Alternative Solution Analysis
Re: Bairds Solar Hot Water Heating
3295 Compon Rd., Victoria, B.C.

I, Gordon Baird, am requesting the consideration for an alternate solution, for the design and install of our solar hot water heating system. This proposal derives from there being a lack of policy and direction on behalf of the Canadian Standards Association on combination systems which incorporate solar thermal collection for use in both domestic space heating and domestic hot water heating. Through prior documentation supplied to the local inspection agency, both CSA and NRCan denote the void in policy and standards on this issue and plan to have something in place by 2009-2010. In light of this they propose that good engineering practice be followed to meet the objectives and functional statements of the code.

In light of this we will explain how are system with the use of existing acceptable practices meets the intent of the code under three areas pertaining to solar domestic hot water heating. The functional statements are as follows:

- **F31-OS3.2** – Minimize the risk of injury to a person in contact with hot surfaces
- **F81-OS3.4** – Minimize the risk of malfunction, interference, damage, tampering, through lack of use or misuse and thus exposing individuals to hazardous susbstances.
- **F70-OH2.2** – Provide potable water and ensure there is no consumption of contaminated water.

Despite the lack of (but intent to create) CSA policy surrounding this issue, there are existing standards elsewhere (eg. Europe EN12975) and common practices and CSA components available to ensure the design and installation meet the above functional criteria. The rationale for choosing solar thermal collection for our heating purposes is based primarily on the popular need to begin utilizing safe sustainable and secure energy so that less demand is placed on infrastructures (oil, gas, electricity), meaning there is less demand on infrastructure and resources in which in their very nature jeopardize large populations through global warming and climate change. In an effort to use sustainable systems, implying separation from existing infrastructures, we already begin to minimize harm to others.

Background of Individual Taking Responsibility

The person taking responsibility for the design is Gordon Baird. Gordon's experience comes from researching and teaching sustainable options in replacement of existing technologies, relying heavily on communications, in this case on Bruce Sibbits and Jeff Knapp from NRCan, Richard Ashly the Chief Inspector for the City of Ottawa, Wes Johnson from Canadian Solar Industries Association (CanSIA), Nitya Harris from Solar BC, Chris Dick professor of engineering from the University of Manitoba, Byron Merriam a certified solar installer(through the CanSIA installers program), and Zev Fischer of Thermomax Industries.

Special Maintainance and Operational Requirements

The intent of the solar thermal collection for the intent of heating both space heating and domestic hot water is meant to be very simple. The domestic hot water system is standard where water is drawn out from the top of a hot water tank. The space heating is designed as a standard hydronic in floor system that is filled with distilled water as the fluid, and where the heat is accepted through a standard CSA approved single walled coil located inside the hot water tank.

The solar thermal collection system is a closed looped system that collects heat from a series of evacuated tube collectors via a passive heat transfer between tubes and manifold, which circulates through to a CSA approved double walled coil in the base of the hot water tank.

Key Features of Each System

Solar Thermal –

- Circulation is powered through a low voltage (12 volt DC) pump
- Pump operation is determined via a 30 watt solar module in which when the sun's intensity reaches minimal level, both the pump operate and the evacuated tubes produce heat.
- Connected to the closed loop system are both a pressure release valve to act as a safety for possible malfunction, and an expansion tank
- Closed loop system is filled with food grade glycol, ensuring that malfunction will not unduly harm individuals if consumed as per MSDS data.
- On key places of the closed loop, signage will be posted as to what food grade glycol to use, and how to use it. Signage will be posted in the mechanical room also ensure obvious understanding of the products used.
- Pressure of the closed loop system will not exceed the minimum operating pressure of the potable water system.

Potable Water –

- Potable water is supplied via well water, through 1 inch municipal line, through to a pressure tank and then into the hot water tank. To ensure that malfunction of the solar thermal coil does not contaminate the potable water system or pressure tank and well, and to ensure that hot water can not flow backwards into both the pressure tank or supply line, two backflow preventers will be installed; between the supply line and the pressure tank and between the pressure tank and hot water inlet.
- The pressure of the potable water system will be set and regulated between 30-and 60 PSI through use of a pressure switch, and an inline pressure control valve that is set for 60 PSI.

Hot Water Storage

- The hot water tank will have the appropriate pressure relief valves to ensure safety in case of malfunction.
- The pressure relief valve will be hooked to a drainage system in which no chance of fluids can come into contact with an individual; and ultimately exit through a floor drain into perimeter drainage.

Hydronic Heating System

- The hydronic heating system was designed by WIRSBRO and Pro Star Mechanical, and meets all the standard requirements of the building code, and as for this system, nothing requires an alternate solution.
- As one added safety feature the system will be filled with distilled water so cross contamination can not occur. A notice of this will also be posted in the mechanical room.

