Energy Audit for

Radiation Protection Building

775 Brookfield
Ottawa, ON

By

EnergyOttawa
An Affiliate of Hydro Ottawa

Prepared for
Public Works & Government Services Canada

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Point of Contact

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1. Executive Summary

1.1 Background

Energy Ottawa was selected to undertake an energy audit of the Radiation Protection Building at 775 Brookfield Rd., Ottawa, Ontario. The resulting energy analysis and recommendations for the site are discussed in this report.

1.2 Summary of Measures and Cost Savings

The potential energy and cost savings from each measure is summarized in each table. The measures have been categorized into the following two groups:

- Category One – These measures have a simple payback of six years or less. Category One measures are highlighted in green.
- Category Two – These measures have long paybacks in excess of 6 years but should be given consideration for other reasons such as tenant comfort, reduced maintenance, building & equipment renewal, etc. Category Two measures are highlighted in orange.

All savings and capital costs outlined in this report are indicative only. Savings will vary based on changes in tenant behaviour, occupancy levels, implemented energy and water efficiency measures and weather. A complete engineering analysis should be completed prior to changing any building mechanical equipment to ensure that all building conditioning needs are met.

Radiation Protection Building - Summary of Energy Efficiency Measures

Description of Energy Savings Measure	Estmated Savings					Energy	Avoided	Estimated Cost Savings						Total	Simple
	Elec. kWh/yr	Nat. Gas m3/yr	HTHW GJ/yr	Ch. Water GJ/yr	Water m3/yr	GJ	GHG Tonnes	Elec. $	Nat. Gas $	HTHW $	Ch. Water $	Water $	Total $	Costs	Payback
Condensing DHW Boiler - Old Wing		(8,818)	300			(32)	14.2		-$6,056	$9,952			$3,897	$13,310	3.4
Recommission BAS - New Wing	131,643		540	166		1,180	81.4	$12,275		$17,914	$4,231		$34,421	$136,434	4.0
Low-flow Toilets - Old Wing					493							$1,337	$1,337	$7,281	5.4
Fume Hood Exhaust and Make-up Air Control	48,620		1,601	656		2,432	201.3	$4,534		$53,126	$16,706		$74,365	$436,810	5.9
Lighting Retrofit	168,529					607	23.5	$15,715					$15,715	$101,275	6.4
Building Automation System - Old Wing	223,006		391	188		1,381	79.9	$20,794		$12,971	$4,777		$38,543	$254,941	6.6
Total Savings From Recommended Measures	571,797	-8,818	2,832	1,009	493	5,569	400.3	$53,318	-$6,056	$93,964	$25,714	$1,337	$168,278	$950,051	5.6
2009 Annual Utilities	3,227,535	3,412	12,092	4,493	4,048	28,332	1,905	$300,953	$2,343	$401,150	$114,471	$10,982	$829,899		
Percent Reduction	17.7%	-258.5%	23.4%	22.5%	12.2%	19.7%	21.0%	17.7%	-258.5%	23.4%	22.5%	12.2%	20.3%		

Energy Intensity - Before Implementation (GJ	1.20	0.01	1.24	0.46		2.92
Energy Intensity - After Implementation (GJ/	0.98	0.05	0.95	0.36		2.34

Energy Savings - Green **Building Renewal & Comfort - Orange**

Total costs include equipment, installation, engineering, project management, profit and overhead.

GHG Emission Factors

Elec	0.1396	kg CO2/kWh
Nat. Gas	1.887	kg CO2/m3
Steam	102.693	kg CO2/GJ
Chill Water	45.811	kg CO2/GJ

Savings Rates

Elec kWh	0.093	$/kWh
Nat. Gas	0.687	$/m3
HTHW	33.17	$/GJ
Chill Water	25.48	$/GJ
Water	2.71	$/m3

Floor Areas	Sq. M.
RPB	9,712.8

1.3 *Savings and Cost Methodology*

1.3.1 Savings

The savings for each of the measures were calculated based on information collected on site as outlined in section 2.

The utility rates applied to the utility consumption savings to calculate the cost savings for each measure are outlined in the table below. These rates are based on the average utility costs over the past year.

Utility	Unit Cost
Electricity	$0.093 per kWh
Natural Gas	$0.687 per m^3
High-temp Hot Water	$33.17 per GJ
Chilled Water	$25.48 per GJ
Water	$2.71 per m^3

The total utility consumption and cost savings from all recommended measures are compared to the total annual consumption and cost for the building. The annual utility information for the year was based on the available billing data. The most complete recent year of data covered the period January 2009 to December 2009. The facility's utility costs for this period were calculated using the unit costs in the table above.

1.3.2 Costs

The installed costs for each measure were determined based on a combination of vendor/contractor pricing, "*RSMeans Cost Data*" and past project experience. The total cost for each project includes the costs of equipment, installation, engineering design, and Energy Ottawa's costs for project management, profit and overhead.

Prices do not include taxes.

1.3.3 Greenhouse Gas Emissions

Greenhouse gas emissions (GHG) from the consumption of energy to operate the building as well as the avoided GHG emissions from implementing the proposed measures have been calculated using the following emissions factors provided by PWGSC.

Utility	GHG Emissions
Electricity	0.03879 tonnes CO_2e per GJ (= 0.1396 kg CO_2e per kWh)
Natural Gas	0.0507 tonnes CO_2e per GJ (= 1.887 kg CO_2e per m^3)
Steam	0.10269 tonnes CO_2e per GJ
Chilled Water	0.04581 tonnes CO_2e per GJ

2. Scope of Work / Methodology

The primary objective of the audit was to identify practical and cost-effective opportunities for reducing utility consumption and costs through retrofit measures and improvements to the facility's systems, building environment and operational procedures. One of the key conditions of evaluating any opportunity is that it maintains or improves tenant comfort while meeting performance levels recommended by industry associations such as ASHRAE and IESNA.

The preparation for the Energy Audit included the following tasks:

- discussions with client for background information;
- review of client goals and requirements;
- site visits and discussions with building operators;
- review of utility information;
- measurement and data logging of major mechanical equipment and environmental conditions;
- determination of best approach for project;
- analysis of potential retrofit measures and their associated costs and savings.

2.1 Information Collected

PWGSC provided the following information:

- Selected mechanical, electrical & controls drawings from the catalogue of drawings listed in Appendix F.
- Utility billing information from 2005 to 2009
- SpaceAUDIT Building Summary, November 2009
- Asset Management Plan, Corporate Research Group, March 2008
- Standard Operating Procedures Manual, April 2009

2.2 Drawings

Appendix F lists all existing mechanical, electrical, architectural drawings that are in PWGSC's possession for this facility.

3. Facility Description

The Radiation Protection Building is a mid-sized laboratory and office building located at 775 Brookfield Rd. The building is composed of two wings identified as the "old wing" (A-Wing) and "new wing" (B-Wing).

The old wing was constructed in two phases in the early 1960's and consists of a basement level and ground floor. The new wing was constructed in 1990 and consists of a basement level, 2 floors, and a mechanical penthouse. The building has a gross floor area of 9,712.8 m^2 and is solely occupied by Health Canada for office and laboratory space.

While the newer laboratory space has remained as originally designed and constructed, the sporadic conversion of most of the original laboratory space to office space has created imbalances and inefficiencies in the mechanical systems. Other recent renovations include replacement of the penthouse roof in 2007, and replacement of the old wing windows in 2009/10.

Building Name	Radiation Protection Building
Address	775 Brookfield Rd., Ottawa
Gross Floor Area	9,712.8 m^2
Date of Construction	1961 through 1990

3.1 Facility Use

Gross Floor Area	**9,712.8 m^2**
Rentable Floor Area	**6,734.2 m^2 (100.0%)**
CSE/DND	6,734.2 m^2 (100.0%)
Tenant	**Hours of Operation**
Health Canada	0700 – 1800 Mon – Fri
Occupancy	
Daytime	350
Nighttime	0
Weekends	0

4. Utility Analysis

4.1 Utility Consumption and Cost

The following utilities service the building:

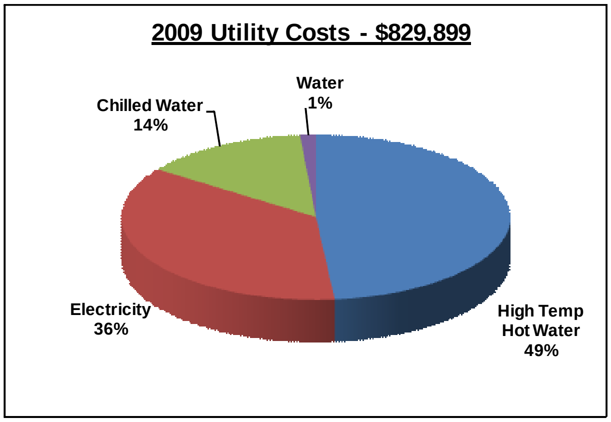
- Electricity – Confederation Heights Central Plant
- High-temperature Hot Water – Confederation Heights Central Plant
- Chilled Water – Confederation Heights Central Plant
- Natural gas – Enbridge Gas Distribution
- Water – City of Ottawa

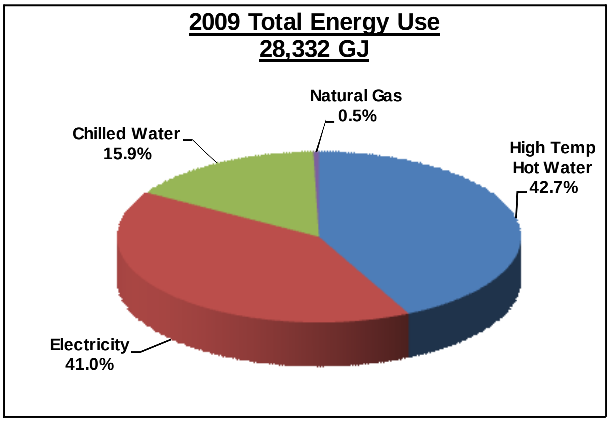
Breakdown of Utilities

The following graphs show the breakdown in utility cost and energy consumption for the facility for January 2009 to December 2009. For comparison purposes, all utilities have been converted to common units of energy (kWh). The following conversion factors were used:

- 1 kWh = 0.0036 GJ
- 1 m^3 of natural gas = 0.0376 GJ

A detailed listing of annual utility consumption and costs is included in Appendix A.

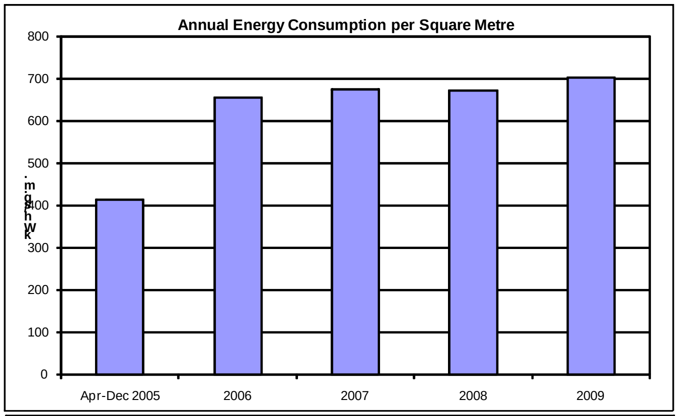


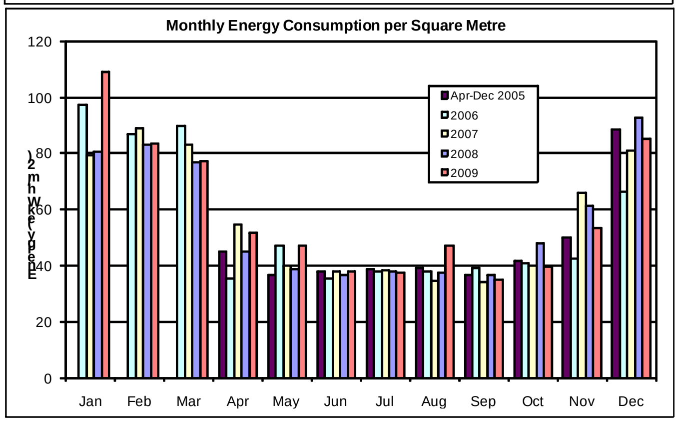


4.2 Benchmarking – Energy

Based on a floor area of 9,712.8 m^2, the total annual energy consumption per square metre for 2009 (after converting electricity, gas, high temp hot water, and chilled water energy to common units - GJ) was 2.92 GJ/m^2.

This is at the low end of the range for a laboratory building which typically has an energy intensity between 2.5 GJ/m^2 and 4.5 GJ/m^2.[1] However, many of the labs have been converted to office space; office buildings typically have an energy intensity between 0.75 GJ/m^2 and 1.75 GJ/m^2.





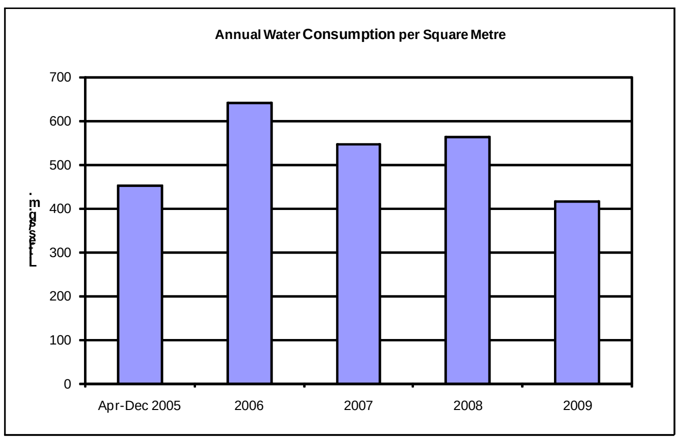
In order to compare the chilled water energy consumption from a central plant to a building with a typical electric chiller, the chilled water use in GJ should be divided by the chiller plant COP (the ratio of energy output to energy input). The estimated COP for the central plant chillers is 5.9; therefore, for every GJ of electricity consumed by the chiller, 5.9 GJ of cooling energy are produced. This results in an energy intensity of only 2.53 GJ/m^2 for the building.

The monthly and annual energy intensities from 2005 to 2009 year-to-date are shown in the graphs to the right.

4.3 Benchmarking – Water

Based on a floor area of 9,712.8 m^2, the total annual water consumption per square metre for the building in 2009 was 416.8 litres/m^2. This is very low for an office building, which typically consumes between 500 litres/m^2 and 1,000 litres/m^2 per year.

The graph to the right shows the annual water intensities from 2005 to 2009 year-to-date.



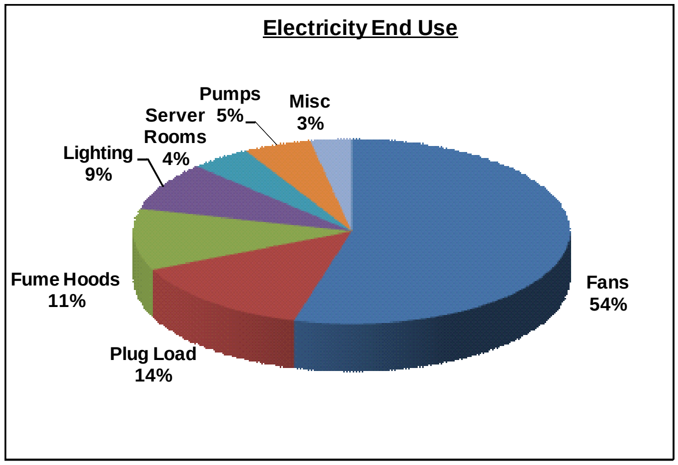
[1] Lawrence Berkeley National Laboratory "*A Design Guide for Energy-Efficient Research Laboratories*," LBNL-PUB-777, September 1996

4.4 Energy End Use

The following graphs show an approximate breakdown of electricity, high-temperature hot water, chilled water, and water consumption for Radiation Protection Building based on their end-use. The breakdown is indicative only and is based on utility data, ammeter readings, nameplate data and engineering calculations. Detailed energy end use inventories for these utilities are included in Appendix B.

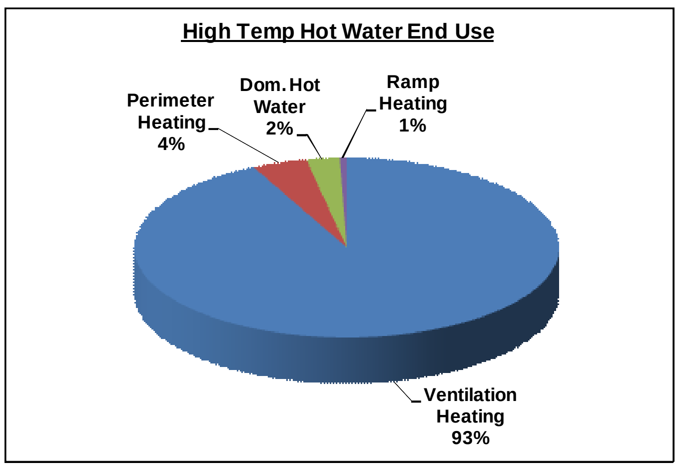
Electricity End Use

The largest end-use of electricity is for ventilation fans driven by the large amount of outdoor air requirements to offset the exhaust from the fume hoods in the building and maintain appropriate pressurization in the lab and non-lab spaces. All air-handlers in the building operate 24 hours per day. The *Miscellaneous* category includes the humidification system, elevators, and compressors for controls and lab equipment.



High-temperature Hot Water End Use

High-temperature hot water is provided to the building from the Confederation Heights Central Plant, and is used for ventilation heating, a small amount of perimeter heating, generating domestic hot water, and ramp heating. The largest end-use is ventilation heating driven by the large amount of outdoor air requirements to offset the exhaust from the fume hoods in the building and the fact that all air-handlers in the building operate 24 hours per day.



Chilled Water End Use

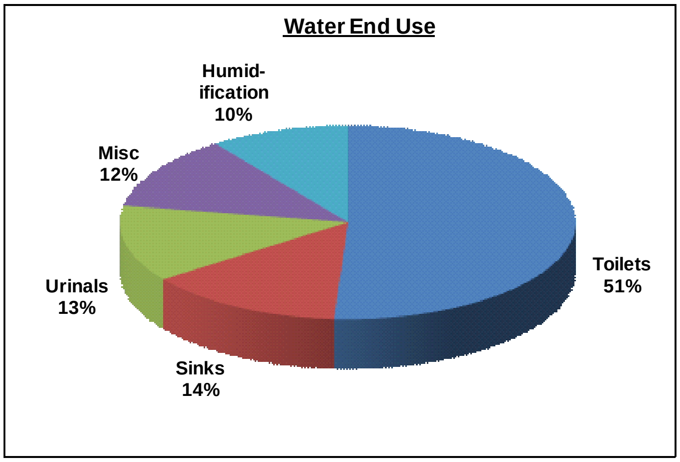
Chilled water is provided to the building from the Confederation Heights Central Plant for the summer months only, and is used entirely for cooling of ventilation air.

Natural Gas End Use

Natural gas is used entirely for generating domestic hot water in the new wing.

4.5 Water End Use

The following graph shows an approximate breakdown of water consumption based on the end-use. The largest water end-use is for washroom fixtures, including toilets, sinks and urinals. The *Miscellaneous* category includes water usage in the labs, and by the custodial staff. A detailed end-use inventory is included in Appendix B.



5. Description of Mechanical Equipment

Detailed schematics of the air-handling systems are included in Appendix D.

5.1 Primary Heating Systems

The building is heated using high temperature hot water (HTHW) from the Confederation Heights Central Plant. The HTHW is available year-round and during the summer it feeds reheat coils in the New Wing air-handling units and domestic hot water (DHW) via an indirect storage tank heater. A Volcano 2,504 kW natural gas fired boiler located in the New Wing acts as a backup heating source if HTHW is not available from the Central Plant.

Two 7.5 hp pumps (lead/lag) circulate the primary heating water through a heat exchanger off of the HTHW supply, through the backup boiler, and to other pump stations.

The New Wing is heated primarily by variable air volume (VAV) boxes with terminal reheat coils in the lab spaces as well as perimeter hydronic radiant panels. The Stairwells, entrance, and loading dock in the New Wing are heated using perimeter radiators, a convector, and hydronic unit heaters respectively. These terminal units are all served by two 5-hp pumps (lead/lag). It was reported that the temperature of the primary loop is kept higher than necessary in order to accommodate the heating load in the loading dock, resulting in overheating of other areas of the building. The perimeter radiation is controlled as a single zone.

The Acoustic AHU in the New Wing is equipped with reheat coils that operate in summer to reheat air after overcooling for dehumidification.

The stairwells and administration areas in the Old Wing are heated by perimeter hydronic radiation. The remainder of the Old Wing is heated by a dual duct boxes fed from AHU-1.

A direct digital control (DDC) building automation system (BAS) controls the central mechanical equipment and VAV boxes with reheat coils in the New Wing. Pneumatic controls are used in the Old Wing to control AHUs, heating valves, and cooling valves.

5.2 Primary Cooling Systems

The building is provided with chilled water from the Confederation Heights Central Plant in the summer months only. Chilled water is used in the cooling coils of the air-handling units.

Spot cooling for server rooms is provided by tenant-owned split direct expansion (DX) air-conditioning units.

5.3 Air-Handling Units

Old Wing

The administration and office areas are served by AHU – 1, a constant volume dual-duct air handler that delivers conditioned air to dual duct terminal boxes for ventilation, heating, and cooling. This unit is equipped with a supply fan, return fan, economizer, hot glycol for fresh air preheat, hot water coil for the hot deck, and chilled water coil for the cold deck.

The labs are provided with 100% outdoor air by AHU-2 to offset fume hood exhaust. This AHU is a constant volume unit equipped with a supply fan and glycol heating coil.

There are 28 fume hoods in the lab spaces, only 21 of which are operational. Exhaust for each fume hood is provided by a constant volume dedicated exhaust fan (typically ½-hp) that dumps the exhaust air to a common plenum. Exhaust from the common plenum is provided by a constant volume fan equipped with relief damper to maintain exhaust air flow with outdoor air if some fume hoods are shut off.

All AHUs are controlled with standalone pneumatics and operate 24/7. The majority of fume hood exhaust fans can be switched by the occupant via the fume hood's onboard controls.

New Wing

AHUs 4, 6, and 7 serve the VAV boxes with reheat coils in Admin, Microwave, and Emergency Response respectively. Each unit is equipped with a supply fan, return fan, variable inlet vanes (VIV) for capacity control, economizer section, hot water heating coil, and chilled water cooling coil.

AHU-3 serves the VAV boxes in Microwave. This AHU is equipped with a supply fan, return fan, variable frequency drive (VFD) for capacity control to minimize noise/vibration, economizer section, hot water heating coil, chilled water cooling coil and hot water reheat coil. Since the Microwave area has stricter tolerances on relative humidity, reheat in the AHU is used in summer to reheat the air after cooling for dehumidification purposes.

AHUs 5 and 8 provide conditioned make-up air to the labs in the South and North ends of the New Wing respectively. Each unit is equipped with a supply fan, remote exhaust fan, VIV for pressurization control, glycol heating coil, and chilled water cooling coil.

AHU-9 provides conditioned ventilation air to the mechanical penthouse. This constant volume unit is equipped with a supply fan, and glycol heating coil. Although the Standard Operating Procedures manual shows this unit to be a typical AHU with mixing section, the unit appears to be acting more like a make-up air unit since the return air damper is significantly smaller than the fresh air intake. It was reported that the heating coil valve is at or close to 100% open for the majority of the heating season.

AHU-10 is a constant volume unit with neither heating nor cooling coils that recirculates air from the penthouse electrical room back to the electrical room. Fresh air dampers in the electrical room walls are controlled based on space temperature to provide some fresh air for cooling which mixes with the supply air from this unit. AHU-10 operates 24/7 regardless of temperature in the electrical room.

There are 38 fume hoods in the lab spaces. Exhaust for each fume hood is provided by a dedicated exhaust fan (typically ½-hp) equipped with a VFD that dumps the exhaust air to the outside. All of the fume hood VFDs were operating at full speed (60 Hz) regardless of fume hood sash position, indicating that no feedback is being provided to the VFD to allow exhaust fan speed to be adjusted.

All AHUs are controlled by a VCI direct digital control (DDC) building automation system (BAS) and operate 24/7. The majority of fume hood exhaust fans can be switched by the occupant via the fume hood's onboard controls.

A detailed list of AHUs and their characteristics is included in Appendix C.

5.4 Exhaust Fans

A list of the building's exhaust fans and their function is included in Appendix C.

5.5 Pumps

A list of the building's pumps and their function is included in Appendix C.

5.6 Domestic Hot Water System

Domestic Hot Water (DHW) in the Old Wing is provided by a heat exchanger off of the HTHW supply with storage in a 1,434 L tank. In the New Wing, there are two 125 MBH atmospheric natural gas fired DHW tanks with a capacity of 73 US Gal each. DHW recirculation pumps operate 24/7 to distribute DHW.

5.7 Lighting

Energy Ottawa conducted a site visit to collect information on the facility operations and equipment at Radiation Protection Building, located at 775 Brookfield Road, Ottawa, Ontario.

Currently, lighting in the Radiation Protection Building is primarily provided by 4 foot, 2-lamp fluorescent tube T12 fixtures with 34W lamps and electromagnetic ballasts. The system wattage of a 4 foot, 2 lamp T12 fluorescent fixture with an electromagnetic ballast is 72W. Some areas contain recessed downlight fixtures that contain 23W compact fluorescent lamps. The occasional 100W incandescent lamp and 4 foot, 2 lamp fluorescent tube T8 fixture can be found in the building. Exit signs are incandescent. Incandescent exit signs contain two 15W lamps each.

All lighting is controlled with on/off switches. Voltage of lighting is to be confirmed. The total watts per square foot of Radiation Protection Building is 0.11W/ft^2. This number was derived by taking the total connected load of the building and dividing by the total area of the building.

A summary of the lighting equipment currently in use can be found in Appendix “E”.

6. Recommended Energy Saving Opportunities

The proposed measures outlined in this section will produce an estimated 5,569 GJ and $168,278 in utility savings per year for an installed cost of $950,051. This represents savings of 20.3% of the building's current utility costs. The avoided greenhouse gas emissions resulting from the implementation of the proposed measures are an estimated 400.3 tonnes of CO_2 per year.

The table on the following page shows the savings from each measure.

Radiation Protection Building - Summary of Energy Efficiency Measures

Description of Energy Savings Measure	Estmated Savings					Energy	Avoided	Estimated Cost Savings						Total	Simple
	Elec. kWh/yr	Nat. Gas m3/yr	HTHW GJ/yr	Ch. Water GJ/yr	Water m3/yr	Energy GJ	GHG Tonnes	Elec. $	Nat. Gas $	HTHW $	Ch. Water $	Water $	Total $	Costs	Payback
Condensing DHW Boiler - Old Wing		(8,818)	300			(32)	14.2		-$6,056	$9,952			$3,897	$13,310	3.4
Recommission BAS - New Wing	131,643		540	166		1,180	81.4	$12,275		$17,914	$4,231		$34,421	$136,434	4.0
Low-flow Toilets - Old Wing					493							$1,337	$1,337	$7,281	5.4
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Total Savings From Recommended Measures	571,797	-8,818	2,832	1,009	493	5,569	400.3	$53,318	-$6,056	$93,964	$25,714	$1,337	$168,278	$950,051	5.6
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Energy Intensity - Before Implementation (GJ	1.20	0.01	1.24	0.46		2.92
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Energy Savings - Green **Building Renewal & Comfort - Orange**

Total costs include equipment, installation, engineering, project management, profit and overhead.

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Elec	0.1396	kg CO2/kWh
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Savings Rates

Elec kWh	0.093	$/kWh
Nat. Gas	0.687	$/m3
HTHW	33.17	$/GJ
Chill Water	25.48	$/GJ
Water	2.71	$/m3

Floor Areas	Sq. M.
RPB	9,712.8

6.1 Category One Measures

6.1.1 Condensing Domestic Hot Water Boiler – Old Wing

Current Conditions

Domestic Hot Water (DHW) in the Old Wing is provided by a heat exchanger off of the HTHW supply with storage in a 1,434 L tank. A fractional horsepower recirculating pump runs 24 hours per day to ensure that hot water is available immediately at all fixtures.

The primary end-uses of DHW are for hand-washing in the washrooms, custodial use, and in the laboratories.

Proposed Retrofit

Energy Ottawa recommends installing a gas-fired condensing boiler to meet the DHW loads of the building. The existing storage tank and recirculating pump would be kept and DHW circulated from the boiler to the tank as needed. The existing heat exchanger between the DHW loop and the HTHW line would be maintained as a backup in the event of a boiler failure.

Natural gas is a significantly cheaper source of energy than HTHW. In addition, condensing boilers can reach efficiencies of up to 97% when supplied with cold inlet water. To maximize efficiency, the domestic hot and cold water piping should be configured to provide water to the boiler that is as cold as possible while staying within the boiler's operating limits.

Consideration should be given to operating the new boiler using sealed combustion air intakes to draw air directly from the outdoors instead of from the boiler room. The use of sealed combustion air would ensure efficient boiler operation while minimizing the risk of freezing domestic cold water piping in the boiler room and minimizing stack effect.

The capital costs in the table below are based on natural gas being available in the penthouse mechanical room of the Old Wing. In the event that bringing gas to this area is cost prohibitive, the electric water heaters could be installed instead of a gas boiler. Electricity is more expensive than natural gas but still significantly cheaper than HTHW.

Savings	Cost Savings	Capital Cost	Payback
(8,818) m^3 nat. gas	-$6,056		
300 GJ HTHW	$9,952		
Total	$3,896	$13,310	3.4 yrs

6.1.2 Recommission Building Automation System – New Wing

Current Conditions

The major mechanical systems in the New Wing are controlled by a VCI direct digital control (DDC) building automation system (BAS). Many of the smaller pieces of HVAC equipment operate on standalone pneumatic or electric controls. A brief review of the control and operation of the HVAC systems identified the potential for control optimization that would result in energy savings and improved comfort conditions. The areas of potential improvement include:

1. Almost all air-handling equipment operates 24/7 regardless of building occupancy.
2. The zones throughout the building are maintained at a constant space temperature regardless of building occupancy.
3. Minimum outdoor air damper (OAD) position is typically between 10% and 20% for the AHUs regardless of occupancy.
4. Based on the BAS sequence of operations, the supply air temperature setpoint for the AHUs to the office areas is typically reset from 13ºC to 26ºC based on room temperature. The supply air temperature setpoint for the make-up air units serving the labs is typically lower, between 13ºC and 18ºC. The supply air to the offices and the labs is then reheated as needed in each zone by terminal reheat coils. During the site visits, both labs and offices were found to have some zones in heating mode and some zones in cooling mode.
5. AHU-10 is a constant volume unit with neither heating nor cooling coils that recirculates air from the penthouse electrical room back to the electrical room. Fresh air dampers in the electrical room walls are controlled based on space temperature to provide fresh air for cooling which mixes with the supply air from this unit. Mixing of fresh air and return air appears to be done by turbulence in the zone rather than in a mixing plenum. AHU-10 operates 24/7 regardless of temperature in the electrical room. According to the SOP, AHU-10 has a mixing plenum, glycol heating coil, and chilled water cooling coil; none of these features could be found during site visits.
6. The Scheduled hot water loop which provides hot water to the perimeter heating and loading dock is reported to require a higher setpoint than originally designed because of the significant heat losses from the loading dock. During the site visit, the HWS temperature of the Scheduled loop was 57ºC when the outdoor air temp was -2ºC. The Constant Temperature loop was only 53ºC at this time.
7. AHU-9 provides conditioned ventilation air to the mechanical penthouse. Although the Standard Operating Procedures manual shows this unit to be a typical AHU with mixing section, the unit appears to be acting more like a make-up air unit since the return air damper is significantly smaller than the fresh air intake. It was reported that the heating coil valve is at or close to 100% open for the majority of the heating season.
8. The domestic hot water (DHW) recirculating pump operates 24/7 to ensure that hot water is immediately available at each water fixture, regardless of building occupancy.
9. A compressor in each wing operates 24/7 to provide the compressed air needs of the controls and the labs. Each compressor has sufficient capacity to supply both wings.

10. The BAS has dozens of input and output points that may or may not be calibrated properly, resulting in poor control of the mechanical systems.

<u>Proposed Retrofit</u>

Energy Ottawa recommends recommissioning the existing BAS systems and implementing new strategies in order to optimize energy savings.

Recommissioning, or retrocommissioning, is the process of applying building commissioning procedures to an existing building in operation. This process ensures that the previously commissioned systems are maintained and operated in accordance with the original design intent. It is also an opportunity to optimize operations beyond the intent of the original designers, using building operation experience as a guide, and accounting for changes to building use since original construction.

In a BAS recommissioning process, opportunities for savings are unknown until the existing system is tested and evaluated. Based on studies of recommissioning projects for typical large office buildings, the recommissioning cost is estimated as $0.35/ft^2, and the expected savings are estimated as 5% to 15% of whole-building energy use (after subtracting consumption from tenant equipment).

The objectives of the recommissioning process will be met by implementing the following strategies:

- Review control points and sequence of operation.
- Temporarily modify setpoints to evaluate if BAS responds appropriately.
- Identify simultaneous heating and cooling, excess outdoor air, end devices requiring calibration/relocation/replacement, and other performance issues.
- Obtain airflow, temperature, and static pressure measurements on all air-handling units (including exhaust fans) to determine if airflows are operating as designed, or if they could be optimized. Assess building pressurization control.
- Identify opportunities for improved building performance, balancing requirements, and systems that are not operating as intended or designed.
- Estimate potential energy savings.

