69,000 ft^2 net) building is comprised of six large trades shops, classrooms, demonstration lab, student study areas, fitness room, gymnasium, offices and support spaces as well as a rooftop testing and viewing area for roof mounted systems.

The Centre of Excellence has been designed to target LEED Canada NC 1.0 Platinum and the International Living Future Institute (ILFI) Living Building Challenge. The Living Building Challenge is comprised of seven performance areas: Site, Water, Energy, Health, Materials, Equity and Beauty. The most notable objectives for the mechanical systems are to target Net Zero Energy by minimizing building energy consumption.

One of the most unique features of the building is that it will be utilized as part of the teaching curriculum with exposed and highlighted HVAC systems, hands-on lab access to HVAC building systems, interactive building controls and live demonstrable building energy consumption data.

AME is proud to say that the project was successfully completed within an accelerated construction schedule as well as on budget

Project Mechanical Innovation
To achieve net-zero energy consumption the mechanical design focused on conserving energy, as well as recovering and capturing energy. An additional challenge associated with the Living Building Challenge is that no energy for the building can be from combustion of any kind. An electric based system also allows the use of electrical net zero metering with the photovoltaic panels covering the roof of the building.

Penticton is located in a valley between Okanagan Lake and Skaha Lake in the interior of British Columbia which is a dry climate with relatively hot summers and cold winters. Several studies were completed to review optimum building geometry, envelope and mechanical systems to reduce energy consumption of mechanical systems for Net-Zero Energy target. The AME Consulting Group proposed an open-loop groundsource water to water heat pump system with in-slab radiant heating and cooling combined with a hybrid natural and mechanical ventilation system with heat recovery. A weather station combined with control indicators were proposed to indicate to the occupants when to open or close operable windows to limit energy consumption.

A solar hot water system provides domestic hot water as well as supplemental building heat. Excess heat is rejected to the ground via the geo-exchange system. Both evacuated tube and flat panels were installed for demonstration purposes and comparison to augment the instructional function of the building.

AME Group proposed using integrated PEX tubing as part of the concrete and wood composite wall panels for the gymnasium. This allowed radiant heating and cooling to be used in the gym without the use of PEX tubing below the wood floor. In addition, ductwork and displacement ventilation diffusers were installed integral with the composite wall panels.

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The building, including passive and active systems, was modeled in IES Virtual Environment by AME Group to determine optimum design and ASHRAE 90.1, 55 and 62.1 compliance.

Energy Efficiency – Groundsource Heat Pump System

The ground source heat pump system for this project utilizes an open loop geo-exchange system to extract heat from the earth using pumped ground water from production wells. The water is passed through a heat exchanger inside the building for heating or cooling and re-injected back into the ground through injection wells on the opposite side of the project site. The system consists of two (2) production wells with well pumps, four (4) injection wells, a heat exchanger (with back-up) and three (3) water to water heat pumps. The heat pumps are only used during winter to heat the building with in-slab heating. In the summer, the heat pumps remain off and ground water is only passed through the heat exchanger to reject the heat from the building (no refrigeration cycle is used). Free cooling helps to further reduce the energy consumption of the building to meet the net zero energy target.

Indoor Air Quality:

The ventilation system is a hybrid system using natural ventilation when environmentally beneficial and using mechanical ventilation with heat recovery when the outdoor conditions are not favourable for natural ventilation. The system uses a roof mounted weather station to determine when to open the windows indicated with a "green light" and a "red light" when windows should be closed. Solar and wind assisted natural ventilation chimneys boost the natural ventilation available with operable windows and were modeled using IES VE to confirm ASHRAE 62.1 compliance. Control dampers on the natural ventilation chimney open or close based on wind direction to optimize natural ventilation. When the natural ventilation system is not being used, the mechanical ventilation system provides outdoor air via displacement diffusers with reverse-flow heat recovery units at the air handling units to reduce energy for heating and cooling outdoor air. The design intent of the combination of the two systems is to reduce building energy use as well as provide optimal indoor air quality and comfort for the occupants. The "red light/green light" system of control requires active response by the students and faculty making them an integral part of the building performance, thereby increasing awareness.

