Professional Engineering Study Services for Solar Panel Investigation

Municipality of East Hants Pool - Milford
August 2013

MCA CONSULTANTS_
ENGINEERS - PROJECT MANAGEMENT
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This proposal is presented to:

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Coordinator of Administrative Services
Municipality of East Hants

Municipality of East Hants
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Appendices

1.0 History of the Firm

MCA Consultants is an engineering firm based in Atlantic Canada with offices in Charlottetown, Prince Edward Island, and Halifax, Nova Scotia. Founded in 1997, we have quickly earned our reputation for providing complete Engineering Consulting & Project Management Services for Commercial, Institutional and Industrial Clients through Canada.

MCA Consultants has particular expertise in design of mechanical building and process services within education, health care, recreational, commercial, pharmaceutical, food processing, and industrial facilities. In addition to traditional services of HVAC, Plumbing, Fire Protection, and Controls systems, MCA Consultants has extensive experience in central utility plant design, district energy systems, industrial refrigeration, geothermal system design, engineering economic analysis, and building energy simulation.

MCA Consultants has successfully provided mechanical and process engineering services to a wide range of public and private sector clients.

In working with most major architects, building owners, and private sector developers the company has acquired a reputation for practical, economical and innovative solutions to client's requirements. These innovative solutions combined with our diversified project experience and local knowledge has resulted in the successful application of proven technologies to optimize energy efficiencies of buildings.

The company has been involved in several types of projects which range in size from half million dollars to in excess of thirty million dollars.

2.0 Project Description

The Municipality of East Hants (MEH) has operated a municipal pool in Milford, NS since the 1960's. The facility provides services to the general public, private events, and instructional classes, among others. In January of 2010, MEH received an energy audit which included details of adding a solar water heating array to the pool facility in Milford. The energy audit led to the issuance of an RFP in August of 2010 and the subsequent award for installation to Scotian Renewables Inc. The expectations of MEH for the installation were the reduction in overall energy costs and a return on investment to MEH in approximately 10 years. Scotian Renewables Inc. stated in their proposal response that the investment would provide a longer estimated payback.

2.1 Existing System Description

The heating plant as it exists at the time of this report provides heat primarily to a pool of approximately 190,000 us gal and also to the domestic hot water system and to the dehumidification system. There is some space heating also connected to the plant. The heating plant sources are the new solar water heating array and existing oil fired boiler and oil fired domestic hot water heater. A control system is connected to the new solar heating system and operates the many valves, pumps, and internet monitoring equipment. The control system is not incorporated into the existing oil fired system. The general operation of the system is to allow the heated water from the solar panel array to provide as much energy as possible to the facility (pool water, domestic hot water,

space heating) and supplement any shortfall with the oil fired system. A system schematic has been attached in the Appendix.

2.2 Reported Problems with Existing System

A number of issues have been reported in the operation of the system during the approximate 3 years of system operation. A brief list of the main items as discovered are listed below:

.1 Air locks which prevented the system from circulating water;
.2 Glycol leaks;
.3 Expansion Tank Failure;
.4 Oil bills have increased;
.5 Automatic air vents leaking;
.6 Multiple solar panels in the array leaking;
.7 Pool water heat exchanger (H/X) leaking;
.8 Pool water varies in temperature;

3.0 Investigation

An investigation was undertaken by MCA Consultants through meetings and site investigations. A preliminary meeting was held on 26 February 2013 at the MEH offices in Elmsdale. In attendance at that meeting was Linda Ramsay, David Brown, Wendy MacLeod (Hill), John Conrod, and Steven Ramsay. Discussions revolved around the process that led to the installation of the solar heating system at the Milford Pool and the benefits and challenges that have resulted.

A site investigation at the Milford pool was carried out on 13 March 2013 with John Conrod and Steven Ramsay. Detailed site review of the existing system layout was conducted and discussions with John Conrod gave detail to the operation of the systems.