Energy Ottawa recommends implementing the following strategies during the BAS recommissioning process.

1. Install variable frequency drives (VFD) on AHUs serving Admin, Microwave, and Emergency Response areas to replace variable inlet vanes (VIV) as method of capacity control when cooling loads in the zone are met and the VAV boxes are at their minimum. VFDs use significantly less energy at part loads than VIVs. Capital costs include the cost for output reactors to protect the fan motors from harmonics generated by the VFDs and for connecting the VFD to the building automation system.

   Slow down the VFDs on the AHUs serving the Admin, Microwave, Emergency Response, and Acoustic areas to minimum speed during unoccupied hours according to a programmed operating schedule in the BAS that is based on the occupancy patterns of the building. Since heating for the majority of the office areas (and labs) is provided by terminal reheat coils, airflow is required to provide heat during unoccupied hours in winter. The outdoor air dampers on these AHUs would be closed during unoccupied hours to minimize heating and cooling energy requirements.

All general exhaust fans and washroom exhaust fans should be scheduled off according to the same occupancy schedule. Install push-button overrides in zones to return the appropriate AHU to regular control for a pre-programmed period of time in the event that the space is used during unoccupied hours.

The savings below are based on slowing down fan speed for 10 hours per night, 7 days per week. The capital costs include the costs required to connect the smaller exhaust fans to the BAS. Consideration should be given to shutting off these AHUs completely during shoulder and summer months.

2. Setback space temperature at night to 18ºC (65ºF) to reduce heat loss through the building envelope by controlling the terminal reheat coils in each zone.

   The pushbutton override described above would return the zones to the occupied setpoint for a pre-programmed period of time in the event that the space is used during unoccupied hours.

3. Install carbon dioxide (CO_2) sensors in the return air stream of AHUs serving Admin, Microwave, Emergency Response, and Acoustic areas. When the AHU is not in free cooling mode, control outdoor air dampers to maintain a maximum differential between CO_2 in the return air stream and outdoor CO_2 levels. HTHW and chilled water savings will be achieved by reducing the amount of outdoor air introduced into the space during periods of low occupancy.

4. Implement a supply air temperature reset strategy for AHUs serving the office and lab areas by polling the position of the terminal reheat coil valve in each zone and maintaining a supply air temperature setpoint at each AHU that minimizes the amount of reheat required in the zones served by that AHU.

5. Install ductwork and mixing dampers on AHU-10 to provide this unit with a proper mixing plenum. Connect AHU-10 to the BAS and shut off based on temperature in the electrical room.

6. Install additional hydronic unit heaters in the loading dock to provide additional heating capacity. Adjust Scheduled loop temperature setpoint and reset schedule to lowest possible setting while still meeting heating loads of all zones served by the Scheduled loop.

7. Provide ductwork, dampers, and controls to convert AHU-9 with a proper mixing section that provides more return air and only introduces between 10 to 20% outdoor air (unless the unit is in economizer mode) instead of the much higher quantity of fresh air currently being provided. Schedule off the unit at night during unoccupied hours but re-enable based on a zone temperature in the penthouse mechanical room that drifts out of an acceptable range. Conduct an indoor air quality study of the penthouse mechanical room to determine if any harmful chemicals are being introduced. Any issues resulting from the study should be addressed by proper sealing of the exhaust fan stacks.

8. Schedule the operation of the DHW circulation pump and washroom exhaust fan to follow the same schedule as the air-handling units.

9. Interconnect the compressed air lines between the two wings in order to allow a single compressor to meet the compressed air needs of both wings. The compressors should be connected to the BAS so that they can be scheduled according to a duty/standby cycle.

Savings	Cost Savings	Capital Cost	Payback
131,643 kWh	$12,275		
555 GJ HTHW	$18,412		
166 GJ Chilled Water	$4,231		
Total	$34,918	$136,434	3.9 yrs

6.1.3 Low-Flow Water Fixtures – Old Wing

Current Conditions

The flow rates and estimated annual consumption of the existing water fixtures in the Old Wing are shown in the table below. The annual consumption figures are estimated based on a population of 125 people in the Old Wing with an equal number of male and female occupants.

Fixture Type	# of Fixtures	Flow rate	Annual Consumption
Flush-valve toilets, wall-mount	9	13 litres/flush	740 m^3
Urinals	4	3.8 litres/flush	185 m^3
Faucet aerators	10	9 litres/minute	200 m^3

Proposed Retrofit

Energy Ottawa recommends replacing the existing toilet flush valves and wall-mounted bowls with 6 litre/flush models. The installation would include the installation of new wax rings, flush valves, bowls, and toilet seats. The expected annual savings from the new toilets is 398 m^3.

In order to prevent clogging and double-flushing, it is recommended that the new toilets score 700 grams or higher in the Maximum Performance Testing of Popular Toilet Models, 13th Edition, 2008. The MaP testing protocol measures the performance of toilets to ensure that they are low-flow (using 6 litres per flush) and scores the toilets on their ability to clear test media (packages of extruded soybean paste and toilet paper) in a single flush. MaP testing is conducted by loading the toilet in 50g and 100g increments of test media until it fails to pass 100% of the media in four of five attempts.

All 6 litre/flush toilets are required to be able to clear 250g of test media in order to meet the minimum standards set forth by CSA and ASNI. A full copy of the protocol and manufacturer test results is available from the Alliance for Water Efficiency at http://www.allianceforwaterefficiency.org/MaP-main.aspx.

Also recommended is the replacement of the existing faucet aerators with 4.5 litre/min models for water savings and water heating energy savings. The expected annual savings from the new aerators is 95 m^3.

The existing urinals are considered efficient at 3.8 litres per flush. If there is a significant fit up of the building for a new tenant over the next two years, consideration should be given to replacing the existing units with waterless urinals. The payback on water savings alone would be very long for waterless urinals, so the capital cost and savings have not been included in the table below.

Water Savings	Cost Savings	Capital Cost	Payback
493 m^3	$1,337	$7,281	5.4 yrs

6.1.4 Fume Hood Exhaust and Make-up Air Control – Both Wings

Current Conditions

Old Wing

The labs are provided with 100% outdoor air by AHU-2 to offset fume hood exhaust.

There are 28 fume hoods in the lab spaces, only 21 of which are operational. Exhaust for each fume hood is provided by a constant volume dedicated exhaust fan (typically ½-hp) that dumps the exhaust air to a common plenum. Exhaust from the common plenum is provided by a constant volume fan equipped with relief damper to maintain exhaust air flow with outdoor air if some fume hoods are shut off.

The majority of fume hood exhaust fans can be switched by the occupant via the fume hood's onboard controls.

New Wing

AHUs 5 and 8 provide conditioned make-up air offset fume hood exhaust from the labs in the South and North ends of the New Wing respectively.

There are 38 fume hoods in the lab spaces. Exhaust for each fume hood is provided by a dedicated exhaust fan, (typically ½-hp) equipped with a VFD, that dumps the exhaust air to the outside. All of the fume hood VFDs were operating at full speed (60 Hz) regardless of fume hood sash position. It is believed that the VFDs were not allowed to modulate in order to maintain the required velocity out of the fume hood stack to create a plume of the required height to disperse any contaminants.

The majority of fume hood exhaust fans can be switched by the occupant via the fume hood's onboard controls.

There have been a significant number of conversions of space from lab to office over the history of the building without proper management of the air balance in each wing. As a result, some fume hood exhaust fans are no longer dedicated to fume hoods but provide general exhaust from office or lab spaces. It was reported that the measurements of the face velocity at each fume hoods has not been undertaken in several years

Proposed Retrofit

Energy Ottawa recommends installing variable-air-volume, pressure-independent, venturi valves in the laboratory areas in the Old Wing to regulate exhaust airflow from the fume hoods and make-up airflow into each lab room while maintaining the necessary exhaust air flow and face velocity at each fume hood and in the exhaust stack. In the New Wing, since the VFDs o the exhaust fans cannot modulate, venturi valves should only be installed on the make-up air supplies to each room to modulate the fresh air brought into the building when fume hoods are shut off.

The system would consist of the following:

- A venturi valve at the exhaust of each fume hood (in the Old Wing only) will modulate the airflow provided by the fume hood exhaust fan based on sash position to maintain the required face velocity (typically between 0.3 m/s (60 feet/min) and 0.5 m/s (100 feet/min)). An occupancy sensor tied installed above the fume hood will allow for a reduction of the airflow to the lower end of the face velocity range.

- A panel display installed on each fume hood will provide feedback to the user on face velocity, whether the unit is in unoccupied mode, and an emergency exhaust option to put the fume hood to maximum flow.
- Each valve will provide feedback on valve position and airflow to a central controller via a peer-to-peer network of controllers to provide control of make-up air quantities into the building and into each lab for proper pressurization control.
- A venturi valve in the make-up air supply to each lab of the Old and New Wings, (provided by AHU-2 in Old Wing and AHUs 5 & 8 in New Wing), will regulate the static pressure in each lab by maintaining an adjustable volume differential (either positive or negative) between the total flows from the fume hoods in the lab and the make-up air to the lab (either from the make-up air units or from adjacent spaces).
- VFDs installed on the supply fans for AHU-2, AHU-5, and AHU-8 will modulate the flow of conditioned outdoor air provided to the labs based on the quantity of exhaust air from all of the fume hoods combined.

Electricity savings will be achieved by slowing down the fans in the make-up air units when the labs are unoccupied and/or multiple fume hoods have sashes set at a lower position. However, the majority of the energy savings will be reduced heating and cooling needs for conditioning outdoor air as the amount of make-up air is modulated based on sash position in all fume hoods. Significantly less energy savings will be achieved in the New Wing since fume hood exhaust fan flow is fixed in order to maintain the required velocity out of the stack; savings will be generated by reducing the fresh air supplied to the labs when fume hoods are shut off or the sashes are closed.

Due to the long history of renovations and changes to use of space, a review of the laboratory ventilation systems should be undertaken. Based on the results of the review, decommission any fume hoods that are no longer in use; disconnect any fume hoods serving office areas; verify face velocities at all fume hoods still in use; verify all make-up air and exhaust airflows to ensure sufficient capacities; and rebalance as needed. This process will help to minimize the installed cost of this measure while maximizing potential savings.

Savings	Cost Savings	Capital Cost	Payback
48,620 kWh	$4,534		
1,601 GJ HTHW	$53,126		
656 GJ Chilled Water	$16,706		
Total	$74,366	$436,810	5.9 yrs

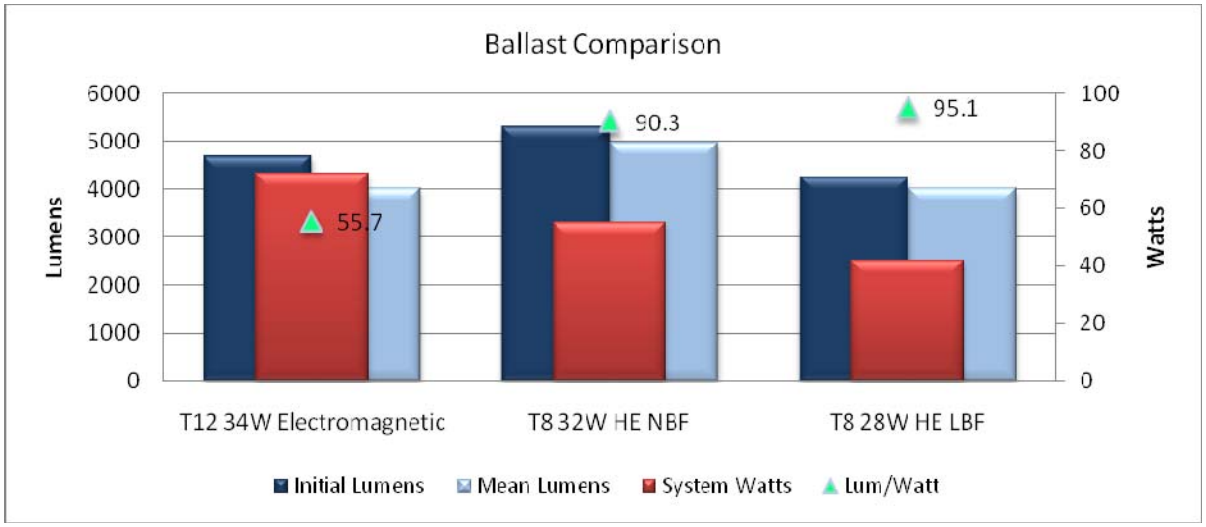
6.2 Category Two Measures

6.2.1 Lighting Retrofit

High Efficiency T8 Retrofit

The current electromagnetic ballasts driving T12 lamps draw significantly more power than their electronic counterparts. Energy Ottawa recommends that all standard output electromagnetic ballasts be converted to High Efficiency (HE) electronic ballasts.

HE Ballasts are available in both a Normal Ballast Factor (NBF) of 0.88, and a Low Ballast Factor (LBF) of 0.78. Lamps are typically chosen as either standard 32W or Super Saver 28W. The system output for various systems can be seen in the table below.



The following replacement lamp/ballast combination options are explored and illustrated in the graph above:

1. 32W T8 lamps with a NBF ballast
2. 28W T8 lamps with a LBF ballast

The existing lamp and ballast combination that is installed in this facility is a 34 watt T12 fluorescent lamp with electromagnetic ballast.

The lamp/ballast combination that provides a close match to the existing electromagnetic T12 lighting system is a 28 watt T8 fluorescent lamp(s) with high efficient (HE) LBF ballast. When we compare the T8 28W HE LBF system with the existing electromagnetic T12 system (T12 34W Electromagnetic), there is a 71% increase in efficiency (Lumens/Watt) with no difference in light output of the system (Mean Lumens). A second option that yields energy savings of 62% over the existing electromagnetic T12 system is a 32W T8 fluorescent lamp and HE NBF ballast. The main difference to this option is a 24% increase in light output compared to the existing electromagnetic T12 system.

Retrofit Options

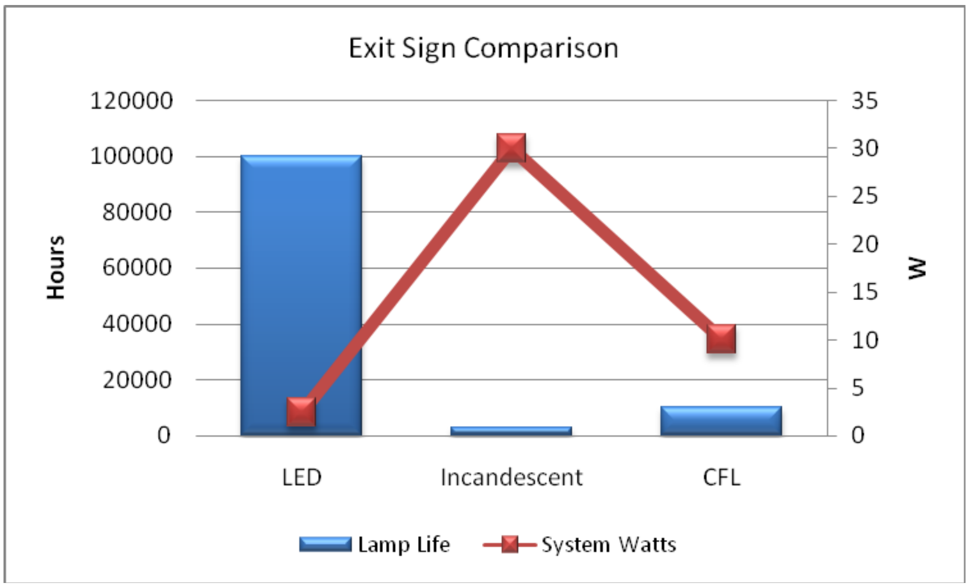
Appendix E details retrofitting all existing electromagnetic T12 to a 28W HE LBF system. Before any measure is implemented, it is recommended that a more detailed photometric study be performed to determine if the new lamp/ballast combination lumen output would be suitable for these applications. Also, it should be noted that all recommended ballasts are electronic ballasts and should be field tested to ensure no harmonic distortion or interference occurs.

Compact Fluorescent Lamps

In some storage areas and mechanical rooms there are 100W incandescent lamps. These lamps should be replaced their equivalent energy efficient compact fluorescent lamps.

LED Retrofit of Exit Signs

Exit signs that currently incorporate incandescent light sources should be converted to LED technology. LED lamps or panels consume minimal power (less than 3 watts), and have extremely long rated life. There are a variety of products that will work well with the various sign styles. LEDs provide a very reasonable payback period (approx 4 years) when examining simple payback on energy terms alone. These numbers are improved even further when considering the maintenance savings of a 30-fold increase in lamp life, despite more expensive replacement lamps. Lamp life varies from each manufacturer; the chart below identifies an estimated lamp life of 100,000 hours. Provision for converting incandescent exist signs to LED strips has been included in the capital cost of the project.



Lighting Summary

Based on the audit of the facility, and incorporating the recommended measures as defined, the savings, cost, and payback for the lighting retrofits are summarized in the table below. This summary is based on using the 28W T8 with LBF option for the High Efficiency T8 Retrofit. The estimated new total watts per square foot of Radiation Protection Building after all proposed measures are implemented is 0.07W/Ft2 (based on total connected lighting load divided by total building square footage).

Savings	Cost Savings	Capital Cost	Payback
168,529 kWh	$15,715	$101,275	6.4 yrs

According to the ERIP Prescriptive Lighting Project Guidelines for 2010, the total incentive for the above lighting measures is estimated to be $30,706.

6.2.2 Building Automation System – Old Wing

Current Conditions

The major mechanical systems in the Old Wing are controlled by standalone pneumatic or electric controls. The mechanical equipment serving the Old Wing is located in the penthouse mechanical room and are described in Section 5.

The stairwells and administration areas in the Old Wing are heated by perimeter hydronic radiation. The remainder of the Old Wing is heated by a dual duct boxes fed from AHU-1.

The administration and office areas are served by AHU – 1, a constant volume dual-duct air handler that delivers conditioned air to dual duct terminal boxes for ventilation, heating, and cooling. This unit is equipped with a supply fan, return fan, economizer, hot glycol for fresh air preheat, hot water coil for the hot deck, and chilled water coil for the cold deck.

All air-handling equipment runs 24/7 to maintain a constant zone temperature regardless of building occupancy.

Proposed Retrofit

Energy Ottawa recommends installing a DDC BAS to replace the pneumatic controls on the central equipment and on the pneumatic dual duct boxes in the zones. The new DDC system will allow the implementation of the following strategies:

- Install variable frequency drives (VFD) on supply and return fans for AHU-1 serving the office areas. Capital costs include the cost for output reactors to protect the fan motors from harmonics generated by the VFDs and for connecting the VFD to the building automation system.

  Slow down the VFDs on the fans to minimum speed during unoccupied hours according to a programmed operating schedule in the BAS that is based on the occupancy patterns of the building. Since heating for the office areas is provided by dual-duct boxes, airflow is required to provide heat during unoccupied hours in winter. The outdoor air dampers on AHU-1 would be closed during unoccupied hours to minimize heating and cooling energy requirements.

  All general exhaust fans and washroom exhaust fans should be scheduled off according to the same occupancy schedule. Install push-button overrides in appropriate zones to return AHU-1 to regular control for a pre-programmed period of time in the event that the space is used during unoccupied hours.

  The savings below are based on slowing down fan speed for 10 hours per night, 7 days per week. Consideration should be given to shutting off AHU-1 completely during shoulder and summer months.

- Setback space temperature at night to 18ºC (65ºF) to reduce heat loss through the building envelope by creating unoccupied setpoints in each zone via the DDC controls on each dual duct box.

  The pushbutton override described above would return the office spaces to the occupied setpoint for a pre-programmed period of time in the event that the space is used during unoccupied hours. Additional space temperature sensors would be installed in the office zones to ensure unoccupied space temperatures are adequate and that the building can recover in time for occupied hours.

- Install carbon dioxide (CO_2) sensors in the return air stream of AHU-1 serving the office areas. When the AHU is not in free cooling mode, control outdoor air dampers to maintain a maximum differential between CO_2 in the return air stream and outdoor CO_2 levels. HTHW and chilled water savings will be achieved by reducing the amount of outdoor air introduced into the space during periods of low occupancy.
- Implement a supply air temperature reset strategy for AHUs serving office and lab areas by polling the position of the dampers in each dual duct box and maintaining a supply air temperature setpoint at each AHU that minimizes the amount of heating required in the zones served by that AHU.
- Schedule off the domestic hot water circulation pump during unoccupied hours to reduce hot water piping losses.

Savings	Cost Savings	Capital Cost	Payback
223,006 kWh	$20,794		
391 GJ HTHW	$12,971		
188 GJ Chilled Water	$4,777		
Total	$38,542	$254,941	6.6 yrs

7. Appendix A – Utility Data

- **Electricity**
- **High-temperature Hot Water**
- **Chilled Water**
- **Natural Gas**
- **Water**

Utility Summary - Radiation Protection Building - 2009

2009 - 9,713 sq.m.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Cost													
Elec Cost	$ 25,316	$ 23,365	$ 25,760	$ 24,940	$ 25,740	$ 25,446	$ 25,188	$ 25,740	$ 24,542	$ 25,188	$ 24,542	$ 25,188	$300,953
Natural Gas Cost	$ 295	$ 178	$ 293	$ 226	$ 223	$ 139	$ 240	$ 190	$ 181	$ 198	$ 179	$ -	$2,343
HTHW Cost	$ 95,147	$ 68,047	$ 57,307	$ 26,806	$ 17,517	$ 4,883	$ 3,255	$ 17,517	$ 4,883	$ 11,393	$ 29,295	$ 65,100	$401,150
Chilled Water Cost	$ -	$ -	$ -	$ -	$ 15,385	$ 27,646	$ 33,124	$ 15,385	$ 16,562	$ 6,370	$ -	$ -	$114,471
Water Cost	$ 1,419	$ 1,056	$ 1,104	$ 1,413	$ 1,114	$ 385	$ 979	$ 204	$ 921	$ 833	$ 762	$ 792	$10,982
Total Cost	$122,177	$92,646	$84,464	$53,385	$59,980	$58,498	$62,785	$59,037	$47,088	$43,981	$54,777	$91,080	$829,898
Energy Consumption													
Electricity (kWh)	269,319	248,565	274,039	268,167	276,778	273,611	270,833	276,778	263,889	270,833	263,889	270,833	3,227,535
Natural Gas (equiv. kWh)	3,423	3,098	3,528	3,686	3,938	2,930	2,846	3,108	2,762	3,633	2,877	-	35,826
HTHW (equivalent kWh)	784,167	560,833	472,222	228,762	149,492	41,667	27,778	149,492	41,667	97,222	250,000	555,556	3,358,856
Chilled Water (equiv. kWh)	-	-	-	-	28,427	51,083	61,205	28,427	30,603	11,770	-	-	211,515
Total (kWh)	1,056,909	812,496	749,789	500,614	458,634	369,290	362,662	457,805	338,920	383,459	516,766	826,389	6,833,732
Water Consumption													
Water (m3)	556	415	433	504	398	138	350	73	329	298	272	283	4,048
Utility Cost per sq.m.													
Elec ($/sq.m.)	$2.61	$2.41	$2.65	$2.57	$2.65	$2.62	$2.59	$2.65	$2.53	$2.59	$2.53	$2.59	$30.99
Natural Gas ($/sq.m.)	$0.03	$0.02	$0.03	$0.02	$0.02	$0.01	$0.02	$0.02	$0.02	$0.02	$0.02	$0.00	$0.24
HTHW ($/sq.m.)	$9.80	$7.01	$5.90	$2.76	$1.80	$0.50	$0.34	$1.80	$0.50	$1.17	$3.02	$6.70	$41.30
Chilled Water ($/sq.m.)	$0.00	$0.00	$0.00	$0.00	$1.58	$2.85	$3.41	$1.58	$1.71	$0.66	$0.00	$0.00	$11.79
Water ($/sq.m.)	$0.15	$0.11	$0.11	$0.15	$0.11	$0.04	$0.10	$0.02	$0.09	$0.09	$0.08	$0.08	$1.13
Total ($/sq.m.)	$12.58	$9.54	$8.70	$5.50	$6.18	$6.02	$6.46	$6.08	$4.85	$4.53	$5.64	$9.38	$85.44
Energy Consump per sq.m.													
Elec (kWh/sq.m.)	27.7	25.6	28.2	27.6	28.5	28.2	27.9	28.5	27.2	27.9	27.2	27.9	332.3
Nat. gas (kWh/sq.m.)	0.4	0.3	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.4	0.3	0.0	3.7
HTHW (kWh/sq.m.)	80.7	57.7	48.6	23.6	15.4	4.3	2.9	15.4	4.3	10.0	25.7	57.2	345.8
Chilled Water (kWh/sq.m.)	0.0	0.0	0.0	0.0	2.9	5.3	6.3	2.9	3.2	1.2	0.0	0.0	21.8
Total (kWh/sq.m.)	108.8	83.7	77.2	51.5	47.2	38.0	37.3	47.1	34.9	39.5	53.2	85.1	703.6
Water Consumption per sq.m.													
Water (litres/sq.m.)	57.2	42.7	44.6	51.9	41.0	14.2	36.0	7.5	33.9	30.6	28.0	29.1	416.8
(1 m3 = 1000 litres)													

For comparison purposes only, the assumed efficiency of the chiller plant is 0.6 kW/ton. This is equivalent to a COP of 5.9 (the ratio of energy output to energy input). Therefore, the conversion from GJ to equivalent kWh is: 1 GJ output / 5.9 x 277.78 kWh/GJ = 47 kWh.

Utility Summary - Radiation Protection Building - 2008

2008 - 9,713 sq.m.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Cost													
Elec Cost	$ 27,328	$ 25,284	$ 26,542	$ 24,923	$ 25,664	$ 24,789	$ 25,502	$ 25,811	$ 25,183	$ 25,965	$ 24,738	$ 25,607	$307,337
Natural Gas Cost	$ 204	$ 146	$ 186	$ 181	$ 195	$ 202	$ 212	$ 172	$ 299	$ 253	$ 739	$ 206	$2,994
HTHW Cost	$ 56,595	$ 61,615	$ 53,380	$ 19,482	$ 10,472	$ 4,090	$ 3,722	$ 4,013	$ 5,769	$ 20,366	$ 37,181	$ 75,795	$352,481
Chilled Water Cost	$ -	$ -	$ -	$ 3,050	$ 6,486	$ 27,757	$ 33,683	$ 27,423	$ 19,983	$ 9,285	$ 6,616	$ -	$134,283
Water Cost	$ 1,278	$ 1,078	$ 1,041	$ 1,218	$ 1,038	$ 1,181	$ 1,047	$ 904	$ 831	$ 977	$ 1,607	$ 1,610	$13,809
Total Cost	$85,405	$88,123	$81,149	$48,854	$43,856	$58,018	$64,166	$58,323	$52,065	$56,846	$70,881	$103,219	$810,905
Energy Consumption													
Electricity (kWh)	278,853	258,001	270,833	265,143	273,025	263,710	271,295	274,588	267,905	276,224	263,175	272,420	3,235,174
Natural Gas (equiv. kWh)	3,528	3,318	3,108	4,106	3,171	4,557	2,856	2,657	3,056	4,253	12,873	3,339	50,820
HTHW (equivalent kWh)	500,556	545,000	472,222	160,539	86,295	33,699	30,673	33,071	47,537	167,817	306,382	624,570	3,008,360
Chilled Water (equiv. kWh)	-	-	-	5,743	12,215	52,273	63,433	51,644	37,633	17,486	12,460	-	252,888
Total (kWh)	782,937	806,319	746,164	435,530	374,706	354,239	368,257	361,959	356,130	465,780	594,890	900,329	6,547,242
Water Consumption													
Water (m3)	522	440	425	478	407	463	411	355	326	383	630	631	5,470
Utility Cost per sq.m.													
Elec ($/sq.m.)	$2.81	$2.60	$2.73	$2.57	$2.64	$2.55	$2.63	$2.66	$2.59	$2.67	$2.55	$2.64	$31.64
Natural Gas ($/sq.m.)	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.03	$0.03	$0.08	$0.02	$0.31
HTHW ($/sq.m.)	$5.83	$6.34	$5.50	$2.01	$1.08	$0.42	$0.38	$0.41	$0.59	$2.10	$3.83	$7.80	$36.29
Chilled Water ($/sq.m.)	$0.00	$0.00	$0.00	$0.31	$0.67	$2.86	$3.47	$2.82	$2.06	$0.96	$0.68	$0.00	$13.83
Water ($/sq.m.)	$0.13	$0.11	$0.11	$0.13	$0.11	$0.12	$0.11	$0.09	$0.09	$0.10	$0.17	$0.17	$1.42
Total ($/sq.m.)	$8.79	$9.07	$8.35	$5.03	$4.52	$5.97	$6.61	$6.00	$5.36	$5.85	$7.30	$10.63	$83.49
Energy Consump per sq.m.													
Elec (kWh/sq.m.)	28.7	26.6	27.9	27.3	28.1	27.2	27.9	28.3	27.6	28.4	27.1	28.0	333.1
Nat. gas (kWh/sq.m.)	0.4	0.3	0.3	0.4	0.3	0.5	0.3	0.3	0.3	0.4	1.3	0.3	5.2
HTHW (kWh/sq.m.)	51.5	56.1	48.6	16.5	8.9	3.5	3.2	3.4	4.9	17.3	31.5	64.3	309.7
Chilled Water (kWh/sq.m.)	0.0	0.0	0.0	0.6	1.3	5.4	6.5	5.3	3.9	1.8	1.3	0.0	26.0
Total (kWh/sq.m.)	80.6	83.0	76.8	44.8	38.6	36.5	37.9	37.3	36.7	48.0	61.2	92.7	674.1
Water Consumption per sq.m.													
Water (litres/sq.m.)	53.7	45.3	43.8	49.2	41.9	47.7	42.3	36.5	33.6	39.4	64.9	65.0	563.2
(1 m3 = 1000 litres)													

For comparison purposes only, the assumed efficiency of the chiller plant is 0.6 kW/ton. This is equivalent to a COP of 5.9 (the ratio of energy output to energy input). Therefore, the conversion from GJ to equivalent kWh is: 1 GJ output / 5.9 x 277.78 kWh/GJ = 47 kWh.

Utility Summary - Radiation Protection Building - 2007

2007 - 9,713 sq.m.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Cost													
Elec Cost	$ 31,190	$ 28,195	$ 30,278	$ 27,543	$ 26,977	$ 25,594	$ 26,932	$ 25,317	$ 25,429	$ 26,464	$ 26,396	$ 27,448	$327,763
Natural Gas Cost	$ 363	$ 148	$ 195	$ 147	$ 179	$ 117	$ 175	$ 121	$ 165	$ 119	$ 186	$ 191	$2,107
HTHW Cost	$ 54,406	$ 68,678	$ 60,287	$ 27,296	$ 9,091	$ 5,665	$ 3,950	$ 2,983	$ 4,169	$ 11,019	$ 41,434	$ 56,721	$345,700
Chilled Water Cost	$ -	$ -	$ -	$ 2,616	$ 13,367	$ 25,059	$ 27,787	$ 22,330	$ 16,125	$ 7,784	$ -	$ -	$115,068
Water Cost	$ 1,215	$ 1,067	$ 1,088	$ 1,016	$ 870	$ 968	$ 894	$ 887	$ 889	$ 909	$ 1,977	$ 1,275	$13,055
Total Cost	$87,174	$98,088	$91,848	$58,617	$50,485	$57,403	$59,738	$51,637	$46,778	$46,296	$69,993	$85,635	$803,693
Energy Consumption													
Electricity (kWh)	286,150	258,668	277,778	281,050	275,278	261,165	274,816	258,333	259,483	270,045	269,349	280,078	3,252,193
Natural Gas (equiv. kWh)	8,390	2,993	3,056	3,003	2,667	2,279	2,646	2,520	3,045	2,468	2,961	4,326	40,352
HTHW (equivalent kWh)	476,389	601,111	527,778	241,472	80,424	50,115	34,946	26,389	36,882	97,483	366,540	501,782	3,041,311
Chilled Water (equiv. kWh)	-	-	-	5,515	28,184	52,835	58,586	47,081	33,998	16,411	-	-	242,611
Total (kWh)	770,928	862,772	808,611	531,040	386,553	366,393	370,994	334,323	333,409	386,407	638,850	786,186	6,576,466
Water Consumption													
Water (m3)	492	432	441	415	355	395	365	362	363	371	807	521	5,317
Utility Cost per sq.m.													
Elec ($/sq.m.)	$3.21	$2.90	$3.12	$2.84	$2.78	$2.64	$2.77	$2.61	$2.62	$2.72	$2.72	$2.83	$33.75
Natural Gas ($/sq.m.)	$0.04	$0.02	$0.02	$0.02	$0.02	$0.01	$0.02	$0.01	$0.02	$0.01	$0.02	$0.02	$0.22
HTHW ($/sq.m.)	$5.60	$7.07	$6.21	$2.81	$0.94	$0.58	$0.41	$0.31	$0.43	$1.13	$4.27	$5.84	$35.59
Chilled Water ($/sq.m.)	$0.00	$0.00	$0.00	$0.27	$1.38	$2.58	$2.86	$2.30	$1.66	$0.80	$0.00	$0.00	$11.85
Water ($/sq.m.)	$0.13	$0.11	$0.11	$0.10	$0.09	$0.10	$0.09	$0.09	$0.09	$0.09	$0.20	$0.13	$1.34
Total ($/sq.m.)	$8.98	$10.10	$9.46	$6.04	$5.20	$5.91	$6.15	$5.32	$4.82	$4.77	$7.21	$8.82	$82.75
Energy Consump per sq.m.													
Elec (kWh/sq.m.)	29.5	26.6	28.6	28.9	28.3	26.9	28.3	26.6	26.7	27.8	27.7	28.8	334.8
Nat. gas (kWh/sq.m.)	0.9	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.4	4.2
HTHW (kWh/sq.m.)	49.0	61.9	54.3	24.9	8.3	5.2	3.6	2.7	3.8	10.0	37.7	51.7	313.1
Chilled Water (kWh/sq.m.)	0.0	0.0	0.0	0.6	2.9	5.4	6.0	4.8	3.5	1.7	0.0	0.0	25.0
Total (kWh/sq.m.)	79.4	88.8	83.3	54.7	39.8	37.7	38.2	34.4	34.3	39.8	65.8	80.9	677.1
Water Consumption per sq.m.													
Water (litres/sq.m.)	50.6	44.5	45.4	42.7	36.5	40.7	37.6	37.3	37.4	38.2	83.1	53.6	547.5
(1 m3 = 1000 litres)													

For comparison purposes only, the assumed efficiency of the chiller plant is 0.6 kW/ton. This is equivalent to a COP of 5.9 (the ratio of energy output to energy input). Therefore, the conversion from GJ to equivalent kWh is: 1 GJ output / 5.9 x 277.78 kWh/GJ = 47 kWh.