Functional Statements

F31-OS3.2 – Minimize the risk of injury to a person in contact with hot surfaces

- Of the solar thermal collection system the only hot surface to come into contact would be the copper tubing, of which will be insulated using a thermally suitable piping insulation, as per Section 6.2.9.2 of the BCBC.
- Pressure relief valves from all systems will be plumbed appropriately to ensure safe removal of hot steam or fluids
- Stating the obvious, neither the tubes nor the manifold into which the tubes plug into get hot, and in light of there being no CSA policy/Standard in place for evacuated tube technology, adherence to good safety practice as set out in the code, and guidelines as set out in the letter from Bruce Sibbits from NRCan for inspectors in light of this void. The Evacuated (Mazdon) tubes are a part of the different Federal and Provincial grants (Eco energy for Heat, and BC Solar Roofs), as well as a European EN 12975 certification.

F81-OS3.4 – Minimize the risk of malfunction, interference, damage, tampering, through lack of use or misuse and thus exposing individuals to hazardous substances.

- The design of the solar thermal system would be limited to malfunction in that it is a closed loop low pressure system.
- In the event of overheating the PT valve would bring pressures back into normal range.
- To prevent freezing, the system will be filled with a food /pharmaceutical grade glycol (propelene glycol), (or suitable ethanol water replacement that meets ASTM D92 standard where as the flashpoint is in excess of 30 degrees C).
- Notice in obvious locations of the type of product contained and used within the system will be posted, including the mechanical room and filling/draining locations on the system.
- A posting of the MSDS data of the food grade glycol will also be posted.
- Utilization of the 30 Watt solar module to control circulation ensures that the system continues to operate in absence of occupants, operates in power failures, and ensures that mechanical alfunction that could otherwise occur through controller and differential thermostats is removed, thus making operation “idiot proof”; when the solar gain is present enough to heat the collectors, there also is the energy present to circulate the system.

F70-OH2.2 – Provide potable water and ensure there is no consumption of contaminated water.

- Use of food grade glycol (propolene glycol), (or ethanol potable water mix with flash point above 30 degrees C in accordance with ASTM Standard D92.)
- CSA approved double walled coil for the glycol system
- Appropriate PT valves on all systems (solar thermal, hydronic, and domestic hot water).
- Use of distilled water in the hydronic heating system.
- Use of Pex tubing in the hydronic system.
- Two backflow preventers situated between potable water main feed and pressure tank, and between pressure tank and inlet to hot water tank.

- Pressure gauges on both the solar thermal loop and the hydronic loop with a posted notice as the applicable safe pressure ranges; to ensure that failing any obvious signs of malfunction such as a coil malfunction that the gage would dictate such. In the case of both the solar thermal and hydronic loops, the increase in pressure equal to or similar to that of the potable water supply would dictate breach of a coil.
- Also the pressure relief valve on both the solar thermal closed loop system and the hydronic system would be set to lower than the minimum pressure of the potable water system, therefore ensuring potable water to enter the breeched system, and cause the system to drain through the PT valve.

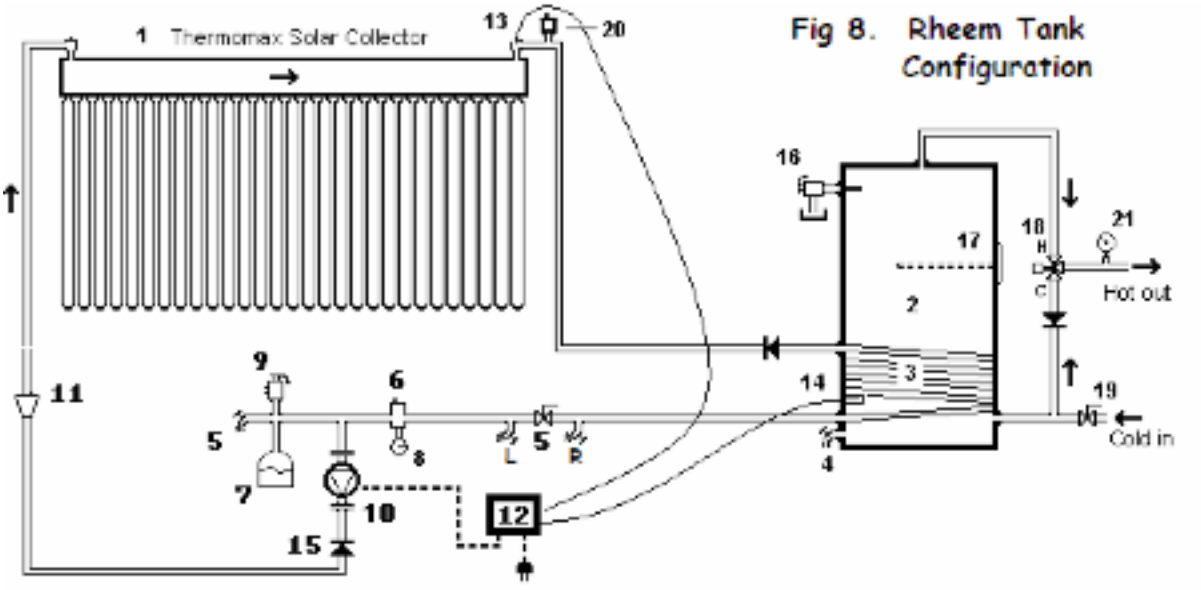
Documentation of system design and components

