uponor

RADIANT SNOW & ICE MELTING

DESIGN AND INSTALLATION MANUAL

Table of Contents

Appendices

This manual is published for architects, engineers, building officials and contractors interested in Uponor Wirsbo Snow & Ice Melting systems. This manual describes the design process and application of snow and ice melting systems that use Wirsbo hePEX™ plus, AQUAPEX® and MultiCor™ tubing products.

Please direct any questions regarding the suitability of an application or a specific design to your local Uponor Wirsbo representative. For the name of your local representative, please call toll free (800) 321-4739.

Chapter 1

Glossary

It is important to be familiar with the terminology used in this manual to fully understand the design and installation of hydronic snow and ice melting systems. Some of the definitions found in this chapter are unique to hydronic snow and ice melting systems and some may be applicable only to Uponor Wirsbo systems.

ASTM — American Society for Testing and Materials. Publishes standard specifications for terminology, labeling, testing and production.

Active Loop Length — The length of tubing within the total loop length that is physically installed for the snow-melt area.

Automatic Operation — A snow and ice melting control strategy that automatically operates the system to remove snow and ice without the interaction of the owner.

BTU (British Thermal Unit) — A unit of measure equal to the amount of energy necessary to raise the temperature of one pound of water one degree Fahrenheit.

BTU/h — The amount of BTU expended per hour.

BTU/h/ft^2 — The amount of BTU expended per hour per square foot of panel. BTU/h/ft^2 is derived by dividing the BTU/h by the amount of available square footage of panel to be heated.

Bypass Loop — A piping arrangement that directs the flow of a heat-absorbing medium (e.g., water) around rather than through a piece of mechanical equipment.

Closed Loop — Any piping arrangement in a circulating system that protects the circulating medium (e.g., water) against exposure to atmospheric pressure.

Closed System — Any closed-loop hydronic tubing system which prevents atmospheric oxygen from entering the system to a degree which effectively protects components from excessive oxidative corrosion. (See the definition for DIN 4726.)

Conduction — A process of heat transfer where heat moves through a material or between two materials that are in direct contact with each other.

Constant Idle Operation — A snow and ice melting system that maintains continuous or minimum slab temperature. From this idle mode temperature, the slab can quickly accelerate to the snow and ice melting temperature when moisture is present on the slab surface.

Convection — Transfer of heat by movement of a liquid or a gas. For example, natural convection is a result of movement caused by changes in density as temperature changes within a fluid medium such as a liquid or a gas. Forced convection is the result of mechanical force moving a fluid or gas.

Crosslinking — A chemical process that changes the molecular structure of a polymer material by linking otherwise independent hydrocarbon chains. Crosslinking creates a three-dimensional network of hydrocarbons. The end product is insoluble and is incapable of being melted.

DIN — Abbreviation for the German Institute of Standards (Deutsches Institut fur Normung).

DIN 4726 — An internationally recognized standard that prescribes, among other things, the maximum rate of oxygen diffusion allowed for non-metallic pipes used in closed-loop hydronic heating systems.

Design Temperature — Equal to the coldest outdoor temperature at which the system will melt snow and ice (in conjunction with snow and ice melting wind speed).

Differential Temperature (Δt) — The difference in temperature between two opposing masses used to describe the potential that exists for heat transfer.

Diffusion — A penetration process that describes the tendency of gas or liquid molecules to spread out into the entire space available (including the spaces that exist within solids, like concrete). Diffusion is expressed as a function of the volume of space that is available. A related process, permeation, describes the movement of such substances through solid membrane and is expressed in terms of the area of membrane penetrated.

Downward Loss — The amount of heat energy in BTU/h/ft^2 transferring downward from the heated slab.

Edge Area — The exposed surface of a radiant heated slab equal to the thickness of the slab multiplied by the exposed linear perimeter length.

Edge Insulation — The amount of insulation (expressed in R-value) placed vertically along the exposed perimeter of the slab.

Emission — A measure of the propensity of a surface to radiate heat energy to its surroundings in the form of long-wave radiation.

Engel Method — A peroxide-based method of manufacturing crosslinked polyethylene (PEX) tubing. Engel-method PEX is crosslinked during the extrusion process while the raw polyethylene is above its crystal melting temperature, creating an even and consistent three-dimensional network of joined hydrocarbons.

Exposed Perimeter Insulation — The amount of insulation (expressed in R-value) placed horizontally to a distance of 4 feet along an exposed perimeter of a heated slab.

Exposed Perimeter Length — Equal to the linear feet of exposed perimeter.

Extrusion — A method used for the continuous formation of tubing from polymer materials.

Floating Action — Output used to modulate the position of an actuator motor and mixing valve. Power is applied to drive the valve further open or closed. If no power is supplied, the valve will remain in its present position.

Floor Insulation — The amount of insulation (expressed in R-value) placed directly below a heated slab to reduce downward heat loss.

HDPE — Abbreviation for high-density polyethylene.

Head Pressure Loss — The pressure available at the outlet side of a pump or inlet side of a flow-conducting system. It is expressed in feet of head. Feet of head is the height of a column of water that can be supported by a pump against standard atmospheric pressure.

Heating Load — The amount of energy (in BTU/h) required for the entire snow and ice melting system.

Injection Mixing — A method of resetting radiant system water by injecting hot boiler water into a lower temperature distribution loop in order to maintain proper supply water temperature. In addition, injection mixing can allow for changes in supply water temperatures based on changes in outside weather conditions. Injection mixing can be controlled through either an on/off valve or variable speed injection pumping using a simple wet-rotor type circulator. Refer to the variable speed injection essay in **Appendix I** for more information.

Leader Loop Length — The horizontal and vertical distance from the area being heated to the manifold in which the loop originated. This distance is multiplied by two (supply and return) and added to the active loop length to obtain the total loop length.

Linear Expansion (thermal) — Refers to the physical material characteristic of a body which causes it to expand in the presence of heat. It is known as heat expansion. Linear expansion creates a force within the product which, if held back by huge compressive strengths such as concrete, will transmit itself as an internal stress. Unlike other tubing products, PEX is highly resistant to stresses caused by linear expansion.

Olefins — Unsaturated hydrocarbon substances (double bond). The most important building blocks (monomers) of the olefins are ethylene, propylene and butylene.

Open System — A circulating hydronic system exposed to atmospheric conditions. Open systems require components resistant to oxidative corrosion. Open systems are the result of continual introduction of fresh water, open vessels or oxygen diffusion through non-metallic components.

Outdoor Design Temperature — Equal to the coldest outdoor temperature at which the system will melt snow and ice. Designs are based on outdoor design temperature and wind speed.

PE — Abbreviation for polyethylene.

PEX — Abbreviation for crosslinked polyethylene.

Perimeter Area — The first 4 horizontal feet in from the exposed perimeter of the slab. Applicable in discussions concerning under-slab insulation.

Perimeter Insulation — The amount of insulation (expressed in R-value) placed horizontally for the first 4 feet along the exposed perimeter of the slab.

Perimeter Length — The linear length of exposed perimeter of the slab.

Polyolefin — A general term for a polymer built from olefins (e.g. polypropylene, polybutylene and polyethylene).

Pressure Loss — The loss of fluid pressure between any two points in a flow-conducting system, expressed in pounds per square inch (psi). The loss of pressure is caused by friction against the tubing walls and is further influenced by the tubing size, length and texture of the inside wall of the tubing, fittings, valves and other components. Pressure loss is also influenced by the temperature and viscosity of the fluid.

Primary/Secondary Pumping — The boiler loop with its own circulator is referred to as the primary loop. Secondary loop is any feed from the primary (boiler loop) that is the same or lower temperature with its own circulator for flow control. Often in snow-melting systems, the secondary flow is first tempered to a lower temperature before entering the secondary loop.

Proportional Valve — A motorized, modulating three-way valve designed to provide consistent supply water temperature based on either outdoor reset temperature or a given setpoint temperature.

R-value — A measure of a material's ability to resist the flow of heat. R-value is expressed in BTU/h/ft^2: (1/U = R).

Radiation — The process in which energy in the form of rays of light or heat is transferred from body to body without heating the intermediate air acting as the transfer medium.

Reactive Tempering Valve — A three-way, non-electric valve that, when used in snow and ice melting applications, will maintain a constant supply water temperature despite variations in boiler supply water temperatures. A reactive tempering valve will mix hot boiler water with cooler panel return water to produce a specific supply water temperature (setpoint).

Semi-automatic Operation — A snow and ice melting control strategy that operates the system during demand periods and stops operation when there is little or no demand. Semi-automatic operation can be turned on and off manually or automatically under timed situations.

Slab Depth — The thickness of the slab at the perimeter.

Slab on Grade — A concrete slab with a perimeter that is less than 4 feet below the surface.

Surface Temperature — The required temperature at the surface required to melt snow or ice for a given climatic condition based on the BTU/h/ft^2 supplied.

Temperature Below — The temperature of the soil below the center of the radiant slab.

Thermal Conductivity (K) — A property of materials that indicates the amount of heat (BTU) that penetrates 1 square foot of a uniform material, 1-inch thick, in one hour for each degree Fahrenheit difference in temperature between the surfaces. It is expressed in BTU/h/ft^2/°F. The thermal conductivity of PEX is 0.22 BTU/h/ft^2/°F.

Thermal Mass — Any material used to store heat energy or the affinity for heat energy.

Total Loop Length — The active loop length added to the leader loop length equals the total loop length.

U-value — The capability of a substance to transfer heat. Used to describe the conductance of a material or composite of materials in construction. U-value is expressed in BTU/h/ft^2 and is the inverse function of R-value: (1/R = U).

Under-slab Area — The interior portion of the slab to include all but the first 4 feet around perimeter.

Under-slab Insulation — The amount of insulation (expressed in R-value) under the interior area of the slab, excluding the perimeter area.

Velocity — The speed of fluid at a specific flow expressed in feet per second (fps).

Water Table Temperature — Equal to the estimated temperature of the water table for the area and should be used when the presence of a water table will affect the performance of the radiant panel heating system. Typically, insulation should be added below a radiant slab if there is a water table within 8 to 10 vertical feet of the slab.

Weather Responsive Reset — A method of fine-tuning a radiant system by changing the system supply water temperature based on changing weather conditions. As the outside temperature decreases, the supply water will increase. Likewise, as the outside temperature increases, the supply water temperature will decrease.

Wind Speed — Equal to the highest wind speed at which the system is designed to melt snow and ice. Designs are based on wind speed and outdoor design temperature.

Chapter 2

Introduction

Winter can be an exciting time of year, especially for sport enthusiasts — snowmobiling, sledding, skiing, hockey. But along with the fun comes shoveling, plowing, sanding and salting — as well as the danger of slipping and sliding and the injuries that can result.

Whether for residential, commercial or industrial applications, Wirsbo Snow & Ice Melting systems provide a safe, reliable and economical alternative to snow removal. Wirsbo Snow & Ice Melting systems circulate warm fluid through PEX tubing buried in concrete, asphalt or a sand bed. The fluid heats the slab until it is warm enough to melt the snow and ice. The system can be controlled simply with an on/off manual switch or be programmed to function automatically.

Wirsbo Snow & Ice Melting systems can be used in a variety of applications. These systems are often used in areas where safe, clean and easy access is critical, including:

- Driveways
- Sidewalks
- Stairs
- Building entrances
- Loading docks
- Hospital emergency entrances
- Wheelchair access ramps
- Parking ramps
- Parking lots
- Helipads

Snow and ice melting systems can also help comply with Americans with Disabilities Act (ADA) regulations for safe and easy access.

Convenience is another major factor when considering a snow and ice melting system. Wirsbo Snow & Ice Melting systems provide:

Safety — Ramps, sidewalks, driveways and steps are free of snow and ice all year long. Accidents are less likely to occur on pavement where snow and ice has not accumulated. Surfaces dry faster and are safer when a Wirsbo Snow & Ice Melting system is operating underfoot.

Reduced Maintenance — No more shoveling, plowing, sanding or salting. No more replacing sod and landscaping damaged by expensive snow-removal equipment. Additionally, carpets are cleaner and last longer because snow and salt are not tracked over them.

Increased Pavement Life — Freeze and thaw cycles can be eliminated, extending the life of concrete, asphalt and especially those hard to shovel or plow brick pavers. Additionally, the infrastructure of parking ramps is not damaged by corrosive chemicals used to melt snow and ice.

Energy Savings — Wirsbo Snow & Ice Melting systems can be designed to take advantage of existing energy sources. For example, facilities often use steam as a primary heat source, which produces condensate. Because these systems typically require only low temperature water, this type of energy or condensate can be captured and used as the heat supply for a snow and ice melting system. The use of waste energy provides a virtually cost-free system operation.

Chapter 3

Wirsbo Tubing Products and Hardware

PEX is an acronym for crosslinked polyethylene. The PE refers to the raw material used to make PEX (polyethylene), and the "X" refers to the crosslinking of the polyethylene across its molecular chains. The molecular chains are linked into a three-dimensional network that makes PEX remarkably durable within a wide range of temperatures and pressures.

Several methods exist to crosslink polyethylene. These methods produce products with very different properties. Particularly, a distinction should be made between PEX produced above the crystal-melting temperature (hot crosslinking), and PEX produced below the crystal-melting temperature (cold crosslinking).

Wirsbo manufactures PEX tubing using the Engel method, a hot crosslinking process. The actual crosslinking takes place during the extrusion process when the base polyethylene is above its crystal-melting temperatures. Classified within the industry as PEX-a tubing, Engel-method PEX is superior to other types of PEX produced below the crystal-melting temperature, which crosslinks after the manufacturing process. Because Wirsbo PEX tubing incorporates crosslinking during the manufacturing process, the crosslinking is essentially built-in. This results in consistent, uniform and evenly crosslinked PEX, with no weak links within its molecular chains.

PEX Stress Resistance

Tubing installed in snow and ice melting applications must be capable of withstanding the extreme stresses that result from installation within a concrete slab, a sand bed or asphalt. Typical stresses include:

- Expansion and contraction that result from repeated heating and subsequent cooling of the heat-transfer fluid
- Mechanical abrasion, shearing and stretching that occurs as a result of installation, normal structural movement and heating and cooling from seasonal weather changes

Wirsbo PEX provides the durability and reliability that's needed for these applications and currently holds the unofficial world record for long-term testing at elevated temperature and pressure. Since 1973, the tubing has been subjected to ongoing testing at 203°F/175 psi by Studvik in Sweden and BASF in Germany. The resulting data indicates a life expectancy of well over 100 years. This is critical for a snow and ice melting system that must withstand years of quiet time contrasted with heating seasons that may require a substantial BTU/h output to meet demand during a harsh winter.

PEX Chemical Resistance
Crosslinked polyethylene has greatly enhanced resistance to chemical-dissolving agents. The unique molecular structure is stable and inert and is unaffected by chemicals commonly found in plumbing and heating systems.

Oxygen Diffusion
Oxygen diffusion can cause corrosion problems in a heating system. All non-metallic (plastic or rubber) tubing is permeable to the passage of dissolved oxygen molecules through its walls. Permeability allows these dissolved oxygen molecules to enter an otherwise closed hydronic heating system.

In any new hydronic heating installation, dissolved oxygen molecules exist in the new, fresh water. The large bubbles are purged from the system prior to initial start-up. The dissolved oxygen, however, remains. This dissolved oxygen is not visible in the form of bubbles, and cannot be eliminated by the use of an air vent or scoop.

As the heating system brings the water up to temperature, these dissolved oxygen molecules become more aggressive. They look for ferrous components in the system to attack. The result is corrosion or rust. After a few years of operation, a layer of rust on all ferrous components becomes apparent.

In a typical hydronic system using metallic pipe, almost all dissolved oxygen molecules are used up and cause a non-aggressive rust called "ferrous oxides" usually within the first 72 hours. That's the end of the corrosion process.

However, in a non-metallic system using plastic or rubber tubing, the corrosion process continues. Nature hates an imbalance. So once all the existing oxygen molecules inside the system are depleted, more dissolved oxygen molecules actually pass through the wall of the tubing to create an equilibrium. When this happens, the corrosion process starts all over again. Left unchecked, this corrosion will continue and cause considerable damage to the ferrous components of the snow and ice melting system.

Damage may include:

- Circulator failures
- Pinhole leaks at expansion tanks
- A red, sludgy build-up inside the system tubing (reducing flow)
- Eventual boiler failure (if a cast-iron or steel boiler is used)

Here are the four ways to manage oxygen diffusion corrosion.

Option 1 — Isolate the heat-transfer fluid from components likely to corrode (e.g., cast-iron pumps, boilers, expansion tanks, etc.) with a non-ferrous heat exchanger. Wirsbo AQUAPEX tubing, without the oxygen diffusion barrier, is available for those systems that isolate the snow-melting loops from the heat plant and circulator components. All other components (e.g., expansion tanks, circulators and piping) on the snow-melting side of the heat exchanger must be made of a non-ferrous material as well.

Option 2 — Eliminate all corrosive ferrous components from the system. Wirsbo AQUAPEX is available for those systems that use non-ferrous components (e.g., bronze pumps, copper tube boilers with bronze headers, etc.).

Option 3 — Treat all heat-transfer fluid with corrosion inhibitors. Corrosion inhibitors require regular maintenance from the heat plant manager to maintain the correct inhibitor level. In the event the system mixture is allowed to lapse, corrosion damage may occur. For these reasons, Wirsbo does not recommend the use of corrosion inhibitors to counter the effects of oxygen diffusion.

Option 4 — Use tubing that limits the oxygen diffusion into the heat-transfer fluid to a level consistent with established standards. Use Wirsbo hePEX plus or MultiCor tubing for these applications.

Selecting a Wirsbo Tubing Product

Wirsbo offers three different tubing products for distribution and two products for supply and return mains for use in snow and ice melting installations.

Distribution — hePEX plus, MultiCor, AQUAPEX

Supply and Return Mains — Large dimension hePEX, high-density polyethylene (HDPE)

Note: Wirsbo hePEX plus and MultiCor must be used when an oxygen diffusion barrier tubing is required.

Wirsbo hePEX plus

Wirsbo hePEX plus is PEX tubing with an oxygen diffusion barrier. The hePEX plus tubing is manufactured using the Engel method (PEX-a) of crosslinking.

Application — Wirsbo hePEX plus is designed for use in closed-loop hydronic snow and ice melting systems operating at sustained temperatures up to 200°F. Corrodible or ferrous components may be used in hot water heating systems designed with Wirsbo hePEX plus tubing.

Standards, Listings and Ratings — Wirsbo hePEX plus is manufactured to meet these standards: ASTM F 876, ASTM F 877 and CAN/CSA B137.5. The Wirsbo hePEX plus has a Standard Grade Hydrostatic Design Stresses and Pressure Rating in accordance with all three temperatures and pressures listed in Table 1 of ASTM F 876. The hePEX plus tubing is tested in accordance with PPI TR-3 and listed in PPI TR-4.

The Standard Grade hydrostatic ratings are:

- 200°F at 80 psi
- 180°F at 100 psi
- 73.4°F at 160 psi

The Hydrostatic Design Stress Board of Plastic Pipe Institute (PPI) issues these pressure and temperature ratings. These values listed are ratings, not limitations. If the designer stays within these parameters during design, there should not be a problem with the product. Burst pressures are values used only in manufacturing the product, not for the system specification or design.

Wirsbo hePEX plus is listed with the following agencies.

- Council of America Building Officials (CABO) One and Two Family Dwelling Code
- ICBO Evaluation Service — ER Number 4407, 5143
- Southern Building Code Congress International (SBCCI) Standard Plumbing Code (PST and ESI Report Number 9661)
- U.S. Department of Housing and Urban Development (HUD) Material Release Number 1269

Barrier Information — hePEX plus is sealed with a special polymer barrier to prevent the diffusion of oxygen through the tubing wall and to protect the ferrous components of a closed-loop hydronic snow and ice melting system from corrosion damage. The barrier consists of an EVOH layer co-extruded onto the tubing during the manufacturing process. Wirsbo applies another thin polyethylene layer over the EVOH barrier on the tubing to reduce possible onsite damage to the oxygen diffusion barrier. This polyethlene layer also provides protection for the EVOH barrier if the tubing is immersed in high moisture applications. The hePEX plus barrier meets the requirements of the German DIN Standard 4726 for oxygen diffusion prevention. The amount of oxygen that enters the system must be less than 0.10 grams per cubic meter per day at 104°F.

Linear Expansion Rate — The unrestrained linear expansion (thermal) rate for hePEX plus tubing is approximately 1.1 inches per 10°F temperature change per 100 feet of tubing.

Dimensions — Wirsbo hePEX plus is available for snow and ice melting applications in the following tubing sizes and volume:

- ⅝" nominal inside diameter (contains 1.34 gallons/100' of tubing)
- ¾" nominal inside diameter (contains 1.84 gallons/100' of tubing)
- 1" nominal inside diameter (contains 3.03 gallons/100' of tubing)

Coil Lengths — Please refer to the Wirsbo Home Comfort Component Catalog for heating products for coil length information.

Wirsbo MultiCor

Wirsbo MultiCor tubing is a multi-layered composite tubing consisting of aluminum tubing sandwiched between two layers of PEX. These PEX layers are bonded to the aluminum with a special adhesive.

Application — Wirsbo MultiCor is designed for use in closed-loop snow and ice melting heating systems operating at sustained temperatures up to 200°F. Corrodible or ferrous components may be used in hot water heating systems designed with Wirsbo MultiCor tubing.

Standards, Listings and Ratings — Wirsbo MultiCor is manufactured to ASTM F 1281 and certified by NSF International. Wirsbo MultiCor has a Standard Grade Hydrostatic Pressure Rating in accordance with the temperatures and pressures listed in Section X1 of ASTM F 1281. The MultiCor tubing is tested in accordance with PPI TR-3 and listed in PPI TR-4. The Standard Grade hydrostatic ratings are:

- 200°F at 100 psi
- 180°F at 125 psi

The Hydrostatic Design Stress Board of PPI issues these pressure and temperature ratings. These values listed are ratings, not limitations. If the designer stays within these parameters during design, there should not be a problem with the product. Burst pressures are values used only in manufacturing the product, not for the system specification or design.

Wirsbo MultiCor is listed with the following agencies:

- ICBO Evaluation Service — ER Number 5298
- Southern Building Code Congress International (SBCCI) Standard Plumbing Code (PST and ESI Report Number 9829)

Barrier Information — MultiCor offers 100% oxygen diffusion protection due to the aluminum within the tubing wall.

Linear Expansion Rate — The unrestrained linear expansion (thermal) rate for MultiCor tubing is approximately 0.156 inches per 10°F temperature change per 100 feet of tubing.

Dimensions — Wirsbo MultiCor is available for snow and ice melting applications in the following tubing sizes and volume:

- ⅝" nominal inside diameter (contains 1.60 gallons/100' of tubing)
- ¾" nominal inside diameter (contains 2.56 gallons/100' of tubing)
- 1" nominal inside diameter (contains 4.20 gallons/100' of tubing)

Coil Lengths — Please refer to the Wirsbo Home Comfort Component Catalog for heating products for coil length information.

Wirsbo AQUAPEX

Wirsbo AQUAPEX is a registered trade name for Wirsbo's hot and cold potable water tubing. It is essentially the same product as Wirsbo hePEX plus, but without the oxygen diffusion barrier.

Application — Wirsbo AQUAPEX can be used in closed-loop snow and ice melting systems operating at sustained temperatures up to 200°F, provided any issues concerning oxygen diffusion are properly addressed. Corrodible or ferrous components may not be used in a system designed with Wirsbo AQUAPEX unless these components are isolated from the tubing.

Standards, Listings and Ratings — Wirsbo AQUAPEX is manufactured to meet these standards: ASTM F 876, ASTM F 877 and CAN/CSA B137.5. The Wirsbo AQUAPEX has a Standard Grade Hydrostatic Design Stresses and Pressure Rating in accordance with all three temperatures and pressures listed in Table 1 of ASTM F 876. AQUAPEX tubing is tested in accordance with PPI TR-3 and listed in PPI TR-4. The Standard Grade hydrostatic ratings are:

- 200°F at 80 psi
- 180°F at 100 psi
- 73.4°F at 160 psi

The Hydrostatic Design Stress Board of PPI issues these pressure and temperature ratings. These values listed are ratings, not limitations. If the designer stays within these parameters during design, there should not be a problem with the product. Burst pressures are values used only in manufacturing of the product, not for the system specification or design.

Wirsbo AQUAPEX is listed with the following agencies.

- ANSI/NSF 14 and 61 Certified
- Council of America Building Officials (CABO) One and Two Family Dwelling Code
- ICBO Evaluation Service — ER Number 5142, 5143

- Southern Building Code Congress International (SBCCI) Standard Plumbing Code (PST and ESI Report Number 9661)
- UPC Listing — Files 3558, 3946, 3960
- U.S. Department of Housing and Urban Development (HUD) Material Release Number 1269

Additional Design Considerations — AQUAPEX is permeable to oxygen at a rate up to 13.6 grams per cubic meter per day at 158°F. Snow and ice melting systems using AQUAPEX tubing must be designed to accept oxygen permeation.

Linear Expansion Rate — The unrestrained linear expansion (thermal) rate for AQUAPEX tubing is approximately 1.1 inches per 10°F temperature change per 100 feet of tubing.

Dimensions — Wirsbo AQUAPEX is available for snow and ice melting applications in the following sizes and volume:

- ⅝" nominal inside diameter* (contains 1.34 gallons/100' of tubing)
- ¾" nominal inside diameter (contains 1.84 gallons/100' of tubing)
- 1" nominal inside diameter (contains 3.03 gallons/100' of tubing)
- 1¼" nominal inside diameter (contains 4.53 gallons/100' of tubing)
- 1½" nominal inside diameter (contains 6.32 gallons/100' of tubing)

Coil Lengths — Please refer to the Wirsbo Professional Plumbing Components Catalog for coil length information.

* ⅝" AQUAPEX tubing and fitting information is found only in the Wirsbo Home Comfort Component Catalog for heating products.

Wirsbo Large Dimension hePEX Tubing

Wirsbo large dimension hePEX tubing is PEX tubing with an oxygen diffusion barrier. The hePEX tubing is manufactured using the Engel method (PEX-a) of crosslinking. This hePEX tubing is metric dimensioned and is not applicable to fitting systems designed for ASTM dimensioned tubing. Refer to the large dimension hePEX fitting assemblies shown in the Wirsbo Home Comfort Component Catalog for heating products for additional information.

Application — Wirsbo large dimension hePEX tubing is used as supply and return mains in closed-loop hydronic snow and ice melting systems operating at sustained temperatures up to 200°F. Corrodible or ferrous components may be used in hot water heating systems designed with Wirsbo hePEX tubing.

Standards, Listings and Ratings — Wirsbo large dimension hePEX is manufactured in accordance with the German DIN 16893 and tested in accordance with DIN 16892. The large dimension hePEX has hydrostatic ratings in accordance with the temperatures and pressures listed in Table 5 of DIN 16893. The hydrostatic ratings are:

- 203°F (95°C) at 87 psi (PB 6 Bar) (maximum intermittent pressure/temperature)
- 194°F (90°C) at 58 psi (4 Bar)
- 140°F (60°C) at 87 psi (6 Bar)

Barrier Information — Large dimension hePEX is sealed with a special polymer barrier to prevent the diffusion of oxygen through the tubing wall and to protect the ferrous components of a closed-loop hydronic heating system from corrosion damage. The barrier consists of an EVOH layer co-extruded onto the tubing during the manufacturing process. The large dimension hePEX tubing barrier meets the requirements of the German DIN Standard 4726 for oxygen diffusion prevention. The amount of oxygen that enters the system must be less than 0.10 grams per cubic meter per day at 104°F. Sustained water temperatures up to 200°F do not affect the large dimension hePEX tubing or its oxygen diffusion barrier.

Linear Expansion Rate — The unrestrained linear expansion (thermal) rate for large dimension hePEX tubing is approximately 1.1 inches per 10°F temperature change per 100 feet of tubing.

Dimensions — Wirsbo large dimension hePEX tubing is available in the following sizes and volumes.

- 32mm nominal outside diameter
  (1.03" approx. inside diameter)
  (contains 4.34 gallons/100' of tubing)
- 40mm nominal outside diameter
  (1.28" approx. inside diameter)
  (contains 6.72 gallons/100' of tubing)
- 50mm nominal outside diameter
  (1.61" approx. inside diameter)
  (contains 10.53 gallons/100' of tubing)
- 63mm nominal outside diameter
  (2.02" approx. inside diameter)
  (contains 16.71 gallons/100' of tubing)

Coil Lengths — All sizes listed above are available only in 328-foot coils (100 meters). Please refer to the Wirsbo Home Comfort Component Catalog for heating products for additional information.

Wirsbo High Density Polyethylene (HDPE) Tubing

Wirsbo HDPE tubing (PE 3408) is a non-barrier product that is joined by heat-fusion welding. Flange adapters are available to transition to non-ferrous piping. Refer to the Wirsbo Home Comfort Component Catalog for heating products for additional fitting and component information.

Application — Wirsbo HDPE can be used as supply and return mains in closed-loop hydronic snow and ice melting systems operating at sustained temperatures up to 140°F, provided any issues concerning oxygen diffusion are properly addressed. Corrodible or ferrous components may not be used in a system designed with Wirsbo HDPE unless these components are isolated from the tubing.

Standards, Listings and Ratings — Wirsbo HDPE tubing and fittings are manufactured by Phillips Driscopipe to meet these standards: ASTM D 3350 and ASTM D 3261. The HDPE tubing has hydrostatic pressure and temperature rating from Plastic Pipe Institute (PPI). The hydrostatic ratings are:

- 140°F at 80 psi
- 120°F at 101 psi
- 100°F at 125 psi
- 73.4°F at 160 psi

Additional Design Considerations — HDPE tubing has an oxygen diffusion rate greater than that allowed by the German DIN 4726. Hydronic snow and ice melting systems using HDPE tubing must be designed to accept oxygen permeation or be isolated from ferrous components in the system.

Linear Expansion Rate — The unrestrained linear expansion (thermal) rate for HDPE tubing is approximately 1.4 inches per 10°F temperature change per 100 feet of tubing.

Dimensions — Wirsbo HDPE tubing is available in the following sizes and volume:

- 2" nominal inside diameter
  (contains 15.0 gallons/100' of tubing)
- 3" nominal inside diameter
  (contains 32.6 gallons/100' of tubing)
- 4" nominal inside diameter
  (contains 53.87 gallons/100' of tubing)

Tubing Lengths — All sizes listed above are available only in 20-foot lengths. Please refer to the Wirsbo Home Comfort Component Catalog for heating products for additional manifold and fitting information.

Wirsbo System Components

Wirsbo offers a complete range of components to complete the snow and ice melting system. **Chapter 7** discusses the control strategies uses to sense the slab and provide the appropriate fluid temperature to effectively melt the snow from the slab. **Chapter 8** provides the mechanical and electrical schematics for these controls. This section outlines the different manifold sets available for residential and commercial applications.

Brass Valved and Valveless Manifolds

The brass valved and valveless manifolds are the same manifolds used in residential and light commercial heating projects. The 1¼" manifold has a valveless supply and a valved return. If isolation is required by the project specification, the valved manifold is used on the supply and return. Refer to **page 16** for the exploded brass manifold view.

Balancing — Remove the black isolation cap from the valve. Invert the black cap and use it as the balancing tool. Turn the cap clockwise until closed. To balance, turn the cap (counter clockwise) the number of required half-turns from close. Place the black cap back onto the valve top. Do not tighten the cap as this will close the valve. The longest loop on the manifold will be left full open. From closed to full open is four half-turns. The other loops will be balanced using the formula shown below.

Loop to be balanced/longest loop on the manifold x 4 = number of half-turns from closed

Example

Loop to be balanced: 200 feet

Longest loop on the manifold: 245 feet

x = 200 / 245 x 4

x = 0.816 x 4

x = 3.3

The inverted cap for that 200-foot loop would be turned open 3.3 half-turns from closed.

Applicable Tubing — These brass valved manifolds support the following tubing.

- ⅝" hePEX plus and AQUAPEX tubing with ProPEX® or QS20-style fitting assemblies
- ⅝" MultiCor tubing with QS20-style fitting assemblies

HDPE Valveless Manifolds

The HDPE manifolds are available in 2, 3 and 4-inch dimensions. The manifolds have 300-series stainless steel ProPEX fitting adapters preformed on the HDPE outlets. The manifold is designed to only support ¾" and 1" PEX tubing. The HDPE manifolds do not have an oxygen diffusion barrier. Primary application is for direct burial in systems isolated with a heat exchanger. Refer to **page 17** for the exploded HDPE manifold view.

Balancing — These manifolds are not designed to balance across the manifold. All loop lengths must be within 3% of each other in length on the manifold.

Example
If the design calls for 267-foot loops on the manifold, then the range of loop lengths must fall within 263 and 271 feet. Three percent of 267 feet is 8 feet — 4 feet either side of your target length.

Supply and return piping to the manifold should be installed in a reverse-return configuration to allow self-balancing across the manifold.

Applicable Tubing — These HDPE manifolds support the following tubing.

- ¾" and 1" hePEX plus and AQUAPEX tubing with ProPEX fitting assemblies

Copper Valved Manifolds

These 2-inch copper valved manifolds are 48 inches long with 12 valved outlets. The outlets come in several configurations of ProPEX or male threaded connections. The outlets are valved with either a ball valve (isolation) or a ball valve/balancing valve combination (isolation with balancing). Refer to **pages 18** and **19** for detailed information about the options available with this manifold.

Balancing — Remove the knurled safety cap from the valve. Using an Allen or hex key, turn the memory spindle clockwise until closed. To balance, turn the hex key (counter clockwise) the number of required turns from close. Replace the safety cap. The longest loop on the manifold will be left full open. From closed to full open is 10 full turns of the memory spindle. Balance the other loops using the formula shown below.

Loop to be balanced/longest loop on the manifold x 10 = number of turns from closed

Example

Loop to be balanced: 250 feet

Longest loop on the manifold: 300 feet

x = 250 / 300 x 10

x = 0.83 x 10

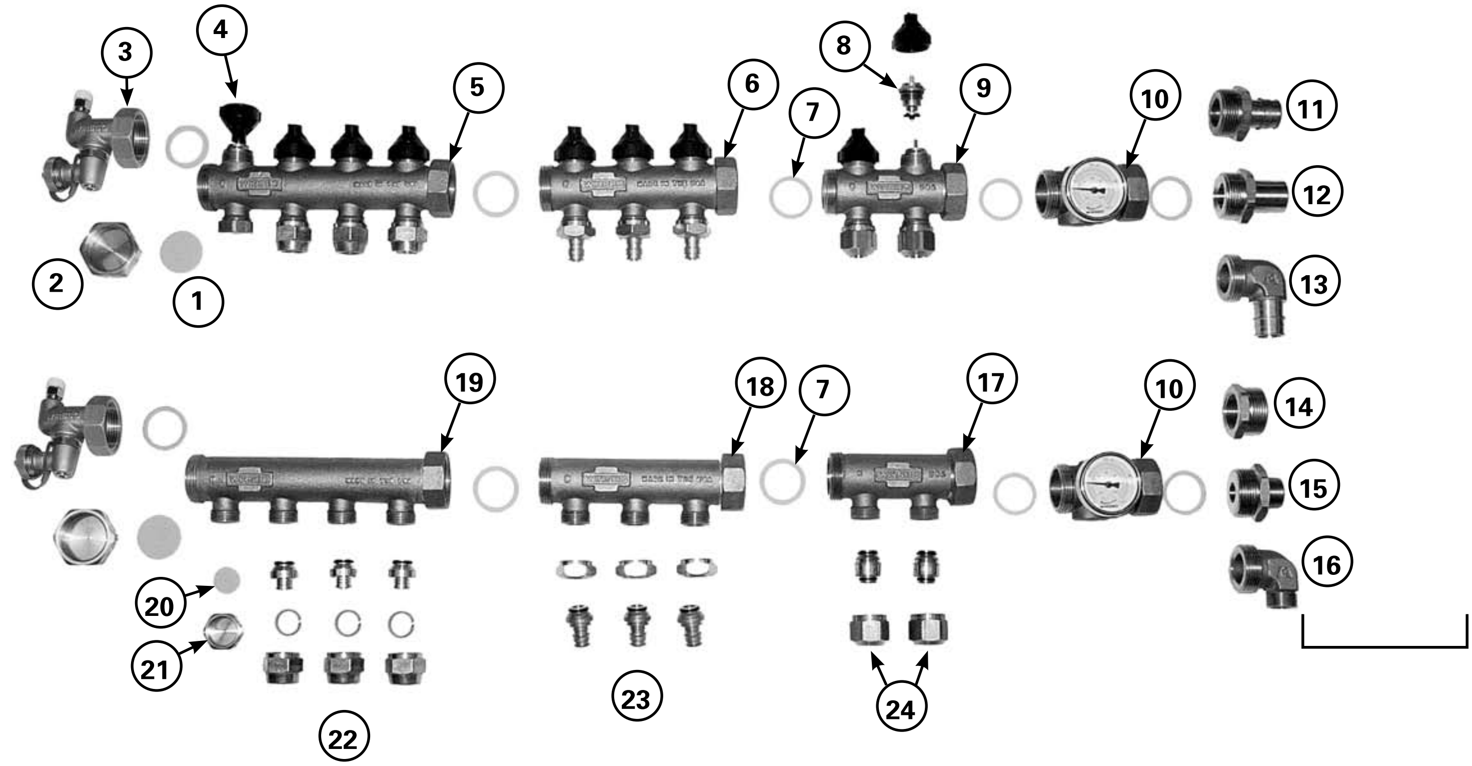
x = 8.3

The memory spindle for that 250-foot loop would be turned open 8.3 turns from closed.