Utility Summary - Radiation Protection Building - 2006

2006 - 9,713 sq.m.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Cost													
Elec Cost	$ 24,896	$ 22,686	$ 25,434	$ 30,032	$ 31,044	$ 28,158	$ 30,205	$ 29,488	$ 28,785	$ 30,241	$ 30,250	$ 31,146	$342,364
Natural Gas Cost	$ 180	$ 198	$ 225	$ 186	$ 172	$ 171	$ 223	$ 143	$ 138	$ 140	$ 932	$ 486	$3,194
HTHW Cost	$ 58,616	$ 51,913	$ 51,363	$ 6,778	$ 14,926	$ 3,522	$ 1,542	$ 4,071	$ 8,721	$ 11,823	$ 12,295	$ 39,515	$265,085
Chilled Water Cost	$ -	$ -	$ -	$ 3,648	$ 18,403	$ 23,903	$ 34,116	$ 27,770	$ 18,002	$ 5,822	$ -	$ -	$131,664
Water Cost	$ 1,340	$ 1,079	$ 1,225	$ 1,182	$ 1,149	$ 1,186	$ 1,186	$ 1,186	$ 1,186	$ 1,247	$ 1,162	$ 1,247	$14,374
Total Cost	$85,032	$75,876	$78,246	$41,826	$65,693	$56,940	$67,272	$62,657	$56,832	$49,274	$44,639	$72,393	$756,681
Energy Consumption													
Electricity (kWh)	292,889	266,897	299,222	275,522	284,808	258,333	277,111	270,528	264,081	277,444	277,522	285,739	3,330,097
Natural Gas (equiv. kWh)	3,308	2,930	3,423	2,972	2,804	2,772	4,179	2,520	2,384	2,667	27,437	13,251	70,644
HTHW (equivalent kWh)	647,778	573,611	567,500	59,342	130,669	30,833	13,500	35,639	76,347	103,500	107,633	345,928	2,692,280
Chilled Water (equiv. kWh)	-	-	-	7,616	38,422	49,906	71,229	57,980	37,586	12,156	-	-	274,895
Total (kWh)	943,974	843,438	870,145	345,451	456,702	341,845	366,019	366,667	380,397	395,768	412,592	644,918	6,367,916
Water Consumption													
Water (m3)	695	559	635	479	465	480	480	480	480	505	470	505	6,232
Utility Cost per sq.m.													
Elec ($/sq.m.)	$2.56	$2.34	$2.62	$3.09	$3.20	$2.90	$3.11	$3.04	$2.96	$3.11	$3.11	$3.21	$35.25
Natural Gas ($/sq.m.)	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.01	$0.01	$0.01	$0.10	$0.05	$0.33
HTHW ($/sq.m.)	$6.03	$5.34	$5.29	$0.70	$1.54	$0.36	$0.16	$0.42	$0.90	$1.22	$1.27	$4.07	$27.29
Chilled Water ($/sq.m.)	$0.00	$0.00	$0.00	$0.38	$1.89	$2.46	$3.51	$2.86	$1.85	$0.60	$0.00	$0.00	$13.56
Water ($/sq.m.)	$0.14	$0.11	$0.13	$0.12	$0.12	$0.12	$0.12	$0.12	$0.12	$0.13	$0.12	$0.13	$1.48
Total ($/sq.m.)	$8.75	$7.81	$8.06	$4.31	$6.76	$5.86	$6.93	$6.45	$5.85	$5.07	$4.60	$7.45	$77.91
Energy Consump per sq.m.													
Elec (kWh/sq.m.)	30.2	27.5	30.8	28.4	29.3	26.6	28.5	27.9	27.2	28.6	28.6	29.4	342.9
Nat. gas (kWh/sq.m.)	0.3	0.3	0.4	0.3	0.3	0.3	0.4	0.3	0.2	0.3	2.8	1.4	7.3
HTHW (kWh/sq.m.)	66.7	59.1	58.4	6.1	13.5	3.2	1.4	3.7	7.9	10.7	11.1	35.6	277.2
Chilled Water (kWh/sq.m.)	0.0	0.0	0.0	0.8	4.0	5.1	7.3	6.0	3.9	1.3	0.0	0.0	28.3
Total (kWh/sq.m.)	97.2	86.8	89.6	35.6	47.0	35.2	37.7	37.8	39.2	40.7	42.5	66.4	655.6
Water Consumption per sq.m.													
Water (litres/sq.m.)	71.5	57.6	65.3	49.3	47.9	49.4	49.4	49.4	49.4	52.0	48.4	52.0	641.6
(1 m3 = 1000 litres)													

For comparison purposes only, the assumed efficiency of the chiller plant is 0.6 kW/ton. This is equivalent to a COP of 5.9 (the ratio of energy output to energy input). Therefore, the conversion from GJ to equivalent kWh is: 1 GJ output / 5.9 x 277.78 kWh/GJ = 47 kWh.

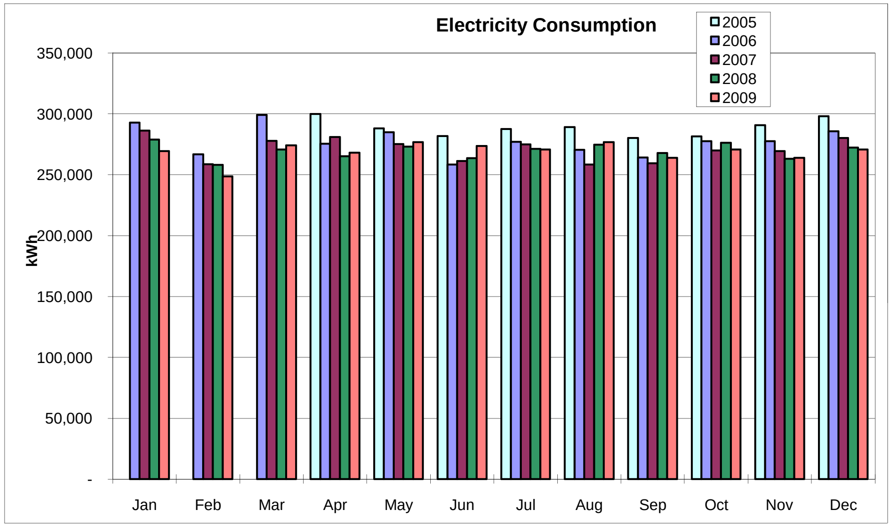
Utility Summary - Radiation Protection Building - 2005

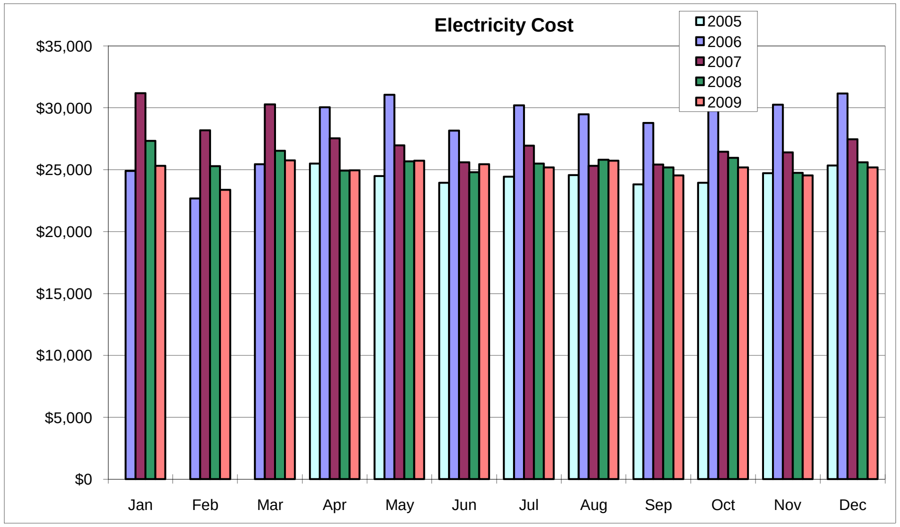
2005 - 9,713 sq.m.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Cost													
Elec Cost				$ 25,498	$ 24,480	$ 23,954	$ 24,445	$ 24,572	$ 23,813	$ 23,939	$ 24,708	$ 25,333	$220,741
Natural Gas Cost				$ 167	$ 112	$ 127	$ 121	$ 128	$ 147	$ 153	$ 160	$ 161	$1,276
HTHW Cost				$ 11,185	$ 3,525	$ 294	$ -	$ 910	$ 1,475	$ 8,358	$ 17,340	$ 50,598	$93,685
Chilled Water Cost				$ 4,436	$ 10,954	$ 32,043	$ 34,874	$ 32,339	$ 21,979	$ 10,580	$ -	$ -	$147,205
Water Cost				$ 1,115	$ 876	$ 811	$ 834	$ 928	$ 875	$ 917	$ 967	$ 1,157	$8,479
Total Cost				$42,400	$39,947	$57,228	$60,274	$58,877	$48,290	$43,947	$43,175	$77,250	$471,387
Energy Consumption													
Electricity (kWh)				299,972	288,000	281,806	287,583	289,083	280,153	281,636	290,683	298,039	2,596,955
Natural Gas (equiv. kWh)				3,843	2,562	2,993	2,615	2,730	3,224	2,699	2,835	2,856	26,355
HTHW (equivalent kWh)				123,583	38,944	3,250	-	10,056	16,303	92,347	191,592	559,072	1,035,147
Chilled Water (equiv. kWh)				10,946	27,029	79,068	86,055	79,798	54,234	26,108	-	-	363,238
Total (kWh)				438,345	356,536	367,116	376,252	381,666	353,914	402,790	485,110	859,967	4,021,695
Water Consumption													
Water (m3)				578	454	420	432	481	454	475	501	600	4,394
Utility Cost per sq.m.													
Elec ($/sq.m.)				$2.63	$2.52	$2.47	$2.52	$2.53	$2.45	$2.46	$2.54	$2.61	$22.73
Natural Gas ($/sq.m.)				$0.02	$0.01	$0.01	$0.01	$0.01	$0.02	$0.02	$0.02	$0.02	$0.13
HTHW ($/sq.m.)				$1.15	$0.36	$0.03	$0.00	$0.09	$0.15	$0.86	$1.79	$5.21	$9.65
Chilled Water ($/sq.m.)				$0.46	$1.13	$3.30	$3.59	$3.33	$2.26	$1.09	$0.00	$0.00	$15.16
Water ($/sq.m.)				$0.11	$0.09	$0.08	$0.09	$0.10	$0.09	$0.09	$0.10	$0.12	$0.87
Total ($/sq.m.)				$4.37	$4.11	$5.89	$6.21	$6.06	$4.97	$4.52	$4.45	$7.95	$48.53
Energy Consump per sq.m.													
Elec (kWh/sq.m.)				30.9	29.7	29.0	29.6	29.8	28.8	29.0	29.9	30.7	267.4
Nat. gas (kWh/sq.m.)				0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	2.7
HTHW (kWh/sq.m.)				12.7	4.0	0.3	0.0	1.0	1.7	9.5	19.7	57.6	106.6
Chilled Water (kWh/sq.m.)				1.1	2.8	8.1	8.9	8.2	5.6	2.7	0.0	0.0	37.4
Total (kWh/sq.m.)				45.1	36.7	37.8	38.7	39.3	36.4	41.5	49.9	88.5	414.1
Water Consumption per sq.m.													
Water (litres/sq.m.)				59.5	46.7	43.2	44.5	49.5	46.7	48.9	51.6	61.7	452.3
(1 m3 = 1000 litres)													

For comparison purposes only, the assumed efficiency of the chiller plant is 0.6 kW/ton. This is equivalent to a COP of 5.9 (the ratio of energy output to energy input). Therefore, the conversion from GJ to equivalent kWh is: 1 GJ output / 5.9 x 277.78 kWh/GJ = 47 kWh.

Radiation Protection Building
Electricity Consumption and Cost History

	2005		2006		2007		2008		2009	
	Consump kWh	Cost	Consump kWh	Cost	Consump kWh	Cost	Consump kWh	Cost	Consump kWh	Cost
Jan	-	$0	292,889	$24,896	286,150	$31,190	278,853	$27,328	269,319	$25,316
Feb	-	$0	266,897	$22,686	258,668	$28,195	258,001	$25,284	248,565	$23,365
Mar	-	$0	299,222	$25,434	277,778	$30,278	270,833	$26,542	274,039	$25,760
Apr	299,972	$25,498	275,522	$30,032	281,050	$27,543	265,143	$24,923	268,167	$24,940
May	288,000	$24,480	284,808	$31,044	275,278	$26,977	273,025	$25,664	276,778	$25,740
Jun	281,806	$23,954	258,333	$28,158	261,165	$25,594	263,710	$24,789	273,611	$25,446
Jul	287,583	$24,445	277,111	$30,205	274,816	$26,932	271,295	$25,502	270,833	$25,188
Aug	289,083	$24,572	270,528	$29,488	258,333	$25,317	274,588	$25,811	276,778	$25,740
Sep	280,153	$23,813	264,081	$28,785	259,483	$25,429	267,905	$25,183	263,889	$24,542
Oct	281,636	$23,939	277,444	$30,241	270,045	$26,464	276,224	$25,965	270,833	$25,188
Nov	290,683	$24,708	277,522	$30,250	269,349	$26,396	263,175	$24,738	263,889	$24,542
Dec	298,039	$25,333	285,739	$31,146	280,078	$27,448	272,420	$25,607	270,833	$25,188
Total	2,596,955	$220,741	3,330,097	$342,364	3,252,193	$327,763	3,235,174	$307,337	3,227,535	$300,953





Radiation Protection Building - Electricity Consumption and Cost

2005	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Date													
Cost				$25,498	$24,480	$23,954	$24,445	$24,572	$23,813	$23,939	$24,708	$25,333	$220,741
Consump (kWh)				299,972	288,000	281,806	287,583	289,083	280,153	281,636	290,683	298,039	2,596,955
# of days				0	0	0	0	0	0	0	0	0	0
GHG (tonnes)				42	40	39	40	40	39	39	41	42	363
Unit Cost ($/kWh)				$0.085	$0.085	$0.085	$0.085	$0.085	$0.085	$0.085	$0.085	$0.085	$0.085

2006	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Date													
Cost	$24,896	$22,686	$25,434	$30,032	$31,044	$28,158	$30,205	$29,488	$28,785	$30,241	$30,250	$31,146	$342,364
Consump (kWh)	292,889	266,897	299,222	275,522	284,808	258,333	277,111	270,528	264,081	277,444	277,522	285,739	3,330,097
# of days	0	0	0	0	0	0	0	0	0	0	0	0	0
GHG (tonnes)	41	37	42	38	40	36	39	38	37	39	39	40	465
Unit Cost ($/kWh)	$0.085	$0.085	$0.085	$0.109	$0.109	$0.109	$0.109	$0.109	$0.109	$0.109	$0.109	$0.109	$0.103

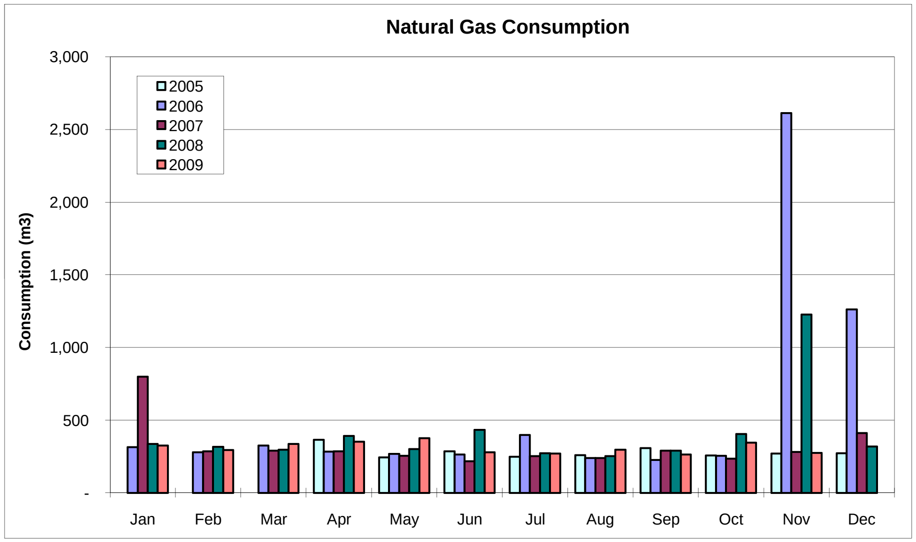
2007	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Date													
Cost	$31,190	$28,195	$30,278	$27,543	$26,977	$25,594	$26,932	$25,317	$25,429	$26,464	$26,396	$27,448	$327,763
Consump (kWh)	286,150	258,668	277,778	281,050	275,278	261,165	274,816	258,333	259,483	270,045	269,349	280,078	3,252,193
# of days	0	0	0	0	0	0	0	0	0	0	0	0	0
GHG (tonnes)	40	36	39	39	38	36	38	36	36	38	38	39	454
Unit Cost ($/kWh)	$0.109	$0.109	$0.109	$0.098	$0.098	$0.098	$0.098	$0.098	$0.098	$0.098	$0.098	$0.098	$0.101

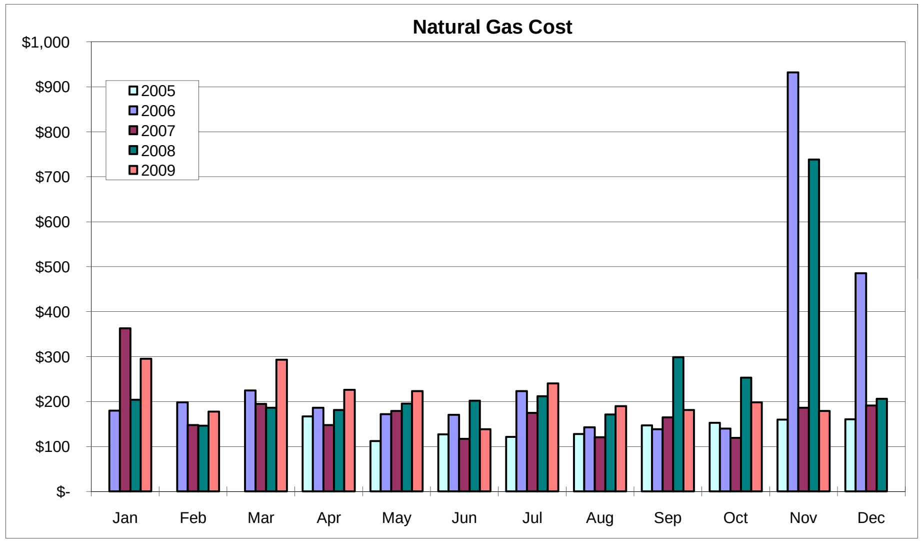
2008	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Date													
Cost	$27,328	$25,284	$26,542	$24,923	$25,664	$24,789	$25,502	$25,811	$25,183	$25,965	$24,738	$25,607	$307,337
Consump (kWh)	278,853	258,001	270,833	265,143	273,025	263,710	271,295	274,588	267,905	276,224	263,175	272,420	3,235,174
# of days	0	0	0	0	0	0	0	0	0	0	0	0	0
GHG (tonnes)	39	36	38	37	38	37	38	38	37	39	37	38	452
Unit Cost ($/kWh)	$0.098	$0.098	$0.098	$0.094	$0.094	$0.094	$0.094	$0.094	$0.094	$0.094	$0.094	$0.094	$0.095

2009	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Date													
Cost	$25,316	$23,365	$25,760	$24,940	$25,740	$25,446	$25,188	$25,740	$24,542	$25,188	$24,542	$25,188	$300,953
Consump (kWh)	269,319	248,565	274,039	268,167	276,778	273,611	270,833	276,778	263,889	270,833	263,889	270,833	3,227,535
# of days	0	0	0	0	0	0	0	0	0	0	0	0	0
GHG (tonnes)	38	35	38	37	39	38	38	39	37	38	37	38	451
Unit Cost ($/kWh)	$0.094	$0.094	$0.094	$0.093	$0.093	$0.093	$0.093	$0.093	$0.093	$0.093	$0.093	$0.093	$0.093

Radiation Protection Building
Natural Gas Consumption and Cost History

	2005			2006			2007			2008			2009		
	Consump (m^3)	Cost		Consump (m^3)	Cost		Consump (m^3)	Cost		Consump (m^3)	Cost		Consump (m^3)	Cost	
Jan	-	$	-	315	$	180	799	$	363	336	$	204	326	$	295
Feb	-	$	-	279	$	198	285	$	148	316	$	146	295	$	178
Mar	-	$	-	326	$	225	291	$	195	296	$	186	336	$	293
Apr	366	$	167	283	$	186	286	$	147	391	$	181	351	$	226
May	244	$	112	267	$	172	254	$	179	302	$	195	375	$	223
Jun	285	$	127	264	$	171	217	$	117	434	$	202	279	$	139
Jul	249	$	121	398	$	223	252	$	175	272	$	212	271	$	240
Aug	260	$	128	240	$	143	240	$	121	253	$	172	296	$	190
Sep	307	$	147	227	$	138	290	$	165	291	$	299	263	$	181
Oct	257	$	153	254	$	140	235	$	119	405	$	253	346	$	198
Nov	270	$	160	2,613	$	932	282	$	186	1,226	$	739	274	$	179
Dec	272	$	161	1,262	$	486	412	$	191	318	$	206	-	$	-
Total	2,510	$	1,276	6,728	$	3,194	3,843	$	2,107	4,840	$	2,994	3,412	$	2,343





Radiation Protection Building - Gas Consumption and Cost

2005	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Read Date													
Cost				$167	$112	$127	$121	$128	$147	$153	$160	$161	$1,276
Consump (m3)				366	244	285	249	260	307	257	270	272	2,510
# of days	0	0	0	0	0	0	0	0	0	0	0	0	0
Unit Cost				$0.46	$0.46	$0.45	$0.49	$0.49	$0.48	$0.59	$0.59	$0.59	$0.51

2006	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Read Date													
Cost	$180	$198	$225	$186	$172	$171	$223	$143	$138	$140	$932	$486	$3,194
Consump (m3)	315	279	326	283	267	264	398	240	227	254	2,613	1,262	6,728
# of days	0	0	0	0	0	0	0	0	0	0	0	0	0
Unit Cost	$0.57	$0.71	$0.69	$0.66	$0.64	$0.65	$0.56	$0.60	$0.61	$0.55	$0.36	$0.38	$0.47

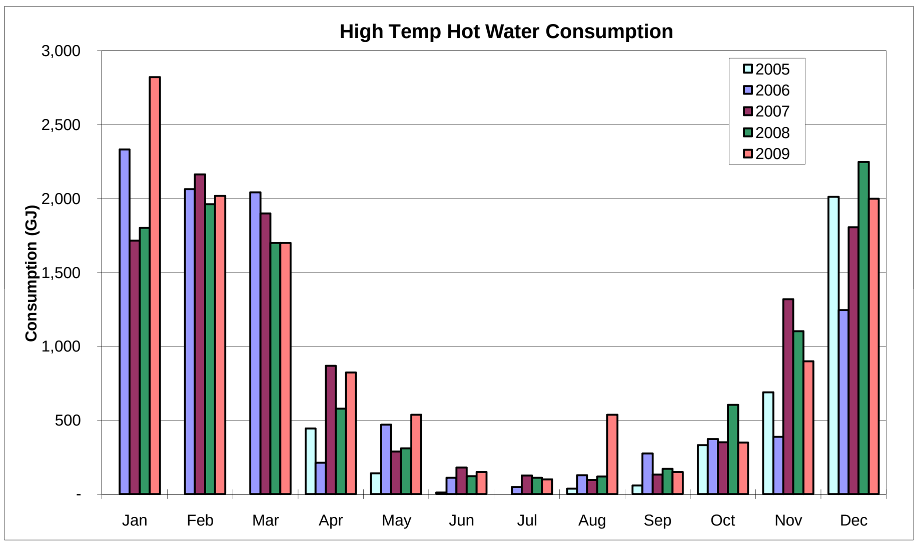
2007	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Read Date													
Cost	$363	$148	$195	$147	$179	$117	$175	$121	$165	$119	$186	$191	$2,107
Consump (m3)	799	285	291	286	254	217	252	240	290	235	282	412	3,843
# of days	0	0	0	0	0	0	0	0	0	0	0	31	31
Unit Cost	$0.45	$0.52	$0.67	$0.52	$0.71	$0.54	$0.69	$0.50	$0.57	$0.51	$0.66	$0.46	$0.55

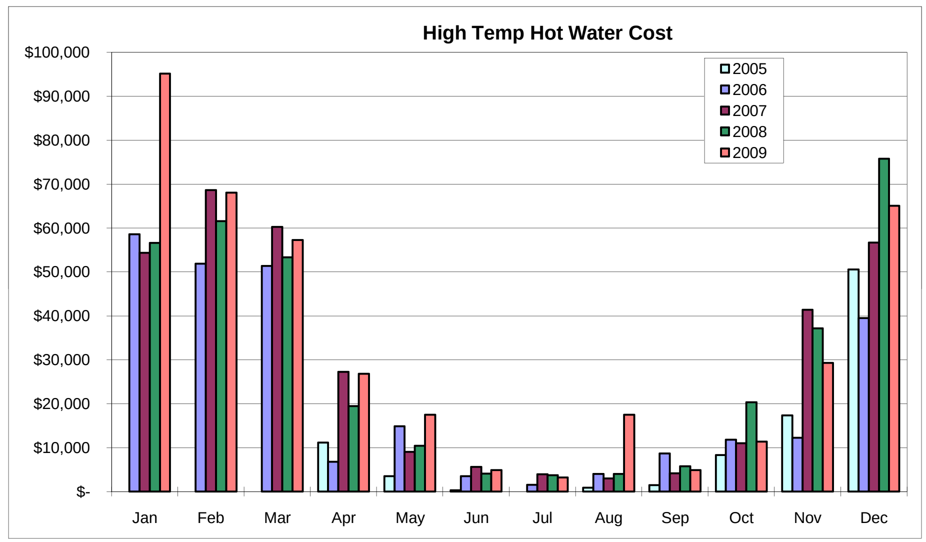
2008	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Read Date													
Cost	$204	$146	$186	$181	$195	$202	$212	$172	$299	$253	$739	$206	$2,994
Consump (m3)	336	316	296	391	302	434	272	253	291	405	1,226	318	4,840
# of days	0	0	0	0	0	0	0	0	0	0	0	0	0
Unit Cost	$0.61	$0.46	$0.63	$0.46	$0.65	$0.46	$0.78	$0.68	$1.03	$0.63	$0.60	$0.65	$0.62

2009	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Read Date													
Cost	$295	$178	$293	$226	$223	$139	$240	$190	$181	$198	$179		$2,343
Consump (m3)	326	295	336	351	375	279	271	296	263	346	274		3,412
# of days	0	0	0	0	0	0	0						0
Unit Cost	$0.90	$0.60	$0.87	$0.65	$0.60	$0.50	$0.89	$0.64	$0.69	$0.57	$0.65		$0.69

Radiation Protection Building
High Temp Hot Water Consumption and Cost History

	2005		2006		2007		2008		2009	
	Consump (GJ)	Cost	Consump (GJ)	Cost	Consump (GJ)	Cost	Consump (GJ)	Cost	Consump (GJ)	Cost
Jan	-	$ -	2,332	$ 58,616	1,715	$ 54,406	1,802	$ 56,595	2,823	$ 95,147
Feb	-	$ -	2,065	$ 51,913	2,164	$ 68,678	1,962	$ 61,615	2,019	$ 68,047
Mar	-	$ -	2,043	$ 51,363	1,900	$ 60,287	1,700	$ 53,380	1,700	$ 57,307
Apr	445	$ 11,185	214	$ 6,778	869	$ 27,296	578	$ 19,482	824	$ 26,806
May	140	$ 3,525	470	$ 14,926	290	$ 9,091	311	$ 10,472	538	$ 17,517
Jun	12	$ 294	111	$ 3,522	180	$ 5,665	121	$ 4,090	150	$ 4,883
Jul	-	$ -	49	$ 1,542	126	$ 3,950	110	$ 3,722	100	$ 3,255
Aug	36	$ 910	128	$ 4,071	95	$ 2,983	119	$ 4,013	538	$ 17,517
Sep	59	$ 1,475	275	$ 8,721	133	$ 4,169	171	$ 5,769	150	$ 4,883
Oct	332	$ 8,358	373	$ 11,823	351	$ 11,019	604	$ 20,366	350	$ 11,393
Nov	690	$ 17,340	387	$ 12,295	1,320	$ 41,434	1,103	$ 37,181	900	$ 29,295
Dec	2,013	$ 50,598	1,245	$ 39,515	1,806	$ 56,721	2,248	$ 75,795	2,000	$ 65,100
Total	**3,727**	**$ 93,685**	**9,692**	**$ 265,085**	**10,949**	**$ 345,700**	**10,830**	**$ 352,481**	**12,092**	**$ 401,150**





Radiation Protection Building - High Temp Hot Water Consumption and Cost

2005	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Reading Date													
Total Cost				$11,185	$3,525	$294	$0	$910	$1,475	$8,358	$17,340	$50,598	$93,685
Consump (GJ)				445	140	12	0	36	59	332	690	2,013	3,727
# of days				0	0	0	0	0	0	0	0	0	0
GHG (tonnes)				46	14	1	0	4	6	34	71	207	383
Unit Cost ($/GJ)				$25.140	$25.140	$25.140		$25.140	$25.140	$25.140	$25.140	$25.140	$25.140

2006	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Reading Date													
Total Cost	$58,616	$51,913	$51,363	$6,778	$14,926	$3,522	$1,542	$4,071	$8,721	$11,823	$12,295	$39,515	$265,085
Consump (GJ)	2,332	2,065	2,043	214	470	111	49	128	275	373	387	1,245	9,692
# of days	0	0	0	0	0	0	0	0	0	0	0	0	0
GHG (tonnes)	239	212	210	22	48	11	5	13	28	38	40	128	995
Unit Cost ($/GJ)	$25.136	$25.139	$25.141	$31.730	$31.730	$31.730	$31.730	$31.730	$31.730	$31.730	$31.730	$31.730	$27.350

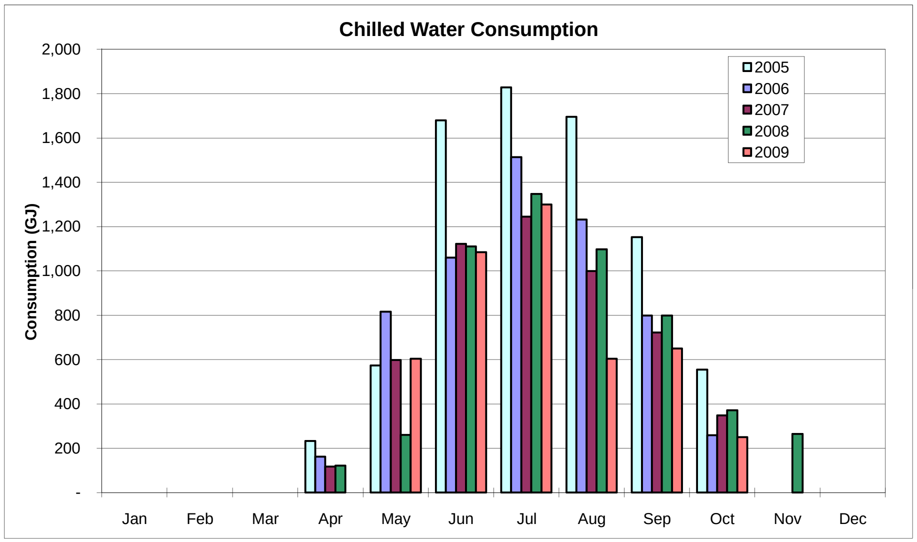
2007	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Reading Date													
Total Cost	$54,406	$68,678	$60,287	$27,296	$9,091	$5,665	$3,950	$2,983	$4,169	$11,019	$41,434	$56,721	$345,700
Consump (GJ)	1,715	2,164	1,900	869	290	180	126	95	133	351	1,320	1,806	10,949
# of days	0	0	0	0	0	0	0	0	0	0	0	0	0
GHG (tonnes)	176	222	195	89	30	19	13	10	14	36	136	186	1,124
Unit Cost ($/GJ)	$31.724	$31.737	$31.730	$31.400	$31.400	$31.400	$31.400	$31.400	$31.400	$31.400	$31.400	$31.400	$31.574