Operation and Maintenance

The system consists of simple mechanical equipment including hydronic pumps, fans and heat pumps minimizing the amount of maintenance and simplifying building operation. The building operation staff have an integral role in educating students and staff about the impact of building use on energy consumption. The design team's goal is for the users to become aware of how their habits impact energy consumption and for the user to check the colour of the "red or green light" before reaching for the window operator.

Cost Effectiveness

Overall the capital cost of the mechanical system was similar to that of a conventional HVAC system. In addition, energy modeling indicates the energy cost savings for the building including envelope, lighting and mechanical systems contribute to a 64% savings over the baseline building (Canadian Model National Energy Code for Buildings). When including the roof mounted Solar Photovoltaic on-site in the energy model, the savings increase to 92% over the baseline model.

Environmental Impact

The carbon emissions reduction for the Jim Pattison Centre of Excellence is approximately 334.2 tons of CO_2 per year (equivalent to CO_2 emissions from 34,000 gallons of gasoline consumed). The goal of the College is to operate the building with net zero electrical energy consumption. The facility is also playing a part in the education of HVAC trades people who will contribute to the sustainable building industry in the future.

FULL PROJECT DESCRIPTION

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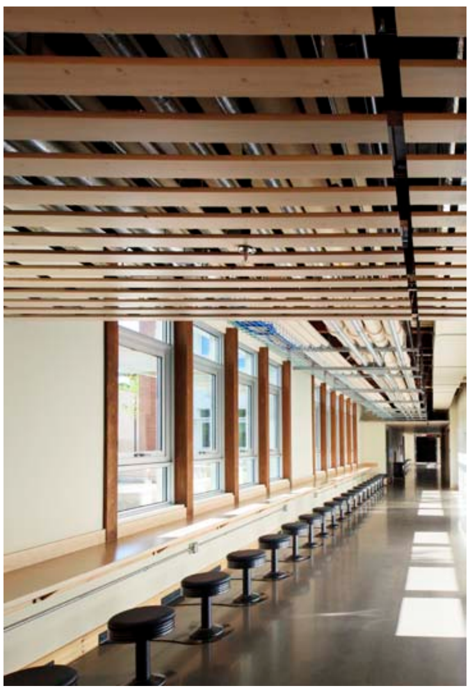
Main Entrance (photo courtesy of CEI Architecture)



Central Corridor with mechanical systems visible along ceiling (photo courtesy of CEI Architecture)

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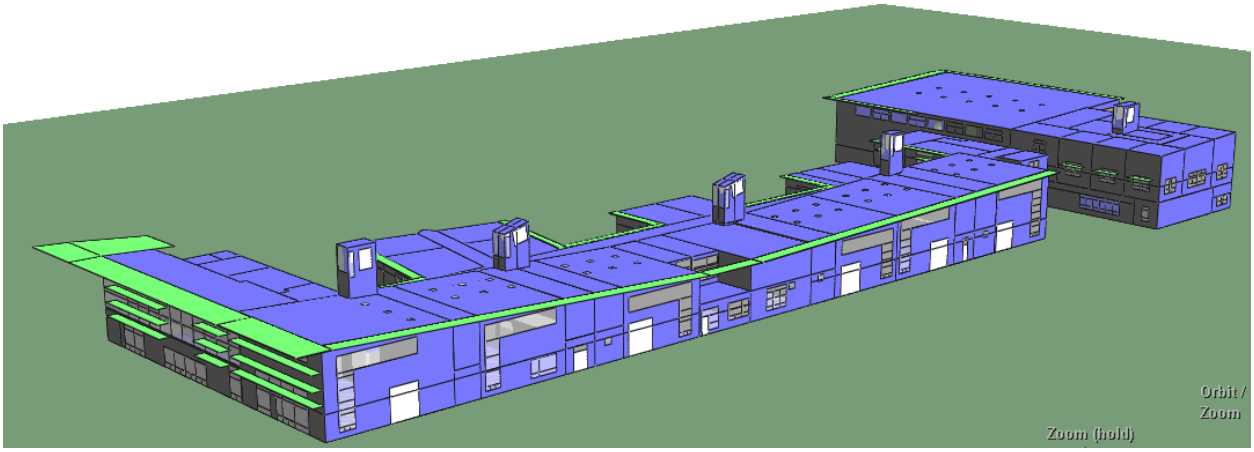