Applicable Tubing — These copper valved manifolds support the following tubing.

- ⅝" and ¾" hePEX plus and AQUAPEX tubing with ProPEX or QS20-style fitting assemblies
- ⅝" and ¾" MultiCor tubing with QS20 -style fitting assemblies

Exploded Brass Manifold View

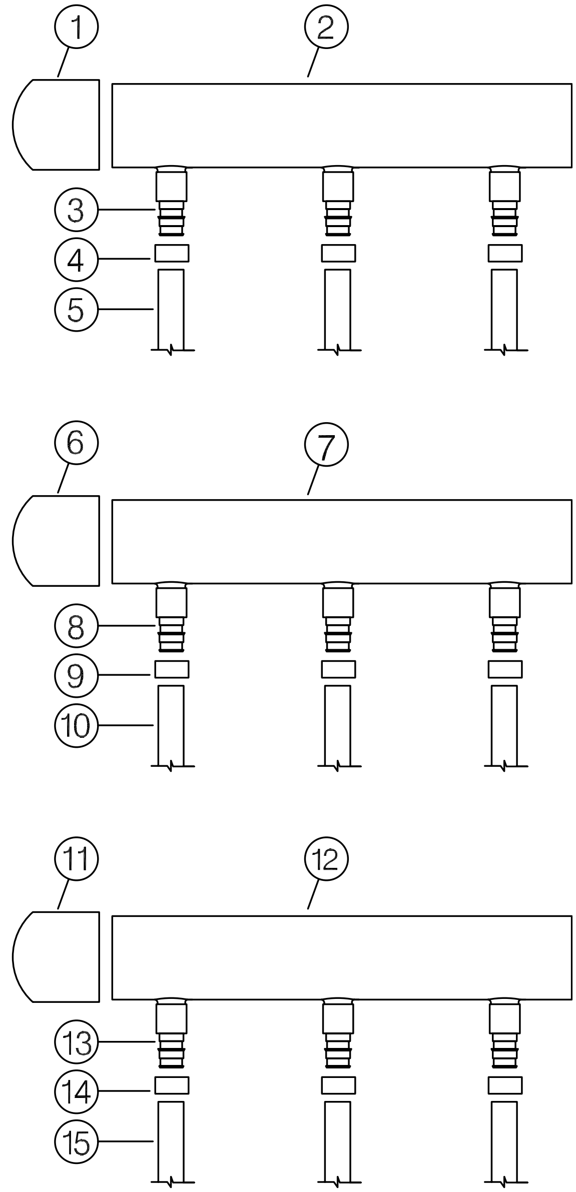


Wirsbo Components

1. Basic End Cap Gasket (A2400032)
2. Basic End Cap (A2080032)
3. End Cap with Vent (A2803250)
4. Flow Balancing Cap (A2600004)
5. Four-loop Valved Manifold (A2553220)
6. Three-loop Valved Manifold (A2533220)
7. Manifold Gasket (A2403232)
8. Manifold Valved Replacement Cartridge (A2450028)
9. Two-loop Valved Manifold (A2513220)
10. Manifold Thermometer Union (A2913210)
11. R32 x ¾" ProPEX Manifold Adapter (Q4143210)
    R32 x 1" ProPEX Manifold Adapter (Q4133210)
12. R32 x ¾" CU Adapter/1" CU Fitting Adapter (A4143210)
    R32 x 1" CU Adapter/1¼" CU Fitting Adapter (A4133210)
13. R32 x ¾" ProPEX Manifold Adapter Elbow (Q4153275)
    R32 x 1" ProPEX Manifold Adapter Elbow (Q4153210)
14. Manifold Bushing, R32 x 1" NPT (A2123210)
    Manifold Bushing, R32 x ¾" NPT (A2133275)
15. R32 x R25 Manifold Adapter (A4143225)
16. R32 x R25 Manifold Adapter Elbow (A4153225)
17. Two-loop Valveless Manifold (A2503220)
18. Three-loop Valveless Manifold (A2523220)
19. Four-loop Valveless Manifold (A2543220)
20. R20 End Cap Gasket (A2400020)
21. R20 End Cap (A2080020)
22. QS-style ⅝" Fitting Assemblies (A4020625)
23. ProPEX ⅝" Fitting Assemblies (Q4020625)
24. MultiCor ⅝" Fitting Assemblies (D4120500)

WIRSBO
Life, Safety, Comfort Systems

Exploded HDPE Manifold View



2" HDPE Manifold with ¾" PEX

1. 2" HDPE End Cap (B2202000)
2. 2" HDPE ProPEX Manifold - 10 outlet (B2252751)
   - 20 outlet (B2252752)
3. ¾" Stainless Steel ProPEX Fittings (preformed on outlet)
4. ¾" ProPEX Rings (Q4680750)
5. ¾" AQUAPEX Tubing (F1100750)

3" HDPE Manifold with ¾" PEX

6. 3" HDPE End Cap (B2203000)
7. 3" HDPE ProPEX Manifold - 10 outlet (B2253751)
   - 20 outlet (B2253752)
8. ¾" Stainless Steel ProPEX Fittings (preformed on outlet)
9. ¾" ProPEX Rings (Q4680750)
10. ¾" AQUAPEX Tubing (F1100750)

4" HDPE Manifold with ¾" PEX

11. 4" HDPE End Cap (B2204000)
12. 3" HDPE ProPEX Manifold - 10 outlet (B2254751)
    - 20 outlet (B2254752)
13. ¾" Stainless Steel ProPEX Fittings (preformed on outlet)
14. ¾" ProPEX Rings (Q4680750)
15. ¾" AQUAPEX Tubing (F1100750)

2" HDPE Manifold with 1" PEX

1. 2" HDPE End Cap (B2202000)
2. 2" HDPE ProPEX® Manifold - 10 outlet (B2272101)
   - 20 outlet (2272102)
3. 1" Stainless Steel ProPEX Fittings (preformed on outlet)
4. 1" ProPEX Rings (Q4681000)
5. 1" AQUAPEX Tubing (F1061000)

3" HDPE Manifold with 1" PEX

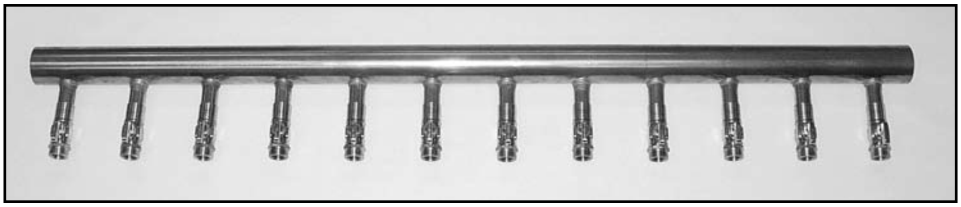
6. 3" HDPE End Cap (B2203000)
7. 3" HDPE ProPEX Manifold - 10 outlet (B2273101)
   - 20 outlet (B2273102)
8. 1" Stainless Steel ProPEX Fittings (preformed on outlet)
9. 1" ProPEX Rings (Q4681000)
10. 1" AQUAPEX Tubing (F1061000)

4" HDPE Manifold with 1" PEX

11. 4" HDPE End Cap (2204000)
12. 4" HDPE ProPEX Manifold - 10 outlet (B2274101)
    - 20 outlet (B2274102)
13. 1" Stainless Steel ProPEX Fittings (preformed on outlet)
14. 1" ProPEX Rings (Q4681000)
15. 1" AQUAPEX Tubing (F1061000)

2" Copper Valved Manifolds

The 2" Copper Valved Manifold comes with 12¾-inch ports that are installed at 4 inches on center. The manifold is 48 inches long. The manifold comes with a series of options for valving.

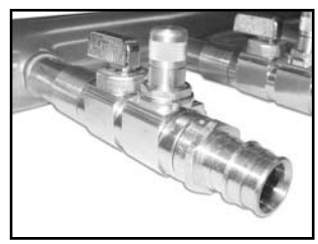


Option 1

The 2" Copper Valved Manifold is available for ⅝" and ¾" ProPEX fitting adapters with an isolation ball valve. This ball valve is used only for isolation and not balancing.

Description	Part No.
2" CU Manifold with ⅝" ProPEX Ball Valve, 12 branches	Q2811263
2" CU Manifold with ¾" ProPEX Ball Valve, 12 branches	Q2811275

Option 2



The 2" Copper Valved Manifold is available for ⅝" and ¾" ProPEX fitting adapters with an isolation ball valve and an in-line balancing valve. This manifold can be used for isolation and balancing.

Description	Part No.
2" CU Manifold with ⅝" ProPEX Balancing/Ball Valve, 12 branches	Q2821263
2" CU Manifold with ¾" ProPEX Balancing/Ball Valve, 12 branches	Q2821275

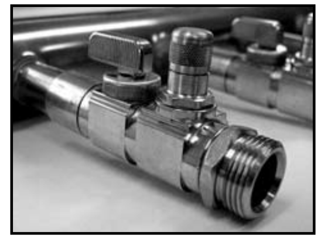
Option 3

The 2" Copper Valved Manifold is available with either a ⅝" tubing to R20 threaded fitting adapter or with a ¾" tubing to R25 threaded fitting adapter. Both fittings come with an isolation ball valve. This ball valve is used only for isolation and not balancing. Tubing fitting assemblies are purchased separately.

Description	Part No.
2" CU Manifold with R20 Ball Valve, 12 branches	F2811220
2" CU Manifold with R25 Ball Valve, 12 branches	F2811225

Option 4

The 2" Copper Valved Manifold is available with either a ⅝" tubing to R20 threaded fitting adapter or with a ¾" tubing to R25 threaded fitting adapter. Both fittings come with an isolation ball valve and an in-line balancing valve. This manifold can be used for isolation and balancing. Tubing fitting assemblies are purchased separately.



Description	Part No.
2" CU Manifold with R20 Balancing/Ball Valve, 12 branches	F2821220
2" CU Manifold with R25 Balancing/Ball Valve, 12 branches	F2821225

Copper End Cap

The 2" Copper End Cap features female threading for drain and venting capabilities. The drain is threaded with ½" FNPT and the opposing vent is threaded with ⅛" FNPT.

Description	Part No.
2" Copper End Cap with FNPT Connections for Vent and Drain	A2402000

Notes

Chapter 4

Installation Methods

The first step in designing a snow and ice melting system is to listen closely to customers' needs. This helps identify how the system should be designed. Wirsbo Snow & Ice Melting systems can be installed in a variety of construction methods. The type of construction method used impacts the control strategy. The extent of snow and ice melting required determines the heat load, the on-center distance of the tubing and the placement of insulation around the slab.

The most common installation methods are:

- Concrete slab
- Two-lift asphalt pours
- Compactable soil/sand bed covered by concrete, asphalt or pavers
- Concrete overpour
- Suspended (bridges)
- Stairs

Compaction

Prior to installing any tubing, a solid foundation must be present to ensure the snow-melting system does not shift or settle. (Compaction is required for any slab, sidewalk, driveway, road, etc.) Typical compaction rates are 96 to 98% for soil, and around 101 to 103% for a compactable soil/sand base as stated by ASTM. A qualified materials testing agency should test the compaction rates.

It is also recommended that you consult local code officials regarding the requirements for the area where the system will be installed. If insulation is required for the snow-melt installation, use an insulation board or material with an under-slab compressive strength rating. To determine the proper compressive strength board or material, review the installation to assess "live" and "dead" load conditions.

Live Loads — People or objects moving across the snow-melt area and the weight associated with them, e.g., people, cars, trucks, utility vehicles, aircraft, etc.

Dead Loads — Fixed or permanent objects and the weight associated with them.

Wirsbo recommends that an architect or engineer review the requirements and materials (if not specified) prior to installation. Improper compaction and insulation materials that do not carry ratings can result in the insulation materials collapsing due to any applied weight.

Installation

To begin the tubing installation, place wire mesh or rebar over the compacted grade. Using Wirsbo wire ties, secure the tubing to the wire mesh or rebar. Place wire ties approximately every 3 feet along straight runs. At the 180-degree turns, tie the tubing at the top of the arc and once on each side, 12 inches from the top of the arc (see **Figure 4-1**). This prevents the tubing from dislodging and/or floating up during the pour.

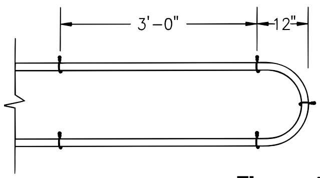


Figure 4-1

When installing PEX tubing over the appropriate strength high-density insulation board, secure the tubing to the insulation board with Wirsbo plastic foam staples using the manual stapler. Place the foam staples approximately every 3 feet along straight runs. At the 180-degree turns, staple the tubing twice at the top of the arc and on each side, 6 inches from the top of the arc (see **Figure 4-2**).

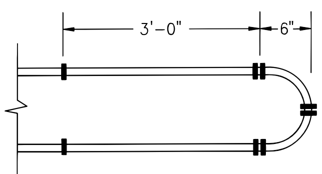


Figure 4-2

Minimum concrete covering for the tubing is detailed in local building codes. Generally, a minimum of 1½ inches of concrete must be over the top of the tubing when the slab is exposed to earth or weather conditions (1997 UBC Sec. 1906.3.10).

Tubing Layout Patterns

The most common layout pattern for snow and ice melting applications is counter flow or reverse return, which allows equal heat across the surface. This is different from radiant floor heating applications where tubing is installed with the supply or warmest water going first to the area of the greatest heat loss — the exterior wall.

Reverse-return Layout — The reverse-return tubing layout allows the entire snow and ice melting surface to heat up equally. Install the tubing as shown in **Figure 4-3** with the supply and return portion of the tubing running parallel to each other.

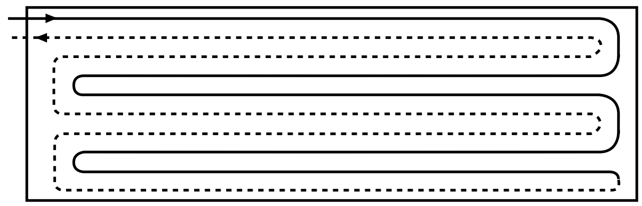


Figure 4-3

Serpentine Layout — The serpentine tubing layout is not as effective in a snow and ice melting application since too great of a surface temperature differential would be experienced across the area (see **Figure 4-4**).

Figure 4-4

Insulation

Load requirements (BTU/h/ft^2) for snow and ice melting applications are significantly higher than what is required for radiant floor heating applications. Therefore, insulation plays a much more important role from the standpoint of performance, efficiency and control.

Performance — The system reacts more quickly to changing climatic conditions when proper insulation is installed. The performance charts in **Appendix C** are calculated with 2-inch high-density insulation or an equivalent R-value of 10 under the slab.

Efficiency — Insulation prevents wasted energy by keeping heat confined to areas that are part of the snow-melting scope, both laterally and vertically downward.

Control — A properly insulated slab allows for a wider variety of control schemes. For example, a semi-automatic control strategy is not recommended for an un-insulated slab.

Heat loss is critical to the performance of any snow and ice melting design and needs to be accounted for in the planning stages. There are two areas to keep in mind when insulating a snow and ice melting application — horizontal/ under slab and vertical/edge.

Horizontal or Under Slab — This is the area or layer directly beneath the tubing. Essentially, this insulation layer is the difference between a high and low mass system. From radiant floor heating applications, we've learned how under-slab insulation can affect start-up times or react to radical changes in weather. When the slab is outside, the issues are compounded. Under-slab insulation must be used when:

- High water tables and/or moist soil conditions are present
- The system is designed for semi-automatic operation
- The linear feet of perimeter is high in relation to the snow-melted area (e.g., sidewalk)

Vertical or Edge — This area denotes the vertical edge of the slab or profile. Edge insulation is used to keep the heat contained within the area for which it is designed and to minimize lateral heat loss. When using edge insulation remember the following.

- Insulate along edges that come into contact with plants or landscaping. If the plants sense warmth, they may be fooled into thinking spring has arrived. This can have a negative effect and ultimately kill any plants, shrubs or grass.
- Insulate down to the frost line (or suitable depth) when under-slab insulation is not installed. Protecting the edge of the slab will only allow for heat to be lost under the bottom edge of the insulation. Insulating in this manner is marginally better than no edge insulation at all.

Construction, Expansion and Control Joints

Construction, expansion and control joints are requirements for every slab application of any size. Coordination between the engineer, concrete installer and the snow-melting contractor is essential to avoid confusion and delays on the project.

Construction Joints — Joints that separate two separate pours of a slab completed at different times are called construction joints. Because it is difficult to construct a large slab in one pour, a bulkhead is installed to contain sections of the slab until the next phase is poured. That makes it easier to move concrete equipment, and reduces the chances that the tubing will be damaged during installation.

Avoiding the Construction Joint — To avoid the construction joint during installation, dip the tubing below the slab into the subsoil (see **Figure 4-5**).

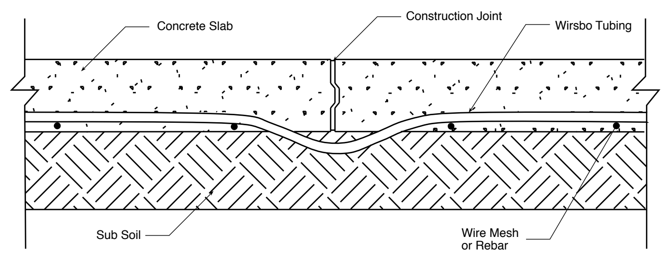


Figure 4-5

Expansion Joints — Sometimes called isolation joints, expansion joints are intended to absorb horizontal movement caused by the thermal expansion and contraction of the slab. Snow and ice melting systems can reduce the range of expansion the slab experiences depending on the control strategy selected.

The coefficient of linear expansion for concrete is approximately 5.5×10^{-6} inch per degree Fahrenheit. This means, roughly, that for every 1°F temperature rise, a 100-foot span of concrete is expected to expand about Z\zn of an inch.

Penetrating the Expansion Joint — If the tubing must penetrate the fibrous expansion joint, wrap it with pipe insulation for 6 inches on both sides of the expansion joint (see **Figure 4-6**).

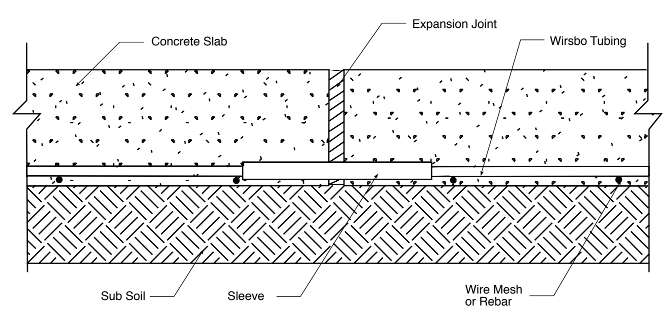


Figure 4-6

Avoiding the Expansion Joint — Dip the tubing below the slab into the subsoil (see **Figure 4-7**).

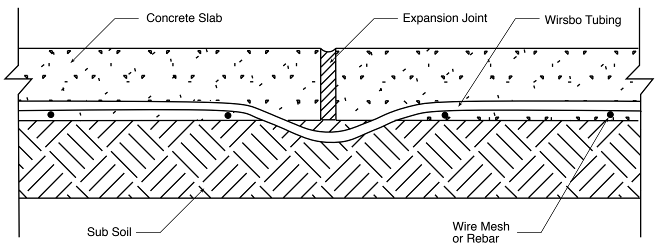


Figure 4-7

When foam insulation is used to sleeve PEX running through an expansion joint and/or to accommodate minor shear action, minimum cover should be determined by the wall thickness of the insulation. For example, if the insulation used is to accommodate ⅜ of an inch of vertical shear, select pipe insulation with a minimum wall thickness ⅜ of an inch.

Control Joints — Control joints allow the concrete to fracture along a controlled line. There is no concern for the tubing penetrating beneath a cut joint during the cracking phase of the concrete. The concern for the tubing is during the phase in which the concrete is initially cut. Depending on the depth of the concrete, the control joint may penetrate from ½ inch to depths greater than 1 inch.

Installation for Control Joints — Ensure that the tubing is secured from the reach of the saw blade and cannot be harmed. It is recommended to secure the tubing 6 inches on each side of the control joint. It is important to mark where the joint can be made after the pour (see **Figure 4-8**).

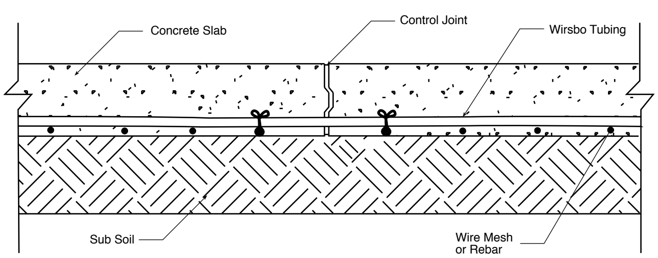


Figure 4-8

Note: When designing a snow and ice melting system, avoid passing the tubing through or below construction, expansion and control joints whenever possible. Coordinate the placement of these joints prior to designing the tubing layout.

Pressurizing

Once the tubing installation is complete with connections to the manifold, pressure test it to a minimum of 60 psi for at least 24 hours (or to local code requirement) to ensure system integrity. It should also remain under pressure during the concrete pour. Pressurize the system with air.
If water is used, you must drain the system after the pour in order to prevent a freeze. Water is not recommended when weather is close to freezing since it is nearly impossible to totally drain the system.

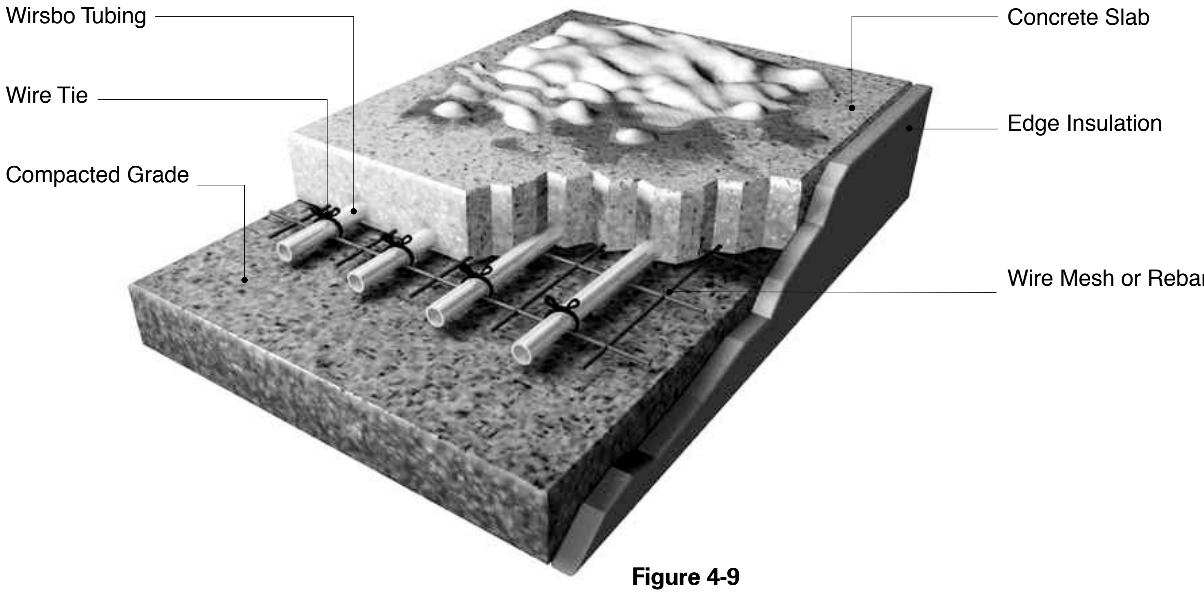


Figure 4-9

Slab On Grade With Edge Insulation Only

Application

This method is for designs with heavy vertical load requirements or cost constraints preventing insulation of the entire slab. With only edge insulation, the heated soil beneath the slab acts as a heat sink storing energy and later supports the slab during a sudden air temperature drop requiring additional heat. Response time is quite slow.

Where Used

This installation is applicable for the following applications.

- Roads
- Emergency accesses
- Helipads
- Loading docks

How to Install

The base layer must be properly compacted prior to installing any tubing. Place wire mesh or rebar over the compacted base material. As shown in **Figure 4-9** above, secure the tubing to the mesh with wire ties or other suitable attachment method. Install vertical insulation along the entire perimeter. It is recommended to install horizontal insulation within the first 4 feet of the slab's perimeter.

What to Look For

- Make sure the base material is properly compacted as specified by the project engineer.
- Be aware that this type of installation will create a heat sink below, and must be factored into the control strategy.
- If a high water table or moist soil conditions are within 8 to 10 vertical feet of the slab, do not use this method.
- Cover the top of the tubing with a minimum of 1½ inches of concrete.

Control Strategy

Use the constant idle or automatic strategy with a minimum idle setpoint temperature above freezing.

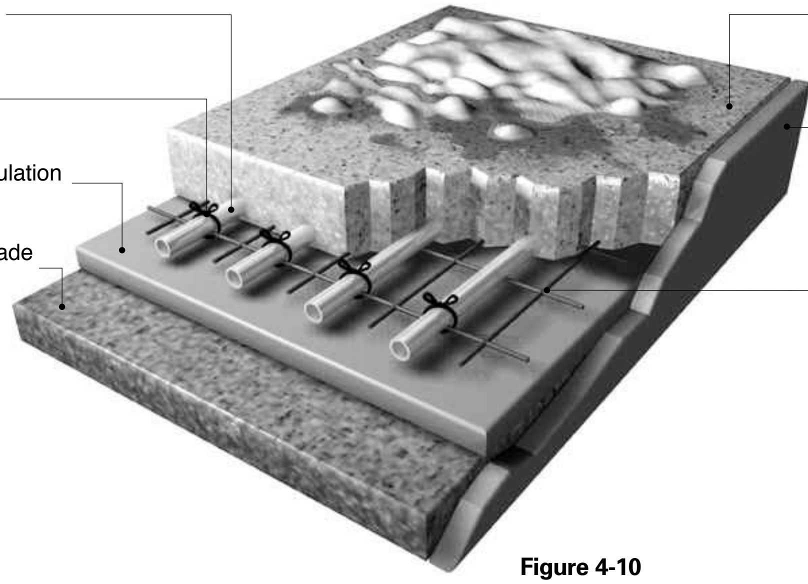


Figure 4-10

Slab On Grade With Under Slab and Edge Insulation

Application

This method is for designs with light to moderate vertical load requirements across the slab. With under slab and edge insulation, the heated slab is isolated from high movement of energy from the slab to the surrounding frozen soil. Response time is fairly quick and even faster if the slab is idled.

Where Used

This installation is applicable for the following applications.

- Sidewalks
- Driveways
- Helipads

How to Install

The base layer must be properly compacted prior to installing the insulation and tubing. There are two ways to install the tubing over the high-density insulation. As shown in **Figure 4-10** above, secure the tubing to the wire mesh or rebar which has been placed over the high-density insulation board. With the other method, secure the tubing to the high-density insulation using Wirsbo plastic staples with the manual stapler.

Install vertical insulation along the entire edge down to the depth of the horizontal under-slab insulation. The insulation creates a thermal break between the heated slab and the frozen ground.

What to Look For

- Make sure the base material is properly compacted as specified by the project engineer.
- Verify whether a high water table or moist soil conditions exist within 8 to 10 vertical feet of the slab. If found, isolate the slab from the moisture.
- Using approved under-slab insulation with vertical compressive strength is critical. Consult with the insulation manufacturer or project engineer for recommendations.
- Cover the top of the tubing with a minimum of 1½ inches of concrete.

Control Strategy

Use the semi- or fully automatic strategy with this installation method.

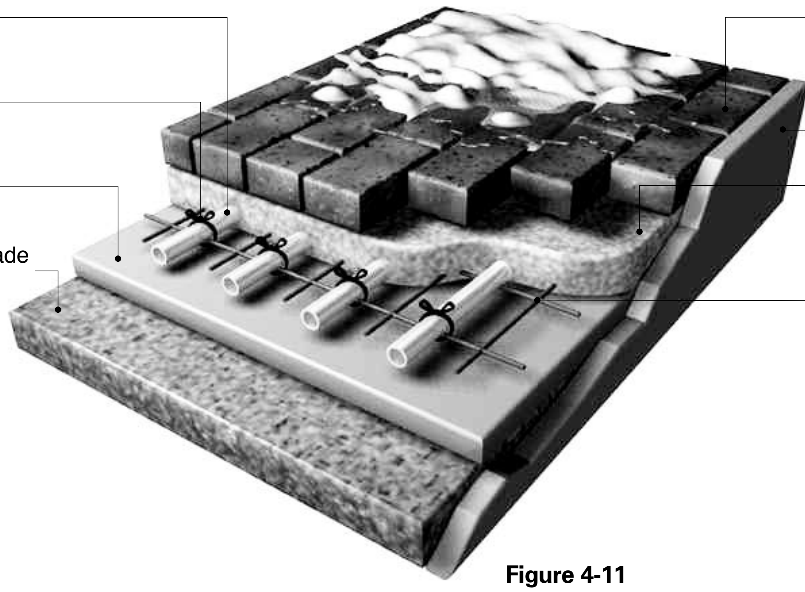


Figure 4-11

Pavers Over a Compactable Soil/Sand Bed

Application

This method is for designs with light vertical load requirements. With insulation, the heated area is isolated from high movement of energy from the system to the surrounding frozen soil. Response time is fairly quick and even faster if the system is idled.

Where Used

This installation is applicable to the following applications.

- Sidewalks
- Driveways
- Low-density roads

How to Install

There are two ways to install the tubing over the high-density insulation. As shown in **Figure 4-11**, secure the tubing to the wire mesh or rebar which has been placed over the high-density insulation board. In the alternative method, secure the tubing to the high-density insulation using Wirsbo plastic staples with the manual stapler.

Install vertical insulation along the entire edge down to the depth of the horizontal insulation. The insulation creates a thermal break between the heated area and the frozen ground.

After installing the tubing, cover with a compactable soil/sand bed (typically 2 to 3 inches) prior to applying pavers or bricks.

What to Look For

- Make sure the base material is properly compacted as specified by the project engineer.
- Verify whether a high water table or moist soil conditions exist within 8 to 10 vertical feet of the snow and ice melting system. If found, isolate the system from the moisture.
- Using approved insulation with vertical compressive strength is critical. Consult with the insulation manufacturer or project engineer for recommendations.
- Supply water temperatures for this application should be no higher than 150°F.

Control Strategy

Use the semi- or fully automatic strategy for this installation method.

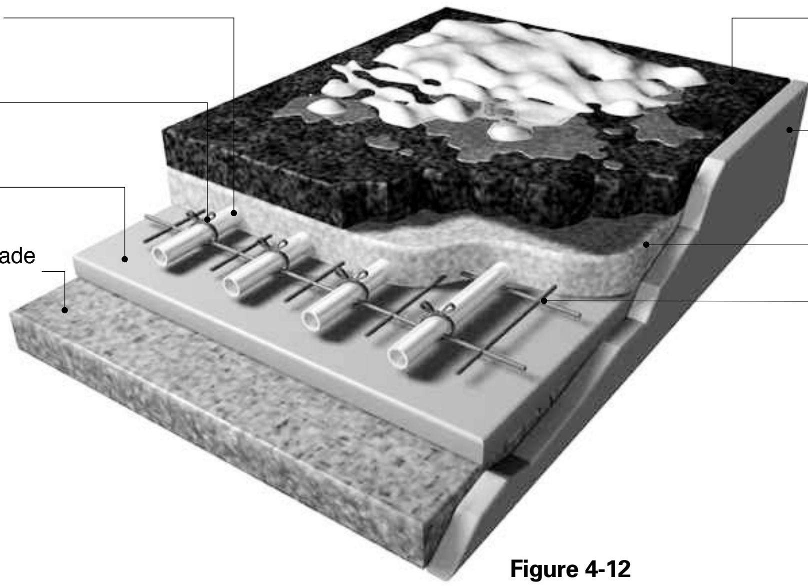


Figure 4-12

Asphalt Pour Over a Compactable Soil/Sand Bed

Application

This method is for designs with light vertical load requirements. With insulation, the heated area is isolated from high movement of energy from the snow and melting system to the surrounding frozen soil. Response time is fairly quick and even faster if the system is idled.

Where Used

This installation is applicable to the following applications.

- Sidewalks
- Driveways
- Low-density roads

How to Install

There are two ways to install the tubing over the high-density insulation. As shown in **Figure 4-12**, secure the tubing to the wire mesh or rebar which has been placed over the high-density insulation board. With the alternative method, secure the tubing to the high-density insulation using Wirsbo plastic staples with the manual stapler.

Install vertical insulation along the entire edge down to the depth of the horizontal insulation. The insulation creates a thermal break between the heated area and the frozen ground.

After installing the tubing, cover with a compactable soil/sand bed (typically 3 inches) prior to applying the asphalt pour.

What to Look For

- Make sure the base material is properly compacted as specified by the project engineer.
- Ensure the soil/sand bed over the tubing can be compacted to a level acceptable for the asphalt installer.
- Verify whether a high water table or moist soil conditions exist within 8 to 10 vertical feet of the snow and ice melting system. If found, isolate the system from the moisture.
- Using approved insulation with vertical compressive strength is critical. Consult with the insulation manufacturer or project engineer for recommendations.
- Supply water temperatures for this application should be no higher than 150°F.

Control Strategy

Use the semi- or fully automatic strategy for this method.

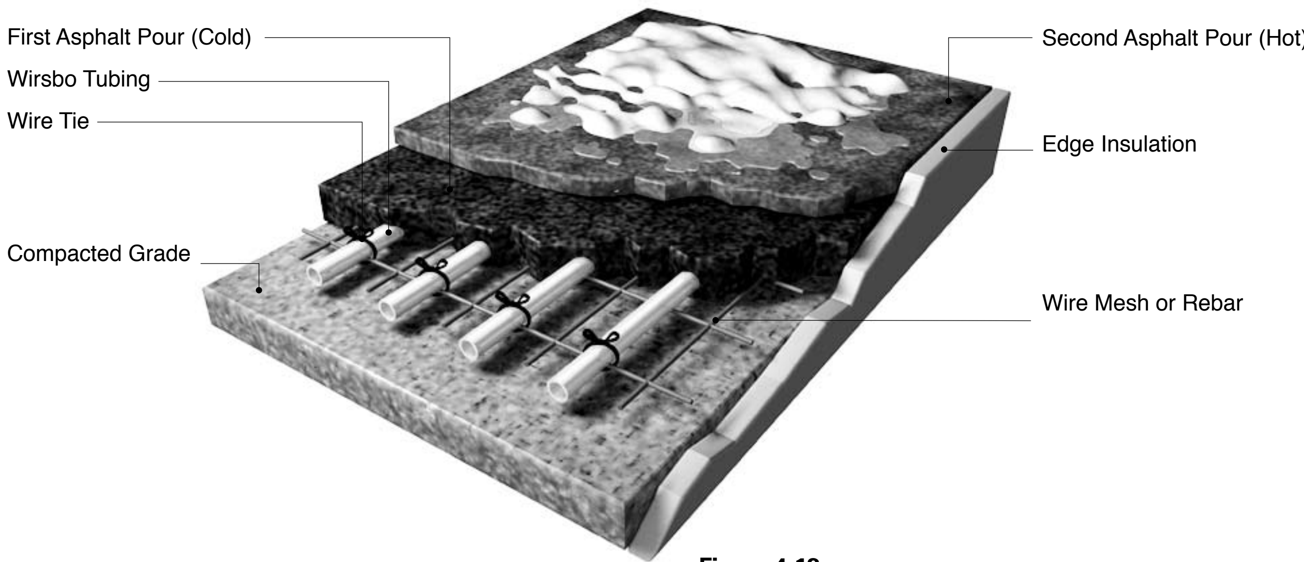


Figure 4-13

Two-lift Asphalt Pour Over a Compacted Grade

Application

This method is for designs with heavy vertical load. It's used only when the asphalt installer requires the higher level of compaction in order to move the paving machine up a slope, or if the application will operate above freezing throughout the heating season. The heated soil beneath the system acts as a heat sink storing energy, and later supports the system during a sudden drop in air temperature that requires additional heat.

Where Used

This installation is applicable to the following applications.

- Steep driveways
- High-density roads
- Emergency accesses

How to Install

Without insulation, place wire mesh or rebar over the compacted base material. Secure tubing to the mesh with wire ties or other suitable attachment method.