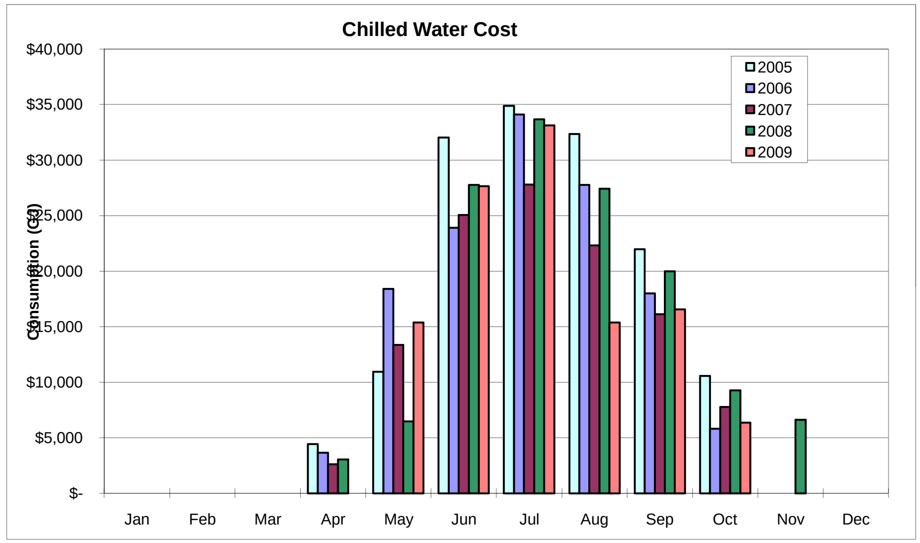
2008	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Reading Date													
Total Cost	$56,595	$61,615	$53,380	$19,482	$10,472	$4,090	$3,722	$4,013	$5,769	$20,366	$37,181	$75,795	$352,481
Consump (GJ)	1,802	1,962	1,700	578	311	121	110	119	171	604	1,103	2,248	10,830
# of days	0	0	0	0	0	0	0	0	0	0	0	0	0
GHG (tonnes)	185	201	175	59	32	12	11	12	18	62	113	231	1,112
Unit Cost ($/GJ)	$31.407	$31.404	$31.400	$33.710	$33.710	$33.710	$33.710	$33.710	$33.710	$33.710	$33.710	$33.710	$32.546

2009	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Reading Date													
Total Cost	$95,147	$68,047	$57,307	$26,806	$17,517	$4,883	$3,255	$17,517	$4,883	$11,393	$29,295	$65,100	$401,150
Consump (GJ)	2,823	2,019	1,700	824	538	150	100	538	150	350	900	2,000	12,092
# of days	0	0	0	0	0	0	0	0	0	0	0	0	0
GHG (tonnes)	290	207	175	85	55	15	10	55	15	36	92	205	1,242
Unit Cost ($/GJ)	$33.704	$33.703	$33.710	$32.550	$32.550	$32.550	$32.550	$32.550	$32.550	$32.550	$32.550	$32.550	$33.175

Radiation Protection Building
Chilled Water Consumption and Cost History

	2005		2006		2007		2008		2009	
	Consump (GJ)	Cost	Consump (GJ)	Cost	Consump (GJ)	Cost	Consump (GJ)	Cost	Consump (GJ)	Cost
Jan	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -
Feb	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -
Mar	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -
Apr	233	$ 4,436	162	$ 3,648	117	$ 2,616	122	$ 3,050	-	$ -
May	574	$ 10,954	816	$ 18,403	599	$ 13,367	259	$ 6,486	604	$ 15,385
Jun	1,679	$ 32,043	1,060	$ 23,903	1,122	$ 25,059	1,110	$ 27,757	1,085	$ 27,646
Jul	1,828	$ 34,874	1,513	$ 34,116	1,244	$ 27,787	1,347	$ 33,683	1,300	$ 33,124
Aug	1,695	$ 32,339	1,232	$ 27,770	1,000	$ 22,330	1,097	$ 27,423	604	$ 15,385
Sep	1,152	$ 21,979	798	$ 18,002	722	$ 16,125	799	$ 19,983	650	$ 16,562
Oct	555	$ 10,580	258	$ 5,822	349	$ 7,784	371	$ 9,285	250	$ 6,370
Nov	-	$ -	-	$ -	-	$ -	265	$ 6,616	-	$ -
Dec	-	$ -	-	$ -	-	$ -	-	$ -	-	$ -
Total	**7,715**	**$ 147,205**	**5,839**	**$ 131,664**	**5,153**	**$ 115,068**	**5,371**	**$ 134,283**	**4,493**	**$ 114,471**





Radiation Protection Building - Chilled Water Consumption and Cost

2005	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Reading Date													
Total Cost				$4,436	$10,954	$32,043	$34,874	$32,339	$21,979	$10,580			$147,205
Consump (GJ)				233	574	1,679	1,828	1,695	1,152	555			7,715
# of days				0	0	0	0	0	0	0			0
GHG (tonnes)				10.7	26.3	76.9	83.7	77.6	52.8	25.4			353
Unit Cost ($/GJ)				$19.080	$19.080	$19.080	$19.080	$19.080	$19.080	$19.080			$19.080

2006	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Reading Date													
Total Cost				$3,648	$18,403	$23,903	$34,116	$27,770	$18,002	$5,822			$131,664
Consump (GJ)				162	816	1,060	1,513	1,232	798	258			5,839
# of days				0	0	0	0	0	0	0			0
GHG (tonnes)				7.4	37.4	48.6	69.3	56.4	36.6	11.8			267
Unit Cost ($/GJ)				$22.550	$22.550	$22.550	$22.550	$22.550	$22.550	$22.550			$22.550

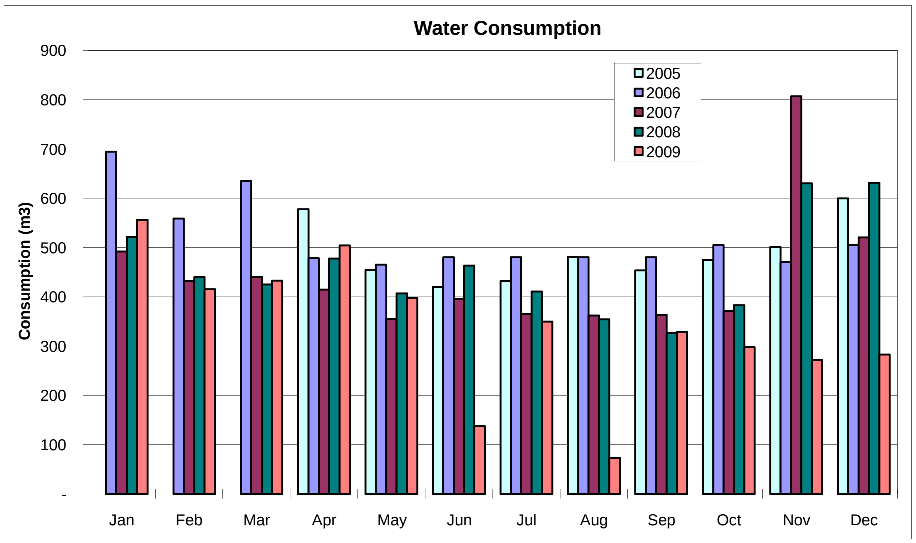
2007	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Reading Date													
Total Cost				$2,616	$13,367	$25,059	$27,787	$22,330	$16,125	$7,784			$115,068
Consump (GJ)				117	599	1,122	1,244	1,000	722	349			5,153
# of days				0	0	0	0	0	0	0			0
GHG (tonnes)				5.4	27.4	51.4	57.0	45.8	33.1	16.0			236
Unit Cost ($/GJ)				$22.330	$22.330	$22.330	$22.330	$22.330	$22.330	$22.330			$22.330

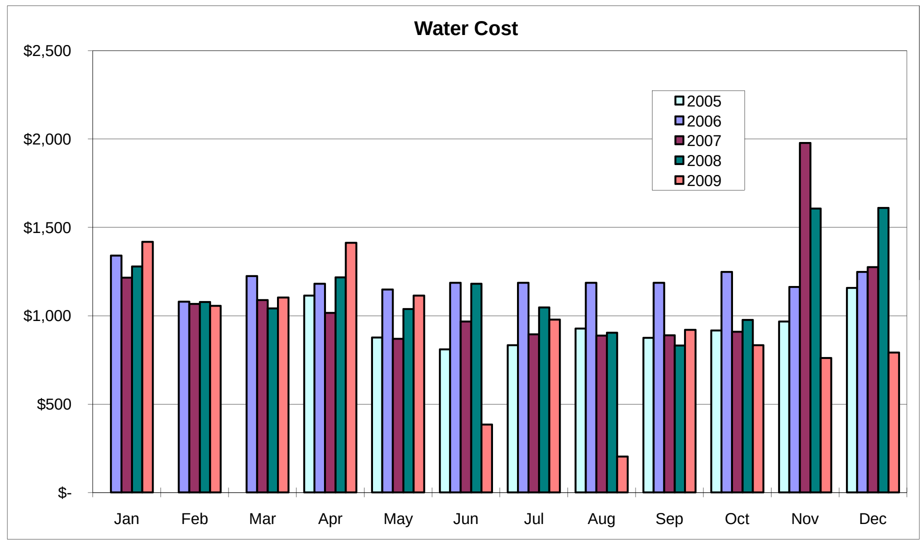
2008	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Reading Date													
Total Cost				$3,050	$6,486	$27,757	$33,683	$27,423	$19,983	$9,285	$6,616		$134,283
Consump (GJ)				122	259	1,110	1,347	1,097	799	371	265		5,371
# of days				0	0	0	0	0	0	0	0		0
GHG (tonnes)				5.6	11.9	50.9	61.7	50.2	36.6	17.0	12.1		246
Unit Cost ($/GJ)				$25.000	$25.000	$25.000	$25.000	$25.000	$25.000	$25.000	$25.000		$25.000

2009	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Reading Date													
Total Cost					$15,385	$27,646	$33,124	$15,385	$16,562	$6,370			$114,471
Consump (GJ)					604	1,085	1,300	604	650	250			4,493
# of days													0
GHG (tonnes)					27.7	49.7	59.6	27.7	29.8	11.5			206
Unit Cost ($/GJ)					$25.480	$25.480	$25.480	$25.480	$25.480	$25.480			$25.480

Radiation Protection Building
Water Consumption and Cost History

	2005 Consump (m³)	2005 Cost	2006 Consump (m³)	2006 Cost	2007 Consump (m³)	2007 Cost	2008 Consump (m³)	2008 Cost	2009 Consump (m³)	2009 Cost
Jan	-	$ -	695	$ 1,340	492	$ 1,215	522	$ 1,278	556	$ 1,419
Feb	-	$ -	559	$ 1,079	432	$ 1,067	440	$ 1,078	415	$ 1,056
Mar	-	$ -	635	$ 1,225	441	$ 1,088	425	$ 1,041	433	$ 1,104
Apr	578	$ 1,115	479	$ 1,182	415	$ 1,016	478	$ 1,218	504	$ 1,413
May	454	$ 876	465	$ 1,149	355	$ 870	407	$ 1,038	398	$ 1,114
Jun	420	$ 811	480	$ 1,186	395	$ 968	463	$ 1,181	138	$ 385
Jul	432	$ 834	480	$ 1,186	365	$ 894	411	$ 1,047	350	$ 979
Aug	481	$ 928	480	$ 1,186	362	$ 887	355	$ 904	73	$ 204
Sep	454	$ 875	480	$ 1,186	363	$ 889	326	$ 831	329	$ 921
Oct	475	$ 917	505	$ 1,247	371	$ 909	383	$ 977	298	$ 833
Nov	501	$ 967	470	$ 1,162	807	$ 1,977	630	$ 1,607	272	$ 762
Dec	600	$ 1,157	505	$ 1,247	521	$ 1,275	631	$ 1,610	283	$ 792
Total	**4,394**	**$ 8,479**	**6,232**	**$ 14,374**	**5,317**	**$ 13,055**	**5,470**	**$ 13,809**	**4,048**	**$ 10,982**





Radiation Protection Building - Water Consumption and Cost

2005	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Read Date													
Cost				$1,115	$876	$811	$834	$928	$875	$917	$967	$1,157	$8,479
Consump (m3)				578	454	420	432	481	454	475	501	600	4,394
# of days				0	0	0	0	0	0	0	0	0	0
Unit Cost				$1.93	$1.93	$1.93	$1.93	$1.93	$1.93	$1.93	$1.93	$1.93	$1.93

2006	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Read Date													
Cost	$1,340	$1,079	$1,225	$1,182	$1,149	$1,186	$1,186	$1,186	$1,186	$1,247	$1,162	$1,247	$14,374
Consump (m3)	695	559	635	479	465	480	480	480	480	505	470	505	6,232
# of days	0	0	0	0	0	0	0	0	0	0	0	0	0
Unit Cost	$1.93	$1.93	$1.93	$2.47	$2.47	$2.47	$2.47	$2.47	$2.47	$2.47	$2.47	$2.47	$2.31

2007	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Read Date													
Cost	$1,215	$1,067	$1,088	$1,016	$870	$968	$894	$887	$889	$909	$1,977	$1,275	$13,055
Consump (m3)	492	432	441	415	355	395	365	362	363	371	807	521	5,317
# of days	0	0	0	0	0	0	0	0	0	0	0	31	31
Unit Cost	$2.47	$2.47	$2.47	$2.45	$2.45	$2.45	$2.45	$2.45	$2.45	$2.45	$2.45	$2.45	$2.46

2008	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Read Date													
Cost	$1,278	$1,078	$1,041	$1,218	$1,038	$1,181	$1,047	$904	$831	$977	$1,607	$1,610	$13,809
Consump (m3)	522	440	425	478	407	463	411	355	326	383	630	631	5,470
# of days	0	0	0	0	0	0	0	0	0	0	0	0	0
Unit Cost	$2.45	$2.45	$2.45	$2.55	$2.55	$2.55	$2.55	$2.55	$2.55	$2.55	$2.55	$2.55	$2.52

2009	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Read Date													
Cost	$1,419	$1,056	$1,104	$1,413	$1,114	$385	$979	$204	$921	$833	$762	$792	$10,982
Consump (m3)	556	415	433	504	398	138	350	73	329	298	272	283	4,048
# of days	0	0	0	0	0	0	0	0	0	0	0	0	0
Unit Cost	$2.55	$2.54	$2.55	$2.80	$2.80	$2.80	$2.80	$2.80	$2.80	$2.80	$2.80	$2.80	$2.71

8. Appendix B – Energy & Water Balances

- **Electricity**
- **High-temperature Hot Water**
- **Chilled Water**
- **Natural Gas**
- **Water**

Building: Radiation Protection Building
Date: Feb-2010
Purpose: Electrical Energy Balance and End-Use

Area : 104,510 ft2
Rate $ 0.093 per kWh

System Estimates	Base				Winter Extra				Summer Extra				Total		
	kW	[kWh]	[kWh/sq.ft.]	[$]	kW	[kWh]	[kWh/sq.ft.]	[$]	kW	[kWh]	[kWh/sq.ft.]	[$]	[kWh]	[kWh/sq.ft.]	[$]
Lighting, Plug and Misc.															
LIGHTING	127.7	279,593	4.00	$ 26,071									279,593	2.68	$ 26,071
PLUG LOAD & LAB EQUIP	52.3	457,753	4.38	$ 42,683									457,753	4.38	$ 42,683
SERVER ROOMS	10.0	87,600	0.84	$ 8,168									87,600	0.84	$ 8,168
ELEVATORS	13.4	34,913	0.33	$ 3,255									34,913	0.33	$ 3,255
AIR COMPRESSORS - KAESER	11.2	49,012	0.47	$ 4,570									49,012	0.47	$ 4,570
AIR COMPRESSORS - DEVILBL	2.2	9,802	0.09	$ 914									9,802	0.09	$ 914
VACUUM PUMP	1.5	6,535	0.06	$ 609									6,535	0.06	$ 609
Domestic Water															
DHW Circ. Pumps (P26 & P27)	0.3	2,723	0.03	$ 254									2,723	0.03	$ 254
HVAC															
AC-1 DUAL DUCT (OLD WING)	101.5	888,755	8.50	$ 82,872									888,755	8.50	$ 82,872
AC-2 MAKE-UP AIR (OLD WING	1.8	15,684	0.15	$ 1,462									15,684	0.15	$ 1,462
FUME HOODS - OLD WING	32.8	287,538	2.75	$ 26,812									287,538	2.75	$ 26,812
GENERAL / WASH EXHAUST	1.1	9,802	0.09	$ 914									9,802	0.09	$ 914
AHU-3 (ACCOUSTICS)	9.0	78,420	0.75	$ 7,312									78,420	0.75	$ 7,312
AHU-4 (ADMIN)	23.5	205,851	1.97	$ 19,195									205,851	1.97	$ 19,195
AHU-5 (LABS - SOUTH)	22.4	196,049	1.88	$ 18,281									196,049	1.88	$ 18,281
AHU-6 (MICROWAVE)	2.4	20,912	0.20	$ 1,950									20,912	0.20	$ 1,950
AHU-7 (EMERG RESPONSE)	3.9	33,982	0.33	$ 3,169									33,982	0.33	$ 3,169
AHU-8 (LABS - NORTH)	26.9	235,259	2.25	$ 21,937									235,259	2.25	$ 21,937
AHU-9 (PENTHOUSE)	5.6	49,012	0.47	$ 4,570									49,012	0.47	$ 4,570
AHU-10 (ELEC ROOM)	1.8	15,684	0.15	$ 1,462									15,684	0.15	$ 1,462
MISC EXHAUST	3.7	32,675	0.31	$ 3,047									32,675	0.31	$ 3,047
FUME HOODS - NEW WING	9.3	65,350	0.63	$ 6,094									65,350	0.63	$ 6,094
NEW WING PENT FAN COIL	0.1	327	0.00	$ 30									327	0.00	$ 30
NEW EMERG RTU - BACKUP	0.0	-	-	$ -									-	-	$ -
Cooling															
LAB AND SERVER DX COOLIN(	17.0	59,500	0.57	$ 5,548									59,500	0.57	$ 5,548
Heating															
HEATING PUMPS - NEW WING					4.2	14,704	0.14	$ 1,371					14,704	0.14	$ 1,371
REHEAT COIL PUMPS	11.2	29,407	0.28	$ 2,742											
TERMINAL REHEAT PUMPS	7.5	65,350	0.63	$ 6,094									65,350	0.63	$ 6,094
PERIMETER PUMPS - NEW					5.6	19,605	0.19	$ 1,828					19,605	0.19	$ 1,828
PERIMETER PUMPS - OLD					1.1	3,921	0.04	$ 366					3,921	0.04	$ 366
RAMP HEATING CIRC PUMP					0.3	613	0.01	$ 57					613	0.01	$ 57
HEATING COIL PUMPS - OLD	3.4	29,407	0.28	$ 2,742									29,407	0.28	$ 2,742
Totals	**503**	**3,246,893**	**31.07**	**$ 302,758**	**11**	**38,842**	**0.37**	**$ 3,622**	**-**	**-**	**-**	**$ -**	**3,285,735**	**31.44**	**$ 303,638**
2008 Utility Data	**0**	**3,120,000**	**29.85**	**$ 290,926**	**0**	**37,478**	**0.36**	**$ 3,495**	**0**	**70,057**	**0.67**	**$ 6,532**	**3,227,535**	**30.88**	**$ 300,953**
Difference		**-4%**				**-4%**				**100%**			**-2%**		

Building: **Radiation Protection Building** Area = 104,510 sq.ft.
Date: **Feb-2010** Rate = $ 33.17 /GJ
Purpose: **High-temp Hot Water End-Use Estimate and Energy Balance**

High Temperature Hot Water

System Estimates	Base			Winter Extra			Summer Extra			Total		
	GJ	[ekWh/sq.ft.]	[$]	GJ	[ekWh/sq.ft.]	[$]	GJ	[ekWh/sq.ft.]	[$]	GJ	[ekWh/sq.ft.]	[$]
Envelope												
New Wing - perimeter heat				500	1.3	$ 16,587				500	1.33	$ 16,587
Old Wing - perimeter heat				500	1.3	$ 16,587				500	1.33	$ 16,587
Ventilation												
New Wing				3,500	9.3	$ 116,112				3,500	9.30	$ 116,112
Reheat (Accoustic - New Wing)	85	0.2	$ 2,820							85	0.23	$ 2,820
Old Wing	2650	7.0	$ 87,913	4,820	12.8	$ 159,903				7,470	19.85	$ 247,816
Miscellaneous												
Domestic Hot Water	300	0.8	$ 9,952							300	0.80	$ 9,952
Ramp Heating				65	0.2	$ 2,156				65	0.17	$ 2,156
Totals	**3,035**	**8.1**	**$ 100,686**	**9,385**	**22.3**	**$ 278,171**				**12,420**	**30.4**	**$ 378,857**
2006 Baseline Data	**2,815**	**7.5**	**$ 93,371**	**9,277**	**24.7**	**$ 307,775**				**12,092**	**32.1**	**$ 401,146**
Difference				**1.2%**						**2.7%**		

Building: Radiation Protection Building
Date: Feb-2010
Purpose: Chilled Water End-Use Estimate and Energy Balance

Area = 104,510 sq.ft.
Rate = $ 25.48 /GJ

Chilled Water

System Estimates	Base			Winter Extra			Summer Extra			Total		
	GJ	ekWh/sq.ft.	[$]	GJ	ekWh/sq.ft.	[$]	GJ	ekWh/sq.ft.	[$]	GJ	ekWh/sq.ft	[$]
Ventilation Cooling - New Wing							2,076	0.9	$ 52,892	2,076	0.9	$ 52,892
Ventilation Cooling - Old Wing							2,500	1.1	$ 63,694	2,500	1.1	$ 63,694
Totals							**4,576**	**2.1**	**$ 116,586**	**4,576**	**2.1**	**$ 116,586**
Jun06 - May07 Baseline							**4,493**	**2.0**	**$ 114,460**	**4,493**	**2.0**	**$ 114,460**
Difference							**1.9%**			**1.9%**		

Building: Radiation Protection Building
Date: Feb-2010
Purpose: Natural Gas End-Use Estimate and Energy Balance

Area = 104,510 sq.ft.
Rate = $ 0.687 /m3

Chilled Water

System Estimates	Base			Winter Extra			Summer Extra			Total		
	m3	ekWh/sq.ft.	[$]	m3	ekWh/sq.ft.	[$]	m3	ekWh/sq.ft.	[$]	m3	ekWh/sq.ft	[$]
Domestic Hot Water	3,412	0.3	$ 2,343							3,412	1.5	$ 2,343
Totals	**3,412**	**0.3**	**$ 2,343**							**3,412**	**1.5**	**$ 2,343**
Jun06 - May07 Baseline	**3,412**	**0.3**	**$ 2,343**							**3,412**	**0.3**	**$ 2,343**
Difference	**0.0%**									**0.0%**		

Building: **Radiation Protection Building** Area = 104,510 sq.ft.
Date: **Feb-10** Rate = $ 2.71 /m3
Purpose: **Water End-Use Estimate and Balance**

<u>Water</u>

System Estimates	Base			Winter Extra			Summer Extra			Total		
	m3	[L/sq.ft.]	[$]	m3	[L/sq.ft.]	[$]	m3	[L/sq.ft.]	[$]	m3	[L/sq.ft.]	[$]
Washrooms												
Toilets	2,061	19.7	$ 5,590							2,061	19.7	$ 5,590
Urinals	516	4.9	$ 1,401							516	4.9	$ 1,401
Sinks	566	5.4	$ 1,536							566	5.4	$ 1,536
Misc												
Laboratory Usage	400	3.8	$ 1,085							400	3.8	$ 1,085
Custodial	100	1.0	$ 271							100	1.0	$ 271
HVAC												
Humidification				400	3.8	$ 1,085				400	3.8	$ 1,085
Totals	**3,643**	**34.9**	**$ 9,883**	**400**	**3.8**	**1,085**				**4,043**	**38.7**	**$ 10,968**
2008 Baseline Data	**3,600**	**34.4**	**$ 9,767**	**789**	**7.6**	**$ 2,142**				**4,390**	**42.0**	**$ 11,908**
Difference	**1.2%**			**-49.3%**						**-7.9%**		

9. Appendix C – HVAC Equipment Lists

- **Air-handling Units**
- **Exhaust Fans**
- **Pumps**

Unit Number	AC – 1	
Location	Old Wing, Penthouse	
Area Served	Dual duct system	
Make	Sheldons	
Fan Type	Centrifugal	
	Supply Fan	**Return Fan**
Design	CV	CV
Horsepower (hp)	100	60
Speed (rpm)	1780	1774
Amps (A)	92	56.5
Volts (V)	575	550
Air Volume (cfm)	N/A	N/A
Cooling Coil	Chilled water	
Heating Coil	Glycol	
Humidification	Steam (not working)	
Schedule		
Days	Monday to Sunday	
Hours	24 hours/day	

Unit Number	AC – 2	
Location	Old Wing, Penthouse	
Area Served	Make-up air old wing labs	
Make	Sheldons	
Fan Type	Centrifugal	
	Supply Fan	**Return Fan**
Design	VIV	
Horsepower (hp)	3	
Speed (rpm)	1730	
Amps (A)	3.8	
Volts (V)	575	
Air Volume (cfm)	N/A	
Cooling Coil	None	
Heating Coil	Glycol	
Humidification	Steam (not working)	
Schedule		
Days	Monday to Sunday	
Hours	24 hours/day	

Unit Number	AHU 3	
Location	New Wing, Penthouse	
Area Served	Acoustics Chamber	
Make	N/A	
Fan Type	Centrifugal	
	Supply Fan	**Return Fan**
Design	VFD	VFD
Horsepower (hp)	15	5
Speed (rpm)	N/A	1735
Amps (A)	N/A	5.4
Volts (V)	575	575
Air Volume (cfm)	N/A	N/A
Cooling Coil	Chilled water	
Heating Coil	Glycol	
Humidification	Steam	
Schedule		
Days	Monday to Sunday	
Hours	24 hours/day	

Unit Number	AHU 4	
Location	New Wing, Penthouse	
Area Served	Administration	
Make	Sheldons	
Fan Type	Centrifugal	
	Supply Fan	**Return Fan**
Design	VIV	VIV
Horsepower (hp)	30	15
Speed (rpm)	1,760	1750
Amps (A)	31	15.2
Volts (V)	575	575
Air Volume (cfm)	N/A	N/A
Cooling Coil	Chilled water	
Heating Coil	Glycol	
Humidification	steam	
Schedule		
Days	Monday to Sunday	
Hours	24 hours/day	

Unit Number	AHU 5	
Location	New Wing, Penthouse	
Area Served	South Labs	
Make	Sheldons	
Fan Type	Centrifugal	
	Supply Fan	Exhaust Fan
Design	VIV	VIV
Horsepower (hp)	30	7.5
Speed (rpm)	N/A	1750
Amps (A)	N/A	N/A
Volts (V)	575	575
Air Volume (cfm)	N/A	N/A
Cooling Coil	Chilled water	
Heating Coil	Glycol	
Humidification	steam	
Schedule		
Days	Monday to Sunday	
Hours	24 hours/day	

Unit Number	AHU 6	
Location	New Wing, Penthouse	
Area Served	Microwave Chamber	
Make	Sheldons	
Fan Type	Centrifugal	
	Supply Fan	Return Fan
Design	VIV	VIV
Horsepower (hp)	3	1
Speed (rpm)	N/A	N/A
Amps (A)	N/A	1.6
Volts (V)	575	575
Air Volume (cfm)	N/A	N/A
Cooling Coil	Chilled water	
Heating Coil	Glycol	
Humidification	Steam (not used)	
Schedule		
Days	Monday to Sunday	
Hours	24 hours/day	

Unit Number	AHU 7	
Location	New Wing, Penthouse	
Area Served	Emergency Response	
Make	Sheldons	
Fan Type	Centrifugal	
	Supply Fan	**Return Fan**
Design	VIV	VIV
Horsepower (hp)	5	1.5
Speed (rpm)	N/A	1745
Amps (A)	N/A	2.0
Volts (V)	575	575
Air Volume (cfm)	N/A	N/A
Cooling Coil	Chilled water	
Heating Coil	Glycol	
Humidification	Steam (not used)	
Schedule		
Days	Monday to Sunday	
Hours	24 hours/day	

Unit Number	AHU 8	
Location	New Wing, Penthouse	
Area Served	North Labs	
Make	Sheldons	
Fan Type	Centrifugal	
	Supply Fan	**Exhaust Fan**
Design	VIV	VIV
Horsepower (hp)	40	5
Speed (rpm)	1740	1740
Amps (A)	38.6	5.6
Volts (V)	575	575
Air Volume (cfm)	N/A	N/A
Cooling Coil	Chilled water	
Heating Coil	Glycol	
Humidification	steam	
Schedule		
Days	Monday to Sunday	
Hours	24 hours/day	

Unit Number	AHU 9	
Location	New Wing, Penthouse	
Area Served	Penthouse	
Make	Sheldons	
Fan Type	Centrifugal	
	Supply Fan	
Design	CV	
Horsepower (hp)	7.5	
Speed (rpm)	1740	
Amps (A)	N/A	
Volts (V)	575	
Air Volume (cfm)	N/A	
Cooling Coil	None	
Heating Coil	Glycol	
Humidification	None	
Schedule		
Days	Monday to Sunday	
Hours	24 hours/day	

Unit Number	AHU 10	
Location	New Wing, Penthouse	
Area Served	Electrical Room	
Make	Sheldons	
Fan Type	Centrifugal	
	Supply Fan	
Design	CV	
Horsepower (hp)	3	
Speed (rpm)	N/A	
Amps (A)	N/A	
Volts (V)	575	
Air Volume (cfm)	N/A	
Cooling Coil	None	
Heating Coil	Glycol	
Humidification	None	
Schedule		
Days	Monday to Sunday	
Hours	24 hours/day	

EXHAUST FANS

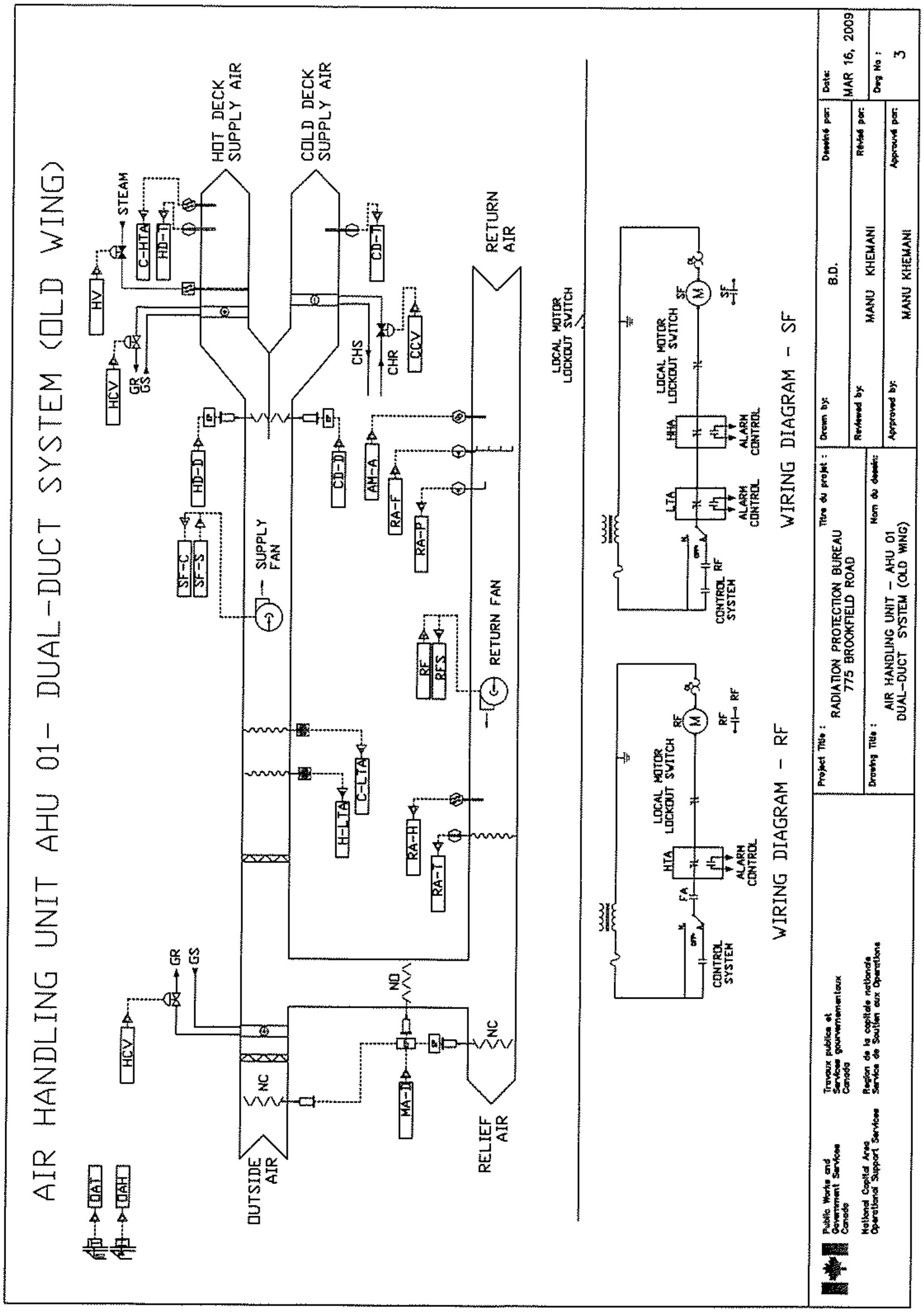
Fan # & Location	System Served	HP	Volts	Amps	Flow (L/s)	Operation
New Wing Penthouse	New Wing Washrooms	1.5	115	-	-	24/7
New Wing Labs	New Wing Fume Hoods (Qty: 38)	1.0	575	1.3	275	24/7
Old Wing Labs	Old Wing Fume Hoods (Qty: 26)	1/16 to 1/2	115	3.9 to 8.2	-	24/7
Old Wing Roof	Old Wing Labs – Common Plenum Exhaust	25 (estimate)	575	-	-	24/7
Old Wing Roof	Old Wing Washrooms	1/10	115	2.7	-	24/7

