Climate Data

The Kelowna, BC CWEC climate data used for this analysis describes a typical meteorological year and includes hourly values for many parameters including:

- Dry bulb temperature
- Dew point temperature
- Relative Humidity
- Solar Radiation
- Wind speed and direction
- Cloud cover

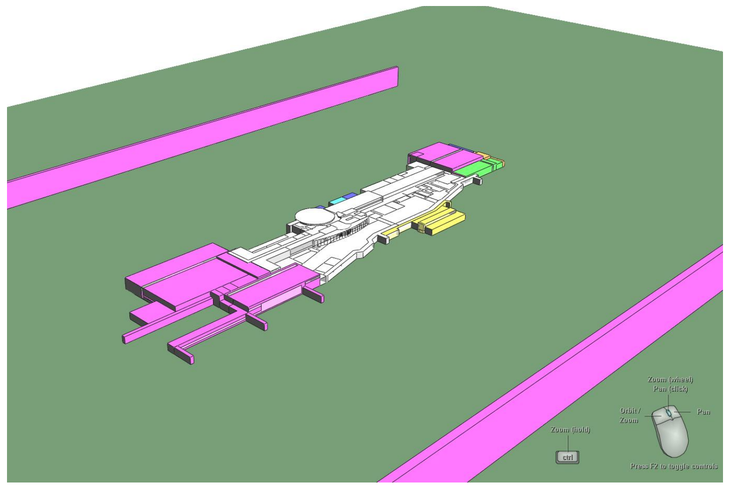


Figure 2 - 3D view of the IES model

Occupancy and Schedules

The following maximum occupancy numbers were used in the model:

CBSA	250
International Baggage Claim 1	202
International Baggage Claim 2	202
Domestic Baggage Claim	874
International/Domestic Hold Room Expansion	416

The maximum occupancy was adjusted according to the following time of day schedule. This schedule is based on the anticipated aircraft arrivals and departures predicted by the J. Suehiro March 2010 YLW Facilities Program Analysis:

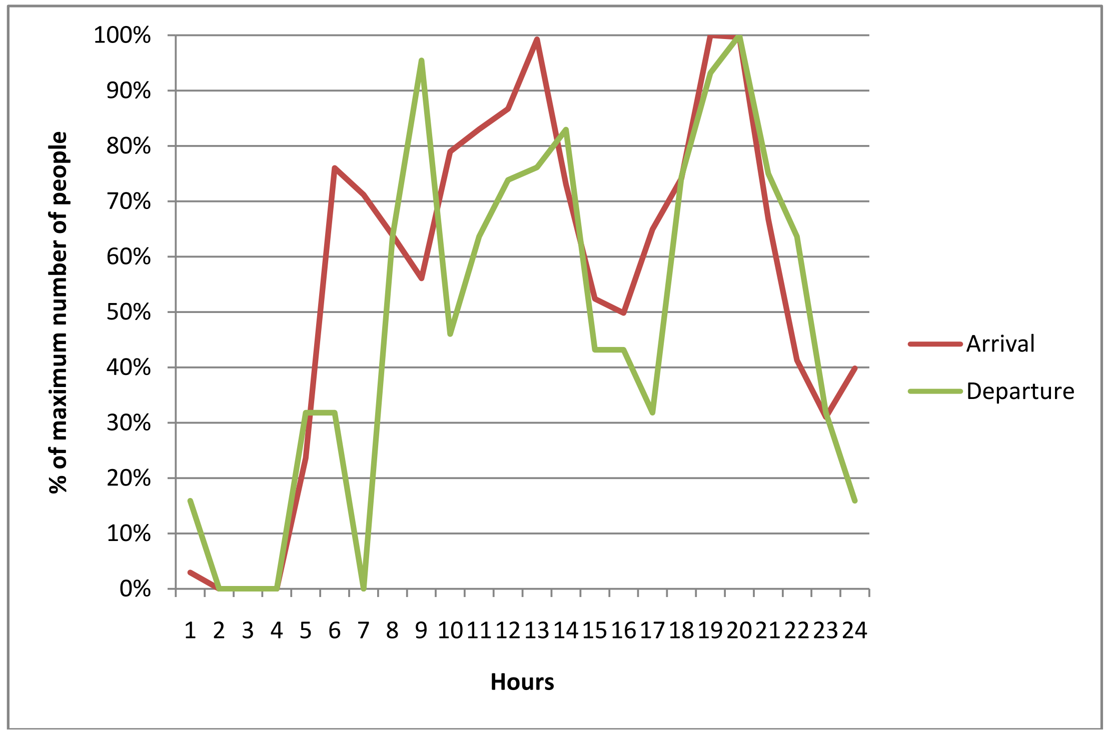


Figure 3 - Occupancy schedule for arrival and departure

Fans are considered to run from 5am to 11pm and light are assumed to operate from 6am to 11pm with a residual lighting power of 15% during the night.

Mechanical and Electrical

New construction mechanical and electrical system energy efficiency is based on the ASHRAE 90.1 2004 standard. Lighting power densities are defined for the different space types. Mechanical system types are defined in the ASHRAE 90.1 2004 Appendix G and equipment performance in section 6. The Design Option section gives details about the mechanical systems modeled.

Radiant floor areas

Radiant floor cooling was considered as a design option. Pipe imbedded in the concrete slab are not practical in certain area of the building where flexibility is required. For this reason, not all the areas were modeled with radiant floor.

Thermal mass elements

Concrete walls and slab where model in some areas to give the building more thermal inertia.

Impact of surrounding mountains on building shading

Mountain range East and West of the Airport have an impact on the solar gain. Mountains shade the building at sun rise and sun set. This has an impact on the energy consumption of the building.

A topographical map was analysed to determine horizon line angle with elevation and distance take-off.

A shading surface with the same height and distance from the airport was modeled in the software. A flat shading surface was used to model the horizon line instead of a mountain surface as it would have the same shading effect without requiring the significant computer processing time required to analyze a complex shape.

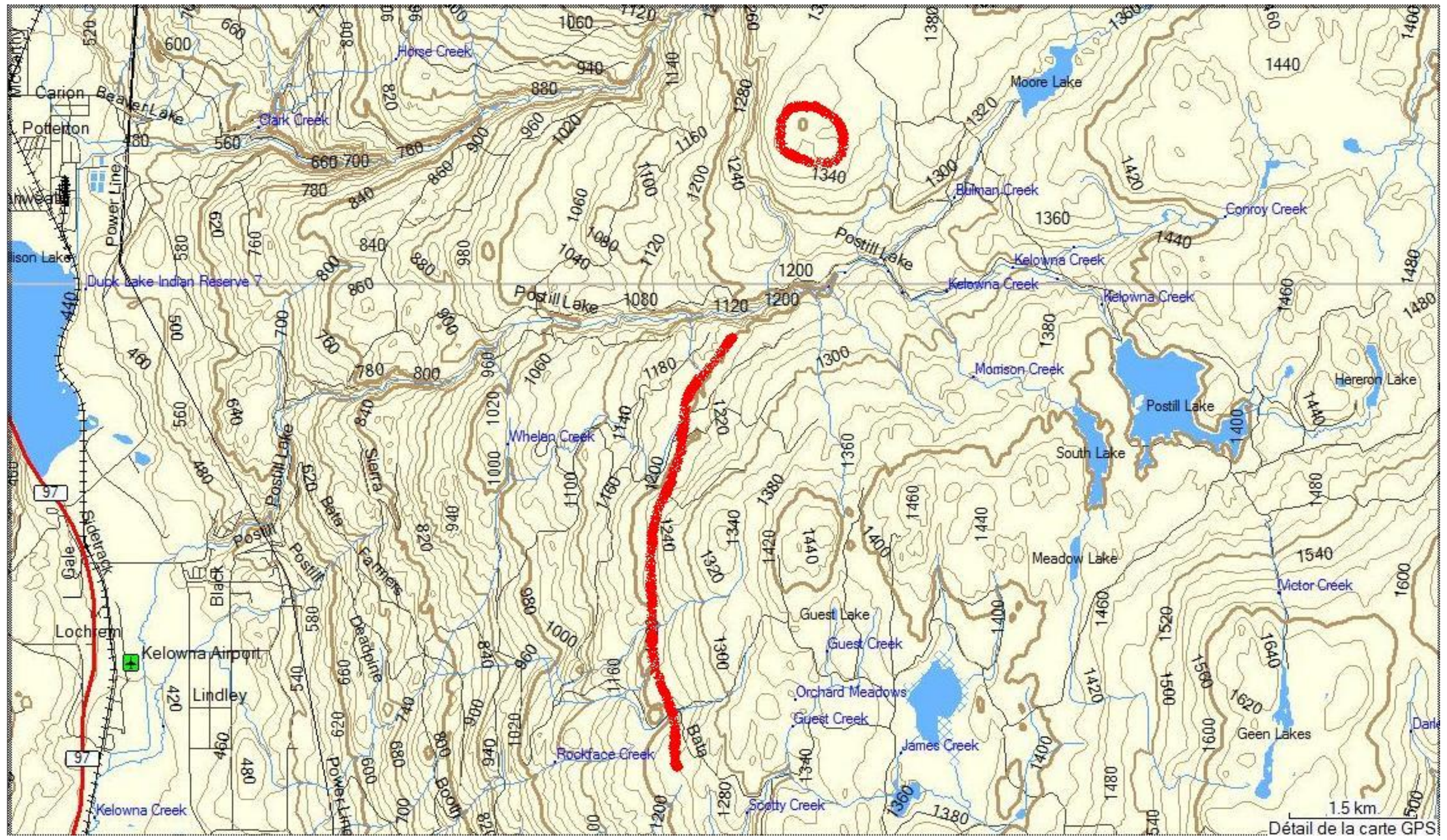


Figure 4 – Topographical map of Kelowna's airport surrounding (East side) identifying the mountain ridge and elevation that shades the airport

The horizon line is at an angle of 10 degrees from the horizontal on the West side and 7 degrees on the East side. This information can be incorporated in a sun path diagram to understand the impact of the mountains. A sun path diagram shows the path of the sun through the sky. This chart shows that the mountains are blocking the sun for the first hour of the day and for the last 40min of the day.

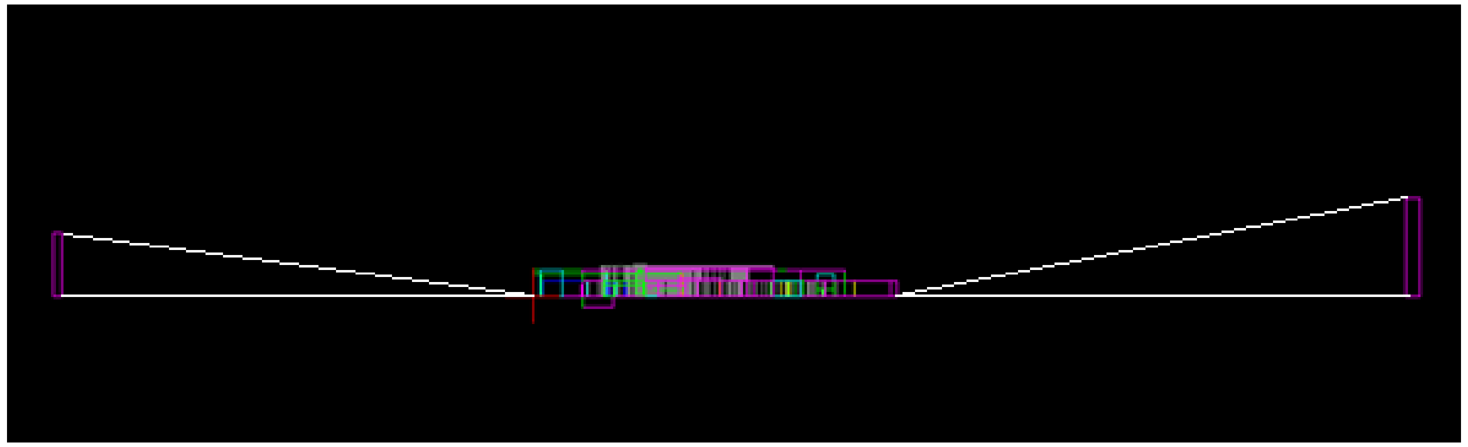


Figure 5 – Horizon line modeled in IES

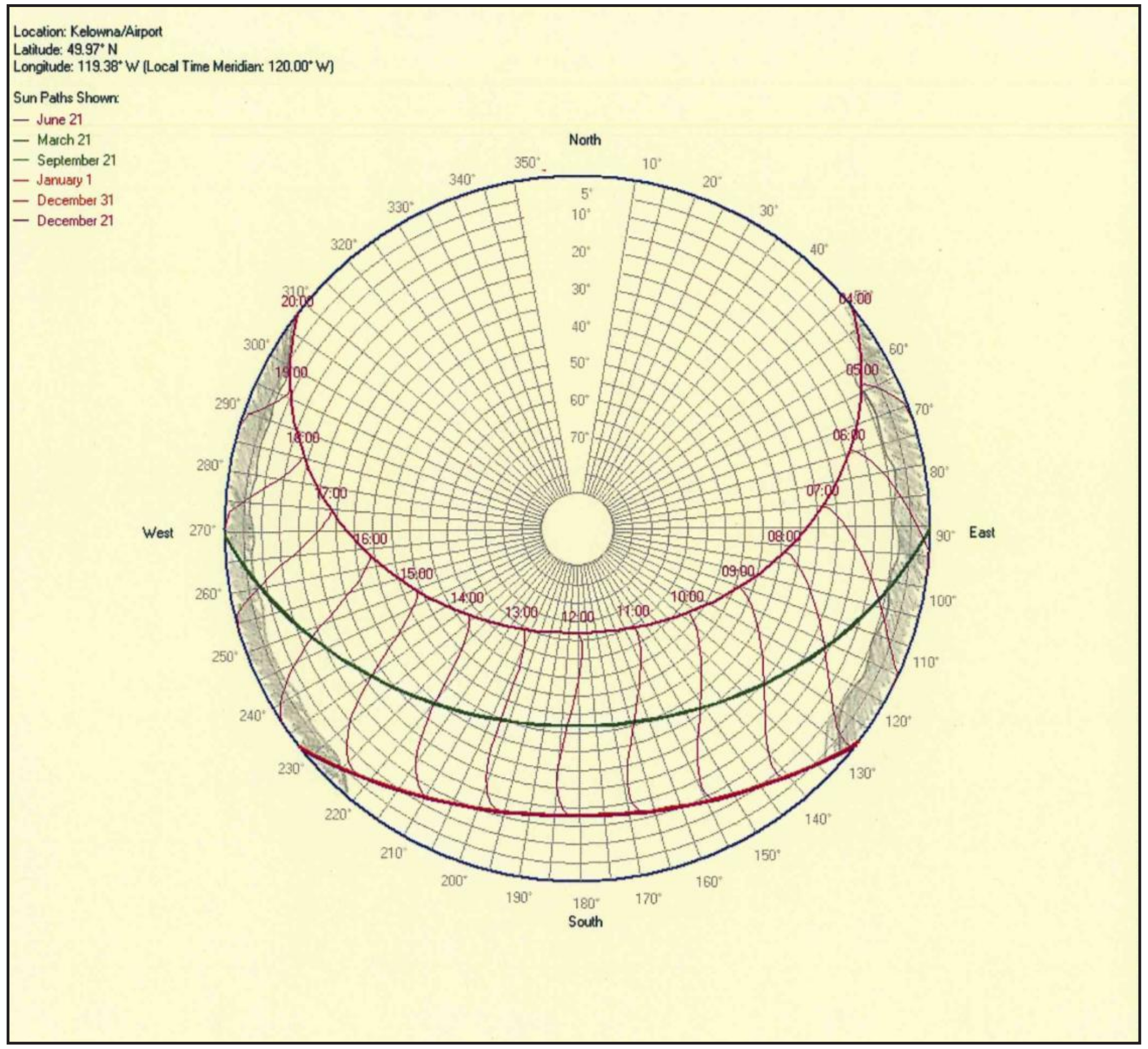


Figure 6 - Sunpath chart for Kelowna showing approximate shading from the mountain in gray

Utility Cost

Base on current utility bills, utility rates are 6.9¢/kWh for electricity and $11.18/GJ for natural gas. These rates include all demand and distribution charges. Designing this building for 2025, future rates need to be used in the analysis. Predicting future energy rates is difficult and subject to great debate. Natural gas is actively traded on the financial markets and can be purchased 5 years in advance. Looking at those future rates, we can identify a trend that can be extrapolated to predict 2025 rates. For this analysis we are being very conservative and are using the following values:

Commodity

Average Commodity price in the last year	Average BC gas supplier rates for fixed 5 year rate	2025 commodity rates used in the analysis
6.83$/GJ	7.9$/GJ	9$/GJ

Distribution Charge

Average distribution charge in the last year	2025 distribution charge used in the analysis
2.27$/GJ	3.7$/GJ

Other Charges

Other charge in the last year	2025 distribution charge used in the analysis
2.08$/GJ	2.08$/GJ

Total Natural gas price used is the sum of the commodity, distribution charge and other charges; 13.7$/GJ.

Future electricity rates are harder to determine due to the fact that the electricity market is regulated in BC. British Columbia government is keeping the rate as stable as possible and price follows the inflation rates. For this reason, electricity rates were kept the same as current rates in the energy simulation.

In our opinion, these rates are quite conservative (low). Higher gas rates were encountered in the last decade and could return particularly if the economy heats up again increasing demand, or if supply is constrained.

Energy Source Carbon Emissions

The following factors were used to convert utility consumption into green house gas emissions:

Electricity: 0.02kg/kWh1F

Gas: 0.181kg/kWh2F

Process Energy

Process energy related to aircraft operation such as the baggage handling systems, bridge powered units and any other aircraft operation were not included in the analysis. The impact of these processes should be done in a separate study to assess the carbon performance of the airport operations. Several opportunities exist to reduce process energy that the airport should consider to help meet their carbon reduction target. Efficient baggage handling systems, a policy to reduce aircraft powered unit use, and efficient apron lighting are a few ideas to be considered.

Integrated design approach

Optimization of facades

The energy model was used in the facade design process to help the design team understand the amount of heat gained from the sun shining through the windows. This is an important design consideration as uncontrolled solar gains can exceed the cooling capacity of efficient HVAC systems such as displacement ventilation and chilled slabs.

Solar and internal gains was analysed for each design option. The significant east and west facades require special attention as the low sun at sunrise and sunset will shine in through the east and west facades causing glare and temperature control challenges. A typical strategy to address these concerns is to reduce the east and west facade glazing ratio. This strategy was in tension with a desire to provide significant views to the apron, runway and mountains. Views are also important at the drop off and pick up areas. The design team balanced these considerations with an approach that varied the glazing ratio and sun shading to respond to the primary considerations for each space.

The IES Energy simulation software was also used to assess daylight performance. This information was used by the design team to adjust the glazing to provide daylight levels that will enhance the occupant experience. The electrical design was able to utilize this day lighting simulation information to inform their design. Lighting controls and systems will allow the electrical lighting to dim or turn off when sufficient day light is available to save on lighting energy.

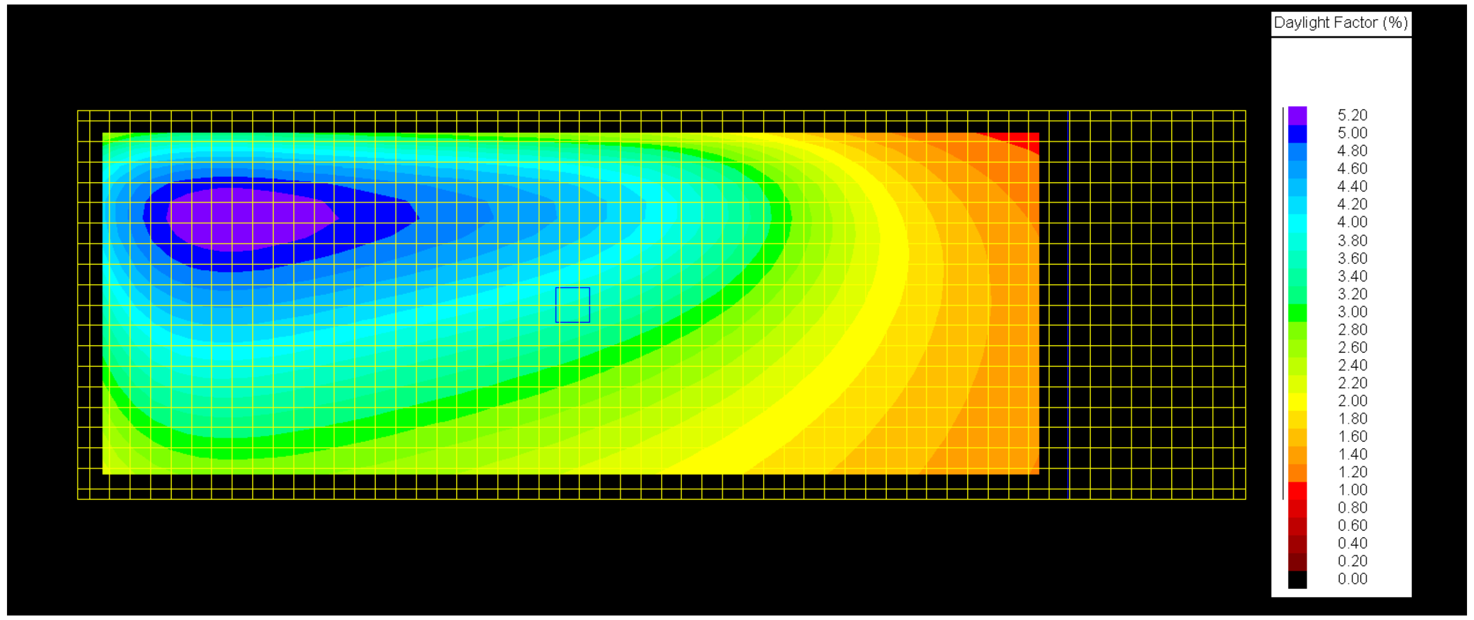


Figure 7 – Daylight analysis in the CBSA area

2 Environment Canada, http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=EAF0E96A-1
3 US Energy Information Administration, http://www.eia.doe.gov/oiaf/1605/coefficients.html

▸ Design Options

		V0	V1	V2A	V2B	V3	V4	V5	V6	
		Existing ATB only	Base Case	Envelope upgrade	Envelope upgrade plus Triple Glazing	Mec&Elec system Upgrade 1	Mec&Elec system Upgrade 2	V3 plus Geothermal	V4 plus Geothermal	Comment
Architecture	Insulation Values to Code		x							Roof R15, Wall R12, Glass Usi=3.2 w/frame
	Upgrade Insulation Values			x	x	x	x	x	x	Roof R30, Wall R24, Glass Usi=1.8 w/ frame
	High Performance Triple Glazing				x	x	x	x	x	Usi=1.1 with frame
	Additional Thermal Mass			x	x	x	x	x	x	
Mechanical	ASHRAE 90.1 mechanical system		x	x	x					Sys 5 VAV DX cooling, hot water coil, boiler 80%
	VAV Supply Units - Wet Coils					x		x		Sys 7 w/ heat recovery , boiler 87%
	Displacement Ventilation - Wet Coils						x		x	DOAS w/heat recovery, boiler 92%
	Geothermal							x	x	
Electrical	ASHRAE 90.1 compliant		x	x	x					
	Light Power Density reduced by 20%					x	x	x	x	
	Daylight sensor						x	x	x	
Existing Building	Existing building with no change	x	x							
	Implement Energy Audit Items without geothermal			x	x	x	x			Reduction as per audit report
	Implementing Energy audit with geothermal							x	x	

Figure 8 - Design Options

V0 represents the existing building without any expansion. CO2 and energy consumption are obtained from real data.

V1 represents the existing with no change with the addition of the expansion built to code. Insulation values, Lighting power density and mechanical system efficiencies meet ASHRAE90.1-2004 minimum requirements. The mechanical system is a VAV system with hot water coils and DX cooling. This is based on ASHRAE90.1-2004 appendix G assumptions that define baseline system types based on building floor area and the number of floors.

V2a is a first upgrade where the energy audit recommendations are implemented in the existing building with the exception of geothermal. Envelope insulation values are upgraded compared to code values.

V2b adds triple glazing to option V2a.

V3 is an upgrade to the mechanical and electrical systems. The mechanical system is a VAV system with hot and chilled water coils, heat recovery and high efficiency boilers. Lighting is upgraded with more efficient fixtures allowing a 20% Lighting Power Density reduction.

Detailed Results

		V0	V1	V2A	V2B	V3	V4	V5	V6
CO2	C02 Production (existing building) (tco2)	502	502	411	411	411	411	196	96
	C02 Production (new building) (tco2)	0	437	383	374	147	53	51	24
	Total CO2 (tCo2)*	502	939	794	786	558	464	247	220
	% overall carbon change	0%	87%	58%	56%	11%	-8%	-51%	-56%
Energy	Annual electricity consumption (MWh)		1160	1152	1146	1133	805	1251	847
	Annual natural gas consumption (MWh)		2289	1989	1942	688	201	142	39
	equivalent kwh/ft2 (new only)		37.8	34.4	33.8	20.0	11.0	15.3	9.7
	Annual electricity consumption (MWh) existing	4244	4244.0	3115.0	3115.0	3115.0	3115.0	3535.0	3535.0
	Annual natural gas consumption (MWh) existing	2354.0	2354.0	1981.0	1981.0	1981.0	1981.0	371.0	371.0
	equivalent kwh/ft2 (new only) existing	61.4	61.4	47.4	47.4	47.4	47.4	36.4	36.4
Cost	Annual electricity Cost ($) new building		$80,040	$79,513	$79,071	$78,201	$55,577	$86,304	$58,438
	Annual natural gas Cost ($) new building		$112,882	$98,098	$95,777	$33,941	$9,933	$6,994	$1,940
	Annual Energy Cost new building		$192,922	$177,611	$174,848	$112,142	$65,510	$93,298	$60,378
	Annual Energy savings		$0	-$15,310	-$18,074	-$80,780	-$127,412	-$99,624	-$132,543
	Annual electricity Cost ($) (existing)		$292,836	$214,936	$214,936	$214,936	$214,936	$243,916	$243,916
	Annual natural gas Cost ($) (existing)3F		$116,099	$97,703	$97,703	$97,703	$97,703	$18,298	$18,298
	Annual Energy Cost (existing)		$408,935	$312,639	$312,639	$312,639	$312,639	$262,214	$262,214
	Annual Energy savings (existing)		$0	-$96,296	-$96,296	-$96,296	-$96,296	-$146,722	-$146,722

Figure 9 - Design options - Results for 2025 building

4 Annual Energy cost uses future rates (see Utility Cost section)

V4 is a second upgrade to the mechanical and electrical systems. In this option, ventilation is decoupled from the cooling by using displacement ventilation and chilled slabs. Heat recovery is still included in the air systems and condensing boilers are used. Lighting is upgraded with daylight and occupancy sensors.

V5 is the same system as V3 with ground source heat pumps acting as the primary source of heating and cooling. The gas boilers are required to meet heating needs on very cold days. Ground source heat pumps are also providing heat to the existing building.

V6 is the same system has V4 with ground source heat pumps acting as the primary source of heating and cooling. The gas boilers are required to meet heating needs on very cold days. Ground source heat pumps are also providing heat to the existing building.

2016 building

		V0	V1	V2A	V2B	V3	V4	V5	V6
CO2	C02 Production (existing building) (tco2)	502	502	411	411	411	411	196	196
	C02 Production (new building) (tco2)		348	305	298	117	42	40	19
	Total CO2 (tCo2)*		850	716	709	528	453	237	216
	% overall carbon change		69%	43%	41%	5%	-10%	-53%	-57%
Energy	Annual electricity consumption (MWh)		923	917	912	902	641	996	674
	Annual natural gas consumption (MWh)		1822	1583	1546	548	160	113	31
	equivalent kwh/ft2 (new only)		38	34	34	20	11	15	10
	Annual electricity consumption (MWh) existing	4244.0	4244.0	3115.0	3115.0	3115.0	3115.0	3535.0	3535.0
	Annual natural gas consumption (MWh) existing	2354.0	2354.0	1981.0	1981.0	1981.0	1981.0	371.0	371.0
	equivalent kwh/ft2 (new only) existing	61.4	61.4	47.4	47.4	47.4	47.4	36.4	36.4
Cost	Annual electricity Cost ($) new building		$63,712	$63,292	$62,940	$62,248	$44,239	$68,698	$46,517
	Annual natural gas Cost ($) new building		$89,854	$78,086	$76,239	$27,017	$7,906	$5,567	$1,545
	Annual Energy Cost new building		$153,566	$141,379	$139,179	$89,265	$52,146	$74,265	$48,061
	Annual Energy savings		$0	-$12,187	-$14,387	-$64,301	-$101,420	-$79,301	-$105,504
	Annual electricity Cost ($) (existing)		$292,836	$214,936	$214,936	$214,936	$214,936	$243,916	$243,916
	Annual natural gas Cost ($) (existing)4F		$116,099	$97,703	$97,703	$97,703	$97,703	$18,298	$18,298
	Annual Energy Cost (existing)		$408,935	$312,639	$312,639	$312,639	$312,639	$262,214	$262,214
	Annual Energy savings (existing)		$0	-$96,296	-$96,296	-$96,296	-$96,296	-$146,722	-$146,722

Figure 10 – Design options - Results for 2025 building

5 Annual Energy cost uses future rates (see Utility Cost section)

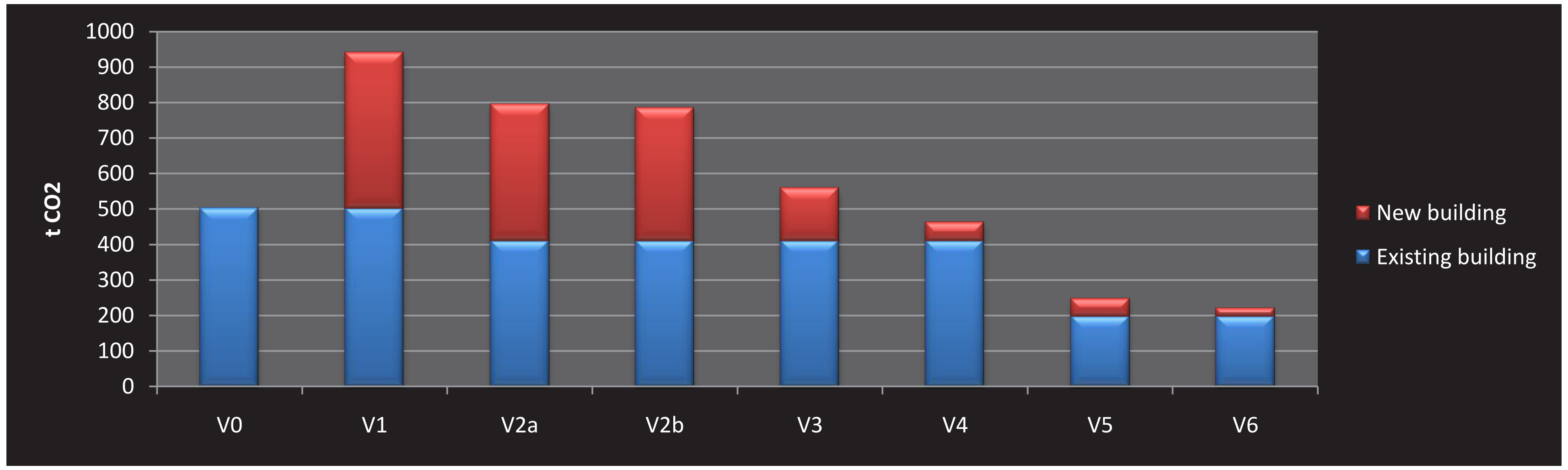


Figure 11 - Design option carbon emissions (2025 building)

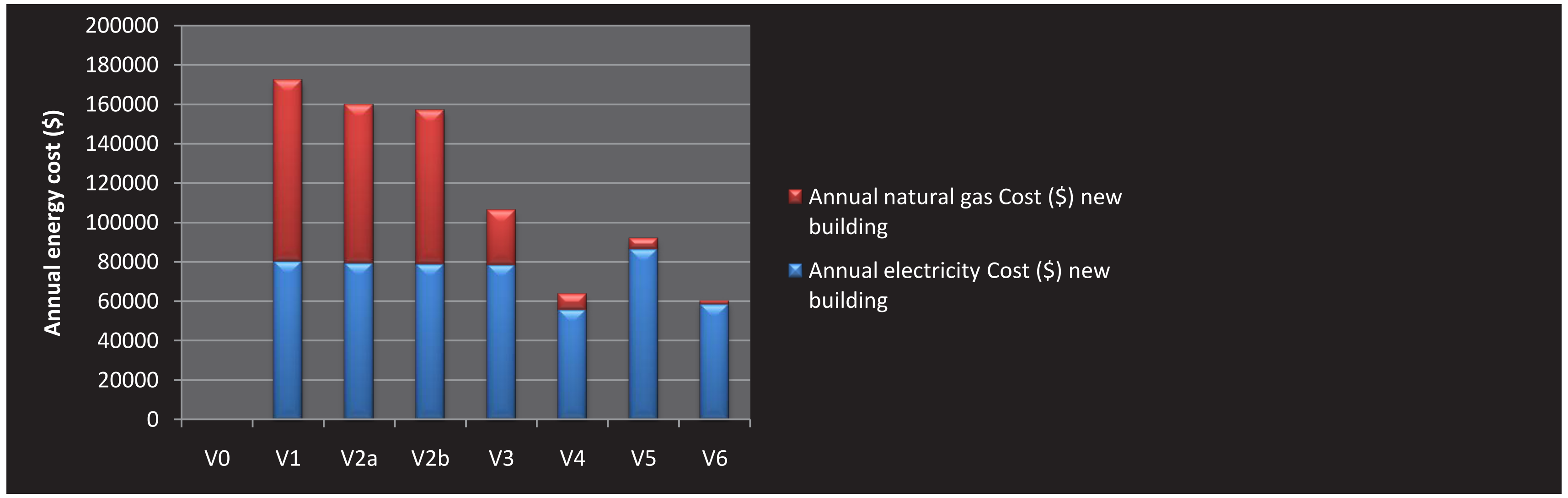


Figure 12 - Design Option annual energy costs (2025 building)

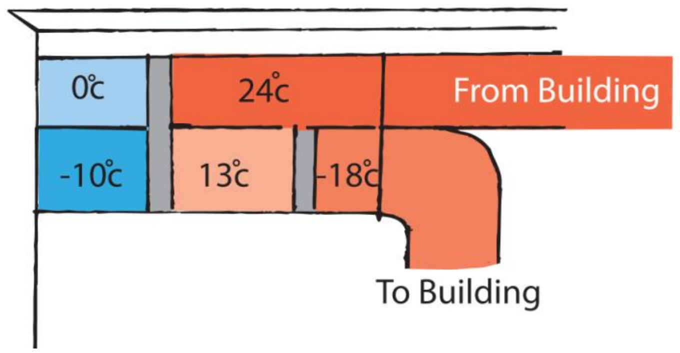
▸ Proposed Energy Conservation Measures

Upgraded Insulation Values

Upgrades to the building envelope are most cost effective at the time of construction. The significant roof area will allow improvements to roof insulation to generate considerable cost effective savings. Wall and glass performance is also important. Further analysis can be performed in the design development phase to find the optimum insulation values for each building component to maximize return on investment. This analysis will confirm the cost effectiveness of the triple glazing option.

Air-to-Air Heat Recovery

Air-to-air heat recovery devices recover heat from the exhaust air to preheat the air intake. In most case return on investment are around 2-3 years.



Decoupling Ventilation and Cooling

Decoupling cooling from the ventilation allows different energy saving opportunities. With a chilled slab system cooling comes from cold surface fed by cold water instead of coming from cold air. Due to the fact that water can carry more energy than air, delivering cooling is more efficient and fan power is reduced. Displacement systems do not require reheat air at terminal boxes, as is often required in VAV systems. Displacement systems are smaller as they only provide air to meet ventilation requirements, instead of both ventilation and cooling needs as required by VAV systems. The cost savings from the reduced displacement air handling systems are often sufficient to pay for the hydronic cooling systems..

Displacement Ventilation

Displacement ventilation supplies air at temperature slightly lower than air temperature at low level to create an air curtain. When this air reaches a source of heat like a person or equipment, it rises as it picks up the heat creating temperature stratification in the room. The higher the ceiling, the more effective displacement systems are at removing heat gain. It has also the advantages of delivering air close to the occupants as opposed to high at the ceiling increasing ventilation effectiveness thereby allowing lower outside air volumes. By coupling this system with a chilled slab, the airport will be able to lower air volumes significantly.