AME Group modelled the building Systems in IES VE (natural ventilation chimneys, solar tubes, external shading visible in image). Six labs/shops are shown along the foreground, classroom on far side of building and gymnasium at far right.

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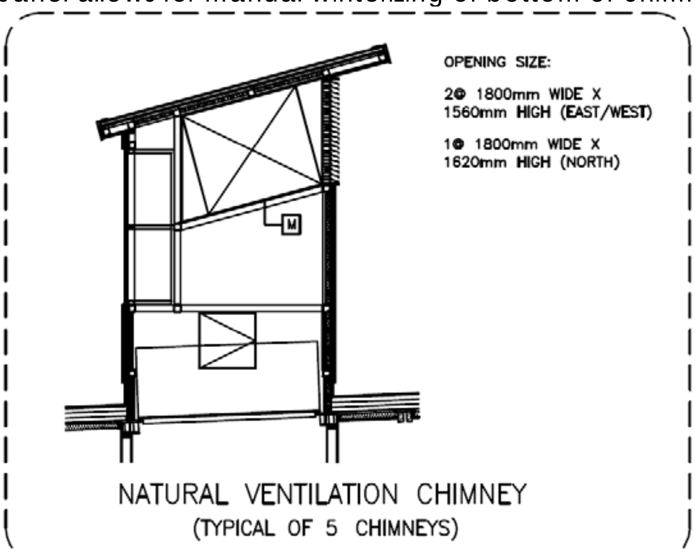
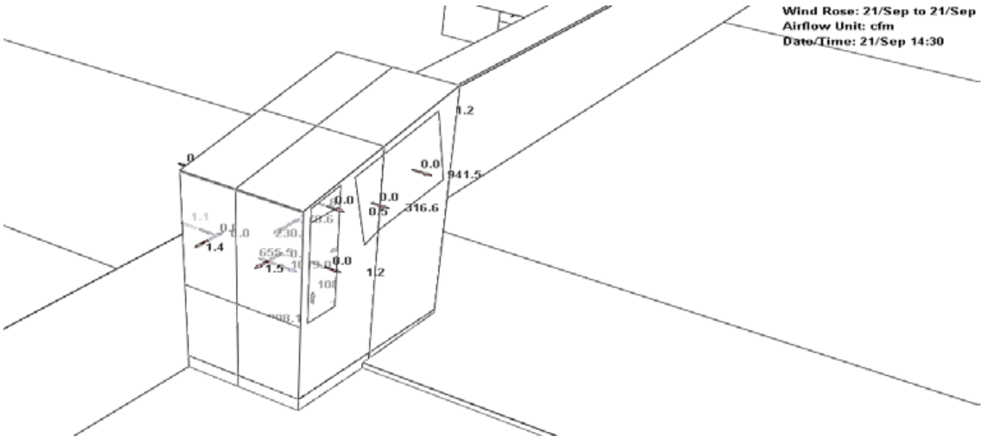
Completed Natural Ventilation Chimney (photo shows the solar assist glazing and East louvre. Access panel allows for manual winterizing of bottom of chimney with R40 insulating blanket)



