ASHRAE's BEST

SECOND PLACE: INDUSTRIAL FACILITIES OR PROCESSES, EXISTING

Mechanical mezzanine at Buanderie Centrale de Montreal, a laundry that underwent a major retrofit that saves $300,000 annually.

LAUNDRY UPGRADE

By Yan Ferron, Eng., Associate Member ASHRAE

For the last three decades, Buanderie Centrale de Montreal (BCM), a non-profit public agency, has offered laundry services to hospitals in the Montreal area. To remain competitive with the private sector and to provide high quality services, BCM needed to modernize its services.

The project results include a completely air-conditioned and dehumidified production area, a 24% productivity increase, an annual energy savings close to $300,000 and a significant increase of the quality of the working environment.

Design Challenges

The services offered by BCM are considered essential services for hospitals that cannot be short of clean linen. The biggest challenge was to accomplish the project without stopping the production. All the work had to be done inside the building's envelope; no expansion was authorized. BCM wanted to increase its annual washing area capacity from 18.7 million lbs (8.5 million kg) of linen to 26.5 million lbs (12 million kg) of linen. HVAC systems and energy recovery equipment had to be installed in several phases and within the space occupied by existing equipment.

During the past 30 years, the neighborhood around BCM has become residential, so the noise levels emanating from the laundry's operations needed to be reduced. Therefore, ventilation units, cooling towers and energy recovery equipment were installed inside the building. Besides reducing noise levels, having

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		Before	After	Difference
Production	Pounds of Linen Annually	18,171,364	21,882,983	20%
Productivity	Pounds of Linen/Hours Worked	108.07	134.08	24%
Natural Gas Consumption	Therms	605,984	496,690	–18%
	Therms/lb of Linen	0.033	0.023	–32%
Electricity Consumption	kWh	4,312,700	4,031,500	–7%
	kWh/lb of Linen	0.237	0.184	–22%

Table 1: Results of the modernization project.

	Before	After	Difference
Total Fresh Air Supply	60,000 cfm	20,000 cfm	–67%
Total Air Supply	165,000 cfm	80,000 cfm	–52%
Total Fans Power	155 hp	105 hp	–32%

Table 2: Airflow comparison, original design vs. new design.

Building at a Glance

Name: Buanderie Centrale de Montréal

Location: Montreal

Owner: Agence de la santé et des services sociaux de Montréal

Principal Use: Laundry Services

Includes: Administrative Area

Employees/Occupants: 122

Gross Square Footage: 111,000

Conditioned Space: 107,250

Substantial Completion/Occupancy: 2009

National Distinctions/Awards: AICQ'S Léonard 2010, Consulting Engineering Next Generation category

the equipment indoors made maintenance easier, especially in winter.

Codes and engineering good practices also have changed. Quebec provincial health-care and workers regulations specified that extra rest periods are required if the indoor wet-bulb globe temperature is higher than 86°F (30°C). Extra rest periods could be as long as 45 minutes every hour, reducing productivity in a significant way. This requirement was not included in the original design.

Space had to be found to include new cooling devices to provide air at a temperature lower than the maximum allowed by regulation—without an increase in annual energy costs. Energy recovery equipment was added to the project to compensate for the energy consumption by the cooling system in summer.

IAQ and Ventilation

The BCM production area is about 100,000 ft^2 (9290 m^2) and separated into three areas: receiving and washing, drying, and finishing and shipping. To limit the dispersion of odors and contaminants, the receiving and washing area must be at a negative pressure with regard to the rest of the areas of production. To do so, fresh air is introduced in the building at the finishing and shipping area and exhausted at the receiving and washing area. Air is transferred from the "cleaner area" to the "dirtier" and follows the inverse path of the washing process.

Original ventilation systems were sized to evacuate the heat rejection of production equipment, mainly steam and natural gas dryers and steam ironers. In Montreal in the summer, outdoor air temperature could be higher than 90°F (32°C). Even with a high fresh airflow, it is hard to maintain an adequate indoor temperature for workers, if the fresh air supply is not cooled. Also, these original ventilation systems were designed at constant flow. Heating power demand was important, adding important costs to the annual energy bills. Furthermore, no humidification was provided in winter. The production area humidity was specified using ASHRAE Standard 55-2004.

All these concerns were addressed in the modernization project. New ventilation design provided a better indoor environment at lower energy costs. Air supply was designed for the occupants' needs instead of the requirements of the equipment. More than 90% of the employees work in the finishing and shipping area (last area of the washing process). It is in this 40,000 ft^2 (3716 m^2) area that fresh air is introduced in the building. The main air-handling unit (AHU) supplies 40,000 cfm (18 878 L/s) with 50% fresh air and includes a cooling coil, a "face and bypass" steam coil and a steam humidifier. Since heating demand was reduced, there was no need for an extra boiler in the project. Existing steam boilers have the capacity to supply all process equipment and the main AHU. Also, in winter, the humidity rate is at 30% when indoor temperature is between 68°F and 73°F (20°C and 23°C), which meets ASHRAE Standard 55.