THERMOMAX

Installation drawings for Thermomax evacuated tube systems.

1.1 Components for SST 60 C/W Single or Double Wall Vented HE

(NOTE: Baird's will be using the 120 double coil tank with double walled coil for solar thermal loop, and single walled coil for hydronic loop – see attached concept drawing).



1. Solar Collector(s)
2. Storage Tank
3. Solar Heat Exchanger
4. Tank Drain
5. Service Valves
6. Air Purger
7. Expansion Vessel
8. Pressure Gauge
9. Pressure Relief Valve
10. Circulating Pump
11. Omit flow meter
12. Differential Solar Controller
13. Collector Sensor
14. Tank Sensor
15. Check Valve
16. T & P Valve
17. Tempering Valve
18. Isolation Valve
19. Optional Item see 6
20. Temperature Gauge

Component Description and Use:

NOTE: Specific products and manufacturers have been mentioned here. Equivalent products may be substituted providing their specifications meet or exceed those of the listed products., all fittings to be non ferrous metals.

1. Solar Collector – modules of 60 Mazdon vacuum tubes collect light energy and converts it to heat. For multiple manifold installations no more than 90 tubes should be connected in series. Equal banks of these should be then plumbed in parallel.

2. Thermomax Storage tank –SST 120DB OG Stainless – 120 Gallon double coil.

3. Heat exchanger –double wall Wand retro-fit heat exchanger – For up to 30 tubes. Tank Drain – periodically the tank should be drained through this to remove sediment build-up.

4. Service Valves – Two hose bibs with a ball valve in between enable filling and flushing of the loop.

5. Air Purger - Spirovent. This required item can greatly assist in expelling air from the loop during filling and maintenance.

6. Expansion Vessel – Extrol #30 by Amtrol.

If the water temperature in the system rises, the water volume will increase resulting in a rise in pressure, and the possibility of damage to the system if the expansion is not absorbed. Also if the system stagnates, an additional 1.5 liters or 0.4 gallons of fluid will boil out per 10 solar tubes. The increase in water volume is contained in the expansion vessel until the water temperature has reduced and the volume returns to its initial level. The vessel comprises of two halves. One half connects directly to the water system. The second, separated by a special diaphragm, contains nitrogen or air. The size of the expansion vessel has to be determined as a function of the total water volume of the solar system, the static height of the system and the water contents of the manifold.

8. Pressure Gauge – Bar 100XKPA, 0-60 psi. Allows the fluid pressure in the loop to be monitored. A rapid fall in pressure would indicate a leak.

9. Pressure Relief Valve – Cash Acme FWC. This adjustable valve will protect the loop from high pressure. It should be set according to the calculations at the bottom of P 29. A fixed Pressure Relief Valve of the correct rating is acceptable.

10. Circulating Pump – El-Sid 20 12 volt DC.

11. Flow Meter – (Optional) Letro LDF-360B. Indicates that the fluid is circulating, how fast – and enables a visual check on the condition of the fluid.

12. Differential Solar Controller –(Optional in exchange for 30 watt PV panel and El-Sid Pump) Thermomax SMT 100, 400 or equivalent. Reads the temperature at the collector and the return and turns the pump ON when it reaches 12°F hotter at the collector and OFF when that differential falls to 4°F.

13. Collector and return Sensors – PT100 platinum film sensor 3 wire compensated c/w with wire lengths of 25M (collector) 5M (return).

14. Tank Sensor – PT100 platinum film sensor with 5M wire.

15. Check Valve – Red White 125S. Prevents the loop from circulating backwards at night when it is hotter in the tank than at the collector.

16. Temperature & Pressure Valve – Cash Acme NCLX-5. Protects the tank from damage by overheating or expansion of the water. Releases when the temperature exceeds 210°F or the pressure exceeds 150 psig.

17. Tempering Valve – Honeywell Sparco AM 101-1. As the solar collector can overheat the tank this valve IS REQUIRED to reduce the water temperature going to the taps by mixing cold water with it. Adjustable from 100°F to 145°F, this valve should be set no higher than 120°F using the temperature gauge.