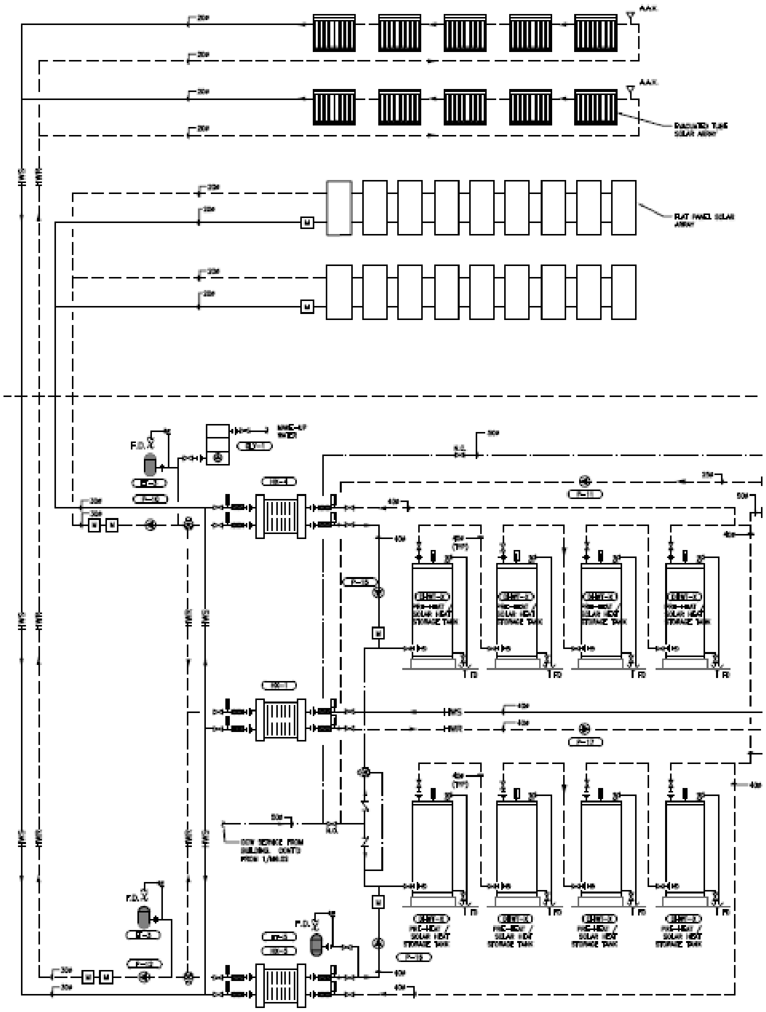
Natural Ventilation Chimney Section. Solar assist glazing on left, dampers and louvres on right.