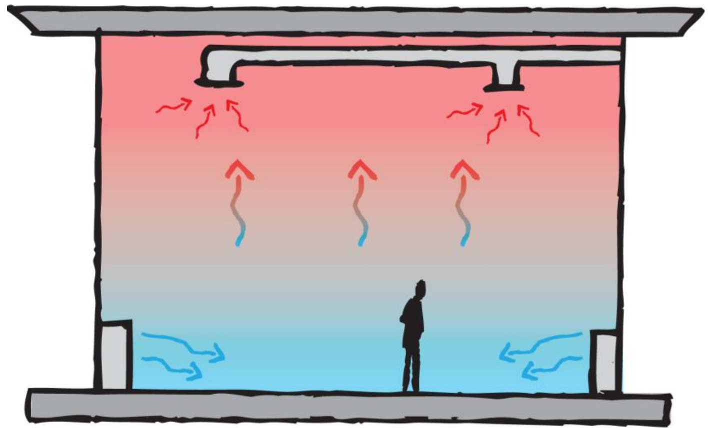


Figure 13 - Displacement ventilation

Radiant Floor/Chilled Slab

Chilled slab uses the radiant effect of a cold surface to absorb heat gain. Cool water runs inside the slab to maintain the floor surface at 18˚C. At 18˚C, the floor is only a few degrees cooler than room temperature - a difference that will be likely unnoticed by most occupants. This concept offers several advantages. Fan power is reduced by using a water based system for cooling. Space temperature can be a few degrees higher because of the radiant effect of the slab on the occupant. One concern with chilled slab system is that they cannot provide sufficient cooling to offset very high heat loads. For this reason, successful chilled slab design requires careful attention to sources of heat gains such as solar gains from nearby windows.

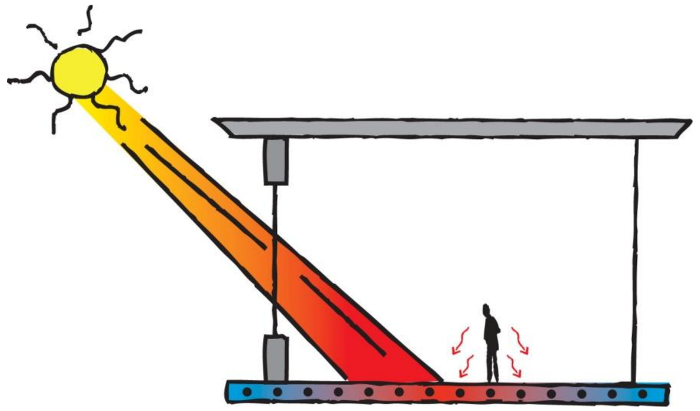
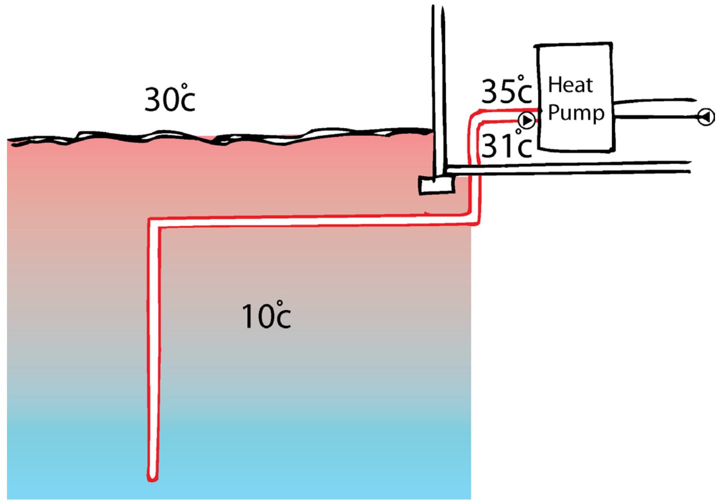


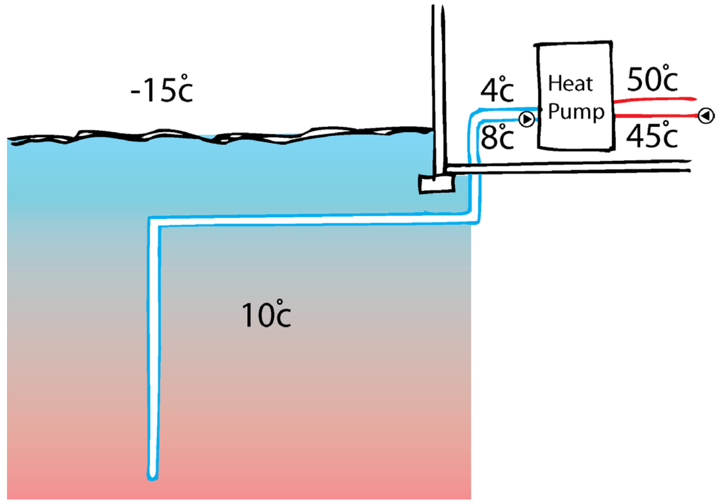
Figure 14 – Chilled slab

Ground Source Heat Pump

Ground source heat pumps extract heat from the ground using heat pumps. Heat pumps are similar to chillers, but the cycle is reversible. In winter mode, the ground is cooled and the heat is rejected into the building. In summer operation, the building is cooled and the heat is rejected into the ground. Since the ground temperature remains constant year round, geothermal cooling is more efficient than a typical cooling system. Source of energy is also different, instead of burning natural gas, electricity runs heat pump compressors and the pumps feeding the geothermal system. Switching the heating energy source from natural gas to electricity will reduce carbon emissions.



In order to make the geothermal system cost effective, the system is coupled with a boiler that serves the heating peak. Heating loads for a complete year were analyzed to determine optimal sizing. By sizing the system for 20% of the peak heating load, 80% of the energy can be supplied from the geothermal field. By combining the geothermal system with a boiler system, the return on investment for this system will be in the 10 year range. Once costs are confirmed by a cost consultant, the analysis can be updated to provide more accurate return on investment information.



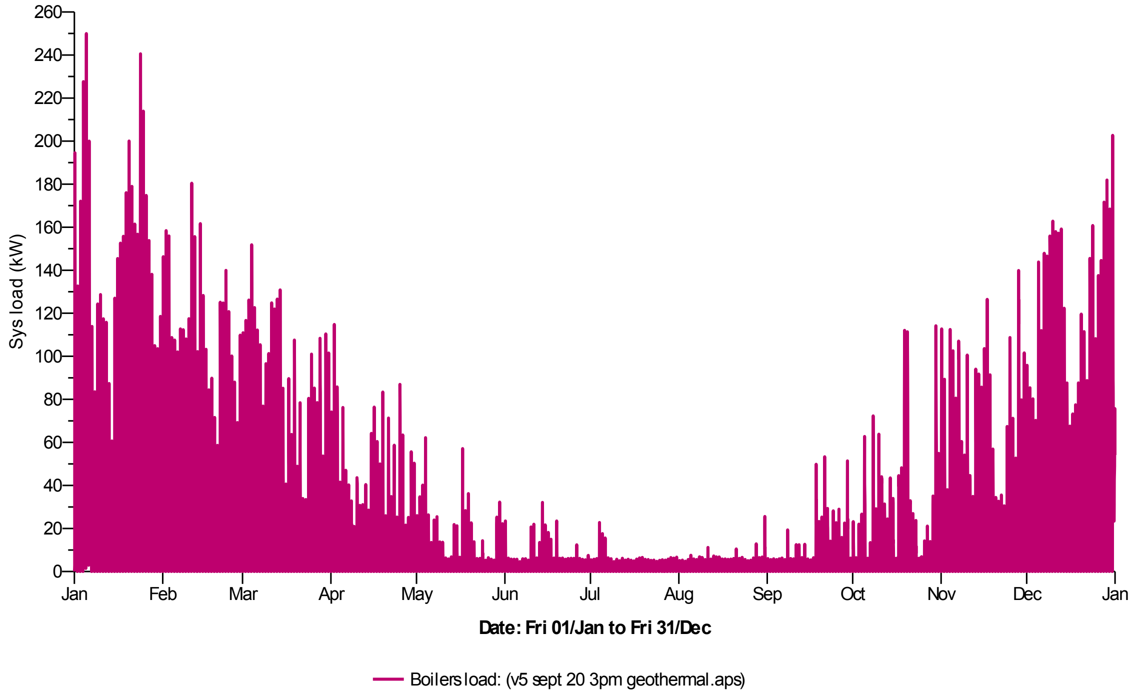


Figure 15 - Cooling load profile for the expansion

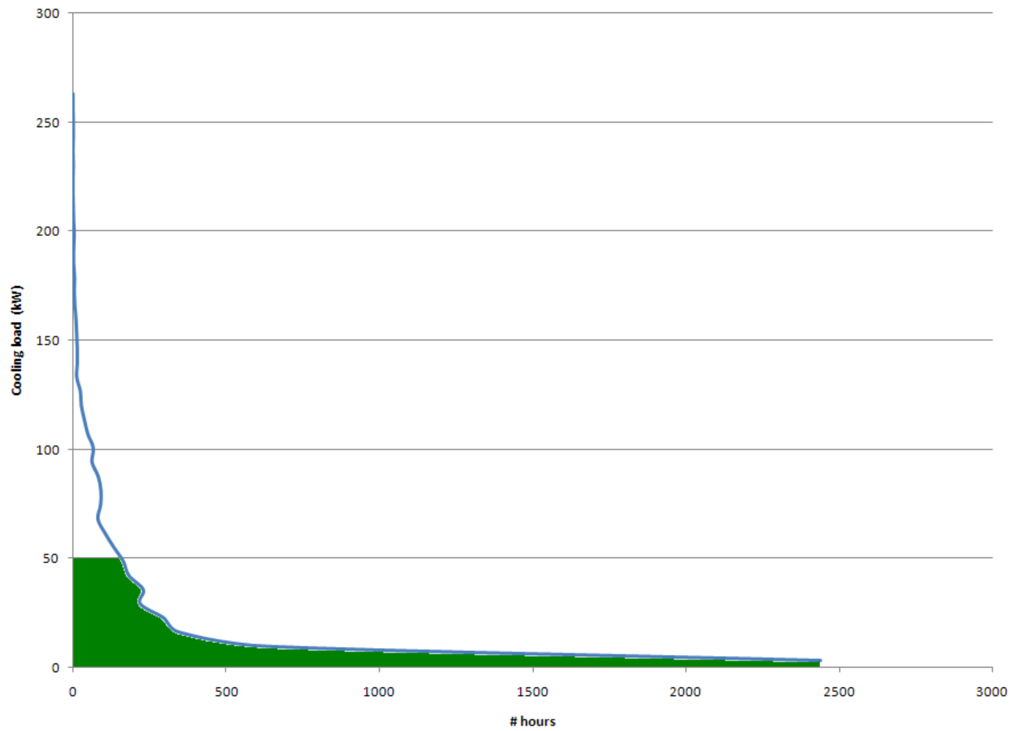


Figure 16 - Cooling load frequency

11.0 STRUCTURAL SYSTEMS

INTRODUCTION

General

The purpose of the Structural Schematic Design Report is to:

- Present the preliminary schemes considered for the structural systems
- Describe the structural systems proposed for the expansion
- Provide the architectural, mechanical, and electrical disciplines with information that will allow the design of the facility to progress, and
- Provide structural information for project costing.

The structural design presented is under development and will be revised and supplemented to meet project expectations, satisfy functional and aesthetic requirements, accommodate the needs of the mechanical and electrical disciplines, and meet cost objectives as the project proceeds.

Project Description

Briefly the Kelowna YLW Expansion comprises several additions to the existing two-storey air terminal building structure, including the trans-border holdroom and international arrivals facilities, domestic arrivals facilities, and outbound bag make-up hall. Phasing of these additions is described earlier in this report. These additions are generally single-storey, with a small two-storey component and a partial basement level beneath the domestic arrivals facility.

Structural Selection Criteria

As the project design develops, we will consider the following:

- **Integration of building systems.** The configuration of the structural roof and floor framing members and lateral load resisting elements will be coordinated closely with the mechanical and electrical systems to provide an efficient and compact integrated building system.
- **Adaptability.** Over time, there may be some desire or need to reconfigure the internal spaces of the air terminal building; the structural systems chosen will allow for future changes to the internal building layout.
- **Safety.** Design loads have been selected that are appropriate for the use and occupancy of the building.
- **Value for money.** Preference will be given to structural systems that provide economy for the project as a whole, taking into account the interdependence of costs between the architectural, structural, mechanical, and electrical systems.
- **Structural serviceability.** The potential for excessive structural deflections or movements will be carefully evaluated
- **Durability and long-term maintenance costs.** Structural materials will be selected that are robust and durable to reduce ongoing maintenance costs, particularly in areas exposed to public view.
- **Appearance.** Exposed structural systems are part of the architectural approach to the design; careful consideration will be given to the appearance of the structure in these areas.

DESIGN CRITERIA

Codes, Standards and Guidelines

Structural systems for the facility will be designed in accordance with the British Columbia Building Code 2006 and the National Building Code 2005 Structural Commentaries (Part 4 of Division B).

Structural components and materials will be proportioned in accordance with the requirements of the following design standards:

- CSA A23.1/A23.2-09 Concrete Materials and Methods of Concrete Construction / Methods of Test and Standard Practices for Concrete
- CAN/CSA A23.3-04 (R2010) Design of Concrete Structures
- CAN/CSA-S16.1-09 Design of Steel Structures
- CAN/CSA-O86-01 Engineering Design in Wood, including CAN/CSA-O86S1-05 Supplement #1
- CSA S304.1-04 Masonry Design for Buildings (Limit States Design).

The engineering design, preparation of related documents and contract administration for the air terminal building will be carried in accordance with the “Guidelines for Structural Engineering Services for Building Projects” published by the Association of Professional Engineers and Geoscientists of British Columbia. An independent concept review of the structural design will be performed by another engineer in accordance with the “Guidelines for Professional Structural Concept Review” published by the Association of Professional Engineers and Geoscientists of British Columbia.

Importance Category

The Building Code requires that an Importance Category be assigned to the facility based on the intended use and occupancy. Kelowna YLW will be designed assuming that the facility is a post-disaster control centre for air transportation.

The following importance factors will be applied to loads:

Load	Ultimate Limit State	Serviceability Limit State
Snow	1.25	0.9
Wind	1.25	0.75
Earthquake	1.5	Not applicable

Design Gravity Loads

Floor and roof areas, unless noted otherwise, will be designed for the following gravity loads:

Main Floor Areas

- Live 4.8 kN/m2
- Concentrated live 9.0 kN
- Super-imposed dead 1.5 kN/m2

Second Floor Areas

- Live 3.0 kN/m2
- Concentrated live 9.0 kN
- Super-imposed dead 1.5 kN/m2

Mechanical Rooms

- Live 3.6 kN/m2
- Equipment Actual weights
- Super-imposed dead 2.0 kN/m2

Roof Areas

- Basic snow and rain (not including drifting or ponding) 3.0 kN/m2
- Live 1.0 kN/m2
- Concentrated live 1.3 kN
- Super-imposed dead 1.0 kN/m2

Lateral Loads from Wind and Earthquake on Primary Structural Members

The lateral load resisting elements will be designed using the following parameters:

Wind

- Reference velocity pressure, 1 in 50 probability of being exceeded in any one year 0.47 kN/m2

Earthquake

- 5% damped spectral response acceleration, expressed as a ratio to gravitational acceleration
- Acceleration and velocity site coefficients
  - » Refer to Geotechnical and Foundation section of the report below
- Structural configuration Irregular
- Seismic Force Resisting System
  Structural steel, moderately ductile concentrically braced frames
  - » Ductility-related force modification factor 3.0
  - » Overstrength-related force modification factor 1.3

Period, T (s)	Spectral Acceleration Sa(T)
0.2	0.28
0.5	0.17
1.0	0.094
2.0	0.056

The seismic restraints for mechanical equipment and services, electrical equipment and services, and architectural components of the air terminal building will be designed by specialist engineers engaged directly by the sub-contractors.

Cladding support elements and attachments to the building structure will be designed for earthquake loads to satisfy the requirements of Article 4.1.8.17 of the British Columbia Building Code 2006

Vertical and Horizontal Deflections

Horizontal components of the structure, floors and roofs, generally deflect downward as a result of gravity loads. Excessive vertical deflections can create concerns, including cracking or crushing of non-structural components, lack of fit for doors and windows, out-of-plumb walls, and water ponding.

Structural members for YLW will be sized to limit deflections that occur after the attachment of non-structural components, including elastic and creep deflections due to sustained load, and immediate deflections due to live or snow load. Deflection limits used in the design are tabulated below, expressed as either an absolute value or as a ratio of span length:

Live Load Deflections	
Roof Members	
Perimeter, smaller of	25 mm L/360
Interior	L/360
Floor members	
Perimeter, smaller of	20 mm L/480
Interior	L/360

Open web steel floor and roof joists will be cambered by an amount equal to the anticipated dead load deflection of the joist. The intent is for the floors to be relatively flat and level, and roofs to have the required slopes for drainage in the long-term under dead loads.

As a result of normal construction procedures and material behavior, it is not possible to achieve perfectly flat and level floors. The project specifications will provide tolerances for floor flatness.

Structural members spanning horizontally, such as girts supporting a curtain wall, will be designed to limit horizontal movements to L/360.

Fire Rating

As discussed in the architectural section of the report, the suspended floors, the supporting columns, and all stair and elevator walls will be designed for a 1 hour fire resistance rating to conform to the required building classification. The roof construction is not required to have a fire resistance rating.

The fire resistance rating for structural steel members is achieved by providing fire retardant spray or other fireproofing on the open web steel joists and structural steel beams, girders, and columns.

CONSTRUCTION MATERIALS

Material Strengths

The following materials are proposed for the YLW expansion:

- Concrete, conforming to CSA-A23.1, made with Type GU Portland cement, as follows:

Application	28 day strength (MPa)	Exposure Class
Foundations	30	N
Interior slab-on-grade	25	N
Exterior slabs	32	C2
Concrete topping on metal deck	25	N

- Grade 400 deformed bar reinforcing steel conforming to CAN/CSA-G30.18
- Structural steel conforming to CAN/CSA-G40.20/G40.21, grade 350W for W shapes and hollow structural sections, grade 300W for other structural shapes and plate
- Open web steel joists conforming to CAN/CSA-S16.1
- Metal decking conforming to the requirements of CAN/CSA-S136
- Timber construction will conform to materials standards referenced in CAN/CSA O86, glulam bending grades 24f-E or 24f-EX and compression grade 16c-E.

Sustainable Design

The sustainable design attributes of the structural systems include:

- **Recycled steel.** Structural steel and reinforcing steel used in expansion of the air terminal building will have a recycled materials content greater than 90%.
- **Re-use of waste materials.** The specifications will require that a portion of the cementitious material used for reinforced concrete members be fly-ash, a waste by product of the coal fired power generation industry. For cast-in-place concrete foundation elements, up to 40% of the total cementitious materials content can be fly ash. For flatwork, fly-ash content is limited to 10% as fly-ash impedes the setting of the concrete and makes slab finishing more difficult.
- **Control of dust and water during construction.** The specifications for the project will be prepared so that the contractor is required to control dust and the erosion of soil from wind and water during construction.
- **Timber framing.** Where practical, portions of the expansion framing will utilize timber harvested from British Columbia forests.

GEOTECHNICAL ISSUES AND FOUNDATIONS

A report titled *"Preliminary Geotechnical Engineering Report, Air Terminal Building (ATB) Expansion, Kelowna International Airport"*, dated February 25, 2010, was prepared by Levelton Consultants Ltd. A second report titled *"Preliminary Geotechnical Engineering Report, Baggage Make-Up Facility Expansion, Kelowna International Airport"*, dated February 23, 2010, was also prepared by Levelton.

The Levelton reports indicate that the soil stratigraphy generally consists of a surface layer of asphalt pavement 100-150 mm thick, underlain by approximately 0.6-1.3 m of compact to dense granular fill, underlain by a layer of firm to stiff clayey silt / silty clay / silt, underlain by interlayered, generally loose to compact sand / silty sand and stiff silt /clay / silty clay.

Groundwater elevations were reported to be between 1.3 and 3.0m below grade.

Recommended site preparation includes removal of the existing asphalt pavement and excavation to the required foundation grade. The anticipated foundation subgrade is existing granular fill, which is recommended to be compacted with vibratory equipment to re-densify any disturbed soils prior to commencing foundation construction. Where excavation exposes fine grained sols, a geotextile will be required as a separator over the subgrade prior to placement of engineered fill.

Levelton recommend that foundations bearing on the existing granular fill or on compacted engineered fill can be designed based on a serviceability limit state (SLS) soil bearing resistance of 125 kPa ,and a factored ultimate limit state (ULS) soil bearing resistance of 190 kPa. Spread and strip footings designed in accordance with these recommendations will be utilized for the facility expansion.

Sulfate concentrations in the collected soil samples range from less than 0.05 and 0.15%, indicating a moderate degree of sulfate attack, and necessitating the use of sulphate-resistant concrete.

Analysis by Levelton of the information gained from cone penetration testing and seismic cone penetration in the area of the expansion indicates that layers of loose sand / silty sand deposits located below the water table are liquefiable during a design-magnitude earthquake. Accordingly, Levelton recommend that design of the structure be based on Site Class 'F' conditions. The results of site-specific analysis undertaken by Levelton indicate that acceleration and velocity site coefficients of 1.78 and 3.64 respectively should be used for earthquake design of the air terminal building.

Levelton also recommends the installation of a perimeter foundation drainage system comprised of rigid, perforated PVC pipe placed within a drain rock surround, wrapped with a non-woven geotexile.

A slab-on-grade floor is considered feasible for this site; this is consistent with the existing construction.

Retaining walls with heights of up to 2.4 m may be required to accommodate the existing grades. These walls will be designed to resist the applied lateral soil pressures.

SUPERSTRUCTURE

Construction Materials

The primary construction materials considered for the superstructure of the expansion are structural steel, concrete and timber.

Cast-in-place concrete was used for a previous portion of the air terminal building superstructure; the exposed structure is prominent in the existing public areas. Concrete construction is site labour intensive, requiring several skilled trades including formwork crews, rebar installers, and concrete placing and finishing crews. The higher labor and material cost, the increased mass of concrete construction (resulting in increased foundation and lateral load resisting systems for sites like Kelowna) do not favor concrete superstructure construction. Consequently, we do not recommend cast-in-place concrete construction for the air terminal building expansion.

The use of structural steel reduces the vertical and lateral loads to be resisted by the structure (as compared to concrete), and also reduces reliance on site labour. Structural steel is anticipated to be the most economical system for the spans and building volumes of the type proposed.

Timber construction has been used on a number of similar projects, allowing the structure to be expressed as part of the architectural design, highlighting the timber that is harvested in British Columbia. Fire rating requirements will suggest timber be limited to roof construction only, although other uses may be possible.

In arriving at the recommended structural systems for the Chilliwack Secondary School we have given close consideration to both structural steel and timber alternatives.

Suspended Floor Construction

Suspended floors for the expansion will comprise concrete topping over composite metal deck, supported on open web steel joists and structural steel beams, consistent with the existing second floor areas.

Roof Framing

The functional needs of the various portions of the expansion, whether the arrival / departure lounges or the bag make-up hall, dictate the structural bay sizes; the structural design must economically accommodate these requirements. The structure may be exposed to view as part of the architectural design in portions of the facility.

After carefully balancing project costs and function with architectural appearance, we recommend that structural steel framing be used for expansion, with possibly some use of timber framing. Preliminary framing plans for the various roof areas are shown in the drawings on this page and the following page.

Roof framing will be sloped to drains.

Lateral Load Resisting System

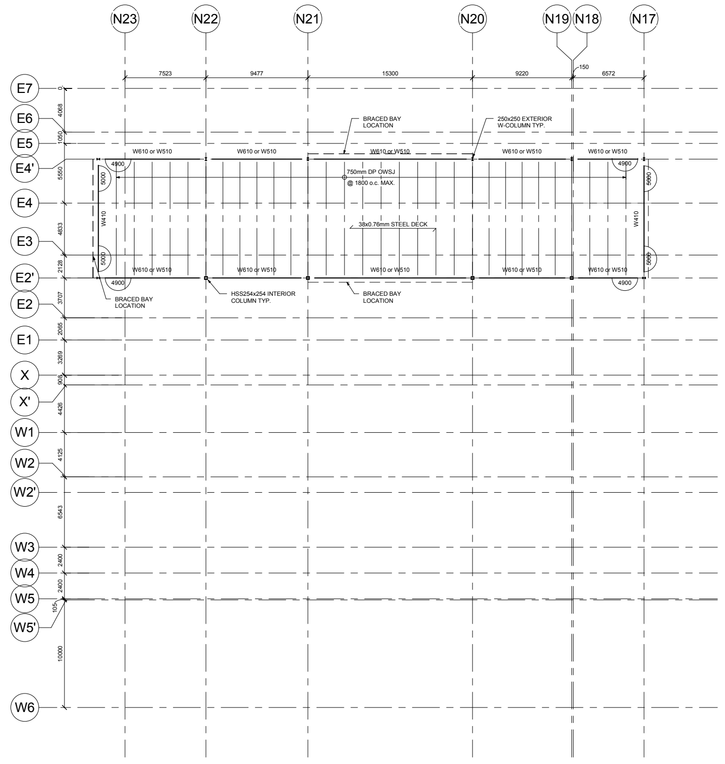
Lateral load resisting elements will be required to stabilize the facility under wind loads and seismic inertial forces. Lateral loads and forces acting on the building will be transferred horizontally through the floor and roof diaphragms to the vertical lateral load resisting elements. The vertical elements that transfer these loads and forces to the foundation will consist of structural steel cross, chevron and V bracing.

In the final design, we will analyze the structure for lateral loads and forces using the ETABS computer program.

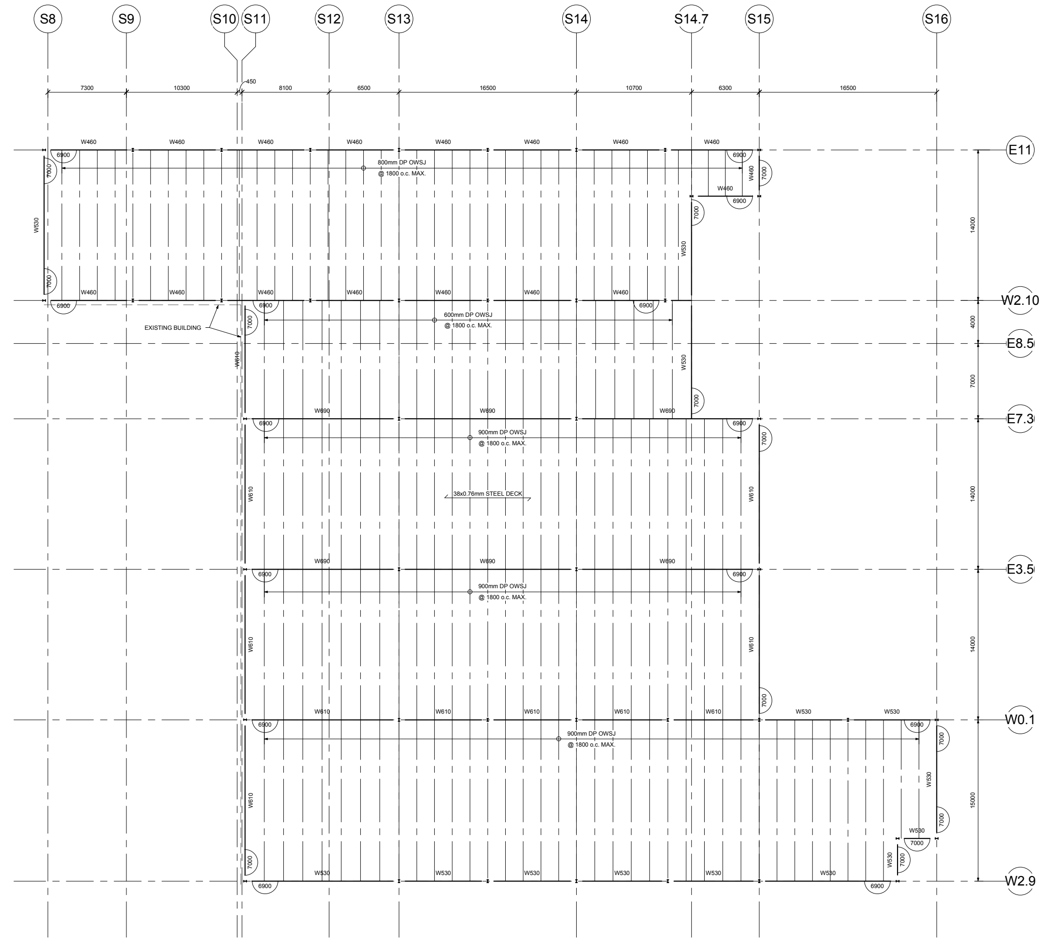
Building Control Joints

To reduce stresses that develop due to concrete shrinkage and thermal movements, structures are typically subdivided by building control joints spaced at approximately 70 m centres. As well, large structures are often separated by expansion joints at structural discontinuities or irregularities to reduce thermal, shrinkage and diaphragm stresses. Further, seismic separation of additions from the existing structure may reduce the extent of required seismic upgrading.

The expanded YLW air terminal building is very long in the north-south direction and somewhat irregular in plan. The international arrivals facilities, the domestic arrivals facilities, and the bag make-up hall each will be separated from the existing structure. The expansion joints are not required within the slab on grade.



1 PHASE 1 EXPANSION PLAN
1 : 200

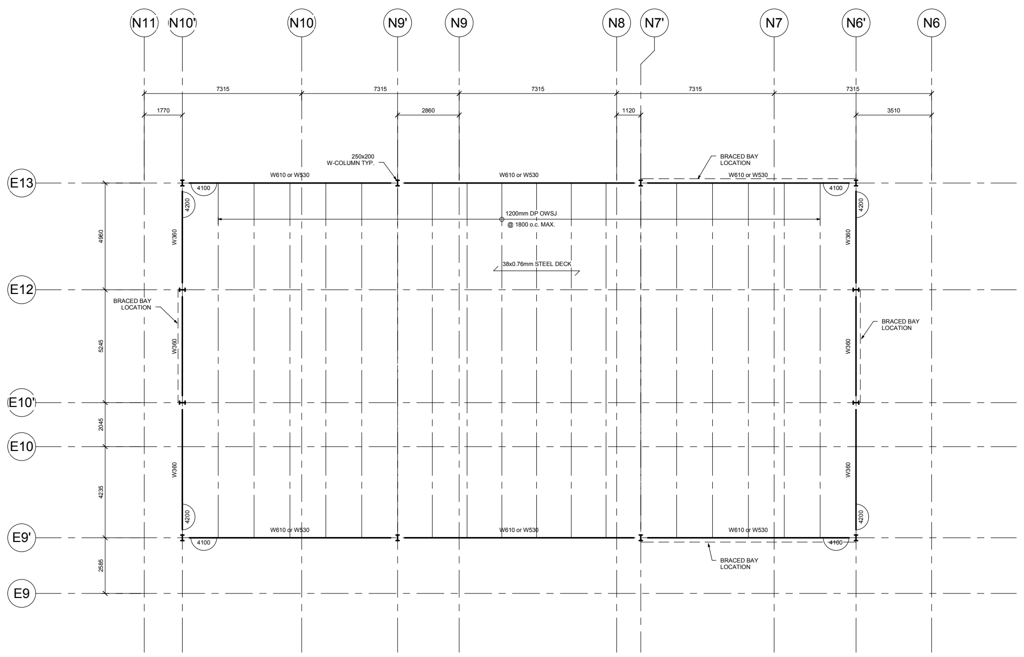


5 PHASE 3 PARTIAL EXPANSION PLAN
1 : 200

NOTE:

1. TOP OF STEEL ELEVATION BASED ON TOP OF FINSHED FLOOR VARIANCE SHOWN THUS: 5000

BEAM ELEVATIONS BASED ON 100mm JOIST SEAT, CONTRACTOR TO ADJUST ELEVATIONS AS REQUIRED FOR JOIST SEAT VARIANCE.



2 PHASE 2 EXPANSION PLAN
1 : 100

COSTING

In determining overall building costs from the information presented in this report, appropriate allowances must be made for atypical geometry, heavily loaded areas, and special framing required to suit the functional requirements of the other disciplines.

Project costs must include allowances for the following:

- The geotechnical requirements for site preparation, granular fill beneath slabs-on-grade and the like, including potential increased structural fill depths due to unanticipated soil conditions.
- Excavation shoring and dewatering requirements
- Structural framing for mechanical and electrical rooms, including pads, curbs, equipment supports, special framing around mechanical and electrical service penetrations, and the like.
- Structural steel framing for stairs, guards, railings and handrails.
- Roof ladders and cages.
- Steel framing for elevator support beams, rail and ladders.
- Framing for overhead doors.
- Structural steel for perimeter metal deck support, diaphragm chords, drag struts and the like.
- Cast-in plates for connections.
- Additional steel or timber framing to provide support for significant suspended loads.
- Miscellaneous structural framing for the support of exterior cladding, glazing, louvers, and screens not accommodated by the steel stud framing.
- Exterior structures such as retaining walls, planters, walks, curbs, and so forth.
- Exterior structural slabs adjacent to entries.
- Fire protection for structural steel and timber members.
- Window washing requirements.

12.0 SIGNAGE AND WAYFINDING

13.0 CIVIL

Information to be provided at a later date.

14.0 CODE

General Project Description

The proposed Kelowna International Airport (KIA) is located in Kelowna BC.

Applicable Building Code

This report identifies building code requirements based upon compliance with the current British Columbia Building Code 2006 (BCBC 2006). References stated herein are to the BC Building Code 2006 unless otherwise indicated

Fire separation assemblies will be based upon Underwriters' Laboratories of Canada List of Equipment and Materials, Fire Resistance (ULC), unless otherwise noted.

AUTHORITY HAVING JURISDICTION

The authority having jurisdiction for the project is the City of Kelowna.

BUILDING HEIGHT AND AREA (APPROXIMATE)

The building area as defined by the BCBC for purposes of determining the classification of the building will be approximately 16,975 m^2.

BUILDING CLASSIFICATION

Occupancy classifications are determined in accordance with the requirements of Subsection 3.1.2.

The majority of the airport expansion will be used for pedestrian circulation, queuing, and waiting areas associated with processing aircraft passengers, and for service areas associated with baggage handling. Therefore, the applicable major occupancy classifications for the main floor are Group A, Division 2, Assembly, Group F, Division 3, Medium Hazard Industrial (baggage areas) and Group D (second floor). To be discussed and confirmed with City of Kelowna.

The KIA will also include ancillary office and retail areas, intended for the use of occupants of the building and interspersed throughout the floor areas on each level. In accordance with Sentence 3.2.2.8.(1), occupancies that constitute more than 10% of the floor area of the storey in which they are located are considered major occupancies. There are no office or retail occupancies that are over 10% of the total floor area located on the main floor.

CONSTRUCTION AND SPRINKLERING REQUIREMENTS

Subsection 3.2.2 describes applicable construction requirements to prevent fire spread and collapse based on building size and occupancy and the provision of automatic sprinklering. For a building containing multiple major occupancies

- Article 3.2.2.6., requirements for the most restrictive major occupancy shall apply to the whole building, and
- Article 3.2.2.7., where one major occupancy is located entirely above another, it is permissible to apply the requirements of Subsection 3.2.2. to each portion of the building separately (while considering the height and area of the whole building), except that the fire-resistance rating of the floor assembly between the major occupancies shall be determined based on the lower occupancy.

Applicable requirements of Subsection 3.2.2., based on the major occupancies within the KIA are as follows.

- Article 3.2.2.24. Group A, Division 2, Assembly, up to 6 Storeys, Any Area, Sprinklered for the Arrivals and Departures level.
- Article 3.2.2.67. Group F, Division 3, Any Height, Any Area, Sprinklered for the areas used for baggage handling
- Article 3.2.2.49. Group D, Any Height, Any Area, Sprinklered for the second floor office area. As the entire second floor is used for office use, it will be considered a major occupancy.

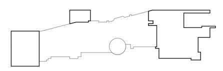
The requirements of 3.2.2.24 and 3.2.2.67 are the most restrictive and will be applied throughout. In summary, construction requirements for the Kelowna Airport expansion are as follows.

- The building will be of non-combustible construction.
- The building will be sprinklered throughout
- For the Arrivals and Departures Levels, floor assemblies will be fire separations with a fire-resistance rating not less than 1 hour. Interconnections will be provided as per requirements listed in 3.2.8.2.(6).
- For the F3 occupancies, floor and wall assemblies between that area and the remainder of the building will be fire separations with a fire-resistance rating not less than 2 hours.
- Loadbearing walls, columns and arches will have a fire-resistance rating not less than that required for the supported assembly.
- Article 3.1.3.1.(3), In a building conforming to the requirements of Articles 3.2.8.2. to 3.2.8.9., the requirements of Sentence (1) for fire separations between major occupancies do not apply at the vertical plane around the perimeter of an opening through the horizontal fire separation. Therefore, no fire separation will be required between the main and second floor (as long as the requirements of Articles 3.2.8.2. to 3.2.8.9. are maintained).