PUMPS

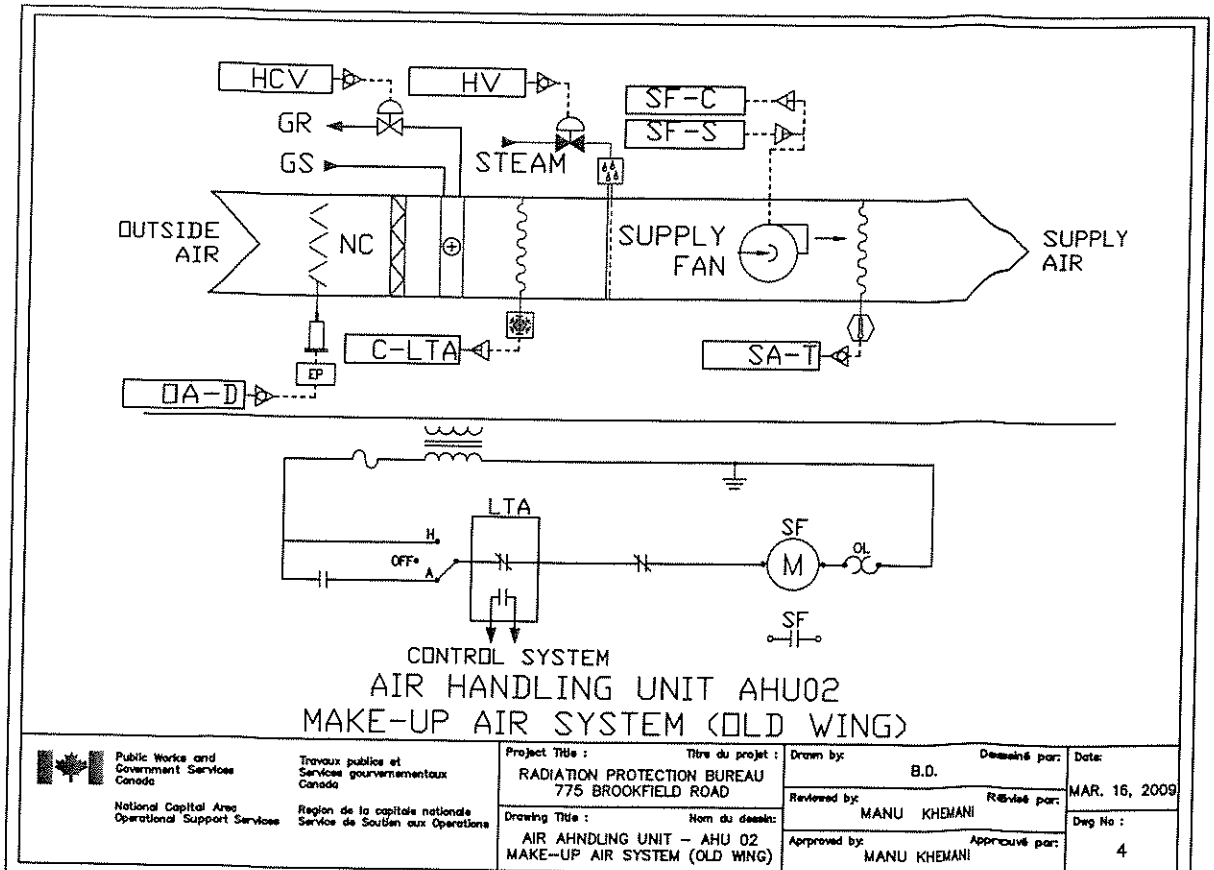
Pump #	System Served	HP	Flow (usgpm)	Operation
P21 & P22 - New Wing Penthouse	Primary Hot Water Loop	7.5	212	Lead/Lag, On when OAT < 18ºC
P25 & P26 – New Wing Penthouse	Hot Glycol Supply to AHU Preheat Coils	15	500	Lead/Lag, 24/7
P31 & P32 – New Wing Penthouse	Constant Temperature Loop – HW Supply for AHU Heating Coils	10	470	Lead/Lag, On when OAT < 18ºC
2 Pumps - New Wing Penthouse	Scheduled Loop – HW Supply for perimeter heating & unit heaters	5	55	Lead/Lag, On when OAT < 18ºC
P1 & P2 - Old Wing Penthouse	HW Supply for Perimeter Heating	1	-	Both on when OAT < 18ºC
DHW Pumps – Old Wing Penthouse	Domestic Hot Water for Old Wing	1/12	2	24/7
Glycol Pump – Old Wing Penthouse	Glycol Preheat Coil in AHU-2	1.5	-	On when OAT < 18ºC
Hot Water Pump – Old Wing Penthouse	HW Supply for Hot Deck Coil in AHU-1	3	-	On when OAT < 18ºC
Ramp Heat – Old Wing Penthouse	Hot Glycol Supply – Ramp heating	½	-	On when OAT < 0ºC

10. Appendix D – Air-handling Unit Schematics

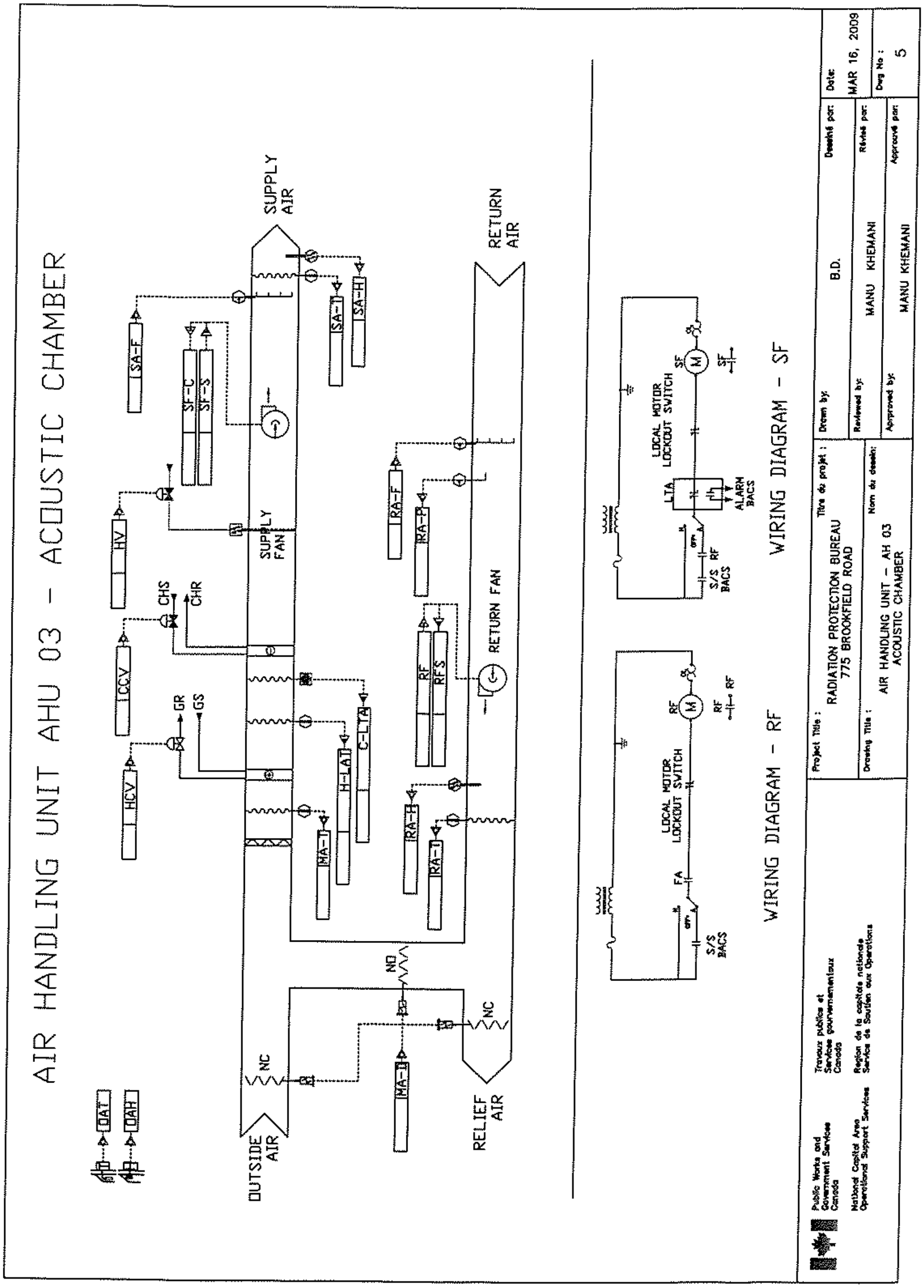
All schematics were taken from the Standard Operating Procedures Manual.



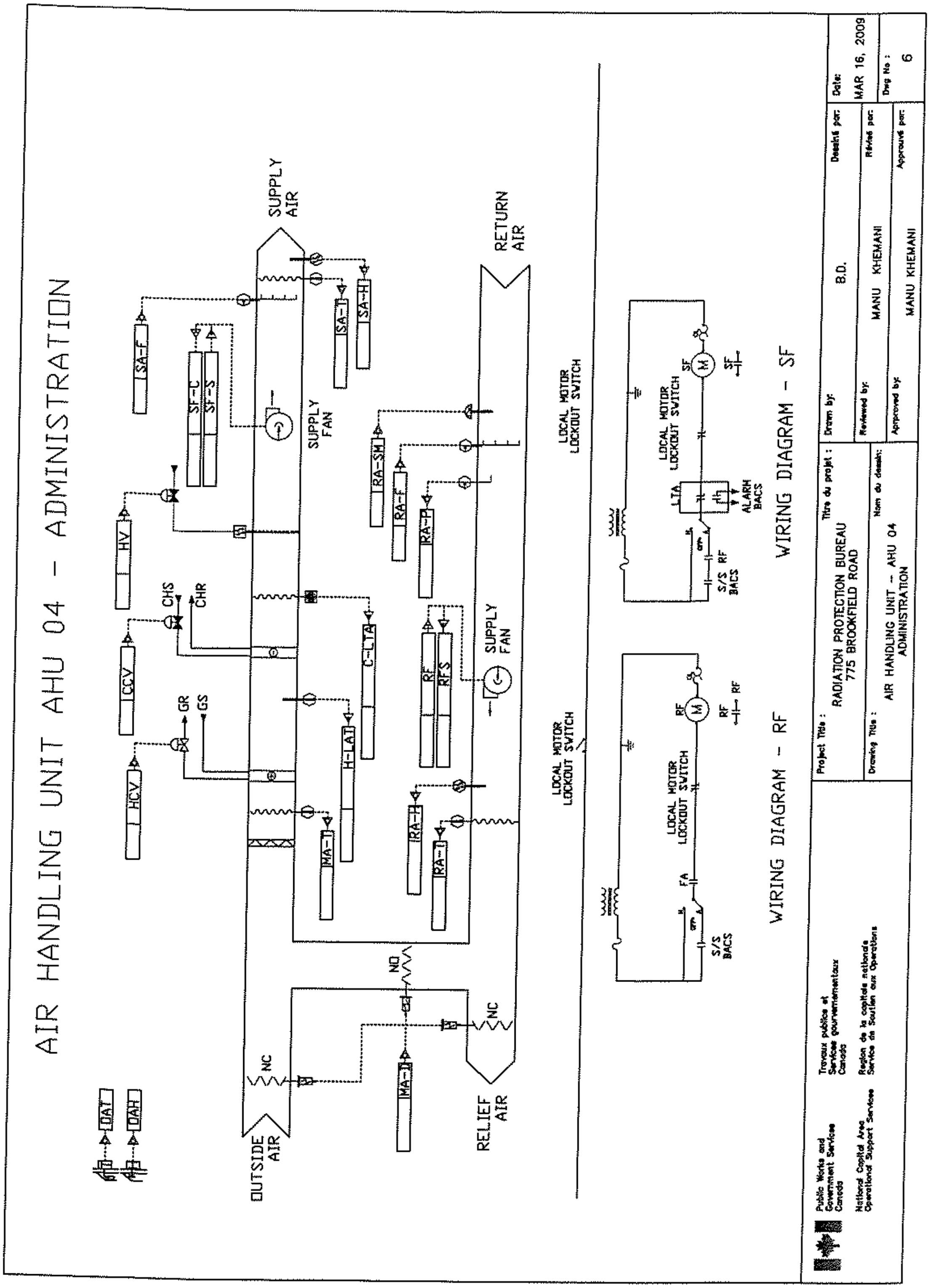
CDS 2 – AIR HANDLING UNIT AHU 01 – DUAL DUCT SYSTEM (OLD WING)



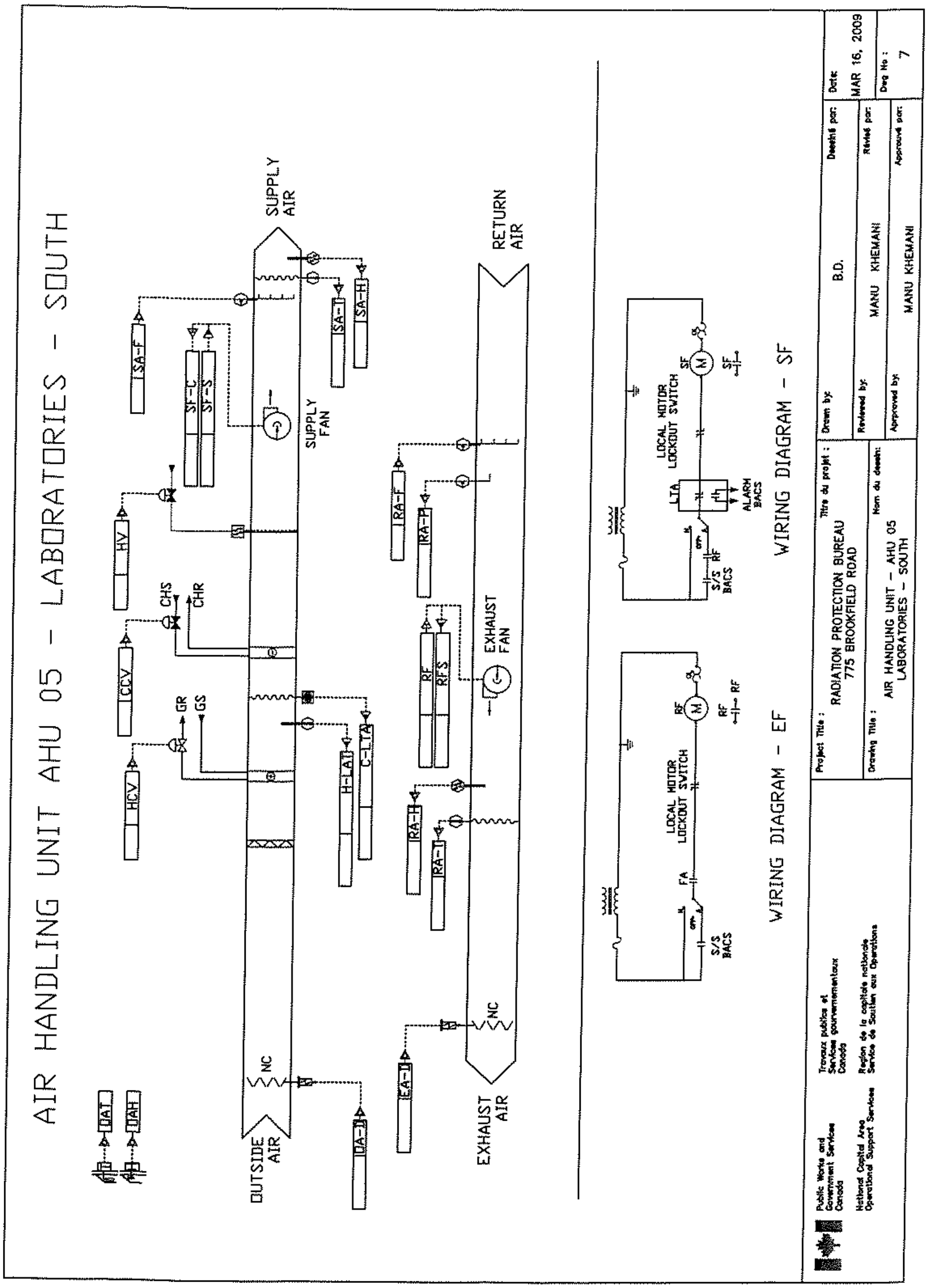
CDS 3 – AIR HANDLING UNIT AHU 02 – MAKEUP AIR SYSTEM (OLD WING)



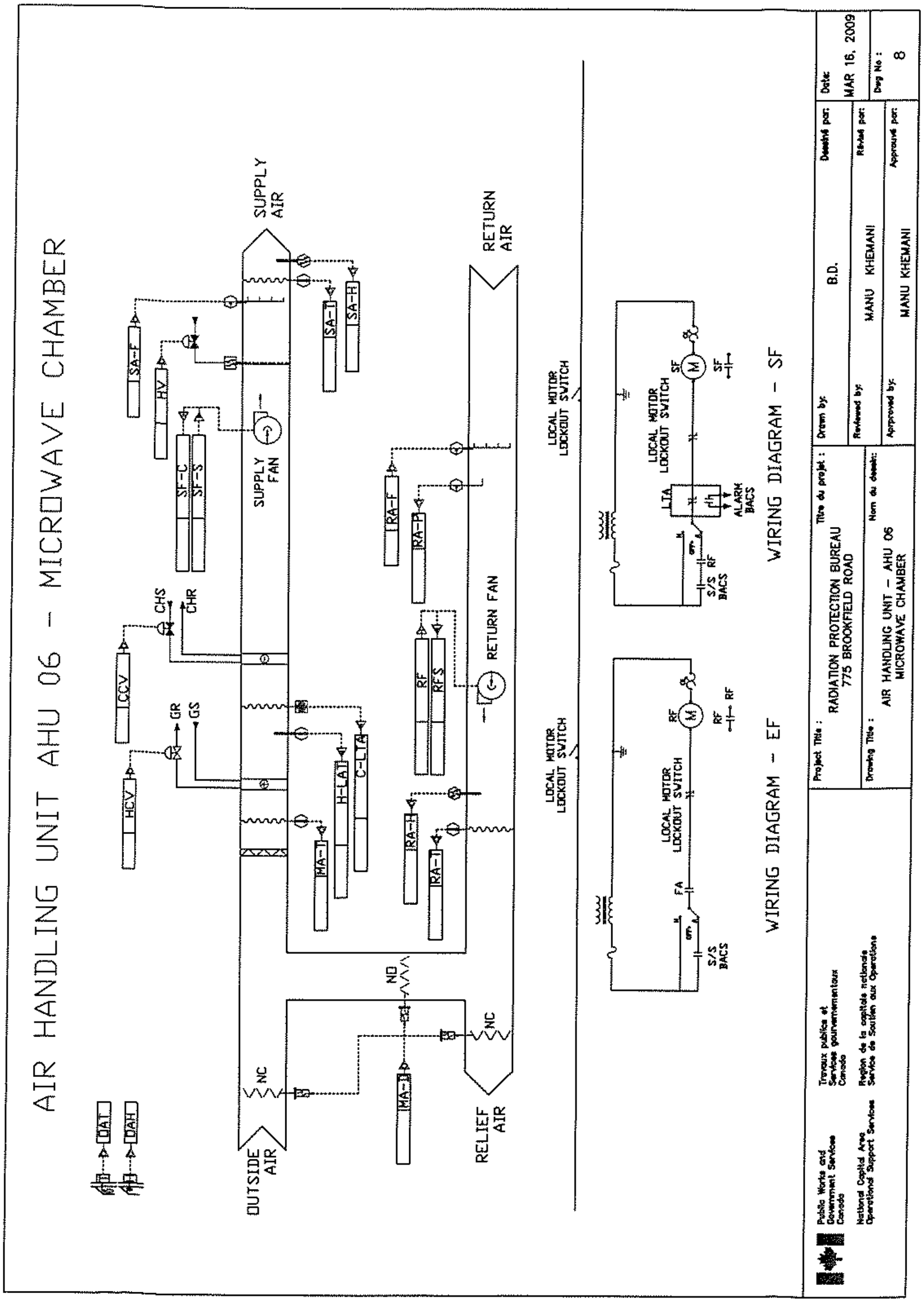
CDS 4 – AIR HANDLING UNIT AHU 03 – ACOUSTIC CHAMBER



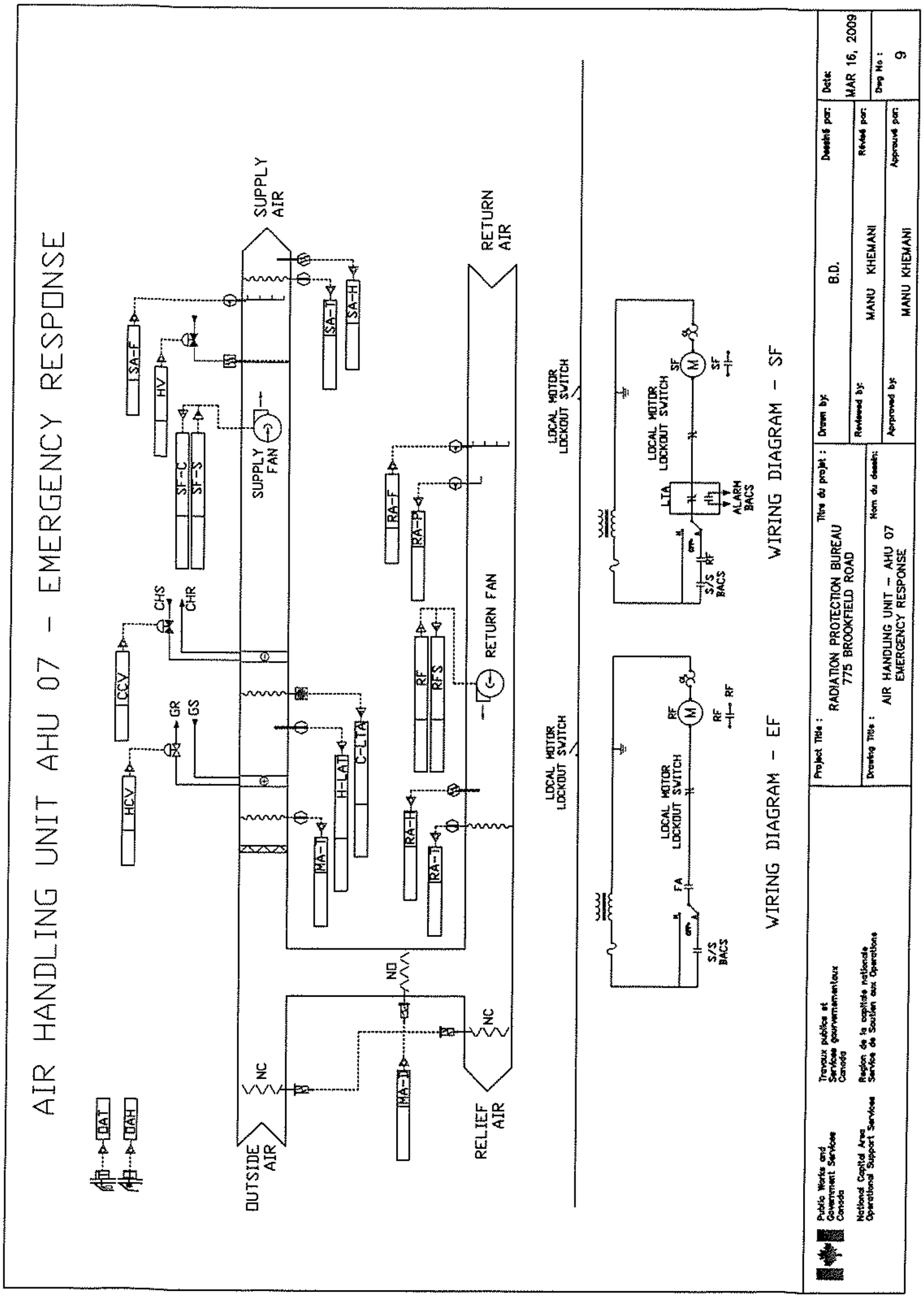
CDS 5 – AIR HANDLING UNIT AHU 04 – ADMINISTRATION



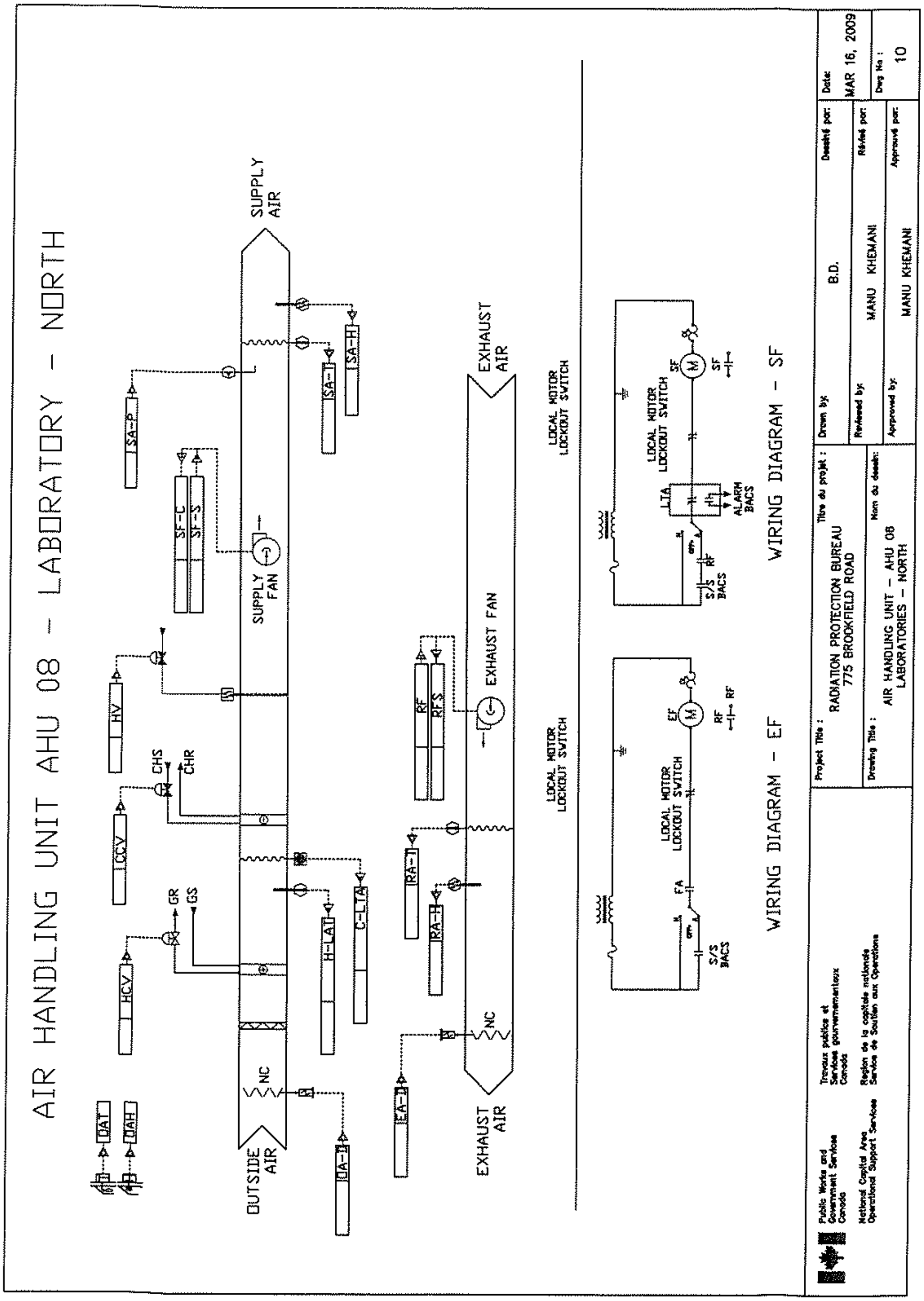
CDS 6 – AIR HANDLING UNIT AHU 05 – LABORATORIES - SOUTH



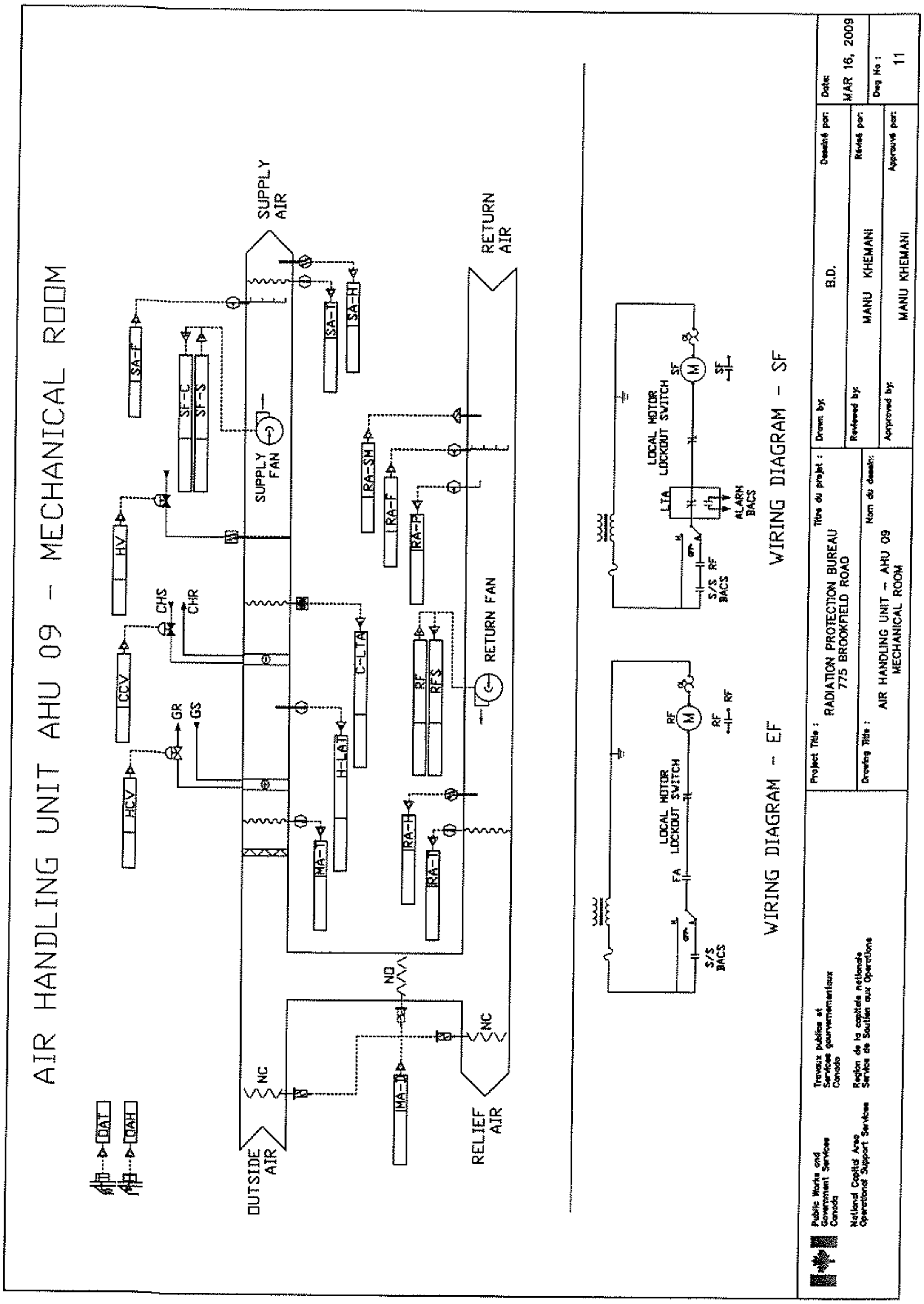
CDS 7 – AIR HANDLING UNIT AHU 06 – MICROWAVE CHAMBER