Natural Ventilation Chimney model output indicating airflow patterns

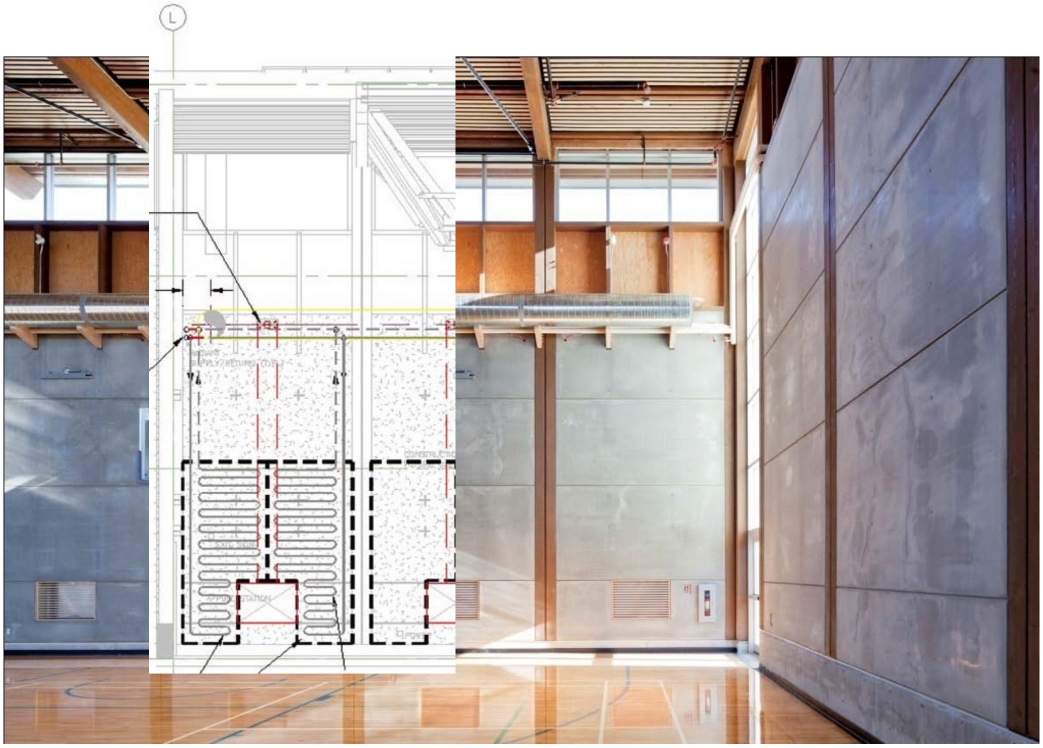
A solar hot water system provides domestic hot water as well as supplemental building heat. Excess heat is rejected to the ground via the geo-exchange system. Both evacuated tube and flat panels were installed for demonstration purposes and comparison to augment the instructional function of the building.

Flat plat solar collectors (background) and vacuum tube racks (foreground), PV cells which cover the roof are located to the left of the solar hot water panels)



Schematic of flat plate and vacuum tube hybrid system

AME Group proposed using integrated PEX tubing as part of the concrete and wood composite wall panels for the gymnasium. This allowed radiant heating and cooling to be used in the gym without the use of PEX tubing below the wood floor. In addition, ductwork and displacement ventilation diffusers were installed integral with the composite wall panels.



Overlay of mechanical drawing on photo shows the integrated hydronic heating imbedded in the concrete portion of the composite wall panels as well as the ventilation ductwork in void space of panel behind concrete

Photo showing installation of composite wall panel

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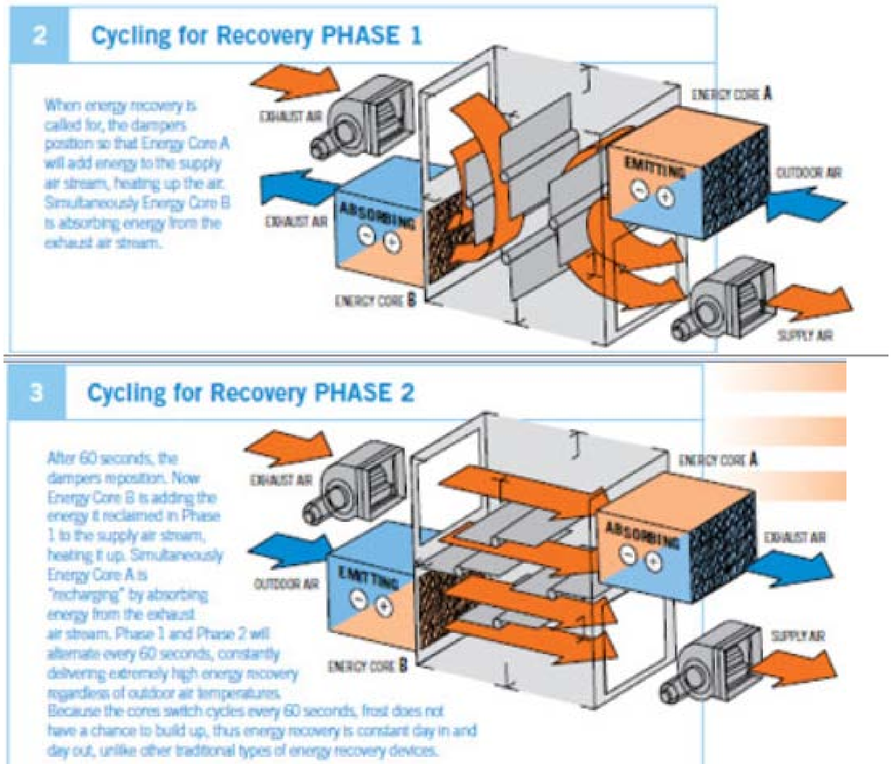
Reversing flow heat recovery unit on mechanical ventilation system provides over 80% heat recovery. Solar Tube Lighting dome is visible in the foreground (used for natural daylight throughout the building).