YLW
Kelowna International Airport

SCHEMATIC DESIGN

KEYPLAN

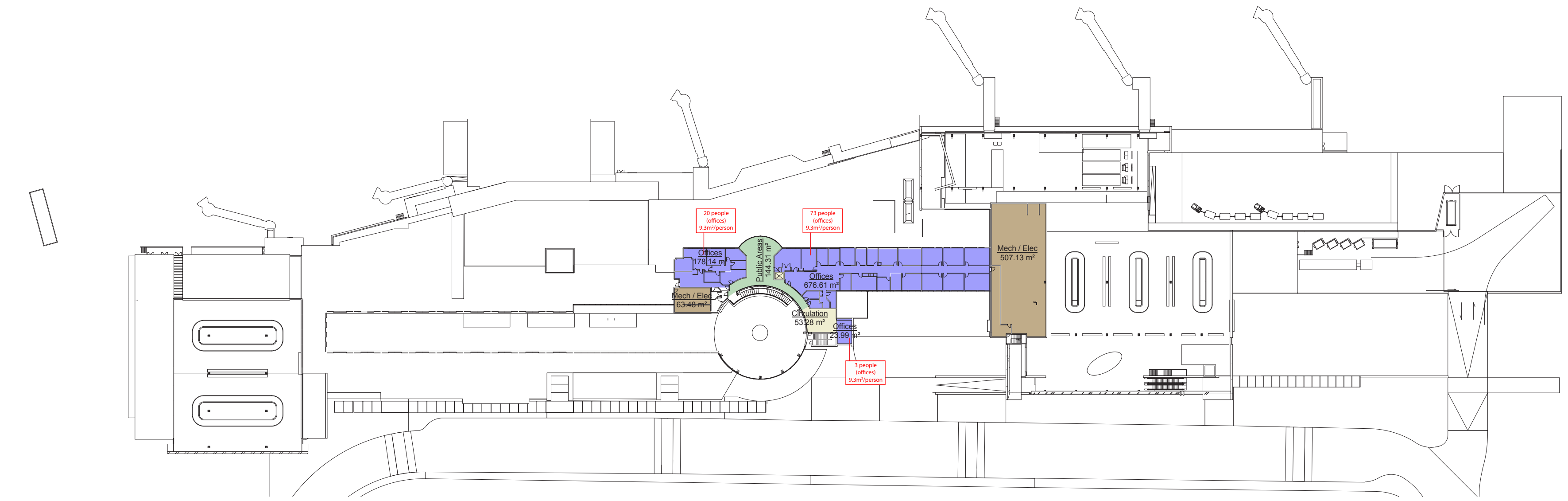


LEGEND

- Bag Claim 2015
- Bag Claim 2025
- Bag System
- Circulation
- Customs CBSA PIL
- Customs Secondary
- Holdroom
- HR Seating
- Mech / Elec
- Meeter Greeter Hall
- Offices
- Public Areas
- RestRooms
- Retail
- Security

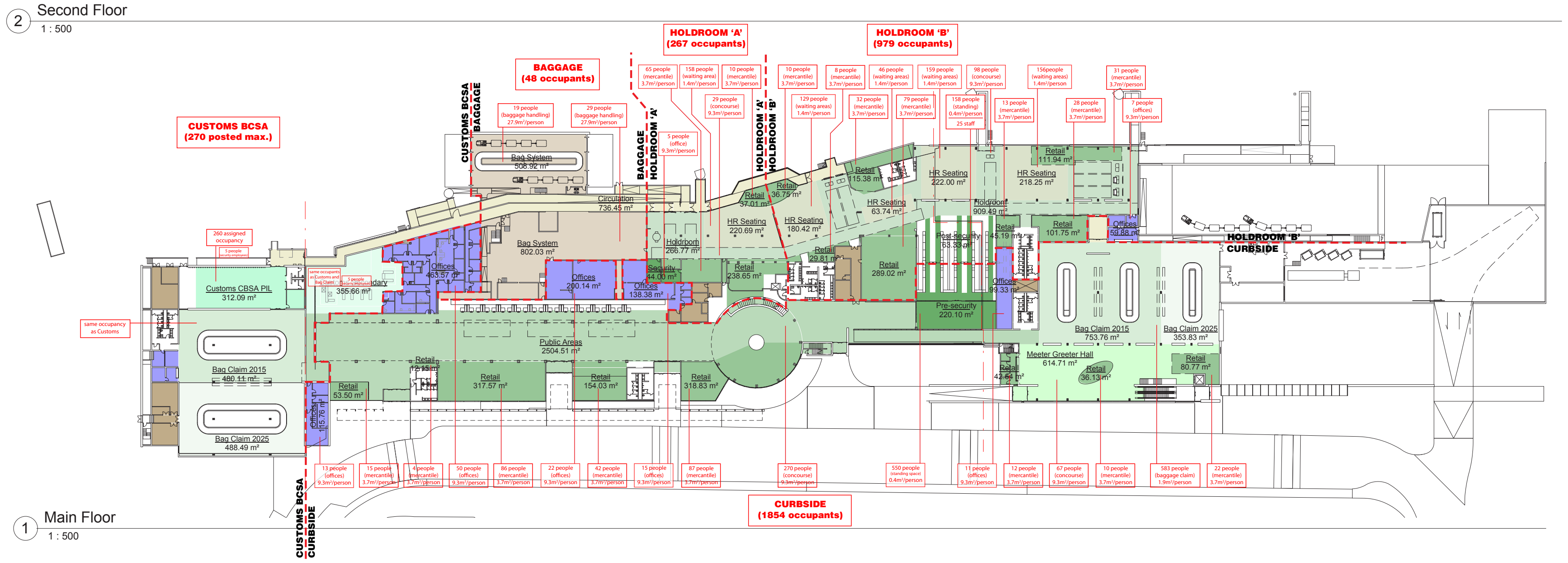
3 Basement
1 : 500

Basement floor - Code Compliance - Area Schedule	
Name	Area
Bag System	1,579 m²
Circulation	151 m²
Mech / Elec	51 m²



2 Second Floor
1 : 500

Second floor - Code Compliance - Area Schedule	
Name	Area
Circulation	59 m²
Mech / Elec	571 m²
Offices	879 m²
Public Areas	144 m²
RestRooms	23 m²



1 Main Floor
1 : 500

Main floor - Code Compliance - Area Schedule	
Name	Area
Bag Claim 2015	1,234 m²
Bag Claim 2025	842 m²
Bag System	1,311 m²
Circulation	773 m²
Customs CBSA PIL	312 m²
Customs Secondary	356 m²
Holdroom	1,176 m²
HR Seating	905 m²
Mech / Elec	422 m²
Meeter Greeter Hall	615 m²
Offices	1,139 m²
Public Areas	2,505 m²
RestRooms	618 m²
Retail	2,021 m²
Security	704 m²

CODE PLANS

INTERCONNECTED FLOOR AREAS

There will be a central Atrium in the building. This interconnected floor space need not conform to the requirements of articles 3.2.8.3. to 3.2.8.9. because:

- The interconnected floor space is open only to the ground and second floors.
- The building is fully sprinklered.
- The building consists of only Group A, Division 1 and 2 occupancies.
- The allowable building area is unlimited.

ADDITIONAL CONSTRUCTION REQUIREMENTS

- Janitor rooms will be separated from the remainder of the building by fire separations having no required fire-resistance rating (3.3.1.21.).
- Exit stairs will be separated from the remainder of the building by fire separations having a 1 hour fire-resistance rating (3.4.4.1.(1)).
- Elevator hoistways will be separated from the remainder of the building by fire separations having a 1 hour fire-resistance rating (Table 3.5.3.1.). Elevator machine rooms will be separated from the remainder of the building (except from the elevator hoistways) by fire separation having a fire-resistance rating of 1 hours (3.5.3.3.).
- Service rooms containing fuel-fired appliances will be separated from the remainder of the building by fire separations having a 1 hour fire-resistance rating (3.6.2.1.(1)).
- A room for the storage of combustible refuse will be separated from the remainder of the building by a fire separation having a fire-resistance rating of 1 hour (3.6.2.5.).
- Vertical service spaces will be separated from the remainder of the building by fire separations having a 45 minute fire-resistance rating (Table 3.6.3.1.), or will be dampered at each floor level.

HIGH BUILDING CONSIDERATIONS

The height of the building from grade to the floor level of the highest storey is approximately 6.9 m. Therefore, the building will not incorporate requirements for high buildings (3.2.6.1.(1)(a)).

SITE ACCESS FOR FIRE FIGHTING

- Because the building area is greater than 600 m2, access for fire department vehicles is required to be provided between 3 m and 15 m of a principle entrance of the building (3.2.5.4. & 5.). The City of Calgary Fire Department, in a meeting dated June 26, 2008, granted approval to provide fire truck access to within 30 m of the main entrance, provided hard surfaces capable of supporting a fire truck were constructed between the roadway and the main entrance.
- The site roadway access route will:
  - Have a clear width not less than 6m.
  - Have a centerline radius not less than 12 m.
  - Have an overhead clearance not less than 5 m.
  - Have a change of gradient no greater than 1 in 12.5.
  - Be designed to support fire-fighting equipment in all climatic conditions.
  - Have no dead-end portions longer than 90 m.
  - Be connected to a public thoroughfare.

OCCUPANT LOADS

The occupant load of a building is used to determine the number and width of exit facilities that must be provided and the width of access routes leading to exits from within floor areas. BCBC 2006 acceptable solutions require occupant load to be determined based on the occupant density factors prescribed in Table 3.1.17.1., and, if not based on those values, a sign indicating an alternative occupant load is required to be posted in a conspicuous location. The occupant load should represent a realistic approximation of the largest number of people who can reasonably be expected to occupy a given floor area.

Additionally, Annex material to NFPA 101 Life Safety Code provides suggested occupant load factors specific to airport floor areas as follows:

NFPA 101 TABLE A.7.3.1.2 AIRPORT TERMINAL OCCUPANT LOAD FACTORS

AIRPORT TERMINAL AREA	M2 / PERSON (GROSS)
Concourse	9.3
Waiting Areas	1.4
Baggage Claim	1.9
Baggage Handling	27.9

Occupant loads in non-public areas of the KIA will be calculated based on application of Table 3.1.17.1., except where NFPA 101 provides factors that are specific to airports.

For the purposes of occupant loads, the Airport has been divided into multiple areas:

The occupant load has been calculated as follows:

MAIN FLOOR

Curbside:		
• Office:	1017.17 sq.m. @ 9.3 sq.m.:	110 persons
• Mercantile:	1015.62 sq.m. @ 3.7 sq.m.:	275 persons
• Concourse:	3119.22 sq.m. @ 9.3 sq.m.:	336 persons
• Standing (pre-security)	220.10 sq.m. @ 0.4 sq.m.:	550 persons
• Baggage Claim	1107.59 sq.m. @ 1.9 sq.m.:	583 persons
		Total: 1854 persons
Customs:		
• Posted Occupancy		270 persons
		Total: 270 persons
Holdroom 'A':		
• Office:	4.00 sq.m. @ 9.3 sq.m.:	5 persons
• Mercantile:	275.66 sq.m. @ 3.7 sq.m.:	75 persons
• Concourse:	266.77 sq.m. @ 9.3 sq.m.:	29 persons
• Waiting Areas	220.69 sq.m. @ 1.4 sq.m.:	158 persons
		Total: 267 persons
Holdroom 'B':		
• Office:	59.88 sq.m. @ 9.3 sq.m.:	7 persons
• Mercantile:	729.84 sq.m. @ 3.7 sq.m.:	198 persons
• Concourse:	909.49 sq.m. @ 9.3 sq.m.:	98 persons
• Waiting Areas	684.41 sq.m. @ 1.4 sq.m.:	489 persons
• Standing (pre-security)	63.33 sq.m. @ 0.4 sq.m.: + 25 staff	184 persons
		Total: 976 persons
Baggage:		
• Baggage Handling:	508.92 sq.m. @ 27.9 sq.m.:	19 persons
• Baggage Handling:	802.03 sq.m. @ 27.9 sq.m.:	29 persons
		Total: 48 persons

SECOND FLOOR		
• Office:	178.14 sq.m. @ 9.3 sq.m.:	20 persons
• Office:	676.61 sq.m. @ 9.3 sq.m.:	73 persons
• Office:	23.99 sq.m. @ 9.3 sq.m.:	3 persons
		Total: 96 persons

BASEMENT FLOOR		
Baggage Handling:	866.02 sq.m. @ 27.9 sq.m.:	31 persons
		Total: 31 persons

EGRESS AND EXIT CAPACITIES

As prescribed by BCBC 2006 Article 3.3.1.17. and Sentence 3.4.3.2.(1), the minimum aggregate width of exits serving floor areas intended for occupancy is to be determined by multiplying the occupant load of the area served by 6.1 mm per person for horizontal routes such as ramps, doorways and corridors, and 8 mm per person for most stairs.

Additionally, for interconnected floor spaces in the KIA, in accordance with Sentence 3.4.3.2.(6), widths are required to be cumulative for the areas served unless the cumulative occupant load can be accommodated within exit stairs or protected floor spaces.

- Every room or suite having an occupant load greater than 60 persons, a travel distance greater than 25 m to a door, or an area greater than 200 m2 will have two egress doors leading from the room or suite (3.3.1.5.).
- The minimum width of corridors used by the public will be 1100 mm (3.3.1.9.(2)).
- Dead end corridors will not exceed 3 m in length (3.3.1.9.(7)).
- Travel distance to at least one exit will not exceed:
    - 45 m in a floor area that contains an occupancy other than a high-hazard industrial occupancy, provided it is sprinklered throughout,
    - 105 m in any floor area served by a public corridor, in which rooms and suites are not separated from the remainder of the floor area by a fire separation, provided the public corridor is not less than 9 m wide, the ceiling height is not less than 4 m, the building is sprinklered throughout, and not more than one half of the required doorways from a room or suite open into the public corridor if the room or suite is required to have more than one egress doorway, and
    - 30 m in any floor area other than those referred to above.
- Guards on stairs will be 920 high at flights, and 1070 high at landings. They shall not have openings greater than 100 mm, nor shall they facilitate climbing (3.4.6.5.).
- Stair Configuration – No flights of stairs will have a vertical rise of more than 3.7 m between floors or landings (3.4.6.3.(1)). Treads for stairs will have a run of not less than 280 mm between successive steps, and risers will be not more than 180 mm (3.4.6.7.(1&2)). The leading edge of each stair tread will have a radius or bevel between 6 and 10 mm in horizontal dimension (3.4.6.7.(4)).
- One exit stair may exit through a lobby in conformance with 3.4.4.2.:
    - The lobby will not be more than 4.5 m above grade.
    - The path through the lobby to the exterior will not exceed 15 m.
    - Service rooms and storage rooms will not open directly into the lobby.
    - The lobby will be separated from adjacent spaces by a fire separation having no required fire-resistance rating.

The required exit widths are as follows:

MAIN FLOOR

Curbside: 1854 persons x 6.1mm/person = **11,310 mm of exit width**

Customs: 270 persons x 6.1mm/person = **1,647 mm of exit width**

Holdrooms: 267+976 = 1243 persons x 6.1mm/person = **7,582 mm of exit width**

Baggage Handling: 48 persons x 6.1mm/person = **293 mm of exit width**
*(2 exits required at minimum widths required by code)

SECOND FLOOR

Office: 96 persons x 8.0mm/person = **768 mm of exit width**
*(2 exits required at minimum widths required by code)

BASEMENT FLOOR

Baggage Handling: 31 persons x 6.1mm/person = **293 mm of exit width**
*(2 exits required at minimum widths required by code)

BARRIER-FREE CONSTRUCTION

- A barrier-free path of travel will be provided to not less than 50% of the pedestrian entrances to the building and throughout all normally occupied spaces (3.8.1.2.(1) & 3.8.2.1.(1)). At least one door at each barrier free entrance will be provided with a power door operator (3.8.3.3.(5)(c)).
- Controls intended for operation by occupants will be mounted between 400 mm and 1200 mm above the floor (3.8.1.5.).
- Barrier-free parking spaces will be provided in accordance with Table 3.8.2.2.
- The exterior passenger loading zone will have an access aisle and curb ramp (3.8.2.2.(3)).
- Appropriate signs will be provided indicating locations of barrier free facilities (3.8.3.).
- Exterior walks that form part of a barrier-free path of travel will be at least 1100 wide and designed as a ramp if the slope exceeds 1 in 20 (3.8.3.2.).
- Every door in a barrier-free path of travel will have a clear width of not less than 800 mm in the open position (3.8.3.3.(1)). Door hardware in a barrier-free path of travel will be of a design that does not require tight grasping and twisting of the wrist as the only means of operation (3.8.3.3.(3)). Closers on interior doors in a barrier free path of travel will include a delayed (3 second) closing time (3.8.3.3.(9)). Except within suites or where power door operators are used, doors in a barrier free path of travel will have a clear space beyond the latch side of 600 mm where the door swings toward the approach side, and 300 mm where the door swings away (3.8.3.3.(10)). Vestibules in a barrier-free path of travel will be at least 1200 mm long in addition to the door swing of any door swinging into the vestibule (3.8.3.3.(11)).
- Ramps in a barrier-free path of travel will be minimum 870 wide between handrails, and will have a maximum slope of 1 in 12 (3.8.3.4.).
- Elevators will comply with Appendix E of CAN/CSA-B44, Safety Code for Elevators (3.8.3.5.). At least one elevator serving each storey will have clear inside cab dimensions of 2032 mm x 1295 mm, and a door width of 1067 mm (Appendix A-3.5.4.1.(1)).
- All assembly areas with an area greater than 100 m2 will be provided with assistive listening devices in accordance with 3.8.3.7.
- Public washrooms will include at least one barrier free water closet stall with an open space having a diameter of not less than 1500 mm. The water closet seat heights, urinal opening heights, lavatory heights and clearances, grab bars, counter heights and mirrors will comply with 3.8.3.8. to 3.8.3.11.
- Counters more than 2 m long that serve the public will have at least one barrier free section not less than 760 mm wide (3.8.3.14.).

PLUMBING SERVICES

PLUMBING SERVICES – Utilizing the occupant loads noted in Section 11, the KIA requires the following washroom fixtures.

LEVEL	DESCRIPTION	OCCUPANT LOAD	NUMBER OF WATER CLOSETS		NUMBER OF URINALS	NUMBER OF LAVATORIES	
			M	F		M	F
1	Curbside	1854	8	19	5	7	10
1	Customs	270	1	6	2	2	3
1	Holdroom ‘A’	267	1	6	2	2	3
1	Holdroom ‘B’	976	3	14	5	4	7
1	Bag System	48	1	2	1	1	1
2	Office	96	1	2	1	1	1
B	Bag System	19	1	1	0	1	1

15.0 COST ESTIMATE

APPENDICES

KELOWNA INTERNATIONAL AIRPORT

Energy Audit Study

City of Kelowna

October 2010

Project Number: 03048C0400

Prepared by:

Grant Kidd, P.Eng., **LEED® AP**
Mechanical Associate

COHOS EVAMY
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1 EXISTING AIRPORT MECHANICAL AND ELECTRICAL SYSTEMS

1.1 General

1.1.1 The Kelowna airport was constructed in many phases from the original 1967 building to the airport today. The mechanical systems have varied over the course of these expansions as technologies and design philosophies have changed. There has been a mix between indoor and outdoor mounted equipment, with several expansion areas served by rooftop units instead of providing internal mechanical rooms. The original internal mechanical systems installed in 1967 and 1971 did not provide for a full central plant concept with room for expandability.

1.1.2 The mechanical systems include multi-zone constant volume, single-zone constant volume rooftop units, fan coils with dedicated outdoor air units, and packaged split system cooling units. The cooling systems include direct expansion (DX) in the majority of the units, a single chiller/tower system to supply fan coils and air handling units.

1.1.3 The existing record drawings were reviewed to determine current mechanical and electrical system configuration, existing equipment installation dates, and potential replacement requirements.

1.1.4 The scope of work for electrical systems was limited to a Lighting Survey to determine potential to reduce lighting energy use and heat gains to the space.

1.2 Existing Ventilation Systems

1.2.1 The East mechanical room 090 was part of the original 1967 construction and originally contained a multi-zone air handling unit, a single boiler, and a centrifugal Trane Torrivent condenser unit. This was revised in 1994 when the single boiler was replaced with two Fulton pulse combustion boilers and the Torrivent unit was replaced with a roof mounted condenser unit. The East mechanical room was renovated again in 2001 when the multi-zone was converted to an outdoor air makeup unit and two additional Buderus Boilers were added. The new outdoor air unit 090 has a hot water heating coil and chilled water cooling coil.

1.2.2 The existing Control Tower room 226 constructed in 1971 contains a dedicated single zone air handling unit with a hot water coil and split DX cooling coil, a single boiler serving the air handling unit and a unit heater, and two outdoor condensing units. The condensing units were replaced in 2001 as part of the major expansion.

1.2.3 The West mechanical room 030 constructed in 1982 contains a multi-zone air handling unit with DX cooling and a dedicated boiler serving the multi-zone heating coil only. This system is constant volume and primarily serves the central original main concourse areas. The DX cooling is served by a roof mounted condensing unit. This mechanical room has not been renovated and the mechanical air handling unit, boiler, and condenser all are beyond their service life.

1.2.4 Mechanical room 223 (unit 045) contains a constant volume mixed air handling unit dedicated to the feature departure lounge area. This unit has a hot water heating coil and chilled water cooling coil. This unit provides outdoor air directly to the departure lounge area.

1.3 Existing Heating Systems

1.3.1 West mechanical room 030 has one 1350 MBH A.O. Smith 80% efficient atmospheric boiler that only serves the multizone unit. The multizone hot deck provides building heat for these zones.

1.3.2 East mechanical room 090 has two 1438 MBH 84% efficient conventional Buderus G515 forced draft boilers that provide primary building heating for the portion of the airport served by fan coils and terminal heating systems. Two 875 MBH Fulton pulse combustion heating boilers are only used for backup. The primary hot water heating loop is constant volume with two-way valves on fan coils and air handling units. Fan coils provide heating or cooling to each zone. Unit heaters, radiation, and force flow units are also served by this heating loops with unit heaters and force flow units on wild loops and radiation served by two-way control valves.

1.3.3 The Control Tower is served by a single 350 MBH Bryan forced draft 80% efficient conventional boiler serving the air handling unit and a single unit heater.

1.3.4 There are various gas fired rooftop single-zone units located throughout the airport facility that can provide heating and cooling for the zones served.

1.3.5 Electric heat is utilized where hydronic heating is not practical or warranted. Gas fired infra-red heaters are used in the baggage drop-off areas.

1.4 Existing Cooling Systems

1.4.1 West mechanical room 030 is served by a DX refrigeration unit.

1.4.2 The East mechanical room 090, Mechanical room 223 (unit 045), and fan coils located throughout the airport are served by chilled water from the central chiller system.

1.4.3 The Control Tower is served by a DX refrigeration unit.

1.4.4 There are substantial numbers of packaged DX cooled rooftop constant volume units serving various expansion areas.

1.4.5 The chiller located in room 121A consists of a 155 ton McQuay R-22 centrifugal chiller and associated external fluid cooler. The chilled water loop has two 100% redundant pumps serving a constant volume chilled water loop with three way valves. The condenser loop has two 100% redundant pumps serving the fluid cooler coil. Free-cooling switchover valves provide winter operation without the chiller.

1.5 Control Sequences

1.5.1 The only control sequences available from Kimco controls were related to the PBS expansion phase of the airport.

1.5.2 The PBS expansion rooftop units RTU 1 to 7 did incorporate some energy conservation measures such as CO2 control of outdoor air, full recirculation during unoccupied periods, temperature turndown to 15 C during unoccupied periods, and economizer modes. However, it was noted that a very low CO2

setpoint of 500 ppm was utilized for the CO2 control which would be ineffective to reduce outdoor air quantities, since a low setpoint will increase outdoor air flow.

1.5.3 Screenshots of all controlled systems are included in Appendix A to provide an overview of the DDC system capabilities. Most mechanical equipment in the airport has some form of central DDC control.

1.5.4 Several trend logs from the control system included in Appendix B were utilized to determine system operating parameters.

2 LIGHTING SURVEY

2.1 Lighting Survey

2.1.1 A lighting survey was conducted between May 26 and May 27, 2010. This survey included a survey of fixture types, hours of use, potential for daylighting, lamp wattage, and illumination levels.

2.1.2 The lighting survey was conducted under daylight and nightime conditions to determine actual artificial lighting levels.

2.1.3 Several existing areas did have occupancy controls to control lighting operation.

2.1.4 Refer to Appendix C for lighting survey data and luminaire schedules.

2.2 Lighting Energy Conservation Strategies

2.2.1 The existing lighting in the Airport has been installed over the past 40 years with some upgrades occurring during expansion phases. Most of the existing T12 fixtures have been replaced with T8 fixtures, but some areas of T12 fixtures remain.

2.2.2 Lighting efficiency has increased substantially with current technologies and Lighting Power Densities lower than 1.0 W/sq.ft. are readily achievable.

2.2.3 The general illuminance levels can be reduced to the minimum necessary to perform the tasks required.

2.2.4 Occupancy sensors can be extended to more areas of the airport.

2.2.5 Daylight harvesting can be implemented in day lit areas, preferably in conjunction with daylight sensors.

3 EXISTING AIRPORT HEATING AND COOLING LOADS

3.1 Design Assumptions

3.1.1 The winter design temperature is -18.1°C.

3.1.2 The summer design temperature is 35.1°C DB, 19.1°C WB.

3.1.3 Occupancy loads based on ASHRAE 62.

3.1.4 Natural gas was approximately $11.18/GJ.

3.1.5 Electricity blended rate was approximately $0.069/kWhr.

3.2 Load Model

3.2.1 IES Virtual Environment was used to model the existing building and the proposed concept design of the new expansion areas.

3.2.2 Refer to Appendix D for a summary of heating and cooling loads based on the block model.

3.3 Heating and Cooling Loads

3.3.1 The calculated cooling load for the existing building based on the block load is approximately 196 tons. The block load is based on the entire building on a system level without individual room by room calculations. This calculation accounts for variation of cooling loads throughout the day as the solar load moves around the building.

3.3.2 Refer to Appendix E. The installed cooling capacity is approximately 378 tons, which is almost double the block load. This is typical of packaged rooftop unit installations, since the cooling units are rated in nominal sizes and provide a fixed amount of cooling. It was also found the existing chiller was not operating at 100% load.

3.3.3 The calculated cooling load for the expansion based on the Concept drawings is 203 tons. However, this cooling load will be reduced based on sustainable design concepts and reduction of proposed window areas.

3.3.4 The calculated heating load for the existing building based on the block load is approximately 3150 MBH.

3.3.5 Refer to Appendix E. The installed heating capacity is approximately 6,100 MBH which is oversized for the application. However, the packaged rooftop units have more heating capacity than is required for the application, which artificially makes the heating system appear oversized.

3.3.6 The heating and cooling systems are slightly oversized, but at the rooftop unit locations.

4 MECHANICAL ENERGY REDUCTION STRATEGIES

4.1 Right-Sizing Heating and Cooling Loads

4.1.1 The existing mechanical systems are oversized particularly in areas with rooftop units. Packaged rooftop units can be replaced with correctly sized hydronic units when life cycle replacement is due.

4.1.2 The new areas will be correctly sized with mechanical units suitable for the application.

4.2 Demand Based Ventilation

4.2.1 The use of CO_2 and occupancy based sensors is highly recommended. The current dedicated outdoor air unit serving the fan coils has variable inlet vanes but should be responding to changes in building occupany.

4.2.2 The CO_2 setpoints should be set at 1000 ppm.

4.3 Heat Recovery

4.3.1 Heat from exhaust should be recovered back to the inlet of the dedicated outdoor air system. Heat recovery systems include energy recovery wheels, runaround coils, and heat pipe systems that recover heat from the exhaust air stream for use in the intake air stream. This reduces energy consumption for pre-heating of outdoor air to the air handling units.

4.3.2 The exhaust systems in the existing airport area are widely distributed and smaller in scale. Therefore, significant recovery of exhaust heat would be difficult and will not payback. The new exhaust systems will be designed to provide central heat recovery.

4.4 Peak Capacity Reductions

4.4.1 The reduction of cooling load by reducing the source heat gain can be a very effective strategy to reduce energy use. The use of external shading devices, operable external dampers, and overhangs help to provide this reduction.

4.4.2 The Rotunda area has a very high cooling load due to the large glass areas facing Southwest. The glazing is quite dark, but substantial quantities of cooling air are still required. Therefore, solar control of this area should be evaluated.

4.4.3 The existing East facing passenger corridors also have substantial glass to allow passengers to view airside areas. However, large numbers of split system air conditioning units are required to cool these corridors. It is recommended that glazing be minimized or external shading incorporated.

5 SERVICE LIFE UPGRADES

5.1 West Mechanical Room - Boiler Replacement

5.1.1 The existing boiler serving the multi-zone unit 030 requires life-cycle replacement. This boiler's only purpose is to serve the multi-zone unit and provide heating to each zone.

5.1.2 ECO: The new West Mechanical room air handling unit should be connected to a new heat pump located in the mechanical room. The temperatures required to serve an air handling unit pre-heat function are compatible with temperatures from a heat pump unit. The heat pump unit would be water to water to allow a centralized installation to serve the multi-zone unit.

5.2 West Mechanical Room – Air Handling Unit Replacement

5.2.1 The existing constant volume multi-zone air handling unit requires life cycle replacement due to age of the unit. It was also noted by operational staff that the existing outdoor air intake for this unit is in a very poor location and is subject to vehicle fume entrainment.

5.2.2 ECO: The new air handling unit should be variable volume with variable volume control of each zone. Occupancy or demand based control (CO_2) can be used to control volume delivered to each zone as well as outdoor air requirements from the unit. It is also proposed that the air handling unit intake and exhaust be reversed so that outdoor air is drawn from the roof area and exhaust is directed towards the taxi stand areas.

5.3 R-22 Screw Chiller

5.3.1 The existing McQuay dual rotary screw chiller is 10 years old and is using R-22 refrigerant which is slated for phase-out in 2020. This chiller utilizes two single-rotor screw compressors operating in parallel on a single evaporator and condenser. The efficiency of this existing chiller is approximately 0.70 kW/ton, new chillers are more efficient and can achieve better than 0.5 kW/ton, particularly when using variable speed control. Variable speed chillers are more efficient at part load since the variable inlet vanes found on constant speed chillers are eliminated. The variable speed operation of the compressor provides much more efficient operation at part-load as the chiller motor operates at a slower speed.

5.3.2 ECO: Replace the existing chiller when the 2016 mechanical room build out occurs by installing a new more efficient and HCFC free chiller in the new mechanical room.

5.4 Packaged Rooftop Units

5.4.1 There are several packaged rooftop units that will require replacement over the course of the expansion project. These units are not as efficient as a central cooling system with typical performance of 1.25 kW/ton on cooling. Packaged rooftop units are also typically single zone and don't provide consistent temperature control in the space. However, some rooftop units have been recently installed and the Owner should continue to obtain the value from these units until replacement is necessary.

5.4.2 ECO: Allow provision to connect replacement rooftop units into the central heating and cooling system when replacement becomes necessary.

5.5 East Mechanical Room – Boilers

5.5.1 The existing Buderus boilers were only installed in 2001 and these boilers are cast iron style with a long potential service life. The hydronic system is also designed for the higher temperatures provided by these boilers. Therefore, these boilers should continue to provide peak loading and backup to a potential geothermal system. The existing Fulton boilers should be removed to provide space for future heat pumps.

5.5.2 ECO: The investment and embodied energy in the Buderus boilers would be wasted if these boilers were replaced. These boilers should be operated to the end of their life cycle.

5.6 Control Room – Boilers and Air Handling Units

5.6.1 The existing control room is no longer being utilized as a control tower. Therefore the small boiler and air handling unit should be demolished and the system connected to the main loop.

5.6.2 ECO: Provide a new hydronic air handling unit with heating coils and chilled water coils served by a heat pump.

6 FUTURE EXPANSION CONSIDERATIONS

6.1 External Geothermal Field

6.1.1 It is proposed to take advantage of the landscape of the airport by utilizing the infield areas for a closed loop geothermal field. The proximity of Mill Creek and Okanagan Lake to the airport suggests that good ground conditions or an aquifer may be available in the area to provide good borehole performance.

6.1.2 Provide primary heating and cooling base loads by utilizing an economically sized geothermal field (to be determined during the expansion project). Provide central heat pumps located in central mechanical rooms to provide heating and cooling to serve loads. Provide geothermal loop distribution throughout the airport to allow heat pumps to draw or reject heat to the loop. Peak load and backup heating and cooling to be provided by central boilers and chillers.

6.2 Distributed Chiller System

6.2.1 Provision of distributed chiller systems will provide more efficient cooling operation since the chillers would be water cooled. The chillers would be located in each main mechanical room: a new north mechanical room, the existing chiller mechanical room, and the new expansion mechanical room.

6.2.2 Provide efficient variable speed chiller systems to provide chilled water to the building and reduce electrical load. Chillers shall be operated whenever required to provide peak capacity and backup.

6.3 Distributed Boiler System

6.3.1 Provision of distributed boiler systems to provide backup and peak heating for the geothermal system. The boilers would be located in each main mechanical room: a new north mechanical room, the West mechanical room, the existing East mechanical room (existing boilers), and the new expansion mechanical room.

6.3.2 Provide condensing boilers to take advantage of new low temperature heating systems and allow interconnection with the geothermal system.

6.4 Utility Transformer

6.4.1 In order to expand the existing Air Terminal Building more power will be needed from the existing utility transformer. By reducing the lighting power density of the existing Air Terminal Building capacity can be freed up from the transformer for use in the expansions to come. As a result, by reducing the lighting power, not only significant energy can be saved but the cost of revising the utility transformer and electrical distribution equipment can be mitigated.

6.4.2 Reduce lighting and cooling power in the existing building to reduce electrical load and accommodate expansion.

7 ENERGY CONSERVATIONS MEASURES – LOW OR NO COST

7.1 Mechanical Equipment Schedules

7.1.1 Mechanical Equipment should be shut down when the building is unoccupied. It was noticed during review of the control system that the majority of equipment does not shut down.

7.1.2 ECO: Utilize equipment scheduling feature to shut down equipment when not required, typically during unoccupied periods.

7.1.3 Energy Savings: as much as $14,000/year, some units may not be shut down or require a longer rebound period.

7.1.4 Capital Cost Estimate: $0

7.1.5 Simple Payback = immediate.

7.2 Chilled Water Pumps

7.2.1 The existing chilled water pumps are running continuously even when the chillers and cooling towers have shut down.

7.2.2 ECO: Shut down the chilled water pumps when not in use.

7.2.3 Energy Savings: $2,000/year

7.2.4 Capital Cost Estimate: $0

7.2.5 Simple Payback = immediate.

7.3 CO2 Control

7.3.1 The existing CO2 control setpoints are set too low. Exterior ambient CO2 levels are typically 400 ppm, ASHRAE 62 recommends that CO2 sensors be set a maximum of 700 ppm over the ambient which corresponds to a comfortable level of ventilation and odour control.

7.3.2 ECO: Revise CO2 setpoints to 400 + 700 ppm = 1100 ppm maximum. We would recommend 1000 ppm as the setpoint with an alarm at 1100 ppm.

7.3.3 Energy savings are hard to quantify but outdoor air volumes should be reduced.

7.3.4 Capital Cost Estimate: $1300. This capital cost estimate is based on programming time for the DDC system vendor.

7.3.5 Simple Payback = immediate.

7.4 Bypass Water Filtration

7.4.1 Domestic water is current being filtered at each entry location by substantial filtration units. These units consume power and are costly to maintain. The current status of domestic water supply quality should be re-evaluated to confirm these filters are necessary. If they are found to be necessary, a separate unfiltered supply should be connected to fixtures such as toilets, urinals, and hose bibs. The cost consultant identified an extra cost of $103,200 to provide these additional plumbing lines, this cost would make this bypass uneconomical.

8 ENERGY CONSERVATIONS MEASURES – MECHANICAL

8.1 Condensing Boilers

8.1.1 Replacement boilers in the West Mechanical room and possibly the Control Tower mechanical room should be condensing style to provide up to 95% seasonal efficiency. The heating system can be modified in both of these

areas to a low temperature design relatively easily since air is used for heating. Condensing boilers will complement a future geothermal loop as well.

8.1.2 The East Mechanical room could also have one condensing boiler installed to operate in the summer and partial load seasons. The existing hot water loop to the fan coils, radiation, and unit heaters is difficult to revise to low temperature operation since this equipment was all sized at high temperatures. However, the reset schedule can be lowered as much as possible to encourage condensing operation.

8.1.3 ECO: Install condensing boilers for all replacement boilers. Condensing boilers are cost effective and have a short payback period.

