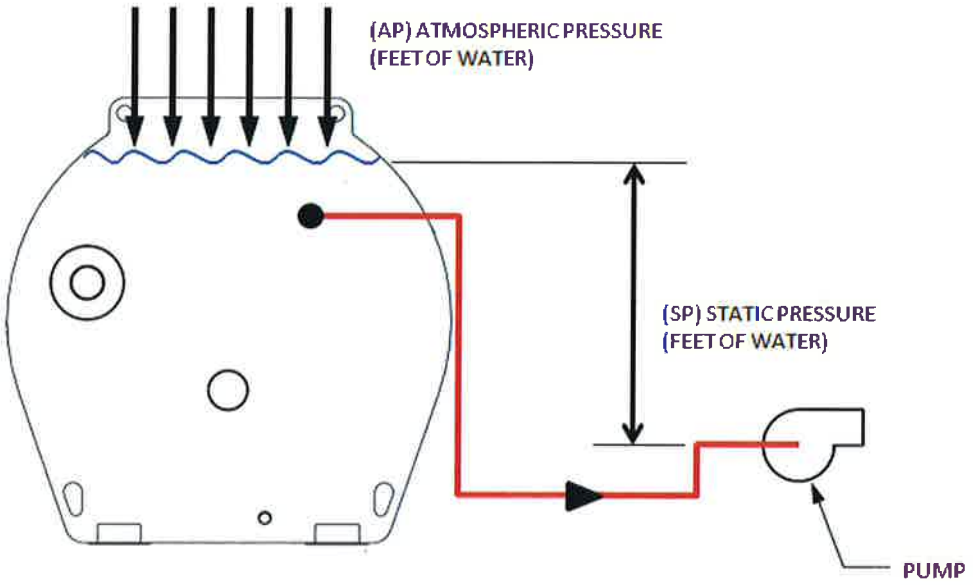
CALCULATION OF NET POSITIVE SUCTION HEAD FOR PUMPS

All GARN® wood heating units are zero pressure closed systems as opposed to:

- Open system – replaces the vast majority of its contained water daily. A good example of this is a domestic water heater.
- Pressurized closed system – replaces little if any of its contained water on a yearly basis and operates with an internal pressure of 15 to 30 PSIG. A good example is a standard hot water boiler that is used for space heating.

A zero pressure closed system does not develop internal pressure due to its unique open vent system. Such systems do replace a minor volume of contained water on a yearly basis. The designer must consider net positive suction head (NPSH) when selecting pumps for such systems. Proper selection will prevent cavitation and suction boiling that can: destroy the pump; prevent the system from attaining its rated heating capacity; or air lock the hydronic system totally.

Graphs of pump performance and net positive suction head requirements are available from pump manufacturers. In all cases, the NPSHA available must be *greater than* the required NPSH for a specific pump. Generally, lower RPM pumps have lower NPSH requirements.



The net positive suction head ***available*** (NPSHA) is calculated:

NPSHA = AP + SP – HL - VP

AP = Job site atmospheric pressure, in feet of water
SP = Static water pressure at the pump, in feet of water
HL = Head loss between GARN® and pump inlet, in feet of water
VP = Vapor pressure at desired HWS temperature, in feet of water

A simple equation for calculating the head loss between the GARN® and the inlet of the pump:

$$HL = \frac{4}{100} * (L + 2 * EL + 1.5 * BV + 3 * GV + 10 * T)$$

L = Length of pipe between the GARN® and the pump inlet
EL = # of 45° and 90° elbows between the GARN® and the pump inlet
BV = # of ball valves between the GARN® and the pump inlet
GV = # of gate valves between the GARN® and the pump inlet
T = # of tees between the GARN® and the pump inlet

HL, is the summation of pipe, fitting, and valve pressure losses between the GARN® unit and the inlet of the pump. All losses are to be calculated at maximum system design flow (GPM).

NPSHA must always be greater than the net positive suction head ***required*** (NPSHR) for the pump at design GPM, or cavitation and suction boiling will occur. The NPSHR is provided by the pump manufacturer (see the *Pump Selection and Installation Guidelines* section of this manual)

The following tables list atmospheric pressure (AP) at various elevations and vapor pressure (VP) at various HWS temperatures.