18. Isolation Valve – Watts WOVS-1. Enables you to turn off the cold water to the tank if necessary.

19. Automatic Air-Vent – Not required with the air purger in the system. Manual air vent is included with the collector for system commissioning.

20. Temperature Gauge - Pasco 1449. Used to set the temperature to the taps with the mixing valve (18). Optionally two extra temperature gauges may be installed in the flow and return to the collector to monitor performance.

General Items:

23. Piping – Copper Type L or M. OD 5/8", ID 1/2". Pipe should be connected with leadfree solder. For pipework of total length 30-50 metres or 100–164 feet, the following

System	**Tubing** Dimensions
30/40 tubes	15mm or ½"
60/90 tubes	22mm or ¾"
120 tubes	128mm or 1"

24. Insulation - AP Armaflex or Rubitex Pipe Insulation. Protects piping against heat loss.

25. Heat Transfer Fluid – Prestone low tox propylene glycol . Protects the system from freezing and corrosion.
Component Life: With the exception of the Heat Transfer Fluid one can reasonably expect these components to last in excess of 10 years – and in many cases more than double that. Individual manufacturer's warranties apply and Thermomax is not responsible for items they did not manufacture.

SOLAR SUPER TANK

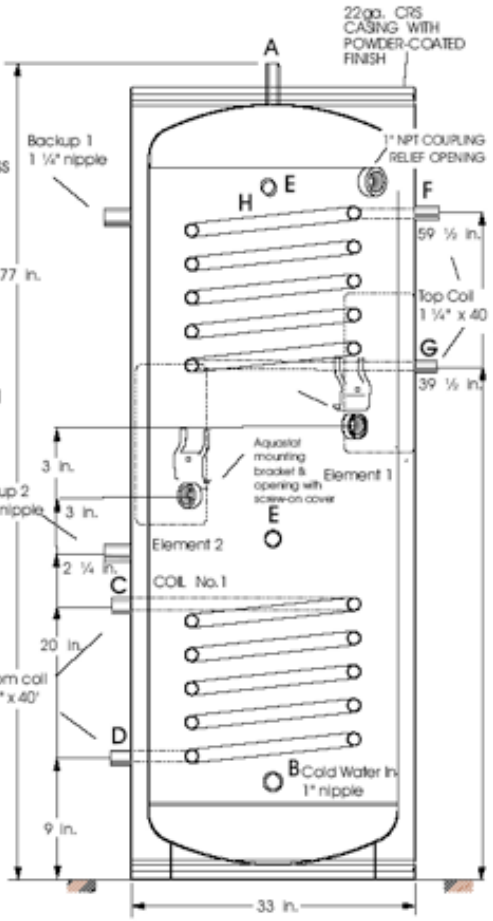
INDIRECTLY FIRED HOT WATER TANK

SST 120DB OG OFF GRID

U.S. Patent No. 5,228,413

TANK CAPACITY U.S.gal.	COIL No.1 HEAT. SURFACE sq.ft.	COIL No.2 HEAT. SURFACE sq.ft.	OPERATING PRESSURE psi.	MAX. OPER. TEMP ° F	SHIPPING WEIGHT lbs.	PRESSURE DROP - COIL #1 ft.water.	COIL LENGTH feet/coil
120	13.09	13.09	150	175	260	5 @ 25 gpm	30/40

- Made in B.C.
- 100% 316L Stainless steel tank and heat exchanger.
- Single-coil heat exchanger design, resulting in lower pressure drop and higher heat transfer rate.
- Uniquely-designed drain and cold water inlet to prevent build up of sediment.
- To minimize coil wear, internal portions are continuous without any welds.



CONNECTIONS

A	Hot water outlet	1 ¼" NPT nipple
B	Cold water inlet	1 ¼" NPT coupl.
C	Supply from solar	1 ¼" NPT nipple
D	Return to solar	1 ¼" NPT nipple
E	Aquastat	½" NPT coupl.
F	Supply to heating	1 ¼" NPT nipple
G	Return from heating	1 ¼" NPT nipple
H	Pressure Relief	¾" NPT coupl.

- Built-in connections for aquastat, temperature gauge, and pressure relief valve.
- Designed for quick and simple installation in the field.
- Powder-coated casing for high quality finish and durability.

Made Exclusively for Thermomax by
K-TAM Manufacturing Inc.

10-YEAR MANUFACTURERS WARRANTY

THERMOMAX

3181 Kingsley St., Victoria, B.C. Canada V8P 4J5

See "Applications" on www.SolarThermal.com

Tel. (250)721-4360 Fax. (250) 721-4329

Concept Drawing Only –

The Baird's system will incorporate a future backup heating system in the same configuration, there will be no electric element, nor will there be a hookup to any other direct heating source like a woodstove or boiler.