As shown in **Figure 4-13,** install vertical insulation along the entire edge. It is recommended to install horizontally insulation within the first 4 feet of the slab's perimeter. The insulation creates thermal breaks between the heated area and the frozen ground.

Carefully place the asphalt over the tubing and rake it level before compacting. Do not use an asphalt machine to lay the first lift of asphalt.

If the asphalt temperature exceeds 180°F, the PEX tubing must be cooled during the lift to prevent damage to the tubing. Connect the tubing or manifold(s) to a fresh water source and continuously run cold water through the tubing to dissipate the heat. The water drains from the return manifold creating an open system.

Note: The temperature of the asphalt poured directly over the tubing must never exceed 240°F.

What to Look For

- Make sure the base material is properly compacted as specified by the project engineer.
- Make sure the PEX is properly cooled during a high-temperature (greater than 180°F) lift.

Control Strategy

Use constant idle or automatic strategy with a minimum idle setpoint temperature above freezing.

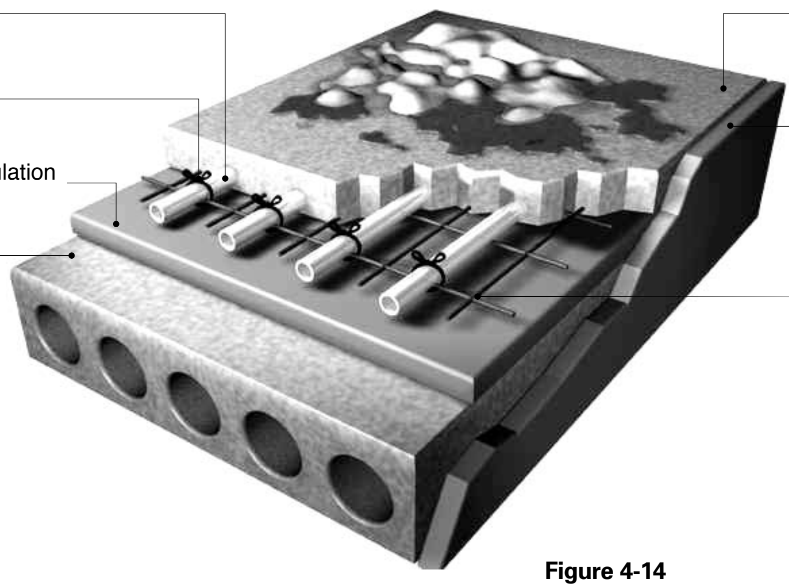


Figure 4-14

Insulated Slab Over Pre-stressed Concrete

Application

This is a commercial installation. It is critical to make an effective thermal break between the heated slab and the structural slab below. Otherwise, the rate of heat migration into the structural slab will result in a loss of control over the snow-melt system.

Where Used

This installation is applicable to the following applications.

- Parking ramps
- Suspended ramps

How to Install

There are two ways to install the tubing over the high-density insulation. As shown in **Figure 4-14**, secure the tubing to flat wire mesh or rebar which has been placed over the high-density insulation board.

With the alternative method, secure the tubing to the high-density insulation using Wirsbo plastic staples with the manual stapler. Plastic foam staples must be the proper length to avoid penetrating completely through the insulation. If the staple is too long and the staple does not seat properly, it may allow the tubing to slide loosely inside the staple.

Install vertical insulation along the entire edge down to the depth of the horizontal under-slab insulation. The use of insulation creates a thermal break between the heated slab and the unheated structural slab.

What to Look For

- Using approved under-slab insulation with vertical compressive strength is critical. Consult with the insulation manufacturer or project engineer for recommendations.
- Ensure a minimum of 1½ inches of concrete is over the top of the tubing.
- Place staples or wire ties no more than 2 to 3 feet apart in the cap pour to eliminate floating.

Control Strategy

Use the automatic strategy with an idle setpoint temperature above freezing.

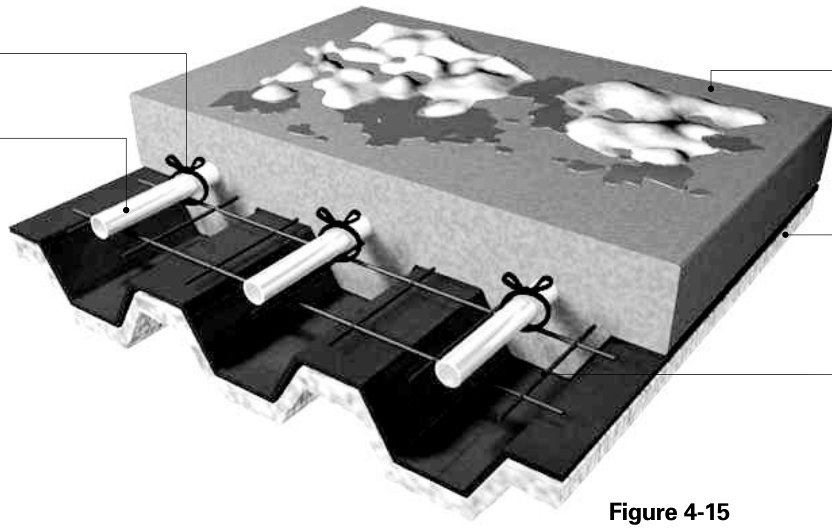


Figure 4-15

Slab Over Insulated Steel Decking

Application

This is a commercial installation. The insulation under the decking is usually sprayed on after construction. It is critical that the resistance value (R-value) of the insulation meets or exceeds the requirement specified in the snow-melt design.

In suspended installations, the effect of wind must be considered in the design. Suspended installations require greater amounts of insulation to overcome the impact of moving air. The insulation should be covered to reduce the wind effect. Additionally, some spray-on insulation is vulnerable to ultraviolet (UV) degradation.

Where Used

This installation is applicable to the following applications.

- Bridges
- Suspended ramps

How to Install

As shown in **Figure 4-15**, secure the tubing to flat mesh or to chaired rebar. Install the tubing within 3 to 4 inches from the surface of the snow-melt slab.

Install the vertical insulation along the entire edge down to the depth of the horizontal under-slab insulation. The insulation creates a thermal break between the heated slab and the surrounding unheated structural.

What to Look For

- Protect the insulation from site abuse and any possible UV degradation, if applicable.
- Consult with the insulation manufacturer or project engineer for recommendations.
- Ensure a minimum of 1½ inches of concrete is over the top of the tubing.
- Place wire ties no more than 2 to 3 feet apart in the cap pour to eliminate floating.

Control Strategy

Use the automatic strategy with an idle setpoint temperature above freezing.

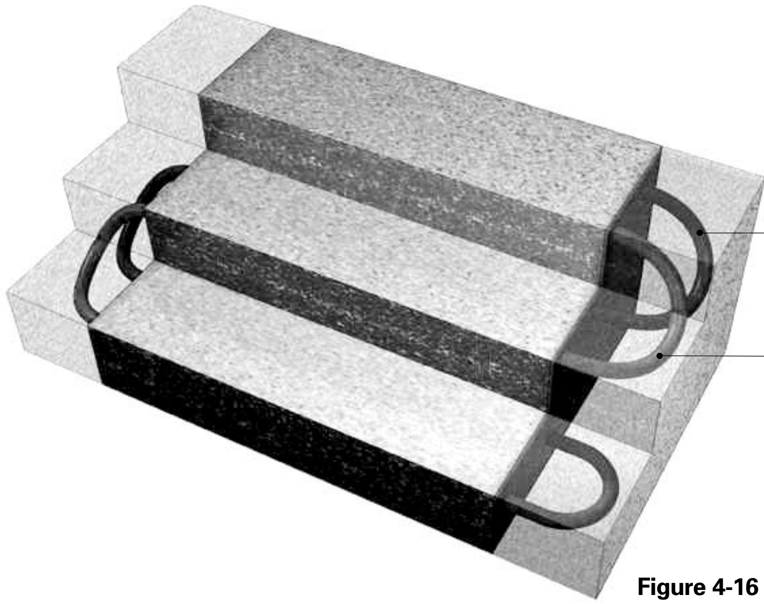


Figure 4-16

Stairs Installation

Application

Stairs can be very hazardous during the winter. They are also the most expensive and time-consuming area for manual snow and ice removal.

Where Used

This installation is applicable to the following applications.

- Public access areas
- Location where hazardous conditions develop quickly (e.g., north-facing installations)
- Where economic alternative methods are required over conventional snow removal

How to Install

The most critical portion of the step is the leading edge formed by the tread and the step riser. This area has the greatest exposure to air temperature and wind effect with the least heated mass to counter these effects.

As shown in **Figure 4-16**, install the tubing parallel to the edge of the step tread. Run supply on the leading edge of the treads. Secure the tubing to the reinforcing bar within the stair structure. Tubing bend supports can assist the install in making the required tight turns.

What to Look For

- Use vertical insulation where it can minimize lateral heat loss and wind effect.
- Install tubing a minimum of 6 inches on center to maximize coverage on stair tread.
- Lay the tubing loop from the top tread down to the bottom tread. This helps eliminate unwanted air traps from developing in the loop.

Control Strategy

Use the constant idle or automatic strategy with an idle setpoint temperature above freezing.

Chapter 5

Design Considerations

Before designing the snow and ice melting system, it is important to educate customers about the system's capabilities and limitations. Proactive communication with customers, especially homeowners, helps manage expectations, limit frustrations and avoid callbacks because they think the system isn't working properly. For example, if the temperature or wind speed exceeds design parameters, educated customers will anticipate some snow or ice accumulation.

This chapter explains what is involved with each step and the logic behind the Wirsbo Snow & Ice Melting System design. **Chapter 6** offers a step-by-step design tutorial that describes how to read and use the various charts in the appendices to size snow and ice melting systems.

Snow and Ice Melting Performance

Snow and ice melting systems must be designed to perform to the customer's needs and expectations. There are many ways to design a snow and ice melting system. They vary in the spacing of tubing, the BTU/h required, how the area is insulated, the depth of the concrete and the controls selected to run the system.

There is a school of thought that says a snow and ice melting system's performance can and should be based on its ability to melt a given number of inches of snow in an hour. Wirsbo looks at the performance of a snow and ice melting system somewhat differently.

Just as it is impossible to predict what the next snowflake to fall out of the sky will look like, it is difficult to predict what kind of snow will fall. It could be a light and fluffy snow shower, a heavy wind-driven snow, sleet, freezing rain or even an ice storm. Many factors affect the ability of a system to melt snow. The most critical are:

- The density of the snow
- The outdoor temperature
- Wind conditions
- Slab surface temperature

Density of Snow — Snow most commonly forms at temperatures between -10 and 40°F. The density can be dramatically different from snowfall to snowfall making it an important consideration when determining how much energy will be required to melt the snow.

Depending upon the air temperature, snow varies in its density. The major contributing factor to the density of snow is its moisture content. The warmer the air temperature during the snowfall, the greater the amount of moisture in the snow. The colder the air temperature during the snowfall, the less the moisture content will be. On average, snow is 10% moisture content. So, a 10-inch snowfall would amount to approximately 1 inch of rain at a warmer temperature.

If the snow is light and fluffy, it is easier to melt because it is relatively low in density. Conversely, 2 inches of heavy moist snow is more difficult to melt because it is denser and requires more energy to melt.

Outdoor Design Temperature — Snow and ice melting systems are typically designed to melt snow at 0°F with a 10-mph wind. Local conditions may require higher or lower design temperatures. With the exception of Class 3 designs (e.g., helipads, emergency entrances), the outdoor design temperature is rarely selected below 0°F. (See classifications of design definitions later in this chapter.)

There is a point at which a design may become financially difficult to justify for operation in Class 1 and some Class 2 applications. In those situations, you can program the Wirsbo pro Series controls with a cold weather cut-off (CWCO) temperature. This allows the owner to automatically turn the system off at a desired temperature. The system automatically restarts as soon as the outdoor temperature rises above the CWCO temperature.

Note: It is important to understand and communicate to customers that as temperature and wind speed exceed design conditions, the snow and ice melting surface may freeze over. As weather conditions return to design, the system will melt the snow and ice that may have accumulated.

Wind Conditions — A snow and ice melting system is often unaffected if the outdoor temperature drops slightly below design. Wind speeds greater than design conditions will affect system performance more adversely. Strong winds steal heat energy from a slab faster than in calm conditions. The presence of buildings, landscaping or even snow fences can reduce the negative effect of wind on a snow and ice melting slab.

Surface Temperature — The slab surface temperature is the result of supply fluid temperature, flow, tubing on-center distance and climatic conditions. The performance charts in **Appendix C** show the surface temperatures at varying climatic conditions, on-center distances and BTU/h/ft^2 loads. These performance charts outline where the BTU/h/ft^2 and required supply fluid temperatures increase or decrease as the design conditions become more or less severe. Typically, design surface temperatures vary from 35 to 45°F.

All these factors combined make it almost impossible to predict with reasonable accuracy the performance of a snow and ice melting system in terms of the number of inches that can be melted in an hour.

The Wirsbo solution is to design the system based on outdoor climatic conditions. Following Wirsbo-specific design charts will ensure a high performance snow and ice melting system.

Classification of Design

Snow and ice melting designs fall into one of three classification levels (1, 2, 3). The higher the classification, the higher the BTU/h/ft^2 load. The on-center recommendations shown with each class are subject to a reduction in on-center distance as the climatic conditions become more severe or the end-user's requirements become more stringent.

Class 1 — Residential driveways, sidewalks or other non-critical surfaces. Tubing can be installed up to 12 inches on center.

Class 2 — Commercial public-use driveways, sidewalks or other public-use surfaces. Tubing usually installed 9 inches on center.

Class 3 — Helipads, emergency entrances or other critical-use surfaces. Tubing usually installed 6 inches on center.

Installation Methods

Refer to **Chapter 4** for information pertaining to installation methods.

Supply Fluid Temperature

The design supply fluid temperature is determined by climatic conditions, BTU/h/ft^2 requirements and the tubing on-center distance. As the climatic conditions warm up or become less severe, the BTU/h/ft^2 load reduces and results in a reduction in supply fluid temperature to the slab. Wirsbo pro Series controls use outdoor sensing to reset the supply fluid temperature as required.

Limitations — Limitations to supply fluid temperatures are due to construction material and not the PEX tubing. The maximum supply fluid should not exceed 150°F for concrete installations. It may not be possible to meet the customer's design request due to limitation of the medium. Consult your local code officials for any additional information on the maximum fluid temperatures that can be operated through these different construction mediums.

Tubing On-center Distance — For most residential snow and ice melting designs, 12 inches on-center spacing is recommended, if design requirements are met. If the calculated supply fluid temperature exceeds the temperature limitations for concrete or sand, it may be necessary to install the tubing at 9 or 6 inches on center to reduce the supply fluid temperature requirements (see **Appendix C**). Reducing the on-center distance reduces the flow requirement per loop and the supply fluid temperatures for the same climatic conditions (air and wind). Reducing the on-center distances also increases the amount of tubing and manifold outlets required.

The on-center distance of the tubing layout impacts the performance of a snow and ice melting system and it is important to understand why. Designing to the outdoor conditions (outdoor temperature and wind speed) and surface temperature for melting the snow or ice is the starting point. Whether the tubing is 12 or 6 inches on center, the load required is the same to achieve these design parameters. However, the supply water temperature requirement is lower for 6 inches versus 12 inches under the same conditions.

The on-center distance of the tubing layout affects the supply water temperature required to meet the performance conditions. The tighter the tube spacing, the lower the water temperature for the same design conditions. Closer tube spacing can be useful in meeting design conditions without exceeding water supply temperatures for the installation method and in accelerated slab warm up.

For all types of installations, residential, commercial or industrial, it is normal for tube spacing to vary from 6 to 12 inches on center. Distances vary depending upon the required performance and traffic. For example, steps, hospital emergency ramps and access areas should not be installed at on-center distances greater than 6 inches because it is essential that these areas are snow and ice-free.

It is recommended not to install tubing with spacing greater than 12 inches on center. Some installations, even with the tubing installed at 12 inches on center, can experience striping depending on tubing depth and control strategy employed. Striping can be seen visually on the surface as the slab begins to melt snow. The areas directly over the tubing will be melted where as the areas between the tubing will still have snow. Normally, this is a temporary situation that remedies itself as the slab comes to temperature.

Keep in mind that the tubing in the slab is the distribution system. If you limit the amount of distribution (tubing) in the slab, you will experience reduced response times, and in worst cases, it will not deliver the amount of BTU/h fast enough to keep up with the slab loss. In other words, a system failure.

Insulation

The use of insulation around the snow and ice melting slab can have a significant effect on the system's ability to perform. When considering insulation, it is important to evaluate the following:

- Compressive strength (application)
- Compaction over time
- Moisture resistance
- R-value (heat-transfer resistance)

Always use an under-slab rated product, as standard fiberglass insulations will not meet the insulating value once it is compressed. Be sure that the insulation selected meets local code and building requirements.

Wirsbo recommends a minimum thickness of 2-inch high-density board for use as perimeter and horizontal insulation. Typically, this gives an R-value of 10.0 (check manufacturer information), and provides a durable surface to walk on while installing the tubing. There are new options for insulation entering the market. Ensure that these products meet the vertical load and compression requirements for under slab installations. Refer to the project engineer for guidance.

Remember, the heat loads (BTU/h/ft^2) in snow-melting systems are much greater than typical home heating systems. Using a higher R-value insulation reduces the energy lost to areas around and below the snow-melt area. Wirsbo highly recommends using insulation for all snow-melt installations.

If there is a high water table or moist soil conditions within 8 to 10 vertical feet of the slab, install a proper drain field beneath the slab. Moisture in the subsoil can create a tremendous rate of downward heat loss. Installing a vapor barrier beneath the slab insulation will not stop the downward migration of heat energy.

Amount of Tubing Needed

To determine the amount of tubing needed based on its on-center placement, use the formulas below.

Tubing 6 inches o.c.:
Square footage x 2.0 = Feet of active tubing

Tubing 9 inches o.c.:
Square footage x 1.333 = Feet of active tubing

Tubing 12 inches o.c.:
Square footage x 1.0 = Feet of active tubing

Remember to add the leader distance to the active loop length to obtain the total loop length.

Loop Lengths

Loop lengths vary depending upon the size of tubing used and the installed on-center distance. In general, the smaller the tubing diameter, the shorter the loop length. Consider ⅝" PEX as the smallest tubing size for snow and ice melting projects.

The total loop length consists of two separate sections: the active loop and the leader length. The active loop is installed within the heated slab. The leader length is the total distance to and from the manifold and heated slab (including any vertical distance).

Keep the manifolds as close to the snow-melt area as possible. This eliminates any unnecessary heat loss from the un-insulated leader lengths from the snow-melt area to the manifold location.

When considering loop lengths, it is important to remember that higher loads require higher flow rates. Higher flow rates generate higher pressure losses through the tubing. Reducing on-center distances and keeping loop lengths shorter lowers pressure drops when evaluating pump curves and circulator sizing.

Example

Total snow and ice melting area: 115 ft^2
Tubing on-center distance: 9 inches
Tubing type and size: ⅝" MultiCor
Distance from melt area to manifold: 15 feet
(leader length)

115 ft^2 x 1.333 = 153 feet of active loop length
153 feet + 30 feet = 183 feet of total loop length

The 115-square foot snow and ice melting area will require one 183-foot loop of ⅝" MultiCor.

The following charts offer the recommended loop lengths for a given tubing type and size. These recommendations enable the system designer to stay within the parameters necessary to coincide with commonly stocked pumps. These loop lengths are recommendations and should not be viewed as limitations.

PEX Size	Average Active Loop	Total Loop
⅝"	225'	250'
¾"	300'	325'
1"	450'	475'

MultiCor Size	Average Active Loop	Total Loop
⅝"	255'	380'
¾"	380'	405'
1"	575'	600'

These charts are based on flow of 0.0102/feet at 120°F fluid temperature, 40% glycol-water mixture. Total loop length is the combination of the active loop length and the leader length. Flow is based on the active loop length. Pressure head drop is based on the total loop length. Total loop values shown reflect pressure head drops below 20 feet of head. Larger projects will require longer loop lengths and greater head drops.

Wirsbo recommends that you do not use ½-inch diameter tubing for snow and ice melting systems. With the high flow requirements of a snow-melt system, smaller diameter tubing produces very high head pressure drops. To counter this, the loop lengths for ½-inch tubing must be shorter than other larger dimension tubing. Smaller-dimension tubing also dictates closer on-center distances to better accommodate the system's requirements.

Heat Transfer Fluids*

The circulating fluid in a snow and ice melting system is a glycol-water mixture. When used in proper concentrations, the glycol-water mixture protects the system from damage due to freezing.

Two types of glycol are available: propylene and ethylene. An ethylene glycol-based fluid is usually the first choice for HVAC service because they are less viscous than propylene glycol fluids, which translates into superior heat transfer efficiency and better low temperature performance. However, in some cases the potential for contact with ground water or other potable water supplies or government regulations call for use of a propylene glycol-based fluid. Propylene glycol fluids feature low acute oral toxicity compared to the oral toxicity of ethylene glycol-based fluids.

Wirsbo recommends propylene glycol as a freeze-protection agent in snow and ice melting systems. Propylene is considered "food grade" or environmentally safe, while ethylene glycol is considered toxic. Neither propylene nor ethylene glycol has any adverse effect on PEX tubing.

Uninhibited or "plain" glycols are sometimes selected for freeze protection because they cost less than inhibited products. But the plain glycols can actually increase the threat of corrosion in your system because they produce organic acids. If left in solution, these acids lower the system pH. If the glycols are not neutralized, the corrosion rate of ethylene glycol on iron is more than 2.5 times greater than water.

Remember, inhibitors designed to stabilize the glycol are beneficial. However, inhibitors designed to prevent corrosion may damage fittings and other metal components in the system when used with non-barrier tubing. An annual maintenance program is required when active chemicals are incorporated into the hydronic snow and ice melting system. Consult the glycol manufacturer's recommendations for glycol and inhibitor use.

Automotive antifreeze products are formulated with silicate-based corrosion inhibitors that are well suited to protect aluminum components in automotive engines, but can actually be harmful to your hydronic system. In hydronic systems, where flow tends to be less turbulent, the silicates in automotive antifreeze can coat and foul heat- transfer surfaces and interfere with the system, reducing energy efficiency. Silicate-based inhibitors can also significantly shorten the life of pump seals. Finally, manufacturers of automotive antifreeze recommend replacing their fluids every two or three years. In contrast, quality heat transfer fluids — which contain inhibitors designed to maintain fluid pH and protect the metals commonly used in hydronic systems — can last 20 years or more with proper maintenance.

Caution: Do not use automotive antifreeze in any hydronic heating or snow and ice melting system. With few exceptions, automotive antifreeze is an ethylene-glycol based solution.

For long-term, maintenance-free operation, heat transfer fluids should only be diluted with good quality potable water with a pH between 9 and 10. Good quality water contains only minute traces of calcium (<50 ppm), magnesium (<50 ppm), chloride (<25 ppm), and sulfate (<25 ppm), and less than 100 ppm of total hardness as $CaCO_3$. If good quality water is not available for your installation, prediluted solutions of heat transfer fluids are available from manufacturers like The Dow Chemical Company.

Burst Protection — Burst protection is required when a system is inactive during the winter, and adequate space for expansion of an ice/slush mixture is available. When system burst protection is desired, glycol requirements are lower. Burst protection is suitable for chilled water systems, lawn sprinkler systems and other systems that are dormant in the winter. Do not use burst glycol concentrations to protect snow and ice melting systems.

Freeze Protection — Freeze protection is important in systems that must operate all winter, requiring the fluid to circulate at low temperatures. Freeze protection is also necessary if the system offers inadequate volume of expansion of an ice/slush fluid mixture. The fluid in any system that must be protected in the event of power or pump failure should contain sufficient glycol for freeze protection. For freeze protection, choose a glycol solution concentration that prevents the formation of ice crystals at a temperature of at least 5°F colder than the lowest expected ambient temperature.

*Source for heat transfer information: The Dow Chemical Company

The percentage of glycol needed in the solution depends on the climatic condition of the area. A 40% glycol to 60% water solution (by volume) is common. Consult with the respective glycol manufacturer for the proper level of mixture for a given area.

Volume Percent Glycol Concentration Required for Freeze Protection Using DOWFROST™* Fluid

Temp.°F	(°C)	Percentage
20	(-7)	18%
10	(-12)	29%
0	(-18)	36%
-10	(-23)	42%
-20	(-29)	46%
-30	(-34)	50%
-40	(-40)	54%
-50	(-46)	57%
-60	(-51)	60%

*Trademark of The Dow Chemical Company

Note: These figures are examples only and may not be appropriate to your situation. Generally, for an extended margin of protection, you should select a temperature in this table that is at least 5°F (3°C) lower than the expected lowest ambient temperature. Inhibitor levels should be adjusted for solutions of less than 20% glycol. Contact Dow for information on specific cases or further assistance.

Fluid Flow — Total fluid flow for the entire system is based on the required BTU/h and the differential temperature selected. Flow per loop is determined by BTU/h/ft^2, tubing on-center distance and the differential temperature.

Differential Temperature (Δt) — Differential temperature is the temperature difference between the supply and the return fluid temperatures.

When designing a system, the differential temperature for snow and ice melting systems is typically designed at a 25°F Δt. This is the basis for the design. System flows and circulator-sizing information can be determined once the design differential temperature is selected.

Under actual operating conditions, the differential temperature varies based on velocity of flow and consumption of energy due to climatic conditions. If the heat loss from the slab increases, the differential temperature increases for a given flow rate. If the heat loss decreases, the differential temperature decreases. Differential temperatures are listed in degrees Fahrenheit.

Pressure Loss — As the heated fluid moves through the tubing there is a loss of pressure associated with this movement. The loss of pressure is listed in pounds per square inch (psi). To convert this value into pump head pressure, multiply the psi by 2.306. The resulting value is listed in feet of pump head pressure. Pressure loss or feet of head is required when selecting the system circulator.

For the snow and ice melting system, flow is based on the length of tubing in the slab (active loop). The leader length is the amount of tubing from the manifold location (supply) to the slab and back (return). Together, the active loop length and the leader length equal the total loop length. Pump head pressure drop is computed with the given flow for a loop and the total loop length. The longer the total loop length, the greater the head pressure drop. Refer to the pressure loss charts in the appendix for the tubing being used on the product.

Tubing Layout Considerations

Refer to **Chapter 4** for information about tubing layout considerations.

Manifold Considerations

Wirsbo offers three manifolds for snow and ice melting applications.

1¼" Brass Manifolds — The tubing size used in the snow and ice melting system determines the type of manifold used. Typically used in residential and small commercial installations, the 1¼" Wirsbo brass manifold is used with ⅝" PEX and MultiCor tubing for snow and ice melting applications. These manifolds are capable of flow balancing, flow isolation and temperature indication.

Note: When used for snow and ice melting, the brass radiant floor heating manifolds are compatible only with ⅝" PEX and MultiCor tubing. Larger tubing sizes cannot be connected to the manifold.

2" Copper Valved Manifolds — These valved manifolds are used with ⅝" and ¾" PEX and MultiCor tubing, and are typically used in commercial applications. The manifolds come with either a ball valve or a combination ball/balancing valve on each outlet. The ball valves on these manifolds are for isolation only. Do not attempt to balance with ball valves. If balancing is required, use the manifolds with the combination ball/balancing valve. Refer to **Chapter 3** for additional information.

HDPE Manifolds — These manifolds are used with ¾" and 1" PEX tubing, and are typically used in commercial applications. HDPE manifolds do not feature an oxygen-diffusion barrier, so they can only be used in systems free of ferrous components. Refer to **Chapter 3** for additional information.

Caution: Do not exceed 140ºF supply fluid temperature to HDPE manifolds and tubing.

HDPE manifolds are not capable of individual loop balancing unless a balancing feature (e.g., flow setter) is added to each loop. These manifolds are usually used in direct burial applications, and the use of valves on the manifold is not desired.

To avoid having to flow balance across the manifold, ensure that loop lengths are within 3% of each other. With the supply and return mains to the manifold piped in a reverse-return configuration and the loops within 3% of each other in length, the manifold will self balance.

Example
If the designed loop lengths for a project is 333 feet, the installed loop lengths can vary no more than 5 feet from this designed loop length. The acceptable range of loop lengths in this example is 328 to 338 feet (333 x 0.03 = 10). A loop length outside this range would require flow balancing for all loops on the manifold.

Brazed-plate Heat Exchangers — Brazed-plate heat exchangers offer isolation and heat transfers between boiler water and snow-melting fluid. Heat exchangers feature two separate chambers, or sides to separate the boiler water from the snow-melting system fluid. The hot boiler water pumps through the heat exchanger, warming up the actual walls of the exchanger itself. Snow-melting system fluid pumps through the other side of the exchanger and is warmed as it comes in contact with the hot walls of the exchanger. The boiler water and the snow-melting system fluid never mix.

Wirsbo heat exchangers are most commonly used to deal with the issue of oxygen diffusion corrosion when non-barrier AQUAPEX tubing is used for snow and ice melting. Non-ferrous components are used along with the non-barrier tubing on the snow-melting side of the heat exchanger. This means using a bronze or stainless steel circulator with non-ferrous flanges, a potable water-type expansion tank, a brass or bronze air separator and all non-ferrous hard piping. Do not use steel or cast-iron piping or other materials with non-barrier tubing.

For snow and ice melting applications, it is more economical and practical to isolate the snow-melt area. If the snow and ice melting part of the system is ever shut down for a period of time, it will not affect the rest of the heating system. It also keeps glycol away from the heat of the boiler. The higher the temperature the glycol solution is subjected to, the shorter its life cycle. In addition, some seals on boilers are not compatible with some glycols. Going through a heat exchanger also reduces, if not eliminates, the issue of cold-water return to the boiler. Refer to the boiler manufacturer for more information. Finally, the cost of using glycol for the entire heating instead of just the snow melting part of the system can be significant.

Control Strategies

Refer to **Chapter 7** for information concerning control strategies and corresponding controls.

Operational Considerations

Listed below are several considerations common to snow and ice melting applications.

Preventing Shock to the Slab — A danger for a snow-melt slab is thermal shock. Shock happens when the slab is heated too quickly causing the concrete to rapidly expand and fracture.

For any control strategy that is designed for on and off operation or shifting between an idle setpoint temperature and a snow-melt temperature, the differential temperature between the supply and return fluid from the slab must be monitored. The control must have a sensor on the supply and return mains to the snow-melt slab. The control must also be able to interpret the difference in temperatures and take the appropriate action — either increasing or decreasing supply water temperature to slowly warm the snow-melt slab.

If the maximum differential temperature (MAX Δt) programmed in the snow-melt control is 30ºF, the control will monitor the return temperature and provide a supply water temperature 30ºF higher than the return. As the fluid returns warmer, the control will increase the supply fluid temperature — keeping within the 30ºF differential temperature. This monitored heating of the slab will continue until the slab reaches the designated temperature.

A possible exception for monitoring would be for a constant idle control strategy (see **Chapter 7**) that becomes active well above freezing and the supply fluid temperature is modulated in respect to outdoor temperature. Constant idle applications are not designed to be turned on and off during the season. They operate continuously throughout the heating season.

Bridging Effect — When a control strategy allows the slab to cool to ambient temperatures, or idle below freezing, there is often a lag in response to falling snow. After a fair amount of snow accumulates on the slab, the system experiences a situation called "bridging." Bridging takes place between the surface of the slab and the corresponding surface of the snow pack. The snow melts against the surface of the slab. Small caves or bridges form over the heated slab. Where the slab loses physical contact with the snow, the transfer of heat energy drops dramatically.

From the surface of the snow, there may be little or no indication that the snow and ice melting system is operating. Eventually the snow will melt from the surface.

If bridging occurs, you can drive a vehicle across the slab to compact the snow against the slab, which will accelerate the melting.

One way to avoid bridging is to make sure the slab is in the heating phase prior to the snowfall.

Drainage — An automatic system idling above freezing or a constant idling system results in minimal run off. Both strategies warm surfaces that melt snow quickly. Much of the moisture generated is lost to the atmosphere in the form of evaporation.

Drainage can be an issue for systems that operate intermittently through the season. Once snow has accumulated on the slab, some run-off will occur.

Plan drains at the point of flow across the slab and the area where the heated slab ends. Remember to provide a form of heat for the drains. The run-off from the snow-melt area will refreeze as soon as it makes contact with the non-heated area.

Concrete Installation — The concrete depth affects the performance of a snow and ice melting system. The thicker the slab, the less accuracy and response with regards to performance. A depth of 4 to 6 inches is optimal. In addition to the depth of the concrete, it's important to watch where the tubing sits in the concrete after the pour.

A more effective system results when the tubing is closer to the top of the pour at 3 to 4 inches from the surface. Whenever possible, you should be present during the concrete pour to ensure system integrity.

Slopes — The slope of a driveway or walkway does not impact the performance of a snow and ice melting system.

What should be considered is the tubing layout pattern. Never run loops up and down the slope. Always lay the tubing perpendicular to the slope and ensure that the supply side enters from the up-slope location. This helps eliminate air traps in the loops.

If a snow and ice detector is used in a slope installation, ensure the detector is installed on a flat area surrounding the device. If the detector is installed level with the slope, false readings or early shutdown of the system could result, because the snow or ice melts from the detector before the rest of the slab surface is clear.

Sizing Mains — With any hydronic system, it is important to properly size the supply and return mains to the snow-melt area. The fluid velocity should be held fairly consistent across the system. Do not size the tubing for velocities below 1.5 feet per second (f/s). Flow velocities below 1.5 f/s will make it difficult if not impossible to remove entrapped air from the system. For smaller dimensioned tubing (less than 2 inches), do not exceed 8 f/s. Velocities greater than 8 f/s may cause erosion damage to metal components within the fluid pathway. Refer to Appendix H for velocity charts.

For a closed-loop system with ferrous components, choose Wirsbo's large dimension hePEX tubing. This tubing offers an EVOH oxygen diffusion barrier on the outside of the tubing. Tubing is available in 32mm, 40mm, 50mm and 63mm dimensions. Refer to **Chapter 3** for more information.

For a closed-loop system with non-ferrous components or an isolated system, choose Wirsbo's HDPE tubing. This tubing does not offer an oxygen diffusion barrier. Tubing and fittings are connected through heat-fusion welding. Tubing is available in 2, 3 and 4-inch dimensions. Refer to **Chapter 3** for more information.

Chapter 6

Design Tutorial

Designing an effective snow and ice melting system requires some preparation. The step-by-step design tutorial in this chapter will help you estimate the amount of tubing needed and establish other design parameters.

The sample exercise uses ⅝" MultiCor, however, the steps also apply to hePEX plus and AQUAPEX as well as to larger tubing sizes. Please refer to **Appendices C** and **E** to guide you through the tutorial. A quick-design worksheet template, which can be copied and used for future installations, is available in **Appendix A.** The detailed manifold worksheet, containing designer notes, is in **Appendix B.** The Wirsbo Advanced Design Suite software can also design the system.

Step 1 — Identify the outside air temperature and wind speed using **Appendix C.** The majority of snowfall occurs between 5 and 34°F. This example assumes a system to be designed at 5°F with a 10-mph wind.

Step 2 — Identify differential temperature (Δt) for the system design. All charts in this manual are based on a 25°F differential temperature.

Step 3 — From the charts in **Appendix C**, select the surface temperature you want the system to achieve at design. This example uses 38°F.

Step 1a.	**Design temperature**	**5°F**
Step 1b.	**Wind speed**	**10 mph**
Step 2.	**Differential temperature**	**25°F**
Step 3.	**Surface temperature**	**38°F**
Step 4.	BTU/h/ft² load	
Step 5a.	Supply fluid temperature	
Step 5b.	Tubing (o.c.) distance	
Step 6.	Area in square feet	
Step 7.	Total BTU/h	
Step 8a.	Tubing type	
Step 8b.	Tubing size	
Step 9.	Total amount of tubing	
Step 10a.	Active loop length	
Step 10b.	Number of loops	
Step 11a.	Leader length	
Step 11b.	Total loop length	
Step 12.	Percentage of glycol (%)	
Step 13a.	Flow per foot of tubing (gpm)	
Step 13b.	Flow per loop (gpm)	
Step 14.	System flow (gpm)	
Step 15a.	Head pressure drop/ft	
Step 15b.	Head pressure drop/loop	

Step 4 — Determine the BTU/h/ft² load for the system at the selected climatic conditions and surface temperature. Starting at the climatic condition row (5°F at 10 mph) in **Appendix C**, move to the right until you intercept the vertical column for 38°F surface temperature. The square foot load for this example is 126 BTU/h/ft².

If you have any difficulty reading the charts, refer to the chart explanation at the beginning of **Appendix C**.

Step 5 — Determine the supply fluid temperature. Within the block designating the BTU/h/ft² load in **Appendix C**, you will see three temperature blocks beneath the load. These are the supply fluid temperatures at different tubing on-center (o.c.) distances. The on-center distances from left to right are: 6 inches, 9 inches and 12 inches.

Note: If the temperature exceeds the recommended maximum (150°F for concrete), reduce the tubing on-center distance until the supply fluid temperature is below the recommended maximum.