A further meeting was held at MCA Consultants office in Dartmouth between Babak Farsi and Steven Ramsay on 01 May 2013. The items discussed were related to the original installation, the operation and monitoring of the system and the current status of the system installed.

4.0 Energy Records

The original driver behind this project was to reduce the energy consumption required to heat the pool water, domestic hot water, and space heating of the Milford Pool. The oil energy records provided through an email from David Brown are detailed below:

Year of Oil Consumption	Oil Consumption (litres)	Solar Panel Array
November 2009 – November 2010	5,973.2 (Base Year)	Pre-Installation
November 2010 – November 2011	7,652.2 (28% increase)	Post Installation
November 2011 – November 2012	11,606.6 (94% increase)	Post Installation

As shown, the oil consumption has increased year over year since the installation of the solar array to be almost double in the 2011 – 2012 year.

5.0 Recommendations

A number of items were identified during our investigations which warrant modifications or adjustments. These items are listed as per below:

.1 **Safety – Energy – Equipment Life Expectancy:** The existing solar panel array contains 40 solar panels and when these panels are all functioning to produce heat for the facility, the heat output during summer conditions will be significant. Through our investigations, it was noted that a summer shut down and cleaning of the pool system is undertaken each year. This coincides approximately with the maximum thermal output of the solar array. During the shutdown of the pool, the solar array does not have an output to dissipate heat energy produced (normally the pool). It appears that this is the main issue regarding the leaks and the failures of the solar array in the past. Most likely, the glycol solution was raised above the safe operating temperature as it remained stagnant in the solar collectors and the liquid expanded to a point where the pressure burst the system components. A program must be put into place where any interruption in flow from the solar collectors will provide for the dissipation of the heat energy in order to keep the temperature and pressure below safe upper limits. This would include the summer shut down, but would also include any other interruptions in flow, such as periodic solar panel isolations (closing of valves, or shutting down of pumps) when leaks or other issues develop. This issue would have contributed to the glycol leaks, automatic air vent leaks, solar panel failures, pool h/x leaking, and would also have contributed to the failure of the expansion tank. It would also have contributed to an increase in the oil bills over the payback expected for the installed system. It would not have contributed to an increase in the oil bills over the previous year when the panels were not installed.

.2 **Energy – Equipment Life Expectancy:** The training manual which was provided by Scotian Renewables Inc. and is dated April 21, 2011 (rev 1) provides a good physical and operational description of the installed solar array system. A more detailed understanding of operating the solar array system is required in order to properly operate the facility on a daily basis. For instance, the manual describes the operation of the system for a person who would already have a good understanding of solar heating systems, automation controls, and mechanical building systems. It would require much more detail if the target audience was for personnel whom did not possess all of those skills. It is recommended that MEH engage a qualified third party to provide ongoing maintenance and oversee operational issues related to the complex mechanical equipment at the Milford Pool Facility. This item would have contributed to the air locks in the system.

.3 **Energy:** - The existing oil fired boiler and the oil fired domestic hot water heater are installed in parallel with the new solar panel array and are used to supplement the heating requirements of the facility when the solar panel array cannot meet the heating load. The control system which was installed to provide optimized operation of the solar panel array is not connected to the oil fired system, or the pool dehumidification system. Through discussions it is has been identified that the boiler system setpoint is manually adjusted based on staff requests for additional heating. A comprehensive control system which would automate the boiler and the oil fired domestic hot water heater and the dehumidification system should be installed. This would incorporate and automate the existing control strategy into the entire facility and would allow all oil energy users to work together with a common purpose. Based on our investigations, it is surmised that the existing oil fired equipment is operating during many hours of the year at a higher temperature than the solar panel array is able to achieve. This would negate the ability of the solar panel array to provide any benefit to the facility. Although there is no evidence, there is also a potential issue where the oil fired system may be providing heated water to the return of the solar panel

array heat exchanger and effectively sending heat to the solar panels. This may be a contributing factor to the increase in the oil energy bills.