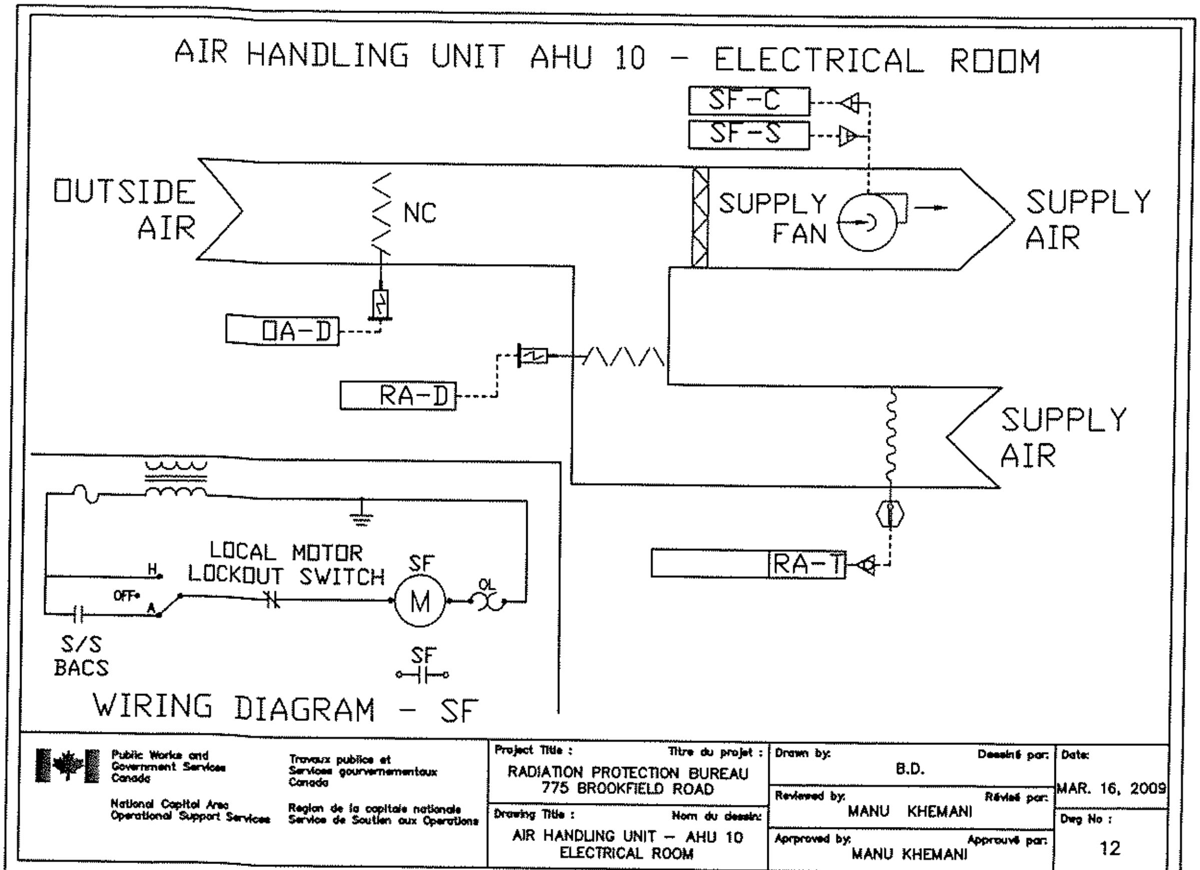
CDS 8 – AIR HANDLING UNIT AHU 07 – EMERGENCY RESPONSE



CDS 9 – AIR HANDLING UNIT AHU 08 – LABORATORIES - NORTH



CDS 10 – AIR HANDLING UNIT AHU 09 – MECHANICAL ROOM



CDS 11 – AIR HANDLING UNIT AHU 10 – ELECTRICAL ROOM

OPERATION CRITERIA

TYPE OF OCCUPANCY

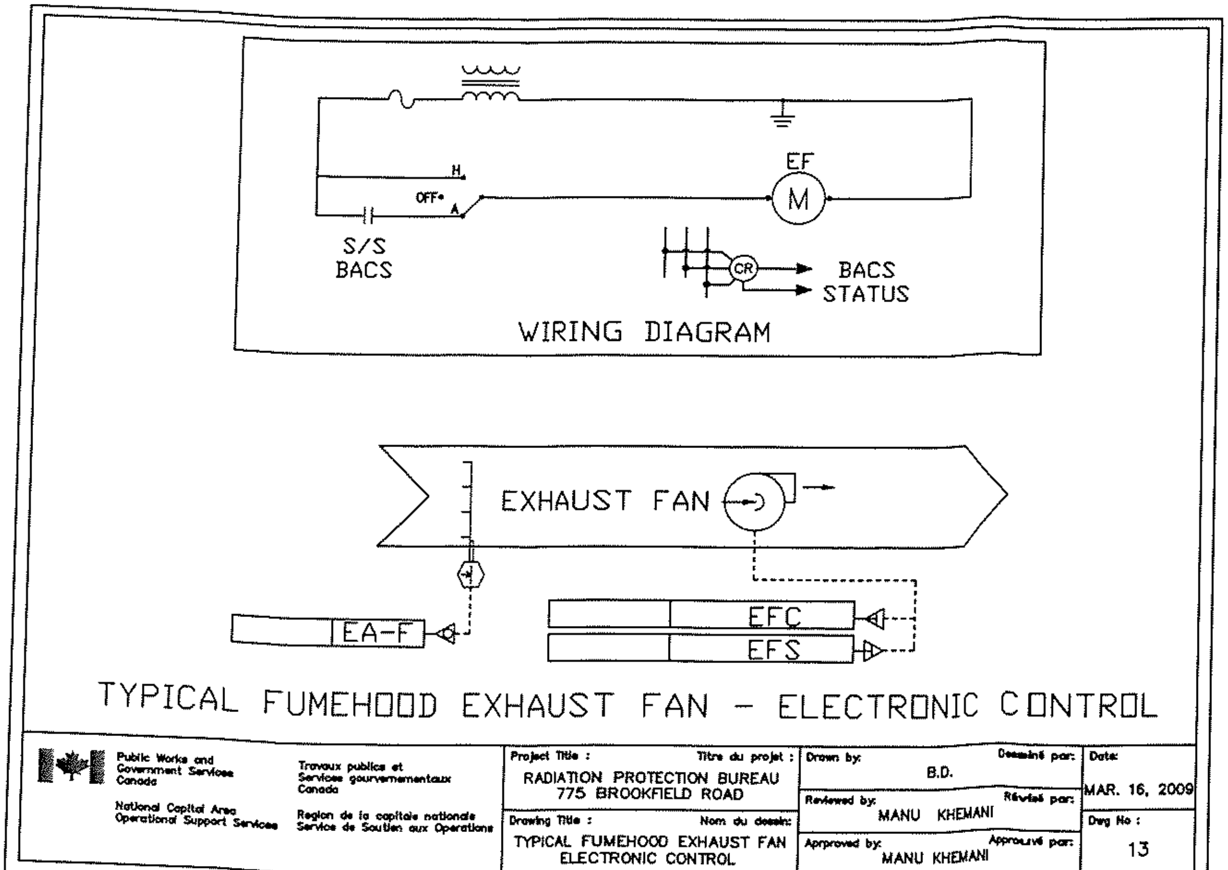
Radiation Protection Bureau has a mix of laboratory and office personnel occupying both Old and New Wings of the building.

AREA SERVED

The Exhaust Fan (EF) serves the Fumehood of the laboratory identified in the respective datasheet, in the New Wing.

SCHEDULE OF OPERATION

The EF runs continuously.



CDS 13 – TYPICAL FUMEHOOD EXHAUST FAN – ELECTRONIC CONTROL – NEW WING

OPERATION CRITERIA

TYPE OF OCCUPANCY

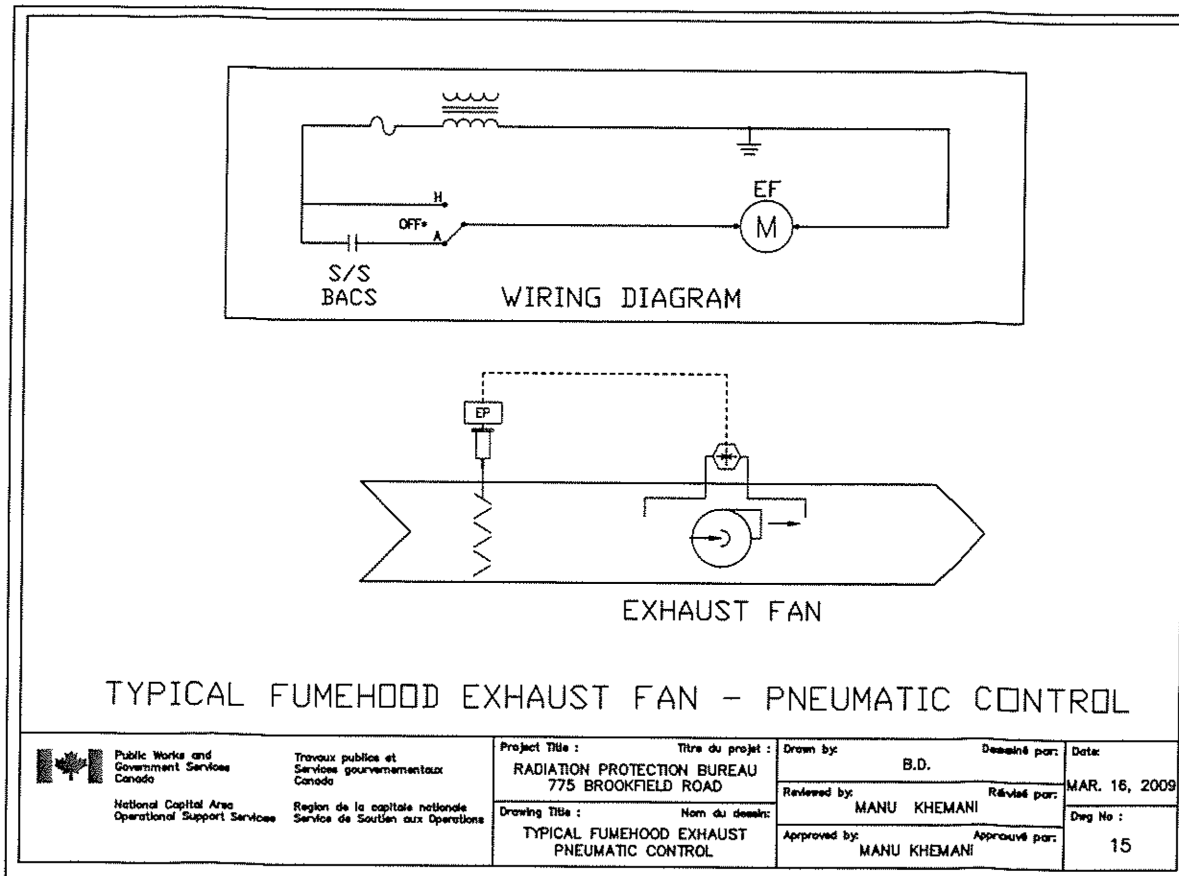
Radiation Protection Bureau has a mix of laboratory and office personnel occupying both Old and New Wings of the building.

AREA SERVED

The Exhaust Fan (EF) serves the Fumehood of the laboratory identified in the respective datasheet, in the Old Wing.

SCHEDULE OF OPERATION

The EF runs continuously.



CDS 14 – TYPICAL FUMEHOOD EXHAUST FAN – PNEUMATIC CONTROL – OLD WING

OPERATION CRITERIA

TYPE OF OCCUPANCY

Radiation Protection Bureau has a mix of laboratory and office personnel occupying both Old and New Wings of the building.

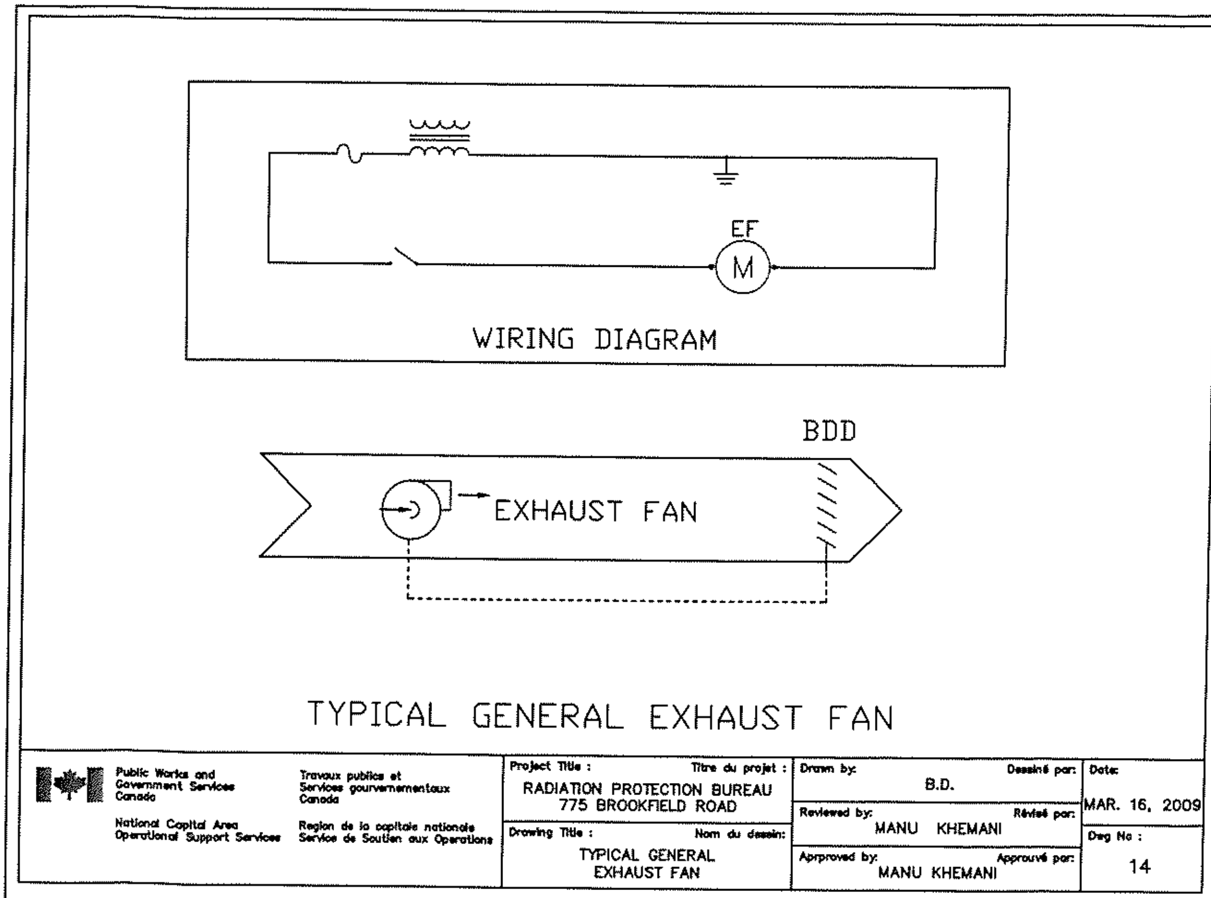
AREA SERVED

The Exhaust Fan (EF) collectively serves all the fumehoods in the Old Wing.

SCHEDULE OF OPERATION

The EF runs continuously. There are two fans – one working and one standby. The operating mode of the fans is alternated every month.

A NEW DIAGRAM IS NEEDED FOR THE BOOSTER FANS



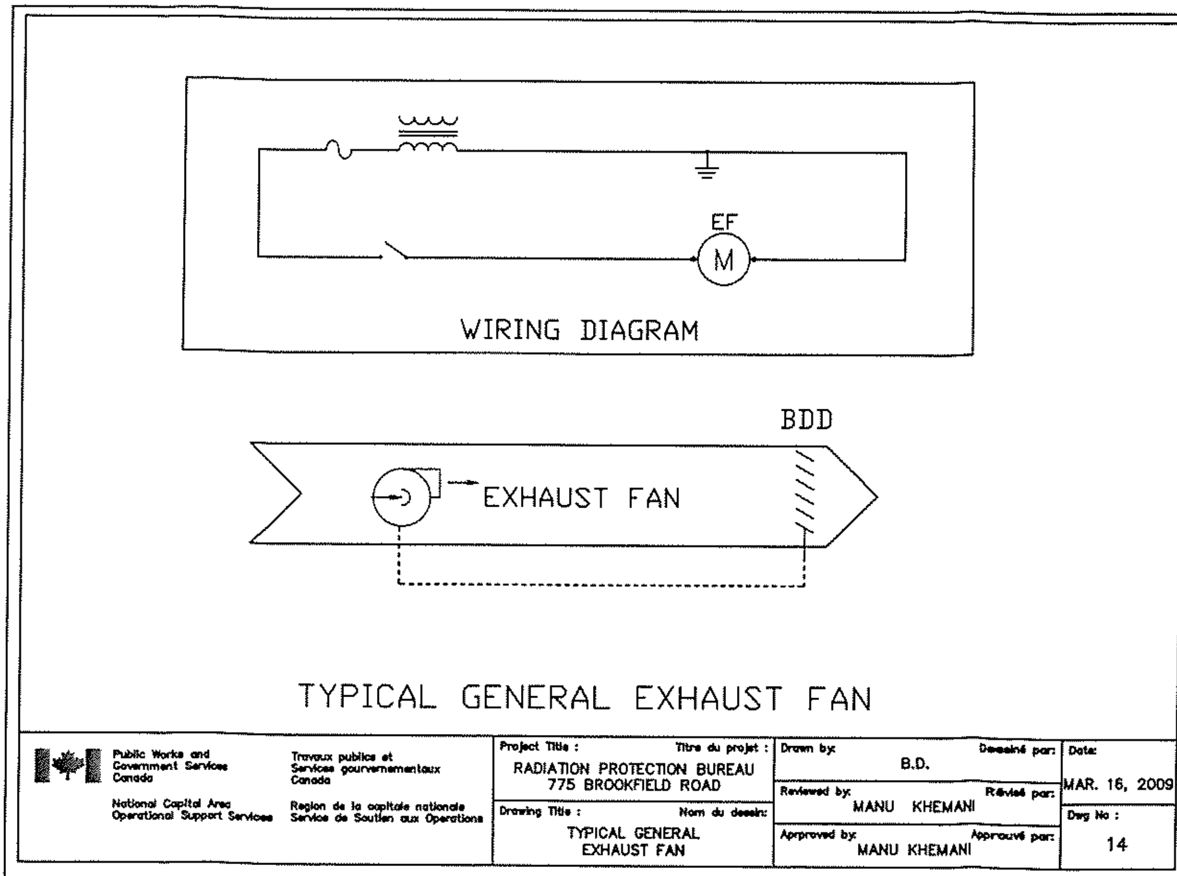
CDS 15 – BOOSTER EXHAUST FAN – FUME HOODS – OLD WING

OPERATION CRITERIA

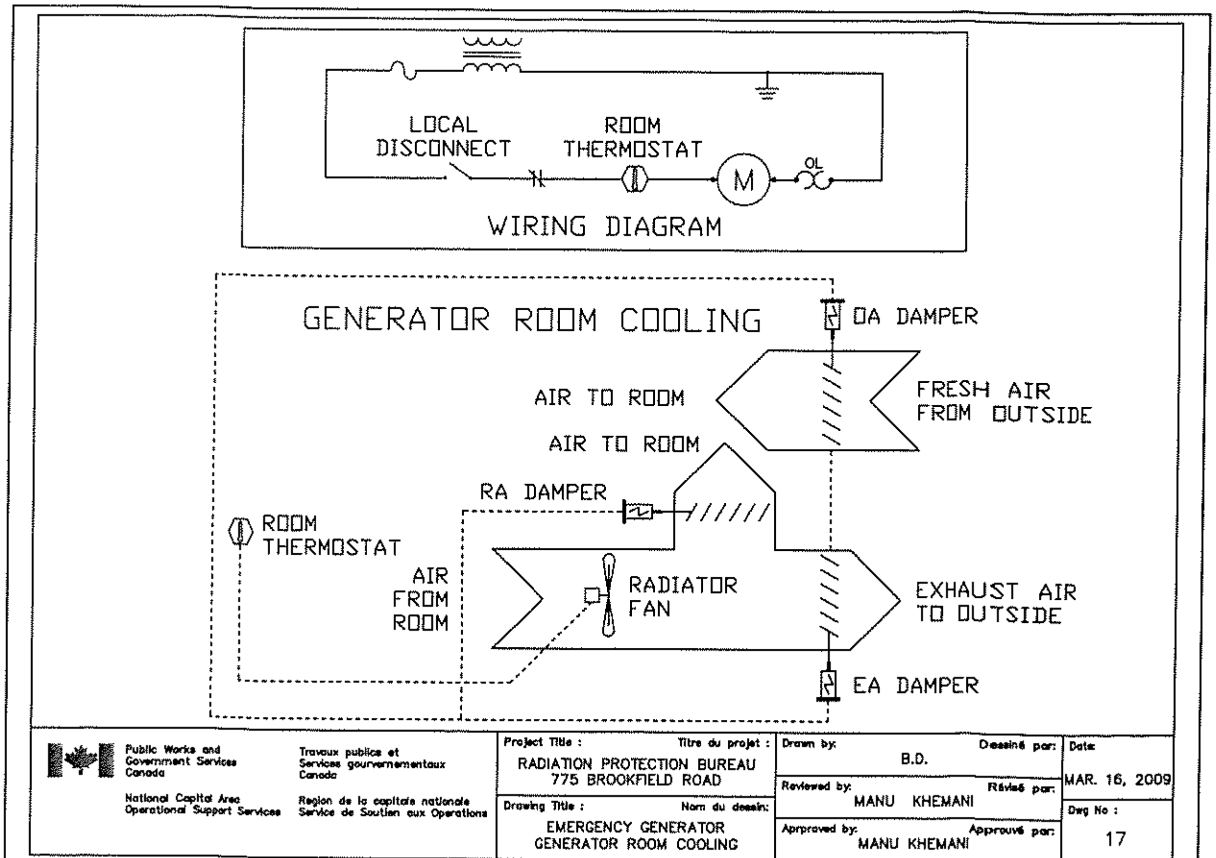
TYPE OF OCCUPANCY
Radiation Protection Bureau has a mix of laboratory and office personnel occupying both Old and New Wings of the building.

AREA SERVED
The Exhaust Fan (EF) serves washrooms in the Old Wing.

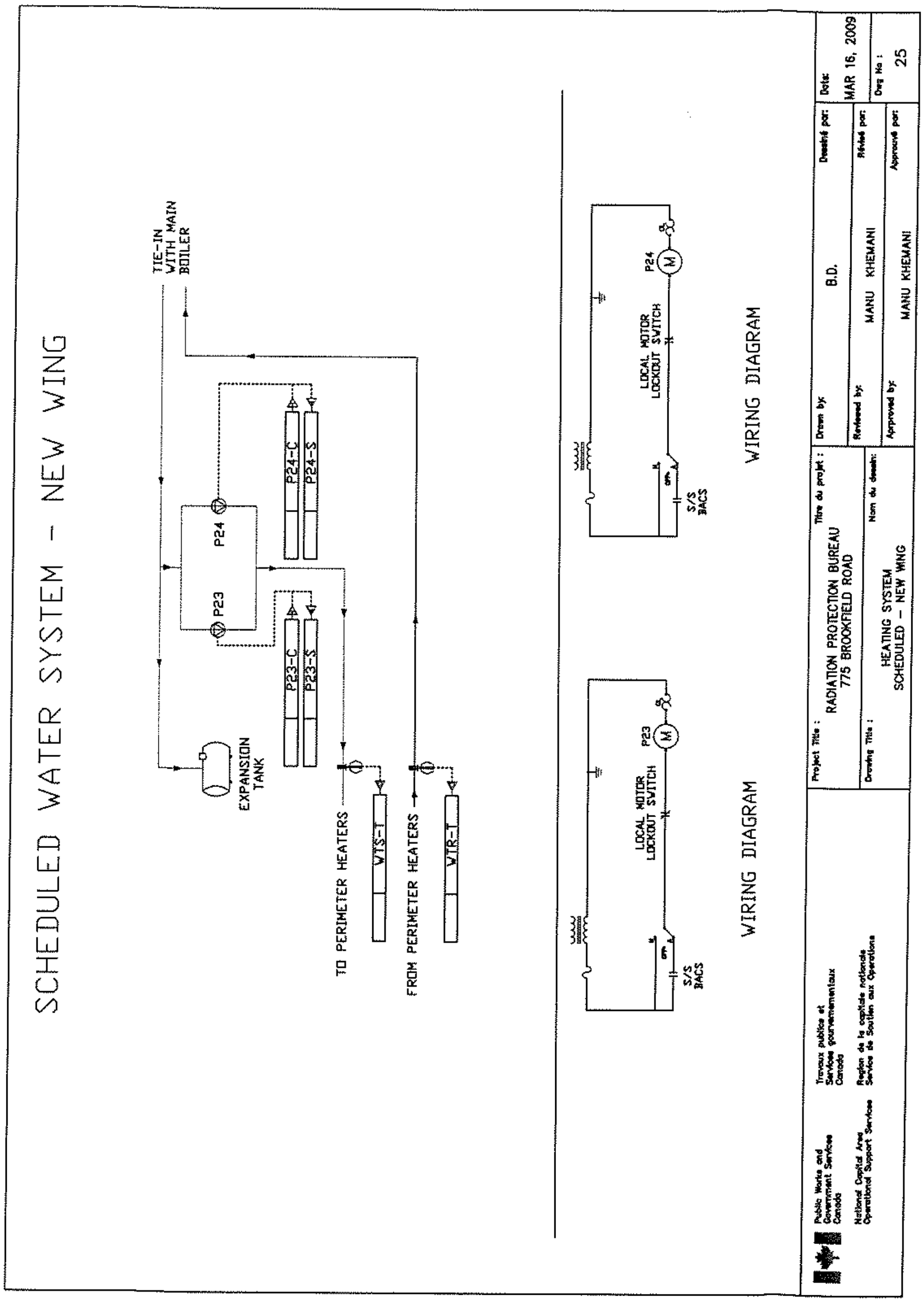
SCHEDULE OF OPERATION
The EF runs continuously. There is no switch to control the fan.



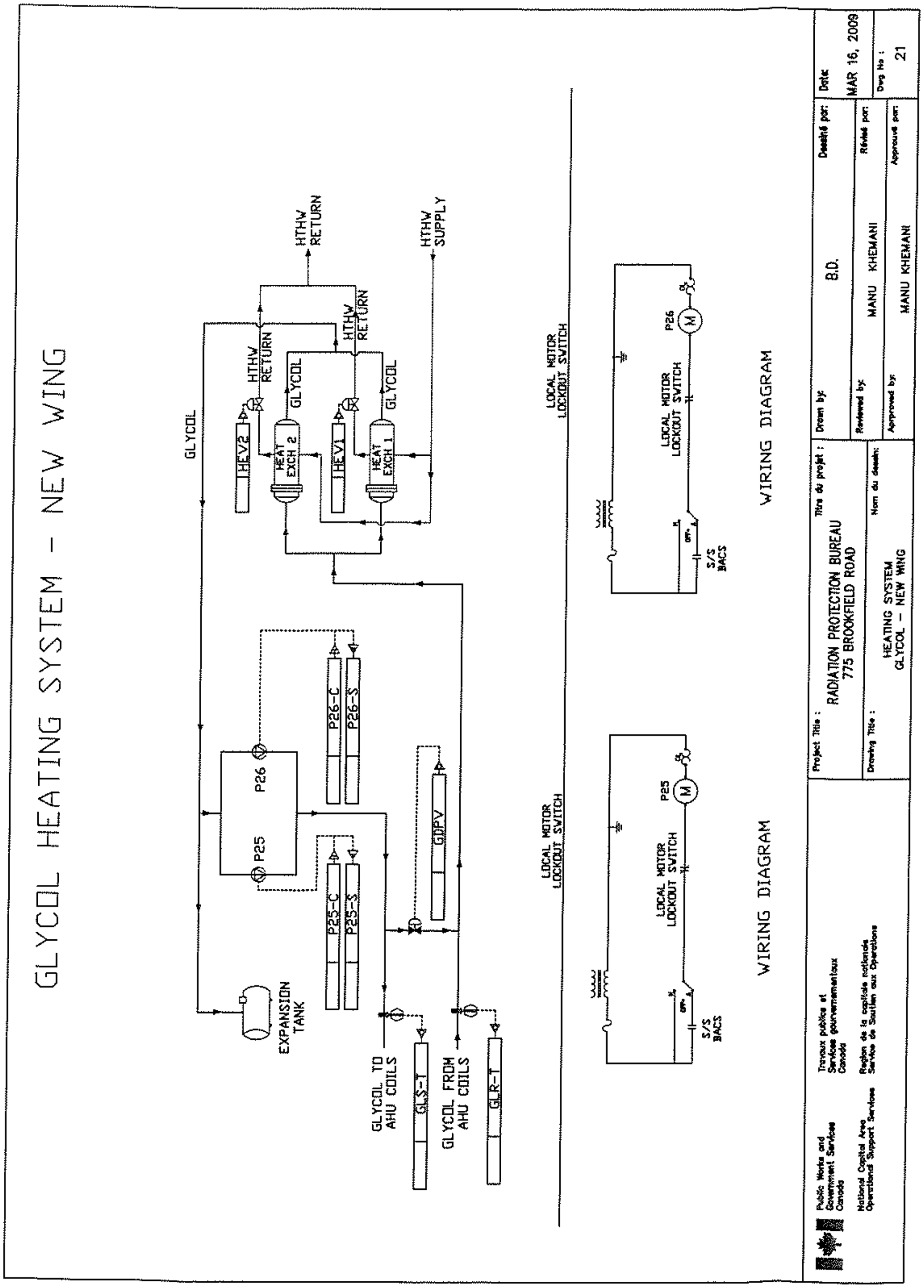
CDS 16 – TYPICAL GENERAL EXHAUST FAN



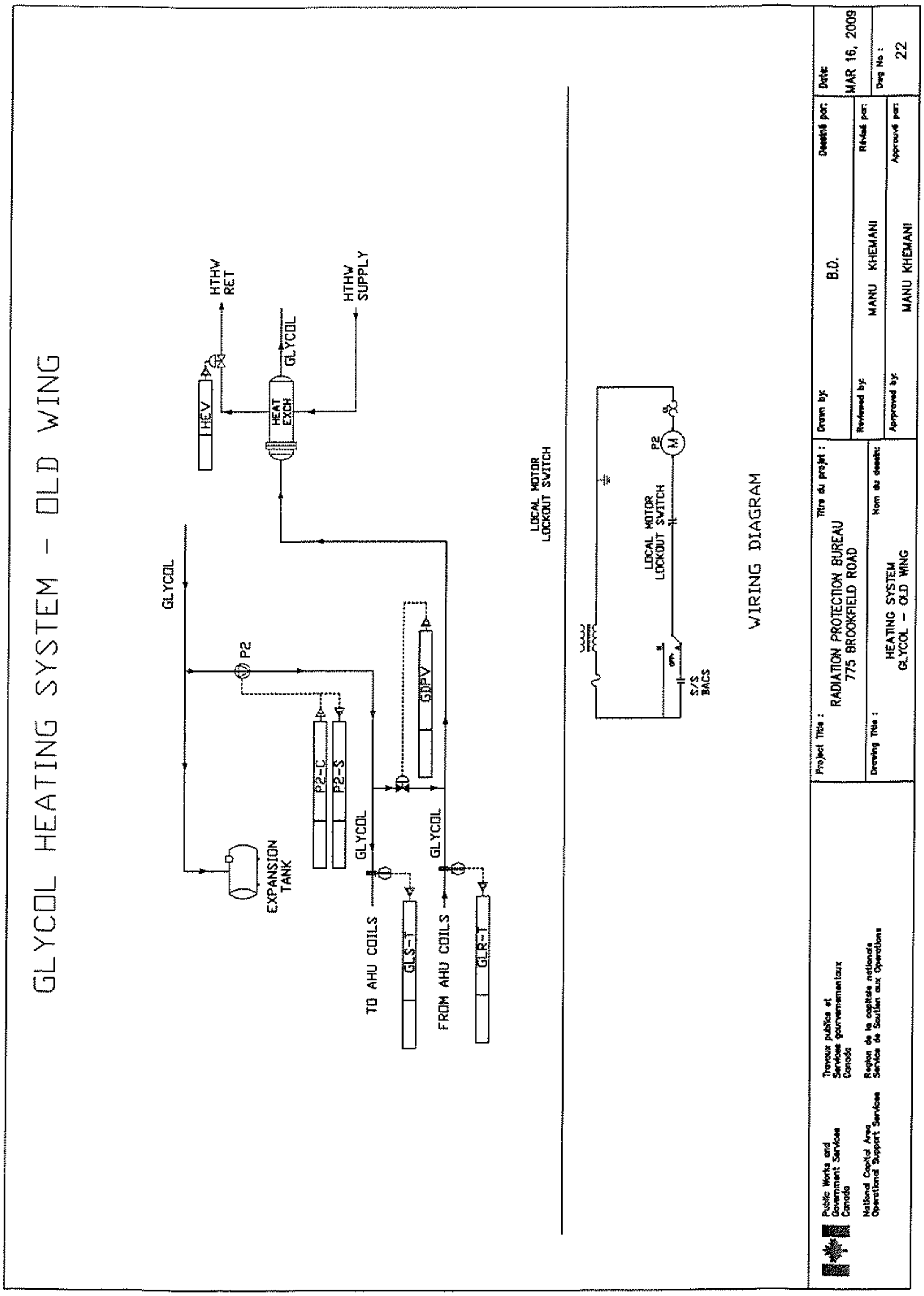
CDS 18 – EMERGENCY GENERATOR – GENERATOR ROOM COOLING