ATMOSPHERIC PRESSURE (AP)

Elevation (ft)	Atmospheric Pressure (ft)	Boiling Point of Water (°F)
Sea Level, 0	33.9	212
1000	32.8	210
2000	31.5	208
3000	30.4	206
4000	29.2	204
5000	28.2	202
6000	27.2	200
7000	26.2	198

VAPOR PRESSURE (VP)

System Type	HWS Temperature (°F)	Vapor Pressure (ft)
Radiant Floor	90	1.68
Radiant Floor	104	2.47
Radiant Floor	113	3.5
Radiant Floor	125	4.56
Air Coil	125	4.56
European Wall Radiator	140	6.65
Hot Water Baseboard*	150	9.02

* Hot water baseboard can be sized to utilize 140°F HWS

UNDERGROUND PIPING:

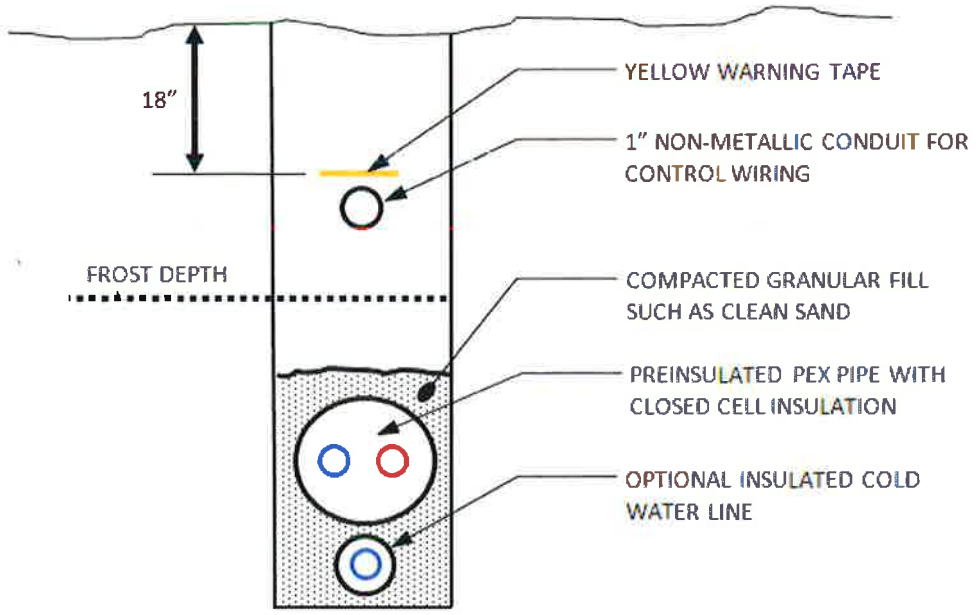
Use only **oxygen barriered,** cross linked, high density polyethylene for underground installation. Pre-insulated PEX pipe manufactured by ComfortPro or Uponor is strongly recommended. Underground piping must be designed to allow for expansion and installed in strict compliance with the manufacturer's specific instructions (such as the Microflex installation guide)

http://www.comfortprosystems.com/pdf/MFInstallGuide2009rev1web.pdf

- **DO NOT** install copper, steel, polybutylene or PVC pipe underground.
- **DO NOT** join pipe underground unless absolutely necessary. If required use **ONLY** materials provided by the pipe manufacturer and installed according to their specific directions.
- In very cold climates place a sheet of 2" thick x 24" to 48" wide foam insulation (blue, pink, yellow or green) board immediately above the pipe, centered on the pipe before back filling the trench. Trench depth in cold climates should be 4 feet (grade to top of pipe) if possible.
- Deeper burial and additional insulation is required when below grade piping extends beneath a parking lot or roadway (frost will normally penetrate the soil to a greater depth in such areas).
- Pressure test for water leaks before back filling the trench.
- If the piping can only be positioned above frost depth, provide a pump timer to circulate water for five to ten minutes every hour during the heating season.
- Avoid burial in continuously wet soils, under creeks, natural land depressions, drainage ponds, etc.

DRY AREA BURIED PIPING DIAGRAM:

- The following diagram shows how preinsulated, underground PEX-a piping shall be laid in dry areas.
- Trench with a "ditch witch" to a depth below the frost line.



MOIST AREA BURIED PIPING DIAGRAM:

- The following diagram shows how preinsulated, underground PEX-a piping shall be laid in areas where moisture may sometimes be present.