Diagrams indicate the reverse flow heat recovery technology employed in the ventilation system. Dampers cycle alternately heating and then recovering heat from aluminum cores.

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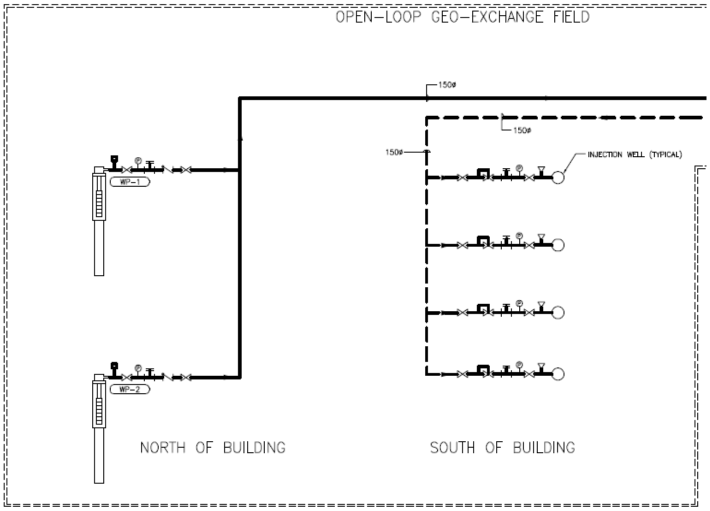

Simple schematic of open loop geo-exchange field. Two turbine well pumps force ground water through a heat exchanger (adding heat to OR taking heat from building) and pushes the water back into the ground via four injection wells

Photo showing underground geo-exchange pipes leading to injection wells at South of property where the ground water is injected back into the ground.