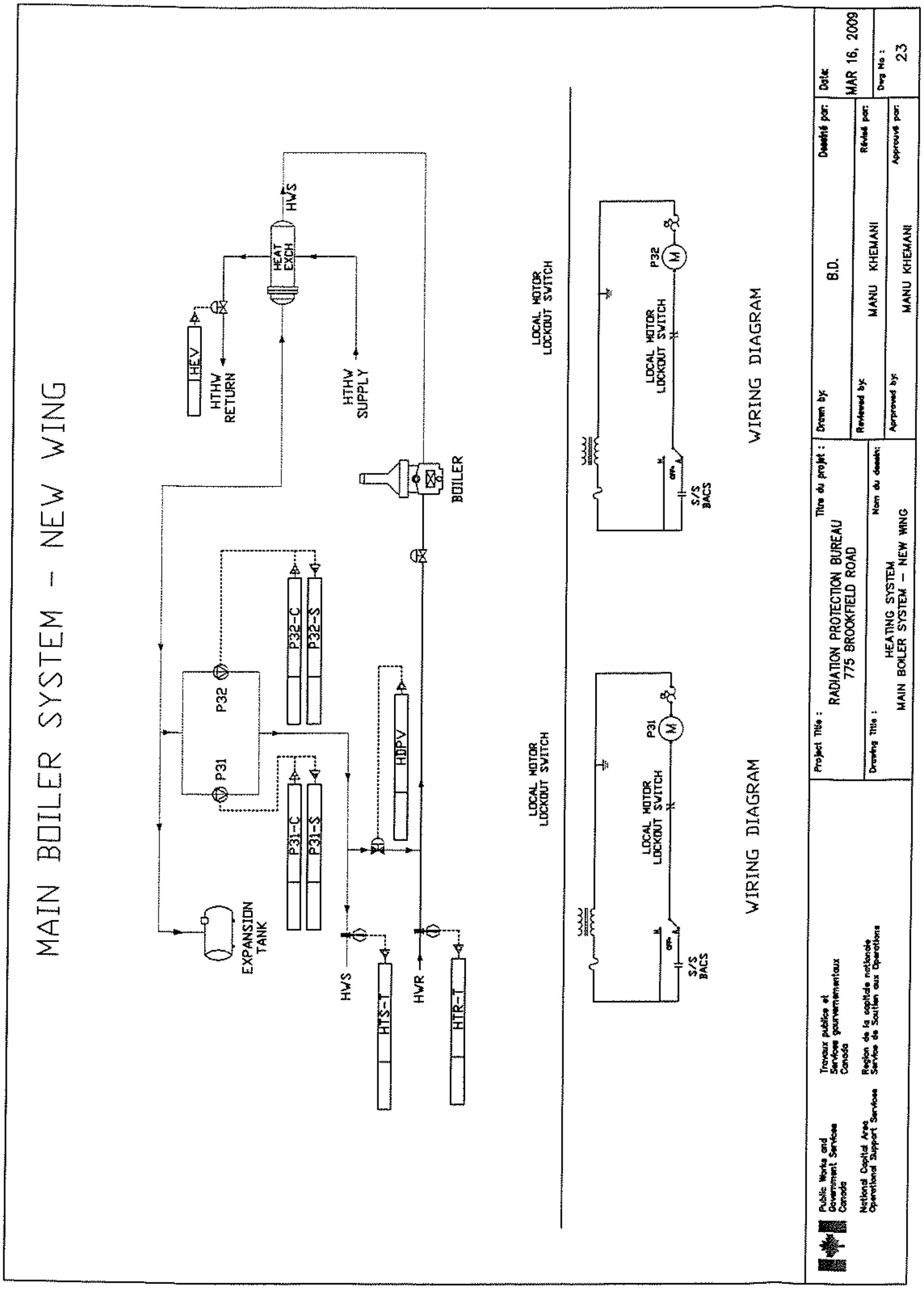
CDS 19 – CONSTANT TEMPERATURE HEATING SYSTEM



CDS 22 – GLYCOL HEATING SYSTEM – NEW WING



CDS 23 – GLYCOL HEATING SYSTEM – OLD WING



CDS 24 – MAIN BOILER SYSTEM (BACK-UP) – NEW WING

OPERATION CRITERIA

TYPE OF OCCUPANCY

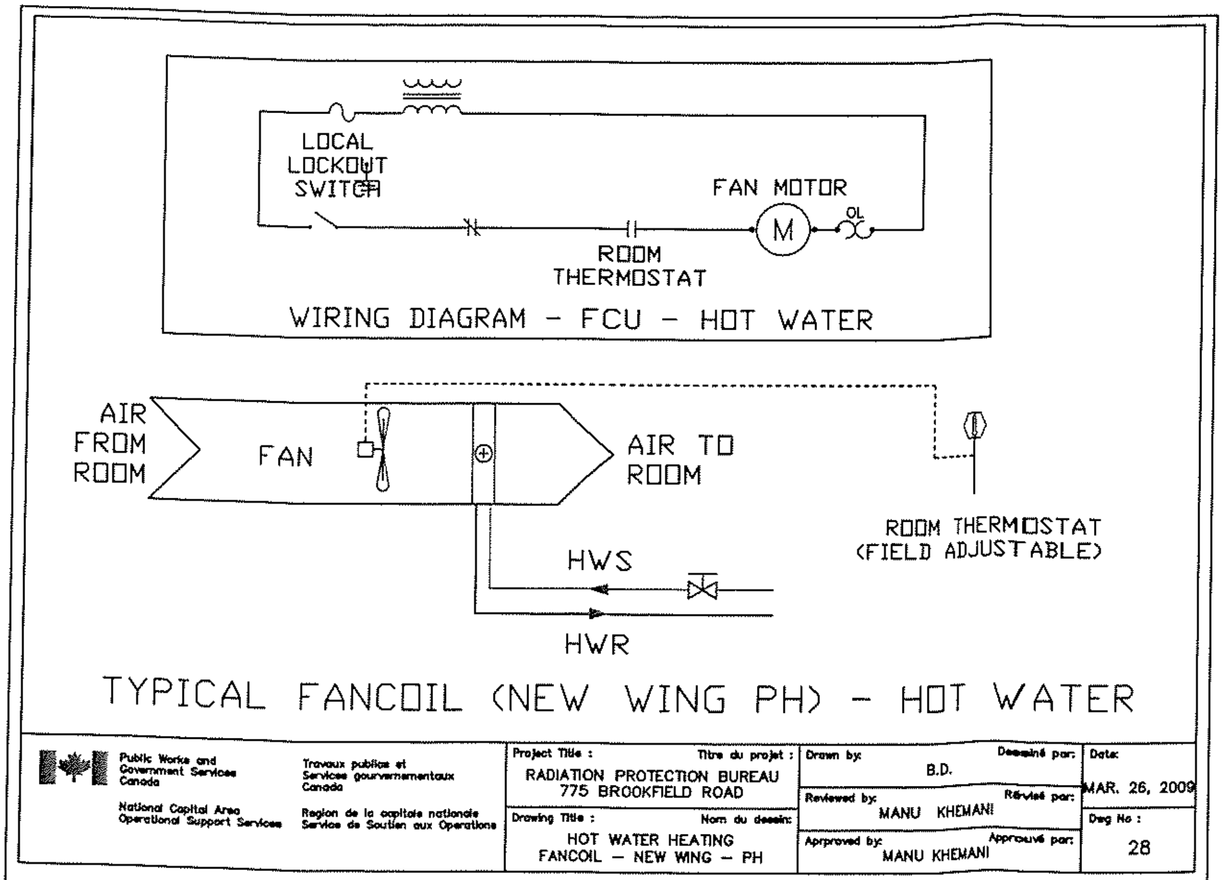
The room served by the fan-coil units has no normal occupancy. It is a Mechanical Room.

AREA SERVED

The fan-coil unit serves to provide heat air in the respective parts of penthouse, to maintain its temperature at a desired level.

SCHEDULE OF OPERATION

The unit does not have a fixed schedule of operation. It starts in response to the demand of the thermostat located in the room.



CDS 29 – TYPICAL FANCOIL HEATER – HOT WATER – NEW WING PH

OPERATION CRITERIA

TYPE OF OCCUPANCY

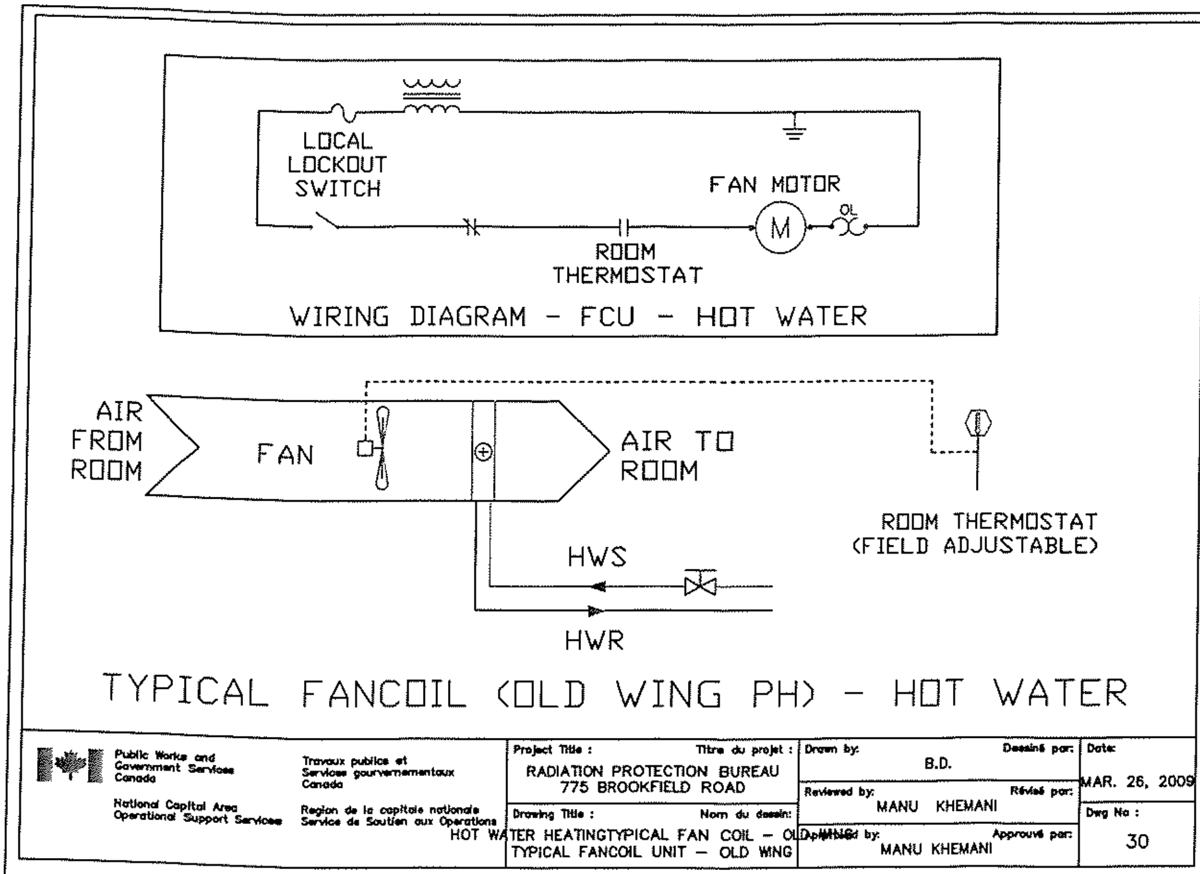
The room served by the fan-coil units has no normal occupancy. It is a Mechanical Room.

AREA SERVED

The fan-coil unit serves to provide heat air in the respective parts of penthouse, to maintain its temperature at a desired level.

SCHEDULE OF OPERATION

The unit does not have a fixed schedule of operation. It starts in response to the demand of the thermostat located in the room.



CDS 31 – TYPICAL FANCOIL HEATER – HOT WATER – OLD WING PH

11. Appendix E – Lighting Retrofit Details

LIGHTING SPREADSHEET

Project: Radiation Protection

0.09325

Area (m2): 104510

Date: Feb.2010

Version: 1

Facility Information	Existing Luminaire Information							Existing Energy Usage			Proposed Measure	Post Retrofit Energy Usage				Installed Cost				Savings			
Room Description	Descripton	Dim	Qty	Mount	Ballast	Lamp	Lamps / Fixture	Watts	Total Watts	Annual kWh	Description	Watts	Hrs	Annual kWh	Total Watts	Material	Labour	Project Costs	Total	kWh	kW	Energy + Demand	Payback
OLD WING - PENTHOUSE																							
MECH PENTHOUSE	INDUST	4'	14	SUSP	EM	T12	2	72	1,008	8,806	28W T8 with LBF Electonic Ballast	42	8,736	5,137	588	$ 308	$ 350	$ 138	$ 796	3,669	0.42	$ 342	2.3
MECH PENTHOUSE	INDUST	4'	17	SUSP	EM	T12	1	36	612	5,346	28W T8 with LBF Electonic Ballast	22	8,736	3,267	374	$ 340	$ 425	$ 161	$ 926	2,079	0.24	$ 194	4.8
MECH PENTHOUSE	TROFFER	2'X4'	1	REC	EM	T12	2	72	72	629	28W T8 with LBF Electonic Ballast	42	8,736	367	42	$ 22	$ 25	$ 10	$ 57	262	0.03	$ 24	2.3
MECH PENTHOUSE	EXIT	N/A	1	SURF	N/A	INCAN	2	30	30	262	LED EXIT	5	8,736	44	5	$ 25	$ 20	$ 9	$ 54	218	0.03	$ 20	2.7
LAB EXHAUST ROOF	SOCKET	N/A	12	SURF	N/A	INCAN	1	100	1,200	10,483	CFL	23	8,736	2,411	276	$ 72	$ 120	$ 40	$ 232	8,072	0.92	$ 753	0.3
LAB EXHAUST ROOF	EXIT	N/A	3	SURF	N/A	INCAN	2	30	90	786	LED EXIT	5	8,736	131	15	$ 75	$ 60	$ 28	$ 163	655	0.08	$ 61	2.7
OLD WING - 1ST FLOOR																							
142	TROFFER	2'X4'	9	REC	EM	T12	4	144	1,296	2,333	28W T8 with LBF Electonic Ballast	84	1,800	1,361	756	$ 234	$ 225	$ 96	$ 555	972	0.54	$ 91	6.1
141	TROFFER	8"X4'	4	REC	EM	T12	2	72	288	518	28W T8 with LBF Electonic Ballast	42	1,800	302	168	$ 88	$ 100	$ 39	$ 227	216	0.12	$ 20	11.3
140	TROFFER	2'X4'	4	REC	EM	T12	2	72	288	518	28W T8 with LBF Electonic Ballast	42	1,800	302	168	$ 88	$ 100	$ 39	$ 227	216	0.12	$ 20	11.3
139	TROFFER	2'X4'	4	REC	EM	T12	2	72	288	518	28W T8 with LBF Electonic Ballast	42	1,800	302	168	$ 88	$ 100	$ 39	$ 227	216	0.12	$ 20	11.3
137	TROFFER	2'X4'	2	REC	EM	T12	2	72	144	259	28W T8 with LBF Electonic Ballast	42	1,800	151	84	$ 44	$ 50	$ 20	$ 114	108	0.06	$ 10	11.3
138	TROFFER	2'X4'	15	REC	EM	T12	2	72	1,080	1,944	28W T8 with LBF Electonic Ballast	42	1,800	1,134	630	$ 330	$ 375	$ 148	$ 853	810	0.45	$ 76	11.3
135	TROFFER	2'X4'	15	REC	EM	T12	2	72	1,080	1,944	28W T8 with LBF Electonic Ballast	42	1,800	1,134	630	$ 330	$ 375	$ 148	$ 853	810	0.45	$ 76	11.3
132	TROFFER	2'X4'	12	REC	EM	T12	4	144	1,728	3,110	28W T8 with LBF Electonic Ballast	84	1,800	1,814	1,008	$ 312	$ 300	$ 129	$ 741	1,296	0.72	$ 121	6.1
133	TROFFER	2'X4'	2	REC	EM	T12	4	144	288	518	28W T8 with LBF Electonic Ballast	84	1,800	302	168	$ 52	$ 50	$ 21	$ 123	216	0.12	$ 20	6.1
147	TROFFER	2'X4'	9	REC	EM	T12	2	72	648	1,166	28W T8 with LBF Electonic Ballast	42	1,800	680	378	$ 198	$ 225	$ 89	$ 512	486	0.27	$ 45	11.3
144	TROFFER	2'X4'	16	REC	EM	T12	2	72	1,152	2,074	28W T8 with LBF Electonic Ballast	42	1,800	1,210	672	$ 352	$ 400	$ 158	$ 910	864	0.48	$ 81	11.3
146	TROFFER	2'X4'	8	REC	EM	T12	2	72	576	1,037	28W T8 with LBF Electonic Ballast	42	1,800	605	336	$ 176	$ 200	$ 79	$ 455	432	0.24	$ 40	11.3
145	TROFFER	2'X4'	16	REC	EM	T12	2	72	1,152	2,074	28W T8 with LBF Electonic Ballast	42	1,800	1,210	672	$ 352	$ 400	$ 158	$ 910	864	0.48	$ 81	11.3
147	TROFFER	2'X4'	8	REC	EM	T12	2	72	576	1,037	28W T8 with LBF Electonic Ballast	42	1,800	605	336	$ 176	$ 200	$ 79	$ 455	432	0.24	$ 40	11.3
149	TROFFER	2'X4'	20	REC	EM	T12	2	72	1,440	2,592	28W T8 with LBF Electonic Ballast	42	1,800	1,512	840	$ 440	$ 500	$ 197	$ 1,137	1,080	0.60	$ 101	11.3
150	TROFFER	2'X4'	8	REC	EM	T12	2	72	576	1,037	28W T8 with LBF Electonic Ballast	42	1,800	605	336	$ 176	$ 200	$ 79	$ 455	432	0.24	$ 40	11.3
151	TROFFER	2'X4'	4	REC	EM	T12	2	72	288	518	28W T8 with LBF Electonic Ballast	42	1,800	302	168	$ 88	$ 100	$ 39	$ 227	216	0.12	$ 20	11.3
153	TROFFER	2'X4'	8	REC	EM	T12	2	72	576	1,037	28W T8 with LBF Electonic Ballast	42	1,800	605	336	$ 176	$ 200	$ 79	$ 455	432	0.24	$ 40	11.3
154	TROFFER	2'X4'	8	REC	EM	T12	2	72	576	1,037	28W T8 with LBF Electonic Ballast	42	1,800	605	336	$ 176	$ 200	$ 79	$ 455	432	0.24	$ 40	11.3
155	TROFFER	2'X4'	8	REC	EM	T12	2	72	576	1,037	28W T8 with LBF Electonic Ballast	42	1,800	605	336	$ 176	$ 200	$ 79	$ 455	432	0.24	$ 40	11.3
156	TROFFER	2'X4'	8	REC	EM	T12	2	72	576	1,037	28W T8 with LBF Electonic Ballast	42	1,800	605	336	$ 176	$ 200	$ 79	$ 455	432	0.24	$ 40	11.3
157	TROFFER	2'X4'	12	REC	EM	T12	2	72	864	1,555	28W T8 with LBF Electonic Ballast	42	1,800	907	504	$ 264	$ 300	$ 118	$ 682	648	0.36	$ 60	11.3
131	INDUST	4'	2	SUSP	EM	T12	2	72	144	259	28W T8 with LBF Electonic Ballast	42	1,800	151	84	$ 44	$ 50	$ 20	$ 114	108	0.06	$ 10	11.3
STORAGE	POT	N/A	4	REC	N/A	INCAN	1	100	400	180	CFL	23	450	41	92	$ 20	$ 40	$ 13	$ 73	139	0.31	$ 13	5.6
CORRIDOR	TROFFER	8"X4'	26	REC	EM	T12	2	72	1,872	16,354	28W T8 with LBF Electonic Ballast	42	8,736	9,540	1,092	$ 572	$ 650	$ 257	$ 1,479	6,814	0.78	$ 635	2.3
MEN'S WASH	INDUST	4'	2	SURF	EM	T12	1	36	72	629	28W T8 with LBF Electonic Ballast	22	8,736	384	44	$ 40	$ 50	$ 19	$ 109	245	0.03	$ 23	4.8
WOMEN'S WASH	INDUST	4'	2	SURF	EM	T12	1	36	72	629	28W T8 with LBF Electonic Ballast	22	8,736	384	44	$ 40	$ 50	$ 19	$ 109	245	0.03	$ 23	4.8
JANITOR	INDUST	4'	1	SURF	EM	T12	1	36	36	16	28W T8 with LBF Electonic Ballast	22	450	10	22	$ 20	$ 25	$ 9	$ 54	6	0.01	$ 1	92.7
	EXIT	N/A	4	SURF	N/A	INCAN	2	30	120	1,048	LED EXIT	5	8,736	175	20	$ 100	$ 80	$ 38	$ 218	874	0.10	$ 81	2.7
OLD WING - D STAIRS																							
	TROFFER	8"X4'	2	REC	EM	T12	2	72	144	1,258	28W T8 with LBF Electonic Ballast	42	8,736	734	84	$ 44	$ 50	$ 20	$ 114	524	0.06	$ 49	2.3
OLD WING - E STAIRS																							
	TROFFER	8"X4'	7	REC	EM	T12	2	72	504	4,403	28W T8 with LBF Electonic Ballast	42	8,736	2,568	294	$ 154	$ 175	$ 69	$ 398	1,835	0.21	$ 171	2.3
OLD WING - F STAIRS																							
	TROFFER	8"X4'	3	REC	EM	T12	2	72	216	1,887	28W T8 with LBF Electonic Ballast	42	8,736	1,101	126	$ 66	$ 75	$ 30	$ 171	786	0.09	$ 73	2.3
OLD WING - 2ND FLOOR																							
279	INDUST	4'	45	SURF	EM	T12	2	72	3,240	5,832	28W T8 with LBF Electonic Ballast	42	1,800	3,402	1,890	$ 990	$ 1,125	$ 444	$ 2,559	2,430	1.35	$ 227	11.3
276	TROFFER	8"X4'	9	REC	EM	T12	2	72	648	1,166	28W T8 with LBF Electonic Ballast	42	1,800	680	378	$ 198	$ 225	$ 89	$ 512	486	0.27	$ 45	11.3
275	TROFFER	2'X4'	4	REC	EM	T12	2	72	288	518	28W T8 with LBF Electonic Ballast	42	1,800	302	168	$ 88	$ 100	$ 39	$ 227	216	0.12	$ 20	11.3

Facility Information	Existing Luminaire Information							Existing Energy Usage			Proposed Measure	Post Retrofit Energy Usage				Installed Cost				Savings			
Room Description	Descripton	Dim	Qty	Mount	Ballast	Lamp	Lamps / Fixture	Watts	Total Watts	Annual kWh	Description	Watts	Hrs	Annual kWh	Total Watts	Material	Labour	Project Costs	Total	kWh	kW	Energy + Demand	Payback
274	TROFFER	2'X4'	6	REC	EM	T12	2	72	432	778	28W T8 with LBF Electonic Ballast	42	1,800	454	252	$ 132	$ 150	$ 59	$ 341	324	0.18	$ 30	11.3
273	TROFFER	2'X4'	4	REC	EM	T12	2	72	288	518	28W T8 with LBF Electonic Ballast	42	1,800	302	168	$ 88	$ 100	$ 39	$ 227	216	0.12	$ 20	11.3
272	TROFFER	2'X4'	9	REC	EM	T12	2	72	648	1,166	28W T8 with LBF Electonic Ballast	42	1,800	680	378	$ 198	$ 225	$ 89	$ 512	486	0.27	$ 45	11.3
271	TROFFER	2'X4'	6	REC	EM	T12	2	72	432	778	28W T8 with LBF Electonic Ballast	42	1,800	454	252	$ 132	$ 150	$ 59	$ 341	324	0.18	$ 30	11.3
269	TROFFER	2'X4'	6	REC	EM	T12	2	72	432	778	28W T8 with LBF Electonic Ballast	42	1,800	454	252	$ 132	$ 150	$ 59	$ 341	324	0.18	$ 30	11.3
270	TROFFER	2'X4'	6	REC	EM	T12	2	72	432	778	28W T8 with LBF Electonic Ballast	42	1,800	454	252	$ 132	$ 150	$ 59	$ 341	324	0.18	$ 30	11.3
267	TROFFER	2'X4'	7	REC	EM	T12	2	72	504	907	28W T8 with LBF Electonic Ballast	42	1,800	529	294	$ 154	$ 175	$ 69	$ 398	378	0.21	$ 35	11.3
268	TROFFER	2'X4'	9	REC	EM	T12	2	72	648	1,166	28W T8 with LBF Electonic Ballast	42	1,800	680	378	$ 198	$ 225	$ 89	$ 512	486	0.27	$ 45	11.3
266	TROFFER	2'X4'	9	REC	EM	T12	2	72	648	1,166	28W T8 with LBF Electonic Ballast	42	1,800	680	378	$ 198	$ 225	$ 89	$ 512	486	0.27	$ 45	11.3
265	TROFFER	2'X4'	16	REC	EM	T12	2	72	1,152	2,074	28W T8 with LBF Electonic Ballast	42	1,800	1,210	672	$ 352	$ 400	$ 158	$ 910	864	0.48	$ 81	11.3
264	TROFFER	2'X4'	9	REC	EM	T12	2	72	648	1,166	28W T8 with LBF Electonic Ballast	42	1,800	680	378	$ 198	$ 225	$ 89	$ 512	486	0.27	$ 45	11.3
263	TROFFER	2'X4'	4	REC	EM	T12	2	72	288	518	28W T8 with LBF Electonic Ballast	42	1,800	302	168	$ 88	$ 100	$ 39	$ 227	216	0.12	$ 20	11.3
261	TROFFER	2'X4'	12	REC	EM	T12	2	72	864	1,555	28W T8 with LBF Electonic Ballast	42	1,800	907	504	$ 264	$ 300	$ 118	$ 682	648	0.36	$ 60	11.3
262	TROFFER	2'X4'	6	REC	EM	T12	2	72	432	778	28W T8 with LBF Electonic Ballast	42	1,800	454	252	$ 132	$ 150	$ 59	$ 341	324	0.18	$ 30	11.3
260	TROFFER	2'X4'	2	REC	E	T8	4	120	240	432	Remain As Is	120	1,800	432	240								
259	TROFFER	2'X4'	12	REC	EM	T12	2	72	864	1,555	28W T8 with LBF Electonic Ballast	42	1,800	907	504	$ 264	$ 300	$ 118	$ 682	648	0.36	$ 60	11.3
258	TROFFER	2'X4'	12	REC	EM	T12	2	72	864	1,555	28W T8 with LBF Electonic Ballast	42	1,800	907	504	$ 264	$ 300	$ 118	$ 682	648	0.36	$ 60	11.3
256	TROFFER	2'X4'	8	REC	EM	T12	2	72	576	1,037	28W T8 with LBF Electonic Ballast	42	1,800	605	336	$ 176	$ 200	$ 79	$ 455	432	0.24	$ 40	11.3
241	TROFFER	2'X4'	2	REC	EM	T12	2	72	144	259	28W T8 with LBF Electonic Ballast	42	1,800	151	84	$ 44	$ 50	$ 20	$ 114	108	0.06	$ 10	11.3
241	TROFFER	8"X4'	4	REC	EM	T12	2	72	288	518	28W T8 with LBF Electonic Ballast	42	1,800	302	168	$ 88	$ 100	$ 39	$ 227	216	0.12	$ 20	11.3
242	TROFFER	2'X4'	7	REC	EM	T12	2	72	504	907	28W T8 with LBF Electonic Ballast	42	1,800	529	294	$ 154	$ 175	$ 69	$ 398	378	0.21	$ 35	11.3
244	TROFFER	2'X4'	4	REC	EM	T12	2	72	288	518	28W T8 with LBF Electonic Ballast	42	1,800	302	168	$ 88	$ 100	$ 39	$ 227	216	0.12	$ 20	11.3
246	TROFFER	2'X4'	2	REC	EM	T12	2	72	144	259	28W T8 with LBF Electonic Ballast	42	1,800	151	84	$ 44	$ 50	$ 20	$ 114	108	0.06	$ 10	11.3
247	TROFFER	2'X4'	4	REC	EM	T12	2	72	288	518	28W T8 with LBF Electonic Ballast	42	1,800	302	168	$ 88	$ 100	$ 39	$ 227	216	0.12	$ 20	11.3
248	TROFFER	2'X4'	4	REC	EM	T12	2	72	288	518	28W T8 with LBF Electonic Ballast	42	1,800	302	168	$ 88	$ 100	$ 39	$ 227	216	0.12	$ 20	11.3
249	TROFFER	2'X4'	4	REC	EM	T12	2	72	288	518	28W T8 with LBF Electonic Ballast	42	1,800	302	168	$ 88	$ 100	$ 39	$ 227	216	0.12	$ 20	11.3
250	TROFFER	2'X4'	4	REC	EM	T12	2	72	288	518	28W T8 with LBF Electonic Ballast	42	1,800	302	168	$ 88	$ 100	$ 39	$ 227	216	0.12	$ 20	11.3
251	TROFFER	2'X4'	4	REC	EM	T12	2	72	288	518	28W T8 with LBF Electonic Ballast	42	1,800	302	168	$ 88	$ 100	$ 39	$ 227	216	0.12	$ 20	11.3
252	TROFFER	2'X4'	4	REC	EM	T12	2	72	288	518	28W T8 with LBF Electonic Ballast	42	1,800	302	168	$ 88	$ 100	$ 39	$ 227	216	0.12	$ 20	11.3
253	TROFFER	2'X4'	4	REC	EM	T12	2	72	288	518	28W T8 with LBF Electonic Ballast	42	1,800	302	168	$ 88	$ 100	$ 39	$ 227	216	0.12	$ 20	11.3
254	TROFFER	2'X4'	4	REC	EM	T12	2	72	288	518	28W T8 with LBF Electonic Ballast	42	1,800	302	168	$ 88	$ 100	$ 39	$ 227	216	0.12	$ 20	11.3
OPEN OFFICE AREA	TROFFER	8"X4'	56	REC	EM	T12	2	72	4,032	7,258	28W T8 with LBF Electonic Ballast	42	1,800	4,234	2,352	$ 1,232	$ 1,400	$ 553	$ 3,185	3,024	1.68	$ 282	11.3
MEN'S WASH	INDUST	4'	2	SURF	EM	T12	1	36	72	629	28W T8 with LBF Electonic Ballast	22	8,736	384	44	$ 40	$ 50	$ 19	$ 109	245	0.03	$ 23	4.8
WOMEN'S WASH	INDUST	4'	2	SURF	EM	T12	1	36	72	629	28W T8 with LBF Electonic Ballast	22	8,736	384	44	$ 40	$ 50	$ 19	$ 109	245	0.03	$ 23	4.8
CORRIDOR	TROFFER	8"X4'	27	REC	EM	T12	2	72	1,944	16,983	28W T8 with LBF Electonic Ballast	42	8,736	9,907	1,134	$ 594	$ 675	$ 266	$ 1,535	7,076	0.81	$ 660	2.3
JANITOR	INDUST	4'	1	SURF	EM	T12	1	36	36	16	28W T8 with LBF Electonic Ballast	22	450	10	22	$ 20	$ 25	$ 9	$ 54	6	0.01	$ 1	92.7
	EXIT	N/A	4	SURF	N/A	INCAN	2	30	120	1,048	LED EXIT	5	8,736	175	20	$ 100	$ 80	$ 38	$ 218	874	0.10	$ 81	2.7
NEW WING - PENTHOUSE																							
MECH PENTHOUSE	TROFFER	8"X4'	2	REC	EM	T12	2	72	144	1,258	28W T8 with LBF Electonic Ballast	42	8,736	734	84	$ 44	$ 50	$ 20	$ 114	524	0.06	$ 49	2.3
MECH PENTHOUSE	INDUST	4'	57	SURF	EM	T12	2	72	4,104	35,853	28W T8 with LBF Electonic Ballast	42	8,736	20,914	2,394	$ 1,254	$ 1,425	$ 563	$ 3,242	14,939	1.71	$ 1,393	2.3
MECH PENTHOUSE	INDUST	4'	2	SURF	E	T8	2	60	120	1,048	28W T8 with LBF Electonic Ballast	42	8,736	734	84	$ 44	$ 50	$ 20	$ 114	314	0.04	$ 29	3.9
MECH PENTHOUSE	EXIT	N/A	4	SURF	N/A	INCAN	2	30	120	1,048	LED EXIT	5	8,736	175	20	$ 100	$ 80	$ 38	$ 218	874	0.10	$ 81	2.7
NEW WING - 3RD FLOOR																							
CORRIDOR	WRAP	8"X4'	13	SURF	EM	T12	2	72	936	8,177	28W T8 with LBF Electonic Ballast	42	8,736	4,770	546	$ 286	$ 325	$ 128	$ 739	3,407	0.39	$ 318	2.3
CORRIDOR	POT	N/A	8	REC	EM	PL	1	23	184	1,607	Remain As Is	23	8,736	1,607	184								
323	TROFFER	8"X4'	16	REC	EM	T12	2	72	1,152	2,074	28W T8 with LBF Electonic Ballast	42	1,800	1,210	672	$ 352	$ 400	$ 158	$ 910	864	0.48	$ 81	11.3
322	TROFFER	8"X4'	34	REC	EM	T12	2	72	2,448	4,406	28W T8 with LBF Electonic Ballast	42	1,800	2,570	1,428	$ 748	$ 850	$ 336	$ 1,934	1,836	1.02	$ 171	11.3
321	TROFFER	8"X4'	27	REC	EM	T12	2	72	1,944	3,499	28W T8 with LBF Electonic Ballast	42	1,800	2,041	1,134	$ 594	$ 675	$ 266	$ 1,535	1,458	0.81	$ 136	11.3
320	TROFFER	8"X4'	4	REC	EM	T12	2	72	288	518	28W T8 with LBF Electonic Ballast	42	1,800	302	168	$ 88	$ 100	$ 39	$ 227	216	0.12	$ 20	11.3
318	TROFFER	8"X4'	16	REC	EM	T12	2	72	1,152	2,074	28W T8 with LBF Electonic Ballast	42	1,800	1,210	672	$ 352	$ 400	$ 158	$ 910	864	0.48	$ 81	11.3
317	TROFFER	8"X4'	6	REC	EM	T12	2	72	432	778	28W T8 with LBF Electonic Ballast	42	1,800	454	252	$ 132	$ 150	$ 59	$ 341	324	0.18	$ 30	11.3
319	TROFFER	8"X4'	4	REC	EM	T12	2	72	288	518	28W T8 with LBF Electonic Ballast	42	1,800	302	168	$ 88	$ 100	$ 39	$ 227	216	0.12	$ 20	11.3
316	TROFFER	8"X4'	8	REC	EM	T12	2	72	576	1,037	28W T8 with LBF Electonic Ballast	42	1,800	605	336	$ 176	$ 200	$ 79	$ 455	432	0.24	$ 40	11.3