The supply fluid temperature for this example is 132°F. This example uses 9 inches on center.

Step 6 — Identify the installation area. This example assumes a 1,700-square foot drive to an office building (17 feet x 100 feet).

Step 7 — Determine the BTU/h requirements for this design (boiler sizing). Take the BTU/h/ft² load and multiply it by the area to be heated.

For this example, multiply 126 BTU/h/ft² by 1,700 square feet for a total load of 214,200 BTU/h.

Step 8 — Determine the type and size of tubing for the design. This example uses ⅝" MultiCor.

Note: Tubing smaller than ⅝" is not recommended for snow and ice melting applications due to the increase in flow requirements. With few exceptions, ⅝" and ¾" tubing will meet the requirements for most snow and ice melting applications.

Step 9 — Determine the amount of tubing required. Use the multiplier shown below for the appropriate tubing on-center distance to obtain the amount of active tubing for the project.

6" o.c. = 2.00 multiplier
9" o.c. = 1.33 multiplier
12" o.c. = 1.00 multiplier

Multiply the square footage of the area by 1.33 (9 inches o.c.). 1,700 x 1.33 = 2,261 feet of active tubing is required for the installation.

Step 1a.	Design temperature	5°F
Step 1b.	Wind speed	10 mph
Step 2.	Differential temperature	25°F
Step 3.	Surface temperature	38°F
Step 4.	**BTU/h/ft² load**	**126**
Step 5a.	**Supply fluid temperature**	**132°F**
Step 5b.	**Tubing (o.c.) distance**	**9"**
Step 6.	**Area in square feet**	**1,700 ft²**
Step 7.	**Total BTU/h**	**214,200**
Step 8a.	**Tubing type**	**MultiCor**
Step 8b.	**Tubing size**	**⅝"**
Step 9.	**Total amount of tubing**	**2,261'**
Step 10a.	Active loop length	
Step 10b.	Number of loops	
Step 11a.	Leader length	
Step 11b.	Total loop length	
Step 12.	Percentage of glycol (%)	
Step 13a.	Flow per foot of tubing (gpm)	
Step 13b.	Flow per loop (gpm)	
Step 14.	System flow (gpm)	
Step 15a.	Head pressure drop/ft	
Step 15b.	Head pressure drop/loop	

Step 10 — Determine the average active loop length and the number of loops for the manifold. The average active loop length is used to calculate preliminary flow and pressure loss. When the design is complete and actual loop lengths are known, flow and pressure loss can be more accurately determined. Refer to the Manifold Worksheet in **Appendix B**.

Divide the total amount of active tubing required by 200 feet (recommended average loop length for ⅝" tubing).

2,261 feet (tubing required) ÷ 200 feet = 11.3 loops.

Round the number of loops to the nearest whole number and divide that new value into the amount of tubing.

2,261 feet divided by 11 loops = 206 feet per loop.

The number of loops for this manifold is 11 with an average active loop length of 206 feet.

Note: It is recommended not to exceed eight loops per manifold when using the 1¼" brass manifold.

Step 11 — Determine the leader length and total loop length for the tubing. The leader length is the amount of tubing between the active heated panel and the manifold location to include any vertical variations. Add the leader length to the active loop length to determine the total loop length.

For this example, use 20 feet of leader length for a total loop length of 226 feet per loop.

Step 12 — Select the percentage of glycol mixture used in the system. Refer to **Chapter 5** of this manual for additional information concerning glycol. In this example, use 40% propylene glycol.

Step 13 — Determine flow in gallons per minute (gpm) per foot of tubing and per loop.

Refer to the flow charts in **Appendix C**. These charts are listed after the performance charts.

1. Enter the charts at the BTU/h/ft² load. This example uses 126 BTU/h/ft².
2. Move horizontally to the appropriate percentage of glycol column. This example uses 40% glycol.
3. To determine the flow value per foot of active loop, follow the BTU/h/ft² load row until it intersects the respective tubing on-center column. This example uses 9 inches on center. The flow per foot in this example is 0.0081 gpm.
4. Multiply the value found in Step 13 with the active loop length. The active loop length for this example is 206 feet.

   206' x 0.0081 gpm = 1.67 gpm per loop.

Step 14 — To obtain the flow for the system, multiply the flow per loop by the number of loops on the system.

1.67 gpm/loop x 11 loops = 18.37 gpm

Step 1a.	Design temperature	5°F
Step 1b.	Wind speed	10 mph
Step 2.	Differential temperature	25°F
Step 3.	Surface temperature	38°F
Step 4.	BTU/h/ft² load	126
Step 5a.	Supply fluid temperature	132°F
Step 5b.	Tubing (o.c.) distance	9"
Step 6.	Area in square feet	1,700 ft²
Step 7.	Total BTU/h	214,200
Step 8a.	Tubing type	MultiCor
Step 8b.	Tubing size	⅝"
Step 9.	Total amount of tubing	2,261'
Step 10a.	**Active loop length**	**206'**
Step 10b.	**Number of loops**	**11 loops**
Step 11a.	**Leader length**	**20'**
Step 11b.	**Total loop length**	**226'**
Step 12.	**Percentage of glycol (%)**	**40%**
Step 13a.	**Flow per foot of tubing (gpm)**	**0.0081**
Step 13b.	**Flow per loop (gpm)**	**1.67**
Step 14.	**System flow (gpm)**	**18.37**
Step 15a.	Head pressure drop/ft	
Step 15b.	Head pressure drop/loop	

Step 15 —Determine the pump head pressure drop. Pressure loss charts are available in **Appendix E** for the different sizes of MultiCor tubing at 30%, 40% and 50% water/glycol solutions and for different fluid supply temperatures. If the supply temperature is between two charts, use the lower temperature chart.

1. Find the correct pressure loss chart in **Appendix E.** (This example uses ⅝" MultiCor at 40% glycol using the 120°F column.)
2. Enter the chart in the “gpm” column at the flow/loop value of 1.67 (as determined in Step 13b). Since 1.67 is between 1.6 and 1.7 round to the higher rate of 1.7.
3. Read the feet of head drop per foot under the appropriate fluid temperature (120°F). The feet of head drop per foot in this example is 0.03090.
4. Multiply the feet of head value by the total loop length.

   0.03090 x 226 = 7.0 feet of head drop

Step 1a.	Design temperature	5°F
Step 1b.	Wind speed	10 mph
Step 2.	Differential temperature	25°F
Step 3.	Surface temperature	38°F
Step 4.	BTU/h/ft² load	126
Step 5a.	Supply fluid temperature	132°F
Step 5b.	Tubing (o.c.) distance	9"
Step 6.	Area in square feet	1,700 ft²
Step 7.	Total BTU/h	214,200
Step 8a.	Tubing type	MultiCor
Step 8b.	Tubing size	⅝"
Step 9.	Total amount of tubing	2,261'
Step 10a.	Active loop length	206'
Step 10b.	Number of loops	11 loops
Step 11a.	Leader length	20'
Step 11b.	Total loop length	226'
Step 12.	Percentage of glycol (%)	40%
Step 13a.	Flow per foot of tubing (gpm)	0.0081
Step 13b.	Flow per loop (gpm)	1.67
Step 14.	System flow (gpm)	18.37
Step 15a.	**Head pressure drop/ft**	**0.03090**
Step 15b.	**Head pressure drop/loop**	**7.0 ft hd**

Chapter 7

Control Strategies

This chapter outlines varying levels of control strategies along with the effect that insulation variables can place on the performance of the system. When planning and designing the snow-melting system, it is important to consider control strategies that support the intended need of the customer and the type of heat source available to the system.

Supply Fluid Tempering

Wirsbo recommends the use of variable speed injection mixing for snow and ice melting applications. The use of injection circulators provides a larger range of support to the snow-melt load. The use of a floating action valve can quickly require an upsizing due to the heavier flow requirements.

Control Strategies

There are three primary ways in which to operate snow and ice melting systems.

1. Constant idle
2. Semi-automatic
3. Automatic

After each control strategy section in this chapter, you will find a description of the applicable controls for that strategy.

Constant Idle

Use this type of control strategy in commercial applications such as the heated aprons before and after a car wash entrance. The slab is maintained above freezing at all times to eliminate the build-up of ice from water dripping off the cars.

The slab sensor is set to maintain a desired temperature above freezing, usually 40 to 45°F. Modulation of supply fluid temperature is provided through the reset capability of the mixing control. As the air temperature drops, the supply fluid temperature to the slab increases. The mixing control also cycles the system pump to the slab in order to maintain the slab setpoint temperature.

Under-slab insulation should be considered in this type of application, especially if a high water table or a moist soil condition is present. A high water table is defined as a water table within 8 to 10 vertical feet of the slab. Vertical insulation down to the frost line is recommended to reduce the amount of lateral energy loss.

Controls for Constant Idle Applications — Wirsbo offers two controls that work in conjunction to support constant idle snow-melting applications — the Wirsbo proMIX™ 201 and Wirsbo SetPoint 501s.

Wirsbo proMIX 201 — The Wirsbo proMIX 201 is a weather-responsive, single temperature reset mixing control for hydronic heating systems. The proMIX 201 provides either reset or setpoint supply water temperatures through the use of a variable speed injection mixing circulator. This control also protects the boiler from low-return water temperatures by monitoring the boiler-return water temperature and adjusting the mixing action of the injection circulator to affect the return water temperature. For more information on installation, programming and operation of the Wirsbo proMIX 201, refer to the Wirsbo proMIX 201 Installation Manual.

Caution: The proMIX 201 does not feature slab-protection capabilities. Do not use this control for on/off snow-melting operations. The proMIX 201 for snow and ice melting can only be used in constant idling mode for applications that remain under operation throughout the heating season.

Wirsbo SetPoint 501s — The SetPoint 501s Controller is a programmable 24VAC control with a slab sensor. The sensor for the control is installed an inch below the surface of the snow-melt slab and monitors the slab temperature. All slab sensors must be installed inside a conduit when embedded in a slab system to allow retrieval should the sensor ever require maintenance. If additional wire is required to properly place the sensor, a total of 500 feet of wire distance from the control to the sensor is possible provided 18-AWG wire is used. For more information on installation, programming and operation of the Wirsbo SetPoint 501s Controller, refer to the Wirsbo SetPoint 501s Controller Installation Manual.

proMIX 201 (A3040201)

SetPoint 501s Controller (A3041501)

proMIX 201 and SetPoint 501s Operation — Use this control strategy only for snow and ice melting systems that require continuous idling operations. Control strategy and components should be installed to meet or exceed the system performance requirements as stated in the system design. Refer to the following sequence.

1. A variable speed injection pump, controlled by the Wirsbo proMIX 201, tempers the supply fluid temperature.
2. The proMIX 201 can reset the supply water temperature as it relates to outdoor temperature. Install the outdoor temperature sensor on the north side of the building out of direct sunlight.
3. The Wirsbo SetPoint 501s is designed to work with the Wirsbo proMIX 201 for continuous idling snow-melt operations.
4. Program the desired slab idling temperature (min. 40°F) into the SetPoint 501s control.
5. The proMIX 201 provides power to the system circulator (P2).
6. The proMIX 201 provides power to the variable speed injection pump (P4).
7. The proMIX 201 initiates boiler call for heat.
8. For proper operation of the control, you must install the outdoor sensor (S4), the system supply sensor (S2), the boiler return sensor (S3) and the 501s slab sensor (S7).
9. The proMIX 201 cannot sense moisture on the surface of the slab.
10. Refer to **Chapter 8** for piping and electrical schematics specific to this control strategy.

WIRSBO®
Life, Safety, Comfort Systems

Semi Automatic

Systems can be designed to be semi-automatic. What differentiates this strategy from a constant idle system is that the start of the melting cycle happens with user interaction, or by pressing the on/off switch. The run cycle ends via a "time-out" feature where the user sets the specific time interval. The setup or programming is more extensive than the constant idle scenario, but it provides additional benefits and safety features for the user. The system automatically shuts off as programmed, which eliminates any wasted fuel consumption.

The reset mixing control modulates the supply fluid temperature. As the air temperature drops, the supply fluid temperature to the slab increases. Likewise, as the air temperature rises, the supply fluid temperature decreases. Additionally, the reset control monitors the return fluid temperature from the snow-melt slab in order to provide proper differential temperatures, which prevents shocking the concrete.

This type of control uses a slab sensor that provides temperature data feedback. Set the control to a temperature to melt snow. Once the desired slab temperature is achieved and the time interval has ended, the control automatically ends the heat demand. This keeps the slab from overheating, so it operates more economically. For example, set the control at a 38°F slab temperature and a four-hour run cycle. To start the melting process, press the button on the control. Once the system reaches 38°F on the sensor, the timer begins. The heat plant continues to cycle and add heat, keeping the slab at 38°F. The snow-melting operation automatically ends after four hours.

A semi-automatic control strategy should incorporate an insulated slab to facilitate a quicker response. Additionally, if a high water table or moist soil condition is present, under-slab insulation with an R-value of at least 10 is mandatory. You must also install a tile system to drain moisture from beneath the heated slab.

The system performance may be dramatically affected if insulation is not installed under and along the slab. Once the system is off for a period of time, the ground will quickly freeze down to the current frost level. Subsequent start-up times will be delayed due to the amount of energy drawn to the frozen subsoil along with the requirements of the slab itself. The lack of insulation will result in increased response times, greater energy consumption, and in worst cases, a failure of the system to perform to specification.

Controls for Semi-Automatic Applications — Wirsbo offers two controls that support semi-automatic snow-melting applications — Wirsbo proMIX™ 212 and Wirsbo SYSTEMpro™ 311.

Wirsbo proMIX 212 — The Wirsbo proMIX 212 is a two-temperature injection control capable of supporting hydronic heating and snow-melting systems. This weather-responsive control uses outdoor reset to automatically adjust the mix loop fluid temperature. The first injection channel is used only for hydronic heating. The second injection channel is used for either hydronic heating or snow melting.

To provide fluid temperature control of a single zone snow-melting system, equip the proMIX 212 with a Slab Sensor (Wirsbo part number A3060072) and a Universal Sensor (Wirsbo part number A3060071). These sensors measure slab and return temperatures. They can be purchased separately or as a part of the Snow Melt Enable Kit (Wirsbo part number A3040039). The Snow Melt Enable Kit also includes the remote start/stop module.

The Snow Melt Enable Kit allows remote on/off control of the snow and ice melting system. The enable kit can be located up to 250 feet from the proMIX 212 control location. Connect the two controls with 18 AWG-2 wire. For more information on installation, programming and operation of the Wirsbo proMIX 212, refer to the Wirsbo proMIX 212 Installation Manual.

proMIX 212 (A3040212)

Snow Melt Enable Kit (A3040039)

proMIX 212 Operation — This control strategy is used for snow and ice melting systems that require manual on/off operations and/or timed operations. Control strategy and components should be installed to meet or exceed the system performance requirements as stated in the system design. Refer to the following sequence.

1. A variable speed injection pump, controlled by the Wirsbo proMIX 212, tempers the supply fluid temperature.

2. The proMIX 212 can reset the supply water temperature as it relates to outdoor temperature. Install the outdoor temperature sensor on the north side of the building out of direct sunlight.
3. The Wirsbo Snow Melt Enable Kit is designed to work specifically with the Wirsbo proMIX 212 for on/off and timed snow-melt operations.
4. The Enable Module from the Snow Melt Enable Kit allows remote access for on/off control and run time of the snow-melt system. Run time for the snow-melt system can also be programmed into the proMIX 212.
5. The run time is programmable from 30 minutes to 18 hours. Run time can be stopped any time through the Enable Module or the proMIX 212.
6. The proMIX 212 can idle the snow-melt slab at a given temperature and accelerate to a higher slab temperature during snow-melting mode.
7. The proMIX provides power to the system circulator (P2).
8. The proMIX 212 operates the variable speed injection pump (P5).
9. The proMIX 212 initiates the boiler call for heat.
10. For proper operation of the control, you must install the outdoor sensor (S4), the system supply sensor (S2), the boiler return sensor (S3), the snow-melt return sensor (S5) and the slab sensor (S7).
11. The proMIX 212 cannot sense moisture on the surface of the slab.
12. Refer to **Chapter 8** for piping and electrical schematics specific to this control strategy.

Wirsbo SYSTEMpro 311 — The Wirsbo SYSTEMpro 311 is a multi-temperature control capable of supporting hydronic heating and snow-melting systems along with single boiler reset. If required, the SYSTEMpro 311 also features Domestic Hot Water (DHW) priority, which is built into the control.

The first temperature channel on the SYSTEMpro 311 is used only for high temperature hydronic heating. The second temperature channel is used for either hydronic heating or snow melting. For snow-melt operations, Wirsbo recommends using variable speed injection mixing from the heat exchanger, rather than a floating action valve.

To provide fluid temperature control of a single-zone snow and ice melting system, the SYSTEMpro 311 must be equipped with a Slab Sensor (Wirsbo part number A3060072) and a Universal Sensor (Wirsbo part number A3060071). These sensors measure slab and return temperatures. They can be purchased separately or as a part of the Snow Melt Enable Kit (Wirsbo part number A3040039). The Snow Melt Enable Kit also includes the remote start/stop module.

The Snow Melt Enable Kit allows remote on/off control of the snow and ice melting system. The enable kit can be located up to 250 feet from the SYSTEMpro 311 control location. The two controls are connected with 18 AWG-2 wire. For more information on installation, programming and operation of the SYSTEMpro 311, refer to the Wirsbo SYSTEMpro 311 Installation Manual.

SYSTEMpro 311 (A3040311)

Snow Melt Enable Kit (A3040039)

SYSTEMpro 311 Operation — This control strategy is used for snow and ice melting systems that require manual on/off operations and/or timed operations. Control strategy and components should be installed to meet or exceed the system performance requirements as stated in the system design. Refer to the following sequence.

1. A variable speed injection pump, controlled by the Wirsbo SYSTEMpro 311, tempers the supply fluid temperature.
2. The SYSTEMpro 311 can reset the supply water temperature as it relates to outdoor temperature. Install the outdoor temperature sensor on the north side of the building out of direct sunlight.
3. The Wirsbo Snow Melt Enable Kit is designed to work specifically with the Wirsbo SYSTEMpro 311 for on/off and timed snow-melt operations.
4. The Enable Module from the Snow Melt Enable Kit allows remote access for on/off control and run time of the snow-melt system. Run time for the snow-melt system can also be programmed into the SYSTEMpro 311.
5. The run time is programmable from 30 minutes to 18 hours. Run time can be stopped any time through the Enable Module or the SYSTEMpro 311.

6. The SYSTEMpro 311 can idle the snow-melt slab at a given temperature and accelerate to a higher slab temperature during the snow-melting mode.
7. The SYSTEMpro 311 activates the system circulator (P1).
8. The SYSTEMpro 311 operates the variable speed injection pump (P4).
9. The SYSTEMpro 311 initiates the boiler call for heat.
10. The outdoor sensor (S4), the system supply sensor (S1), the boiler supply sensor (S3), the snow-melt return sensor (S5) and the slab sensor (S7) must be installed for proper operation of the control.
11. The SYSTEMpro 311 cannot sense moisture on the surface of the slab.
12. Refer to **Chapter 8** for piping and electrical schematics specific to this strategy.

Automatic

A fully automated system requires user input to program the control. Once powered up, the control takes over from there. Automatic controls eliminate human intervention to start and stop the snow- melting system. These systems incorporate a disk or sensor at the surface level of the snow-melting area. These types of sensors offer increased capabilities over conventional slab sensors. For example, they provide outdoor temperature feedback, current slab temperature and detect the presence of moisture (snow or ice at temperatures below 32°F). Most advanced automated controls provide snow and ice detection, the ability to idle the system (considered as a slab low limit) and react to outdoor ambient conditions. The ability to sense outdoor temperatures offers the option of locking out a heat demand when it is too warm or too cold. These features optimize fuel consumption. Conditions may exist where it is either too cold for snow to fall or too warm for snow to accumulate due to solar exposure.

There is a difference between idle setpoint temperature for the slab and the snow-melt setpoint temperature. To idle a slab under the automatic control strategy, maintain the slab at a setpoint temperature until activated by the control to accelerate into the snow-melt mode. The control then targets the snow-melt setpoint temperature as its new slab temperature. Supply fluid temperatures are adjusted by the mixing control to support this new, higher setpoint temperature.

Often the idling setpoint temperature is just under freezing (28 to 30°F). This allows the system to respond quicker to a call for snow melt than if the slab was allowed to cool down to ambient temperatures. At other times, the specification may require that the slab should not freeze. In this situation, the idle setpoint temperature is maintained above freezing (34 to 36°F). This setpoint is often used in Class 3 snow-melt applications or when the surface condition of the slab is critical, such as an emergency helipad.

An automatic control strategy should incorporate an insulated slab to facilitate a quicker response. Additionally, if a high water table or moist soil condition is present, under-slab insulation with an R-value of at least 10 is mandatory. You must also install a tile system to drain moisture away from beneath the heated slab.

The system performance may be dramatically affected if insulation is not installed under and along the slab. Once the system is off for a period of time, the ground will quickly freeze down to the current frost level. Subsequent start-up times will be delayed due to the amount of energy drawn to the frozen subsoil along with the requirements of the slab itself. The lack of insulation will result in increased response times, greater energy consumption, and in worst cases, a failure of the system to perform to specification.

Controls for Automatic Applications — Wirsbo offers one control that supports automatic snow-melting applications.

Wirsbo SNOWpro™ 411 — The SNOWpro 411, a fully automatic snow and ice melting control, responds to changing weather conditions. It offers one-temperature reset using a variable speed injection pump. The SNOWpro 411 can also provide boiler return water temperature protection, which otherwise could result in flue gas condensation and buildup. A boiler enable switch (not boiler reset) is used to turn on the boiler and boiler pump. Included with the SNOWpro 411 is a snow and ice detector. The detector senses the presence of moisture on the surface of the slab. It also monitors the slab temperature. For more information on installation, programming and operation of the SNOWpro 411, refer to the Wirsbo SNOWpro 411 Installation Manual.

SNOWpro 411 (A3040411)

Snow and Ice Detector (included)

SNOWpro 411 Operation — This control strategy is used for snow and ice melting systems that require total automatic control of idle and snow-melt operations. Control strategy and components should be installed to meet or exceed the system performance requirements as stated in the system design.

1. A variable speed injection pump, controlled by the Wirsbo SNOWpro 411, tempers the supply fluid temperature.
2. The Wirsbo Snow and Ice Detector monitors the presence of moisture on the sensor (snow-melt mode) and slab temperature.
3. The SNOWpro 411 resets the supply water temperature as it relates to outdoor temperature. Install the outdoor temperature sensor on the north side of the building out of direct sunlight.
4. The run time is programmable from 30 minutes to 17 hours. It can also be programmed to infinity as it will operate in snow-melt mode as long as there is moisture present on the sensor.
5. The SNOWpro 411 can idle the snow-melt slab at a given temperature and automatically accelerate to a higher supply fluid temperature during snow-melting mode.
6. The SNOWpro 411 automatically switches from snow-melt mode to idle mode once the snow and ice detector indicates the lack of moisture on the sensor.
7. The SNOWpro 411 activates the system circulator (P1).
8. The SNOWpro 411 activates the variable speed injection pump (P4).
9. The SNOWpro 411 initiates the boiler call for heat.
10. The SNOWpro 411 activates the boiler circulator (P3).
11. For proper operation of the control, you must install the outdoor sensor (S4), the system supply sensor (S1), the boiler return sensor (S3), the snow-melt return sensor (S5) and the snow and ice detector (S8).
12. The SNOWpro 411, through the snow and ice detector, can sense the presence of moisture on the surface of the slab.
13. Refer to **Chapter 8** for piping and electrical schematics specific to this strategy.

Summation

For the following control strategies, use the appropriate Wirsbo controls.

Constant Idle — proMIX 201 with the SetPoint 501s (note caution on **page 46**)

Semi-Automatic — proMIX 212 or SYSTEMpro 311 (both require Snow Melt Enable Kit)

Automatic — SNOWpro 411 (comes packaged with a snow and ice detector)

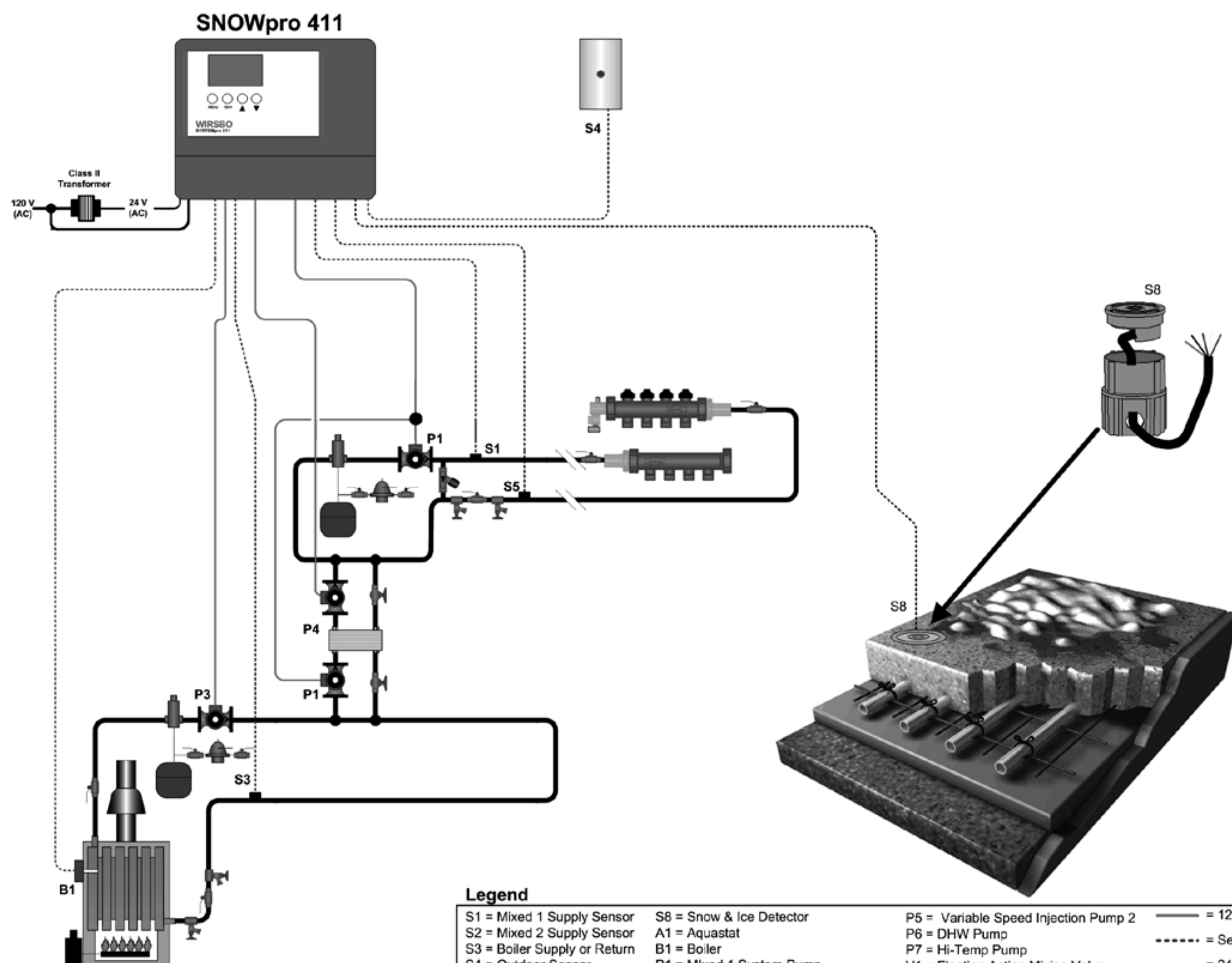
Chapter 8

Piping and Electrical Schematics

The boiler schematics outlined in this chapter are conceptual drawings, which illustrate the various piping and heat plant options available. Actual heating systems must be installed in accordance with the respective local codes.

Refer to the heat source manufacturer's installation and operation instructions for specific near boiler piping and operating parameters.

Application Drawing W411-1s | Bringing *comfort* to life | **WIRSBO** *Life, Safety, Comfort Systems* | Uponor | **Mechanical** Page 1 of 2



Legend

S1 = Mixed 1 Supply Sensor	S8 = Snow & Ice Detector	P5 = Variable Speed Injection Pump 2	—— = 120 V (AC)
S2 = Mixed 2 Supply Sensor	A1 = Aquastat	P6 = DHW Pump	------ = Sensor Wire
S3 = Boiler Supply or Return	B1 = Boiler	P7 = Hi-Temp Pump	------ = 24 V (AC)
S4 = Outdoor Sensor	P1 = Mixed 1 System Pump	V1 = Floating Action Mixing Valve	------ = T-stat Wire
S5 = Mixed Return Sensor	P2 = Mixed 2 System Pump	T = Thermostat or Heat Demand	—— = Misc.
S6 = DHW Sensor	P3 = Boiler Pump		
S7 = Slab Sensor	P4 = Variable Speed Injection Pump 1		

NOTE: This drawing is conceptual only, not an engineered drawing. It is up to the system designer to determine the necessary components for and configuration of the particular system designed, including additional equipment, isolation relays (for loads greater than the control's specified output ratings), and any safety devices which in the judgement of the designer are appropriate. Certain components may have been left out on this drawing for the purpose of clarity. Mechanical considerations such as tee spacing, flow control, pipe sizing and pump selection, is the responsibility of the installing contractor. Local codes and trade practices must be followed.

Symbols

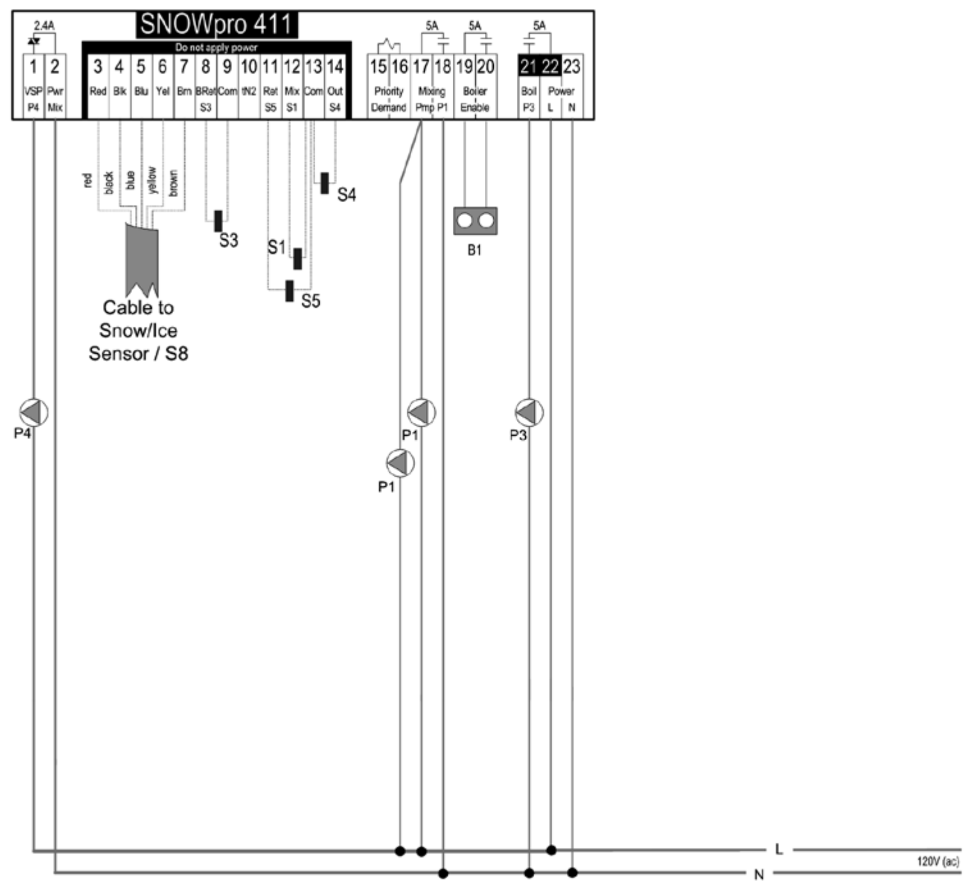
= Pump	= Air Separator & Expansion Tank w/ fill	= Zone Valve	= Ball Valve	= Flow Check	
= Floating Action Mixing Valve	= Tempering Valve	= Heat Exchanger	= Pressure By-Pass Valve	= Globe Valve	= Drain Valve

Project:

Uponor Wirsbo
5925 148th Street W.
Apple Valley, MN 55124
Phone: **1-800-321-4739**
Fax: 1-952-891-1409
www.wirsbo.com

Drawn by:	**Checked by:**
Rep:	**DATE:**

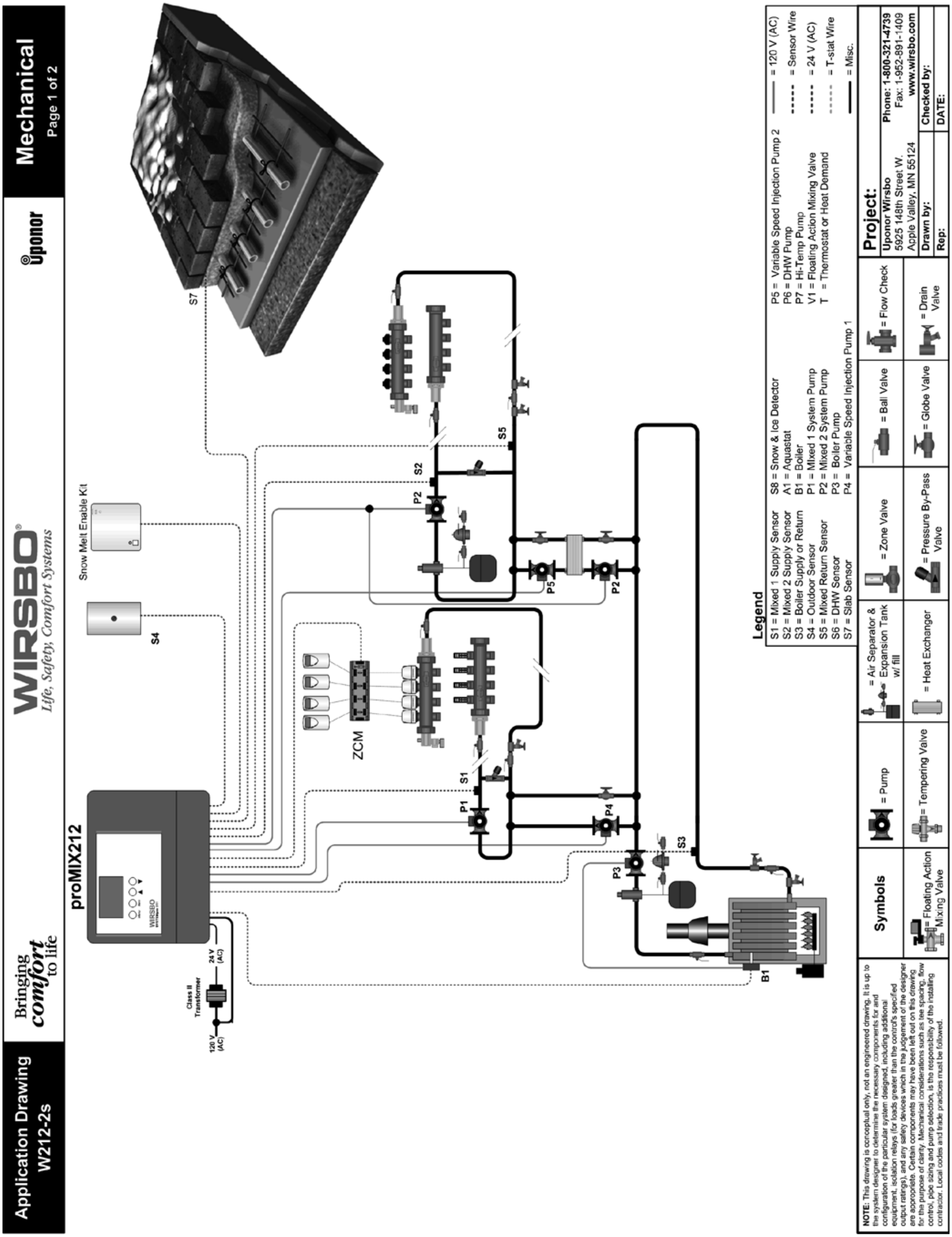
Application Drawing W411-1s	Bringing comfort to life	WIRSBO® Life, Safety, Comfort Systems	Uponor	Electrical Page 2 of 2



Legend

NOTE: This drawing is conceptual only, not an engineered drawing. It is up to the system designer to determine the necessary components for and configuration of the particular system designed, including additional equipment, isolation relays (for loads greater than the control's specified output ratings), and any safety devices which in the judgement of the designer are appropriate. Certain components may have been left out on this drawing for the purpose of clarity. Mechanical considerations such as tee spacing, flow control, pipe sizing and pump selection, is the responsibility of the installing contractor. Local codes and trade practices must be followed.	S1 = Mixed 1 Supply Sensor S2 = Mixed 2 Supply Sensor S3 = Boiler Supply or Return S4 = Outdoor Sensor S5 = Mixed Return Sensor S6 = DHW Sensor S7 = Slab Sensor	S8 = Snow & Ice Detector A1 = Aquastat B1 = Boiler P1 = Mixed 1 System Pump P2 = Mixed 2 System Pump P3 = Boiler Pump P4 = Variable Speed Injection Pump 1	P5 = Variable Speed Injection Pump 2 P6 = DHW Pump P7 = Hi-Temp Pump V1 = Floating Action Mixing Valve T = Thermostat or Heat Demand	—— = 120 V (AC) ----- = Sensor Wire ----- = 24 V (AC) ----- = T-stat Wire —— = Misc.