8.1.4 Capital Cost Estimate: The opportunity to install condensing boilers is at life-cycle replacement of existing conventional boilers. There will be an up-charge for condensing boilers and the associated stainless steel flues, but this charge will be minimal. Estimated up-charge from a conventional boiler for the West mechanical room would be $30,000 for a condensing boiler system. <u>Note: This cost estimate is the delta for condensing boilers over conventional only, this estimate does not include the entire project cost for boiler replacement.</u>

8.1.5 Energy Savings = $15,019/year. Simple Payback = 2.0 years

8.1.6 Greenhouse Gas savings = 67.5 tCO2.

8.2 Centralized Chilled Water Systems

8.2.1 The existing systems are a mix of direct expansion (DX) condensers, packaged DX units, and a chilled water loop for internal fan coils. The existing direct expansion equipment should be replaced whenever possible with water cooled chillers or as part of a geothermal heat pump loop.

8.2.2 ECO: Provide water cooled chillers for peak loading and as backup for the geothermal system.

8.2.3 Capital Cost Estimate: The capital cost for central chilled water systems can be budgeted in the capital upgrades of each expansion. The intent is to provide geothermal piping mains from the north end of the airport to the south end of the airport to allow connection of heat pump units. The central chillers will be located at the North and South end to support the heat pumps. There will be a capital cost premium between provision of packaged rooftop DX units and central chillers with wet coil units and hydronic piping. The cost premium based on a 200 ton chiller and associated equipment was estimated at $108,700. <u>Note: this cost premium is a the delta between packaged rooftop DX units and central chillers only, not the cost estimate for the entire chilled water system.</u>

8.2.4 Energy Savings = $9500/year. Simple Payback = 11.4 years.

8.2.5 Greenhouse Gas savings = 2.8 tCO2.

8.3 Variable Speed Pumping Systems

8.3.1 The existing heating and cooling pumps serving the hot water and chilled water loops are constant volume. All fan coils and air handling units have 3-way valves and systems are primary only.

8.3.2 ECO: Provide variable speed drives on distribution pumps, add constant volume primary pumps on boilers and chillers complete with a decoupling bridge.

8.3.3 Capital Cost Estimate: There are large numbers of fan coils, approximately 60, that will require replacement of the 3-way valves with 2-way valves to provide variable flow in the system. It is possible to retrofit the 3-way valves to 2-way valves by blocking off one port, which would be significantly less expensive than trying to convert all the existing valves. The capital cost assuming retrofit or maintenance replacement of the 3-way valves is approximately $122,000. Note: this cost estimate assume that the fan coil valves will be replaced as part of the renovation work in each area, therefore ceilings will be accessible for replacement.

8.3.4 Energy Savings = $6,200/year. Simple Payback = 19.7 years.

8.3.5 Greenhouse Gas savings = 1.8 tCO2.

8.4 Geothermal Ground Source Systems

8.4.1 The potential for geothermal ground source systems is being evaluated as part of the Concept design for the airport expansions. There is sufficient land area on the airport infield to accommodate a closed loop system. There is also potential of utilizing standing column geothermal wells, this should be evaluated in the design phase. The geothermal field will not provide the entire heating and cooling load for the airport, with peak loads accommodate by boilers for heating and chillers for cooling.

8.4.2 ECO: Provide a geothermal energy loop throughout the airport connecting the North and South ends to an open or closed ground source heat pump system. This system will allow movement of heat from year round internal load areas to perimeter areas and will provide substantially better performance than the air side condensers typically used. Split systems are available to allow connection of the heat pump loop to existing refrigerant coils or provide cooling to service rooms.

8.4.3 Capital Cost Estimate: The capital cost estimate for the geothermal field will be highly variable based upon open versus closed loop, disturbance to the runway, and overnight premiums for well drilling. However, it is estimated that the geothermal field to support the existing airport block cooling load of approximately 200 tons would be $532,500. Note: this cost estimate is based on 2 tons/well, approximately 100 - 76 m deep vertical bore wells, and 150 mm supply and return piping c/w with manifolds and branch piping connecting to each well.

8.4.4 Energy Savings are approximately $30,000/year over an equivalent condensing boiler system. Simple payback = 17.7 years.

8.4.5 Greenhouse Gas Savings = 283 tCO2.

9 ENERGY CONSERVATION MEASURES – ELECTRICAL

9.1 ASHRAE 90.1 Energy Compliance

9.1.1 The existing lighting system in the building is consuming 1.31 W/ft2. ASHRAE 90.1 specifies lighting power densities for specific spaces within airports and

further states that a transportation building should have Lighting Power Densities (LPD) lower than 1.0 W/ft2. With LEED Certification in mind ASHRAE 90.1 would have to be further reduced by 10%. Therefore the Lighting Power Density target for the airport would be 0.9W/ft2. While the airport may not file for LEED certification this Lighting Power Density reduction represents a LEED pre-requisite minimum and should be considered a best practice whenever Energy Conservation is being pursued. A combination of techniques would be used to achieve the LPD of 0.9W/ft2. Examples are replacing light fixtures, de-lamping the existing fixtures, revising branch circuits, and revising the Lighting Control system program.

9.1.2 ECO: Re-lamp and re-fixture as necessary to surpass ASHRAE 90.1 by 10%.

9.1.3 Energy Savings: 31% of total lighting power, 292615 kW*h/year based on 18hour/day operation, or $20200 at $0.069/kW*h.

9.1.4 Capital Cost Estimate: $27390.

9.1.5 Simple Payback = 1.4 year.

9.2 Administration Open Office Area General Illuminance Levels

9.2.1 The existing lighting system in the open office area is to provide 550 lux on average to the working surface. Providing 550 lux on the desktop in an environment with 4 foot partitions is ineffective due to shadowing. Reducing the area lighting illuminance level to 350 lux will provide a comfortable work environment as well as introduce cost savings through reduced energy consumption, fixture maintenance and re-lamping. Using supplemental task lighting at each workstation will ensure that the occupants receive a comfortable amount of light where they require it.

9.2.2 ECO: Redesign open office area lighting to 350 lux with supplemental task lighting.

9.2.3 Energy Savings: Energy savings and costs for this option are grouped in with the Ashrae 90.1 Energy Compliance Option.

9.2.4 Capital Cost Estimate: Included above.

9.3 Occupancy Sensing in Private Offices

9.3.1 Each private office space uses one or two local switches to control the lights in the space. By installing wall mount occupancy sensors to replace the local switches the lights will always be turned off when the spaces are not occupied. Semi-Automatic Occupancy Sensing is recommended. If there are special requirements of a particular office that require a manual "lights on" override, that feature can be provided with the wall mounted occupancy sensor.

9.3.2 ECO: Install wall mounted occupancy sensors in private office to reduce lighting energy consumption in unoccupied spaces.

9.3.3 Energy Savings: 50% of office lighting energy, 87000 kW*h per year, or $6000 at $0.069/kW*h per year.

9.3.4 Capital Cost Estimate: $14775

9.3.5 Simple Payback = 2.5 years

9.4 Occupancy Sensing in Baggage Claim

9.4.1 Due to the nature of arrival times, the baggage claim area remains inactive for large periods of time during the airports daily operation. Using occupancy sensors in the airside corridor and CBSA area with manual override switches in the Baggage Claim area, the lights could be automatically turned off for a significant period of time each day. A reduced lighting level would be provided during the inactive mode to allow occupants to safely move about the space.

9.4.2 ECO: Install ceiling mounted occupancy sensors in airside corridor and CBSA processing area to reduce amount of time Baggage Claim light fixtures are turned on.

9.4.3 Energy Savings: 50% of Baggage Claim lighting energy, 40000 kW*h per year, or $2750 at $0.069/kW*h per year.

9.4.4 Capital Cost Estimate: $8100

9.4.5 Simple Payback = 2.9 years.

9.5 Washrooms, Locker, Janitor and Storage Rooms Occupancy Sensing

9.5.1 Many Janitor Rooms and Storage rooms often have the lights left on. Wall and ceiling mount occupancy sensors in semi automatic operation would ensure these lights are turned off when the rooms are not in use. The public and staff washrooms are currently turned on all day. Ceiling mounted occupancy sensors in fully automatic mode could effectively turn these lights.

9.5.2 ECO: Install ceiling mounted occupancy sensors in common all washrooms, Janitor Rooms, and Storage Rooms to turn lights off when not in use.

9.5.3 Energy Savings: 50% of room lighting energy or 29500 kW*h at $0.067/kW*h per year, or $2000 at $0.069/kW*h per year.

9.5.4 Capital Cost Estimate: $2175

9.5.5 Simple Payback = 1.1 years.

9.6 Concourse Daylight Harvesting

9.6.1 The Central Concourse has both skylights and clerestories. These features introduce large amounts of daylight into the space and during daytime hours the daylight dominates the lighting in the space. The electric lighting in the concourse could be turned off in the morning when the sun rises and turned on in the evening when the sun sets based on an outdoor photocell.

9.6.2 ECO: Commission existing photocell sensor to turn off concourse lighting during daylight hours.

9.6.3 Energy Savings: 12 hours of daylight harvesting per day for 206000 kW*h, or $14250 at $0.069/kW*h per year.

9.6.4 Capital Cost Estimate: $15,000.

9.6.5 Simple Payback = 1.1 years.

9.7 Rotunda Lounge Daylight Harvesting

9.7.1 The Rotunda Lunge has tall glazing on the West side. These windows introduce large amounts of daylight into the space and during daytime hours the daylight dominates the lounge area lighting in the space. The electric lighting in the upper Rotunda Lounge could be turned off during daylight hours, although the lower Rotunda area where passengers pass through en route to pre-board screening should remain on. The lighting system in the Rotunda Lounge area should be re-evaluated for energy efficiency. The Metal halide indirect lighting system shining upwards on the painted grey perforated curved mesh panel is extremely inefficient. A different ceiling type, or down lighting fixture could allow for a decrease the Lighting Power Density in the area.

9.7.2 ECO: Commission existing photocell sensor to turn off Rotunda Lounge lighting during daylight hours and re-evaluate indirect lighting system to further reduce the lighting power density.

9.7.3 Energy Savings: 12 hours of daylight harvesting per day. Calculated with Concourse lighting above.

9.7.4 Capital Cost Estimate: Included above.

9.8 Daylight Sensing to Control Air Side Corridor Lighting

9.8.1 The Air Side Corridor has large windows approximately every 8 feet. These windows provide ample daylight in the corridor during daytime hours. The electric lighting in the Air Side Corridor could be turned off where ever there are windows during daylight hours.

9.8.2 ECO: Install East facing photocell and commission turn off Air Side Corridor lighting during daylight hours.

9.8.3 Energy Savings: 12 hours of daylight harvesting per day. Calculated with Concourse lighting above.

9.8.4 Capital Cost Estimate: $1300.

9.9 Building Lighting Control System

9.9.1 The Douglas Relay System controls the lighting circuits throughout the building and allows for great lighting flexibility. By revising the time clock and photocell schedules, a more stringent control scheme could be implemented. In general the light fixtures are connected to a large number of small zones. This affords great flexibility although some wiring may need to be revised to allow for maximum implementation of the above strategies. Reducing the hours that exterior light fixtures are turned on by turning them off during the late night period would add further savings.

9.9.2 ECO: Re-commission Time clock and Photocell Schedules for interior and exterior light fixtures. Revise wiring of light circuits as necessary to allow for implementation of daylight harvesting.

9.9.3 Energy Savings: Difficult to quantify.

9.9.4 Capital Cost Estimate: $2000

9.10 Building Luminaire Retrofit

9.10.1 The building has had almost all Fluorescent T12 lamps replaced with Energy Saving T8 lamps however there are a number of T12 lamps still in operation, most notably in the exterior canopy. These fixtures have high mercury content, are inefficient, and should be replaced or re-lamped to T8.

9.10.2 ECO: Retrofit the remaining T12 lamps to be T8 lamps.

9.10.3 Energy Savings: 20% of fixture lighting energy or 1260 kW*h per year, or $90 at $0.067/kW*h per year.

9.10.4 Capital Cost Estimate: $6900

9.10.5 Simple Payback = 76 years.

9.11 Branch Wiring Revisions

9.11.1 In order to facilitate the above options, minor revisions to the electrical branch wiring may be necessary. These changes may be required in order to create the daylight harvesting schemes and revise fixtures to meet ASHRAE 90.1 depending on the existing conditions.

9.11.2 ECO: Facilitate technical completion of above ECO's

9.11.3 Capital Cost Estimate: $16398

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10 SUMMARY

10.1 Mechanical ECO Summary Table

#	Description	ECO	Energy Savings	Capital Cost	Simple Payback	tCO2
.1	Revise Mechanical Schedules	Shut Down Air Handling Units Overnight	$ 14,000	None	Immediate	4.1
.2	Chilled Water Pumps	Shut Down Chilled Water Pumps Overnight	$ 2,000	None	Immediate	0.6
.3	C02 Control	Revise setpoints to 1000 ppm	Difficult to quantify	$1,300	Immediate	-
.4	Bypass Water Filtration	Remove or bypass water filtration, check water quality, provide dedicated piping to water closets	Difficult to quantify	$0 - if water quality is bad, $103,200	Immediate	-
.5	Condensing Boilers	Install condensing boilers when upgrading	$15,000	$30,000	2.0 years	67.5
.6	Central Chillers	Install central water cooled chillers instead of DX units	$9,500	$108,700	11.4 years	2.8
.7	Variable Speed Pumping	Install variable speed drives and 2-way valves on fan coils	$6,200	$122,000	19.7 years	1.8
.8	Geothermal Heat Pump System	Install a ground source geothermal system in conjunction with future expansions	$30,000	$532,500	17.7 years	283

10.2 Electrical ECO Summary Table

#	Description	ECO	Energy Savings	Capital Cost	Simple Payback	tCO2
.1	ASHRAE 90.1 Compliance	Revise lighting from 1.31 W/sq.ft. to 0.9 W/sq.ft.	$20,200	$27,390	1.4 years	5.9
.2	Administration Office Illumination	Reduce illumination to 350 lux	Included item .1	Included item .1	Included item .1	
.3	Occupancy sensors in Private Offices	Add Occupancy Sensors in all private offices	$6,000	$14,775	2.5 years	1.7
.4	Occupancy sensors in Baggage Claim	Add Occupancy Sensors to Baggage Claim	$2,750	$8,100	2.9 years	0.8
.5	WR, LR, JR, and Storage Room Occupancy Sensors	Add Occupancy Sensors to Misc Rooms	$2,000	$2,175	1.1 years	0.6
.6	Concourse Daylight Harvesting	Commission existing photocell to turn off concourse lighting during the day	$14,250	$15,000	1.1 years	4.1
.7	Rotunda Lounge Daylight Harvesting	Commission existing photocell to turn off concourse lighting during the day	Included item .6	Included item .6	Included item .6	
.8	Daylight Sensing for Control Air Side Corridor	Daylight sensing to Air Side Corridor	$1,300	Included item .6	Included item .6	0.3
.9	Building Lighting Control System	Recommisson time clock and photo-cells to exterior light fixtures	Difficult to quantify	$2,000	Immediate	
.10	Building Luminaire Retrofit	Retrofit remaining T12 lamps to T8 lamps	$ 90	$6,900	76 years	
.11	Branch Wiring Revisions	Allowance to complete ECO's 1-10		$16,398		

11 PHASING

11.1 PHASE 1- CBSA PIL and Transborder Holdroom Modification

#	Description	Phase 1 ECO Description	Phase 1 Capital Cost
.1	Revise Mechanical Schedules	Shut Down Air Handling Units Overnight	None
.2	Chilled Water Pumps	Shut Down Chilled Water Pumps Overnight	None
.3	C02 Control	Revise setpoints to 1000 ppm	$1,300
.4	Bypass Water Filtration	Remove or bypass water filtration, check water quality	$0
.5	Condensing Boilers	Install condensing boiler in PIL mechanical room for backup. Install condensing boiler in West mechanical room for life cycle replacement.	$15,000
.6	Central Chillers	Install backup water cooled chiller and tower in PIL mechanical room	$40,000
.7	Variable Speed Pumping	Install variable speed drives and 2-way valves on fan coils in Transborder renovation area.	$61,000
.8	Geothermal Heat Pump System	Install two heat pumps in PIL mechanical room, main underground piping and partial geothermal field	$175,000
#	**Description**	**Phase 1 ECO Description**	**Phase 1 Capital Cost**
.1	ASHRAE 90.1 Compliance	Mockup areas created for areas that will require new fixturing, De-Lamping in areas where this option can be achieved.	$6,825
.2	Administration Office	Reduce illumination to 350 lux	Included

	Illumination		item .1
.3	Occupancy sensors in Private Offices	Add Occupancy Sensors in all private offices	$14,775
.5	WR, LR, JR, and Storage Room Occupancy Sensors	Add Occupancy Sensors to Misc Rooms	$2,175
.6	Concourse Daylight Harvesting	Testing only	$15,000
.7	Rotunda Lounge Daylight Harvesting	Commission photocell sensors	Included item .6
.8	Daylight Sensing for Control Air Side Corridor	Daylight sensing to Air Side Corridor	$1,300
.9	Building Lighting Control System	Recommisson time clock and photo-cells to exterior light fixtures	$1,000
.10	Building Luminaire Retrofit	Retrofit remaining T12 lamps to T8 lamps	$6,900
.11	Branch Wiring Revisions	Allowance to complete ECO's 1-10, as required in Phases 1, 2, 3, 4	$4,373

Total: $ 344,648

11.2 Phase 2 - Outbound Baggage Hall and Modifications to Air Side Corridor / Generator Facility

#	Description	Phase 2 ECO Description	Phase 2 Capital Cost
.8	Geothermal Heat Pump System	Install geothermal pipes through new airside corridors	$107,500
#	**Description**	**Phase 2 ECO Description**	**Phase 2 Capital Cost**
.1	ASHRAE 90.1 Compliance	Revise lighting from 1.31 W/sq.ft. to 0.9 W/sq.ft by re-lamping in existing terminal	$10,328

		building concourse air and ground-side where it is required (up to and not including the Rotunda)	
.6	Concourse Daylight Harvesting	Commission and implement after fixture up-grades	None
.11	Branch Wiring Revisions	Allowance to complete ECO's 1-10	$4,373

Total: $ 122,201

11.3 Phase 3 – Domestic Bag Claim / Meeter Greeter / Holdroom Expansion / Loading Area

#	Description	Phase 3 ECO Description	Phase 3 Capital Cost
.5	Condensing Boilers	Install condensing boilers when upgrading	$15,000
.6	Central Chillers	Install new central chiller and cooling tower in new mechanical room	$68,700
.7	Variable Speed Pumping	Install variable speed drives and 2-way valves on fan coils in renovated areas	$61,000
.8	Geothermal Heat Pump System	Install ground source heat pumps in new penthouse and extend source piping to penthouse	$250,000
#	**Description**	**Phase 3 ECO Description**	**Phase 3 Capital Cost**
.7	Rotunda Lounge Daylight Harvesting	Lighting Fixture Improvements	Included item .6
.11	Branch Wiring Revisions	Allowance to complete ECO's 1-10	$4,373

Total: $399,073

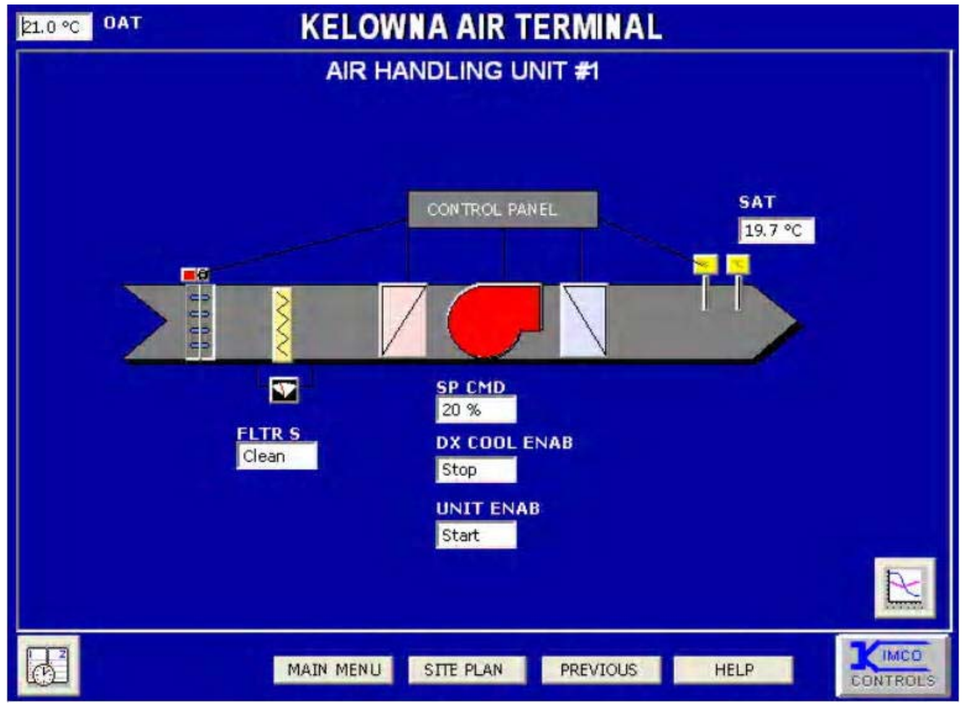
11.4 Phase 4 - International Bag Claim / Meeter Greeter Modifications / CBSA Secondary Expansion

#	Description	Phase 4 ECO Description	Phase 4 Capital Cost
.7	Variable Speed Pumping	Install variable speed drives and 2-way valves on fan coils	$30,000
#	**Description**	**Phase 4 ECO Description**	**Phase 4 Capital Cost**
.1	ASHRAE 90.1 Compliance	Revise lighting from 1.31 W/sq.ft. to 0.9 W/sq.ft. Complete re-lamping in areas that were affected by renovation or new construction during Phase 3.	$10,237
.4	Occupancy sensors in Baggage Claim	Add Occupancy Sensors to Baggage Claim	$8,100
.9	Building Lighting Control System	Re-commission time clock and photo-cells to exterior light fixtures	$1,000
.11	Branch Wiring Revisions	Allowance to complete ECO's 1-10	$3,279

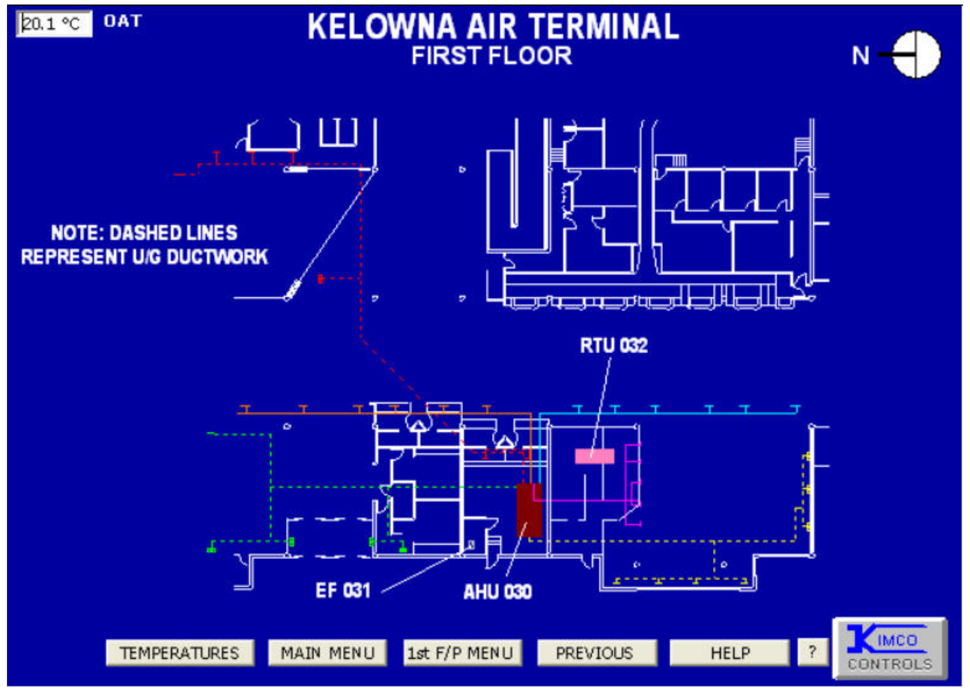
Total: $ 52,616

APPENDIX A

EXISTING MECHANICAL SYSTEMS



AHU-1



AHU030-DUCTWORK

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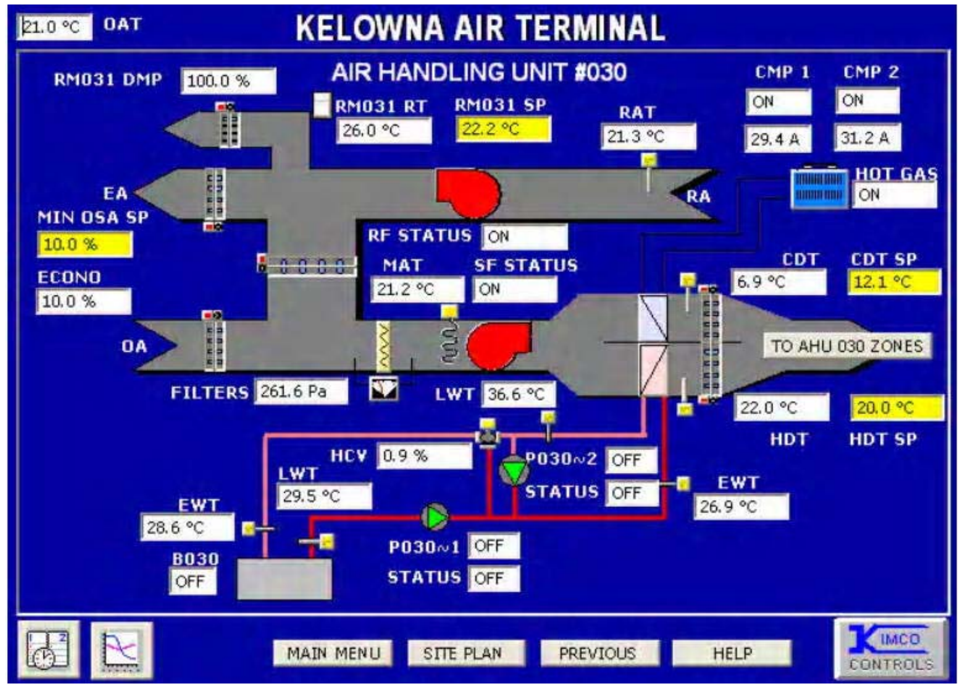

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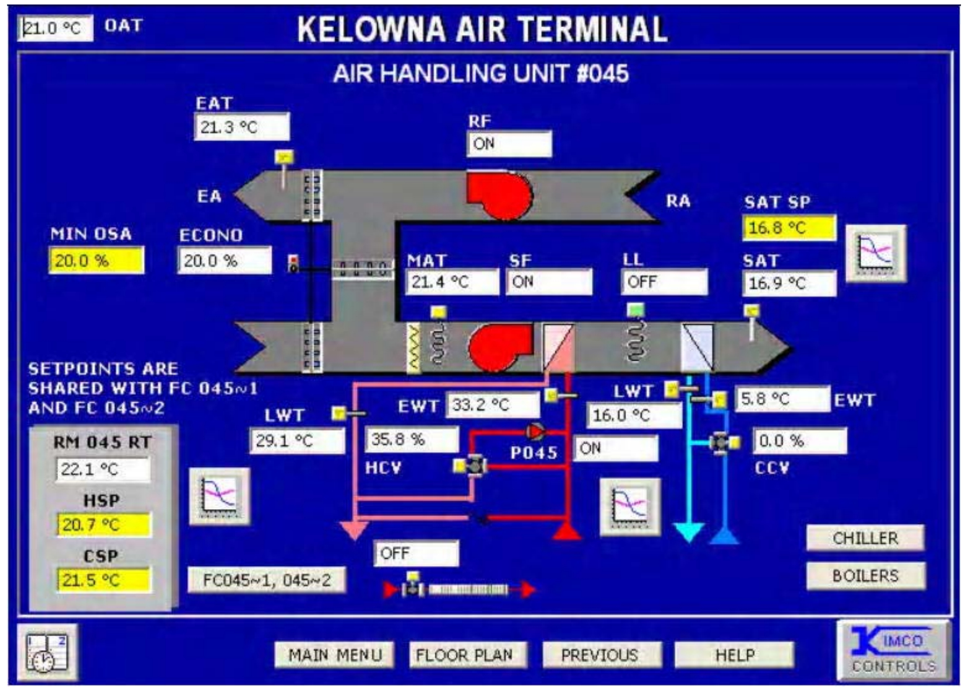

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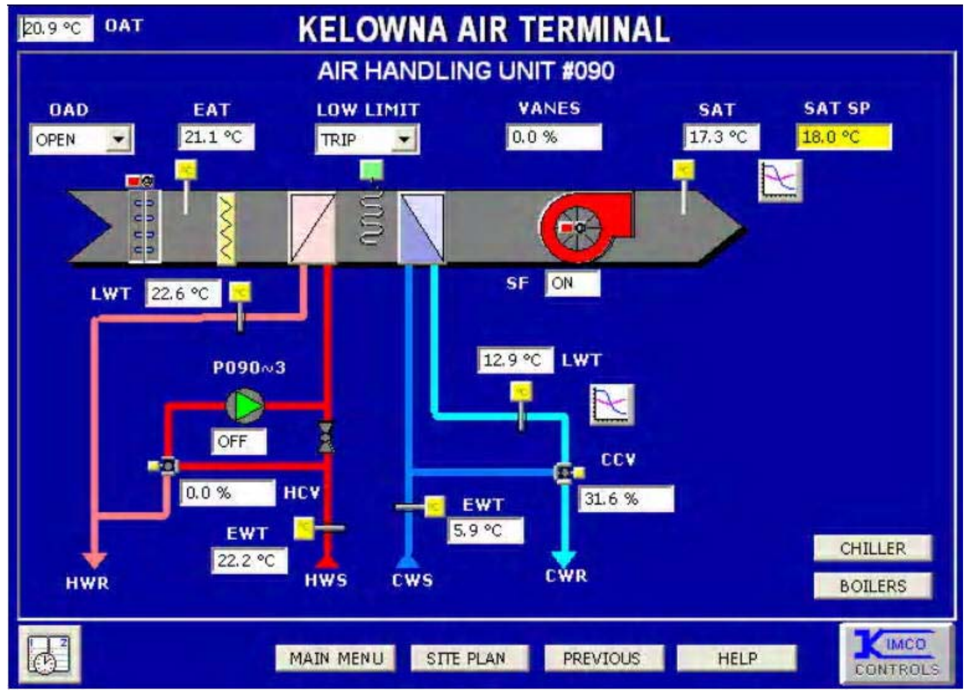

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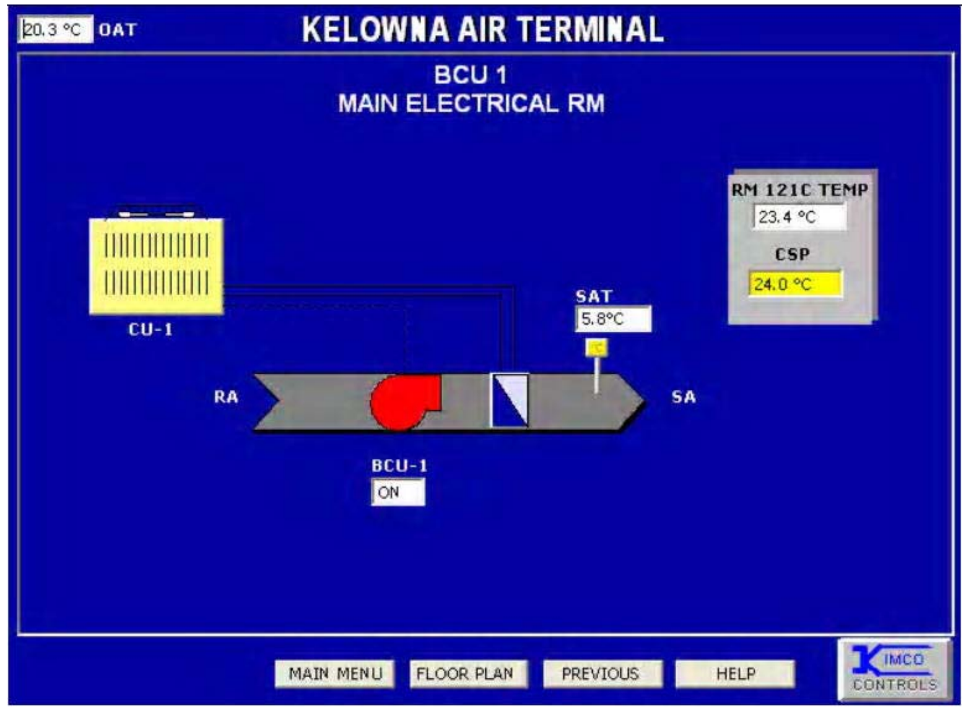

BCU1

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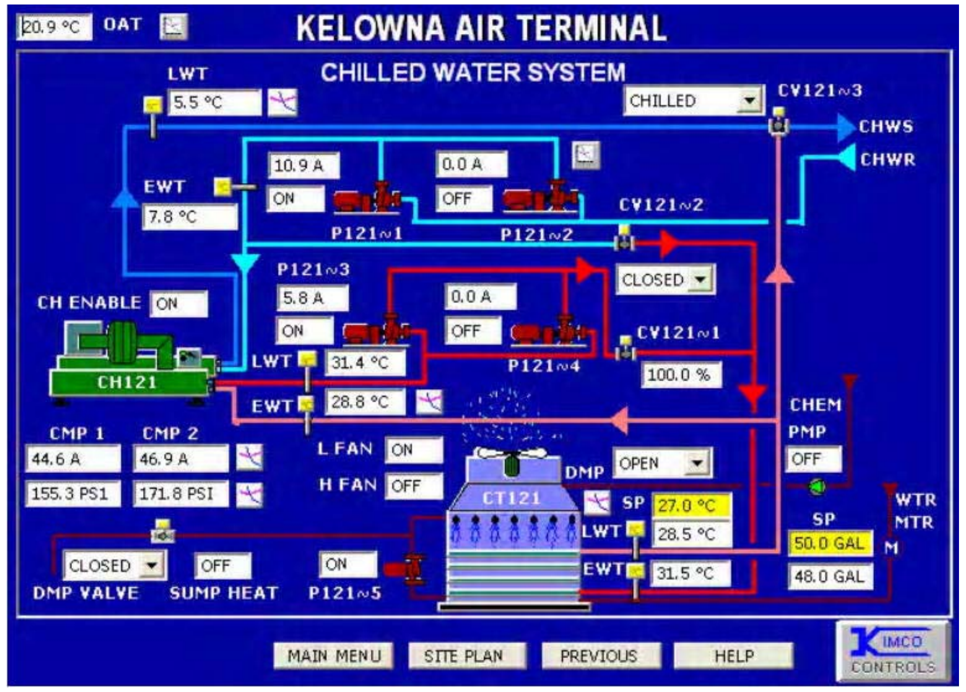
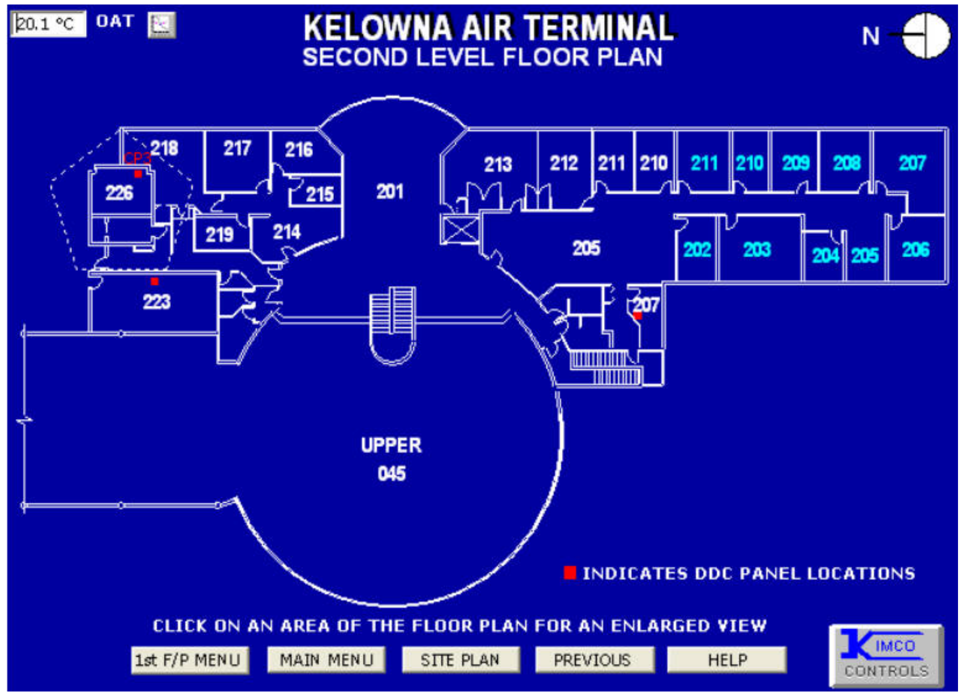