In-slab tubing prior to concrete pouring

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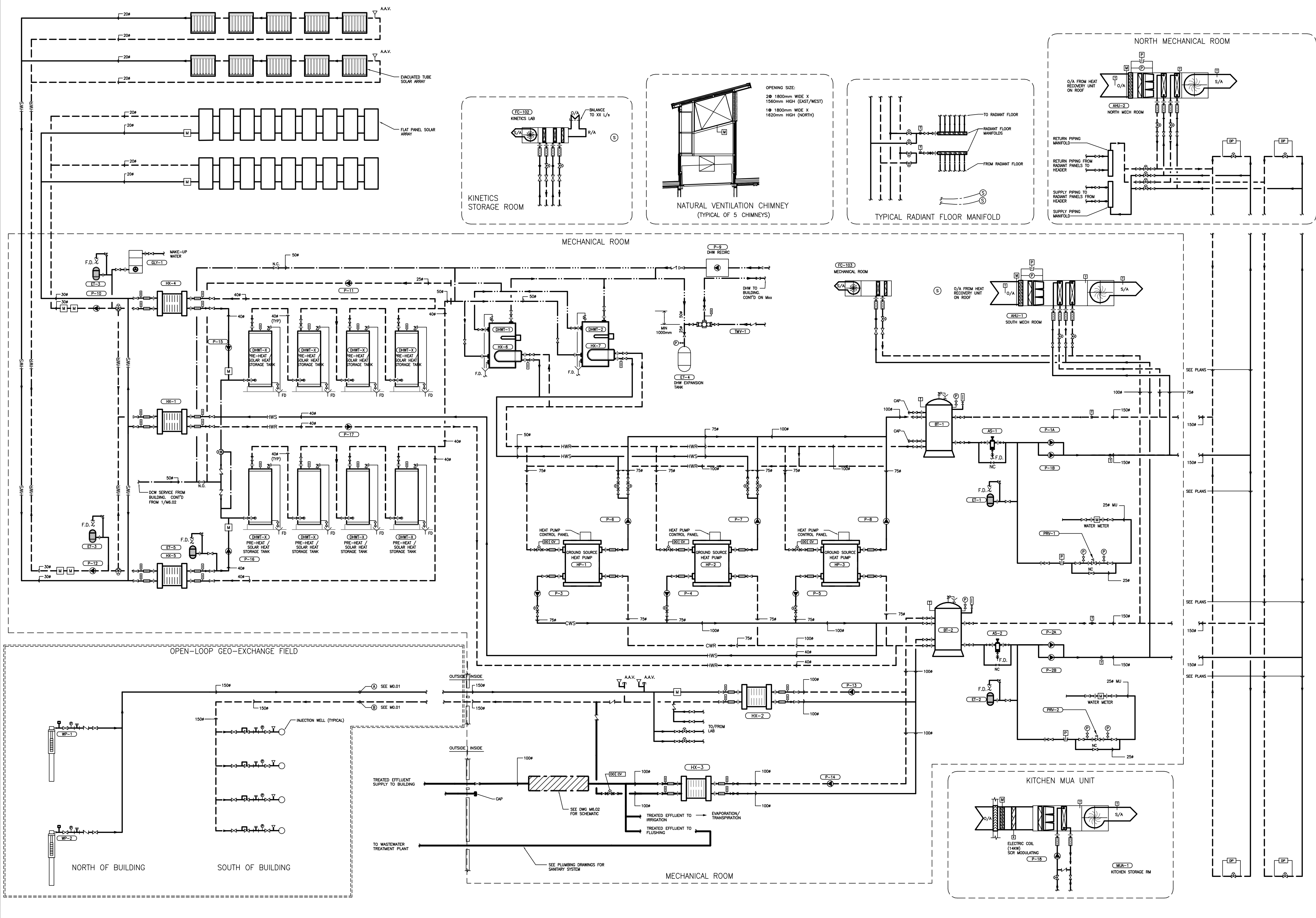
Photo of the Geo-Exchange Lab where the students can learn about the open loop geo-exchange system (stainless steel piping above) and closed loop geo-exchange system (pipes coming up from below). Displacement Ventilation ductwork and diffuser is also visible to the left. In all shops/labs the mechanical systems are visible to the students.

Photo shows the vision panels between mechanical room and student study area of the College.



HYDRONIC SCHEMATIC

M6.01 NO SCALE

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METRIC

ALL DIMENSIONS UNLESS OTHERWISE NOTED ARE IN MILLIMETRES

ISSUED FOR

NO.	DATE	DESCRIPTION

PROJECT TITLE

OKANAGAN COLLEGE
PENTICTON CAMPUS
Penticton Centre of Excellence in Sustainable Building Technologies and Renewable Energy Conservation
538 Duncan Ave. West
Penticton, BC
V2A 8E1

DRAWING TITLE

MECHANCIAL SCHEMATICS & EQUIPMENT

DATE 17 JAN 11 DRAWN
PLOT DATE 17 JANUARY 2011
CAD FILE -

PROJECT NO. B09-006-12

DRAWING NO. M6.01