Project:	
Uponor Wirsbo 5925 148th Street W. Apple Valley, MN 55124	**Phone: 1-800-321-4739** Fax: 1-952-891-1409 **www.wirsbo.com**
Drawn by:	**Checked by:**
Rep:	**DATE:**


Application Drawing
W212-2s
Bringing comfort to life
WIRSBO
Life, Safety, Comfort Systems
Uponor
Mechanical
Page 1 of 2
proMIX212
Snow Melt Enable Kit
ZCM
Class II Transformer
120 V (AC)
24 V (AC)
Legend
S1 = Mixed 1 Supply Sensor
S2 = Mixed 2 Supply Sensor
S3 = Boiler Supply or Return
S4 = Outdoor Sensor
S5 = Mixed Return Sensor
S6 = DHW Sensor
S7 = Slab Sensor
S8 = Snow & Ice Detector
A1 = Aquastat
B1 = Boiler
P1 = Mixed 1 System Pump
P2 = Mixed 2 System Pump
P3 = Boiler Pump
P4 = Variable Speed Injection Pump 1
P5 = Variable Speed Injection Pump 2
P6 = DHW Pump
P7 = Hi-Temp Pump
V1 = Floating Action Mixing Valve
T = Thermostat or Heat Demand
= 120 V (AC)
= Sensor Wire
= 24 V (AC)
= T-stat Wire
= Misc.
Symbols
= Pump
= Air Separator & Expansion Tank w/ fill
= Zone Valve
= Ball Valve
= Flow Check
= Floating Action Mixing Valve
= Tempering Valve
= Heat Exchanger
= Pressure By-Pass Valve
= Globe Valve
= Drain Valve
Project:
Uponor Wirsbo
5925 148th Street W.
Apple Valley, MN 55124
Phone: 1-800-321-4739
Fax: 1-952-891-1409
www.wirsbo.com
Drawn by:
Checked by:
Rep:
DATE:

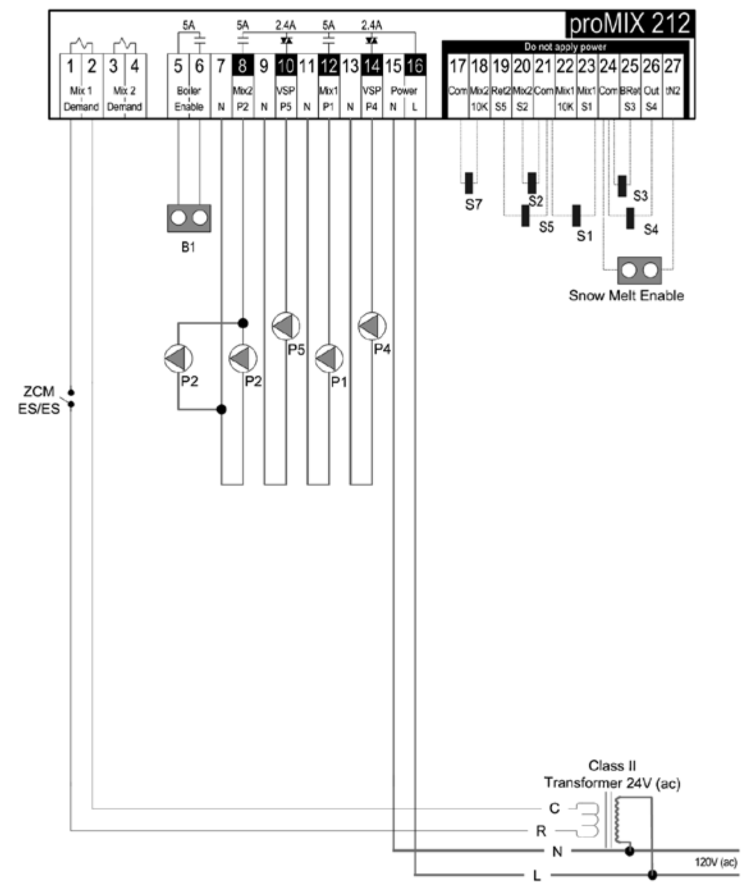
Application Drawing
W212-2s

Bringing comfort to life

WIRSBO®
Life, Safety, Comfort Systems

Uponor

Electrical
Page 2 of 2



Legend

NOTE: This drawing is conceptual only, not an engineered drawing. It is up to the system designer to determine the necessary components for and configuration of the particular system designed, including additional equipment, isolation relays (for loads greater than the control's specified output ratings), and any safety devices which in the judgement of the designer are appropriate. Certain components may have been left out on this drawing for the purpose of clarity. Mechanical considerations such as tee spacing, flow control, pipe sizing and pump selection, is the responsibility of the installing contractor. Local codes and trade practices must be followed.

S1 = Mixed 1 Supply Sensor
S2 = Mixed 2 Supply Sensor
S3 = Boiler Supply or Return
S4 = Outdoor Sensor
S5 = Mixed Return Sensor
S6 = DHW Sensor
S7 = Slab Sensor
S8 = Snow & Ice Detector
A1 = Aquastat
B1 = Boiler
P1 = Mixed 1 System Pump
P2 = Mixed 2 System Pump
P3 = Boiler Pump
P4 = Variable Speed Injection Pump 1
P5 = Variable Speed Injection Pump 2
P6 = DHW Pump
P7 = Hi-Temp Pump
V1 = Floating Action Mixing Valve
T = Thermostat or Heat Demand

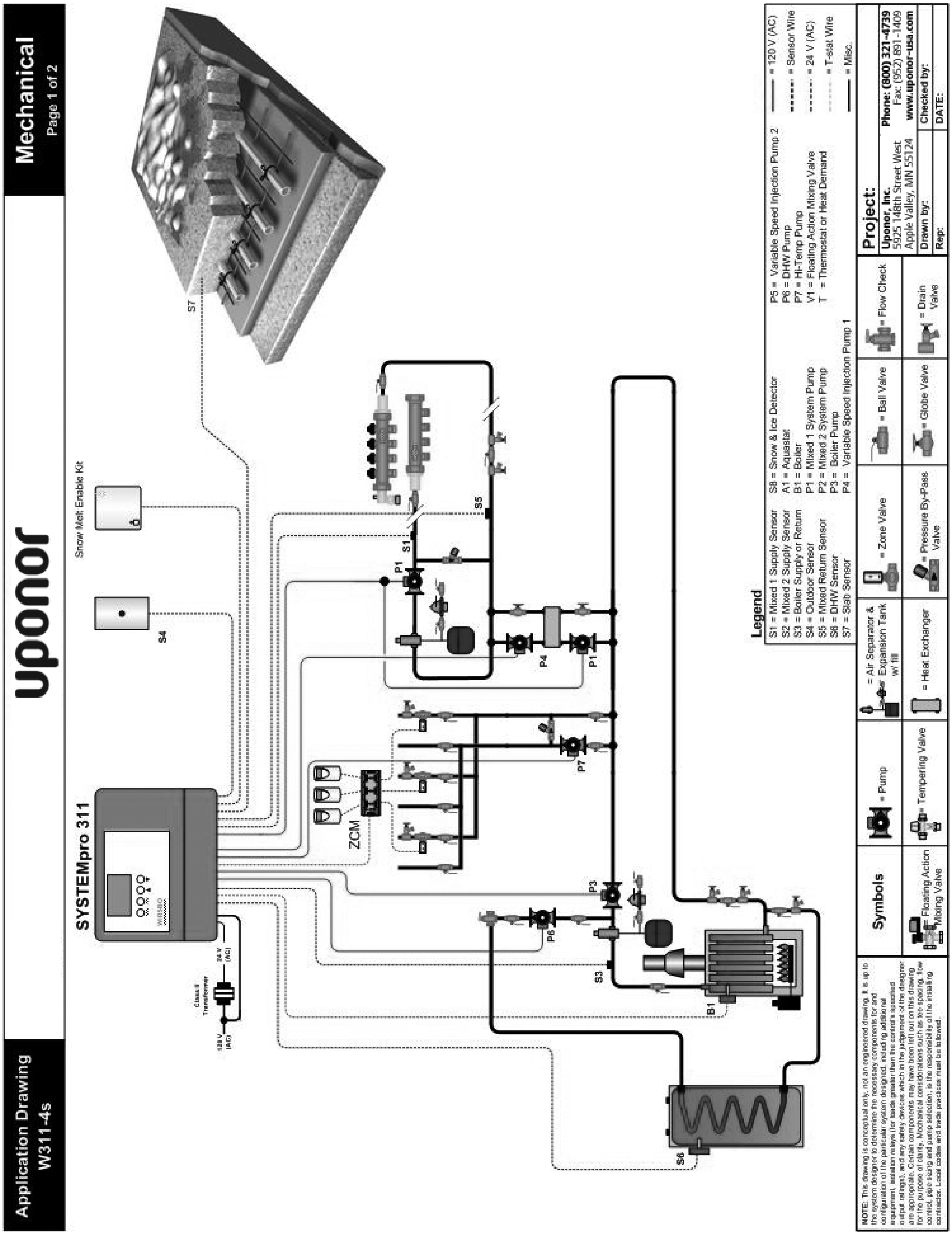
——— = 120 V (AC)
- - - - - = Sensor Wire
- - - - - = 24 V (AC)
- - - - - = T-stat Wire
——— = Misc.

Project:

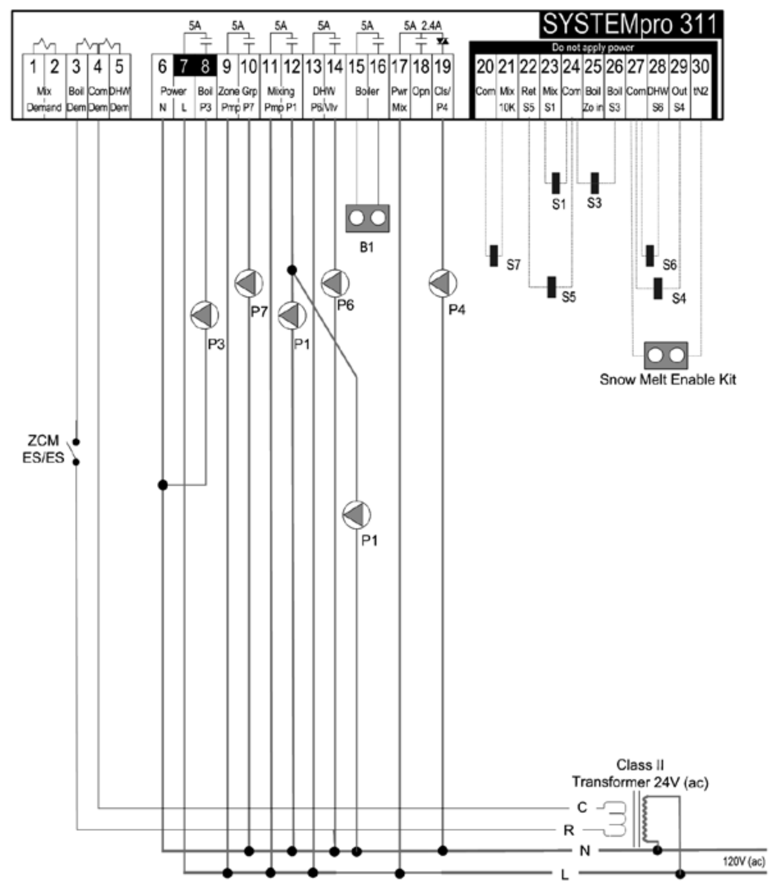
Uponor Wirsbo
5925 148th Street W.
Apple Valley, MN 55124

Phone: 1-800-321-4739
Fax: 1-952-891-1409
www.wirsbo.com

Drawn by:
Checked by:
Rep:
DATE:


Application Drawing
W311-4s
uponor
Mechanical
Page 1 of 2
SYSTEMpro 311
Snow Melt Enable Kit
ZCM
Legend
S1 = Mixed 1 Supply Sensor
S2 = Mixed 2 Supply Sensor
S3 = Boiler Supply or Return
S4 = Outdoor Sensor
S5 = Mixed Return Sensor
S6 = DHW Sensor
S7 = Slab Sensor
S8 = Snow & Ice Detector
A1 = Aquastat
B1 = Boiler
P1 = Mixed 1 System Pump
P2 = Mixed 2 System Pump
P3 = Boiler Pump
P4 = Variable Speed Injection Pump 1
P5 = Variable Speed Injection Pump 2
P6 = DHW Pump
P7 = Hi-Temp Pump
V1 = Floating Action Mixing Valve
T = Thermostat or Heat Demand
= 120 V (AC)
= Sensor Wire
= 24 V (AC)
= T-stat Wire
= Misc.
Symbols
= Floating Action Mixing Valve
= Pump
= Tempering Valve
= Air Separator & Expansion Tank w/ fill
= Heat Exchanger
= Zone Valve
= Pressure By-Pass Valve
= Ball Valve
= Globe Valve
= Flow Check
= Drain Valve
Project:
Uponor, Inc.
5925 148th Street West
Apple Valley, MN 55124
Phone: (800) 321-4739
Fax: (952) 891-1409
www.uponor-usa.com
Drawn by:
Checked by:
Rep:
DATE:

Application Drawing W311-4s	Bringing comfort to life	WIRSBO® Life, Safety, Comfort Systems	Uponor	Electrical Page 2 of 2



Legend

NOTE: This drawing is conceptual only, not an engineered drawing. It is up to the system designer to determine the necessary components for and configuration of the particular system designed, including additional equipment, isolation relays (for loads greater than the control's specified output ratings), and any safety devices which in the judgement of the designer are appropriate. Certain components may have been left out on this drawing for the purpose of clarity. Mechanical considerations such as tee spacing, flow control, pipe sizing and pump selection, is the responsibility of the installing contractor. Local codes and trade practices must be followed.

S1 = Mixed 1 Supply Sensor
S2 = Mixed 2 Supply Sensor
S3 = Boiler Supply or Return
S4 = Outdoor Sensor
S5 = Mixed Return Sensor
S6 = DHW Sensor
S7 = Slab Sensor
S8 = Snow & Ice Detector
A1 = Aquastat
B1 = Boiler
P1 = Mixed 1 System Pump
P2 = Mixed 2 System Pump
P3 = Boiler Pump
P4 = Variable Speed Injection Pump 1
P5 = Variable Speed Injection Pump 2
P6 = DHW Pump
P7 = Hi-Temp Pump
V1 = Floating Action Mixing Valve
T = Thermostat or Heat Demand

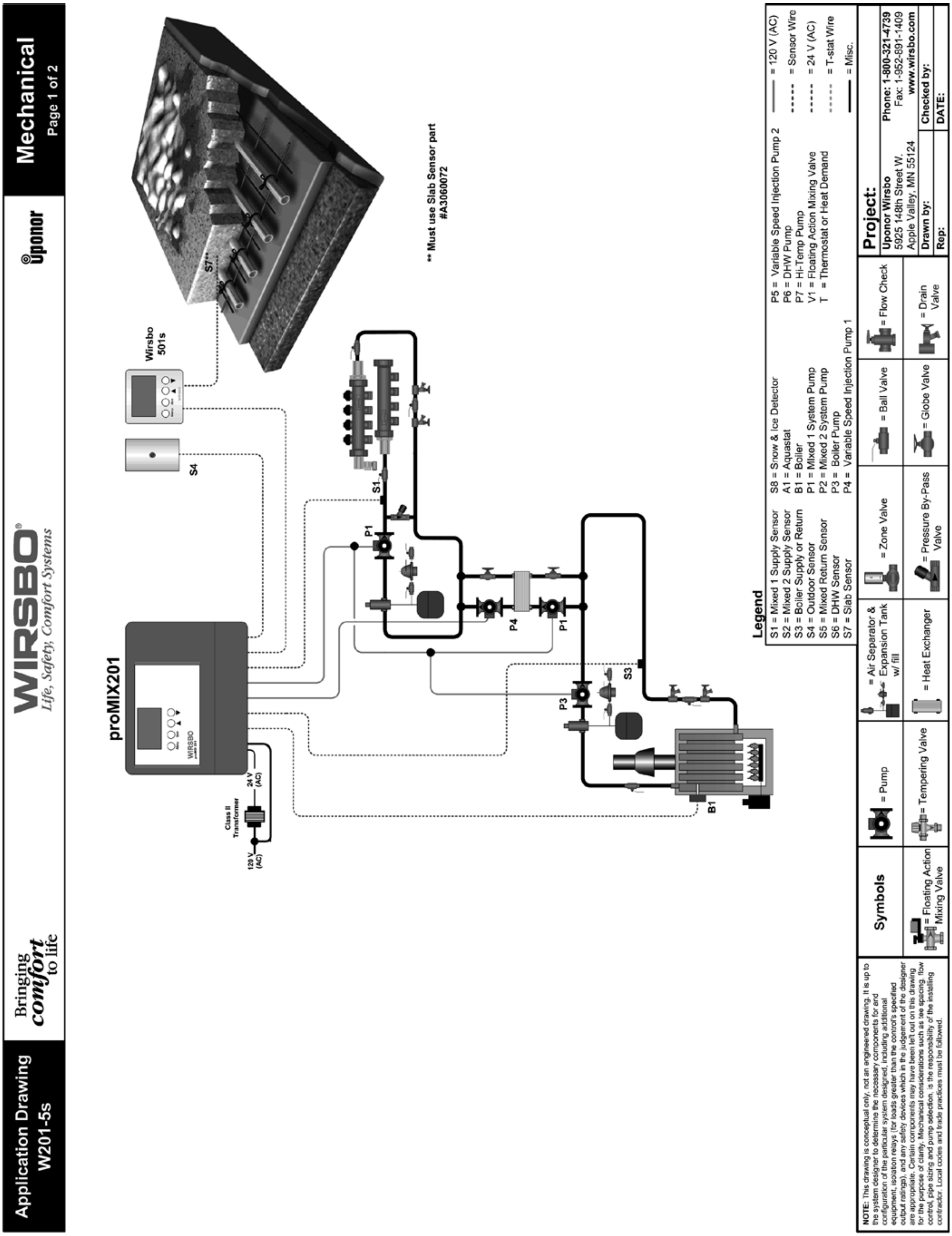
= 120 V (AC)
= Sensor Wire
= 24 V (AC)
= T-stat Wire
= Misc.

Project:

Uponor Wirsbo
5925 148th Street W.
Apple Valley, MN 55124

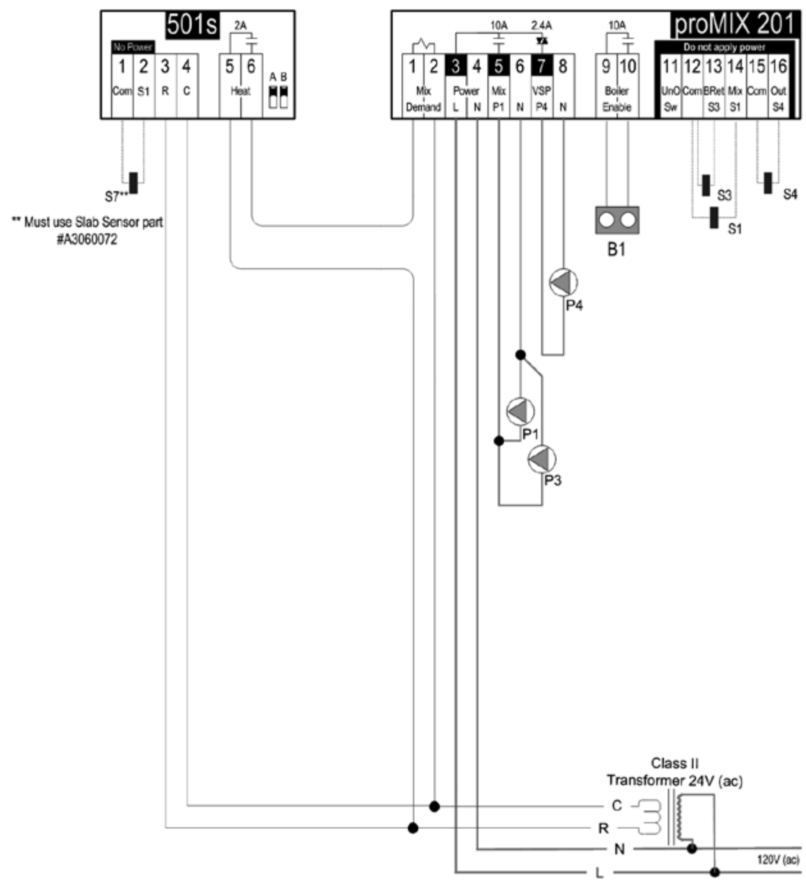
Phone: 1-800-321-4739
Fax: 1-952-891-1409
www.wirsbo.com

Drawn by:	**Checked by:**
Rep:	**DATE:**



Application Drawing
W201-5s
Bringing comfort to life
WIRSBO
Life, Safety, Comfort Systems
Uponor
Mechanical
Page 1 of 2
proMIX201
Class II Transformer
120 V (AC)
24 V (AC)
S4
Wirsbo 501s
S7**
** Must use Slab Sensor part #A3060072
S1
P1
P4
P1
S3
P3
B1
Legend
S1 = Mixed 1 Supply Sensor
S2 = Mixed 2 Supply Sensor
S3 = Boiler Supply or Return
S4 = Outdoor Sensor
S5 = Mixed Return Sensor
S6 = DHW Sensor
S7 = Slab Sensor
S8 = Snow & Ice Detector
A1 = Aquastat
B1 = Boiler
P1 = Mixed 1 System Pump
P2 = Mixed 2 System Pump
P3 = Boiler Pump
P4 = Variable Speed Injection Pump 1
P5 = Variable Speed Injection Pump 2
P6 = DHW Pump
P7 = Hi-Temp Pump
V1 = Floating Action Mixing Valve
T = Thermostat or Heat Demand
= 120 V (AC)
= Sensor Wire
= 24 V (AC)
= T-stat Wire
= Misc.
Symbols
= Floating Action Mixing Valve
= Pump
= Tempering Valve
= Air Separator & Expansion Tank w/ fill
= Heat Exchanger
= Zone Valve
= Pressure By-Pass Valve
= Ball Valve
= Globe Valve
= Flow Check
= Drain Valve
Project:
Uponor Wirsbo
5925 148th Street W.
Apple Valley, MN 55124
Phone: 1-800-321-4739
Fax: 1-952-891-1409
www.wirsbo.com
Drawn by:
Checked by:
Rep:
DATE:
NOTE: This drawing is conceptual only, not an engineered drawing. It is up to the system designer to determine the necessary components for and configuration of the particular system designed, including additional equipment, isolation relays (for loads greater than the control's specified output ratings), and any safety devices which in the judgement of the designer are appropriate. Certain components may have been left out on this drawing for the purpose of clarity. Mechanical considerations such as tee spacing, flow control, pipe sizing and pump selection, is the responsibility of the installing contractor. Local codes and trade practices must be followed.

Application Drawing W201-5s	Bringing comfort to life	WIRSBO® Life, Safety, Comfort Systems	Uponor	Electrical Page 2 of 2



Legend

NOTE: This drawing is conceptual only, not an engineered drawing. It is up to the system designer to determine the necessary components for and configuration of the particular system designed, including additional equipment, isolation relays (for loads greater than the control's specified output ratings), and any safety devices which in the judgement of the designer are appropriate. Certain components may have been left out on this drawing for the purpose of clarity. Mechanical considerations such as tee spacing, flow control, pipe sizing and pump selection, is the responsibility of the installing contractor. Local codes and trade practices must be followed.

S1 = Mixed 1 Supply Sensor
S2 = Mixed 2 Supply Sensor
S3 = Boiler Supply or Return
S4 = Outdoor Sensor
S5 = Mixed Return Sensor
S6 = DHW Sensor
S7 = Slab Sensor

S8 = Snow & Ice Detector
A1 = Aquastat
B1 = Boiler
P1 = Mixed 1 System Pump
P2 = Mixed 2 System Pump
P3 = Boiler Pump
P4 = Variable Speed Injection Pump 1

P5 = Variable Speed Injection Pump 2
P6 = DHW Pump
P7 = Hi-Temp Pump
V1 = Floating Action Mixing Valve
T = Thermostat or Heat Demand

——— = 120 V (AC)
- - - - = Sensor Wire
- - - - = 24 V (AC)
- - - - = T-stat Wire
——— = Misc.

Project:	
Uponor Wirsbo 5925 148th Street W. Apple Valley, MN 55124	**Phone: 1-800-321-4739** Fax: 1-952-891-1409 **www.wirsbo.com**
Drawn by:	**Checked by:**
Rep:	**DATE:**

Notes

Snow and Ice Melting Design Analysis Worksheet

Project Name: ______________________________ Location: ______________________________

Step 1a.	Design temperature	_______	°F
Step 1b.	Wind speed	_______	mph
Step 2.	Differential temperature	_______	°F
Step 3.	Surface temperature	_______	°F
Step 4.	BTU/h/ft^2 load	_______	BTU/h/ft^2
Step 5a.	Supply fluid temperature	_______	°F
Step 5b.	Tubing on-center (o.c.) distance	_______	inches
Step 6.	Area in square feet	_______	ft^2
Step 7.	Total BTU/h	_______	BTU/h
Step 8a.	Tubing type	_______	
Step 8b.	Tubing size	_______	inch
Step 9.	Total amount of tubing	_______	feet
Step 10a.	Active loop length	_______	feet
Step 10b.	Number of loops	_______	loops
Step 11a.	Leader length	_______	feet
Step 11b.	Total loop length	_______	feet
Step 12.	Percentage of glycol	_______	%
Step 13a.	Flow per foot of tubing	_______	gpm/ft
Step 13b.	Flow per loop	_______	gpm/loop
Step 14.	System flow	_______	gpm
Step 15a.	Head pressure drop per foot	_______	feet of head
Step 15b.	Head pressure drop/loop	_______	feet of head*

Refer to **Chapter 6** for instructions on how to complete this worksheet.

* The head pressure drop information is used only for the manifold. For proper pump sizing, add the amount of head pressure drop before and after the manifold location to this value.

Notes

Project Name: ____________________ **Manifold Number:** ______

		Loop 1	Loop 2	Loop 3	Loop 4	Loop 5	Loop 6	Loop 7	Loop 8	Loop 9	Loop 10
A	Design temperature (°F)										
B	Wind speed (mph)										
C	Differential temperature (°F)										
D	Surface temperature (°F)										
E	BTU/h/ft^2										
F	Supply fluid temperature (°F)										
G	Tubing o.c. distance										
H	Area to be heated (ft^2)										
I	Type of tubing										
J	Tubing size										
K	Active loop length										
L	Leader loop length										
M	Total loop length										
N	Percentage of glycol (%)										
O	Flow per foot										
P	Flow per loop (gpm)										
Q	Head pressure drop/ft (ft of hd)										
R	Head pressure drop/loop (ft of hd)										
S	Loop balancing turns										

Manifold Totals

T	Supply fluid temp. (°F)	
U	Manifold flow (gpm)	
V	Highest pressure head (ft)	

(Shaded cells) Do not exceed 8 loops per manifold when using the 1 1/4" brass manifold.

A Select the outdoor design temperature from **Appendix C**.
B Select the wind speed in mph from **Appendix C**.
C Enter the differential temperature (25°F).
D Select the desired surface temperature from **Appendix C**.
E Enter the BTU/h/ft^2 based on the climatic conditions and the surface temperature. Refer to **Appendix C**.
F Enter the supply fluid temperature from **Appendix C** based on the climatic conditions and value in row **G**.
G Enter the tubing on-center (o.c.) distance.
H Enter the square footage of area to be heated by this loop.
I Select the type of tubing to be used.
J Select the size of tubing to be used.
K Multiply the value in row **H** with the appropriate o.c. multiplier (6" = 2.0; 9" = 1.33; 12" = 1.0)
L Enter the distance from the slab area to the manifold x 2 (supply and return).
M Add rows **K** and **L** together.
N Enter the percentage of glycol/water solution to be used.
O Using the information in rows **E**, **G** and **N**, go to **Appendix C** and select the flow per foot.
P Multiply the value in row **K** by the value in row **O**.
Q Use the information in rows **F**, **I**, **J**, **N** and **P** with the appropriate Appendix (either **D** or **E**) to obtain the head pressure drop per foot.
R Multiply row **M** by the value in row **Q**.
S These cells are calculated after the design is completed. Use the balancing information for the respective manifold used as shown in **Chapter 3**.
T Enter the highest value from row **F**.
U Enter the total of all values from row **P**.
V Enter the highest value from row **R**.

Notes

This appendix is divided into two sections — Performance Charts and Flow Charts. This page is to assist you in interpreting the charts in order to complete the design.

The snow and ice melting design is based on climatic conditions and a desired slab surface temperature. Enter the Performance Chart at the appropriate climatic conditions (outdoor temperature and wind speed). Next select the desired slab surface temperature.

These two entries intersect in the cell showing the BTU/h/ft² and supply fluid temperatures for tubing installed at 6, 9 and 12 inches on center.

BTU/h/ft²

Outdoor Temp.	Wind Speed	Surface Temperatures 43°F			44°F			45°F		
15°F	[illegible]	**38**			[illegible]			**44**		
		94	[illegible]	121	96	110	125	98	[illegible]	128
	10 mph	**107**			**111**			**115**		
		107	125	143	109	128	148	113	132	152
10°F	0 mph	**78**			**81**			**84**		
		93	106	119	95	109	123	98	112	127
	5 mph	**94**			**97**			**100**		
		100	116	132	103	119	136	105	122	140
	10 mph	**126**			**130**			**134**		
		116	137	159	119	141	163	122	144	168
5°F	0 mph	**93**			**96**			**99**		
		100	115	132	102	118	136	105	122	139
	5 mph	**108**			**111**			**114**		
		107	125	143	109	128	148	112	131	152
	10 mph	**145**			**149**			**153**		
		125	150	175	128	153	179	131	156	184

Supply temperature for 6" on center

Supply temperature for 9" on center

Supply temperature for 12" on center

Supply fluid temperatures that exceed the maximum supply fluid temperature into concrete are shaded in gray and must not be used for design. In accordance with the Uniformed Building Code (UBC), the maximum temperature for concrete should not exceed 150°F.

Shaded areas = Exceeds design limits → 151

Outdoor Temp.	Wind Speed	Surface Temperatures 35°F			36°F			37°F			38°F		
25°F	**0 mph**	**19**			**21**			**24**			**26**		
		57	60	63	59	62	66	61	65	70	63	67	73
	5 mph	**28**			**31**			**34**			**37**		
		61	66	71	63	68	75	66	72	79	68	74	82
	10 mph	**38**			**42**			**46**			**50**		
		66	72	80	69	76	84	72	79	88	74	83	94
20°F	**0 mph**	**30**			**33**			**35**			**38**		
		62	67	73	64	69	76	66	71	79	68	75	81
	5 mph	**42**			**45**			**48**			**52**		
		67	74	83	69	77	85	72	80	89	75	83	93
	10 mph	**56**			**61**			**64**			**69**		
		74	83	94	77	87	99	79	90	103	83	94	107
15°F	**0 mph**	**41**			**45**			**48**			**51**		
		68	75	81	70	78	86	73	81	89	75	83	93
	5 mph	**56**			**59**			**62**			**65**		
		74	84	94	77	87	97	79	90	100	82	93	104
	10 mph	**76**			**79**			**84**			**87**		
		84	97	110	87	100	113	90	104	119	92	107	123
10°F	**0 mph**	**55**			**58**			**61**			**64**		
		74	83	93	76	86	96	79	89	100	81	92	103
	5 mph	**70**			**73**			**76**			**79**		
		81	93	106	84	96	108	86	99	112	88	102	116
	10 mph	**95**			**98**			**103**			**107**		
		93	109	126	96	112	129	99	116	135	102	120	139
5°F	**0 mph**	**69**			**72**			**75**			**77**		
		81	92	105	83	95	108	85	98	111	88	101	115
	5 mph	**84**			**88**			**90**			**93**		
		88	102	117	91	105	121	93	108	124	95	111	127
	10 mph	**114**			**118**			**121**			**126**		
		102	122	142	105	125	146	108	128	150	111	132	154
0°F	**0 mph**	**83**			**86**			**89**			**92**		
		87	101	116	90	104	120	92	107	122	95	110	126
	5 mph	**98**			**102**			**104**			**108**		
		95	111	129	97	114	133	100	117	135	102	120	139
	10 mph	**133**			**137**			**141**			**145**		
		112	134	157	114	137	162	117	141	166	120	144	170
-5°F	**0 mph**	**98**			**101**			**104**			**107**		
		95	111	128	97	114	132	99	117	135	102	120	139
	5 mph	**113**			**116**			**119**			**122**		
		102	121	141	104	123	145	107	127	147	109	129	151
	10 mph	**152**			**156**			**160**			**165**		
		120	146	172	124	150	177	126	153	182	129	156	186
-10°F	**0 mph**	**113**			**116**			**119**			**123**		
		102	121	141	104	124	145	107	127	147	110	130	151
	5 mph	**127**			**130**			**133**			**136**		
		109	130	152	111	133	156	114	136	159	116	139	162
	10 mph	**172**			**175**			**180**			**183**		
		130	159	190	133	162	194	136	166	198	139	169	202

Shaded areas = Exceeds design limits → 151

Surface Temperatures												Wind Speed	Outdoor Temp.
39°F			40°F			41°F			42°F				
	28			**31**			**33**			**36**		**0 mph**	**25°F**
65	70	76	67	72	79	70	75	82	72	78	85		
	40			**43**			**46**			**49**		**5 mph**	
71	77	85	73	80	90	76	83	92	78	86	95		
	53			**57**			**61**			**65**		**10 mph**	
77	86	96	80	89	100	83	93	104	86	97	109		
	40			**44**			**46**			**49**		**0 mph**	**20°F**
70	77	84	73	80	88	75	82	90	77	85	94		
	54			**57**			**62**			**64**		**5 mph**	
76	85	95	80	88	99	83	94	105	84	95	106		
	72			**77**			**84**			**86**		**10 mph**	
85	97	111	89	101	115	93	107	123	94	108	123		
	53			**56**			**59**			**61**		**0 mph**	**15°F**
77	86	95	79	89	97	82	91	102	84	94	104		
	68			**71**			**74**			**77**		**5 mph**	
84	95	107	87	99	112	89	101	115	91	104	117		
	91			**95**			**99**			**103**		**10 mph**	
95	110	126	98	114	131	101	118	135	104	121	140		
	67			**69**			**73**			**75**		**0 mph**	**10°F**
84	95	107	86	97	110	88	101	113	91	103	117		
	82			**85**			**88**			**91**		**5 mph**	
91	105	120	93	108	123	96	111	126	98	113	130		
	110			**115**			**118**			**122**		**10 mph**	
104	123	143	107	127	147	110	130	151	113	133	155		
	81			**83**			**87**			**90**		**0 mph**	**5°F**
90	104	118	92	106	123	95	110	125	98	113	127		
	96			**99**			**102**			**105**		**5 mph**	
98	114	130	100	117	134	102	120	138	105	122	140		
	129			**134**			**137**			**141**		**10 mph**	
114	135	158	117	139	164	119	143	167	122	146	171		
	95			**98**			**101**			**104**		**0 mph**	**0°F**
97	113	128	100	116	132	102	119	136	104	122	139		
	110			**113**			**116**			**119**		**5 mph**	
104	123	141	107	126	145	109	129	149	112	132	153		
	149			**152**			**157**			**160**		**10 mph**	
123	148	174	126	151	179	129	155	182	131	158	187		
	110			**113**			**116**			**119**		**0 mph**	**-5°F**
104	123	141	107	126	145	109	129	149	112	132	152		
	125			**127**			**131**			**133**		**5 mph**	
111	132	153	114	135	157	116	138	161	118	141	163		
	168			**172**			**176**			**180**		**10 mph**	
132	160	190	135	164	194	138	167	198	141	171	202		
	126			**129**			**132**			**135**		**0 mph**	**-10°F**
112	133	154	114	136	158	117	139	162	120	142	165		
	139			**142**			**145**			**148**		**5 mph**	
119	142	166	121	145	168	123	148	173	126	150	176		
	187			**191**			**195**			**199**		**10 mph**	
141	173	206	144	177	211	147	180	214	150	183	219		