.4 **Safety:** The thermostatic mixing valve which is located on the oil fired domestic hot water heater has failed and needs to be replaced. This valve should be replaced with an automatic style valve which will track the hot water supply temperature and supply only the domestic water temperature needed. If a manual style valve is used, then a great risk is presented that if the hot water supply temperature is raised, then scalding hot water may be sent to the showers and the hand sinks within the facility.

.5 **Energy – Equipment Life Expectancy:** The dehumidification system was noted as being in fair to poor condition during our site investigation. The fresh air dampers were in poor shape, the pool air coil was extremely dirty, and the operational details of the system did not seem to be clear. An assessment of the dehumidification system by a qualified technician should be undertaken to review the operational performance. An integrated control strategy should be incorporated into the dehumidification system and the heating system including humidity levels, fresh air requirements, operational hours, etc. This may be a contributing factor to the increase in the oil energy bills.

(Figure 1) The air coil in the Dehumidification Unit

.6 **Safety - Operating:** The existing system, including the new solar heating system does not have a good labeling system on the piping and the valves. This does not allow good trouble shooting, ease of system understanding or easy access to the system for shut downs. A labeling strategy should be established which shows direction of flow arrows, fluid within the pipe, and valve designations (ie. solar array supply water isolation valve, solar array drain valve, etc.).

.7 **Safety – Energy:** Some of the controls which were installed on the new solar heating system were noted during our site investigation as being faulty. The differential temperature controller (GL-30) which controls the circulator pumps on the solar array was malfunctioning at the time of our site investigation. This was noted to John Conrod and subsequently discussed with Babak Farsi. Some of the temperature sensors which are strapped to pipes are not fastened securely and are not making good contact with the pipes and under the pipe insulation. A comprehensive review should be undertaken by Scotian Renewables Inc. to make sure that all controls are working properly and are located and secured as intended by the original design. This may be a contributing factor to the increase in the oil energy bills.

(Figure 2) GL-30 controller

6.0 Conclusions

A detailed site investigation was conducted and multiple meetings were held. The outcome of this was a list of seven specific recommendations to make the system use less energy, make it operate in a uniform and cohesive manner, provide safe operation, and extend the life expectancy of the equipment.

The underlying issue of the 94% increase in the oil bills was not identified in any single major issue. There was no “smoking gun” item which showed to be the definite problem responsible for this. The system is relatively small and therefore the possible locations for the energy to go are few.

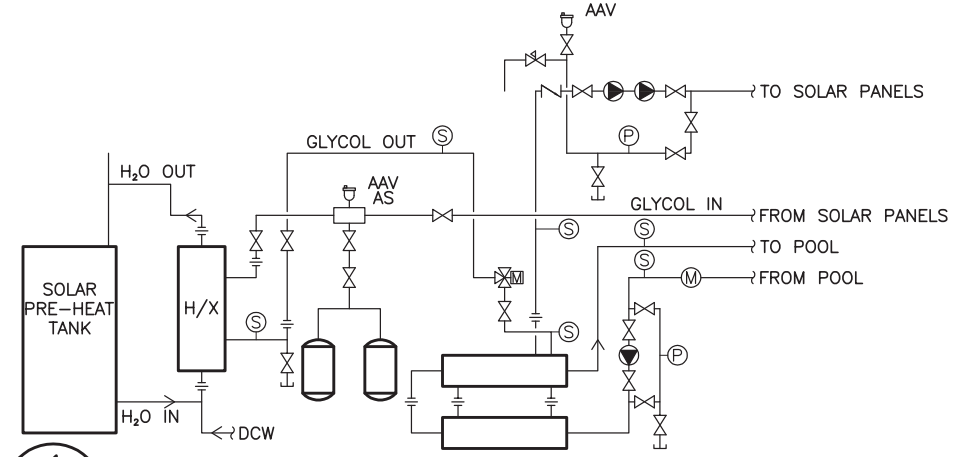
- The MEH staff has stated that the pool temperatures have not increased, therefore the energy is not in the pool water. Just as an information item, it would require approximately 75 litres of oil to raise the pool temperature by 1 degree Fahrenheit.
- The fresh air component of the dehumidification system can play a role in the oil energy consumption. In our discussions, we have recommended that this system be reviewed and an integrated control strategy be instated to reduce the energy costs.
- The manual controls on the oil fired equipment raises a concern that without the solar array and the oil fired system working under the same control strategy, there is potential for missed oil saving opportunities.
- Poor maintenance on the dehumidification system can contribute to increased oil costs as the dehumidifier will have to work harder in order to output the same energy to the pool air. Dirty coils will not transfer the energy as easily as clean coils.
- There is potential for a failure in the solar array controls to account for increased oil energy usage, but there was no evidence noted which would suggest this has occurred.

