Re - NH SB 218

Comments by Water Energy Distributors Inc – 2 Starwood Dr., Hampstead NH (603) 329-8122

Carl D. Orio, Chairman, CGD, AI August 6, 2012

1.0 REQUIREMENT– comments relating to:

Measure “useful thermal energy” produced by geothermal heat pump systems

2.0 HEAT PUMP OPERATION

2.1 Any refrigerant device moves energy from one location to another. In doing so the device may change the temperature of the fluid[1], one component of energy, but not changing the total energy transferred. What is put INTO a refrigerant device is what is TAKEN OUT of a refrigeration device. The “useful thermal energy” can be quantified by measuring energy IN or energy OUT of a refrigeration device.

2.2 A refrigeration device that can be “reversed” is termed a heat pump. The outside interface of a heat pump can either produce a cooled fluid or a heated fluid from or to external energy. Conversely the inside[2] of the same device can produce a heated or a cooled fluid to or from the inside of a building. A heat pump is defined as a device that can be internally switched to transfer useful thermal energy in either direction.

2.3 A heat pump that interfaces (aka couples) to the earth, either drawing thermal energy in (winter) or sinking thermal energy (summer) is termed a geothermal heat pump.

2.4 The source of energy becomes the “cold” or EVAPORATOR side of the heat pump. The destination for the transferred energy is known as the CONDENSER or “hot” side. Note that the evaporator and condenser sides change on a seasonal basis.

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[1] Air and liquids are both technically defined as fluids, as both follow “fluid flow” laws

[2] Inside and outside are terms adopted by the International Standards Organization (ISO). The Out side represents the source of thermal energy, outside the building being conditioned and the inside being the space being conditioned by a heat pumps. The two terms have been adopted to avoid the confusion between air conditioning which has only a single condenser outside and a single evaporator inside. A heat pump reverses these function on a seasonal basis – with the evaporator extracting useful thermal energy from the earth in the winter and accepting thermal energy in the summer

3.0 MEASURING USEFUL THERMAL ENERGY

3.1 Approaches

- Direct thermal energy transfer measurement
- Individual thermal energy transfer
- Aggregated thermal energy transfer

3.2 – DIRECT THERMAL ENERGY TRANSFER MEASUREMENT – New Accumulating Instrumentation Required

As above, a heat pump does not create energy it moves energy from one point to another, e.g. outside to inside (winter) and reverses for summer operation. Measured thermal energy in or out of a heat pump must be the same whether measured at the input or output. Side of the heat pump.

Measuring geothermal input thermal energy is the sum of the geothermal fluid and electric motor energy. Measured at the evaporator side of the heat pump.

SOURCE ENERGY SIDE Measurement (EVAPORATOR)

Well Water source- Gpm X 500 X temperature differential X 3.413 = watts
Closed Loop source – Gpm X 485 X temperature difference x 3.413 = watts
PLUS – Electrical energy used to drive motors
Volts X Amps X power factor = watts

EQUALS – watts of total thermal energy transferred into heat pump

DESTINATION SIDE Measurement (CONDENSER)

Air flow CFM X 1.08 X temperature differential X 3.413 = watts

EQUALS – watts of total thermal energy transferred out of the heat pump

Destination side air measurement is least computationally complex as electric contribution and heat transfer factors associated with water or closed loop fluids is included in the condenser side transferred energy.

Measuring air flow has been simplified with the advent of the electronic commutated blower motors (ECM) used in the majority of today's residential heat pump blowers. An ECM blower motor will deliver the cubic feet of air per minute (CFM) programmed into its electronic controller under all approved installation methods. Measuring total energy transferred becomes a simple temperature differential task.

Many lower cost and lower efficiency geothermal heat pumps utilize a conventional permanent split capacitor (PSC) motor. The PSC blower in these heat pumps is not a constant cfm flow rate blower motor. Its measurement becomes complex and prone to error. For this reason, suggest any air side measurement not be utilized for heat pumps with a PSC blower and only water side measurements made.

3.3 INDIVIDUAL THERMAL ENERGY TRANSFER – Employing fielded instrumentation - requires interpretation

Public Service of New Hampshire (PSNH) and the New Hampshire Electric Cooperative (NH Coop) both have separately metered geothermal heat pump installations in place. There are approximately 300 or more of these meters installed, some for several years. These separate meters are read monthly and monitor heat pump and well or closed loop pumping energy use in kilowatts. As above, this is one component of the energy transferred. *Hence, a portion of monthly and annual kWh are known and are presently being monitored.*

Each of these instillations required a rigid “manual-J” energy transfer loss and transfer gain estimate at the time of instillation (NH Building Code section) and consequent selection of the heat pump size. *Hence, the designed BTU/kWh transfer requirement of each geothermal heat pump is known.*

Each heat pump, has an in-place test of its performance and operational efficiency. These tests are made with field grade equipment and are a good representation of that heat pump’s performance. *Hence, each heat pump has a verification of proper installation, its capacity and efficiency.*

A simple annual energy transfer estimate for that individual heat pump can be made by:

Heating months total kWh X Measured COP efficiency = Heating season total kWh transferred

Cooling months total kWh X Measured COP efficiency = Cooling season total kWh transferred.

Suggest:

Pilot program be promptly initiated utilizing available in-place monitoring and startup testing of individual heat pump efficiencies as an efficiency base. Utilize geothermal heat pump manufacture's published variation of capacities and efficiencies based upon monthly weather conditions and estimated entering water or antifreeze solution temperatures, from existing earth coupling models and actual well temperature data.

3.4 AGGREGATED THERMAL ENERGY TRANSFER – A verification and boundary of the total thermal energy transfer potential by geothermal heat pumps.

As above, only totally aggregate both PSNH and the Coop kWh meters on geothermal heat pumps. In a more simplistic manner, total kWh of these presently monitored heat pumps can be aggregated and simply multiples by published ISO-13256 (third party rating) of geothermal heat pump efficiencies at standard conditions.

While not a rigid one by one heat pump analysis, this approach can be implemented with little resources an can provide a "path-finder" for continuing acquisition of geothermal energy transfer information.

This suggested first step can provide valuable information on the methods, viability and costs for further instrumentation and analysis required for RPS program success.