Shaded areas = Exceeds design limits → 151

Outdoor Temp.	Wind Speed	Surface Temperatures 43°F			44°F			45°F		
25°F	0 mph		**38**			**41**			**44**	
		74	80	86	76	83	91	78	86	94
	5 mph		**52**			**55**			**58**	
		80	89	99	82	92	102	85	95	106
	10 mph		**69**			**73**			**77**	
		88	100	113	91	104	118	95	108	212
20°F	0 mph		**52**			**55**			**57**	
		80	89	99	82	91	102	83	93	104
	5 mph		**66**			**69**			**72**	
		86	97	110	88	100	113	91	103	117
	10 mph		**88**			**91**			**96**	
		96	110	128	98	114	131	103	120	137
15°F	0 mph		**65**			**67**			**70**	
		86	97	109	89	100	111	91	103	114
	5 mph		**80**			**83**			**86**	
		94	107	121	96	110	125	98	113	128
	10 mph		**107**			**111**			**115**	
		107	125	143	109	128	148	113	132	152
10°F	0 mph		**78**			**81**			**84**	
		93	106	119	95	109	123	98	112	127
	5 mph		**94**			**97**			**100**	
		100	116	132	103	119	136	105	122	140
	10 mph		**126**			**130**			**134**	
		116	137	159	119	141	163	122	144	168
5°F	0 mph		**93**			**96**			**99**	
		100	115	132	102	118	136	105	122	139
	5 mph		**108**			**111**			**114**	
		107	125	143	109	128	148	112	131	152
	10 mph		**145**			**149**			**153**	
		125	150	175	128	153	179	131	156	184
0°F	0 mph		**108**			**111**			**114**	
		107	125	145	110	128	147	112	131	151
	5 mph		**122**			**125**			**128**	
		114	134	157	117	138	160	119	140	163
	10 mph		**166**			**168**			**172**	
		134	162	193	137	166	196	140	169	201
-5°F	0 mph		**123**			**126**			**129**	
		114	135	157	117	138	157	119	141	164
	5 mph		**137**			**139**			**143**	
		121	144	168	123	147	171	126	150	174
	10 mph		**183**			**188**			**191**	
		143	174	207	146	178	212	149	181	216
-10°F	0 mph		**138**			**142**			**145**	
		122	145	169	125	142	174	128	152	177
	5 mph		**151**			**154**			**157**	
		129	154	181	130	156	183	133	159	169
	10 mph		**203**			**207**			**211**	
		153	187	224	156	190	228	159	194	231

Shaded areas = Exceeds design limits → 151

Flow Per Foot of Active Loop Length

Glycol Percentage									Load In BTU/h/ft^2
30% Glycol			40% Glycol			50% Glycol			
6" o.c.	9"o.c.	12" o.c.	6" o.c.	9"o.c.	12" o.c.	6" o.c.	9"o.c.	12" o.c.	
0.0008	0.0012	0.0017	0.0009	0.0013	0.0017	0.0009	0.0014	0.0018	**20**
0.0009	0.0014	0.0018	0.0009	0.0014	0.0019	0.0010	0.0015	0.0020	**22**
0.0010	0.0015	0.0020	0.0010	0.0015	0.0021	0.0011	0.0017	0.0022	**24**
0.0011	0.0016	0.0022	0.0011	0.0017	0.0022	0.0012	0.0018	0.0024	**26**
0.0012	0.0017	0.0023	0.0012	0.0018	0.0024	0.0013	0.0019	0.0026	**28**
0.0012	0.0019	0.0025	0.0013	0.0019	0.0026	0.0014	0.0021	0.0028	**30**
0.0013	0.0020	0.0027	0.0014	0.0021	0.0027	0.0015	0.0022	0.0029	**32**
0.0014	0.0021	0.0028	0.0015	0.0022	0.0029	0.0016	0.0023	0.0031	**34**
0.0015	0.0022	0.0030	0.0015	0.0023	0.0031	0.0017	0.0025	0.0033	**36**
0.0016	0.0024	0.0032	0.0016	0.0024	0.0033	0.0017	0.0026	0.0035	**38**
0.0017	0.0025	0.0033	0.0017	0.0026	0.0034	0.0018	0.0028	0.0037	**40**
0.0017	0.0026	0.0035	0.0018	0.0027	0.0036	0.0019	0.0029	0.0039	**42**
0.0018	0.0027	0.0037	0.0019	0.0028	0.0038	0.0020	0.0030	0.0040	**44**
0.0019	0.0029	0.0038	0.0020	0.0030	0.0039	0.0021	0.0032	0.0042	**46**
0.0020	0.0030	0.0040	0.0021	0.0031	0.0041	0.0022	0.0033	0.0044	**48**
0.0021	0.0031	0.0042	0.0021	0.0032	0.0043	0.0023	0.0034	0.0046	**50**
0.0022	0.0032	0.0043	0.0022	0.0033	0.0045	0.0024	0.0036	0.0048	**52**
0.0022	0.0034	0.0045	0.0023	0.0035	0.0046	0.0025	0.0037	0.0050	**54**
0.0023	0.0035	0.0047	0.0024	0.0036	0.0048	0.0026	0.0039	0.0051	**56**
0.0024	0.0036	0.0048	0.0025	0.0037	0.0050	0.0027	0.0040	0.0053	**58**
0.0025	0.0037	0.0050	0.0026	0.0039	0.0051	0.0028	0.0041	0.0055	**60**
0.0026	0.0039	0.0052	0.0027	0.0040	0.0053	0.0028	0.0043	0.0057	**62**
0.0027	0.0040	0.0053	0.0027	0.0041	0.0055	0.0029	0.0044	0.0059	**64**
0.0027	0.0041	0.0055	0.0028	0.0042	0.0057	0.0030	0.0045	0.0061	**66**
0.0028	0.0042	0.0057	0.0029	0.0044	0.0058	0.0031	0.0047	0.0062	**68**
0.0029	0.0044	0.0058	0.0030	0.0045	0.0060	0.0032	0.0048	0.0064	**70**
0.0030	0.0045	0.0060	0.0031	0.0046	0.0062	0.0033	0.0050	0.0066	**72**
0.0031	0.0046	0.0062	0.0032	0.0048	0.0063	0.0034	0.0051	0.0068	**74**
0.0032	0.0047	0.0063	0.0033	0.0049	0.0065	0.0035	0.0052	0.0070	**76**
0.0032	0.0049	0.0065	0.0033	0.0050	0.0067	0.0036	0.0054	0.0072	**78**
0.0033	0.0050	0.0067	0.0034	0.0051	0.0069	0.0037	0.0055	0.0073	**80**
0.0034	0.0051	0.0068	0.0035	0.0053	0.0070	0.0038	0.0056	0.0075	**82**
0.0035	0.0052	0.0070	0.0036	0.0054	0.0072	0.0039	0.0058	0.0077	**84**
0.0036	0.0054	0.0072	0.0037	0.0055	0.0074	0.0039	0.0059	0.0079	**86**
0.0037	0.0055	0.0073	0.0038	0.0057	0.0075	0.0040	0.0061	0.0081	**88**
0.0037	0.0056	0.0075	0.0039	0.0058	0.0077	0.0041	0.0062	0.0083	**90**
0.0038	0.0057	0.0077	0.0039	0.0059	0.0079	0.0042	0.0063	0.0084	**92**
0.0039	0.0059	0.0078	0.0040	0.0060	0.0081	0.0043	0.0065	0.0086	**94**
0.0040	0.0060	0.0080	0.0041	0.0062	0.0082	0.0044	0.0066	0.0088	**96**
0.0041	0.0061	0.0082	0.0042	0.0063	0.0084	0.0045	0.0068	0.0090	**98**

To calculate flow for a given loop:

1. Select the BTU/h/ft^2 load that was determined from the Performance Charts in this Appendix.
2. Select the percentage of glycol mix in the snow and ice melting system.
3. Within the glycol percentage column, select the on-center (o.c.) distance for the installed tubing.
4. Move horizontally from the BTU/h/ft^2 load toward the applicable o.c. column.
5. Where these lines intersect is the flow per foot of active loop.
6. Multiply the flow per loop value by the length of active loop within the total loop to obtain the flow for the loop.

Example:

1. A snow and ice melting system designed for 0°F with a 10-mph wind with a 38°F surface temperature. The load is 145 BTU/h/ft^2.
2. Enter the flow charts at 146 BTU/h/ft^2 (round up from 145 in step 1). Then move across to the 40% glycol with the tubing at 9" o.c.
3. Flow per foot is 0.0094 gpm. If the active loop is 200' of a total loop of 245', multiply 0.0094 by 200 = 1.88 gpm per loop.

Flow Per Foot of Active Loop Length

Load In BTU/h/ft^2	Glycol Percentage								
	30% Glycol			40% Glycol			50% Glycol		
	6" o.c.	9"o.c.	12" o.c.	6" o.c.	9"o.c.	12" o.c.	6" o.c.	9"o.c.	12" o.c.
100	0.0042	0.0062	0.0083	0.0043	0.0064	0.0086	0.0046	0.0069	0.0092
102	0.0042	0.0064	0.0085	0.0044	0.0066	0.0087	0.0047	0.0070	0.0094
104	0.0043	0.0065	0.0087	0.0045	0.0067	0.0089	0.0048	0.0072	0.0096
106	0.0044	0.0066	0.0088	0.0045	0.0068	0.0091	0.0049	0.0073	0.0097
108	0.0045	0.0067	0.0090	0.0046	0.0069	0.0092	0.0050	0.0074	0.0099
110	0.0046	0.0069	0.0092	0.0047	0.0071	0.0094	0.0051	0.0076	0.0101
112	0.0047	0.0070	0.0093	0.0048	0.0072	0.0096	0.0051	0.0077	0.0103
114	0.0047	0.0071	0.0095	0.0049	0.0073	0.0098	0.0052	0.0079	0.0105
116	0.0048	0.0072	0.0097	0.0050	0.0075	0.0099	0.0053	0.0080	0.0107
118	0.0049	0.0074	0.0098	0.0051	0.0076	0.0101	0.0054	0.0081	0.0108
120	0.0050	0.0075	0.0100	0.0051	0.0077	0.0103	0.0055	0.0083	0.0110
122	0.0051	0.0076	0.0102	0.0052	0.0078	0.0104	0.0056	0.0084	0.0112
124	0.0052	0.0077	0.0103	0.0053	0.0080	0.0106	0.0057	0.0085	0.0114
126	0.0052	0.0079	0.0105	0.0054	0.0081	0.0108	0.0058	0.0087	0.0116
128	0.0053	0.0080	0.0107	0.0055	0.0082	0.0110	0.0059	0.0088	0.0118
130	0.0054	0.0081	0.0108	0.0056	0.0083	0.0111	0.0060	0.0090	0.0119
132	0.0055	0.0082	0.0110	0.0057	0.0085	0.0113	0.0061	0.0091	0.0121
134	0.0056	0.0084	0.0112	0.0057	0.0086	0.0115	0.0062	0.0092	0.0123
136	0.0057	0.0085	0.0113	0.0058	0.0087	0.0116	0.0062	0.0094	0.0125
138	0.0058	0.0087	0.0116	0.0060	0.0089	0.0119	0.0064	0.0096	0.0128
140	0.0058	0.0087	0.0117	0.0060	0.0090	0.0120	0.0064	0.0096	0.0129
142	0.0059	0.0089	0.0118	0.0061	0.0091	0.0122	0.0065	0.0098	0.0130
144	0.0060	0.0090	0.0120	0.0062	0.0092	0.0123	0.0066	0.0099	0.0132
146	0.0061	0.0091	0.0122	0.0063	0.0094	0.0125	0.0067	0.0101	0.0134
148	0.0062	0.0092	0.0123	0.0063	0.0095	0.0127	0.0068	0.0102	0.0136
150	0.0062	0.0094	0.0125	0.0064	0.0096	0.0128	0.0069	0.0103	0.0138
152	0.0063	0.0095	0.0127	0.0065	0.0098	0.0130	0.0070	0.0105	0.0140
154	0.0064	0.0096	0.0128	0.0066	0.0099	0.0132	0.0071	0.0106	0.0141
156	0.0065	0.0097	0.0130	0.0067	0.0100	0.0134	0.0072	0.0107	0.0143
158	0.0066	0.0099	0.0132	0.0068	0.0101	0.0135	0.0073	0.0109	0.0145
160	0.0067	0.0100	0.0133	0.0069	0.0103	0.0137	0.0073	0.0110	0.0147
162	0.0067	0.0101	0.0135	0.0069	0.0104	0.0139	0.0074	0.0112	0.0149
164	0.0068	0.0102	0.0137	0.0070	0.0105	0.0140	0.0075	0.0113	0.0151
166	0.0069	0.0104	0.0138	0.0071	0.0107	0.0142	0.0076	0.0114	0.0152
168	0.0070	0.0105	0.0140	0.0072	0.0108	0.0144	0.0077	0.0116	0.0154
170	0.0071	0.0106	0.0142	0.0073	0.0109	0.0146	0.0078	0.0117	0.0156
172	0.0072	0.0107	0.0143	0.0074	0.0110	0.0147	0.0079	0.0118	0.0158
174	0.0072	0.0109	0.0145	0.0075	0.0112	0.0149	0.0080	0.0120	0.0160
176	0.0073	0.0110	0.0147	0.0075	0.0113	0.0151	0.0081	0.0121	0.0162
178	0.0074	0.0111	0.0148	0.0076	0.0114	0.0152	0.0082	0.0123	0.0163

Flow Per Foot of Active Loop Length

Glycol Percentage									Load
30% Glycol			40% Glycol			50% Glycol			In
6" o.c.	9"o.c.	12" o.c.	6" o.c.	9"o.c.	12" o.c.	6" o.c.	9"o.c.	12" o.c.	BTU/h/ft^2
0.0075	0.0112	0.0150	0.0077	0.0116	0.0154	0.0083	0.0124	0.0165	**180**
0.0076	0.0114	0.0152	0.0078	0.0117	0.0156	0.0084	0.0125	0.0167	**182**
0.0077	0.0115	0.0153	0.0079	0.0118	0.0158	0.0084	0.0127	0.0169	**184**
0.0077	0.0116	0.0155	0.0080	0.0119	0.0159	0.0085	0.0128	0.0171	**186**
0.0078	0.0117	0.0157	0.0081	0.0121	0.0161	0.0086	0.0129	0.0173	**188**
0.0079	0.0119	0.0158	0.0081	0.0122	0.0163	0.0087	0.0131	0.0174	**190**
0.0080	0.0120	0.0160	0.0082	0.0123	0.0164	0.0088	0.0132	0.0176	**192**
0.0081	0.0121	0.0162	0.0083	0.0125	0.0166	0.0089	0.0134	0.0178	**194**
0.0082	0.0122	0.0163	0.0084	0.0126	0.0168	0.0090	0.0135	0.0180	**196**
0.0082	0.0124	0.0165	0.0085	0.0127	0.0170	0.0091	0.0136	0.0182	**198**
0.0083	0.0125	0.0167	0.0086	0.0128	0.0171	0.0092	0.0138	0.0184	**200**
0.0084	0.0126	0.0168	0.0086	0.0130	0.0173	0.0093	0.0139	0.0186	**202**
0.0085	0.0127	0.0170	0.0087	0.0131	0.0175	0.0094	0.0141	0.0187	**204**
0.0086	0.0129	0.0172	0.0088	0.0132	0.0176	0.0095	0.0142	0.0189	**206**
0.0087	0.0130	0.0173	0.0089	0.0134	0.0178	0.0096	0.0143	0.0191	**208**
0.0087	0.0131	0.0175	0.0090	0.0135	0.0180	0.0096	0.0145	0.0193	**210**
0.0088	0.0132	0.0177	0.0091	0.0136	0.0182	0.0097	0.0146	0.0195	**212**
0.0089	0.0134	0.0178	0.0092	0.0137	0.0183	0.0098	0.0147	0.0197	**214**
0.0090	0.0135	0.0180	0.0092	0.0139	0.0185	0.0099	0.0149	0.0198	**216**
0.0091	0.0136	0.0182	0.0093	0.0140	0.0187	0.0100	0.0150	0.0200	**218**
0.0092	0.0137	0.0183	0.0094	0.0141	0.0188	0.0101	0.0152	0.0202	**220**
0.0092	0.0139	0.0185	0.0095	0.0143	0.0190	0.0102	0.0153	0.0204	**222**
0.0093	0.0140	0.0187	0.0096	0.0144	0.0192	0.0103	0.0154	0.0206	**224**
0.0094	0.0141	0.0188	0.0097	0.0145	0.0194	0.0104	0.0156	0.0208	**226**
0.0095	0.0142	0.0190	0.0098	0.0146	0.0195	0.0105	0.0157	0.0209	**228**
0.0096	0.0144	0.0192	0.0098	0.0148	0.0197	0.0106	0.0158	0.0211	**230**
0.0097	0.0145	0.0193	0.0099	0.0149	0.0199	0.0107	0.0160	0.0213	**232**
0.0097	0.0146	0.0195	0.0100	0.0150	0.0200	0.0107	0.0161	0.0215	**234**
0.0098	0.0147	0.0197	0.0101	0.0152	0.0202	0.0108	0.0163	0.0217	**236**
0.0099	0.0149	0.0198	0.0102	0.0153	0.0204	0.0109	0.0164	0.0219	**238**
0.0100	0.0150	0.0200	0.0103	0.0154	0.0206	0.0110	0.0165	0.0220	**240**
0.0101	0.0151	0.0202	0.0104	0.0155	0.0207	0.0111	0.0167	0.0222	**242**
0.0102	0.0152	0.0203	0.0104	0.0157	0.0209	0.0112	0.0168	0.0224	**244**
0.0102	0.0154	0.0205	0.0105	0.0158	0.0211	0.0113	0.0169	0.0226	**246**
0.0103	0.0155	0.0207	0.0106	0.0159	0.0212	0.0114	0.0171	0.0228	**248**
0.0104	0.0156	0.0208	0.0107	0.0161	0.0214	0.0115	0.0172	0.0230	**250**
0.0105	0.0157	0.0210	0.0108	0.0162	0.0216	0.0116	0.0174	0.0231	**252**
0.0106	0.0159	0.0212	0.0109	0.0163	0.0218	0.0117	0.0175	0.0233	**254**
0.0107	0.0160	0.0213	0.0110	0.0164	0.0219	0.0118	0.0176	0.0235	**256**
0.0107	0.0161	0.0215	0.0110	0.0166	0.0221	0.0118	0.0178	0.0237	**258**

Notes

30% Glycol / Water Solution

PRESSURE LOSS PER FOOT
5/8" hePEX plus and AQUAPEX

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.1	0.00032	0.00030	0.00028	0.00026	0.00025	0.00024
0.2	0.00109	0.00103	0.00095	0.00090	0.00086	0.00083
0.3	0.00224	0.00212	0.00195	0.00186	0.00176	0.00170
0.4	0.00373	0.00353	0.00326	0.00311	0.00295	0.00285
0.5	0.00555	0.00525	0.00485	0.00463	0.00439	0.00424
0.6	0.00768	0.00727	0.00671	0.00641	0.00608	0.00587
0.7	0.01011	0.00957	0.00883	0.00844	0.00800	0.00773
0.8	0.01283	0.01214	0.01121	0.01071	0.01016	0.00981
0.9	0.01582	0.01498	0.01383	0.01322	0.01254	0.01211
1.0	0.01909	0.01808	0.01670	0.01596	0.01513	0.01462
1.1	0.02263	0.02143	0.01979	0.01892	0.01795	0.01734
1.2	0.02643	0.02503	0.02312	0.02211	0.02097	0.02026
1.3	0.03049	0.02887	0.02668	0.02551	0.02420	0.02338
1.4	0.03480	0.03296	0.03046	0.02912	0.02763	0.02669
1.5	0.03936	0.03728	0.03446	0.03295	0.03126	0.03021
1.6	0.04416	0.04184	0.03867	0.03698	0.03509	0.03391
1.7	0.04921	0.04663	0.04310	0.04122	0.03911	0.03780
1.8	0.05450	0.05164	0.04774	0.04566	0.04333	0.04187
1.9	0.06003	0.05688	0.05259	0.05030	0.04774	0.04613
2.0	0.06579	0.06234	0.05765	0.05513	0.05233	0.05058
2.1	0.07178	0.06802	0.06291	0.06017	0.05711	0.05520
2.2	0.07800	0.07392	0.06837	0.06539	0.06208	0.06000
2.3	0.08445	0.08004	0.07403	0.07081	0.06723	0.06498
2.4	0.09113	0.08637	0.07989	0.07642	0.07256	0.07013
2.5	0.09803	0.09291	0.08595	0.08222	0.07807	0.07546
2.6	0.10515	0.09967	0.09221	0.08821	0.08376	0.08096
2.7	0.11249	0.10663	0.09865	0.09438	0.08962	0.08663
2.8	0.12004	0.11380	0.10530	0.10074	0.09566	0.09248
2.9	0.12782	0.12117	0.11213	0.10728	0.10188	0.09849
3.0	0.13581	0.12875	0.11915	0.11400	0.10827	0.10467
3.1	0.14401	0.13654	0.12636	0.12091	0.11483	0.11102
3.2	0.15243	0.14452	0.13376	0.12799	0.12156	0.11753
3.3	0.16106	0.15271	0.14134	0.13525	0.12847	0.12420
3.4	0.16989	0.16109	0.14911	0.14269	0.13554	0.13105
3.5	0.17894	0.16967	0.15707	0.15031	0.14278	0.13805
3.6	0.18819	0.17845	0.16520	0.15810	0.15019	0.14521
3.7	0.19765	0.18743	0.17352	0.16607	0.15776	0.15254
3.8	0.20731	0.19660	0.18202	0.17421	0.16550	0.16003
3.9	0.21718	0.20596	0.19070	0.18252	0.17340	0.16767
4.0	0.22725	0.21552	0.19956	0.19101	0.18147	0.17548

PRESSURE LOSS PER FOOT
3/4" hePEX plus and AQUAPEX

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.5	0.00263	0.00249	0.00230	0.00219	0.00208	0.00201
0.6	0.00364	0.00345	0.00318	0.00304	0.00288	0.00278
0.7	0.00479	0.00453	0.00419	0.00400	0.00379	0.00366
0.8	0.00608	0.00575	0.00531	0.00507	0.00481	0.00465
0.9	0.00750	0.00710	0.00655	0.00626	0.00594	0.00573
1.0	0.00905	0.00857	0.00791	0.00756	0.00717	0.00692
1.1	0.01072	0.01015	0.00938	0.00896	0.00850	0.00821
1.2	0.01252	0.01186	0.01095	0.01047	0.00993	0.00959
1.3	0.01444	0.01368	0.01264	0.01208	0.01146	0.01107
1.4	0.01649	0.01561	0.01442	0.01379	0.01308	0.01264
1.5	0.01865	0.01766	0.01632	0.01560	0.01480	0.01430
1.6	0.02092	0.01982	0.01831	0.01751	0.01661	0.01605
1.7	0.02331	0.02208	0.02041	0.01951	0.01851	0.01789
1.8	0.02582	0.02446	0.02260	0.02161	0.02051	0.01982
1.9	0.02843	0.02694	0.02490	0.02381	0.02259	0.02183
2.0	0.03116	0.02952	0.02729	0.02610	0.02477	0.02393
2.1	0.03400	0.03221	0.02978	0.02848	0.02703	0.02612
2.2	0.03694	0.03500	0.03236	0.03095	0.02938	0.02839
2.3	0.04000	0.03790	0.03504	0.03352	0.03181	0.03074
2.4	0.04316	0.04089	0.03782	0.03617	0.03433	0.03318
2.5	0.04642	0.04399	0.04068	0.03891	0.03694	0.03570
2.6	0.04979	0.04719	0.04364	0.04174	0.03963	0.03830
2.7	0.05327	0.05048	0.04669	0.04466	0.04240	0.04098
2.8	0.05684	0.05387	0.04983	0.04767	0.04526	0.04375
2.9	0.06052	0.05736	0.05307	0.05076	0.04820	0.04659
3.0	0.06430	0.06095	0.05639	0.05394	0.05122	0.04951
3.1	0.06819	0.06463	0.05980	0.05721	0.05432	0.05251
3.2	0.07217	0.06841	0.06330	0.06056	0.05750	0.05559
3.3	0.07625	0.07228	0.06688	0.06399	0.06077	0.05874
3.4	0.08043	0.07625	0.07056	0.06751	0.06411	0.06198
3.5	0.08471	0.08031	0.07432	0.07111	0.06753	0.06529
3.6	0.08909	0.08447	0.07817	0.07480	0.07104	0.06868
3.7	0.09357	0.08871	0.08210	0.07856	0.07462	0.07214
3.8	0.09814	0.09305	0.08612	0.08241	0.07827	0.07568
3.9	0.10281	0.09748	0.09023	0.08634	0.08201	0.07929
4.0	0.10757	0.10200	0.09442	0.09035	0.08582	0.08298
4.1	0.11243	0.10661	0.09869	0.09445	0.08971	0.08674
4.2	0.11739	0.11131	0.10305	0.09862	0.09368	0.09058
4.3	0.12244	0.11610	0.10749	0.10287	0.09772	0.09449
4.4	0.12758	0.12099	0.11201	0.10720	0.10184	0.09847
4.5	0.13282	0.12596	0.11662	0.11161	0.10604	0.10253
4.6	0.13814	0.13101	0.12131	0.11610	0.11031	0.10666
4.7	0.14357	0.13616	0.12608	0.12067	0.11465	0.11086
4.8	0.14908	0.14139	0.13093	0.12532	0.11907	0.11514
4.9	0.15469	0.14672	0.13587	0.13005	0.12356	0.11949
5.0	0.16039	0.15212	0.14088	0.13485	0.12813	0.12391
5.1	0.16618	0.15762	0.14598	0.13973	0.13277	0.12840
5.2	0.17206	0.16320	0.15115	0.14469	0.13749	0.13296
5.3	0.17803	0.16887	0.15641	0.14972	0.14227	0.13759
5.4	0.18409	0.17462	0.16174	0.15483	0.14713	0.14229
5.5	0.19024	0.18046	0.16716	0.16002	0.15207	0.14707

30% Glycol / Water Solution

PRESSURE LOSS PER FOOT
5/8" hePEX plus and AQUAPEX

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.1	0.00032	0.00030	0.00028	0.00026	0.00025	0.00024
0.2	0.00109	0.00103	0.00095	0.00090	0.00086	0.00083
0.3	0.00224	0.00212	0.00195	0.00186	0.00176	0.00170
0.4	0.00373	0.00353	0.00326	0.00311	0.00295	0.00285
0.5	0.00555	0.00525	0.00485	0.00463	0.00439	0.00424
0.6	0.00768	0.00727	0.00671	0.00641	0.00608	0.00587
0.7	0.01011	0.00957	0.00883	0.00844	0.00800	0.00773
0.8	0.01283	0.01214	0.01121	0.01071	0.01016	0.00981
0.9	0.01582	0.01498	0.01383	0.01322	0.01254	0.01211
1.0	0.01909	0.01808	0.01670	0.01596	0.01513	0.01462
1.1	0.02263	0.02143	0.01979	0.01892	0.01795	0.01734
1.2	0.02643	0.02503	0.02312	0.02211	0.02097	0.02026
1.3	0.03049	0.02887	0.02668	0.02551	0.02420	0.02338
1.4	0.03480	0.03296	0.03046	0.02912	0.02763	0.02669
1.5	0.03936	0.03728	0.03446	0.03295	0.03126	0.03021
1.6	0.04416	0.04184	0.03867	0.03698	0.03509	0.03391
1.7	0.04921	0.04663	0.04310	0.04122	0.03911	0.03780
1.8	0.05450	0.05164	0.04774	0.04566	0.04333	0.04187
1.9	0.06003	0.05688	0.05259	0.05030	0.04774	0.04613
2.0	0.06579	0.06234	0.05765	0.05513	0.05233	0.05058
2.1	0.07178	0.06802	0.06291	0.06017	0.05711	0.05520
2.2	0.07800	0.07392	0.06837	0.06539	0.06208	0.06000
2.3	0.08445	0.08004	0.07403	0.07081	0.06723	0.06498
2.4	0.09113	0.08637	0.07989	0.07642	0.07256	0.07013
2.5	0.09803	0.09291	0.08595	0.08222	0.07807	0.07546
2.6	0.10515	0.09967	0.09221	0.08821	0.08376	0.08096
2.7	0.11249	0.10663	0.09865	0.09438	0.08962	0.08663
2.8	0.12004	0.11380	0.10530	0.10074	0.09566	0.09248
2.9	0.12782	0.12117	0.11213	0.10728	0.10188	0.09849
3.0	0.13581	0.12875	0.11915	0.11400	0.10827	0.10467
3.1	0.14401	0.13654	0.12636	0.12091	0.11483	0.11102
3.2	0.15243	0.14452	0.13376	0.12799	0.12156	0.11753
3.3	0.16106	0.15271	0.14134	0.13525	0.12847	0.12420
3.4	0.16989	0.16109	0.14911	0.14269	0.13554	0.13105
3.5	0.17894	0.16967	0.15707	0.15031	0.14278	0.13805
3.6	0.18819	0.17845	0.16520	0.15810	0.15019	0.14521
3.7	0.19765	0.18743	0.17352	0.16607	0.15776	0.15254
3.8	0.20731	0.19660	0.18202	0.17421	0.16550	0.16003
3.9	0.21718	0.20596	0.19070	0.18252	0.17340	0.16767
4.0	0.22725	0.21552	0.19956	0.19101	0.18147	0.17548

PRESSURE LOSS PER FOOT
3/4" hePEX plus and AQUAPEX

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.5	0.00263	0.00249	0.00230	0.00219	0.00208	0.00201
0.6	0.00364	0.00345	0.00318	0.00304	0.00288	0.00278
0.7	0.00479	0.00453	0.00419	0.00400	0.00379	0.00366
0.8	0.00608	0.00575	0.00531	0.00507	0.00481	0.00465
0.9	0.00750	0.00710	0.00655	0.00626	0.00594	0.00573
1.0	0.00905	0.00857	0.00791	0.00756	0.00717	0.00692
1.1	0.01072	0.01015	0.00938	0.00896	0.00850	0.00821
1.2	0.01252	0.01186	0.01095	0.01047	0.00993	0.00959
1.3	0.01444	0.01368	0.01264	0.01208	0.01146	0.01107
1.4	0.01649	0.01561	0.01442	0.01379	0.01308	0.01264
1.5	0.01865	0.01766	0.01632	0.01560	0.01480	0.01430
1.6	0.02092	0.01982	0.01831	0.01751	0.01661	0.01605
1.7	0.02331	0.02208	0.02041	0.01951	0.01851	0.01789
1.8	0.02582	0.02446	0.02260	0.02161	0.02051	0.01982
1.9	0.02843	0.02694	0.02490	0.02381	0.02259	0.02183
2.0	0.03116	0.02952	0.02729	0.02610	0.02477	0.02393
2.1	0.03400	0.03221	0.02978	0.02848	0.02703	0.02612
2.2	0.03694	0.03500	0.03236	0.03095	0.02938	0.02839
2.3	0.04000	0.03790	0.03504	0.03352	0.03181	0.03074
2.4	0.04316	0.04089	0.03782	0.03617	0.03433	0.03318
2.5	0.04642	0.04399	0.04068	0.03891	0.03694	0.03570
2.6	0.04979	0.04719	0.04364	0.04174	0.03963	0.03830
2.7	0.05327	0.05048	0.04669	0.04466	0.04240	0.04098
2.8	0.05684	0.05387	0.04983	0.04767	0.04526	0.04375
2.9	0.06052	0.05736	0.05307	0.05076	0.04820	0.04659
3.0	0.06430	0.06095	0.05639	0.05394	0.05122	0.04951
3.1	0.06819	0.06463	0.05980	0.05721	0.05432	0.05251
3.2	0.07217	0.06841	0.06330	0.06056	0.05750	0.05559
3.3	0.07625	0.07228	0.06688	0.06399	0.06077	0.05874
3.4	0.08043	0.07625	0.07056	0.06751	0.06411	0.06198
3.5	0.08471	0.08031	0.07432	0.07111	0.06753	0.06529
3.6	0.08909	0.08447	0.07817	0.07480	0.07104	0.06868
3.7	0.09357	0.08871	0.08210	0.07856	0.07462	0.07214
3.8	0.09814	0.09305	0.08612	0.08241	0.07827	0.07568
3.9	0.10281	0.09748	0.09023	0.08634	0.08201	0.07929
4.0	0.10757	0.10200	0.09442	0.09035	0.08582	0.08298
4.1	0.11243	0.10661	0.09869	0.09445	0.08971	0.08674
4.2	0.11739	0.11131	0.10305	0.09862	0.09368	0.09058
4.3	0.12244	0.11610	0.10749	0.10287	0.09772	0.09449
4.4	0.12758	0.12099	0.11201	0.10720	0.10184	0.09847
4.5	0.13282	0.12596	0.11662	0.11161	0.10604	0.10253
4.6	0.13814	0.13101	0.12131	0.11610	0.11031	0.10666
4.7	0.14357	0.13616	0.12608	0.12067	0.11465	0.11086
4.8	0.14908	0.14139	0.13093	0.12532	0.11907	0.11514
4.9	0.15469	0.14672	0.13587	0.13005	0.12356	0.11949
5.0	0.16039	0.15212	0.14088	0.13485	0.12813	0.12391
5.1	0.16618	0.15762	0.14598	0.13973	0.13277	0.12840
5.2	0.17206	0.16320	0.15115	0.14469	0.13749	0.13296
5.3	0.17803	0.16887	0.15641	0.14972	0.14227	0.13759
5.4	0.18409	0.17462	0.16174	0.15483	0.14713	0.14229
5.5	0.19024	0.18046	0.16716	0.16002	0.15207	0.14707

30% Glycol / Water Solution

PRESSURE LOSS PER FOOT
5/8" hePEX plus and AQUAPEX

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.1	0.00032	0.00030	0.00028	0.00026	0.00025	0.00024
0.2	0.00109	0.00103	0.00095	0.00090	0.00086	0.00083
0.3	0.00224	0.00212	0.00195	0.00186	0.00176	0.00170
0.4	0.00373	0.00353	0.00326	0.00311	0.00295	0.00285
0.5	0.00555	0.00525	0.00485	0.00463	0.00439	0.00424
0.6	0.00768	0.00727	0.00671	0.00641	0.00608	0.00587
0.7	0.01011	0.00957	0.00883	0.00844	0.00800	0.00773
0.8	0.01283	0.01214	0.01121	0.01071	0.01016	0.00981
0.9	0.01582	0.01498	0.01383	0.01322	0.01254	0.01211
1.0	0.01909	0.01808	0.01670	0.01596	0.01513	0.01462
1.1	0.02263	0.02143	0.01979	0.01892	0.01795	0.01734
1.2	0.02643	0.02503	0.02312	0.02211	0.02097	0.02026
1.3	0.03049	0.02887	0.02668	0.02551	0.02420	0.02338
1.4	0.03480	0.03296	0.03046	0.02912	0.02763	0.02669
1.5	0.03936	0.03728	0.03446	0.03295	0.03126	0.03021
1.6	0.04416	0.04184	0.03867	0.03698	0.03509	0.03391
1.7	0.04921	0.04663	0.04310	0.04122	0.03911	0.03780
1.8	0.05450	0.05164	0.04774	0.04566	0.04333	0.04187
1.9	0.06003	0.05688	0.05259	0.05030	0.04774	0.04613
2.0	0.06579	0.06234	0.05765	0.05513	0.05233	0.05058
2.1	0.07178	0.06802	0.06291	0.06017	0.05711	0.05520
2.2	0.07800	0.07392	0.06837	0.06539	0.06208	0.06000
2.3	0.08445	0.08004	0.07403	0.07081	0.06723	0.06498
2.4	0.09113	0.08637	0.07989	0.07642	0.07256	0.07013
2.5	0.09803	0.09291	0.08595	0.08222	0.07807	0.07546
2.6	0.10515	0.09967	0.09221	0.08821	0.08376	0.08096
2.7	0.11249	0.10663	0.09865	0.09438	0.08962	0.08663
2.8	0.12004	0.11380	0.10530	0.10074	0.09566	0.09248
2.9	0.12782	0.12117	0.11213	0.10728	0.10188	0.09849
3.0	0.13581	0.12875	0.11915	0.11400	0.10827	0.10467
3.1	0.14401	0.13654	0.12636	0.12091	0.11483	0.11102
3.2	0.15243	0.14452	0.13376	0.12799	0.12156	0.11753
3.3	0.16106	0.15271	0.14134	0.13525	0.12847	0.12420
3.4	0.16989	0.16109	0.14911	0.14269	0.13554	0.13105
3.5	0.17894	0.16967	0.15707	0.15031	0.14278	0.13805
3.6	0.18819	0.17845	0.16520	0.15810	0.15019	0.14521
3.7	0.19765	0.18743	0.17352	0.16607	0.15776	0.15254
3.8	0.20731	0.19660	0.18202	0.17421	0.16550	0.16003
3.9	0.21718	0.20596	0.19070	0.18252	0.17340	0.16767
4.0	0.22725	0.21552	0.19956	0.19101	0.18147	0.17548