CHILLER WATER SYSTEM



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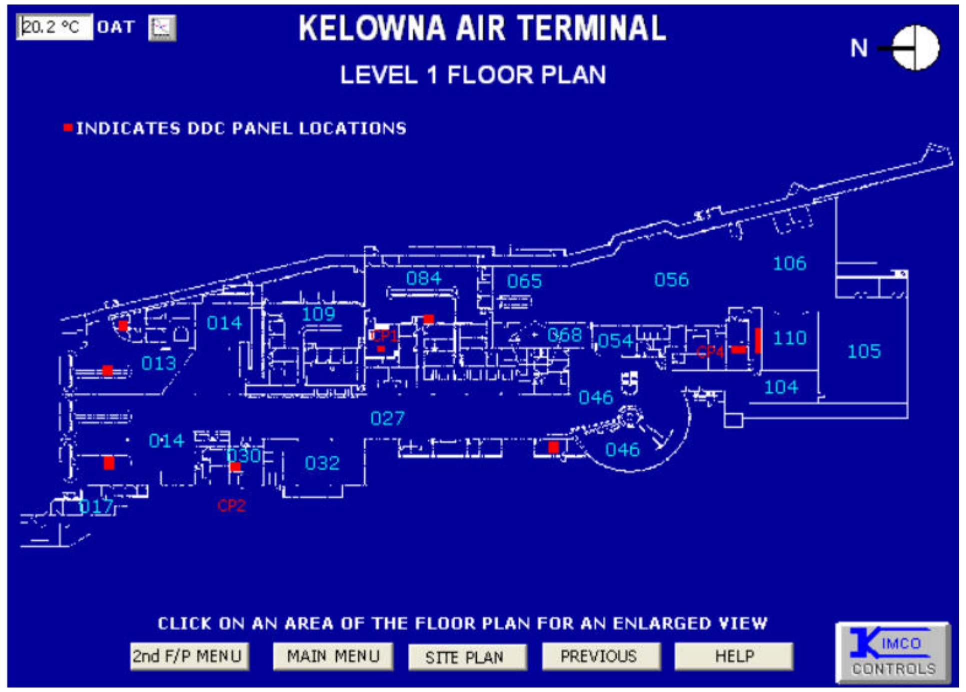

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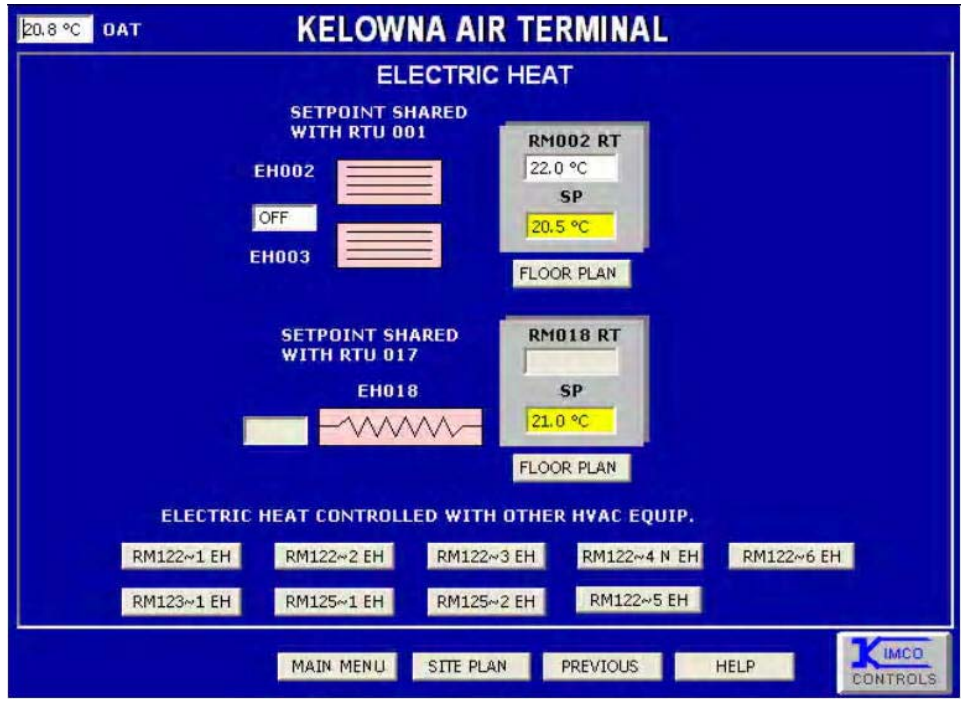

ELECTRIC HEAT 1

COHOS EVAMY
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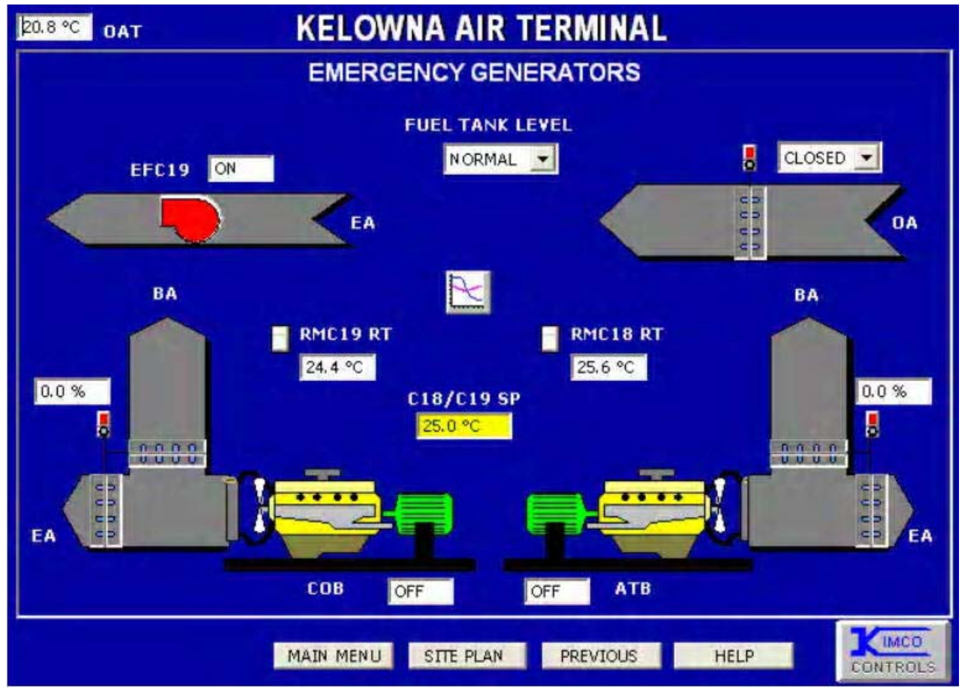

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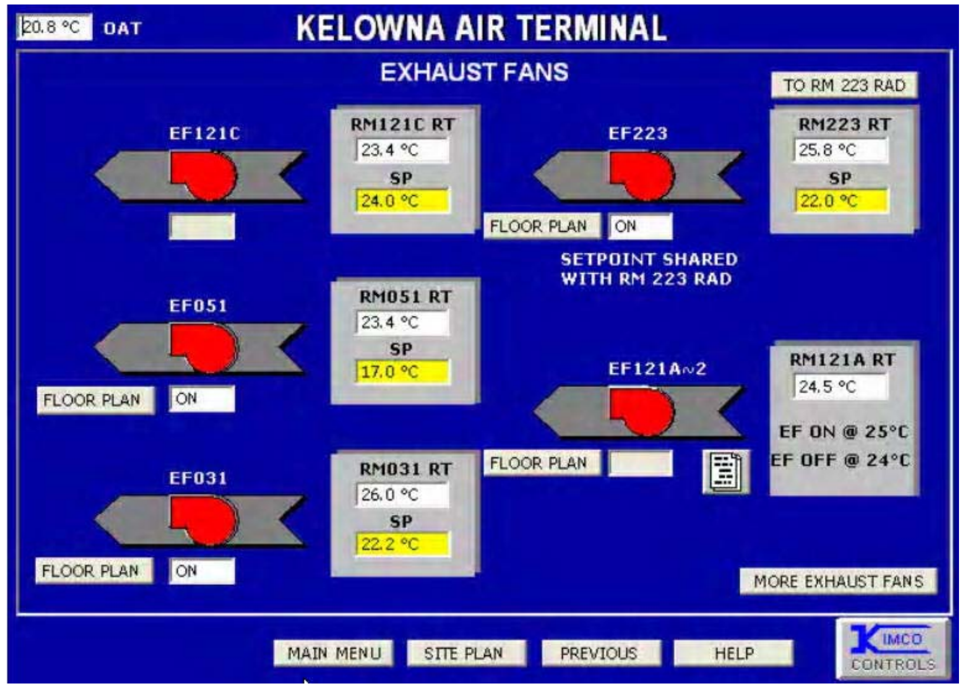

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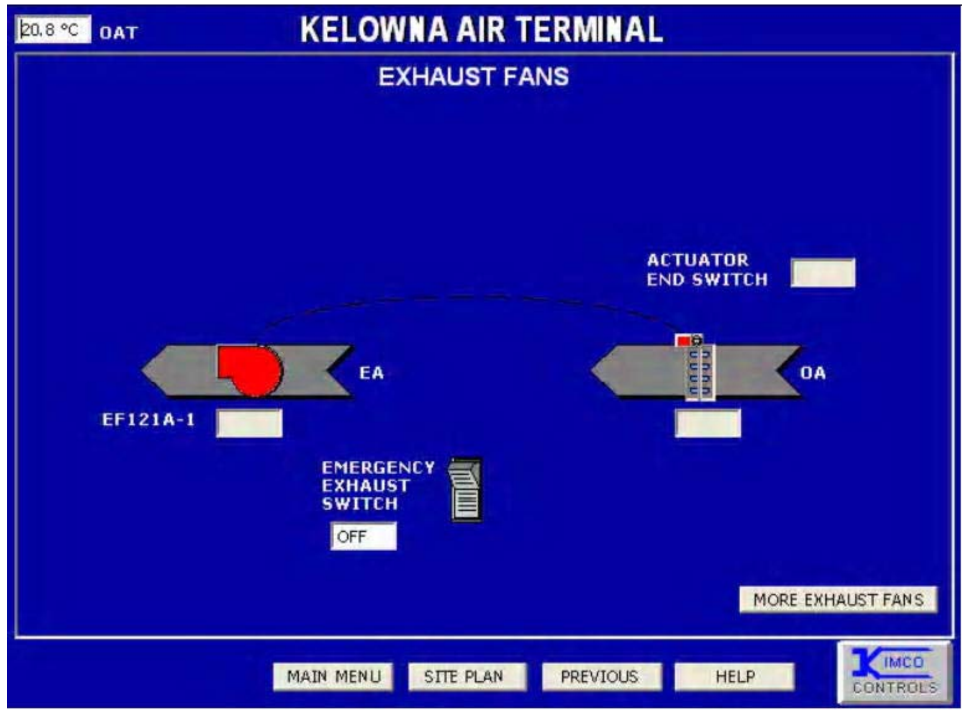

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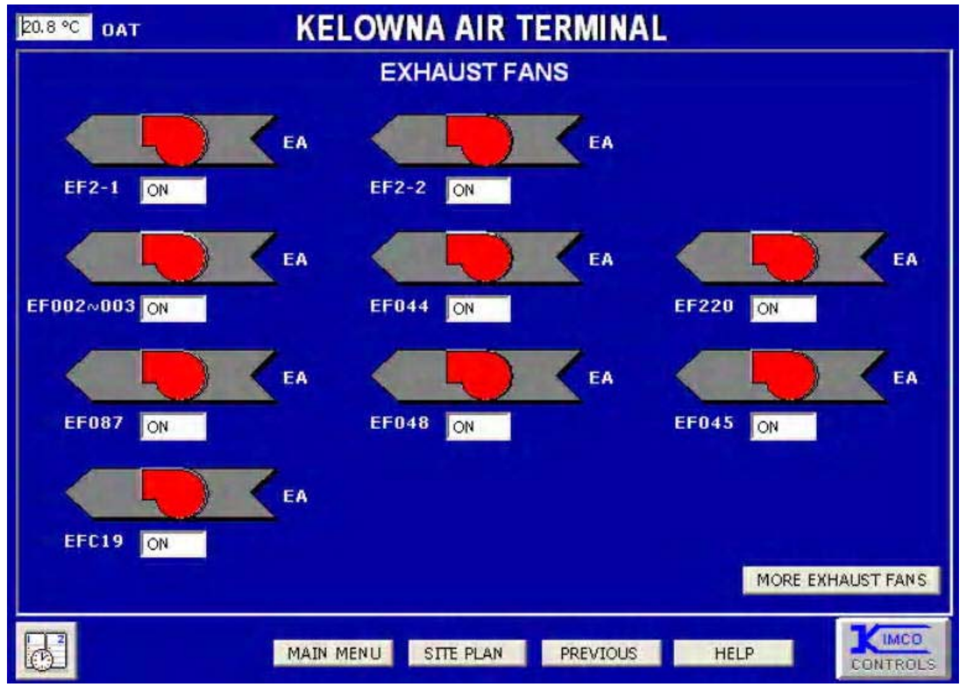

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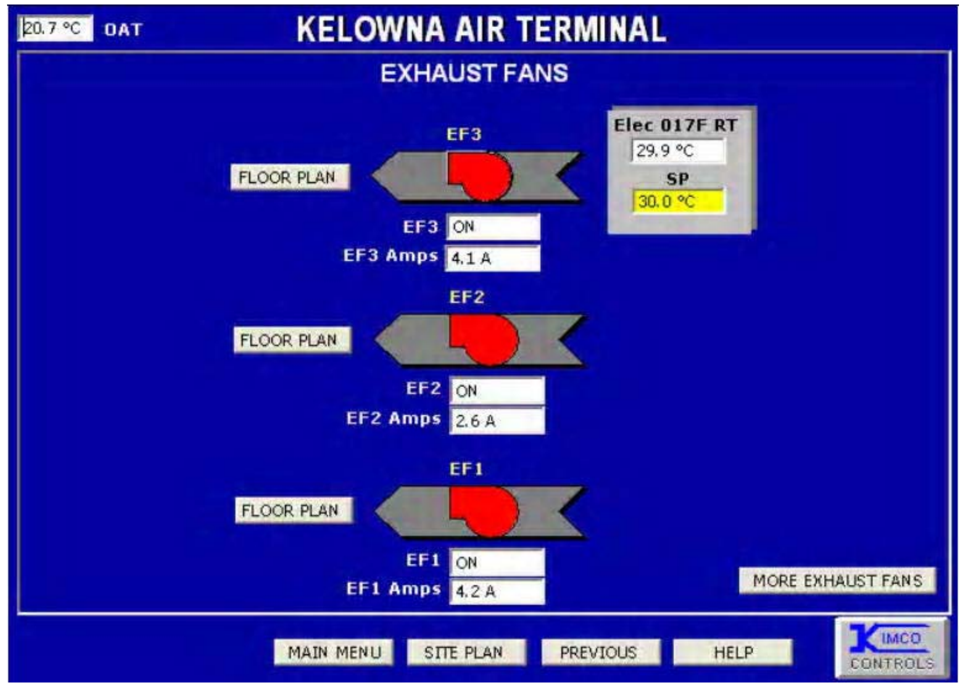

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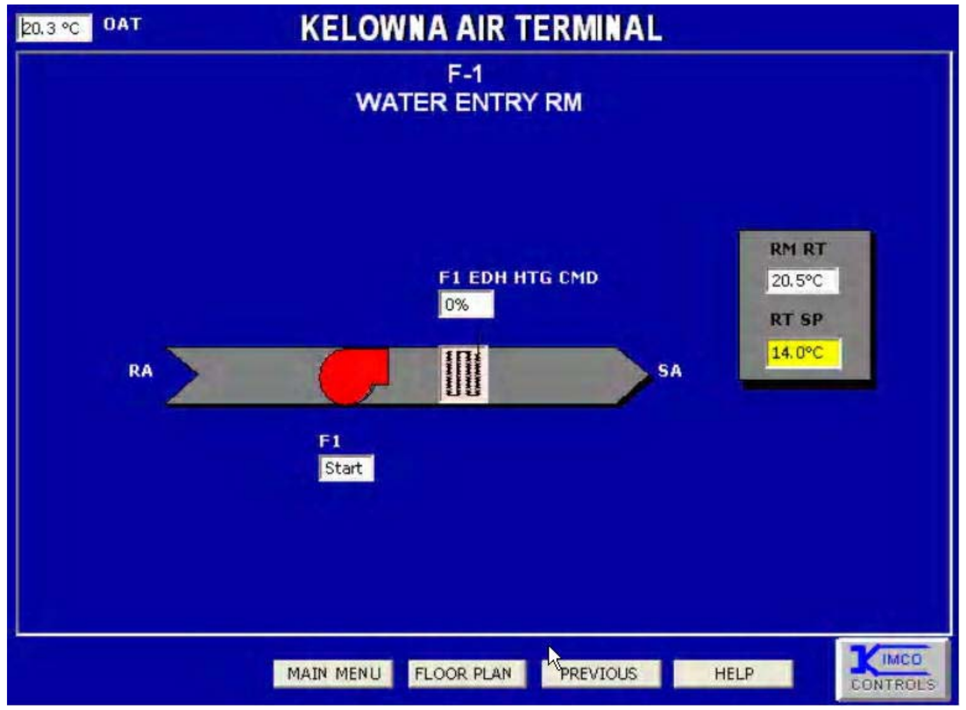

F1 WATER ENTRY

FAN COIL PBS EXPANSION

FAN COIL MENU 1

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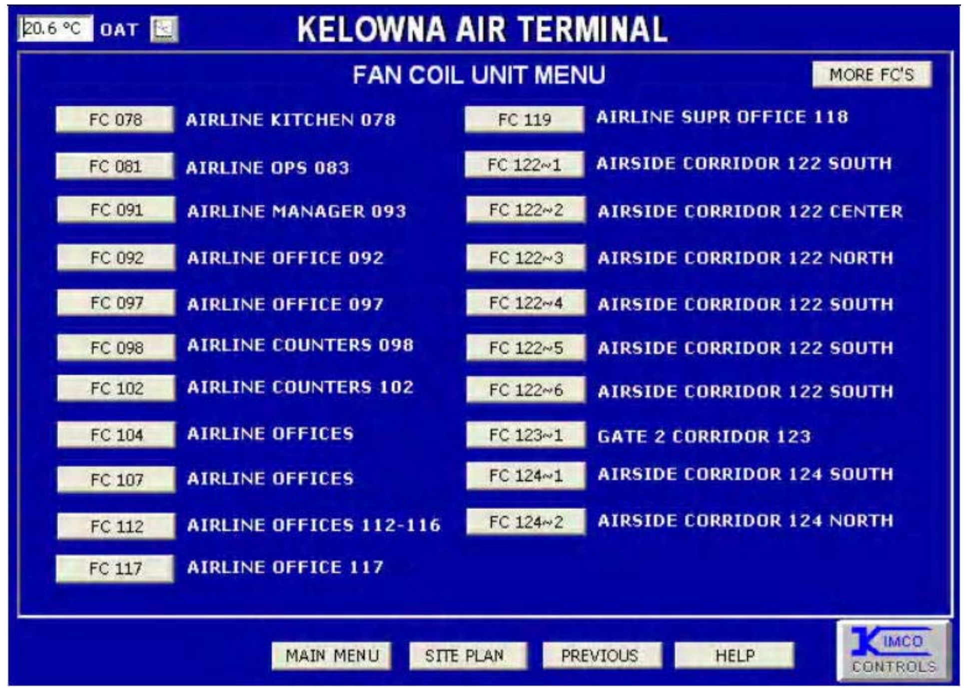

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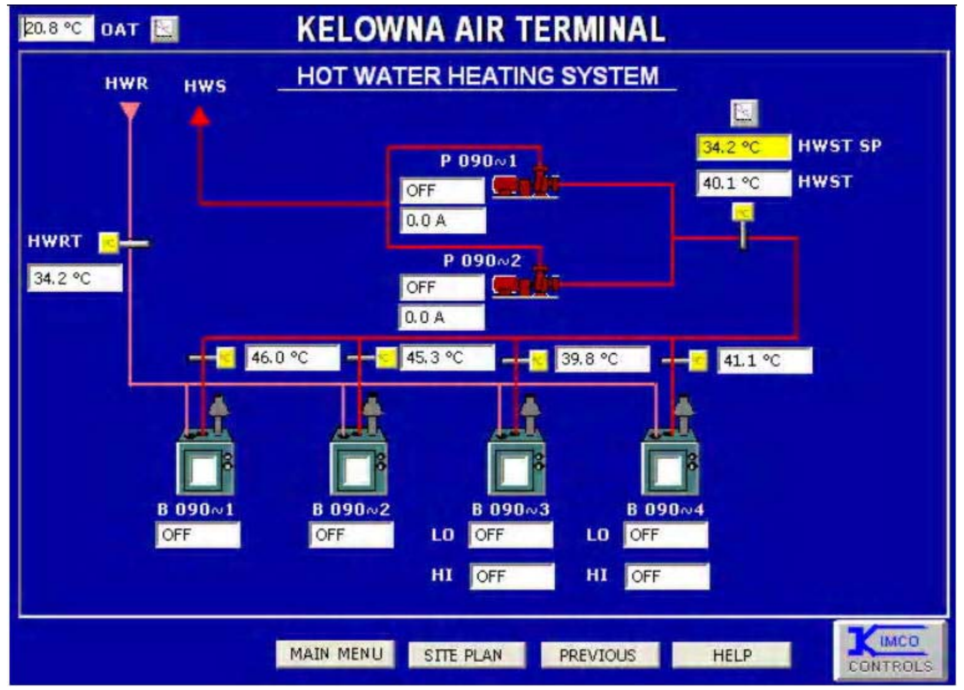
FAN COIL MENU 3

FORCE FLOW MENU



HOT WATER HEATING SYSTEM

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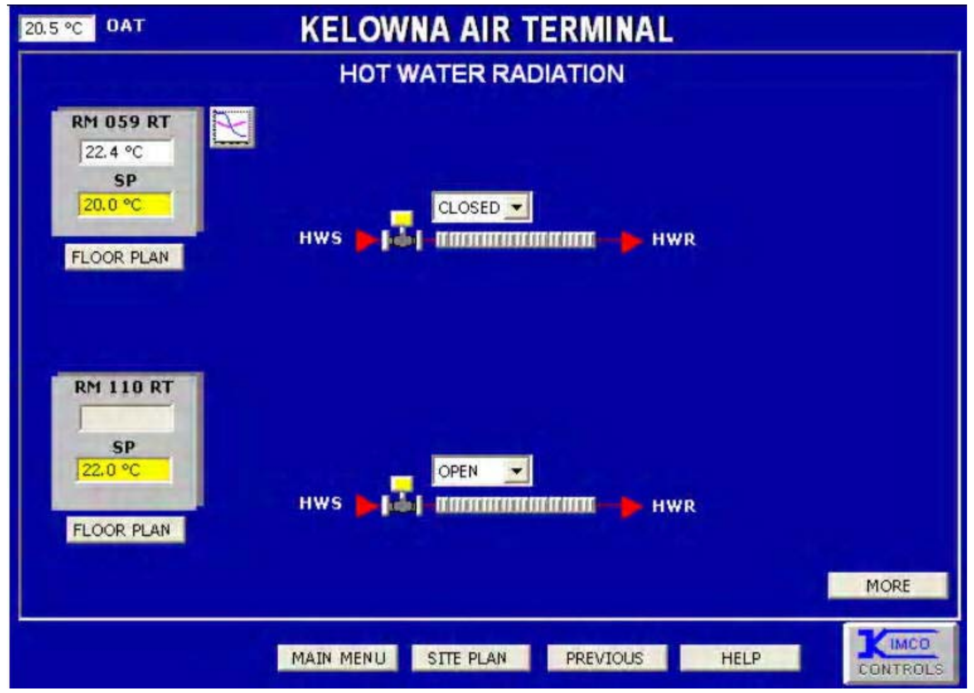
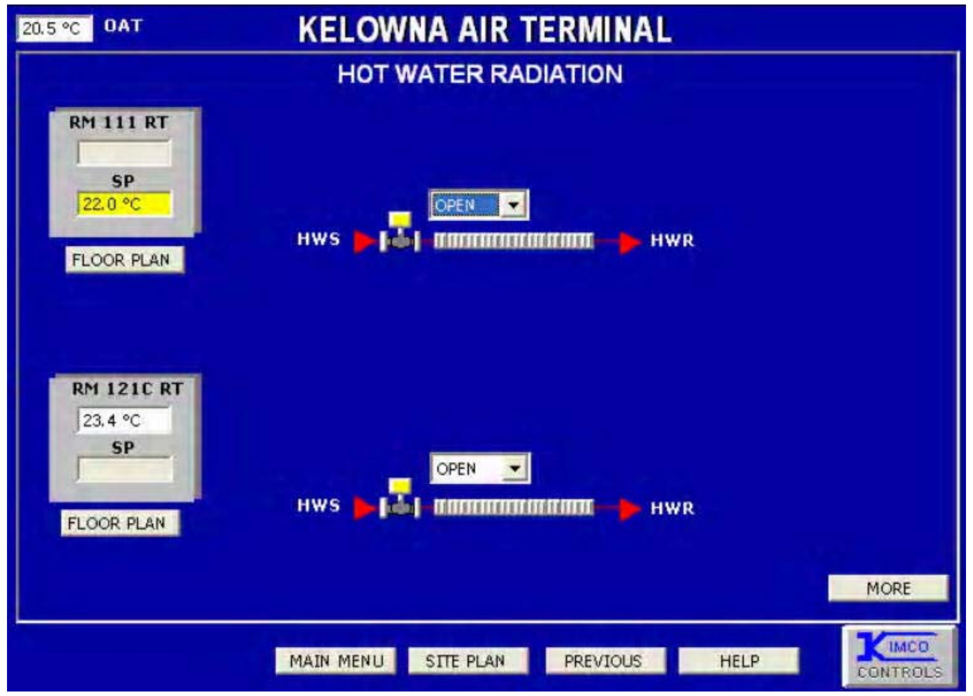


HOT WATER RADIATION 1



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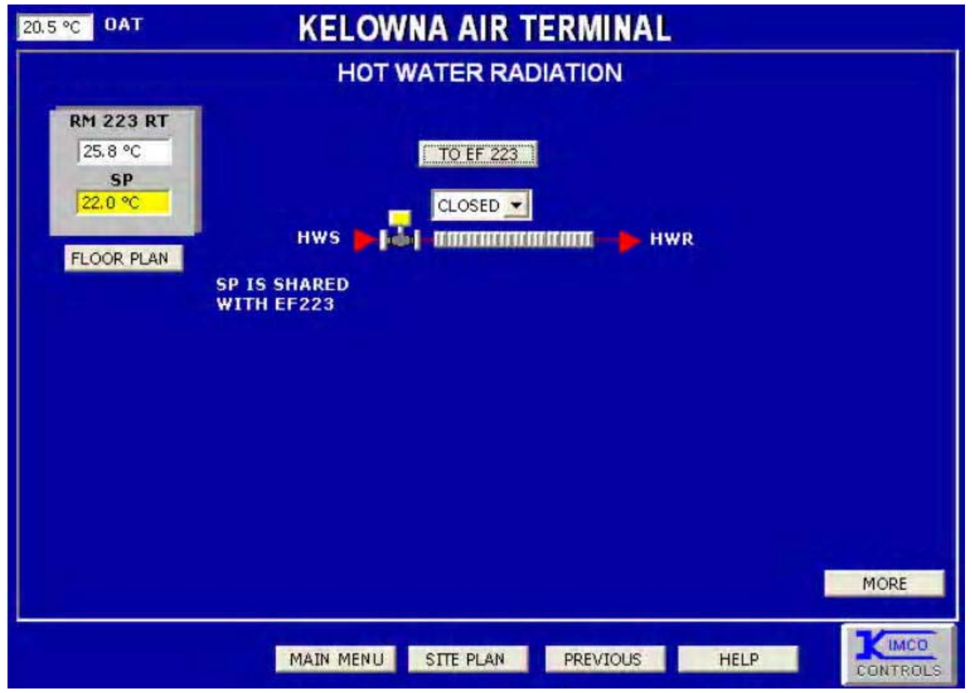

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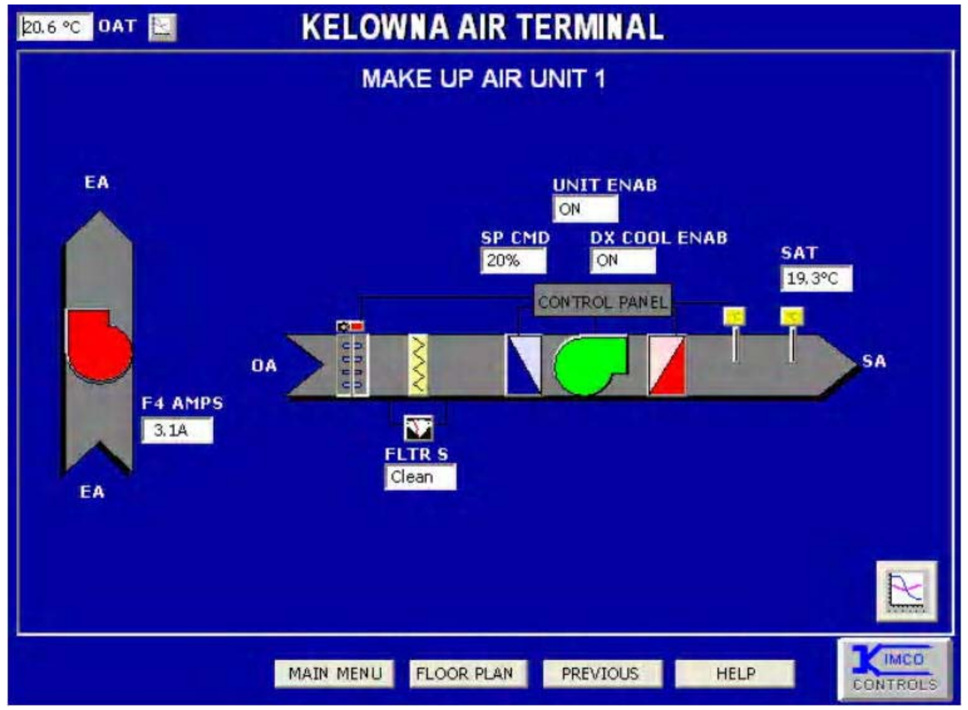

MAKE UP AIR UNIT 1-PBS

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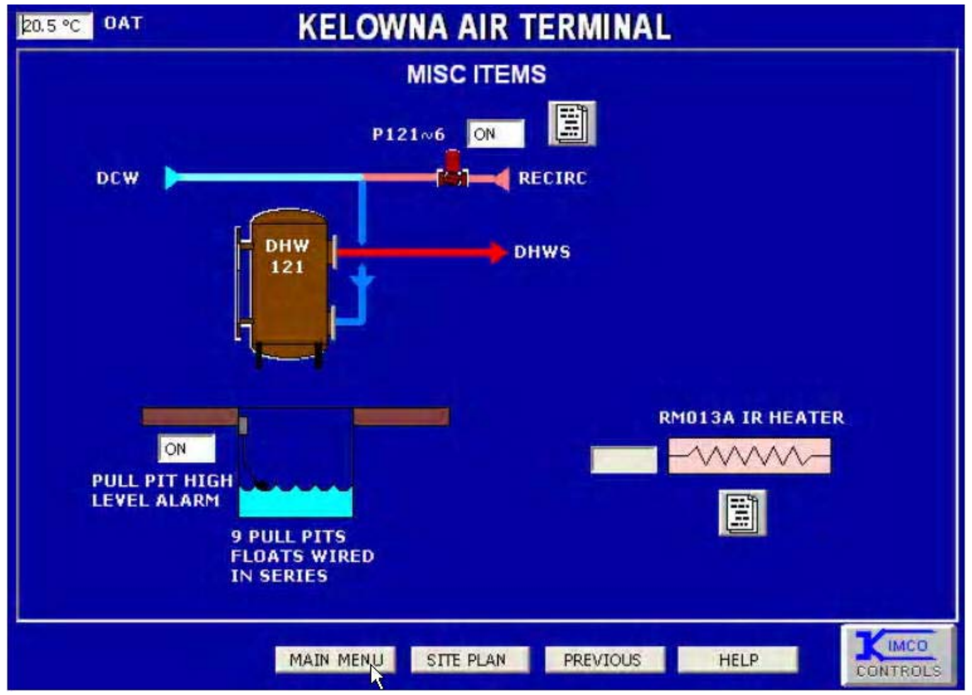
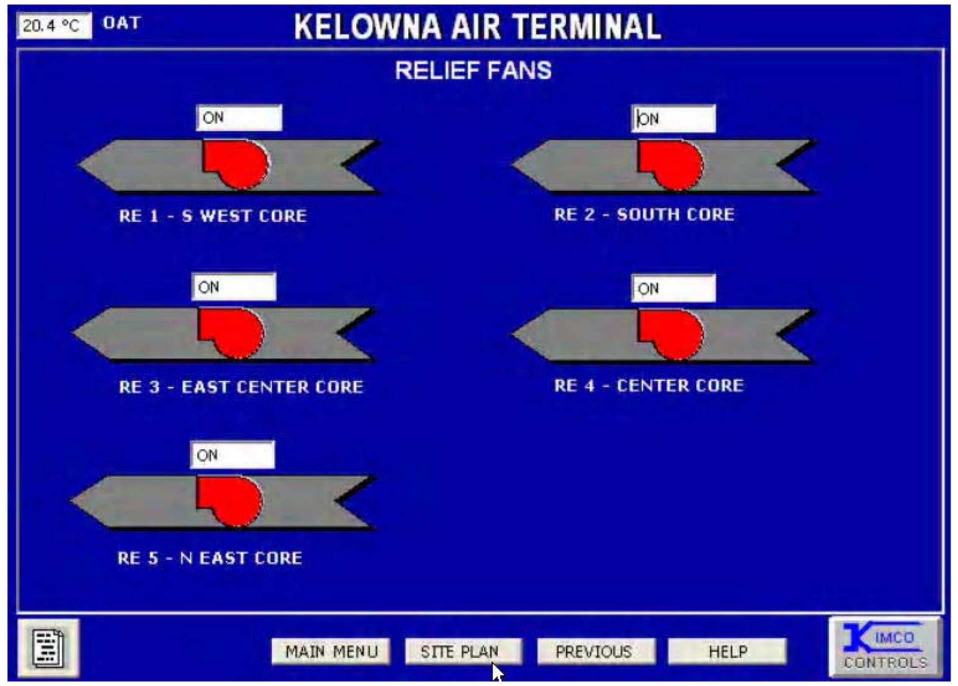
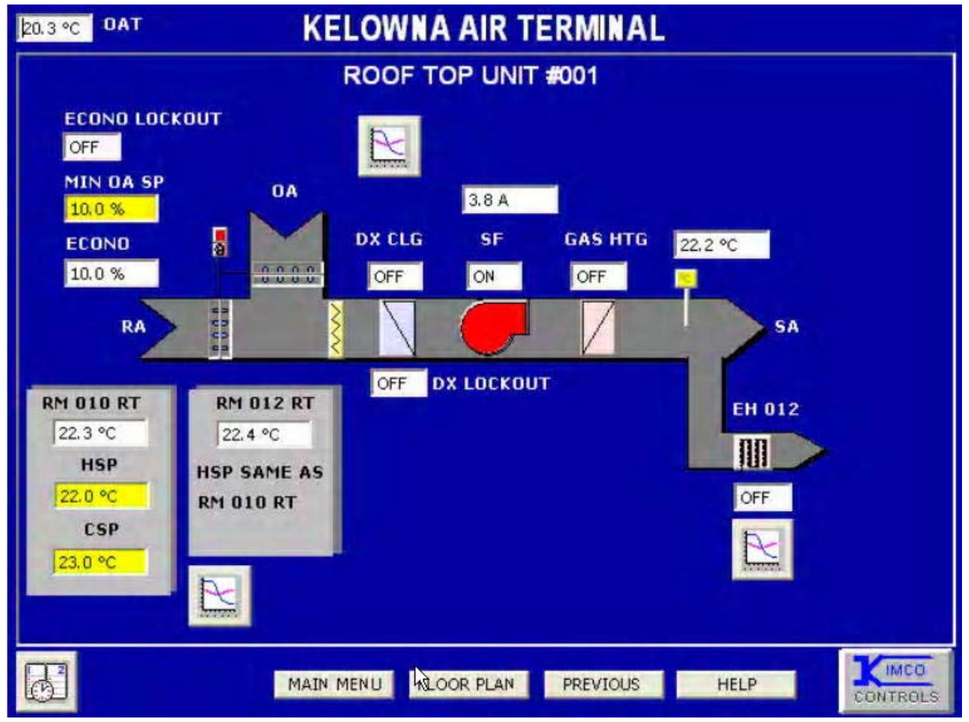