Air is transferred from the finishing and shipping area toward the drying area.

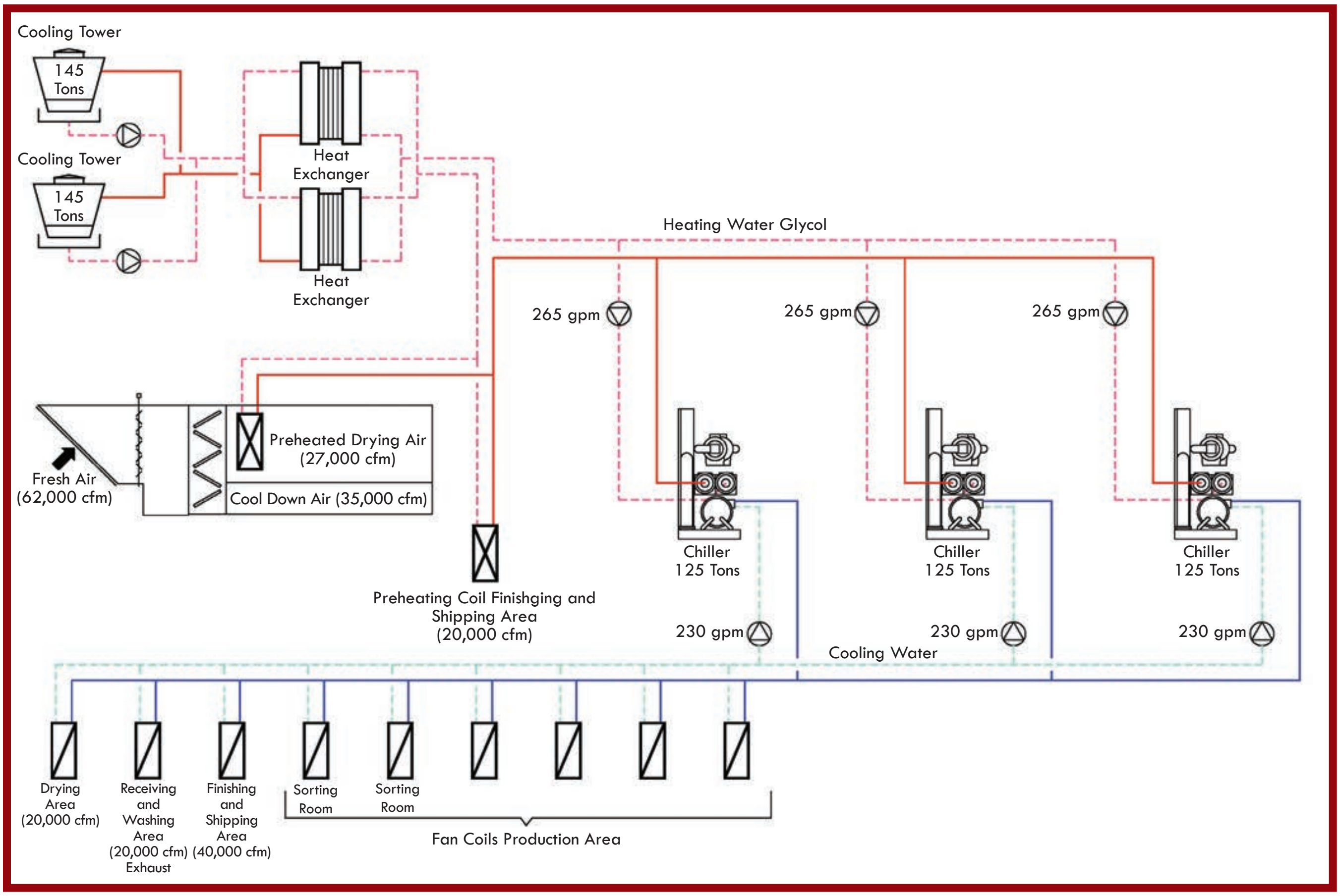

Figure 1: Heat recovery and HVAC networks.

A 20,000 cfm (9439 L/s) AHU provides cooling for the drying area. Dryers' heat rejection is cooled before reaching other areas.