PRESSURE LOSS PER FOOT
3/4" hePEX plus and AQUAPEX

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.5	0.00263	0.00249	0.00230	0.00219	0.00208	0.00201
0.6	0.00364	0.00345	0.00318	0.00304	0.00288	0.00278
0.7	0.00479	0.00453	0.00419	0.00400	0.00379	0.00366
0.8	0.00608	0.00575	0.00531	0.00507	0.00481	0.00465
0.9	0.00750	0.00710	0.00655	0.00626	0.00594	0.00573
1.0	0.00905	0.00857	0.00791	0.00756	0.00717	0.00692
1.1	0.01072	0.01015	0.00938	0.00896	0.00850	0.00821
1.2	0.01252	0.01186	0.01095	0.01047	0.00993	0.00959
1.3	0.01444	0.01368	0.01264	0.01208	0.01146	0.01107
1.4	0.01649	0.01561	0.01442	0.01379	0.01308	0.01264
1.5	0.01865	0.01766	0.01632	0.01560	0.01480	0.01430
1.6	0.02092	0.01982	0.01831	0.01751	0.01661	0.01605
1.7	0.02331	0.02208	0.02041	0.01951	0.01851	0.01789
1.8	0.02582	0.02446	0.02260	0.02161	0.02051	0.01982
1.9	0.02843	0.02694	0.02490	0.02381	0.02259	0.02183
2.0	0.03116	0.02952	0.02729	0.02610	0.02477	0.02393
2.1	0.03400	0.03221	0.02978	0.02848	0.02703	0.02612
2.2	0.03694	0.03500	0.03236	0.03095	0.02938	0.02839
2.3	0.04000	0.03790	0.03504	0.03352	0.03181	0.03074
2.4	0.04316	0.04089	0.03782	0.03617	0.03433	0.03318
2.5	0.04642	0.04399	0.04068	0.03891	0.03694	0.03570
2.6	0.04979	0.04719	0.04364	0.04174	0.03963	0.03830
2.7	0.05327	0.05048	0.04669	0.04466	0.04240	0.04098
2.8	0.05684	0.05387	0.04983	0.04767	0.04526	0.04375
2.9	0.06052	0.05736	0.05307	0.05076	0.04820	0.04659
3.0	0.06430	0.06095	0.05639	0.05394	0.05122	0.04951
3.1	0.06819	0.06463	0.05980	0.05721	0.05432	0.05251
3.2	0.07217	0.06841	0.06330	0.06056	0.05750	0.05559
3.3	0.07625	0.07228	0.06688	0.06399	0.06077	0.05874
3.4	0.08043	0.07625	0.07056	0.06751	0.06411	0.06198
3.5	0.08471	0.08031	0.07432	0.07111	0.06753	0.06529
3.6	0.08909	0.08447	0.07817	0.07480	0.07104	0.06868
3.7	0.09357	0.08871	0.08210	0.07856	0.07462	0.07214
3.8	0.09814	0.09305	0.08612	0.08241	0.07827	0.07568
3.9	0.10281	0.09748	0.09023	0.08634	0.08201	0.07929
4.0	0.10757	0.10200	0.09442	0.09035	0.08582	0.08298
4.1	0.11243	0.10661	0.09869	0.09445	0.08971	0.08674
4.2	0.11739	0.11131	0.10305	0.09862	0.09368	0.09058
4.3	0.12244	0.11610	0.10749	0.10287	0.09772	0.09449
4.4	0.12758	0.12099	0.11201	0.10720	0.10184	0.09847
4.5	0.13282	0.12596	0.11662	0.11161	0.10604	0.10253
4.6	0.13814	0.13101	0.12131	0.11610	0.11031	0.10666
4.7	0.14357	0.13616	0.12608	0.12067	0.11465	0.11086
4.8	0.14908	0.14139	0.13093	0.12532	0.11907	0.11514
4.9	0.15469	0.14672	0.13587	0.13005	0.12356	0.11949
5.0	0.16039	0.15212	0.14088	0.13485	0.12813	0.12391
5.1	0.16618	0.15762	0.14598	0.13973	0.13277	0.12840
5.2	0.17206	0.16320	0.15115	0.14469	0.13749	0.13296
5.3	0.17803	0.16887	0.15641	0.14972	0.14227	0.13759
5.4	0.18409	0.17462	0.16174	0.15483	0.14713	0.14229
5.5	0.19024	0.18046	0.16716	0.16002	0.15207	0.14707

40% Glycol / Water Solution

PRESSURE LOSS PER FOOT
5/8" hePEX plus and AQUAPEX

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.1	0.00035	0.00033	0.00030	0.00028	0.00027	0.00025
0.2	0.00120	0.00112	0.00104	0.00097	0.00091	0.00087
0.3	0.00246	0.00229	0.00214	0.00200	0.00188	0.00178
0.4	0.00410	0.00383	0.00357	0.00333	0.00313	0.00298
0.5	0.00610	0.00569	0.00532	0.00496	0.00466	0.00443
0.6	0.00843	0.00788	0.00736	0.00687	0.00646	0.00614
0.7	0.01110	0.01036	0.00968	0.00904	0.00850	0.00808
0.8	0.01408	0.01315	0.01228	0.01147	0.01079	0.01026
0.9	0.01736	0.01622	0.01515	0.01415	0.01332	0.01266
1.0	0.02095	0.01957	0.01829	0.01708	0.01607	0.01528
1.1	0.02482	0.02319	0.02168	0.02025	0.01906	0.01812
1.2	0.02899	0.02709	0.02532	0.02366	0.02227	0.02117
1.3	0.03343	0.03124	0.02921	0.02729	0.02569	0.02443
1.4	0.03815	0.03566	0.03334	0.03116	0.02933	0.02790
1.5	0.04315	0.04033	0.03771	0.03525	0.03318	0.03156
1.6	0.04841	0.04526	0.04232	0.03956	0.03724	0.03543
1.7	0.05394	0.05043	0.04716	0.04409	0.04151	0.03949
1.8	0.05973	0.05585	0.05223	0.04883	0.04598	0.04374
1.9	0.06578	0.06151	0.05753	0.05379	0.05065	0.04819
2.0	0.07209	0.06741	0.06305	0.05896	0.05552	0.05283
2.1	0.07865	0.07354	0.06880	0.06433	0.06059	0.05765
2.2	0.08545	0.07992	0.07477	0.06992	0.06586	0.06267
2.3	0.09251	0.08652	0.08095	0.07571	0.07131	0.06786
2.4	0.09982	0.09336	0.08735	0.08170	0.07696	0.07324
2.5	0.10736	0.10042	0.09397	0.08789	0.08280	0.07880
2.6	0.11515	0.10772	0.10080	0.09428	0.08883	0.08454
2.7	0.12318	0.11523	0.10784	0.10088	0.09504	0.09046
2.8	0.13145	0.12297	0.11509	0.10766	0.10144	0.09656
2.9	0.13995	0.13093	0.12254	0.11465	0.10803	0.10283
3.0	0.14869	0.13912	0.13021	0.12182	0.11480	0.10928
3.1	0.15766	0.14752	0.13808	0.12919	0.12175	0.11590
3.2	0.16687	0.15614	0.14615	0.13676	0.12888	0.12269
3.3	0.17630	0.16497	0.15443	0.14451	0.13619	0.12966
3.4	0.18596	0.17402	0.16291	0.15245	0.14368	0.13680
3.5	0.19585	0.18328	0.17158	0.16058	0.15135	0.14410
3.6	0.20596	0.19275	0.18046	0.16889	0.15919	0.15158
3.7	0.21630	0.20244	0.18954	0.17739	0.16721	0.15922
3.8	0.22686	0.21233	0.19881	0.18608	0.17541	0.16703
3.9	0.23765	0.22243	0.20827	0.19495	0.18378	0.17500
4.0	0.24865	0.23274	0.21794	0.20400	0.19232	0.18314

PRESSURE LOSS PER FOOT
3/4" hePEX plus and AQUAPEX

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.5	0.00289	0.00270	0.00252	0.00235	0.00221	0.00210
0.6	0.00400	0.00373	0.00349	0.00325	0.00306	0.00291
0.7	0.00526	0.00491	0.00459	0.00428	0.00403	0.00383
0.8	0.00667	0.00623	0.00582	0.00543	0.00511	0.00486
0.9	0.00823	0.00769	0.00718	0.00671	0.00631	0.00600
1.0	0.00993	0.00927	0.00867	0.00809	0.00761	0.00724
1.1	0.01177	0.01099	0.01027	0.00959	0.00903	0.00858
1.2	0.01374	0.01284	0.01200	0.01121	0.01054	0.01002
1.3	0.01584	0.01480	0.01384	0.01293	0.01217	0.01157
1.4	0.01808	0.01690	0.01579	0.01476	0.01389	0.01321
1.5	0.02045	0.01911	0.01786	0.01669	0.01571	0.01494
1.6	0.02294	0.02144	0.02005	0.01873	0.01763	0.01677
1.7	0.02556	0.02389	0.02234	0.02088	0.01965	0.01869
1.8	0.02830	0.02646	0.02474	0.02312	0.02177	0.02070
1.9	0.03117	0.02914	0.02725	0.02547	0.02398	0.02281
2.0	0.03415	0.03193	0.02986	0.02791	0.02628	0.02500
2.1	0.03726	0.03484	0.03258	0.03046	0.02868	0.02729
2.2	0.04048	0.03785	0.03540	0.03310	0.03117	0.02966
2.3	0.04383	0.04098	0.03833	0.03584	0.03375	0.03211
2.4	0.04728	0.04422	0.04136	0.03868	0.03643	0.03466
2.5	0.05086	0.04756	0.04449	0.04161	0.03919	0.03729
2.6	0.05455	0.05101	0.04772	0.04463	0.04204	0.04000
2.7	0.05835	0.05457	0.05106	0.04775	0.04498	0.04280
2.8	0.06226	0.05823	0.05449	0.05096	0.04801	0.04569
2.9	0.06629	0.06200	0.05802	0.05426	0.05112	0.04865
3.0	0.07043	0.06588	0.06164	0.05766	0.05432	0.05170
3.1	0.07467	0.06985	0.06537	0.06115	0.05761	0.05483
3.2	0.07903	0.07393	0.06919	0.06472	0.06098	0.05804
3.3	0.08349	0.07811	0.07310	0.06839	0.06444	0.06134
3.4	0.08807	0.08239	0.07711	0.07214	0.06798	0.06471
3.5	0.09275	0.08678	0.08122	0.07599	0.07161	0.06816
3.6	0.09754	0.09126	0.08542	0.07992	0.07532	0.07170
3.7	0.10243	0.09584	0.08971	0.08394	0.07911	0.07531
3.8	0.10743	0.10052	0.09410	0.08805	0.08298	0.07900
3.9	0.11253	0.10530	0.09858	0.09225	0.08694	0.08277
4.0	0.11774	0.11018	0.10315	0.09653	0.09098	0.08662
4.1	0.12306	0.11516	0.10781	0.10089	0.09510	0.09054
4.2	0.12847	0.12023	0.11256	0.10535	0.09930	0.09455
4.3	0.13399	0.12540	0.11741	0.10989	0.10358	0.09863
4.4	0.13961	0.13067	0.12234	0.11451	0.10794	0.10278
4.5	0.14534	0.13603	0.12737	0.11922	0.11238	0.10701
4.6	0.15116	0.14149	0.13248	0.12401	0.11690	0.11132
4.7	0.15709	0.14704	0.13769	0.12888	0.12150	0.11571
4.8	0.16312	0.15268	0.14298	0.13384	0.12618	0.12016
4.9	0.16924	0.15842	0.14836	0.13888	0.13094	0.12470
5.0	0.17547	0.16426	0.15383	0.14400	0.13577	0.12931
5.1	0.18179	0.17018	0.15938	0.14921	0.14068	0.13399
5.2	0.18822	0.17620	0.16502	0.15450	0.14568	0.13874
5.3	0.19474	0.18232	0.17075	0.15987	0.15074	0.14357
5.4	0.20136	0.18852	0.17657	0.16532	0.15589	0.14848
5.5	0.20808	0.19482	0.18247	0.17085	0.16111	0.15346

40% Glycol / Water Solution

PRESSURE LOSS PER FOOT
5/8" hePEX plus and AQUAPEX

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.1	0.00035	0.00033	0.00030	0.00028	0.00027	0.00025
0.2	0.00120	0.00112	0.00104	0.00097	0.00091	0.00087
0.3	0.00246	0.00229	0.00214	0.00200	0.00188	0.00178
0.4	0.00410	0.00383	0.00357	0.00333	0.00313	0.00298
0.5	0.00610	0.00569	0.00532	0.00496	0.00466	0.00443
0.6	0.00843	0.00788	0.00736	0.00687	0.00646	0.00614
0.7	0.01110	0.01036	0.00968	0.00904	0.00850	0.00808
0.8	0.01408	0.01315	0.01228	0.01147	0.01079	0.01026
0.9	0.01736	0.01622	0.01515	0.01415	0.01332	0.01266
1.0	0.02095	0.01957	0.01829	0.01708	0.01607	0.01528
1.1	0.02482	0.02319	0.02168	0.02025	0.01906	0.01812
1.2	0.02899	0.02709	0.02532	0.02366	0.02227	0.02117
1.3	0.03343	0.03124	0.02921	0.02729	0.02569	0.02443
1.4	0.03815	0.03566	0.03334	0.03116	0.02933	0.02790
1.5	0.04315	0.04033	0.03771	0.03525	0.03318	0.03156
1.6	0.04841	0.04526	0.04232	0.03956	0.03724	0.03543
1.7	0.05394	0.05043	0.04716	0.04409	0.04151	0.03949
1.8	0.05973	0.05585	0.05223	0.04883	0.04598	0.04374
1.9	0.06578	0.06151	0.05753	0.05379	0.05065	0.04819
2.0	0.07209	0.06741	0.06305	0.05896	0.05552	0.05283
2.1	0.07865	0.07354	0.06880	0.06433	0.06059	0.05765
2.2	0.08545	0.07992	0.07477	0.06992	0.06586	0.06267
2.3	0.09251	0.08652	0.08095	0.07571	0.07131	0.06786
2.4	0.09982	0.09336	0.08735	0.08170	0.07696	0.07324
2.5	0.10736	0.10042	0.09397	0.08789	0.08280	0.07880
2.6	0.11515	0.10772	0.10080	0.09428	0.08883	0.08454
2.7	0.12318	0.11523	0.10784	0.10088	0.09504	0.09046
2.8	0.13145	0.12297	0.11509	0.10766	0.10144	0.09656
2.9	0.13995	0.13093	0.12254	0.11465	0.10803	0.10283
3.0	0.14869	0.13912	0.13021	0.12182	0.11480	0.10928
3.1	0.15766	0.14752	0.13808	0.12919	0.12175	0.11590
3.2	0.16687	0.15614	0.14615	0.13676	0.12888	0.12269
3.3	0.17630	0.16497	0.15443	0.14451	0.13619	0.12966
3.4	0.18596	0.17402	0.16291	0.15245	0.14368	0.13680
3.5	0.19585	0.18328	0.17158	0.16058	0.15135	0.14410
3.6	0.20596	0.19275	0.18046	0.16889	0.15919	0.15158
3.7	0.21630	0.20244	0.18954	0.17739	0.16721	0.15922
3.8	0.22686	0.21233	0.19881	0.18608	0.17541	0.16703
3.9	0.23765	0.22243	0.20827	0.19495	0.18378	0.17500
4.0	0.24865	0.23274	0.21794	0.20400	0.19232	0.18314

PRESSURE LOSS PER FOOT
3/4" hePEX plus and AQUAPEX

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.5	0.00289	0.00270	0.00252	0.00235	0.00221	0.00210
0.6	0.00400	0.00373	0.00349	0.00325	0.00306	0.00291
0.7	0.00526	0.00491	0.00459	0.00428	0.00403	0.00383
0.8	0.00667	0.00623	0.00582	0.00543	0.00511	0.00486
0.9	0.00823	0.00769	0.00718	0.00671	0.00631	0.00600
1.0	0.00993	0.00927	0.00867	0.00809	0.00761	0.00724
1.1	0.01177	0.01099	0.01027	0.00959	0.00903	0.00858
1.2	0.01374	0.01284	0.01200	0.01121	0.01054	0.01002
1.3	0.01584	0.01480	0.01384	0.01293	0.01217	0.01157
1.4	0.01808	0.01690	0.01579	0.01476	0.01389	0.01321
1.5	0.02045	0.01911	0.01786	0.01669	0.01571	0.01494
1.6	0.02294	0.02144	0.02005	0.01873	0.01763	0.01677
1.7	0.02556	0.02389	0.02234	0.02088	0.01965	0.01869
1.8	0.02830	0.02646	0.02474	0.02312	0.02177	0.02070
1.9	0.03117	0.02914	0.02725	0.02547	0.02398	0.02281
2.0	0.03415	0.03193	0.02986	0.02791	0.02628	0.02500
2.1	0.03726	0.03484	0.03258	0.03046	0.02868	0.02729
2.2	0.04048	0.03785	0.03540	0.03310	0.03117	0.02966
2.3	0.04383	0.04098	0.03833	0.03584	0.03375	0.03211
2.4	0.04728	0.04422	0.04136	0.03868	0.03643	0.03466
2.5	0.05086	0.04756	0.04449	0.04161	0.03919	0.03729
2.6	0.05455	0.05101	0.04772	0.04463	0.04204	0.04000
2.7	0.05835	0.05457	0.05106	0.04775	0.04498	0.04280
2.8	0.06226	0.05823	0.05449	0.05096	0.04801	0.04569
2.9	0.06629	0.06200	0.05802	0.05426	0.05112	0.04865
3.0	0.07043	0.06588	0.06164	0.05766	0.05432	0.05170
3.1	0.07467	0.06985	0.06537	0.06115	0.05761	0.05483
3.2	0.07903	0.07393	0.06919	0.06472	0.06098	0.05804
3.3	0.08349	0.07811	0.07310	0.06839	0.06444	0.06134
3.4	0.08807	0.08239	0.07711	0.07214	0.06798	0.06471
3.5	0.09275	0.08678	0.08122	0.07599	0.07161	0.06816
3.6	0.09754	0.09126	0.08542	0.07992	0.07532	0.07170
3.7	0.10243	0.09584	0.08971	0.08394	0.07911	0.07531
3.8	0.10743	0.10052	0.09410	0.08805	0.08298	0.07900
3.9	0.11253	0.10530	0.09858	0.09225	0.08694	0.08277
4.0	0.11774	0.11018	0.10315	0.09653	0.09098	0.08662
4.1	0.12306	0.11516	0.10781	0.10089	0.09510	0.09054
4.2	0.12847	0.12023	0.11256	0.10535	0.09930	0.09455
4.3	0.13399	0.12540	0.11741	0.10989	0.10358	0.09863
4.4	0.13961	0.13067	0.12234	0.11451	0.10794	0.10278
4.5	0.14534	0.13603	0.12737	0.11922	0.11238	0.10701
4.6	0.15116	0.14149	0.13248	0.12401	0.11690	0.11132
4.7	0.15709	0.14704	0.13769	0.12888	0.12150	0.11571
4.8	0.16312	0.15268	0.14298	0.13384	0.12618	0.12016
4.9	0.16924	0.15842	0.14836	0.13888	0.13094	0.12470
5.0	0.17547	0.16426	0.15383	0.14400	0.13577	0.12931
5.1	0.18179	0.17018	0.15938	0.14921	0.14068	0.13399
5.2	0.18822	0.17620	0.16502	0.15450	0.14568	0.13874
5.3	0.19474	0.18232	0.17075	0.15987	0.15074	0.14357
5.4	0.20136	0.18852	0.17657	0.16532	0.15589	0.14848
5.5	0.20808	0.19482	0.18247	0.17085	0.16111	0.15346

40% Glycol / Water Solution

PRESSURE LOSS PER FOOT
5/8" hePEX plus and AQUAPEX

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.1	0.00035	0.00033	0.00030	0.00028	0.00027	0.00025
0.2	0.00120	0.00112	0.00104	0.00097	0.00091	0.00087
0.3	0.00246	0.00229	0.00214	0.00200	0.00188	0.00178
0.4	0.00410	0.00383	0.00357	0.00333	0.00313	0.00298
0.5	0.00610	0.00569	0.00532	0.00496	0.00466	0.00443
0.6	0.00843	0.00788	0.00736	0.00687	0.00646	0.00614
0.7	0.01110	0.01036	0.00968	0.00904	0.00850	0.00808
0.8	0.01408	0.01315	0.01228	0.01147	0.01079	0.01026
0.9	0.01736	0.01622	0.01515	0.01415	0.01332	0.01266
1.0	0.02095	0.01957	0.01829	0.01708	0.01607	0.01528
1.1	0.02482	0.02319	0.02168	0.02025	0.01906	0.01812
1.2	0.02899	0.02709	0.02532	0.02366	0.02227	0.02117
1.3	0.03343	0.03124	0.02921	0.02729	0.02569	0.02443
1.4	0.03815	0.03566	0.03334	0.03116	0.02933	0.02790
1.5	0.04315	0.04033	0.03771	0.03525	0.03318	0.03156
1.6	0.04841	0.04526	0.04232	0.03956	0.03724	0.03543
1.7	0.05394	0.05043	0.04716	0.04409	0.04151	0.03949
1.8	0.05973	0.05585	0.05223	0.04883	0.04598	0.04374
1.9	0.06578	0.06151	0.05753	0.05379	0.05065	0.04819
2.0	0.07209	0.06741	0.06305	0.05896	0.05552	0.05283
2.1	0.07865	0.07354	0.06880	0.06433	0.06059	0.05765
2.2	0.08545	0.07992	0.07477	0.06992	0.06586	0.06267
2.3	0.09251	0.08652	0.08095	0.07571	0.07131	0.06786
2.4	0.09982	0.09336	0.08735	0.08170	0.07696	0.07324
2.5	0.10736	0.10042	0.09397	0.08789	0.08280	0.07880
2.6	0.11515	0.10772	0.10080	0.09428	0.08883	0.08454
2.7	0.12318	0.11523	0.10784	0.10088	0.09504	0.09046
2.8	0.13145	0.12297	0.11509	0.10766	0.10144	0.09656
2.9	0.13995	0.13093	0.12254	0.11465	0.10803	0.10283
3.0	0.14869	0.13912	0.13021	0.12182	0.11480	0.10928
3.1	0.15766	0.14752	0.13808	0.12919	0.12175	0.11590
3.2	0.16687	0.15614	0.14615	0.13676	0.12888	0.12269
3.3	0.17630	0.16497	0.15443	0.14451	0.13619	0.12966
3.4	0.18596	0.17402	0.16291	0.15245	0.14368	0.13680
3.5	0.19585	0.18328	0.17158	0.16058	0.15135	0.14410
3.6	0.20596	0.19275	0.18046	0.16889	0.15919	0.15158
3.7	0.21630	0.20244	0.18954	0.17739	0.16721	0.15922
3.8	0.22686	0.21233	0.19881	0.18608	0.17541	0.16703
3.9	0.23765	0.22243	0.20827	0.19495	0.18378	0.17500
4.0	0.24865	0.23274	0.21794	0.20400	0.19232	0.18314

PRESSURE LOSS PER FOOT
3/4" hePEX plus and AQUAPEX

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.5	0.00289	0.00270	0.00252	0.00235	0.00221	0.00210
0.6	0.00400	0.00373	0.00349	0.00325	0.00306	0.00291
0.7	0.00526	0.00491	0.00459	0.00428	0.00403	0.00383
0.8	0.00667	0.00623	0.00582	0.00543	0.00511	0.00486
0.9	0.00823	0.00769	0.00718	0.00671	0.00631	0.00600
1.0	0.00993	0.00927	0.00867	0.00809	0.00761	0.00724
1.1	0.01177	0.01099	0.01027	0.00959	0.00903	0.00858
1.2	0.01374	0.01284	0.01200	0.01121	0.01054	0.01002
1.3	0.01584	0.01480	0.01384	0.01293	0.01217	0.01157
1.4	0.01808	0.01690	0.01579	0.01476	0.01389	0.01321
1.5	0.02045	0.01911	0.01786	0.01669	0.01571	0.01494
1.6	0.02294	0.02144	0.02005	0.01873	0.01763	0.01677
1.7	0.02556	0.02389	0.02234	0.02088	0.01965	0.01869
1.8	0.02830	0.02646	0.02474	0.02312	0.02177	0.02070
1.9	0.03117	0.02914	0.02725	0.02547	0.02398	0.02281
2.0	0.03415	0.03193	0.02986	0.02791	0.02628	0.02500
2.1	0.03726	0.03484	0.03258	0.03046	0.02868	0.02729
2.2	0.04048	0.03785	0.03540	0.03310	0.03117	0.02966
2.3	0.04383	0.04098	0.03833	0.03584	0.03375	0.03211
2.4	0.04728	0.04422	0.04136	0.03868	0.03643	0.03466
2.5	0.05086	0.04756	0.04449	0.04161	0.03919	0.03729
2.6	0.05455	0.05101	0.04772	0.04463	0.04204	0.04000
2.7	0.05835	0.05457	0.05106	0.04775	0.04498	0.04280
2.8	0.06226	0.05823	0.05449	0.05096	0.04801	0.04569
2.9	0.06629	0.06200	0.05802	0.05426	0.05112	0.04865
3.0	0.07043	0.06588	0.06164	0.05766	0.05432	0.05170
3.1	0.07467	0.06985	0.06537	0.06115	0.05761	0.05483
3.2	0.07903	0.07393	0.06919	0.06472	0.06098	0.05804
3.3	0.08349	0.07811	0.07310	0.06839	0.06444	0.06134
3.4	0.08807	0.08239	0.07711	0.07214	0.06798	0.06471
3.5	0.09275	0.08678	0.08122	0.07599	0.07161	0.06816
3.6	0.09754	0.09126	0.08542	0.07992	0.07532	0.07170
3.7	0.10243	0.09584	0.08971	0.08394	0.07911	0.07531
3.8	0.10743	0.10052	0.09410	0.08805	0.08298	0.07900
3.9	0.11253	0.10530	0.09858	0.09225	0.08694	0.08277
4.0	0.11774	0.11018	0.10315	0.09653	0.09098	0.08662
4.1	0.12306	0.11516	0.10781	0.10089	0.09510	0.09054
4.2	0.12847	0.12023	0.11256	0.10535	0.09930	0.09455
4.3	0.13399	0.12540	0.11741	0.10989	0.10358	0.09863
4.4	0.13961	0.13067	0.12234	0.11451	0.10794	0.10278
4.5	0.14534	0.13603	0.12737	0.11922	0.11238	0.10701
4.6	0.15116	0.14149	0.13248	0.12401	0.11690	0.11132
4.7	0.15709	0.14704	0.13769	0.12888	0.12150	0.11571
4.8	0.16312	0.15268	0.14298	0.13384	0.12618	0.12016
4.9	0.16924	0.15842	0.14836	0.13888	0.13094	0.12470
5.0	0.17547	0.16426	0.15383	0.14400	0.13577	0.12931
5.1	0.18179	0.17018	0.15938	0.14921	0.14068	0.13399
5.2	0.18822	0.17620	0.16502	0.15450	0.14568	0.13874
5.3	0.19474	0.18232	0.17075	0.15987	0.15074	0.14357
5.4	0.20136	0.18852	0.17657	0.16532	0.15589	0.14848
5.5	0.20808	0.19482	0.18247	0.17085	0.16111	0.15346

50% Glycol / Water Solution

PRESSURE LOSS PER FOOT
5/8" hePEX plus and AQUAPEX

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.1	0.00039	0.00034	0.00032	0.00030	0.00028	0.00027
0.2	0.00132	0.00118	0.00108	0.00101	0.00096	0.00092
0.3	0.00272	0.00242	0.00222	0.00208	0.00197	0.00189
0.4	0.00453	0.00404	0.00371	0.00347	0.00329	0.00316
0.5	0.00673	0.00600	0.00552	0.00516	0.00490	0.00470
0.6	0.00931	0.00830	0.00764	0.00715	0.00678	0.00650
0.7	0.01225	0.01092	0.01005	0.00941	0.00893	0.00856
0.8	0.01553	0.01386	0.01275	0.01194	0.01133	0.01086
0.9	0.01915	0.01709	0.01573	0.01473	0.01398	0.01341
1.0	0.02310	0.02062	0.01898	0.01777	0.01688	0.01618
1.1	0.02737	0.02444	0.02250	0.02107	0.02001	0.01919
1.2	0.03196	0.02854	0.02628	0.02461	0.02338	0.02242
1.3	0.03686	0.03292	0.03031	0.02839	0.02697	0.02586
1.4	0.04206	0.03757	0.03460	0.03241	0.03079	0.02953
1.5	0.04756	0.04249	0.03913	0.03666	0.03483	0.03340
1.6	0.05335	0.04767	0.04391	0.04114	0.03909	0.03749
1.7	0.05944	0.05311	0.04893	0.04585	0.04356	0.04179
1.8	0.06581	0.05882	0.05419	0.05078	0.04825	0.04629
1.9	0.07247	0.06477	0.05968	0.05593	0.05315	0.05099
2.0	0.07941	0.07098	0.06541	0.06130	0.05826	0.05589
2.1	0.08662	0.07744	0.07137	0.06689	0.06357	0.06099
2.2	0.09412	0.08415	0.07755	0.07270	0.06909	0.06629
2.3	0.10188	0.09110	0.08397	0.07871	0.07481	0.07178
2.4	0.10991	0.09829	0.09060	0.08494	0.08074	0.07747
2.5	0.11822	0.10573	0.09746	0.09137	0.08686	0.08334
2.6	0.12678	0.11340	0.10454	0.09802	0.09317	0.08941
2.7	0.13561	0.12131	0.11184	0.10487	0.09969	0.09566
2.8	0.14470	0.12945	0.11936	0.11192	0.10640	0.10210
2.9	0.15405	0.13783	0.12709	0.11917	0.11330	0.10873
3.0	0.16366	0.14643	0.13503	0.12663	0.12039	0.11554
3.1	0.17353	0.15527	0.14319	0.13429	0.12768	0.12254
3.2	0.18364	0.16434	0.15156	0.14214	0.13515	0.12971
3.3	0.19401	0.17363	0.16014	0.15019	0.14281	0.13707
3.4	0.20463	0.18314	0.16892	0.15844	0.15066	0.14461
3.5	0.21550	0.19289	0.17792	0.16689	0.15869	0.15232
3.6	0.22661	0.20285	0.18712	0.17552	0.16691	0.16022
3.7	0.23798	0.21303	0.19652	0.18435	0.17532	0.16829
3.8	0.24958	0.22344	0.20613	0.19337	0.18390	0.17653
3.9	0.26143	0.23406	0.21594	0.20259	0.19267	0.18495
4.0	0.27352	0.24490	0.22596	0.21199	0.20162	0.19355

PRESSURE LOSS PER FOOT
3/4" hePEX plus and AQUAPEX

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.5	0.00319	0.00285	0.00262	0.00245	0.00232	0.00223
0.6	0.00442	0.00394	0.00362	0.00339	0.00321	0.00308
0.7	0.00581	0.00518	0.00476	0.00446	0.00423	0.00406
0.8	0.00736	0.00657	0.00604	0.00566	0.00537	0.00515
0.9	0.00908	0.00810	0.00745	0.00698	0.00663	0.00635
1.0	0.01095	0.00977	0.00899	0.00842	0.00800	0.00767
1.1	0.01298	0.01158	0.01066	0.00998	0.00948	0.00909
1.2	0.01515	0.01353	0.01245	0.01166	0.01107	0.01062
1.3	0.01747	0.01560	0.01436	0.01345	0.01277	0.01225
1.4	0.01994	0.01780	0.01639	0.01535	0.01458	0.01398
1.5	0.02254	0.02013	0.01854	0.01736	0.01649	0.01582
1.6	0.02529	0.02259	0.02080	0.01949	0.01851	0.01775
1.7	0.02817	0.02517	0.02318	0.02171	0.02063	0.01978
1.8	0.03119	0.02787	0.02567	0.02405	0.02285	0.02191
1.9	0.03435	0.03069	0.02827	0.02649	0.02517	0.02414
2.0	0.03763	0.03363	0.03098	0.02903	0.02758	0.02646
2.1	0.04105	0.03669	0.03380	0.03167	0.03010	0.02887
2.2	0.04460	0.03986	0.03673	0.03442	0.03271	0.03138
2.3	0.04828	0.04316	0.03977	0.03727	0.03542	0.03398
2.4	0.05208	0.04656	0.04291	0.04022	0.03822	0.03667
2.5	0.05602	0.05008	0.04615	0.04326	0.04111	0.03945
2.6	0.06007	0.05371	0.04950	0.04640	0.04410	0.04232
2.7	0.06426	0.05746	0.05296	0.04965	0.04719	0.04527
2.8	0.06856	0.06131	0.05652	0.05298	0.05036	0.04832
2.9	0.07299	0.06528	0.06017	0.05642	0.05362	0.05146
3.0	0.07754	0.06935	0.06393	0.05994	0.05698	0.05468
3.1	0.08221	0.07354	0.06780	0.06357	0.06043	0.05799
3.2	0.08700	0.07783	0.07176	0.06728	0.06396	0.06138
3.3	0.09191	0.08223	0.07582	0.07109	0.06759	0.06486
3.4	0.09694	0.08673	0.07997	0.07499	0.07130	0.06842
3.5	0.10209	0.09134	0.08423	0.07899	0.07510	0.07207
3.6	0.10735	0.09606	0.08858	0.08307	0.07898	0.07580
3.7	0.11273	0.10088	0.09303	0.08725	0.08296	0.07962
3.8	0.11823	0.10580	0.09758	0.09152	0.08702	0.08352
3.9	0.12384	0.11083	0.10222	0.09588	0.09116	0.08750
4.0	0.12956	0.11596	0.10696	0.10032	0.09540	0.09156
4.1	0.13540	0.12120	0.11179	0.10486	0.09971	0.09571
4.2	0.14136	0.12653	0.11672	0.10948	0.10411	0.09994
4.3	0.14742	0.13197	0.12174	0.11420	0.10860	0.10425
4.4	0.15360	0.13750	0.12685	0.11900	0.11317	0.10863
4.5	0.15989	0.14314	0.13206	0.12389	0.11782	0.11310
4.6	0.16629	0.14888	0.13736	0.12886	0.12256	0.11765
4.7	0.17280	0.15472	0.14275	0.13393	0.12738	0.12228
4.8	0.17942	0.16066	0.14823	0.13908	0.13228	0.12699
4.9	0.18615	0.16669	0.15381	0.14431	0.13726	0.13177
5.0	0.19299	0.17283	0.15948	0.14963	0.14232	0.13664
5.1	0.19994	0.17906	0.16523	0.15504	0.14747	0.14158
5.2	0.20700	0.18539	0.17108	0.16053	0.15270	0.14660
5.3	0.21416	0.19181	0.17702	0.16611	0.15800	0.15170
5.4	0.22144	0.19834	0.18304	0.17177	0.16339	0.15688
5.5	0.22882	0.20496	0.18916	0.17751	0.16886	0.16213

50% Glycol / Water Solution

PRESSURE LOSS PER FOOT
5/8" hePEX plus and AQUAPEX

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.1	0.00039	0.00034	0.00032	0.00030	0.00028	0.00027
0.2	0.00132	0.00118	0.00108	0.00101	0.00096	0.00092
0.3	0.00272	0.00242	0.00222	0.00208	0.00197	0.00189
0.4	0.00453	0.00404	0.00371	0.00347	0.00329	0.00316
0.5	0.00673	0.00600	0.00552	0.00516	0.00490	0.00470
0.6	0.00931	0.00830	0.00764	0.00715	0.00678	0.00650
0.7	0.01225	0.01092	0.01005	0.00941	0.00893	0.00856
0.8	0.01553	0.01386	0.01275	0.01194	0.01133	0.01086
0.9	0.01915	0.01709	0.01573	0.01473	0.01398	0.01341
1.0	0.02310	0.02062	0.01898	0.01777	0.01688	0.01618
1.1	0.02737	0.02444	0.02250	0.02107	0.02001	0.01919
1.2	0.03196	0.02854	0.02628	0.02461	0.02338	0.02242
1.3	0.03686	0.03292	0.03031	0.02839	0.02697	0.02586
1.4	0.04206	0.03757	0.03460	0.03241	0.03079	0.02953
1.5	0.04756	0.04249	0.03913	0.03666	0.03483	0.03340
1.6	0.05335	0.04767	0.04391	0.04114	0.03909	0.03749
1.7	0.05944	0.05311	0.04893	0.04585	0.04356	0.04179
1.8	0.06581	0.05882	0.05419	0.05078	0.04825	0.04629
1.9	0.07247	0.06477	0.05968	0.05593	0.05315	0.05099
2.0	0.07941	0.07098	0.06541	0.06130	0.05826	0.05589
2.1	0.08662	0.07744	0.07137	0.06689	0.06357	0.06099
2.2	0.09412	0.08415	0.07755	0.07270	0.06909	0.06629
2.3	0.10188	0.09110	0.08397	0.07871	0.07481	0.07178
2.4	0.10991	0.09829	0.09060	0.08494	0.08074	0.07747
2.5	0.11822	0.10573	0.09746	0.09137	0.08686	0.08334
2.6	0.12678	0.11340	0.10454	0.09802	0.09317	0.08941
2.7	0.13561	0.12131	0.11184	0.10487	0.09969	0.09566
2.8	0.14470	0.12945	0.11936	0.11192	0.10640	0.10210
2.9	0.15405	0.13783	0.12709	0.11917	0.11330	0.10873
3.0	0.16366	0.14643	0.13503	0.12663	0.12039	0.11554
3.1	0.17353	0.15527	0.14319	0.13429	0.12768	0.12254
3.2	0.18364	0.16434	0.15156	0.14214	0.13515	0.12971
3.3	0.19401	0.17363	0.16014	0.15019	0.14281	0.13707
3.4	0.20463	0.18314	0.16892	0.15844	0.15066	0.14461
3.5	0.21550	0.19289	0.17792	0.16689	0.15869	0.15232
3.6	0.22661	0.20285	0.18712	0.17552	0.16691	0.16022
3.7	0.23798	0.21303	0.19652	0.18435	0.17532	0.16829
3.8	0.24958	0.22344	0.20613	0.19337	0.18390	0.17653
3.9	0.26143	0.23406	0.21594	0.20259	0.19267	0.18495
4.0	0.27352	0.24490	0.22596	0.21199	0.20162	0.19355

