COOLING STRATEGY STATUS UPDATE
APPENDIX B

TORONTO CATHOLIC DISTRICT SCHOOL BOARD
ST. CECILIA CS

Feasibility Study for Air Conditioning Upgrade

Prepared by: **SAB Engineering Inc.**

March 2019

588 Edward Ave., Unit 25
Richmond Hill, Ontario
L4C 9Y6
Tel: (905)-787-8885
Fax: (905)-787-8771
E-mail: sabengineering@rogers.com

Table of Contents

588 Edward Ave., Unit 25
Richmond Hill, Ontario
L4C 9Y6
Tel: (905)-787-8885
Fax: (905)-787-8771
E-mail: sabengineering@rogers.com

1. EXECUTIVE SUMMARY

SAB Engineering Inc. was retained to inspect the St Cecilia CS and assess two systems for providing air conditioning, respectively:

- Portable air equipment
- VRF air conditioning equipment

The site visit took place on March 15th 2019. Classrooms, corridors and service areas where visually reviewed in all three sections of the building and at all three floors. The inspection included a review of the existing power supply to the school and the demand of the building over a 24 month period.

Subsequent to our site inspection, we held discussions with several equipment manufacturers, in both categories selected for evaluation.

The conclusions of our review can be summarized as follows:

1. The total cooling load of the instructional spaces and offices/admin areas is in the 60 ton range. This does not include corridors, service spaces, washrooms or the Gym.

2. The current power service to the school is single phase and has an estimated spare of about 200A; this is the equivalent of approx. 10-15 ton of cooling, depending on equipment efficiency and diversity. In its current configuration, the power supply of the school cannot cover the anticipated 60 ton load.

3. Should a power upgrade be considered, the estimated cost to switch to a pad-mounted transformer and 3 phase power is $200,000.

4. The estimated cost of installing portable air conditioners is estimated at $120,000 at full 60 ton capacity or $20,000 if no power upgrade is considered.

5. The estimated cost of installing a VRF system is estimated at $395,000 at full 60 ton capacity, or $60,000 if no power upgrade is considered.

6. The larger cost of the VRF equipment is a reflection of its complexity and increased efficiency including controllability; without a power upgrade, the VRF system can cover approx. 40% more space than the portable air conditioners.

The advantages and disadvantages of each system are detailed in the report below.

2. BUILDING DESCRIPTION

The school is a three-floor and appears to consist of an original building (the north-end) and two subsequent additions. The total footprint of the building is approx. 52,000 sq.ft plus 2,500 sq.ft. Gym. This includes corridors, washrooms, stairwells, storage and service spaces. The net instructional areas (classrooms and kindergartens) are in the 30,000 sq.ft. range.

The lower floor is partially underground and includes daycare areas, a music room and three more classrooms; it also allows access to the double-height Gym. Also at the lower floor, there are large sanitary groups (male/female) and service rooms (caretaker, three mechanical rooms and the main electrical room)

The second floor consists almost exclusively of classrooms (10 of them) plus offices and administration. There are no student washrooms at the second floor

The third floor includes 12 classrooms and several storage/custodial areas.

With the exception of the partial basement level, the upper two floors have high ceilings, covered with plaster. The original building has a patterned plaster ceiling which appears original to the time it was built. In all areas, lighting fixtures are either suspended by hanging rods or affixed to the ceiling. The only area which has a dropped ceiling (approx. 16" clearance from structure) is a section of the corridor in the basement, leading to the entrance of the Gym.

The basement ceiling is somewhat lower, but still covered with plaster, with the exception of a corridor section leading into the Gym. The Gym ceiling is a steel deck supported by OWSJ.

In all areas, the windows appeared new and recently installed. They generally run from approx. 36" above the floor to the ceiling. Most have operable sections.

3. EXISTING BUILDING SERVICES

Heating is provided by hot water prepared in two boiler rooms; one located at the south end which includes a pair of new sectional cast iron boilers and the other one located in the original south-side building, which includes a single firebox boiler, likely to be original to the building.

The heating is distributed throughout the building through exposed piping running along the corridor and classroom walls. The terminal heating equipment is a mix of sloped top copper-tube convectors and cast iron radiators. Generally, the terminal equipment at the upper floors is fed from the floor below. In the basement, the hot water pipes also run exposed, feeding the terminal equipment from the top. The hot water piping appears relatively recently installed, and likely to have replaced older piping which may have run under the slab.

At the partial basement level, the music room and the kindergarten classrooms include horizontal unit ventilators which provide both ventilation and air conditioning. Staff reported that at least

588 Edward Ave., Unit 25
Richmond Hill, Ontario
L4C 9Y6
Tel: (905)-787-8885
Fax: (905)-787-8771
E-mail: sabengineering@rogers.com

three out of five unit ventilators are defective. For the rest of the school, there is sanitary exhaust from the washrooms (with the fans located on the roof) and some general exhaust in some classrooms, running in the cubicles at the back of those classrooms.

The Gym is separately ventilated through two grilles located at the upper level; heating is provided by sloped top baseboards running at approx. 10 ft above the floor.