In summary, if an integrated control system is installed and a comprehensive operation and maintenance program is initiated, there should be no discrepancy in increased oil costs. The systems shall operate as one and the oil savings (if attributable to operation) should be realized.

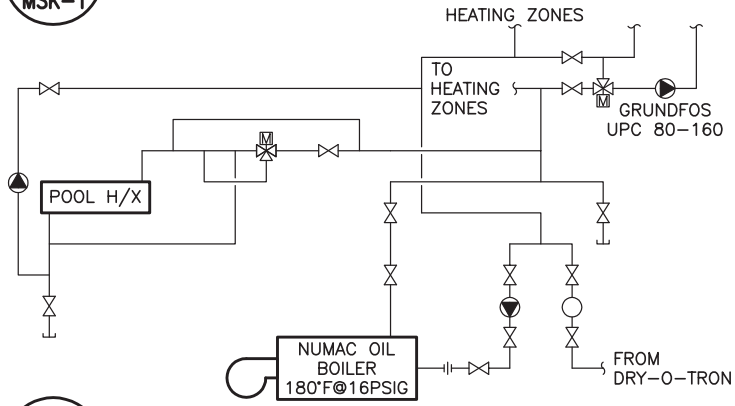
The solar equipment installed has the potential to provide real oil savings to the Milford Pool. The efficiencies of this solar system are certainly acceptable for this installation. There is greater efficient product and systems available in this market, but this system, if operated correctly, should provide a financial return to MEH.

APPENDIX A

MSK-1 – Boiler & DHW Heater Schematics



1 MSK-1 POOL HEATING SCHEMATIC
SCALE: NTS



2 MSK-1 BOILER SCHEMATIC
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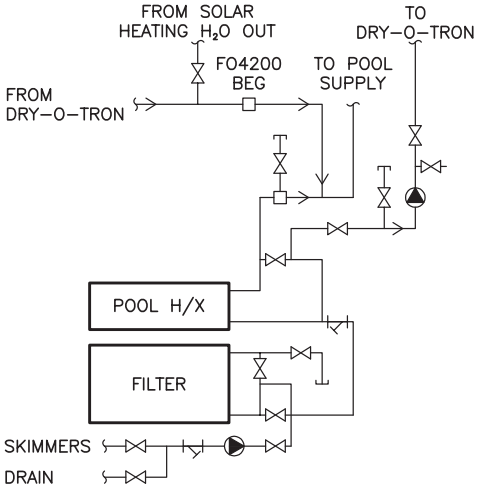

3 MSK-1 POOL FILTER SCHEMATIC
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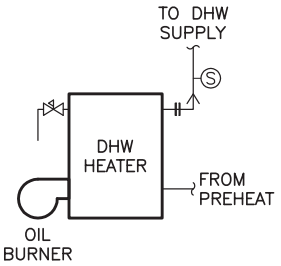

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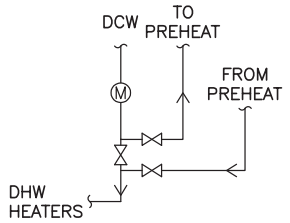

5 MSK-1 SCHEMATIC
SCALE: NTS

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Project
SOLAR PANEL HEATING INVESTIGATION

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Drawing Title
BOILER & DHW HEATER SCHEMATICS

Drawing No.
MSK-1

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