MISCELLANEOUS ITEMS

MISCELLANEOUS PBS EXPANSION



RELIEF FANS



RTU001

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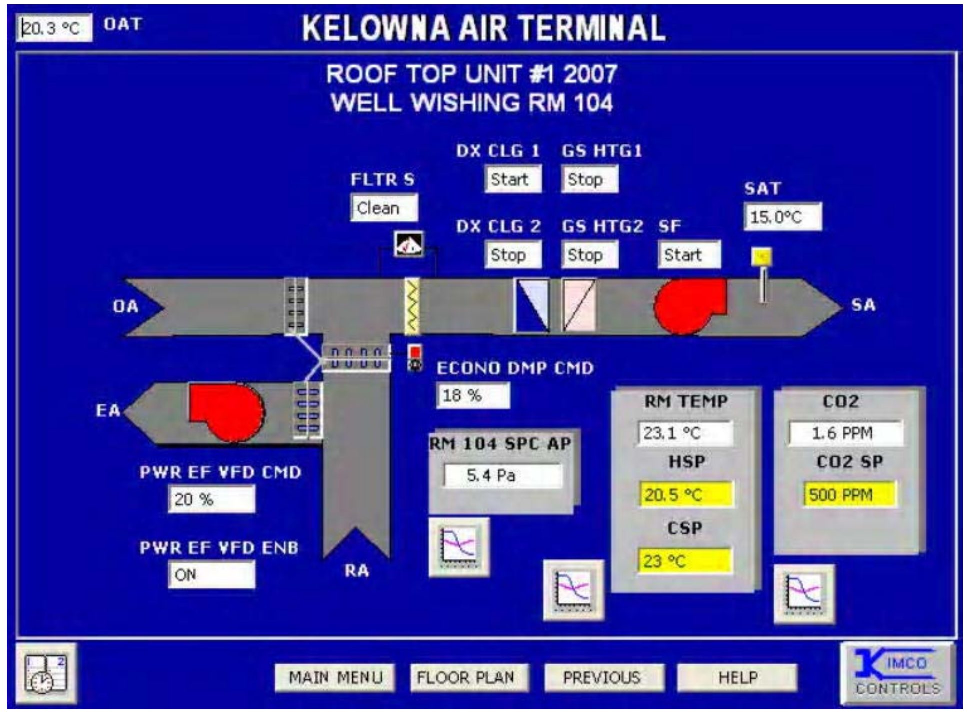

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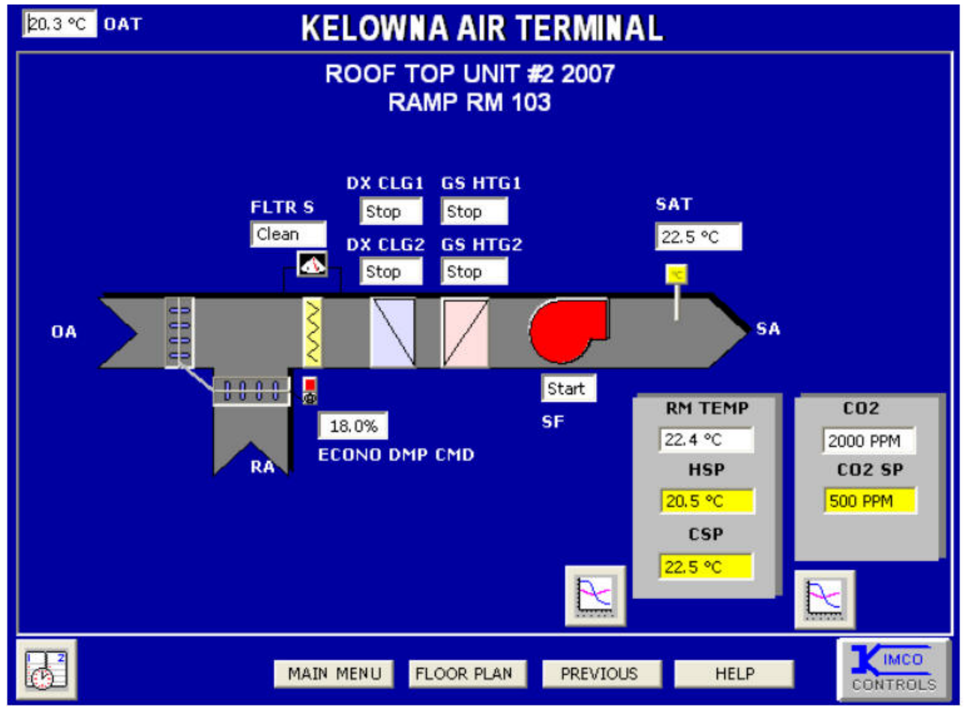

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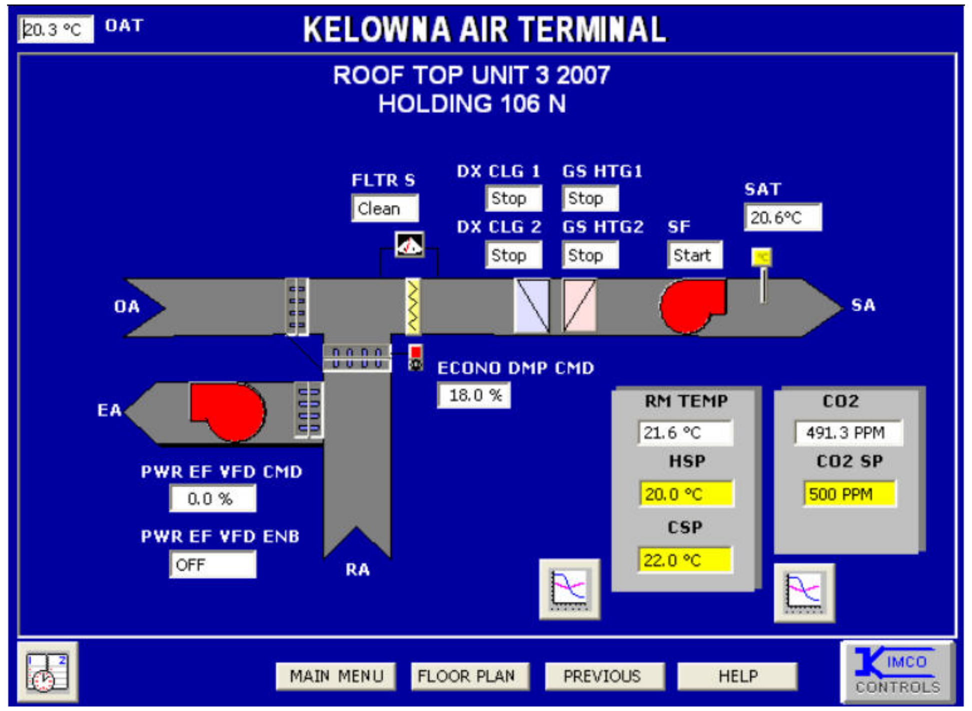

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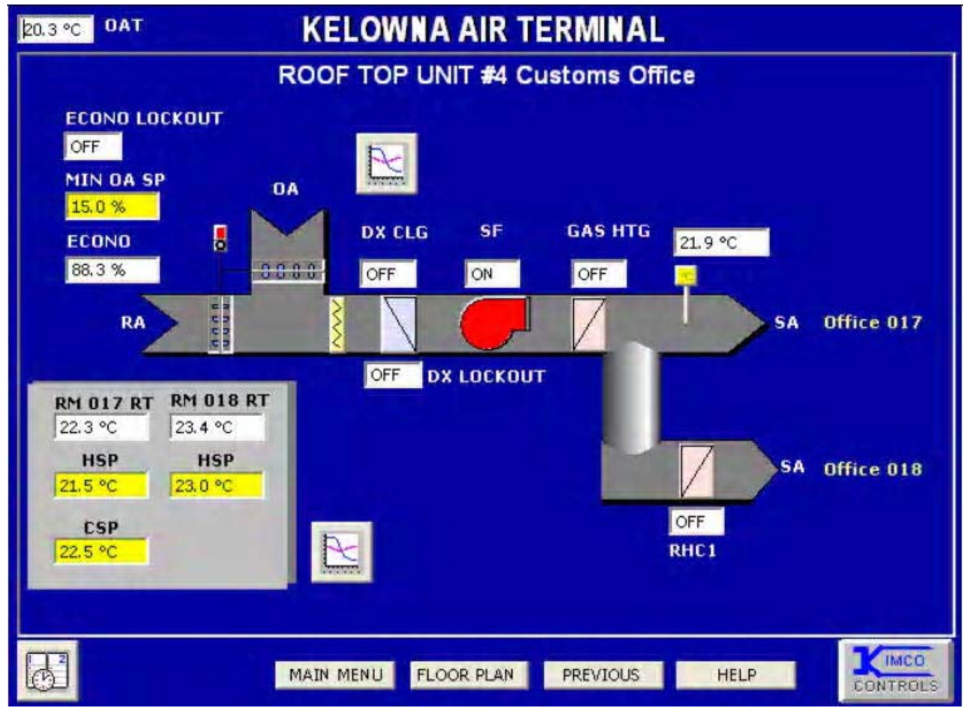

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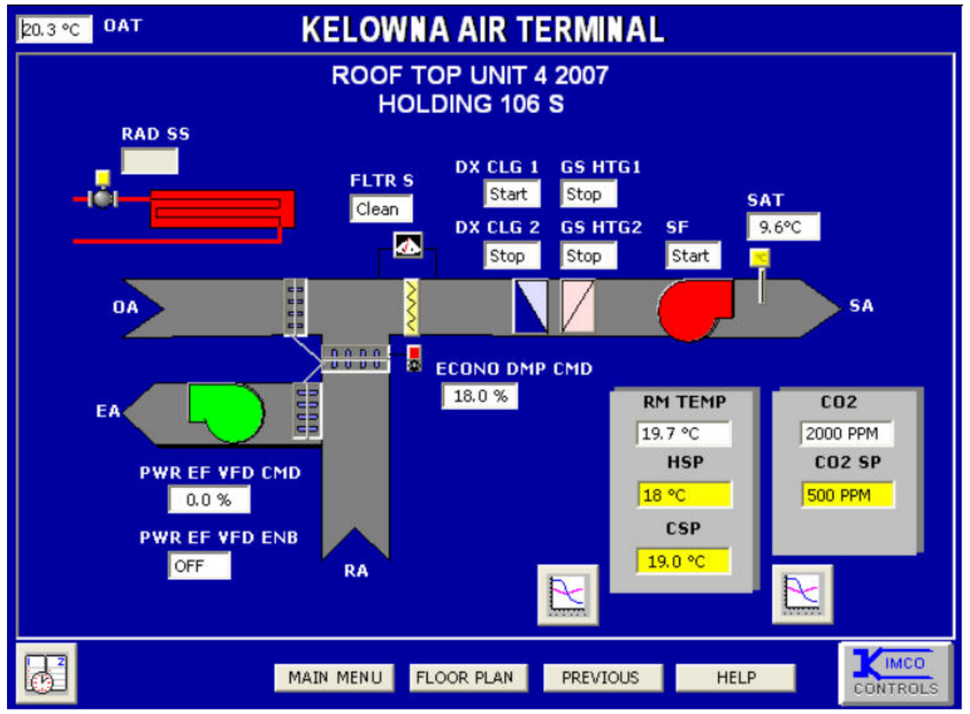

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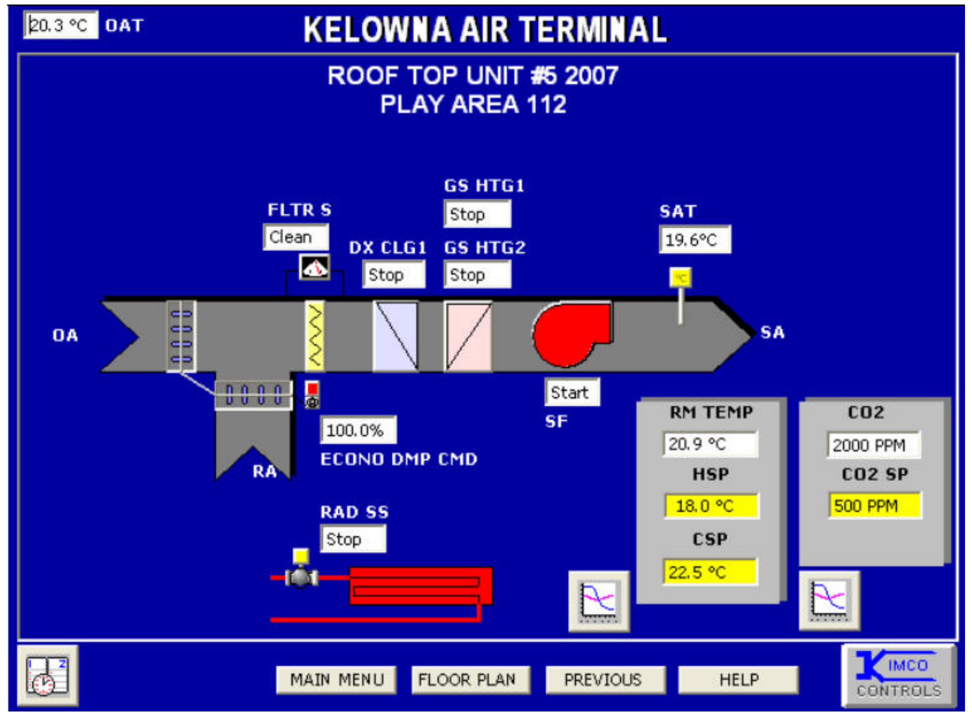

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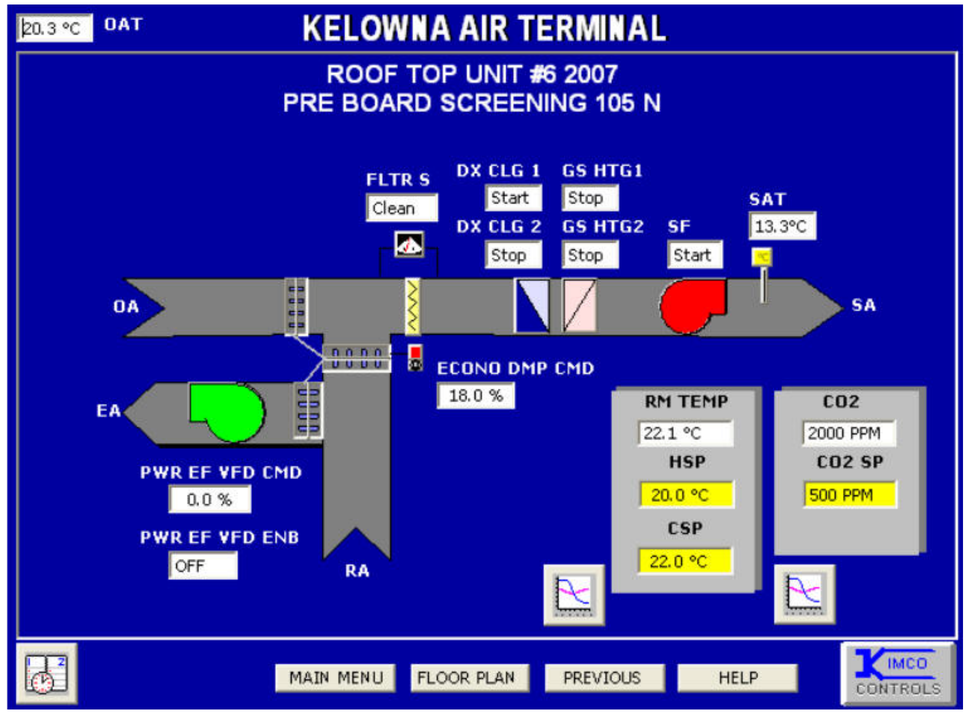

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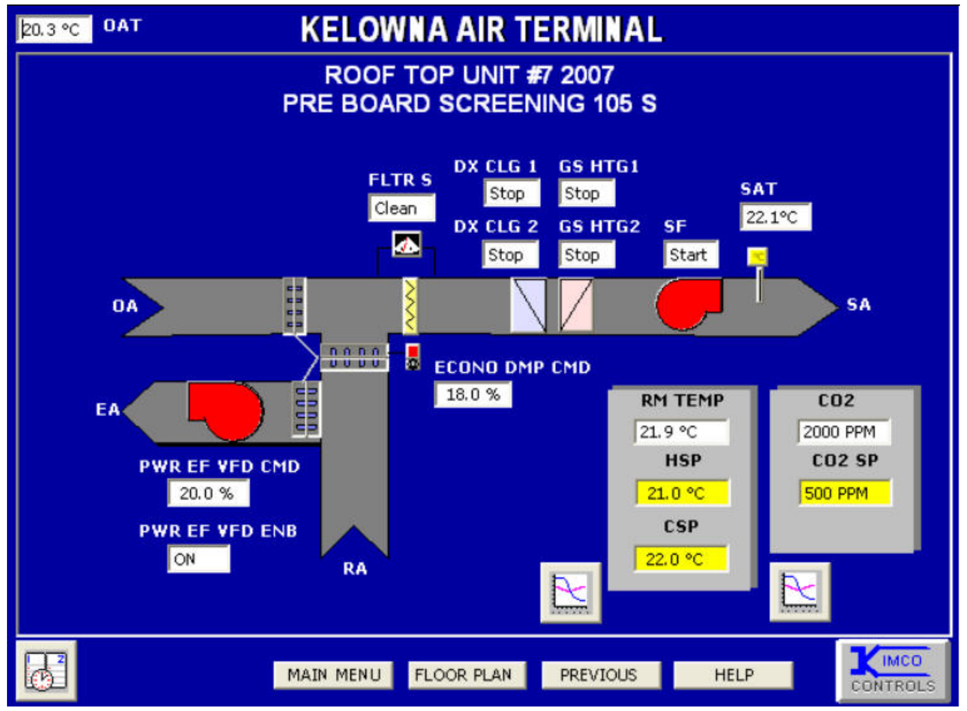

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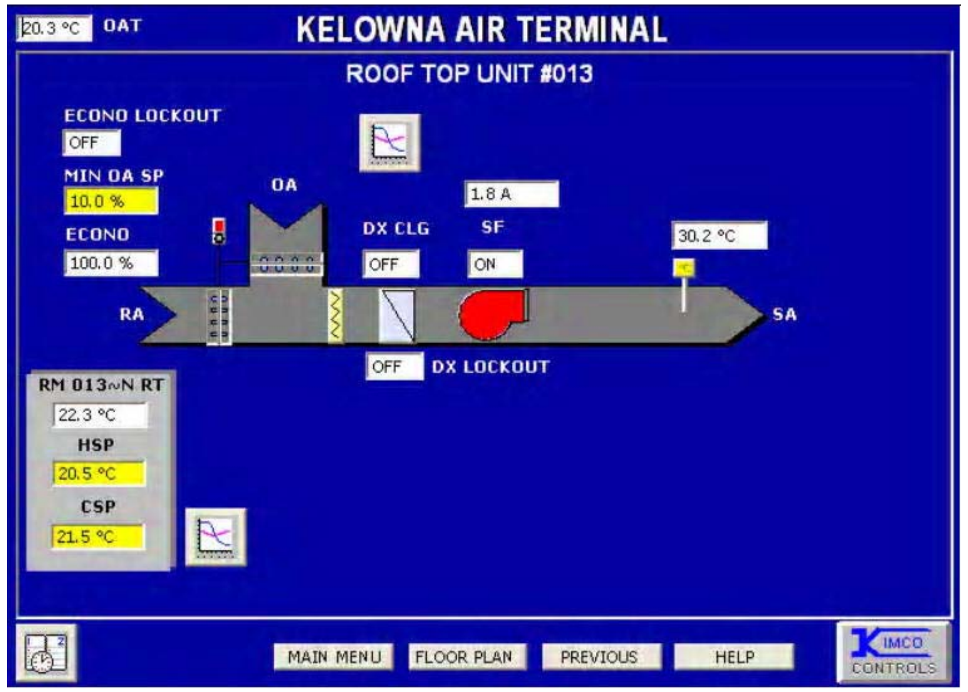

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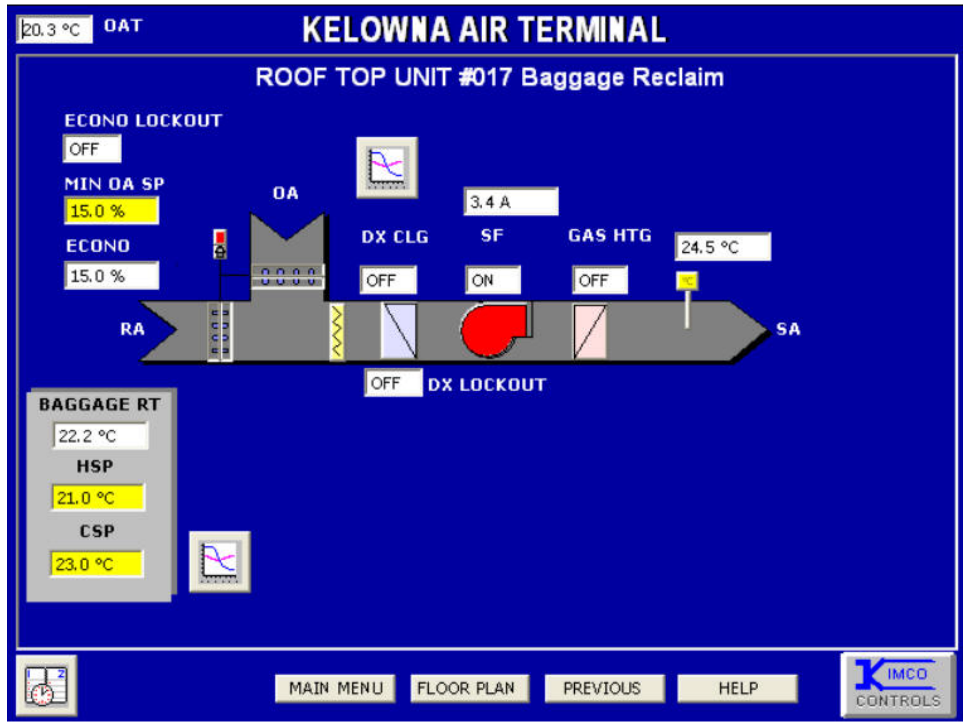

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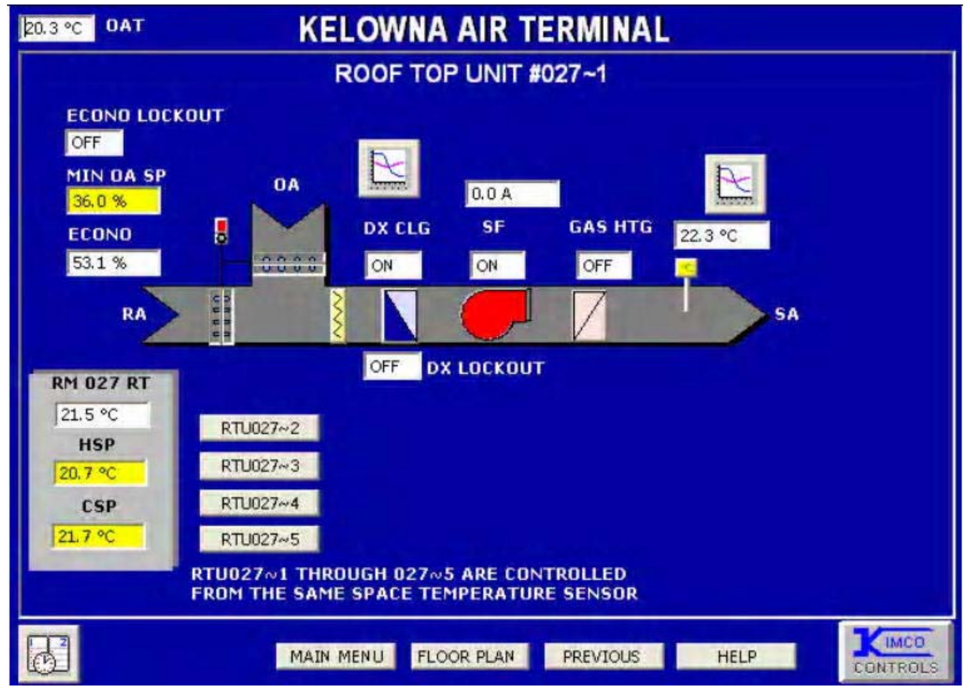

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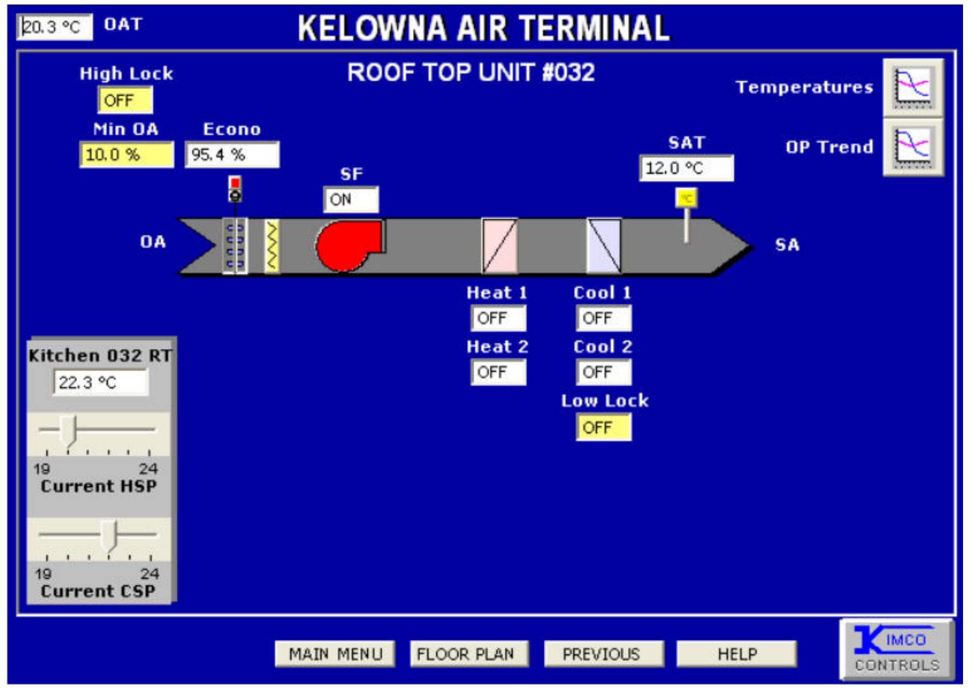

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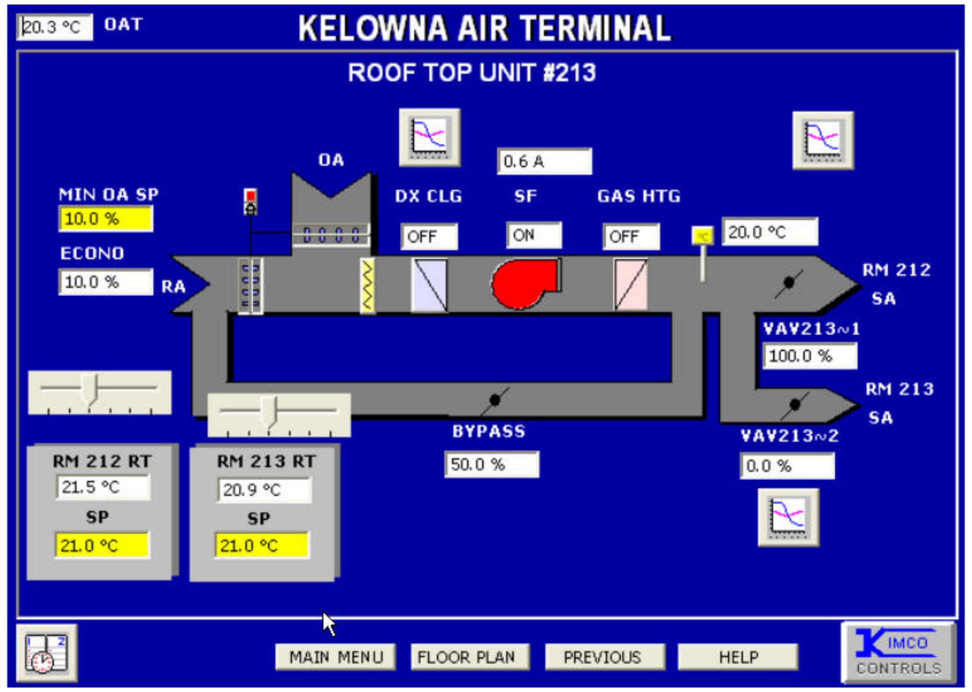

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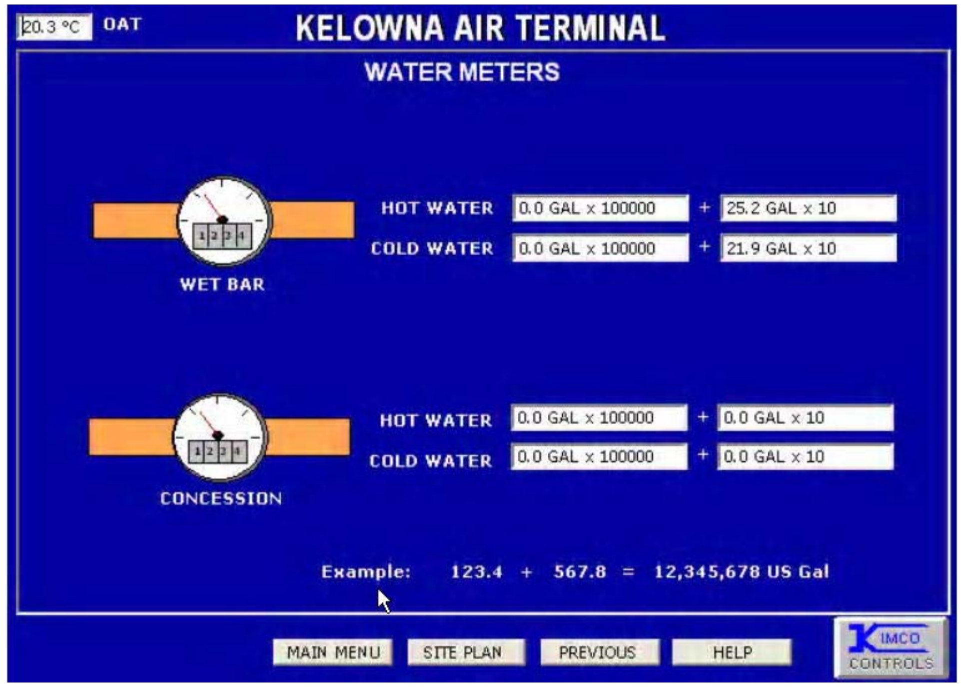

WATER METERS 1

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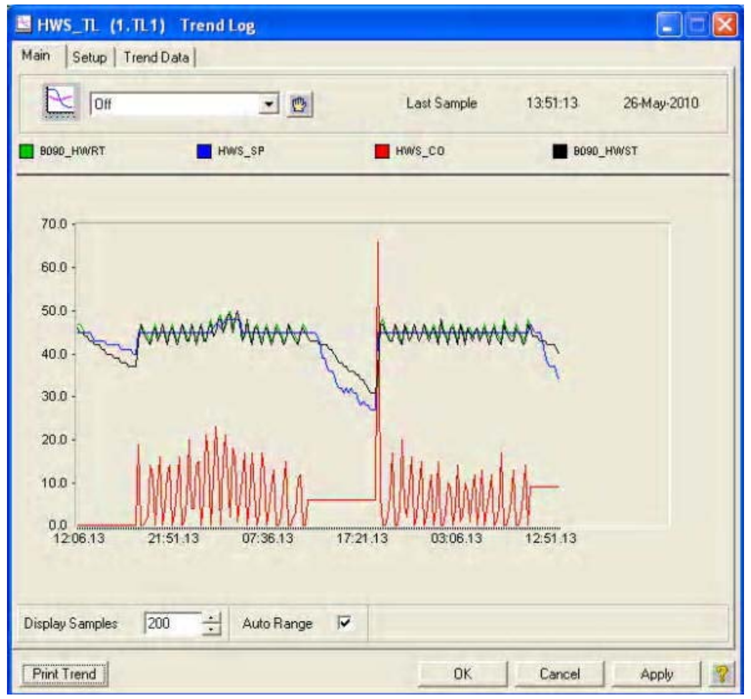
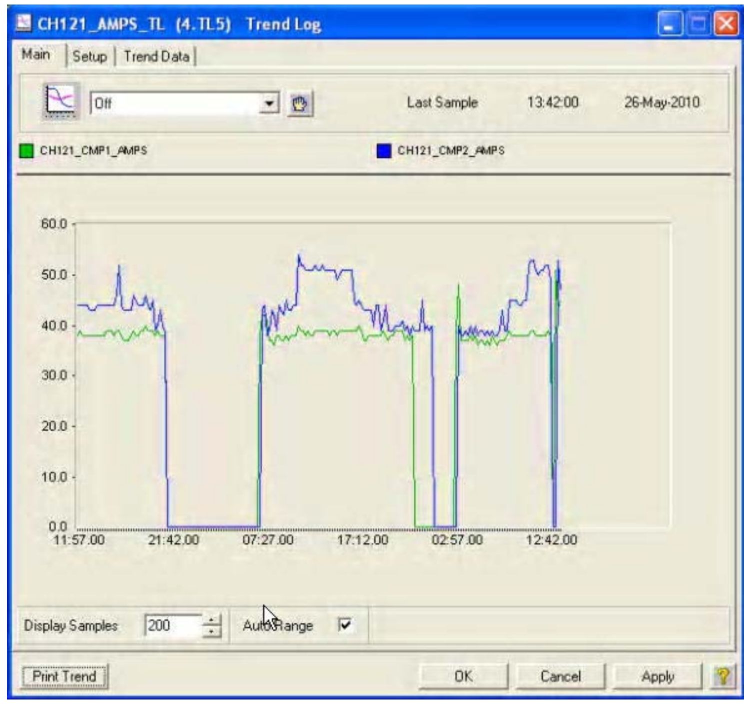
APPENDIX B

TREND LOGS

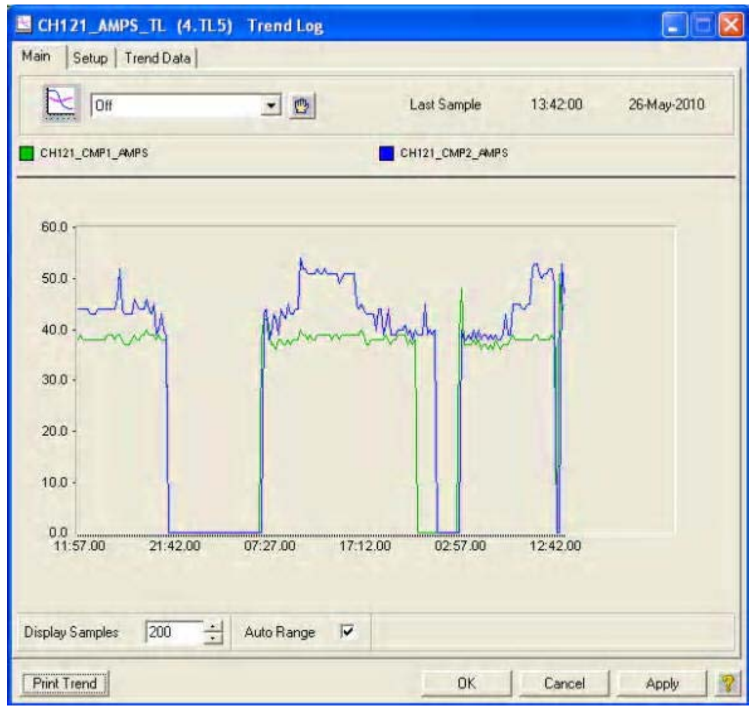


BOILER TREND



CHILLER LOG

COHOS EVAMY
integratedesign



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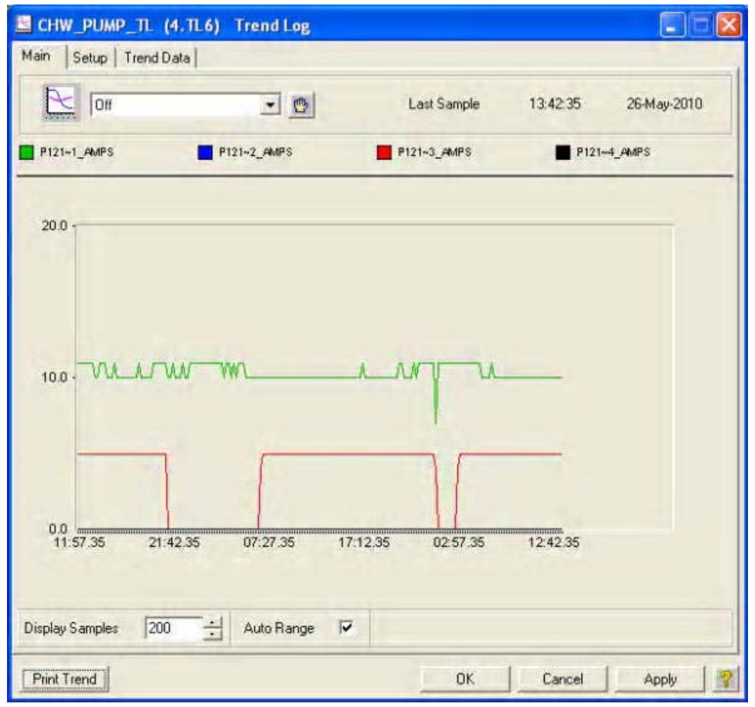