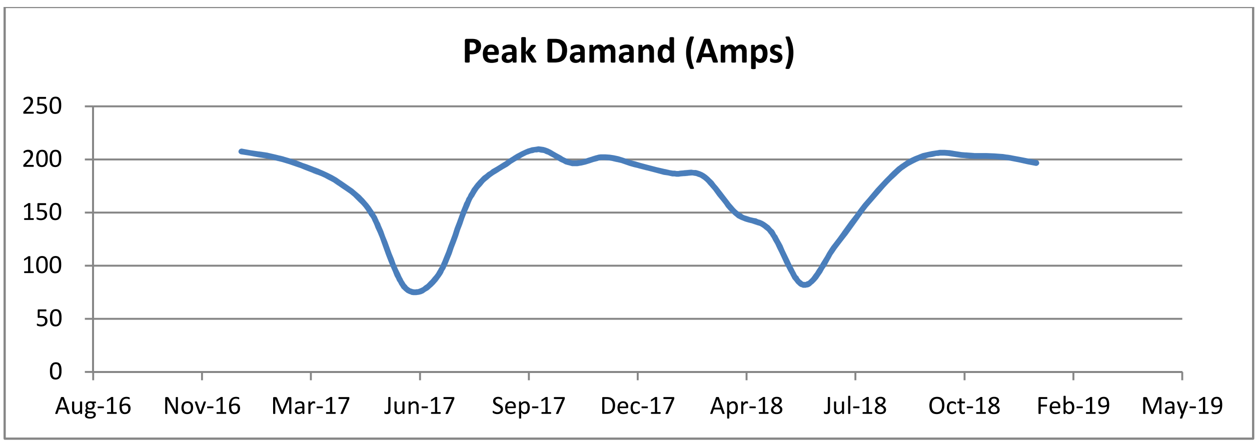
The domestic hot water is prepared in a pair of gas-fired heaters located in a separate mechanical room in the basement. This room is connected to the main electrical room.

4. POWER SUPPLY

Power supply to the building comes from Evelyn Ave via aerial cables fed from a pole mounted transformer. The supply wiring drop underground along a separate wood pole and resurface in the electrical room.

The main switchgear serving the building appeared new and in good condition. It was manufactured by Siemens and is rated at 120V/240V/1phase/3 wire/450Amps. From the main switchgear, the power is distributed throughout the school via a breaker panel board and serves multiple breaker panels. The new panel board has multiple spare slots available.

For the last consecutive 24 months, the school demand varied as follows:



The graph confirms that during the winter months, there are peaks in demand caused by the operation of the burners and pumps, while in the summer, the average demand is in the 150 Amp range (discounting the lowest values associated with the summer vacation).

Limiting the demand to 80% of the rated service, it appears reasonable to assume that the school has a summer spare capacity of approx. 200 Amp single phase.

588 Edward Ave., Unit 25
Richmond Hill, Ontario
L4C 9Y6
Tel: (905)-787-8885
Fax: (905)-787-8771
E-mail: sabengineering@rogers.com

5. ESTIMATED COOLING LOAD AND HYDRO SERVICE

If the instructional areas only are taken into account and the spaces already conditioned by unit ventilators are deducted, we estimate the cooling load of the building at 60 ton (211 kW).

With the current single phase service, the cooling load and associated heat rejection fans converts into an additional summer load of 980 Amps. This is clearly impossible to achieve with a 200 Amp spare capacity.

The only feasible conclusion is that if substantial air conditioning is included (without taking into account ancillary spaces and the Gym), a new 3-phase service is required to service the school, sized at min. 208V/3ph/4W/1,000A (unless 575V/3ph power is available on the street, in which case the service size can drop to 400 Amps).

6. PORTABLE AIR CONDITIONERS

Any air conditioning system contains two heat exchanging coils: a cooling coil located in the space to be conditioned (where heat is absorbed) and another coil usually located outdoors, through which the heat absorbed from the conditioned space is rejected to the ambient.

Portable air conditioners combine both coils and the refrigeration section in a single enclosure. However, the heat extracted from the space needs to be rejected, so portable air conditioners are equipped with flexible round ducts, through which air from outside the conditioned space is drawn in, picks up the heat, and is rejected back outside the conditioned space.

Where one or two such units are used as a temporary solution, heat rejection air is drawn from and return back to the corridor. Clearly, this is not feasible if multiple portable units are employed; the corridor would become unbearable hot and beyond a certain point, would no longer be able to accept the rejected heat.

With portable air conditioners, heat rejection will have to use the outdoor air, using new dedicated openings in the windows to which the two flexible ducts will be connected.

Another point of interest is dehumidification; conditioned air loses some of its moisture content which becomes liquid and needs to be removed. Usually, with portable air conditioners, the

588 Edward Ave., Unit 25
Richmond Hill, Ontario
L4C 9Y6
Tel: (905)-787-8885
Fax: (905)-787-8771
E-mail: sabengineering@rogers.com

condensate accumulates in a dedicated reservoir, which needs to be periodically emptied. More sophisticated models include a switch which will disable the equipment if the condensate receiver is full.