Facility Information	Existing Luminaire Information							Existing Energy Usage			Proposed Measure	Post Retrofit Energy Usage				Installed Cost				Savings			
Room Description	Descripton	Dim	Qty	Mount	Ballast	Lamp	Lamps / Fixture	Watts	Total Watts	Annual kWh	Description	Watts	Hrs	Annual kWh	Total Watts	Material	Labour	Project Costs	Total	kWh	kW	Energy + Demand	Payback
313	TROFFER	8"X4'	6	REC	EM	T12	2	72	432	778	28W T8 with LBF Electonic Ballast	42	1,800	454	252	$ 132	$ 150	$ 59	$ 341	324	0.18	$ 30	11.3
314	TROFFER	8"X4'	8	REC	EM	T12	2	72	576	1,037	28W T8 with LBF Electonic Ballast	42	1,800	605	336	$ 176	$ 200	$ 79	$ 455	432	0.24	$ 40	11.3
311	TROFFER	8"X4'	8	REC	EM	T12	2	72	576	1,037	28W T8 with LBF Electonic Ballast	42	1,800	605	336	$ 176	$ 200	$ 79	$ 455	432	0.24	$ 40	11.3
309	TROFFER	8"X4'	8	REC	EM	T12	2	72	576	1,037	28W T8 with LBF Electonic Ballast	42	1,800	605	336	$ 176	$ 200	$ 79	$ 455	432	0.24	$ 40	11.3
312	TROFFER	8"X4'	8	REC	EM	T12	2	72	576	1,037	28W T8 with LBF Electonic Ballast	42	1,800	605	336	$ 176	$ 200	$ 79	$ 455	432	0.24	$ 40	11.3
310	TROFFER	8"X4'	8	REC	EM	T12	2	72	576	1,037	28W T8 with LBF Electonic Ballast	42	1,800	605	336	$ 176	$ 200	$ 79	$ 455	432	0.24	$ 40	11.3
308	TROFFER	8"X4'	8	REC	EM	T12	2	72	576	1,037	28W T8 with LBF Electonic Ballast	42	1,800	605	336	$ 176	$ 200	$ 79	$ 455	432	0.24	$ 40	11.3
307	TROFFER	8"X4'	15	REC	EM	T12	2	72	1,080	1,944	28W T8 with LBF Electonic Ballast	42	1,800	1,134	630	$ 330	$ 375	$ 148	$ 853	810	0.45	$ 76	11.3
306	INDUST	4'	2	SURF	EM	T12	2	72	144	259	28W T8 with LBF Electonic Ballast	42	1,800	151	84	$ 44	$ 50	$ 20	$ 114	108	0.06	$ 10	11.3
301	TROFFER	8"X4'	16	REC	EM	T12	2	72	1,152	2,074	28W T8 with LBF Electonic Ballast	42	1,800	1,210	672	$ 352	$ 400	$ 158	$ 910	864	0.48	$ 81	11.3
302	TROFFER	8"X4'	4	REC	EM	T12	2	72	288	518	28W T8 with LBF Electonic Ballast	42	1,800	302	168	$ 88	$ 100	$ 39	$ 227	216	0.12	$ 20	11.3
303	TROFFER	2'X4'	8	REC	E	T8	2	60	480	864	Remain As Is	60	1,800	864	480								
305	INDUST	4'	14	SURF	E	T8	2	60	840	1,512	Remain As Is	60	1,800	1,512	840								
MEN'S WASH	INDUST	4'	12	SURF	EM	T12	1	36	432	3,774	28W T8 with LBF Electonic Ballast	22	8,736	2,306	264	$ 240	$ 300	$ 113	$ 653	1,468	0.17	$ 137	4.8
WOMEN'S WASH	INDUST	4'	12	SURF	EM	T12	1	36	432	3,774	28W T8 with LBF Electonic Ballast	22	8,736	2,306	264	$ 240	$ 300	$ 113	$ 653	1,468	0.17	$ 137	4.8
JANITOR	INDUST	4'	1	SURF	EM	T12	1	36	36	16	28W T8 with LBF Electonic Ballast	22	450	10	22	$ 20	$ 25	$ 9	$ 54	6	0.01	$ 1	92.7
	EXIT	N/A	4	SURF	N/A	INCAN	2	30	120	1,048	LED EXIT	5	8,736	175	20	$ 100	$ 80	$ 38	$ 218	874	0.10	$ 81	2.7
NEW WING - B STAIRS																							
CORRIDOR	WRAP	8"X4'	8	SURF	EM	T12	2	72	576	5,032	28W T8 with LBF Electonic Ballast	42	8,736	2,935	336	$ 176	$ 200	$ 79	$ 455	2,097	0.24	$ 196	2.3
NEW WING - 2ND FLOOR																							
CORRIDOR	WRAP	8"X4'	14	SURF	EM	T12	2	72	1,008	8,806	28W T8 with LBF Electonic Ballast	42	8,736	5,137	588	$ 308	$ 350	$ 138	$ 796	3,669	0.42	$ 342	2.3
238	TROFFER	8"X4'	35	REC	EM	T12	2	72	2,520	4,536	28W T8 with LBF Electonic Ballast	42	1,800	2,646	1,470	$ 770	$ 875	$ 345	$ 1,990	1,890	1.05	$ 176	11.3
237	TROFFER	8"X4'	21	REC	EM	T12	2	72	1,512	2,722	28W T8 with LBF Electonic Ballast	42	1,800	1,588	882	$ 462	$ 525	$ 207	$ 1,194	1,134	0.63	$ 106	11.3
235	TROFFER	8"X4'	2	REC	EM	T12	2	72	144	259	28W T8 with LBF Electonic Ballast	42	1,800	151	84	$ 44	$ 50	$ 20	$ 114	108	0.06	$ 10	11.3
236	INDUST	4'	12	SURF	EM	T12	2	72	864	1,555	28W T8 with LBF Electonic Ballast	42	1,800	907	504	$ 264	$ 300	$ 118	$ 682	648	0.36	$ 60	11.3
234	TROFFER	8"X4'	23	REC	EM	T12	2	72	1,656	2,981	28W T8 with LBF Electonic Ballast	42	1,800	1,739	966	$ 506	$ 575	$ 227	$ 1,308	1,242	0.69	$ 116	11.3
233	TROFFER	8"X4'	16	REC	EM	T12	2	72	1,152	2,074	28W T8 with LBF Electonic Ballast	42	1,800	1,210	672	$ 352	$ 400	$ 158	$ 910	864	0.48	$ 81	11.3
232	TROFFER	8"X4'	4	REC	EM	T12	2	72	288	518	28W T8 with LBF Electonic Ballast	42	1,800	302	168	$ 88	$ 100	$ 39	$ 227	216	0.12	$ 20	11.3
231	TROFFER	8"X4'	16	REC	EM	T12	2	72	1,152	2,074	28W T8 with LBF Electonic Ballast	42	1,800	1,210	672	$ 352	$ 400	$ 158	$ 910	864	0.48	$ 81	11.3
229	TROFFER	8"X4'	16	REC	EM	T12	2	72	1,152	2,074	28W T8 with LBF Electonic Ballast	42	1,800	1,210	672	$ 352	$ 400	$ 158	$ 910	864	0.48	$ 81	11.3
230	TROFFER	8"X4'	16	REC	EM	T12	2	72	1,152	2,074	28W T8 with LBF Electonic Ballast	42	1,800	1,210	672	$ 352	$ 400	$ 158	$ 910	864	0.48	$ 81	11.3
227	TROFFER	8"X4'	8	REC	EM	T12	2	72	576	1,037	28W T8 with LBF Electonic Ballast	42	1,800	605	336	$ 176	$ 200	$ 79	$ 455	432	0.24	$ 40	11.3
228	TROFFER	8"X4'	16	REC	EM	T12	2	72	1,152	2,074	28W T8 with LBF Electonic Ballast	42	1,800	1,210	672	$ 352	$ 400	$ 158	$ 910	864	0.48	$ 81	11.3
226	TROFFER	8"X4'	2	REC	EM	T12	2	72	144	259	28W T8 with LBF Electonic Ballast	42	1,800	151	84	$ 44	$ 50	$ 20	$ 114	108	0.06	$ 10	11.3
225	TROFFER	8"X4'	10	REC	EM	T12	2	72	720	1,296	28W T8 with LBF Electonic Ballast	42	1,800	756	420	$ 220	$ 250	$ 99	$ 569	540	0.30	$ 50	11.3
224	TROFFER	8"X4'	14	REC	EM	T12	2	72	1,008	1,814	28W T8 with LBF Electonic Ballast	42	1,800	1,058	588	$ 308	$ 350	$ 138	$ 796	756	0.42	$ 70	11.3
223	TROFFER	8"X4'	16	REC	EM	T12	2	72	1,152	2,074	28W T8 with LBF Electonic Ballast	42	1,800	1,210	672	$ 352	$ 400	$ 158	$ 910	864	0.48	$ 81	11.3
220-212	INDUST	4'	15	SURF	EM	T12	2	72	1,080	1,944	28W T8 with LBF Electonic Ballast	42	1,800	1,134	630	$ 330	$ 375	$ 148	$ 853	810	0.45	$ 76	11.3
201	TROFFER	8"X4'	36	REC	EM	T12	2	72	2,592	4,666	28W T8 with LBF Electonic Ballast	42	1,800	2,722	1,512	$ 792	$ 900	$ 355	$ 2,047	1,944	1.08	$ 181	11.3
204	TROFFER	8"X4'	2	REC	EM	T12	2	72	144	259	28W T8 with LBF Electonic Ballast	42	1,800	151	84	$ 44	$ 50	$ 20	$ 114	108	0.06	$ 10	11.3
205	TROFFER	8"X4'	16	REC	EM	T12	2	72	1,152	2,074	28W T8 with LBF Electonic Ballast	42	1,800	1,210	672	$ 352	$ 400	$ 158	$ 910	864	0.48	$ 81	11.3
209	TROFFER	8"X4'	15	REC	EM	T12	2	72	1,080	1,944	28W T8 with LBF Electonic Ballast	42	1,800	1,134	630	$ 330	$ 375	$ 148	$ 853	810	0.45	$ 76	11.3
205B	TROFFER	8"X4'	23	REC	EM	T12	2	72	1,656	2,981	28W T8 with LBF Electonic Ballast	42	1,800	1,739	966	$ 506	$ 575	$ 227	$ 1,308	1,242	0.69	$ 116	11.3
206	TROFFER	8"X4'	7	REC	EM	T12	2	72	504	907	28W T8 with LBF Electonic Ballast	42	1,800	529	294	$ 154	$ 175	$ 69	$ 398	378	0.21	$ 35	11.3
208	TROFFER	8"X4'	5	REC	EM	T12	2	72	360	648	28W T8 with LBF Electonic Ballast	42	1,800	378	210	$ 110	$ 125	$ 49	$ 284	270	0.15	$ 25	11.3
MEN'S WASH	INDUST	4'	2	SURF	EM	T12	1	36	72	629	28W T8 with LBF Electonic Ballast	22	8,736	384	44	$ 40	$ 50	$ 19	$ 109	245	0.03	$ 23	4.8
MEN'S WASH	INDUST	4'	12	SURF	EM	T12	1	36	432	3,774	28W T8 with LBF Electonic Ballast	22	8,736	2,306	264	$ 240	$ 300	$ 113	$ 653	1,468	0.17	$ 137	4.8
WOMEN'S WASH	INDUST	4'	12	SURF	EM	T12	1	36	432	3,774	28W T8 with LBF Electonic Ballast	22	8,736	2,306	264	$ 240	$ 300	$ 113	$ 653	1,468	0.17	$ 137	4.8
JANITOR	INDUST	4'	1	SURF	EM	T12	2	72	72	32	28W T8 with LBF Electonic Ballast	42	450	19	42	$ 22	$ 25	$ 10	$ 57	14	0.03	$ 1	45.2
FOYER	WRAP	8"X4'	15	SURF	EM	T12	2	72	1,080	9,435	28W T8 with LBF Electonic Ballast	42	8,736	5,504	630	$ 330	$ 375	$ 148	$ 853	3,931	0.45	$ 367	2.3
FOYER	POT	N/A	12	REC	EM	PL	1	23	276	2,411	Remain As Is	23	8,736	2,411	276								
FOYER	SCONCE	N/A	5	SURF	EM	PL	1	23	115	1,005	Remain As Is	23	8,736	1,005	115								
LUNCHROOM	INDUST	4'	29	SURF	EM	T12	1	36	1,044	9,120	28W T8 with LBF Electonic Ballast	22	8,736	5,574	638	$ 580	$ 725	$ 274	$ 1,579	3,547	0.41	$ 331	4.8
LUNCHROOM	POT	N/A	2	REC	EM	PL	1	23	46	402	Remain As Is	23	8,736	402	46								

Facility Information	Existing Luminaire Information							Existing Energy Usage			Proposed Measure	Post Retrofit Energy Usage				Installed Cost				Savings			
Room Description	Descripton	Dim	Qty	Mount	Ballast	Lamp	Lamps / Fixture	Watts	Total Watts	Annual kWh	Description	Watts	Hrs	Annual kWh	Total Watts	Material	Labour	Project Costs	Total	kWh	kW	Energy + Demand	Payback
LUNCHROOM	WRAP	8"X4'	4	SURF	EM	T12	2	72	288	2,516	28W T8 with LBF Electonic Ballast	42	8,736	1,468	168	$ 88	$ 100	$ 39	$ 227	1,048	0.12	$ 98	2.3
	EXIT	N/A	4	SURF	N/A	INCAN	2	30	120	1,048	LED EXIT	5	8,736	175	20	$ 100	$ 80	$ 38	$ 218	874	0.10	$ 81	2.7
NEW WING - C STAIRS																							
	WRAP	8"X4'	4	SURF	EM	T12	2	72	288	2,516	28W T8 with LBF Electonic Ballast	42	8,736	1,468	168	$ 88	$ 100	$ 39	$ 227	1,048	0.12	$ 98	2.3
NEW WING - 1ST FLOOR																							
106	TROFFER	8"X4'	20	REC	EM	T12	2	72	1,440	2,592	28W T8 with LBF Electonic Ballast	42	1,800	1,512	840	$ 440	$ 500	$ 197	$ 1,137	1,080	0.60	$ 101	11.3
105	TROFFER	8"X4'	52	REC	EM	T12	2	72	3,744	6,739	28W T8 with LBF Electonic Ballast	42	1,800	3,931	2,184	$ 1,144	$ 1,300	$ 513	$ 2,957	2,808	1.56	$ 262	11.3
107	TROFFER	8"X4'	5	REC	EM	T12	2	72	360	648	28W T8 with LBF Electonic Ballast	42	1,800	378	210	$ 110	$ 125	$ 49	$ 284	270	0.15	$ 25	11.3
108	TROFFER	8"X4'	2	REC	EM	T12	2	72	144	259	28W T8 with LBF Electonic Ballast	42	1,800	151	84	$ 44	$ 50	$ 20	$ 114	108	0.06	$ 10	11.3
103	TROFFER	8"X4'	21	REC	EM	T12	2	72	1,512	2,722	28W T8 with LBF Electonic Ballast	42	1,800	1,588	882	$ 462	$ 525	$ 207	$ 1,194	1,134	0.63	$ 106	11.3
101	TROFFER	8"X4'	11	REC	EM	T12	2	72	792	1,426	28W T8 with LBF Electonic Ballast	42	1,800	832	462	$ 242	$ 275	$ 109	$ 626	594	0.33	$ 55	11.3
113	TROFFER	8"X4'	5	REC	EM	T12	2	72	360	648	28W T8 with LBF Electonic Ballast	42	1,800	378	210	$ 110	$ 125	$ 49	$ 284	270	0.15	$ 25	11.3
114	TROFFER	8"X4'	6	REC	EM	T12	2	72	432	778	28W T8 with LBF Electonic Ballast	42	1,800	454	252	$ 132	$ 150	$ 59	$ 341	324	0.18	$ 30	11.3
115	TROFFER	8"X4'	3	REC	EM	T12	2	72	216	389	28W T8 with LBF Electonic Ballast	42	1,800	227	126	$ 66	$ 75	$ 30	$ 171	162	0.09	$ 15	11.3
112	TROFFER	8"X4'	4	REC	EM	T12	2	72	288	518	28W T8 with LBF Electonic Ballast	42	1,800	302	168	$ 88	$ 100	$ 39	$ 227	216	0.12	$ 20	11.3
111	TROFFER	8"X4'	6	REC	EM	T12	2	72	432	778	28W T8 with LBF Electonic Ballast	42	1,800	454	252	$ 132	$ 150	$ 59	$ 341	324	0.18	$ 30	11.3
110	TROFFER	2'x2'	9	REC	EM	T12U	2	72	648	1,166	28W T8 with LBF Electonic Ballast	42	1,800	680	378	$ 198	$ 225	$ 89	$ 512	486	0.27	$ 45	11.3
109	TROFFER	8"X4'	7	REC	EM	T12	2	72	504	907	28W T8 with LBF Electonic Ballast	42	1,800	529	294	$ 154	$ 175	$ 69	$ 398	378	0.21	$ 35	11.3
116	TROFFER	8"X4'	8	REC	EM	T12	2	72	576	1,037	28W T8 with LBF Electonic Ballast	42	1,800	605	336	$ 176	$ 200	$ 79	$ 455	432	0.24	$ 40	11.3
118	TROFFER	8"X4'	7	REC	EM	T12	2	72	504	907	28W T8 with LBF Electonic Ballast	42	1,800	529	294	$ 154	$ 175	$ 69	$ 398	378	0.21	$ 35	11.3
121	TROFFER	8"X4'	2	REC	EM	T12	2	72	144	259	28W T8 with LBF Electonic Ballast	42	1,800	151	84	$ 44	$ 50	$ 20	$ 114	108	0.06	$ 10	11.3
120	TROFFER	8"X4'	14	REC	EM	T12	2	72	1,008	1,814	28W T8 with LBF Electonic Ballast	42	1,800	1,058	588	$ 308	$ 350	$ 138	$ 796	756	0.42	$ 70	11.3
123	TROFFER	8"X4'	20	REC	EM	T12	2	72	1,440	2,592	28W T8 with LBF Electonic Ballast	42	1,800	1,512	840	$ 440	$ 500	$ 197	$ 1,137	1,080	0.60	$ 101	11.3
124	TROFFER	8"X4'	20	REC	EM	T12	2	72	1,440	2,592	28W T8 with LBF Electonic Ballast	42	1,800	1,512	840	$ 440	$ 500	$ 197	$ 1,137	1,080	0.60	$ 101	11.3
125	TROFFER	8"X4'	30	REC	EM	T12	2	72	2,160	3,888	28W T8 with LBF Electonic Ballast	42	1,800	2,268	1,260	$ 660	$ 750	$ 296	$ 1,706	1,620	0.90	$ 151	11.3
126	TROFFER	8"X4'	15	REC	EM	T12	2	72	1,080	1,944	28W T8 with LBF Electonic Ballast	42	1,800	1,134	630	$ 330	$ 375	$ 148	$ 853	810	0.45	$ 76	11.3
127	TROFFER	8"X4'	30	REC	EM	T12	2	72	2,160	3,888	28W T8 with LBF Electonic Ballast	42	1,800	2,268	1,260	$ 660	$ 750	$ 296	$ 1,706	1,620	0.90	$ 151	11.3
128	TROFFER	8"X4'	15	REC	EM	T12	2	72	1,080	1,944	28W T8 with LBF Electonic Ballast	42	1,800	1,134	630	$ 330	$ 375	$ 148	$ 853	810	0.45	$ 76	11.3
129	TROFFER	8"X4'	7	REC	EM	T12	2	72	504	907	28W T8 with LBF Electonic Ballast	42	1,800	529	294	$ 154	$ 175	$ 69	$ 398	378	0.21	$ 35	11.3
CORRIDOR	TROFFER	8"X4'	27	REC	EM	T12	2	72	1,944	16,983	28W T8 with LBF Electonic Ballast	42	8,736	9,907	1,134	$ 594	$ 675	$ 266	$ 1,535	7,076	0.81	$ 660	2.3
JANITOR	WRAP	8"X4'	1	SURF	EM	T12	2	72	72	32	28W T8 with LBF Electonic Ballast	42	450	19	42	$ 22	$ 25	$ 10	$ 57	14	0.03	$ 1	45.2
MEN'S WASH	INDUST	4'	10	SURF	EM	T12	1	36	360	3,145	28W T8 with LBF Electonic Ballast	22	8,736	1,922	220	$ 200	$ 250	$ 95	$ 545	1,223	0.14	$ 114	4.8
MEN'S WASH	POT	N/A	1	REC	EM	PL	1	23	23	201	Remain As Is	23	8,736	201	23								
MEN'S SHOWER	TROFFER	8"X4'	6	REC	EM	T12	2	72	432	3,774	28W T8 with LBF Electonic Ballast	42	8,736	2,201	252	$ 132	$ 150	$ 59	$ 341	1,572	0.18	$ 147	2.3
MEN'S SHOWER	INDUST	4'	1	SURF	EM	T12	1	36	36	314	28W T8 with LBF Electonic Ballast	22	8,736	192	22	$ 20	$ 25	$ 9	$ 54	122	0.01	$ 11	4.8
MEN'S SHOWER	POT	N/A	2	REC	EM	PL	1	23	46	402	Remain As Is	23	8,736	402	46								
WOMEN'S WASH	INDUST	4'	10	SURF	EM	T12	1	36	360	3,145	28W T8 with LBF Electonic Ballast	22	8,736	1,922	220	$ 200	$ 250	$ 95	$ 545	1,223	0.14	$ 114	4.8
WOMEN'S WASH	POT	N/A	1	REC	EM	PL	1	23	23	201	Remain As Is	23	8,736	201	23								
WOMEN'S SHOWER	TROFFER	8"X4'	6	REC	EM	T12	2	72	432	3,774	28W T8 with LBF Electonic Ballast	42	8,736	2,201	252	$ 132	$ 150	$ 59	$ 341	1,572	0.18	$ 147	2.3
WOMEN'S SHOWER	INDUST	4'	1	SURF	EM	T12	1	36	36	314	28W T8 with LBF Electonic Ballast	22	8,736	192	22	$ 20	$ 25	$ 9	$ 54	122	0.01	$ 11	4.8
WOMEN'S SHOWER	POT	N/A	2	REC	EM	PL	1	23	46	402	Remain As Is	23	8,736	402	46								
	EXIT	N/A	8	SURF	N/A	INCAN	2	30	240	2,097	LED EXIT	5	8,736	349	40	$ 176	$ 200	$ 79	$ 455	1,747	0.20	$ 163	2.8
SUMMARY									Total Connected Load	Annual Energy Consumption (kWh)				Annual Energy Consumption (kWh)	Total Connected Load	Total Materials	Total Labour	Total Project Cost	Total Installed Cost	Total Annual kWh Savings	Total Demand Reduction	Total Annual Utility Savings	Aggregate Simple Payback
									127,723	399,418				230,889	74,649	$39,158	$44,540	$17,577	$101,275	168,529	53	$15,715	6.4

Notes:

- Cost of electricity based on $0.094/kWh
- Contractor responsible for shunted sockets
- No patching or painting allowed for in this report
- Labour pricing based on continuous access to each space

12. Appendix F – Drawing List

PROJECTS LIST

BUILDING	project no	spec loc	location	year	as built	c b	project title	arch	struc	mech	elec	total
RADIATION PROTECTION BUILDING			221C		No	No	SITE PLAN	1				1
RADIATION PROTECTION BUILDING	651015		221C		No	No	NEW STAIRS TO ROOF AND NEW GUARD RAIL			1		1
RADIATION PROTECTION BUILDING	878317		221C		No	No	ELECTRICAL LAYOUT FOR AIR MONITORING AND RAIN SAMPLING EQUIPMENT				1	1
RADIATION PROTECTION BUILDING			221A	1959	No	No	BUILDING SITE AND OFFICE LAYOUT - (PROPOSED AND SUPERSEDED)	25				25
RADIATION PROTECTION BUILDING	CA 60-7-10		221C	1960	Yes	No	OUTDOOR EXPOSURE AREA - CONTROL HOUSE	4				4
RADIATION PROTECTION BUILDING	CA 60-6-10		221C	1960	No	No	TOTAL BODY MONITOR WING	4	2	2	1	9
RADIATION PROTECTION BUILDING			221C	1961	No	No	REVISED SITE PLAN SHOWING FUTURE LAB. AND OFFICE EXTENSIONS	1				1
RADIATION PROTECTION BUILDING	9640-12-230 31		221C	1963	No	No	SHOP DRAWINGS (CAN. GENERAL ELECTRICAL COMPANY LTD.)				18	18
RADIATION PROTECTION BUILDING	CA 60-10-9	DR 159	221A	1964	Yes	Yes	ORIGINAL PLANS WITH REVISIONS	30	15	31	24	100
RADIATION PROTECTION BUILDING			221C	1964	No	No	FIRE ALARM CONTROL BOX				1	1
RADIATION PROTECTION BUILDING	5075-2		221C	1964	No	No	BASEMENT AND FIST FLOORS - BUZZER SYSTEM				2	2
RADIATION PROTECTION BUILDING	5075-3		221C	1965	No	No	NEW PERMANENT BAFFLE	1				1
RADIATION PROTECTION BUILDING	5075-1		221C	1965	No	No	ALTERATIONS TO ROOF AND RELATED WORK	1				1
RADIATION PROTECTION BUILDING			221C	1966	No	No	FUME HOOD WASHING INSTALLATION			1		1
RADIATION PROTECTION BUILDING	94021		221C	1969	No	No	E.D.P. INSTALLATIONS	1		1	1	3
RADIATION PROTECTION BUILDING			221C	1969	No	No	PERMANENT BUILDING SIGN	1				1
RADIATION PROTECTION BUILDING	600556DN0 04		221B	1977	Yes	No	FIRE ALARM SYSTEM				3	3
RADIATION PROTECTION BUILDING	600556DT0 03		221C	1977	No	No	NEW COMPUTER INSTALLATIONS - BASEMENT FLOOR	1				1
RADIATION PROTECTION BUILDING	040393		221C	1980	No	No	COWLS FOR FRESH AIR INTAKE LOUVERS			1		1
RADIATION PROTECTION BUILDING	040805	DR 05	221B	1981	No	No	AIR CONDITION SYSTEM MODIFICATIONS			2		2
RADIATION PROTECTION BUILDING	043184/1	DR 10	SPEC	1984		No	AIR BALANCING MODIFICATIONS					0
RADIATION PROTECTION BUILDING	043184	DR 10	221B	1985	No	No	IMPROVMENT TO BLDG. VENTILATION SYSTEMS	5	1	37	7	50
RADIATION PROTECTION BUILDING	043953		221B	1986	No	No	SITE SURVEY PLANS	5				5
RADIATION PROTECTION BUILDING	702260	DR 38	SPEC	1986		No	METAL STAIRS AND GUARD RAIL					0

PROJECTS LIST

BUILDING	project no	spec loc	location	year	as built	C/O	project title	arch	struc	mech	elec	total
RADIATION PROTECTION BUILDING	700426/1		1578A	1988	Yes	No	RELOCATION OF ACCESS ROAD	4				4
RADIATION PROTECTION BUILDING	702921	DR 41	221C	1988	No	No	MOD. TO ROOM A2 - EXPOSURE ROOM	1		1		2
RADIATION PROTECTION BUILDING	700426/2	DR 30	1578A	1989	No	No	PILE TESTING	1				1
RADIATION PROTECTION BUILDING	703351		221B	1989	No	No	ROOM 102 MOVABLE DETECTOR ASSEMBLY		1			1
RADIATION PROTECTION BUILDING	700426	DR 29	1578C	1989	No	Yes	ADDITION TO RADIATION PROTECTION BLDG. - (MECH. AND ELECT. PLANS - FRENCH)			25	14	39
RADIATION PROTECTION BUILDING	700426	DR 29	1578B	1989	Yes	Yes	ADDITION TO RADIATION PROTECTION BLDG. - (ARCH. PLANS)	51	26			77
RADIATION PROTECTION BUILDING	700426		221C	1990	Yes	No	STRUCTURAL STEEL SHOP DRAWINGS		49			49
RADIATION PROTECTION BUILDING	98-1885-1	DR 98	221B	1993	Yes	No	LAB FURNITURE AND EQUIPMENT	18				18
RADIATION PROTECTION BUILDING	306697	DR 84	1578A	1995	No	No	HEATING & HUMIDIFICATION SYSTEM MODIFICATIONS			3	1	4
RADIATION PROTECTION BUILDING	690840	DR 98	221B	1997	No	No	RECONSTRUCTION OF COURTYARD PARKING AREA AND ACCESS ROAD	2				2
RADIATION PROTECTION BUILDING	630132-P1	DR 107	1578A	1999	No	No	REPLACEMENT OF EXISTING EXHAUST FAN			2		2
RADIATION PROTECTION BUILDING	413871	DR 111	221C	2000	No	No	MECHANICAL ALTERATIONS TO THE ANECHOIC CHAMBER			1		1
RADIATION PROTECTION BUILDING	423489	DR 117	221C	2001	No	No	NEW WALKWAY AND EQUIPMENT PLATFORM	1				1
RADIATION PROTECTION BUILDING	420614	DR 116	1578A	2001	No	No	REPLACEMENT OF MECHANICAL EXHAUST IN PENTHOUSE			6		6
RADIATION PROTECTION BUILDING	420530	DR 116	1578A	2001	No	No	REBALANCING AND HOOD CONTROLS			2		2
RADIATION PROTECTION BUILDING	458308	DR 132	221C	2004	No	No	PARTIAL ROOF REPLACEMENT	1				1
RADIATION PROTECTION BUILDING	457220	DR 135	221D	2005	No	Yes	RE-ROOFING, OLD WING	6		1	1	8
RADIATION PROTECTION BUILDING	457220/1	PLAN ROOM	221D	2007	No	Yes	ROOF MANIFOLD ENCLOSURE	7	3	1	1	12
RADIATION PROTECTION BUILDING	487000	PLAN ROOM	221D	2007	No	No	DD MICROWAVE AND ANECHOIC (ACCOUSTIC) CHAMBER			2	3	5
RADIATION PROTECTION BUILDING	R.006053.003	PLAN ROOM	1578D	2008	No	Yes	EMERGENCY POWER FOR EMERGENCY RESPONCE CENTER			1	2	3
RADIATION PROTECTION BUILDING	R.006816.002	PLAN ROOM	221D	2009	No	Yes	WINDOW REPLACEMENT	15				15
RADIATION PROTECTION BUILDING	R.021662.002	PLAN ROOM	221D	2009	No	Yes	ROOF REPLACEMENT	2				2