CHILLER PUMPS

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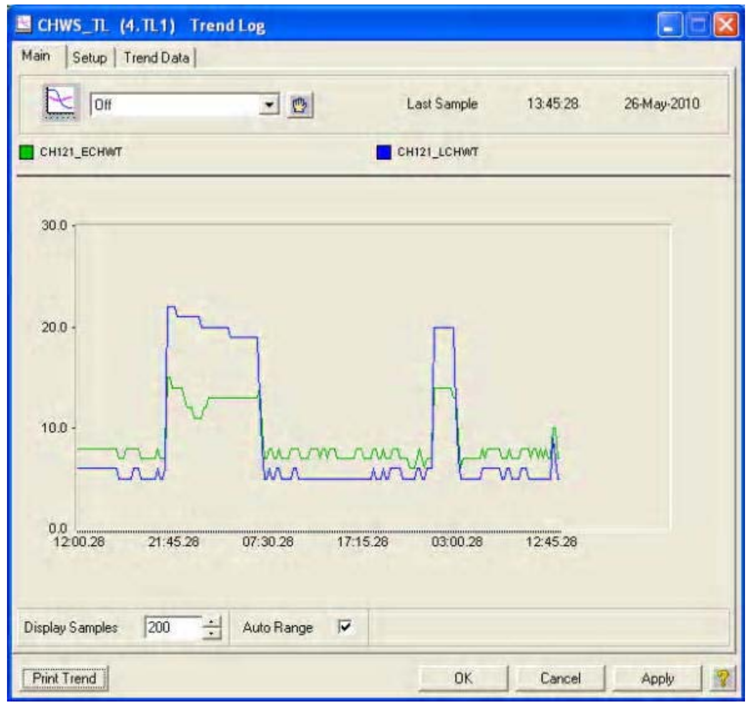
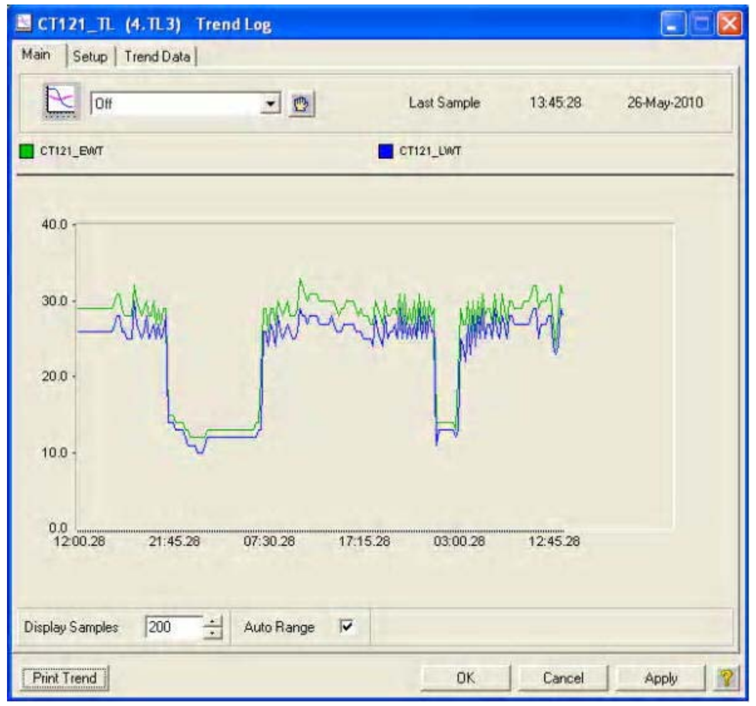
integratedesign



CHILLER TEMP LOG



COOLING TOWER TEMP

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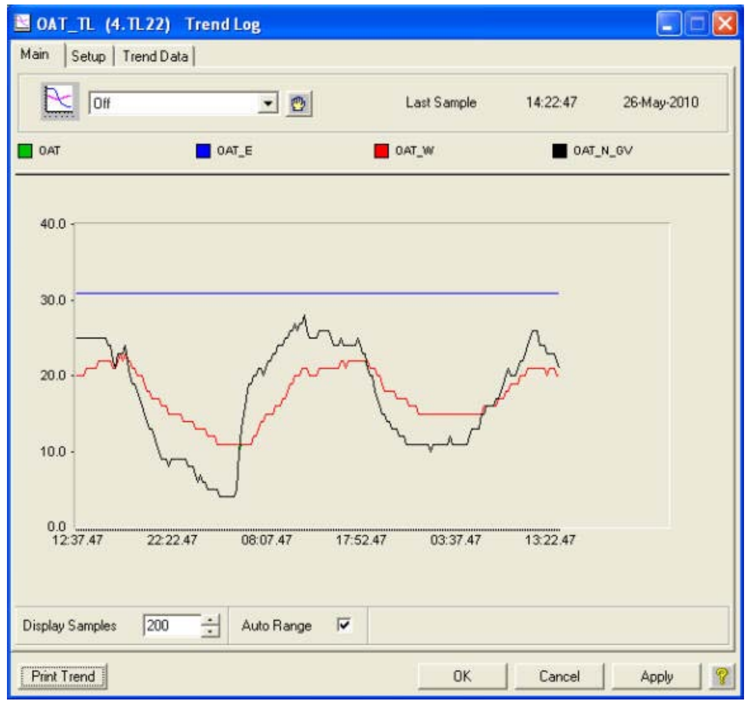


OAT TREND

APPENDIX C

LUMINAIRE AND LIGHTING AUDIT DATA

Luminaire Schedule		Kelowna Airport Lighting Audit		C03048				
	Luminaire Configuration	Lamps Per Fixture	Lamps max	Lamp Type	Lamp Wattage	Mounting Type	Image Number	
A	2x2 Parabolic	2	2	Twin Tube	40	Rec	411	
A1	2x2 Parabolic	3	3	Twin Tube	40	Rec/Sus	410	
A2	2x2 Lensed	2	2	Twin Tube	40	Rec		
A3	1x4 Lensed	2	2	T8	32	Wall	420	
A4								
A5	Downlight with Cross Baffle	1	1	DTT CFL	32	Rec		
A6	Downlight with Cross Baffle	2	2	DTT CFL	26	Rec		
A7	4' Lensed Vandal	2	2	T8	32	Rec	425	
A8	2x4 Parabolic	3	3	T8	32	Rec	430	
A9	1x4 Lenses	2	2	T8	32	Rec	431	
A10	Downlight Cross Baffle	2	2	DTT CFL	13	Rec		
A11	2x4 Lensed	3	3	T8	32	Rec	436	
A12	1x4 Lensed	2	2	T8	32	Rec	437	
A13	2x4 Lensed	3	3	T8	32	Rec	438	
A14	2 lamp Strip	2	2	T8	32	Sus	439	
A15	Downlight - No lens	2	2	DTT CFL	26	Rec	455	
A16	4" Linear with Cross Baffle	1	1	T8	32	Rec	501	
A17	2x4 Lensed	4	4	T8	32	Rec	582	
A18	Downlight	1	1	Inc	75	Rec		
A19	Wall Light	1	1	Inc	100	Wall		
B	4' Wraparound	2	2	T8	32	Sur	419	
B1	4' Vanity	2	2	T8	32	Wall	421	
B2	4' Strip in Cove	2	2	T8	32	Wall	433	
B3	4' Vanity	2	2	T8	32	Wall	441	
B4	4' Strip	2	2	T8	32	Sur		
B5	4' Vanity	2	2	T8	32	Wall	442	
B6	4' Strip	1	1	T8	32	Sur		
B7	4' Linear	2	2	T8	32	Sus		
B8	4' Indirect/Direct	2	2	T8	32	Sus	460	
B9	4' Indirect/Direct	2	2	T8	32	Sus	461	
B10	4' Indirect/Direct	2	2	T8	32	Sus		
B11	1x4 Surface Lensed	2	2	T8	32	Sur	463	
D1	Metal Halide Canopy	1	1	MH	100	Sur	574	
D2	Metal Halide Canopy	1	1	MH	100	Sur	575	
D3	Weather Proof 4' Strip	2	2	T12	40	Sur	576	

Project # 03048C04 Project Name: Kelowna Aiport Project Location: Kelowna, BC Date: May 26, 2010 - May 27, 2010

Existing Room Information							Existing Luminaire Information														Illumination Levels (lux)		
Room Number	Room Name	Room Type	Room Description	Room Dimensions	System Voltage	Switching Controls	Luminaire Type	Luminaire Condition	Luminaire Quantity	Luminaire Configuration	Hours of Use Day time	Possible Hours of Daylight Harvesting	Lamps per Luminaire	Lamps per Fixture Max	Lamp Type	Lamp Wattage	Mounting Type	Luminaire Height	Ceiling Type	Ceiling Condition	Between	Under	Wall Margin
new arrivals	Baggage pick up				120		A	Good	48	2x2 Parabolic	18		2	2	Twin Tube	40	Rec	10	T-Bar	Good	420	520	
					120		A5	Good	2	Downlight with Cross Baffle	18		1	1	DTT CFL	32	Rec	10	Drywall	Good			
existing arrivals	Baggage pick up				120		A1	Good	110	2x2 Parabolic	18	6	3	3	Twin Tube	40	Rec/Sus	10	T-Bar	Good	650	810	
					120		A2	Good	4	2x2 Lensed	18	6	2	2	Twin Tube	40	Rec	12	Arch	Good			
022	West Jet Baggage Services	Office			120	L-Switch	A	Good	3	2x2 Parabolic	18		2	2	Twin Tube	40	Rec	8	T-Bar	Good		330	
021	Jazz Baggage Services	Office			120	L-Switch	A	Good	3	2x2 Parabolic	18		2	2	Twin Tube	40	Rec	8	T-Bar	Good	450	550	
019	Commissionaire Security	Office			120	L-Switch	A1	Good	2	2x2 Parabolic	18		3	3	Twin Tube	40	Rec/Sus	8	T-Bar	Good		700	
020	Commissionaire Storage	Storage			120	L-Switch	A2	Fair	1	2x2 Lensed	18		2	2	Twin Tube	40	Rec	8	T-Bar	Good	350	500	
017	Customs Office	Office			120		A	Good	20	2x2 Parabolic	18		2	2	Twin Tube	40	Rec	8	T-Bar	Good	600	700	
	Customs Storage	Storage			120	Occ Sen	A2	Good	1	2x2 Lensed	18		2	2	Twin Tube	40	Rec	8	Drywall	Good		480	
	Customs Lunch Room	Office			120	L-Switch	B	Good	2	4' Wraparound	18		2	2	T8	32	Sur	8	Drywall	Good	370	530	
	Mens Locker Room	Locker Room			120	Occ Sen	B1	Good	1	4' Vanity	18		2	2	T8	32	Wall	7	Drywall	Good	440	525	
	Mens Locker Room	Locker Room			120	Occ Sen	A3	Good	3	1x4 Lensed	18		2	2	T8	32	Wall	8	Drywall	Good			
	Mens Locker Room	Locker Room			120	Occ Sen	A6	Good	1	Downlight with Cross Baffle	18		2	2	DTT CFL	26	Rec	8	Drywall	Good			
	Womens Locker Room	Locker Room			120	Occ Sen	A3	Good	2	1x4 Lensed	18		2	2	T8	32	Wall	8	Drywall	Good	430	500	
	Womens Locker Room	Locker Room			120	Occ Sen	B1	Good	1	4' Vanity	18		2	2	T8	32	Wall	7	Drywall	Good			
011	Process	Office			120	L-Switch	A1	Good	11	2x2 Parabolic	18		3	3	Twin Tube	40	Rec/Sus	8	T-Bar	Good	200	625	
010	Office	Office			120	L-Switch	A	Good	3	2x2 Parabolic	18		2	2	Twin Tube	40	Rec	8	T-Bar	Good	200	530	
009	DOC	Office			120	L-Switch	A	Good	2	2x2 Parabolic	18		2	2	Twin Tube	40	Rec	8	T-Bar	Good	380	440	
012	Detention				120		B2	Good	2	4' Strip in Cove	18		2	2	T8	32	Wall	8	Drywall	Good	410	520	
008	Hold				120		A7	Good	2	4' Lensed Vandal	18		2	2	T8	32	Rec	8	Drywall	Good	330	380	
005	Storage	Storage			120	L-Switch	A2	Fair	1	2x2 Lensed	18		2	2	Twin Tube	40	Rec	8	T-Bar	Good		470	
006	Comms Room	Service			120	L-Switch	A2	Good	2	2x2 Lensed	18		2	2	Twin Tube	40	Rec	8	T-Bar	Fair	460	640	
004	Corridor				120	L-Switch	A	Good	3	2x2 Parabolic	18		2	2	Twin Tube	40	Rec	8	T-Bar	Good		400	
027	Main Concourse	Lobby			120		A1	Good	172	2x2 Parabolic	18	12	3	3	Twin Tube	40	Rec/Sus	25	Arch	Good	1200	1500	
027	Main Concourse	Lobby			120		Signage	Good	39		18	12	2	2	T12	40	Wall	12	Arch	Good			
102	Airline Counter	Office			120		A1	Good	19	2x2 Parabolic	18		3	3	Twin Tube	40	Rec/Sus	8	Open	Fair	950	1000	
104	Air Canada Office	Office			120	L-Switch	A8	Good	2	2x4 Parabolic	18		3	3	T8	32	Rec	7.5	T-Bar	Good	500	730	
105	Lockers	Locker Room			120	L-Switch	A8	Good	2	2x4 Parabolic	18		3	3	T8	32	Rec	7.5	T-Bar	Good	1100	1300	
106	Lunch Room	Office			120	L-Switch	A8	Good	4	2x4 Parabolic	18		3	3	T8	32	Rec	7.5	T-Bar	Good	600	1000	
107a	Air Canada	Storage			120	L-Switch	A8	Good	2	2x4 Parabolic	18		3	3	T8	32	Rec	7.5	T-Bar	Good	680	760	
107b	Office	Office			120	L-Switch	A8	Good	2	2x4 Parabolic	18		3	3	T8	32	Rec	7.5	T-Bar	Good	650	850	
107c	Office	Office			120	L-Switch	A8	Good	2	2x4 Parabolic	18		3	3	T8	32	Rec	7.5	T-Bar	Good	750	1000	
103	Corridor	Corridor			120	L-Switch	A9	Good	4	1x4 Lenses	18		2	2	T8	32	Rec	7.5	T-Bar	Good	100	500	
107d	Office	Office			120	L-Switch	A8	Good	2	2x4 Parabolic	18		3	3	T8	32	Rec	7.5	T-Bar	Good	580	1000	
100	Handi-Cap Washroom	Washroom			120	L-Switch	B	Good	1	4' Wraparound	18		2	2	T8	32	Sur	8	Drywall	Good	350	650	
100	Handi-Cap Washroom	Washroom			120	L-Switch	B2	Good	2	4' Strip in Cove	18		2	2	T8	32	Wall	7	Drywall	Good			
099	Mens Washroom	Washroom			120	L-Switch	B	Good	2	4' Wraparound	18		2	2	T8	32	Sur	7	Drywall	Good	160	350	
099	Mens Washroom	Washroom			120	L-Switch	B2	Good	2	4' Strip in Cove	18		2	2	T8	32	Wall	7	Drywall	Good			
099	Mens Washroom	Washroom			120	L-Switch	A10	Good	1	Downlight Cross Baffle	18		2	2	DTT CFL	13	Rec	8	Drywall	Good			
101	Womens Washroom	Washroom			120	L-Switch	B	Good	3	4' Wraparound	18		2	2	T8	32	Sur	7	Drywall	Good	160	350	
101	Womens Washroom	Washroom			120	L-Switch	B2	Good	2	4' Strip in Cove	18		2	2	T8	32	Wall	7	Drywall	Good			
101	Womens Washroom	Washroom			120	L-Switch	A10	Good	1	Downlight Cross Baffle	18		2	2	DTT CFL	13	Rec	8	Drywall	Good			
098	West Jet Airline	Office			120		A1	Good	43	2x2 Parabolic	18		3	3	Twin Tube	40	Rec/Sus	8	T-Bar	Good	200	1600	
073	Land Lines	Storage			120	L-Switch	A8	Good	1	2x4 Parabolic	18		3	3	T8	32	Rec	8	T-Bar	Good	320	580	
072	Telecom	Service			120		B	Good	8	4' Wraparound	18		2	2	T8	32	Sur	7	Open	Fair			
	First Aid	Examination			120	L-Switch	A11	Good	2	2x4 Lensed	18		3	3	T8	32	Rec	8	T-Bar	Good	900	1000	
075	Office	Office			120	L-Switch	A1	Good	2	2x2 Parabolic	18		3	3	Twin Tube	40	Rec/Sus	8	T-Bar	Good	500	1000	
078a	Office	Office			120	L-Switch	A11	Good	3	2x4 Lensed	18		3	3	T8	32	Rec	8	T-Bar	Good	390	550	
007	Bond Room	Storage			120	L-Switch	A2	Fair	2	2x2 Lensed	18		2	2	Twin Tube	40	Rec	8	T-Bar	Good	260	310	
078	Lunch Room	Office			120	L-Switch	A8	Good	2	2x4 Parabolic	18		3	3	T8	32	Rec	8	T-Bar	Good	630	840	
080	Storage	Storage			120	L-Switch	A12	Good	1	1x4 Lensed	18		2	2	T8	32	Rec	8	T-Bar	Good	270	400	
081	Training Room	Office			120	L-Switch	A8	Good	3	2x4 Parabolic	18		3	3	T8	32	Rec	8	T-Bar	Good	420	560	
082	Office	Office			120	L-Switch	A8	Good	3	2x4 Parabolic	18		3	3	T8	32	Rec	8	T-Bar	Good	600	1050	
083	Office	Office			120	L-Switch	A8	Good	3	2x4 Parabolic	18		3	3	T8	32	Rec	8	T-Bar	Good	620	950	
077a	Corridor	Corridor			120		A13	Good	3	2x4 Lensed	18		3	3	T8	32	Rec	8	T-Bar	Good		760	
079	Corridor	Corridor			120		A13	Good	2	2x4 Lensed	18		3	3	T8	32	Rec	8	T-Bar	Good		460	
077	Corridor	Corridor			120		A12	Good	2	1x4 Lensed	18		2	2	T8	32	Rec	8	T-Bar	Good		460	
096	Corridor	Corridor			120		A9	Good	2	1x4 Lenses	18		2	2	T8	32	Rec	8	T-Bar	Good		480	
097	Lunch Room	Office			120	L-Switch	A8	Good	4	2x4 Parabolic	18		3	3	T8	32	Rec	8	T-Bar	Good	820	1100	
094	Retail Storage	Storage			120						18												
092	Lunch Room	Office			120	L-Switch	A13	Good	2	2x4 Lensed	18		3	3	T8	32	Rec	8	T-Bar	Good	200	630	
091	Security Office	Office			120	L-Switch	A8	Good	2	2x4 Parabolic	18		3	3	T8	32	Rec	8	T-Bar	Good	630	720	
093	CBSA	Office			120	L-Switch	A8		2	2x4 Parabolic	18		3	3	T8	32	Rec	8	T-Bar	Good	490	1000	
095	Locker Room	Locker Room			120	L-Switch	A8		4	2x4 Parabolic	18		3	3	T8	32	Rec	8	T-Bar	Good		1400	
021	KAO Comms	Service			120	L-Switch	A14		4	2 lamp Strip	18		2	2	T8	32	Sus	8	Open	Good			
128	Black and Mac Office	Office			120	L-Switch	A1		4	2x2 Parabolic	18		3	3	Twin Tube	40	Rec/Sus	8	T-Bar	Good	1000	1300	
070	Black and Mac Office	Office			120	L-Switch	A8		2	2x4 Parabolic	18		3	3	T8	32	Rec	8	T-Bar	Good	550	1500	
048	Mens Washroom	Washroom			120		A6		7	Downlight with Cross Baffle	18		2	2	DTT CFL	26	Rec	8	Drywall	Good	250	350	
048	Mens Washroom	Washroom			120		B3	Poor	2	4' Vanity	18		2	2	T8	32	Wall	7	Drywall	Good			
052	Janitor	Service			120		B4		1	4' Strip	18		2	2	T8	32	Sur	8	Drywall	Good			
049	Handi-Cap Washroom	Washroom			120	Occ Sen	B5		1	4' Vanity	18		2	2	T8	32	Wall	7	Drywall	Good	250	400	
050	Womens Washroom	Washroom			120		A6		8	Downlight with Cross Baffle	18		2	2	DTT CFL	26	Rec	8	Drywall	Good	350	400	
050	Womens Washroom	Washroom			120		B3		3	4' Vanity	18		2	2	T8	32	Wall	7	Drywall	Good			

051	Elevator Machine Room	Service			120	Occ Sen	B6		2	4' Strip	18		1	1	T8	32	Sur	7	Drywall	Good		360	
	South Water Feature Pump room	Service			120	L-Switch	A14		1	2 lamp Strip	18		2	2	T8	32	Sus	7	Open	Good			
046	Lounge	Lounge			120		D1		24	Metal Halide Canopy	18	12	1	1	MH	100	Sur	20	Arch	Good	See Plans for detailed analysis		
046	Lounge	Lounge			120		A6		60	Downlight with Cross Baffle	18	12	2	2	DTT CFL	26	Rec	25	Drywall	Good			
046	Lounge	Lounge			120		A14		12	2 lamp Strip	18	12	2	2	T8	32	Sus	8	T-Bar	Good			
046	Lounge	Lounge			120		A1		27	2x2 Parabolic	18		3	3	Twin Tube	40	Rec/Sus	8	T-Bar	Good			
	Lounge Bar	Restaurant			120		B7		4	4' Linear	18		2	2	T8	32	Sus	7	Open	Fair			
	Lounge Bar	Restaurant			120		A6		2	Downlight with Cross Baffle	18		2	2	DTT CFL	26	Rec	8	Open	Good			
	Skyway Gourmet	Storage			120		A8		2	2x4 Parabolic	18		3	3	T8	32	Rec	8	T-Bar	Good			
036	Duty Manager	Office			120		A1		2	2x2 Parabolic	18		3	3	Twin Tube	40	Rec/Sus	8	T-Bar	Good	800	1000	
035	RCMP	Office			120		A1		2	2x2 Parabolic	18		3	3	Twin Tube	40	Rec/Sus	8	T-Bar	Good	800	1000	
034	Airport Ambassador	Office			120		A1		2	2x2 Parabolic	18		3	3	Twin Tube	40	Rec/Sus	8	T-Bar	Good	800	1000	
028/029	Car Rentals	Office			120		A1		13	2x2 Parabolic	18		3	3	Twin Tube	40	Rec/Sus						
075	Janitor	Service			120		A14		1	2 lamp Strip	18		2	2	T8	32	Sus	7	Open	Good			
026	Mens Washroom	Washroom			120		B2		3	4' Strip in Cove	18		2	2	T8	32	Wall	7	Drywall	Good	250	950	
026	Mens Washroom	Washroom			120		A15		7	Downlight - No lens	18		2	2	DTT CFL	26	Rec	8	Drywall	Good			
024	Womens Washroom	Washroom			120		B2		3	4' Strip in Cove	18		2	2	T8	32	Wall	7	Drywall	Good	250	750	
024	Womens Washroom	Washroom			120		A15		7	Downlight - No lens	18		2	2	DTT CFL	26	Rec	8	Drywall	Good			
	Control Tower	Office			120		A18		14	Downlight	18		1	1	Inc	75	Rec	8	T-Bar	Good			
	Control Tower Washroom	Washroom			120		A19		1	Wall Light	18		1	1	Inc	100	Wall	6	Drywall	Poor			
218	Weather Office	Office			120	L-Switch	B8		6	4' Indirect/Direct	18		2	2	T8	32	Sus	8	T-Bar	Good	630	1000	
230	Storage	Storage			120	Occ Sen	A13		2	2x4 Lensed	18		3	3	T8	32	Rec	8	T-Bar	Good	230	350	
	Washroom	Washroom	2xT8 Vanity, 1x32 Surface Round, and		120	Occ Sen					18												
220	Corrridor	Corridor			120	L-Switch	A		8	2x2 Parabolic	18		2	2	Twin Tube	40	Rec	8	T-Bar	Good	350	600	
214	General Office	Office			120	L-Switch	B8		7	4' Indirect/Direct	18		2	2	T8	32	Sus	7	T-Bar	Good	470	810	
	General Office Closet				120	L-Switch	A6		1	Downlight with Cross Baffle	18		2	2	DTT CFL	26	Rec	8	T-Bar	Good			
216	Operations Super Intendant	Office			120	L-Switch	B8		4	4' Indirect/Direct	18		2	2	T8	32	Sus	7	T-Bar	Good	550	730	
216	Operations Super Intendant	Office			120	L-Switch	A6		2	Downlight with Cross Baffle	18		2	2	DTT CFL	26	Rec	8	T-Bar	Good			
217	Tower Manager	Office			120	L-Switch	B8		4	4' Indirect/Direct	18		2	2	T8	32	Sus	7	T-Bar	Good	500	950	
217	Tower Manager	Office			120	L-Switch	A6		2	Downlight with Cross Baffle	18		2	2	DTT CFL	26	Rec	8	T-Bar	Good			
219	Training Room	Office			120	L-Switch	B8		2	4' Indirect/Direct	18		2	2	T8	32	Sus	7	T-Bar	Good	550	600	
206	Office	Office			120	L-Switch	B9		4	4' Indirect/Direct	18		2	2	T8	32	Sus	7	T-Bar	Good	700	1400	
207	Office	Office			120	L-Switch	B9		6	4' Indirect/Direct	18		2	2	T8	32	Sus	7	T-Bar	Good	700	1900	
208	Office	Office			120	Occ Sen	B9		4	4' Indirect/Direct	18		2	2	T8	32	Sus	7	T-Bar	Good	550	1250	
205	Office	Office			120		B9		2	4' Indirect/Direct	18		2	2	T8	32	Sus	7	T-Bar	Good	570	100	
204	Office	Office			120	Occ Sen	B9		2	4' Indirect/Direct	18		2	2	T8	32	Sus	7	T-Bar	Good	500	850	
209	Office	Office			120	Occ Sen	B9		2	4' Indirect/Direct	18		2	2	T8	32	Sus	7	T-Bar	Good	500	1000	
203	Lunch Room	Office			120	Occ Sen	B9		4	4' Indirect/Direct	18		2	2	T8	32	Sus	7	T-Bar	Good	800	1000	
210a	Office	Office			120	L-Switch	B9		4	4' Indirect/Direct	18		2	2	T8	32	Sus	7	T-Bar	Good	500	1000	
210b	Office	Office			120	L-Switch	B9		2	4' Indirect/Direct	18		2	2	T8	32	Sus	7	T-Bar	Good	600	750	
211	Office	Office			120	L-Switch	B9		2	4' Indirect/Direct	18		2	2	T8	32	Sus	7	T-Bar	Good	600	750	
213	Boardroom	Office			120	L-Switch	A6		5	Downlight with Cross Baffle	18		2	2	DTT CFL	26	Rec	8	T-Bar	Good	460	640	
213	Boardroom	Office			120	L-Switch	A8		4	2x4 Parabolic	18		3	3	T8	32	Rec	8	T-Bar	Good			
213	Boardroom	Office			120	L-Switch	B9		3	4' Indirect/Direct	18		2	2	T8	32	Sus	7	T-Bar	Good			
205	Storage	Storage			120	L-Switch	A8		2	2x4 Parabolic	18		3	3	T8	32	Rec	8	T-Bar	Good	650	850	
205	Comms Room	Service			120	L-Switch	A13		2	2x4 Lensed	18		3	3	T8	32	Rec	8	T-Bar	Good		500	
205	General Office	Office			120	L-Switch	B10		17	4' Indirect/Direct	18		2	2	T8	32	Sus	7	T-Bar	Good	550	810	
205	General Office	Office			120	L-Switch	A13		2	2x4 Lensed	18		3	3	T8	32	Rec	8	T-Bar	Good			
205	General Office	Office			120	L-Switch	A10		3	Downlight Cross Baffle	18		2	2	DTT CFL	13	Rec	8	T-Bar	Good			
201	Corridor	Corridor			120	L-Switch	B10		6	4' Indirect/Direct	18		2	2	T8	32	Sus	7	T-Bar	Good	150	650	
203	Mens Washroom	Washroom			120	Occ Sen	B11		1	1x4 Surface Lensed	18		2	2	T8	32	Sur	7	Drywall	Good	150	650	
204	Womens Washroom	Washroom			120	Occ Sen	B11		2	1x4 Surface Lensed	18		2	2	T8	32	Sur	7	Drywall	Good	300	420	
	CATSA Screening	Examination			120		A16		50	4" Linear with Cross Baffle	18		1	1	T8	32	Rec	8	T-Bar	Good	220	300	
	CATSA Screening	Examination			120		A10		20	Downlight Cross Baffle	18		2	2	DTT CFL	13	Rec	8	T-Bar	Good			
	Ground Side Exterior				120		D1		14	Metal Halide Canopy	18		1	1	MH	100	Sur	8					
	Ground Side Exterior				120		D2		1	Metal Halide Canopy	18		1	1	MH	100	Sur	8					
	Ground Side Exterior				120		D3		33	Weather Proof 4' Strip	18		2	2	T12	40	Sur	12					
	Ground Side Exterior				120		A6		11	Downlight with Cross Baffle	18		2	2	DTT CFL	26	Rec	10					
	Boarding Lounge				120		A1		128	2x2 Parabolic	18		3	3	Twin Tube	40	Rec/Sus	8	T-Bar	Good	See plans for detailed analysis		
	Boarding Lounge				120		A6		80	Downlight with Cross Baffle	18		2	2	DTT CFL	26	Rec	8	Drywall	Good			
121	Airside Corridor 1 and 2				120		A1		34	2x2 Parabolic	18	12	3	3	Twin Tube	40	Rec/Sus	8	T-Bar	Good	550	950	
	Airside Corridor 3				120		A1		15	2x2 Parabolic	18	12	3	3	Twin Tube	40	Rec/Sus	8	T-Bar	Good	550	1200	
	Airside Corridor 4				120		A1		27	2x2 Parabolic	18	12	3	3	Twin Tube	40	Rec/Sus	8	T-Bar	Good	700	1600	
	Airside Corridor 5				120		A1		10	2x2 Parabolic	18	12	3	3	Twin Tube	40	Rec/Sus	8	T-Bar	Good	200	700	
	International Departures				120		A1		26	2x2 Parabolic	18		3	3	Twin Tube	40	Rec/Sus	8	T-Bar	Good			
	International Departures				120		A6		42	Downlight with Cross Baffle	18		2	2	DTT CFL	26	Rec	8	Drywall	Good			
113	Arrivals Ramp (high)				120		A1		15	2x2 Parabolic	18		3	3	Twin Tube	40	Rec/Sus	8	T-Bar	Good	250	700	
113	Arrivals Ramp (low)				120		A1		10	2x2 Parabolic	18		3	3	Twin Tube	40	Rec/Sus	8	Open	Good		900	
	Baggage Hall				120		A14		94	2 lamp Strip	18		2	2	T8	32	Sus	10	Open	Good		460	
112	Visual Inspection	Office			120		A1		2	2x2 Parabolic	18		3	3	Twin Tube	40	Rec/Sus	8	T-Bar	Good			
086	Storage	Storage			120	Occ Sen	A14		2	2 lamp Strip	18		2	2	T8	32	Sus	10	Open	Good			
085	Storage	Storage			120	Occ Sen	A14		11	2 lamp Strip	18		2	2	T8	32	Sus	10	Open	Good			
087a	Baggage Hall Mens Washroom	Washroom			120	Occ Sen	B5		1	4' Vanity	18		2	2	T8	32	Wall	7	Drywall	Good		250	
087b	Baggage Hall Womens Washroom	Washroom			120	Occ Sen	B5		1	4' Vanity	18		2	2	T8	32	Wall	7	Drywall	Good		250	
114	Corridor	Corridor			120		B5		7	4' Vanity	18		2	2	T8	32	Wall	7	Drywall	Good		470	
115	Office	Office			120	L-Switch	A17		2	2x4 Lensed	18		4	4	T8	32	Rec	8	T-Bar	Good	450	1000	
116	Storage	Storage			120	L-Switch	A17		2	2x4 Lensed	18		4	4	T8	32	Rec	8	T-Bar	Good	370	680	
117	Office	Office	2 of 3 lamps turned off		120	L-Switch	A8		2	2x4 Parabolic	18		3	3	T8	32	Rec	8	T-Bar	Good	280	350	
	Comms Closet	Service			120	L-Switch	A14		1	2 lamp Strip	18		2	2	T8	32	Sus	7	Open				
119	Airline Lunchroom	Office			120	L-Switch	A8		4	2x4 Parabolic	18		3	3	T8	32	Rec	8	T-Bar	Good		720	
118	Airline Office	Office			120	L-Switch	A8		2	2x4 Parabolic	18		3	3	T8	32	Rec	8	T-Bar	Good	560	720	
	North Baggage Drop Off	Service			120	Occ Sen	A14		10	2 lamp Strip	18		2	2	T8	32	Sus	7	Open				
	North Baggage Vestibule	Service			120		B5		2	4' Vanity	18		2	2	T8	32	Wall	7	Drywall	Good			
089	Storage	Storage			120	Occ Sen	A14		2	2 lamp Strip	18		2	2	T8	32	Sus	7	Open	Good			
088	Storage	Storage			120	Occ Sen	A14		2	2 lamp Strip	18		2	2	T8	32	Sus	7	Open	Good			
	Under Ramp Storage	Storage			120	Occ Sen	A14		5	2 lamp Strip	18		2	2	T8	32	Sus	5	Open	Good			
	N. Baggage Room Built Out Storage	Storage			120	L-Switch	A14		2	2 lamp Strip	18		2	2	T8	32	Sus	7	Open	Good			
	S. Baggage Room Built Out Storage	Storage			120	L-Switch	A14		2	2 lamp Strip	18		2	2	T8	32	Sus	7	Open	Good			

APPENDIX D

HEATING AND COOLING CALCULATIONS

	Peak Date	Peak Time	Air temperature (°C)	Space conditioning sensible (kW)	Internal gain (kW)	Solar gain (kW)	External conduction gain (kW)	Internal conduction gain (kW)	Air system input sensible (kW)	Infiltration gain (kW)
Multi-Zone	Jul	15:30	26	-110.6	68.3	33.1	5.3	0.4	10.7	3.5
Pre-Screening 105	Jul	14:30	26	-20.0	17.9	0.0	1.3	0.1	2.5	0.7
Well Fishing Area 104	Jul	17:30	26	-41.1	15.2	28.2	-2.1	-0.8	2.2	0.6
Departure Concourse 045	Jul	16:30	26	-60.3	28.0	30.2	0.4	-0.2	4.4	1.8
Check-In Area	Jul	16:30	26	-57.4	24.9	27.5	3.0	-0.3	12.7	2.3
International Arrival 013	Jul	14:30	26	-40.6	36.3	0.1	2.3	0.6	5.2	1.4
Airline Operation	Jul	15:30	26	-15.9	12.0	0.0	0.3	2.6	4.8	1.0
Baggage Makeup 084	Sep	5:30	30.0	-8.7	32.1	0.0	-10.0	-1.8	-8.7	-12.1
International Departure Floor	Jul	15:30	26	-36.9	32.7	0.3	2.4	0.0	5.1	1.4
Top Secret Room	Jul	14:30	26	-12.5	13.9	0.1	-2.4	0.5	2.0	0.5
Airside Corridor	Jul	8:30	26	-27.9	4.9	29.2	-5.9	-0.3	-0.4	-0.1
Airside Corridor	Jul	9:30	26	-74.5	28.0	63.5	-19.3	3.5	-1.3	-0.4
Custom General Office 017	Jul	17:30	26	-11.2	4.0	7.0	0.2	-0.3	1.4	0.3
Departure Floor 062	Jul	14:30	26	-65.6	63.6	0.0	-1.8	1.7	9.0	2.1
Office	Jul	15:30	26	-48.0	17.3	12.9	13.5	3.4	7.0	1.0
Total Existing Cooling Loads (kW):				**-631.1**					**56.6**	
Total Existing Cooling Loads (tons):				**-179.5**					**16.1**	
North Expansion	Jul	15:30	26	-91.4	55.0	7.4	26.4	0.2	8.6	2.4
Baggage Hall Expansion	Sep	5:30	34.1	-9.4	27.4	0.0	-8.3	-1.3	-9.4	-8.7
North Expansion - Beyond Plan	Jul	17:30	26	-58.1	26.7	28.4	2.0	-0.1	3.8	1.1
South Expansion - Beyond Plan	Jul	15:30	26	-102.9	52.1	34.4	14.2	-0.1	8.2	2.3
South Expansion	Jul	16:30	26	-406.4	216.5	107.8	72.6	0.1	33.9	9.4
Total Existing Cooling Loads (kW):				**-668.3**					**45.1**	
Total Existing Cooling Loads (tons):				**-190.1**					**12.8**	