Finally, the airflow is transferred to the receiving and washing area to be evacuated. An exhaust air unit of 20,000 cfm (9439 L/s) is installed in this area that is always at a lower pressure than all other production areas. The exhaust air unit is equipped with a cooling coil. In winter, exhaust air is cooled before leaving the building, providing a heat recovery load of 325,000 Btu/h (95 kW). This energy is reused in the heating process.

After modernizing its services, Buanderie Centrale de Montreal, increased its productivity by 24%.

Some equipment or processes reject significant amounts of heat. To reduce the total air supply in the production area, six fan coils were added to the ventilation design. These units provided spot cooling where required, such as the sorting room where 10 to 12 employees work. The unit cooling capacities vary from 3 to 5 tons (10.6 to 17.6 kW).

This ventilation configuration and air-conditioning systems make it possible to temperate the whole production sector. Indoor temperature is maintained between 75°F and 80°F (24°C and 27°C) in summer. The extra rest period that was required because of high indoor temperature is no longer necessary. In spite of a significant reduction of fresh airflow, BCM ventilation meets ASHRAE Standard 62. It recommends approximately 14,000 cfm (6607 L/s) of fresh air in this case. Design fresh air supply is greater than ASHRAE Standard 62-2007 to meet local codes, which are more restrictive. To match the fresh supply airflow, the exhaust rate in the receiving and washing area is at 1.45 cfm/ft^2 (7.4 L/s·m^2), which is higher than the minimal ASHRAE Standard 62 of 1.00 cfm/ft^2 (7.4 L/s·m^2) for soiled laundry storage rooms.

Energy Efficiency

In winter, outdoor air temperatures are often under 32°F (0°C) in Montreal and can fall as low as –22°F (–30°C). In these conditions, the only heating loads for the production area are the fresh air supply and infiltration air coming by the receiving and shipping docks. Cooling loads are present all year long in some parts of the production area. Before the project, this energy was evacuated by the ventilation systems. Now, the energy is recovered and used to preheat 20,000 cfm (9439 L/s) of fresh air supply and up to 27,000 cfm (12 743 L/s) of drying air (process air) used by the dryers.

A cooling water network at 45°F (7°C) supplies fan coils, AHU cooling coils and exhaust air unit cooling coil. The recovered heat is pumped through the network to three heat recovery screw chillers that transfer the energy into a heating glycol water network. Each chiller has a nominal cooling capacity of 125 tons (440 kW) and a COP of 3.5. Heating network temperature varies from 85°F to 110°F (29°C to 43°C). This heating network supplies the two preheating coils and two heat exchangers for two cooling towers. Each cooling tower has a nominal heat rejection capacity of 145 tons (510 kW).

For outside temperatures of 41°F (5°C) and lower, all cooling energy is used in the heating process. Cooling towers are shut down for winter.

When outside temperatures increase and are higher than 41°F (5°C), the cooling towers are authorized to work. Energy not used to preheat drying air is evacuated by the cooling towers. The fresh air supply does not need to be heated.

The drying process includes two steps: the drying mode and the cool down mode. In the drying mode, dryers require supply air at 230°F (110°C). There is a need for heating air 12 months a year because the heat recovery system operates even in summer. In cool down mode, outside air is directly supplied to the dryers without being heated or cooled.

To reject heat in the drying air, an indoor air supply plenum was constructed. This interior plenum is 60 ft (18.3 m) long, 25 ft (7.6 m) wide and 7 ft (2.1 m) high and can supply a total of 62,000 cfm (29 261 L/s) to the dryers. The plenum is divided in two sections, one for the drying air with a preheating coil and a supply capacity of 27,000 cfm (12 743 L/s), and one for the cool down air with a capacity of 35,000 cfm (16 518 L/s). Usually, dryers use indoor air to dry linen, which requires a makeup air unit to supply air inside the building.

BCM has 21 dryers connected to the plenum. Each dryer can take air from the two sections, meaning that 42 openings are made in the plenum. A set of dampers for each group of connections allows dryers to take air from only one section at a time, depending on the stage of the process. By separating air in two compartments, only air used to dry linen will be preheated. This configuration optimizes energy recovery, especially in winter, when the cooling loads are not enough to satisfy the preheating load. The efficiency of this system depends on outdoor temperature. According to the data taken from the control computer, for an outside air temperature of 8°F (–13°C), preheated air inside the drying air section of the plenum is at 95°F (35°C), a reduction of 39% of the heating load (natural gas savings).