Portable air conditioners are typically in the 1 to 2 ton cooling capacity range and can use a regular 115V plug, provided that it is dedicated to it and has a rating of 20 Amps or more.

The purchasing cost is in the $800 range, to which installation costs must be added (windows modifications to accept flexible tubing connections, power supply, etc.). Our estimate is that one installed unit, fully functional, with a capacity of 1 ton of cooling, will require funding in the range of $2,000. Each classroom will require one or two units, depending on space size and orientation. The total portable air conditioning system costs as preliminary sized herein would cost around $120,000.

Upgrading the power to 3-phase and a pad-mounted transformer, together with new cabling and switchgear is estimated to take another $200,000. Without a power upgrade, the existing hydro service would be able to support air conditioning 7-8 classrooms and the offices/reception area.

6.1. Advantages:

Equipment works at 115V/single phase, easy to set up once power and window kit are available, cost is reasonable. There is minimal disturbance to building elements (walls, ceilings, roofs, etc).

6.2. Disadvantages

Ungainly sight, requires cutting through the new windows, require caretaking to periodically empty the condensate reservoir. Cannot be tied into BAS, controls are basically manual. Life expectancy is not great, likely to be in the 10 year range.

7. VRF AIR CONDITIONING EQUIPMENT

VRF air conditioning are the latest and most efficient iteration of the multi-split systems which first appeared on the market approx. 20 years ago. The concept is based on using one single heat rejection device (located outdoors) serving multiple evaporators inside a building. All evaporators are tied by refrigerant lines to the remote condensing unit.

Since the amount of heat reject by each evaporator varies with the indoor conditions, the first generation of multi-split air conditioners had limitations in terms of how many indoor evaporators can be tied into a single condensing unit.

SAB
ENGINEERING Inc.

588 Edward Ave., Unit 25
Richmond Hill, Ontario
L4C 9Y6
Tel: (905)-787-8885
Fax: (905)-787-8771
E-mail: sabengineering@rogers.com

Over time, the equipment evolved and the latest generation of condensing units contain variable speed refrigeration compressors and condenser fans, basically varying the amount of refrigerant flowing through the system with the actual building load at all times. With this development, the number of indoor condensing units which can be served by a single condenser increased substantially. At the same time, the technology of "ganging" up multiple condensing units allows system capacities to go over 100 ton or more.

Developments took place as far as evaporators are concerned as well; there are all sorts of evaporators on the market from vertical floor mounted, to wall mounted, ceiling mounted, plenum mounted, cassette type integrated with a T-bar ceiling, etc. Multiple types of evaporators can be used with any given system. Typical evaporators range in cooling capacity from ½ ton to 3 ton.

For St Cecilia CS, we anticipate that a system consisting of four 16-ton condensers mounted on the roof and tied to approx. 30 indoor evaporators will be adequate. We see the wall-mounted evaporators as the most economical for the school, in the absence of ceiling plernums. Refrigerant lines between the evaporators and the condensing units on the roof can line exposed, along the walls. Several small openings in the walls and ceilings are anticipated.

Like with any air conditioning system, condensation will occur. The typical solution is to have a common collection pipe looping around all the evaporators at each floor and collecting the condensate from each evaporator. Then, the common collector (usually 2" diam) will discharge in a caretaker's sink or similar. No human intervention is required.

All evaporators operate based on a programmable wall mounted thermostat; remote control units are available, but they usually get misplaced, so fixed space sensors are preferred.

The purchasing cost of a 60 ton multi-split air conditioning system is estimated to be in the $200,000 range. Labour costs to install the refrigerant lines, power supply and condensate drainage, provide roof supports and building envelope openings are estimated to be in the $175,000 range. Unlike the portable units, engineering work is required as well, to size the refrigerant lines and support the equipment on the roof. This is estimated to be in the $20,000 range. The total system installation as preliminary sized herein is estimated to cost $395,000.

Upgrading the power to 3-phase and a pad-mounted transformer, together with new cabling and switchgear is estimated to take another $200,000. Without a power upgrade, the existing hydro service would be able to three 5 ton systems and 15 indoor evaporators which may serve 12 classrooms and the offices/administration areas.

7.1. Advantages:

Equipment works with an entire range of voltages, from 203V/1phase to 575V/3phase. It is the most energy efficient distributed equipment on the market today and it is easy to control, operate and monitor. Condensate removal does not require manual intervention.

The equipment is quiet and aesthetic, provided that refrigerant lines and power cables are mounted from behind. It does not project that “temporary” solution image, it is a permanent installation and the life expectancy is in the 25 years range.

7.2. Disadvantages

System is expensive and requires some penetrations through walls and ceilings, which may contain asbestos. Troubleshooting requires manufacturer’s intervention (there are few independent outfits which can troubleshoot and repair such equipment).

We hope you find the information contained in this report to your satisfaction. Should you have questions or concerns, please don’t hesitate to contact our office.

Sincerely,

Gabriela Strashun, P.Eng.
SAB Engineering Inc.