	Air temperature (°C)	Space conditioning sensible (kW)	External conduction gain (kW)	Internal conduction gain (kW)	Air system input sensible (kW)	Infiltration gain (kW)	Dry resultant temperature (°C)	Aux vent gain (kW)	Natural vent gain (kW)	DHW heating demand (kW)
Multi-Zone	21	85.1	-70.9	0.2	-43.8	-14.4	23.1	0.0	0.0	0.0
Pre-Screening 105	21	15.2	-12.1	0.1	-11.5	-3.2	22.9	0.0	0.0	0.0
Well Fishing Area 104	21	28.5	-25.9	0.1	-9.7	-2.7	22.8	0.0	0.0	0.0
Departure Concourse 045	21	52.8	-45.6	0.2	-17.9	-7.5	22.9	0.0	0.0	0.0
Check-In Area	21	73.1	-63.3	-0.5	-51.9	-9.3	24.5	0.0	0.0	0.0
International Arrival 013	21	31.6	-25.1	-0.1	-23.3	-6.5	23.1	0.0	0.0	0.0
Airline Operation	21	20.1	-16.5	0.5	-19.7	-4.1	23.1	0.0	0.0	0.0
Baggage Makeup 084	21	55.6	-25.1	-0.8	-21.4	-29.7	24.6	0.0	0.0	0.0
International Departure Floor	21	28.9	-23.3	0.2	-21.0	-5.8	23.0	0.0	0.0	0.0
Top Secret Room	21	6.0	-4.1	0.1	-8.9	-2.1	22.9	0.0	0.0	0.0
Airside Corridor	21	20.0	-19.3	0.2	-3.2	-0.9	22.3	0.0	0.0	0.0
Airside Corridor	21	83.5	-79.3	0.8	-17.9	-5.0	22.6	0.0	0.0	0.0
Custom General Office 017	21	13.8	-12.5	0.1	-6.4	-1.3	22.9	0.0	0.0	0.0
Departure Floor 062	21	44.1	-34.7	0.1	-40.8	-9.4	23.3	0.0	0.0	0.0
Office	21	40.1	-35.8	-0.3	-28.5	-4.0	23.7	0.0	0.0	0.0
Total Existing Heating Loads (kW):		**598.5**			**-325.9**					
Total Existing Heating Loads (MBH):		**2043.2**			**-1112.5**					
North Expansion	21	85.0	-75.0	-0.2	-35.3	-9.8	23.4	0.0	0.0	0.0
Baggage Hall Expansion	21	51.3	-34.0	-0.4	-18.3	-16.9	24.6	0.0	0.0	0.0
North Expansion - Beyond Plan	21	45.9	-41.1	0.0	-17.1	-4.7	23.1	0.0	0.0	0.0
South Expansion - Beyond Plan	21	80.9	-71.6	0.0	-33.4	-9.3	23.4	0.0	0.0	0.0
South Expansion	21	346.0	-307.0	-0.4	-138.8	-38.6	23.6	0.0	0.0	0.0
Total Existing Heating Loads (kW):		**609.0**			**-242.9**					
Total Existing Heating Loads (MBH):		**2079.1**			**-829.3**					

APPENDIX E

EXISTING MECHANICAL EQUIPMENT

TAG	Equipment	Make	Cooling Capacity (btu)	Cooling Capacity (tons)	Cooling Capacity (kW)	Heating Capacity (btu)
BLR-01/02	Buderus Boiler	Buderus	0	0		2,876,000
BLR-03/04	Fulton Boiler	Fulton	-	0		-
DHW-01	State Turbo Sand Blaster DHW	State	-	0		
BLR-05	Atmospheric Boiler	A.O. Smith	-	0		1,350,000
DHW-02	Atmopheric Water heater (DHW)	0	-	0		
BLR-06	Bryan Boiler	Bryan	-	0		350,000
CHL-01	Chiller	Mcquay	1,860,000	155	93	-
DHW-03	Domestic Hot water boiler	A.O.Smith	-	0		
SPLT-01/14	Split unit	Mr. Slim	336,000	28	33.6	-
RTU-1	RTU-1	Lennox	48,000	4	4.8	120,000
RTU-2	RTU-2	TRANE	36,000	3	3.6	-
RTU-4	RTU-4	Lennox	36,000	3	3.6	90,000
RTU-5	RTU-5	Lennox	48,000	4	4.8	120,000
RTU-6	RTU-6	TRANE	600,000	50	60	-
RTU-7	RTU-7	Lennox	-	0	0	-
RTU-8	RTU-8	TRANE	150,000	12.5	15	250,000
RTU-9	RTU-9	TRANE	150,000	12.5	15	250,000
RTU-10	RTU-10	TRANE	60,000	5	6	130,000
RTU-11	RTU-11	TRANE	120,000	10	12	250,000
RTU-12	RTU-12	TRANE	120,000	10	12	250,000
RTU-13	RTU-13	TRANE	150,000	12.5	15	250,000
RTU-14	RTU-14	TRANE	180,000	15	18	350,000
RTU-027-04	RTU-027-04	Lennox	150,000	12.5	15	375,000
RTU-15	RTU-15	TRANE	24,000	2	2.4	50,000
ENG-A-1	ENG-A-1	ENG-A	108,000	9	10.8	250,000
ENG-A-2	ENG-A-2	ENG-A	360,000	30	36	350,000
	TOTAL		**4,536,000**	**378**	**361**	**7,661,000**
		Tons	**378**		**MBH @ 80%:**	**6,129**

COHOS EVAMY integratedesign™

Black & McDonald

Here is a list of the fan and pump we would like to have a amperage reading on:

WEST MECHANICAL ROOM
1. PUMP P-1: water pump – 120volt, 5.1amps
2. F1: Return Fan – 575volt, 3-phase (4.7A, 4.6A, 4.8A)
3. MZ1: Multi-Zone Unit – 575volt, 3-phase (12.1A, 12.2A, 12.1A)

EAST MECHANICAL ROOM
1. P-90-1 – 575volt, 3-phase (7.5A, 7.3A, 7.3A)
2. P-90-2 – pumps 1&2 alternate and share the same load
3. AHU-090: Supply fan – 575volt, 3-phase (4.3A, 4.4A, 4.4A)

2ND FLOOR MECHANICAL ROOM (CONTROL TOWER)
1. CC-1 : SUPPLY – 208volt, 1-phase, 6.7amps

CHILLER ROOM
1. P-121-1: Evaporator pump – 575volt, 3-phase (10.3A, 10.4, 10.7A)
2. P-121-2: Evaporator pump - pumps 1&2 alternate and share the same load
3. P-121-3: Condenser pump – 575volt, 3-phase (5.9A, 5.4A, 5.7A)
4. P-121-4: Condenser pump - pumps 3&4 alternate and share the same load

ROOF MECHANICAL ROOM
1. AHU-045-SUPPLY – 575volt, 3-phase (9.1A, 9.1A, 10.1A)
2. AHU-045-RETURN – 575volt, 3-phase (3.8A, 3.9A, 3.8A)

APPENDIX F

ENERGY CONSERVATION MEASURES

Operating Schedule Revision

Reduce operation time of ventilation units to match Aiport operating time.

		Estimated Fan Power (kW)	Estimated CFM
	RTU-1	2.22	2,222
	RTU-2	1.67	1,667
	RTU-4	1.67	1,667
	RTU-5	2.22	2,222
	RTU-6	27.78	27,778
	RTU-7	-	-
	RTU-8	6.94	6,944
	RTU-9	6.94	6,944
	RTU-10	2.78	2,778
	RTU-11	5.56	5,556
	RTU-12	5.56	5,556
	RTU-13	6.94	6,944
	RTU-14	8.33	8,333
	RTU-027-04	1.39	1,389
	RTU-15	1.11	1,111
	ENG-A-1	5.00	2,256
	ENG-A-2	16.67	3,000
	P-90-1	7.50	
	AHU-90	4.5	7,500
	Pump P-1	0.60	
	MZ-1 Supply	12.2	12,000
	MZ-1 return	4.50	
	CC-1	1.4	1,500
	P-121-1	10.40	
	P-121-3	5.4	
	AHU-045 S	9.10	1,000
	AHU-045 R	3.9	
	TOTAL	162.28	108,367

Hours	168	hrs/week
Yearly Consumption	1,134,127	kWh/yr
Monthly Consumption	94,511	kWh/mth
Reduced Hours	112	hrs/week
Yearly Consumption	756,085	kWh/yr
Monthly Consumption	63,007	kWh/mth

Control Saving (Fans)		
Yearly Energy Saving	**378,042**	**kWh**
Yearly Cost Savings	**26,121.23 $**	
Heating Reduction		
Yearly Energy Saving	**1,264**	**gj**
Yearly Cost Savings	**14,129 $**	

RETScreen Energy Model - Energy efficiency measures project

Fuels & schedules ☑ Show data

Fuel	Fuel type 1	Fuel type 2	Fuel type 3	Fuel type 4	Fuel type 5	Fuel type 6
Fuel type	Electricity					
Fuel consumption - unit	MWh					
Fuel rate - unit	$/kWh					
Fuel rate	0.069					

Schedule	Unit		Schedule 1	Schedule 2	Schedule 3	Schedule 4	Schedule 5	Schedule 6
Description			24/7					
				Occupied	Occupied	Occupied	Occupied	Occupied
Temperature - space heating	°C		21.0					
Temperature - space cooling	°C		25.0					
Temperature - unoccupied	+/-°C							
Occupancy rate - daily			h/d					
Monday			24					
Tuesday			24					
Wednesday			24					
Thursday			24					
Friday			24					
Saturday			24					
Sunday			24					
Occupancy rate - annual	h/yr		8,760					
	%		100%					
Heating/cooling changeover temperature	°C	16.0						
Length of heating season	d	252						
Length of cooling season	d	113						

Facility characteristics ☐ Show data

Summary ☑ Show data

	Fuel		Base case		Proposed case		Fuel cost savings	
Fuel type	Fuel consumption - unit	Fuel rate	Fuel consumption	Fuel cost	Fuel consumption	Fuel cost	Fuel saved	Fuel cost savings
Electricity	MWh	$ 69.000	185.0	$ 12,762	95.9	$ 6,615	89.1	$ 6,147

Project verification Fuel type	Fuel consumption - unit	Fuel consumption - historical	Fuel consumption Base case	Fuel consumption - variance
Electricity	MWh		185.0	

Energy	Heating GJ	Cooling GJ	Electricity GJ	Total GJ
Energy - base case			666	666
Energy - proposed case			345	345
Energy saved			321	321
Energy saved - %			48.2%	48.2%

Benchmark		
Energy unit	GJ	
Reference unit	m²	

Emission Analysis

Base case electricity system (Baseline) Country - region	Fuel type	GHG emission factor (excl. T&D) tCO2/MWh	T&D losses %	GHG emission factor tCO2/MWh
Canada	All types	0.196	10.0%	0.218

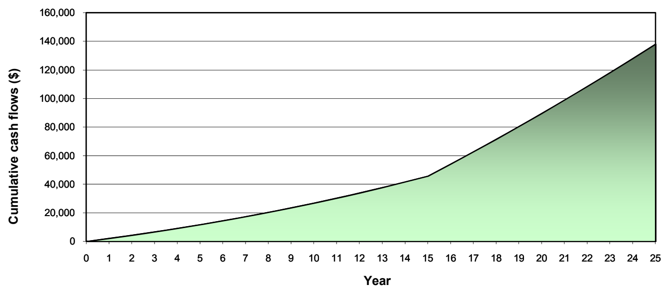
GHG emission					
Base case	tCO2	40.3			
Proposed case	tCO2	20.9			
Gross annual GHG emission reduction	tCO2	19.4			
GHG credits transaction fee	%				
Net annual GHG emission reduction	tCO2	19.4	is equivalent to	3.6	Cars & light trucks not used

GHG reduction income		
GHG reduction credit rate	$/tCO2	

Financial Analysis

Financial parameters			
Inflation rate	%	2.0%	
Project life	yr	25	
Debt ratio	%	100%	
Debt interest rate	%	3.00%	
Debt term	yr	15	
Initial costs			
Energy efficiency measures	$	50,000	100.0%
Other	$		0.0%
Total initial costs	$	50,000	100.0%
Incentives and grants	$		0.0%
Annual costs and debt payments			
O&M (savings) costs	$	0	
Fuel cost - proposed case	$	6,615	
Debt payments - 15 yrs	$	4,188	
Other	$		
Total annual costs	$	10,803	
Annual savings and income			
Fuel cost - base case	$	12,762	
Other	$		
Total annual savings and income	$	12,762	
Financial viability			
Pre-tax IRR - equity	%	positive	
Pre-tax IRR - assets	%	6.9%	
Simple payback	yr	8.1	
Equity payback	yr	immediate	

Cumulative cash flows graph



RETScreen Energy Model - Heating project

Heating project

	Unit	Base case	Proposed case		Incremental initial costs
Heated floor area for building	m²	9,900			
Energy efficiency measures			0%		
Heating load for building	W/m²	94	94		
Domestic hot water heating base demand	%	10%	10%		
Total heating	MWh	2,164	2,164		
Base load heating system					
Technology		Conventional	Boiler		
Capacity	kW	925.7	925.7	100.0%	$ 30,000
Heating delivered	MWh	2,164.1	2,164.1	100.0%	
Fuel type		Natural gas - GJ	Natural gas - GJ		
Seasonal efficiency	%	80%	93%		
Fuel consumption - annual	GJ	9,738	8,377	GJ	
Fuel rate	$/GJ	11.180	11.180	$/GJ	
Fuel cost	$	108,876	93,657		
Peak load heating system					
Technology					
Suggested capacity	kW		0.0		
Capacity	kW			0.0%	
Fuel type			Natural gas - m³		
Seasonal efficiency	%				
Fuel consumption - annual	m³		0		
Heating delivered	MWh		0.0	0.0%	
Fuel rate	$/m³				
Fuel cost	$		0		

Emission Analysis

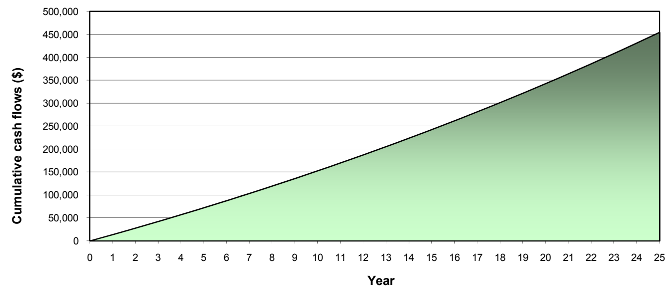
GHG emission					
Base case	tCO2	484.2			
Proposed case	tCO2	416.5			
Gross annual GHG emission reduction	tCO2	67.7			
GHG credits transaction fee	%				
Net annual GHG emission reduction	tCO2	67.7	is equivalent to	12.4	Cars & light trucks not used

GHG reduction income		
GHG reduction credit rate	$/tCO2	

Financial Analysis

Financial parameters			
Inflation rate	%	2.0%	
Project life	yr	25	
Debt ratio	%	100%	
Debt interest rate	%	3.00%	
Debt term	yr	25	
Initial costs			
Heating system	$	30,000	100.0%
Other	$		0.0%
Total initial costs	$	30,000	100.0%
Incentives and grants	$		0.0%
Annual costs and debt payments			
O&M (savings) costs	$		
Fuel cost - proposed case	$	93,657	
Debt payments - 25 yrs	$	1,723	
Other	$		
Total annual costs	$	95,379	
Annual savings and income			
Fuel cost - base case	$	108,876	
Other	$		
Total annual savings and income	$	108,876	
Financial viability			
Pre-tax IRR - equity	%	positive	
Pre-tax IRR - assets	%	48.2%	
Simple payback	yr	2.0	
Equity payback	yr	immediate	

Cumulative cash flows graph



RETScreen Energy Model - Cooling project

Cooling project

	Unit	Base case	Proposed case		Incremental initial costs
Cooled floor area for building	m²	10,000			
Energy efficiency measures			0%		
Cooling load for building	W/m²	63	63		
Non-weather dependant cooling	%	0%	0%		
Total cooling	MWh	785	785		
Base load cooling system					
Technology			Compressor		
Capacity	kW	631.0	631.0	100.0%	$ 75,000
Cooling delivered	MWh	784.7	784.7	100.0%	
Fuel type		Electricity	Electricity		
Coefficient of performance - seasonal		2.90	7.00		
Fuel consumption - annual	MWh	271	112	MWh	
Fuel rate	$/kWh	0.069	0.069	$/kWh	
Fuel cost	$	18,670	7,735		
Peak load cooling system					
Technology					
Suggested capacity	kW		0.0		
Capacity	kW			0.0%	
Fuel type			Electricity		
Coefficient of performance - seasonal					
Fuel consumption - annual	MWh		0		
Cooling delivered	MWh		0.0	0.0%	
Fuel rate	$/kWh				
Fuel cost	$		0		

Emission Analysis

Base case electricity system (Baseline)

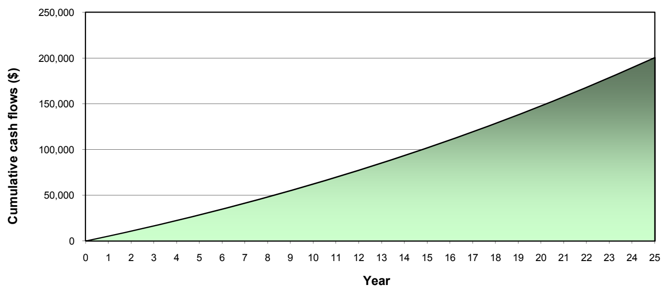
Country - region	Fuel type	GHG emission factor (excl. T&D) tCO2/MWh	T&D losses %	GHG emission factor tCO2/MWh
Canada	All types	0.196	10.0%	0.218

GHG emission					
Base case	tCO2	59.0			
Proposed case	tCO2	24.4			
Gross annual GHG emission reduction	tCO2	34.6			
GHG credits transaction fee	%				
Net annual GHG emission reduction	tCO2	34.6	is equivalent to	6.3	Cars & light trucks not used
GHG reduction income					
GHG reduction credit rate	$/tCO2				

Financial Analysis

Financial parameters			
Inflation rate	%	2.0%	
Project life	yr	25	
Debt ratio	%	100%	
Debt interest rate	%	3.00%	
Debt term	yr	25	
Initial costs			
Cooling system	$	75,000	100.0%
Other	$		0.0%
Total initial costs	$	75,000	100.0%
Incentives and grants	$		0.0%
Annual costs and debt payments			
O&M (savings) costs	$	1,500	
Fuel cost - proposed case	$	7,735	
Debt payments - 25 yrs	$	4,307	
Other	$		
Total annual costs	$	13,542	
Annual savings and income			
Fuel cost - base case	$	18,670	
Other	$		
Total annual savings and income	$	18,670	
Financial viability			
Pre-tax IRR - equity	%	positive	
Pre-tax IRR - assets	%	8.1%	
Simple payback	yr	7.9	
Equity payback	yr	immediate	

Cumulative cash flows graph



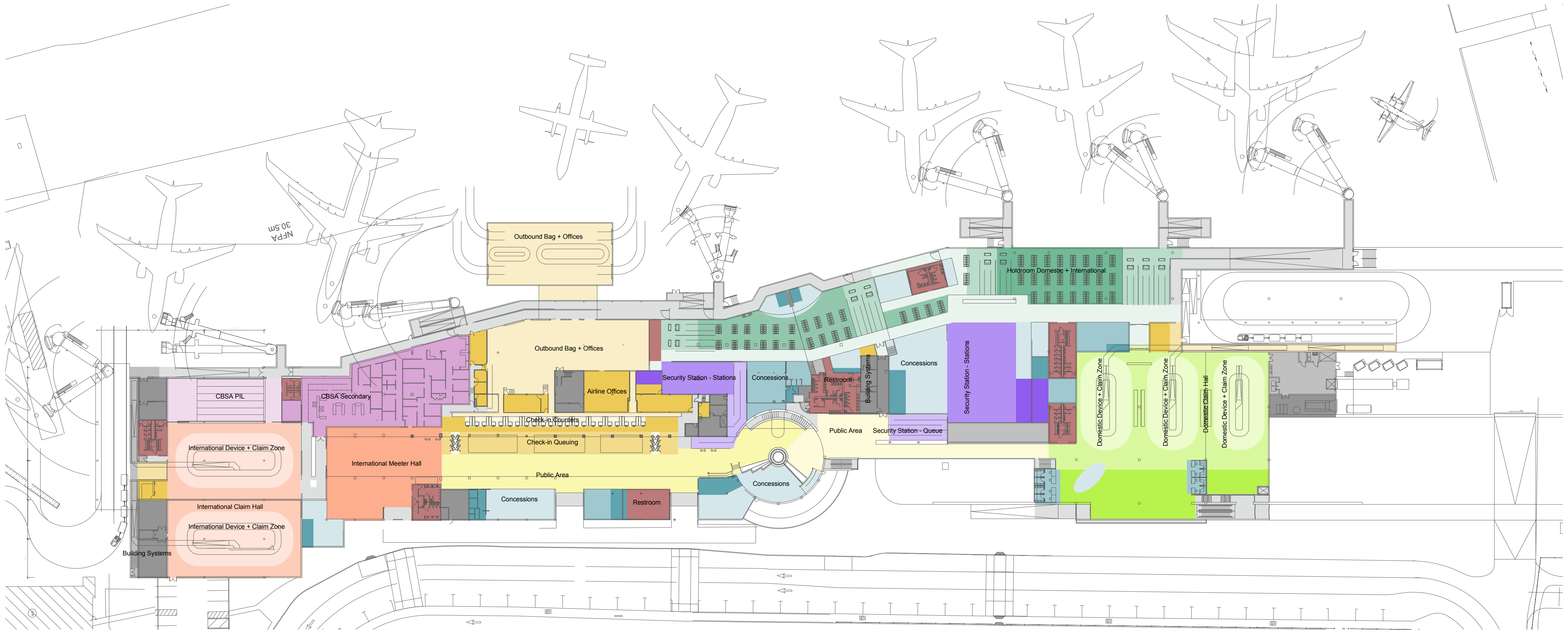
Building Area Legend

- 1A Check-in Counters
- 1B1 Check-in Queueing
- 1B2 Outbound Bag + Offices
- 1B3 Airline Offices
- 1B4 Check-in circulation
- 1C Public Area
- 1D1 Security Station - Queue
- 1D2 Security Station - Stations
- 1D3 Security Station - Offices
- 2A CBSA PIL
- 2B CBSA Secondary
- 2E1 International Device + Claim Zone
- 2F International Claim Hall
- 2G International Meeter Hall
- 2H1 Domestic Device + Claim Zone
- 2H3 Baggage Service Offices
- 2I Domestic Claim Hall
- 2J Domestic Meeter Hall
- 3A1 Holdroom Domestic + International
- 3A2 Holdroom Trans Border
- 3A3 Podium & Gate Control
- 3B Holdroom Circulation
- 4A Restroom
- 4B Concessions - Food
- 4C1 Concessions - Retail
- 4C2 Concessions - Support
- 5A Administrative / Operational Spaces
- 6A Building Systems
- Circulation
- Public Area

YLW 2025 Building Area	
Name	**Area**
1 Departures	
Check-in Counters	141 m²
Check-in Queuing	320 m²
Outbound Bag + Offices	1427 m²
Airline Offices	436 m²
Check-in circulation	120 m²
Public Area	808 m²
Security Station - Queue	207 m²
Security Station - Stations	608 m²
Security Station - Offices	116 m²
2 Arrivals	
CBSA PIL	334 m²
CBSA Secondary	772 m²
International Device + Claim Zone	781 m²
International Claim Hall	582 m²

YLW 2025 Building Area	
Name	**Area**
International Meeter Hall	611 m²
Domestic Device + Claim Zone	844 m²
Baggage Service Offices	58 m²
Domestic Claim Hall	668 m²
Domestic Meeter Hall	458 m²
3 Concourses	
Holdroom Domestic + International	449 m²
Holdroom Trans Border	455 m²
Podium & Gate Control	461 m²
4 Public Spaces	
Concessions	1026 m²

YLW 2025 Building Area	
Name	**Area**
Concessions	499 m²
Concessions	222 m²
5 Aviation Dept	
Administrative / Operational Spaces	1582 m²
6 Building Systems	
Building Systems	2364 m²
N/A	
Circulation	1964 m²
Public Area	569 m²
Structure & Features	86 m²

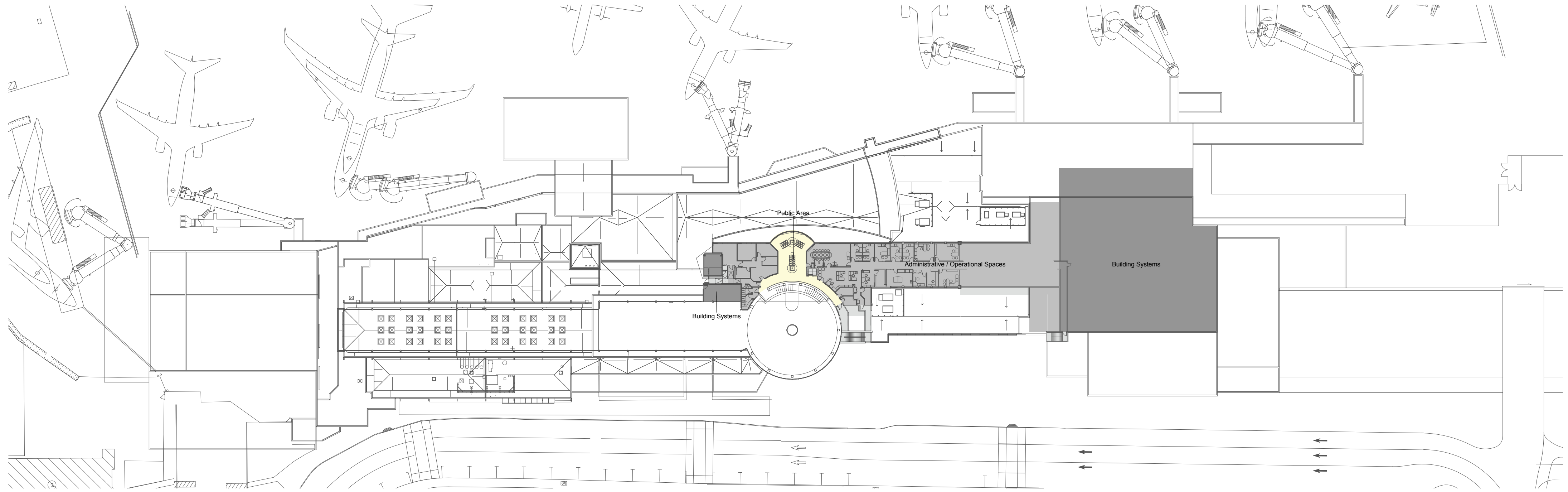


Level 1 - Areas

Concept Plan Area Reconciliation

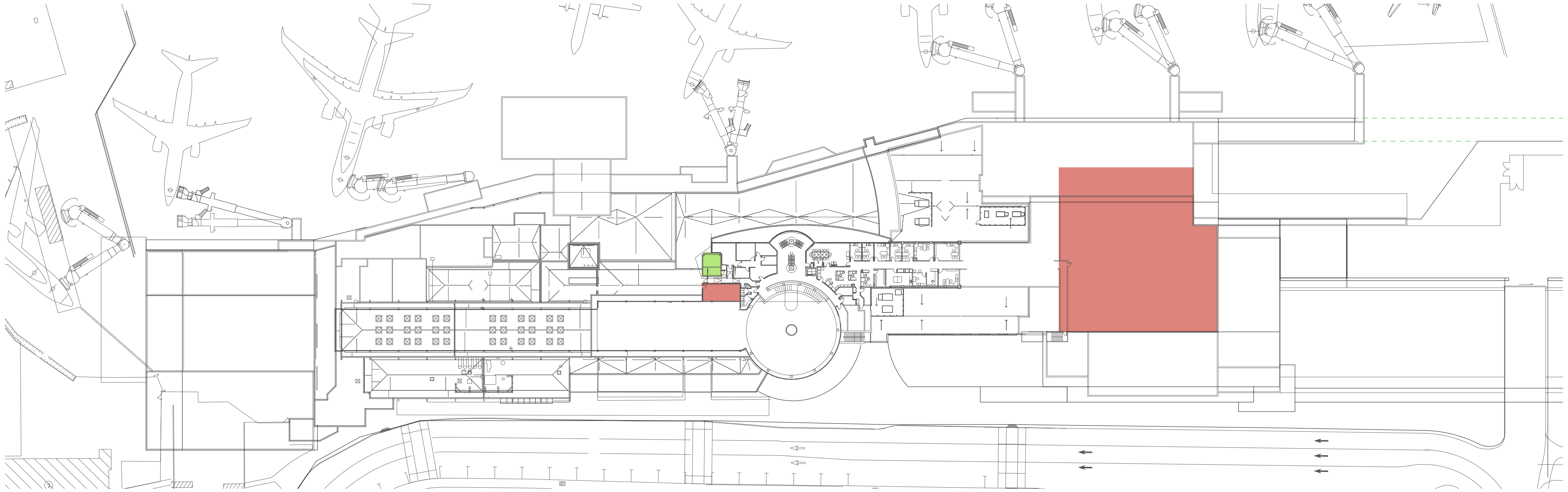
Building Area Legend

- 5A Administrative / Operational Spaces
- 6A Building Systems
- Circulation
- Public Area



Level 2 - Areas
1 : 400

Concept Plan Area Reconciliation

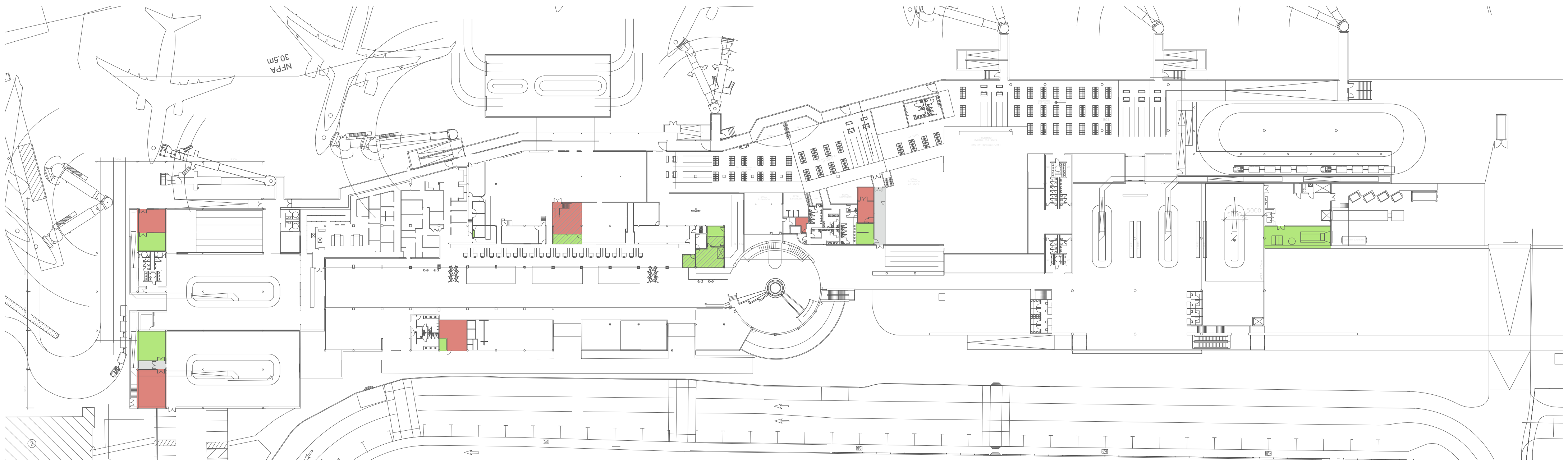


2 Level 2 - Building Sysytems
1 : 400

Building Area Legend

- Circulation
- Electrical
- Mechanical

Building system areas			
Util Sub Type	Level	Area	Name
Circulation	Level 1 - Areas	62 m²	Building Systems
		62 m²	
Electrical	Level 1 - Areas	317 m²	Building Systems
Electrical	Level 2 - Areas	31 m²	Building Systems
		348 m²	
Mechanical	Level 1 - Areas	283 m²	Building Systems
Mechanical	Level 2 - Areas	1671 m²	Building Systems
		1954 m²	
		2364 m²	



Level 1 - Building Sysytems

Concept Plan Area Reconciliation

JACOBS Consultancy

Memorandum

To: **Janice Liebe**

From: **Jim Slavin**

CC.: **Henry Castorf**

Date: **12 May 2010**

Re: **Primary security line-Kelowna Development program**

Attached please find a mark-up of the concept diagrams that shows the security line between airside and groundside. Any portal at this line will be subject to security control requirements and CCTV/access control equipment is implied.

The design team will need to attend to staff crossing points for:

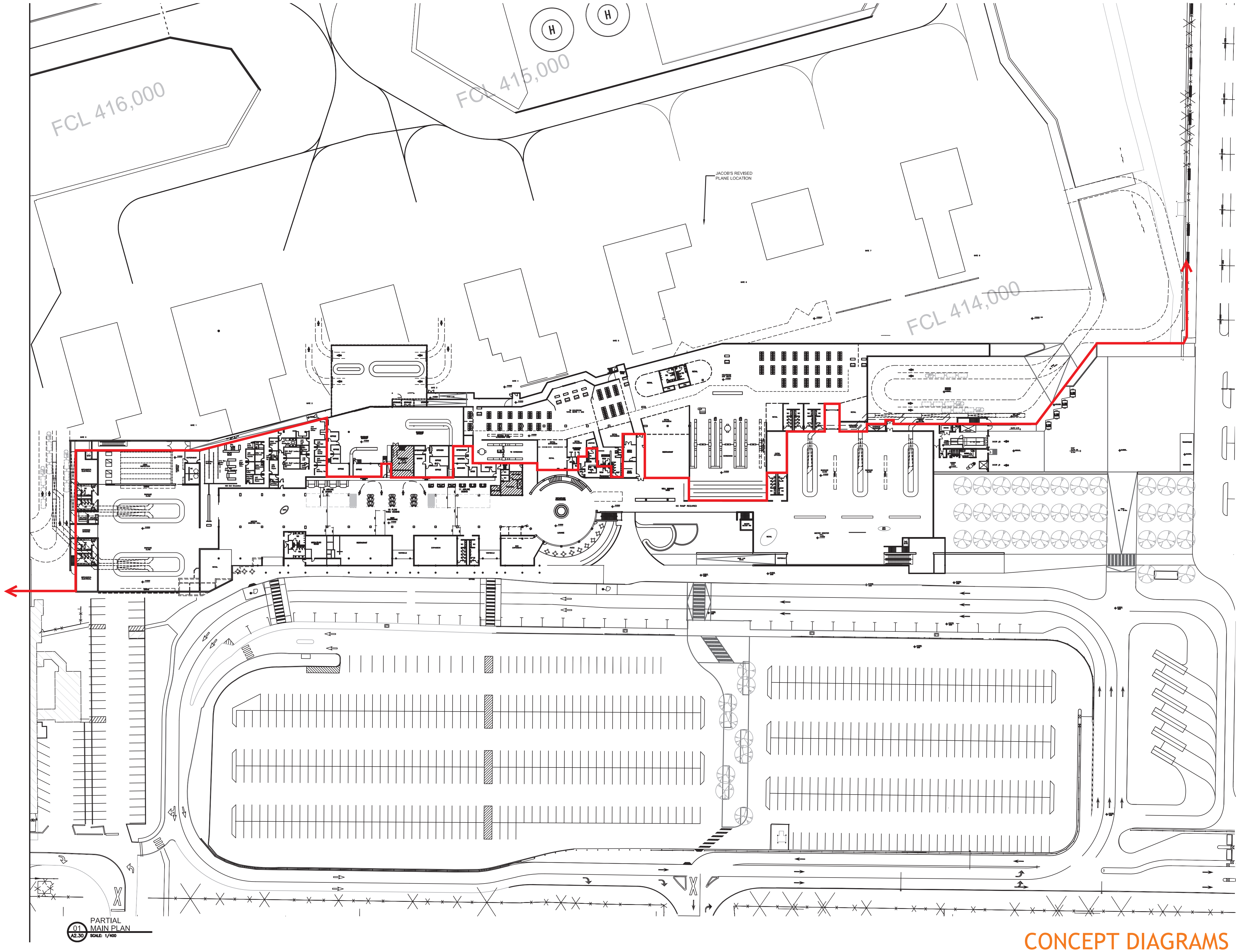
- Baggage agents- they will need to pass across the passenger corridor to get to their work locations and return.
- Airline agents-they will need an access to the domestic holdroom and return.
- Concession staff-and more importantly materials/logistics for post security locations.
- CBSA security-they have their own access/entry control requirements and the blue line denotes their similar, but separate, boundary. If we recall the statement of requirements correctly, CBSA are entitled to an apron access location and nearby vehicle parking site.

Sincerely,

Jim Slavin

Associate Director

Jacobs Consultancy



CONCEPT DIAGRAMS