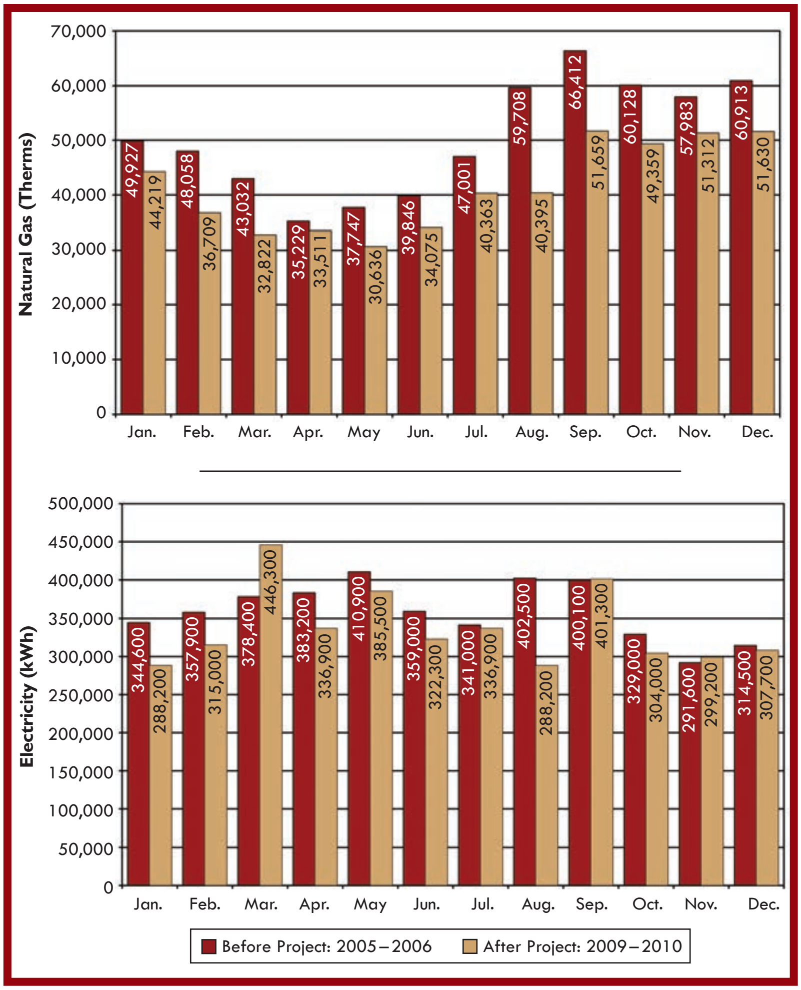

Figure 2: Natural gas consumption (top) and electricity consumption (bottom) compared before and after the project.

To complete the energy-efficiency measures, the lighting setup also was optimized. The BCM production area lighting system consisted originally of 458 W mercury vapor lamps. The lamp depreciation factor was high with a small lumen output. The levels of illumination did not meet the Illuminating Engineering Society of North America recommendations. In the modernization project, old fixtures and T12 lighting fixtures (72 W each) were replaced by T5HO lighting fixtures (120 W) and T8 lighting fixtures (54 W each). Combined with a new lighting layout and four new skylights, recommended lighting levels are now met while power consumption is reduced by 66,300 W.

Operation and Maintenance

Inside a typical industrial laundry, lint accumulation could be a problem, especially without a good maintenance program. All new BCM HVAC equipment is linked to a centralized control system. Operators can follow the system's status in remote locations and in real time. Maintenance is now faster and more efficient, especially when systems break down or when filters need to be changed. Monitoring filter states makes filter replacements more reliable and contributes to improving internal air quality.

Available workspace was reserved for the new production equipment, such as washing tunnels and linen folders. To free floor space, HVAC and energy-efficiency equipment were all installed at height. A majority of equipment, AHU, cooling towers, heat exchangers, chillers and pumps were grouped together on one mechanical mezzanine. With HVAC equipment in the same location, maintenance is easier than before, when ventilation units were dispersed around laundry, from the basement to the roof.

Drying air supply plenum.

Cost Effectiveness and Environmental Impact

The total project cost for the HVAC systems upgrade, including energy-efficiency systems, was about $2.5 million. As shown in *Table 1* (Page 45), energy savings per unit of production represent more than 30% for natural gas and more than 20% for electricity. No increase in power demand was registered for cooling all production areas, due to a reduction in ventilation fans horsepower and lighting power demand. Total annual energy savings amount to about $300,000, offering a single payback period of 8.4 years for this project.

Considering only the $500,000 extra costs for the energy efficiency measures (because the HVAC systems upgrade was a necessity), the project single payback period decreases to 1.7 years.

The BCM modernization project has an important impact on the reduction of greenhouse gas (GHG) emissions. Savings of natural gas combustion represented more than the 1,250 metric tons of equivalent CO_2 that are not generated (roughly the emissions of 285 average cars annually).●