PRESSURE LOSS PER FOOT
3/4" hePEX plus and AQUAPEX

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.5	0.00319	0.00285	0.00262	0.00245	0.00232	0.00223
0.6	0.00442	0.00394	0.00362	0.00339	0.00321	0.00308
0.7	0.00581	0.00518	0.00476	0.00446	0.00423	0.00406
0.8	0.00736	0.00657	0.00604	0.00566	0.00537	0.00515
0.9	0.00908	0.00810	0.00745	0.00698	0.00663	0.00635
1.0	0.01095	0.00977	0.00899	0.00842	0.00800	0.00767
1.1	0.01298	0.01158	0.01066	0.00998	0.00948	0.00909
1.2	0.01515	0.01353	0.01245	0.01166	0.01107	0.01062
1.3	0.01747	0.01560	0.01436	0.01345	0.01277	0.01225
1.4	0.01994	0.01780	0.01639	0.01535	0.01458	0.01398
1.5	0.02254	0.02013	0.01854	0.01736	0.01649	0.01582
1.6	0.02529	0.02259	0.02080	0.01949	0.01851	0.01775
1.7	0.02817	0.02517	0.02318	0.02171	0.02063	0.01978
1.8	0.03119	0.02787	0.02567	0.02405	0.02285	0.02191
1.9	0.03435	0.03069	0.02827	0.02649	0.02517	0.02414
2.0	0.03763	0.03363	0.03098	0.02903	0.02758	0.02646
2.1	0.04105	0.03669	0.03380	0.03167	0.03010	0.02887
2.2	0.04460	0.03986	0.03673	0.03442	0.03271	0.03138
2.3	0.04828	0.04316	0.03977	0.03727	0.03542	0.03398
2.4	0.05208	0.04656	0.04291	0.04022	0.03822	0.03667
2.5	0.05602	0.05008	0.04615	0.04326	0.04111	0.03945
2.6	0.06007	0.05371	0.04950	0.04640	0.04410	0.04232
2.7	0.06426	0.05746	0.05296	0.04965	0.04719	0.04527
2.8	0.06856	0.06131	0.05652	0.05298	0.05036	0.04832
2.9	0.07299	0.06528	0.06017	0.05642	0.05362	0.05146
3.0	0.07754	0.06935	0.06393	0.05994	0.05698	0.05468
3.1	0.08221	0.07354	0.06780	0.06357	0.06043	0.05799
3.2	0.08700	0.07783	0.07176	0.06728	0.06396	0.06138
3.3	0.09191	0.08223	0.07582	0.07109	0.06759	0.06486
3.4	0.09694	0.08673	0.07997	0.07499	0.07130	0.06842
3.5	0.10209	0.09134	0.08423	0.07899	0.07510	0.07207
3.6	0.10735	0.09606	0.08858	0.08307	0.07898	0.07580
3.7	0.11273	0.10088	0.09303	0.08725	0.08296	0.07962
3.8	0.11823	0.10580	0.09758	0.09152	0.08702	0.08352
3.9	0.12384	0.11083	0.10222	0.09588	0.09116	0.08750
4.0	0.12956	0.11596	0.10696	0.10032	0.09540	0.09156
4.1	0.13540	0.12120	0.11179	0.10486	0.09971	0.09571
4.2	0.14136	0.12653	0.11672	0.10948	0.10411	0.09994
4.3	0.14742	0.13197	0.12174	0.11420	0.10860	0.10425
4.4	0.15360	0.13750	0.12685	0.11900	0.11317	0.10863
4.5	0.15989	0.14314	0.13206	0.12389	0.11782	0.11310
4.6	0.16629	0.14888	0.13736	0.12886	0.12256	0.11765
4.7	0.17280	0.15472	0.14275	0.13393	0.12738	0.12228
4.8	0.17942	0.16066	0.14823	0.13908	0.13228	0.12699
4.9	0.18615	0.16669	0.15381	0.14431	0.13726	0.13177
5.0	0.19299	0.17283	0.15948	0.14963	0.14232	0.13664
5.1	0.19994	0.17906	0.16523	0.15504	0.14747	0.14158
5.2	0.20700	0.18539	0.17108	0.16053	0.15270	0.14660
5.3	0.21416	0.19181	0.17702	0.16611	0.15800	0.15170
5.4	0.22144	0.19834	0.18304	0.17177	0.16339	0.15688
5.5	0.22882	0.20496	0.18916	0.17751	0.16886	0.16213

50% Glycol / Water Solution

PRESSURE LOSS PER FOOT
5/8" hePEX plus and AQUAPEX

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.1	0.00039	0.00034	0.00032	0.00030	0.00028	0.00027
0.2	0.00132	0.00118	0.00108	0.00101	0.00096	0.00092
0.3	0.00272	0.00242	0.00222	0.00208	0.00197	0.00189
0.4	0.00453	0.00404	0.00371	0.00347	0.00329	0.00316
0.5	0.00673	0.00600	0.00552	0.00516	0.00490	0.00470
0.6	0.00931	0.00830	0.00764	0.00715	0.00678	0.00650
0.7	0.01225	0.01092	0.01005	0.00941	0.00893	0.00856
0.8	0.01553	0.01386	0.01275	0.01194	0.01133	0.01086
0.9	0.01915	0.01709	0.01573	0.01473	0.01398	0.01341
1.0	0.02310	0.02062	0.01898	0.01777	0.01688	0.01618
1.1	0.02737	0.02444	0.02250	0.02107	0.02001	0.01919
1.2	0.03196	0.02854	0.02628	0.02461	0.02338	0.02242
1.3	0.03686	0.03292	0.03031	0.02839	0.02697	0.02586
1.4	0.04206	0.03757	0.03460	0.03241	0.03079	0.02953
1.5	0.04756	0.04249	0.03913	0.03666	0.03483	0.03340
1.6	0.05335	0.04767	0.04391	0.04114	0.03909	0.03749
1.7	0.05944	0.05311	0.04893	0.04585	0.04356	0.04179
1.8	0.06581	0.05882	0.05419	0.05078	0.04825	0.04629
1.9	0.07247	0.06477	0.05968	0.05593	0.05315	0.05099
2.0	0.07941	0.07098	0.06541	0.06130	0.05826	0.05589
2.1	0.08662	0.07744	0.07137	0.06689	0.06357	0.06099
2.2	0.09412	0.08415	0.07755	0.07270	0.06909	0.06629
2.3	0.10188	0.09110	0.08397	0.07871	0.07481	0.07178
2.4	0.10991	0.09829	0.09060	0.08494	0.08074	0.07747
2.5	0.11822	0.10573	0.09746	0.09137	0.08686	0.08334
2.6	0.12678	0.11340	0.10454	0.09802	0.09317	0.08941
2.7	0.13561	0.12131	0.11184	0.10487	0.09969	0.09566
2.8	0.14470	0.12945	0.11936	0.11192	0.10640	0.10210
2.9	0.15405	0.13783	0.12709	0.11917	0.11330	0.10873
3.0	0.16366	0.14643	0.13503	0.12663	0.12039	0.11554
3.1	0.17353	0.15527	0.14319	0.13429	0.12768	0.12254
3.2	0.18364	0.16434	0.15156	0.14214	0.13515	0.12971
3.3	0.19401	0.17363	0.16014	0.15019	0.14281	0.13707
3.4	0.20463	0.18314	0.16892	0.15844	0.15066	0.14461
3.5	0.21550	0.19289	0.17792	0.16689	0.15869	0.15232
3.6	0.22661	0.20285	0.18712	0.17552	0.16691	0.16022
3.7	0.23798	0.21303	0.19652	0.18435	0.17532	0.16829
3.8	0.24958	0.22344	0.20613	0.19337	0.18390	0.17653
3.9	0.26143	0.23406	0.21594	0.20259	0.19267	0.18495
4.0	0.27352	0.24490	0.22596	0.21199	0.20162	0.19355

PRESSURE LOSS PER FOOT
3/4" hePEX plus and AQUAPEX

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.5	0.00319	0.00285	0.00262	0.00245	0.00232	0.00223
0.6	0.00442	0.00394	0.00362	0.00339	0.00321	0.00308
0.7	0.00581	0.00518	0.00476	0.00446	0.00423	0.00406
0.8	0.00736	0.00657	0.00604	0.00566	0.00537	0.00515
0.9	0.00908	0.00810	0.00745	0.00698	0.00663	0.00635
1.0	0.01095	0.00977	0.00899	0.00842	0.00800	0.00767
1.1	0.01298	0.01158	0.01066	0.00998	0.00948	0.00909
1.2	0.01515	0.01353	0.01245	0.01166	0.01107	0.01062
1.3	0.01747	0.01560	0.01436	0.01345	0.01277	0.01225
1.4	0.01994	0.01780	0.01639	0.01535	0.01458	0.01398
1.5	0.02254	0.02013	0.01854	0.01736	0.01649	0.01582
1.6	0.02529	0.02259	0.02080	0.01949	0.01851	0.01775
1.7	0.02817	0.02517	0.02318	0.02171	0.02063	0.01978
1.8	0.03119	0.02787	0.02567	0.02405	0.02285	0.02191
1.9	0.03435	0.03069	0.02827	0.02649	0.02517	0.02414
2.0	0.03763	0.03363	0.03098	0.02903	0.02758	0.02646
2.1	0.04105	0.03669	0.03380	0.03167	0.03010	0.02887
2.2	0.04460	0.03986	0.03673	0.03442	0.03271	0.03138
2.3	0.04828	0.04316	0.03977	0.03727	0.03542	0.03398
2.4	0.05208	0.04656	0.04291	0.04022	0.03822	0.03667
2.5	0.05602	0.05008	0.04615	0.04326	0.04111	0.03945
2.6	0.06007	0.05371	0.04950	0.04640	0.04410	0.04232
2.7	0.06426	0.05746	0.05296	0.04965	0.04719	0.04527
2.8	0.06856	0.06131	0.05652	0.05298	0.05036	0.04832
2.9	0.07299	0.06528	0.06017	0.05642	0.05362	0.05146
3.0	0.07754	0.06935	0.06393	0.05994	0.05698	0.05468
3.1	0.08221	0.07354	0.06780	0.06357	0.06043	0.05799
3.2	0.08700	0.07783	0.07176	0.06728	0.06396	0.06138
3.3	0.09191	0.08223	0.07582	0.07109	0.06759	0.06486
3.4	0.09694	0.08673	0.07997	0.07499	0.07130	0.06842
3.5	0.10209	0.09134	0.08423	0.07899	0.07510	0.07207
3.6	0.10735	0.09606	0.08858	0.08307	0.07898	0.07580
3.7	0.11273	0.10088	0.09303	0.08725	0.08296	0.07962
3.8	0.11823	0.10580	0.09758	0.09152	0.08702	0.08352
3.9	0.12384	0.11083	0.10222	0.09588	0.09116	0.08750
4.0	0.12956	0.11596	0.10696	0.10032	0.09540	0.09156
4.1	0.13540	0.12120	0.11179	0.10486	0.09971	0.09571
4.2	0.14136	0.12653	0.11672	0.10948	0.10411	0.09994
4.3	0.14742	0.13197	0.12174	0.11420	0.10860	0.10425
4.4	0.15360	0.13750	0.12685	0.11900	0.11317	0.10863
4.5	0.15989	0.14314	0.13206	0.12389	0.11782	0.11310
4.6	0.16629	0.14888	0.13736	0.12886	0.12256	0.11765
4.7	0.17280	0.15472	0.14275	0.13393	0.12738	0.12228
4.8	0.17942	0.16066	0.14823	0.13908	0.13228	0.12699
4.9	0.18615	0.16669	0.15381	0.14431	0.13726	0.13177
5.0	0.19299	0.17283	0.15948	0.14963	0.14232	0.13664
5.1	0.19994	0.17906	0.16523	0.15504	0.14747	0.14158
5.2	0.20700	0.18539	0.17108	0.16053	0.15270	0.14660
5.3	0.21416	0.19181	0.17702	0.16611	0.15800	0.15170
5.4	0.22144	0.19834	0.18304	0.17177	0.16339	0.15688
5.5	0.22882	0.20496	0.18916	0.17751	0.16886	0.16213

Notes

30% Glycol / Water Solution

PRESSURE LOSS PER FOOT
5/8" MultiCor

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.5	0.00364	0.00344	0.00318	0.00303	0.00288	0.00278
0.6	0.00504	0.00477	0.00440	0.00420	0.00398	0.00384
0.7	0.00663	0.00627	0.00579	0.00553	0.00524	0.00506
0.8	0.00841	0.00796	0.00735	0.00702	0.00666	0.00643
0.9	0.01037	0.00982	0.00906	0.00866	0.00821	0.00793
1.0	0.01251	0.01185	0.01094	0.01046	0.00992	0.00958
1.1	0.01483	0.01404	0.01297	0.01240	0.01176	0.01136
1.2	0.01732	0.01640	0.01515	0.01448	0.01374	0.01327
1.3	0.01998	0.01892	0.01748	0.01671	0.01585	0.01531
1.4	0.02281	0.02160	0.01996	0.01908	0.01810	0.01749
1.5	0.02579	0.02443	0.02258	0.02158	0.02048	0.01978
1.6	0.02894	0.02742	0.02534	0.02422	0.02299	0.02221
1.7	0.03225	0.03055	0.02824	0.02700	0.02562	0.02476
1.8	0.03572	0.03384	0.03128	0.02991	0.02838	0.02742
1.9	0.03934	0.03727	0.03445	0.03295	0.03127	0.03021
2.0	0.04311	0.04085	0.03776	0.03611	0.03428	0.03312
2.1	0.04704	0.04457	0.04121	0.03941	0.03741	0.03615
2.2	0.05111	0.04843	0.04478	0.04283	0.04066	0.03929
2.3	0.05534	0.05244	0.04849	0.04638	0.04403	0.04255
2.4	0.05971	0.05658	0.05233	0.05006	0.04752	0.04593
2.5	0.06423	0.06087	0.05630	0.05385	0.05113	0.04941
2.6	0.06889	0.06529	0.06040	0.05777	0.05485	0.05302
2.7	0.07370	0.06985	0.06462	0.06181	0.05869	0.05673
2.8	0.07865	0.07455	0.06897	0.06598	0.06265	0.06055
2.9	0.08374	0.07938	0.07344	0.07026	0.06671	0.06449
3.0	0.08898	0.08434	0.07804	0.07466	0.07090	0.06853
3.1	0.09435	0.08944	0.08276	0.07918	0.07519	0.07269
3.2	0.09986	0.09467	0.08760	0.08382	0.07960	0.07695
3.3	0.10551	0.10003	0.09257	0.08857	0.08412	0.08132
3.4	0.11130	0.10552	0.09766	0.09344	0.08875	0.08580
3.5	0.11722	0.11114	0.10286	0.09843	0.09349	0.09038
3.6	0.12328	0.11689	0.10819	0.10353	0.09834	0.09507
3.7	0.12948	0.12277	0.11364	0.10874	0.10329	0.09987
3.8	0.13580	0.12877	0.11920	0.11407	0.10836	0.10477
3.9	0.14227	0.13490	0.12489	0.11952	0.11353	0.10977
4.0	0.14886	0.14116	0.13069	0.12507	0.11881	0.11488
4.1	0.15559	0.14754	0.13660	0.13073	0.12420	0.12009
4.2	0.16244	0.15405	0.14264	0.13651	0.12969	0.12540
4.3	0.16943	0.16069	0.14878	0.14240	0.13529	0.13082
4.4	0.17655	0.16744	0.15505	0.14840	0.14099	0.13634
4.5	0.18380	0.17432	0.16142	0.15451	0.14680	0.14196
4.6	0.19118	0.18132	0.16792	0.16072	0.15271	0.14768
4.7	0.19868	0.18845	0.17452	0.16705	0.15873	0.15350
4.8	0.20632	0.19569	0.18124	0.17349	0.16485	0.15942
4.9	0.21408	0.20306	0.18807	0.18003	0.17107	0.16544
5.0	0.22196	0.21055	0.19502	0.18668	0.17740	0.17156

PRESSURE LOSS PER FOOT
3/4" MultiCor

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
1.0	0.00409	0.00388	0.00358	0.00342	0.00324	0.00313
1.2	0.00567	0.00536	0.00495	0.00473	0.00449	0.00434
1.4	0.00746	0.00706	0.00652	0.00623	0.00591	0.00571
1.6	0.00946	0.00896	0.00828	0.00792	0.00751	0.00725
1.8	0.01168	0.01106	0.01022	0.00977	0.00927	0.00896
2.0	0.01409	0.01335	0.01234	0.01180	0.01119	0.01081
2.2	0.01671	0.01583	0.01463	0.01399	0.01328	0.01283
2.4	0.01952	0.01849	0.01709	0.01635	0.01551	0.01499
2.6	0.02252	0.02133	0.01973	0.01886	0.01791	0.01730
2.8	0.02570	0.02436	0.02252	0.02154	0.02045	0.01976
3.0	0.02908	0.02755	0.02548	0.02437	0.02314	0.02236
3.2	0.03263	0.03093	0.02860	0.02736	0.02598	0.02511
3.4	0.03637	0.03447	0.03188	0.03050	0.02896	0.02799
3.6	0.04028	0.03818	0.03532	0.03379	0.03208	0.03101
3.8	0.04437	0.04206	0.03891	0.03723	0.03535	0.03417
4.0	0.04863	0.04610	0.04266	0.04081	0.03876	0.03747
4.2	0.05306	0.05031	0.04656	0.04455	0.04231	0.04090
4.4	0.05767	0.05467	0.05060	0.04842	0.04599	0.04446
4.6	0.06244	0.05920	0.05480	0.05244	0.04981	0.04816
4.8	0.06738	0.06389	0.05914	0.05660	0.05376	0.05198
5.0	0.07249	0.06874	0.06364	0.06090	0.05785	0.05594
5.2	0.07776	0.07374	0.06827	0.06534	0.06207	0.06002
5.4	0.08319	0.07890	0.07305	0.06992	0.06643	0.06423
5.6	0.08879	0.08421	0.07798	0.07463	0.07091	0.06857
5.8	0.09455	0.08967	0.08304	0.07949	0.07552	0.07303
6.0	0.10047	0.09529	0.08825	0.08448	0.08027	0.07762
6.2	0.10654	0.10106	0.09360	0.08960	0.08514	0.08234
6.4	0.11277	0.10698	0.09909	0.09485	0.09014	0.08717
6.6	0.11917	0.11304	0.10471	0.10024	0.09526	0.09213
6.8	0.12571	0.11926	0.11048	0.10577	0.10052	0.09721
7.0	0.13241	0.12562	0.11638	0.11142	0.10589	0.10242
7.2	0.13927	0.13213	0.12242	0.11720	0.11140	0.10774
7.4	0.14628	0.13878	0.12859	0.12312	0.11702	0.11319
7.6	0.15344	0.14558	0.13490	0.12916	0.12277	0.11875
7.8	0.16075	0.15253	0.14134	0.13533	0.12864	0.12443
8.0	0.16821	0.15961	0.14791	0.14163	0.13464	0.13023
8.2	0.17582	0.16684	0.15462	0.14806	0.14075	0.13615
8.4	0.18358	0.17421	0.16146	0.15461	0.14699	0.14219
8.6	0.19149	0.18173	0.16843	0.16129	0.15334	0.14834
8.8	0.19955	0.18938	0.17554	0.16810	0.15982	0.15461
9.0	0.20776	0.19717	0.18277	0.17503	0.16642	0.16099

30% Glycol / Water Solution

PRESSURE LOSS PER FOOT
5/8" MultiCor

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.5	0.00364	0.00344	0.00318	0.00303	0.00288	0.00278
0.6	0.00504	0.00477	0.00440	0.00420	0.00398	0.00384
0.7	0.00663	0.00627	0.00579	0.00553	0.00524	0.00506
0.8	0.00841	0.00796	0.00735	0.00702	0.00666	0.00643
0.9	0.01037	0.00982	0.00906	0.00866	0.00821	0.00793
1.0	0.01251	0.01185	0.01094	0.01046	0.00992	0.00958
1.1	0.01483	0.01404	0.01297	0.01240	0.01176	0.01136
1.2	0.01732	0.01640	0.01515	0.01448	0.01374	0.01327
1.3	0.01998	0.01892	0.01748	0.01671	0.01585	0.01531
1.4	0.02281	0.02160	0.01996	0.01908	0.01810	0.01749
1.5	0.02579	0.02443	0.02258	0.02158	0.02048	0.01978
1.6	0.02894	0.02742	0.02534	0.02422	0.02299	0.02221
1.7	0.03225	0.03055	0.02824	0.02700	0.02562	0.02476
1.8	0.03572	0.03384	0.03128	0.02991	0.02838	0.02742
1.9	0.03934	0.03727	0.03445	0.03295	0.03127	0.03021
2.0	0.04311	0.04085	0.03776	0.03611	0.03428	0.03312
2.1	0.04704	0.04457	0.04121	0.03941	0.03741	0.03615
2.2	0.05111	0.04843	0.04478	0.04283	0.04066	0.03929
2.3	0.05534	0.05244	0.04849	0.04638	0.04403	0.04255
2.4	0.05971	0.05658	0.05233	0.05006	0.04752	0.04593
2.5	0.06423	0.06087	0.05630	0.05385	0.05113	0.04941
2.6	0.06889	0.06529	0.06040	0.05777	0.05485	0.05302
2.7	0.07370	0.06985	0.06462	0.06181	0.05869	0.05673
2.8	0.07865	0.07455	0.06897	0.06598	0.06265	0.06055
2.9	0.08374	0.07938	0.07344	0.07026	0.06671	0.06449
3.0	0.08898	0.08434	0.07804	0.07466	0.07090	0.06853
3.1	0.09435	0.08944	0.08276	0.07918	0.07519	0.07269
3.2	0.09986	0.09467	0.08760	0.08382	0.07960	0.07695
3.3	0.10551	0.10003	0.09257	0.08857	0.08412	0.08132
3.4	0.11130	0.10552	0.09766	0.09344	0.08875	0.08580
3.5	0.11722	0.11114	0.10286	0.09843	0.09349	0.09038
3.6	0.12328	0.11689	0.10819	0.10353	0.09834	0.09507
3.7	0.12948	0.12277	0.11364	0.10874	0.10329	0.09987
3.8	0.13580	0.12877	0.11920	0.11407	0.10836	0.10477
3.9	0.14227	0.13490	0.12489	0.11952	0.11353	0.10977
4.0	0.14886	0.14116	0.13069	0.12507	0.11881	0.11488
4.1	0.15559	0.14754	0.13660	0.13073	0.12420	0.12009
4.2	0.16244	0.15405	0.14264	0.13651	0.12969	0.12540
4.3	0.16943	0.16069	0.14878	0.14240	0.13529	0.13082
4.4	0.17655	0.16744	0.15505	0.14840	0.14099	0.13634
4.5	0.18380	0.17432	0.16142	0.15451	0.14680	0.14196
4.6	0.19118	0.18132	0.16792	0.16072	0.15271	0.14768
4.7	0.19868	0.18845	0.17452	0.16705	0.15873	0.15350
4.8	0.20632	0.19569	0.18124	0.17349	0.16485	0.15942
4.9	0.21408	0.20306	0.18807	0.18003	0.17107	0.16544
5.0	0.22196	0.21055	0.19502	0.18668	0.17740	0.17156

PRESSURE LOSS PER FOOT
3/4" MultiCor

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
1.0	0.00409	0.00388	0.00358	0.00342	0.00324	0.00313
1.2	0.00567	0.00536	0.00495	0.00473	0.00449	0.00434
1.4	0.00746	0.00706	0.00652	0.00623	0.00591	0.00571
1.6	0.00946	0.00896	0.00828	0.00792	0.00751	0.00725
1.8	0.01168	0.01106	0.01022	0.00977	0.00927	0.00896
2.0	0.01409	0.01335	0.01234	0.01180	0.01119	0.01081
2.2	0.01671	0.01583	0.01463	0.01399	0.01328	0.01283
2.4	0.01952	0.01849	0.01709	0.01635	0.01551	0.01499
2.6	0.02252	0.02133	0.01973	0.01886	0.01791	0.01730
2.8	0.02570	0.02436	0.02252	0.02154	0.02045	0.01976
3.0	0.02908	0.02755	0.02548	0.02437	0.02314	0.02236
3.2	0.03263	0.03093	0.02860	0.02736	0.02598	0.02511
3.4	0.03637	0.03447	0.03188	0.03050	0.02896	0.02799
3.6	0.04028	0.03818	0.03532	0.03379	0.03208	0.03101
3.8	0.04437	0.04206	0.03891	0.03723	0.03535	0.03417
4.0	0.04863	0.04610	0.04266	0.04081	0.03876	0.03747
4.2	0.05306	0.05031	0.04656	0.04455	0.04231	0.04090
4.4	0.05767	0.05467	0.05060	0.04842	0.04599	0.04446
4.6	0.06244	0.05920	0.05480	0.05244	0.04981	0.04816
4.8	0.06738	0.06389	0.05914	0.05660	0.05376	0.05198
5.0	0.07249	0.06874	0.06364	0.06090	0.05785	0.05594
5.2	0.07776	0.07374	0.06827	0.06534	0.06207	0.06002
5.4	0.08319	0.07890	0.07305	0.06992	0.06643	0.06423
5.6	0.08879	0.08421	0.07798	0.07463	0.07091	0.06857
5.8	0.09455	0.08967	0.08304	0.07949	0.07552	0.07303
6.0	0.10047	0.09529	0.08825	0.08448	0.08027	0.07762
6.2	0.10654	0.10106	0.09360	0.08960	0.08514	0.08234
6.4	0.11277	0.10698	0.09909	0.09485	0.09014	0.08717
6.6	0.11917	0.11304	0.10471	0.10024	0.09526	0.09213
6.8	0.12571	0.11926	0.11048	0.10577	0.10052	0.09721
7.0	0.13241	0.12562	0.11638	0.11142	0.10589	0.10242
7.2	0.13927	0.13213	0.12242	0.11720	0.11140	0.10774
7.4	0.14628	0.13878	0.12859	0.12312	0.11702	0.11319
7.6	0.15344	0.14558	0.13490	0.12916	0.12277	0.11875
7.8	0.16075	0.15253	0.14134	0.13533	0.12864	0.12443
8.0	0.16821	0.15961	0.14791	0.14163	0.13464	0.13023
8.2	0.17582	0.16684	0.15462	0.14806	0.14075	0.13615
8.4	0.18358	0.17421	0.16146	0.15461	0.14699	0.14219
8.6	0.19149	0.18173	0.16843	0.16129	0.15334	0.14834
8.8	0.19955	0.18938	0.17554	0.16810	0.15982	0.15461
9.0	0.20776	0.19717	0.18277	0.17503	0.16642	0.16099

40% Glycol / Water Solution

PRESSURE LOSS PER FOOT
5/8" MultiCor

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.5	0.00400	0.00373	0.00348	0.00325	0.00306	0.00290
0.6	0.00553	0.00516	0.00482	0.00450	0.00423	0.00402
0.7	0.00728	0.00679	0.00635	0.00592	0.00557	0.00530
0.8	0.00923	0.00862	0.00805	0.00752	0.00707	0.00672
0.9	0.01138	0.01063	0.00993	0.00928	0.00873	0.00829
1.0	0.01373	0.01283	0.01199	0.01120	0.01053	0.01001
1.1	0.01627	0.01520	0.01421	0.01327	0.01249	0.01187
1.2	0.01900	0.01775	0.01659	0.01550	0.01459	0.01387
1.3	0.02191	0.02048	0.01914	0.01788	0.01683	0.01601
1.4	0.02501	0.02337	0.02185	0.02042	0.01922	0.01827
1.5	0.02828	0.02643	0.02471	0.02309	0.02174	0.02068
1.6	0.03173	0.02966	0.02773	0.02592	0.02440	0.02321
1.7	0.03535	0.03305	0.03090	0.02888	0.02719	0.02587
1.8	0.03915	0.03660	0.03422	0.03199	0.03012	0.02865
1.9	0.04311	0.04031	0.03770	0.03524	0.03318	0.03157
2.0	0.04724	0.04417	0.04131	0.03862	0.03637	0.03460
2.1	0.05154	0.04819	0.04508	0.04215	0.03969	0.03776
2.2	0.05600	0.05237	0.04899	0.04580	0.04314	0.04104
2.3	0.06063	0.05669	0.05304	0.04959	0.04671	0.04445
2.4	0.06541	0.06117	0.05723	0.05352	0.05041	0.04797
2.5	0.07036	0.06580	0.06156	0.05757	0.05423	0.05161
2.6	0.07546	0.07058	0.06604	0.06176	0.05818	0.05537
2.7	0.08072	0.07550	0.07065	0.06608	0.06225	0.05924
2.8	0.08614	0.08057	0.07539	0.07052	0.06644	0.06323
2.9	0.09171	0.08579	0.08028	0.07510	0.07075	0.06734
3.0	0.09743	0.09115	0.08530	0.07979	0.07518	0.07156
3.1	0.10331	0.09665	0.09045	0.08462	0.07973	0.07590
3.2	0.10934	0.10229	0.09574	0.08957	0.08440	0.08034
3.3	0.11552	0.10808	0.10116	0.09465	0.08919	0.08490
3.4	0.12185	0.11401	0.10671	0.09985	0.09409	0.08957
3.5	0.12832	0.12007	0.11239	0.10517	0.09911	0.09436
3.6	0.13495	0.12628	0.11821	0.11061	0.10425	0.09925
3.7	0.14172	0.13262	0.12415	0.11618	0.10950	0.10425
3.8	0.14864	0.13910	0.13022	0.12187	0.11486	0.10936
3.9	0.15570	0.14571	0.13642	0.12767	0.12034	0.11458
4.0	0.16291	0.15247	0.14275	0.13360	0.12593	0.11991
4.1	0.17026	0.15935	0.14920	0.13965	0.13164	0.12534
4.2	0.17776	0.16637	0.15578	0.14581	0.13745	0.13089
4.3	0.18540	0.17353	0.16249	0.15209	0.14338	0.13653
4.4	0.19318	0.18082	0.16932	0.15849	0.14942	0.14229
4.5	0.20110	0.18824	0.17627	0.16501	0.15557	0.14815
4.6	0.20916	0.19579	0.18335	0.17164	0.16183	0.15412
4.7	0.21736	0.20348	0.19055	0.17839	0.16819	0.16019
4.8	0.22570	0.21129	0.19788	0.18526	0.17467	0.16636
4.9	0.23418	0.21924	0.20533	0.19224	0.18126	0.17264
5.0	0.24280	0.22731	0.21290	0.19933	0.18795	0.17902
5.1	0.25155	0.23551	0.22059	0.20654	0.19476	0.18550
5.2	0.26045	0.24385	0.22840	0.21386	0.20167	0.19209
5.3	0.26948	0.25231	0.23633	0.22129	0.20868	0.19878
5.4	0.27864	0.26090	0.24439	0.22884	0.21581	0.20557
5.5	0.28794	0.26961	0.25256	0.23650	0.22304	0.21246

PRESSURE LOSS PER FOOT
3/4" MultiCor

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
1.0	0.00449	0.00420	0.00392	0.00366	0.00344	0.00327
1.2	0.00622	0.00581	0.00543	0.00507	0.00477	0.00453
1.4	0.00818	0.00765	0.00714	0.00667	0.00628	0.00597
1.6	0.01038	0.00970	0.00907	0.00847	0.00797	0.00758
1.8	0.01281	0.01197	0.01119	0.01046	0.00984	0.00936
2.0	0.01545	0.01444	0.01350	0.01262	0.01188	0.01130
2.2	0.01832	0.01712	0.01601	0.01497	0.01409	0.01340
2.4	0.02139	0.02000	0.01870	0.01748	0.01646	0.01566
2.6	0.02467	0.02307	0.02158	0.02017	0.01900	0.01808
2.8	0.02816	0.02634	0.02463	0.02303	0.02169	0.02064
3.0	0.03185	0.02979	0.02787	0.02606	0.02455	0.02336
3.2	0.03574	0.03343	0.03128	0.02925	0.02755	0.02622
3.4	0.03983	0.03726	0.03486	0.03260	0.03072	0.02923
3.6	0.04411	0.04126	0.03861	0.03612	0.03403	0.03239
3.8	0.04858	0.04545	0.04253	0.03979	0.03749	0.03568
4.0	0.05324	0.04981	0.04662	0.04362	0.04110	0.03912
4.2	0.05809	0.05435	0.05087	0.04760	0.04486	0.04270
4.4	0.06313	0.05907	0.05529	0.05174	0.04876	0.04642
4.6	0.06835	0.06396	0.05987	0.05603	0.05280	0.05027
4.8	0.07375	0.06902	0.06461	0.06047	0.05699	0.05426
5.0	0.07933	0.07424	0.06951	0.06506	0.06132	0.05839
5.2	0.08509	0.07964	0.07457	0.06979	0.06579	0.06265
5.4	0.09103	0.08521	0.07978	0.07468	0.07040	0.06704
5.6	0.09715	0.09094	0.08515	0.07971	0.07515	0.07156
5.8	0.10344	0.09683	0.09068	0.08489	0.08003	0.07622
6.0	0.10991	0.10289	0.09636	0.09021	0.08505	0.08100
6.2	0.11655	0.10911	0.10219	0.09567	0.09021	0.08592
6.4	0.12336	0.11549	0.10817	0.10128	0.09550	0.09096
6.6	0.13034	0.12203	0.11430	0.10703	0.10093	0.09613
6.8	0.13749	0.12873	0.12059	0.11292	0.10648	0.10143
7.0	0.14481	0.13559	0.12702	0.11894	0.11217	0.10686
7.2	0.15230	0.14261	0.13360	0.12511	0.11800	0.11241
7.4	0.15995	0.14978	0.14032	0.13142	0.12395	0.11808
7.6	0.16777	0.15711	0.14720	0.13786	0.13003	0.12388
7.8	0.17575	0.16460	0.15422	0.14444	0.13624	0.12981
8.0	0.18390	0.17224	0.16138	0.15116	0.14258	0.13585
8.2	0.19221	0.18003	0.16869	0.15801	0.14905	0.14202
8.4	0.20069	0.18797	0.17614	0.16500	0.15565	0.14831
8.6	0.20932	0.19607	0.18373	0.17212	0.16238	0.15472
8.8	0.21812	0.20432	0.19147	0.17937	0.16923	0.16126
9.0	0.22708	0.21271	0.19935	0.18676	0.17620	0.16791
9.2	0.23619	0.22126	0.20737	0.19428	0.18330	0.17468
9.4	0.24547	0.22996	0.21552	0.20193	0.19053	0.18158
9.6	0.25490	0.23880	0.22382	0.20972	0.19788	0.18859
9.8	0.26449	0.24780	0.23226	0.21763	0.20536	0.19572
10.0	0.27424	0.25694	0.24084	0.22568	0.21296	0.20297
10.2	0.28414	0.26623	0.24955	0.23385	0.22068	0.21033
10.4	0.29420	0.27566	0.25840	0.24215	0.22852	0.21781
10.6	0.30442	0.28524	0.26739	0.25059	0.23649	0.22541
10.8	0.31479	0.29496	0.27652	0.25915	0.24457	0.23313
11.0	0.32531	0.30483	0.28578	0.26784	0.25278	0.24096

40% Glycol / Water Solution

PRESSURE LOSS PER FOOT
5/8" MultiCor

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.5	0.00400	0.00373	0.00348	0.00325	0.00306	0.00290
0.6	0.00553	0.00516	0.00482	0.00450	0.00423	0.00402
0.7	0.00728	0.00679	0.00635	0.00592	0.00557	0.00530
0.8	0.00923	0.00862	0.00805	0.00752	0.00707	0.00672
0.9	0.01138	0.01063	0.00993	0.00928	0.00873	0.00829
1.0	0.01373	0.01283	0.01199	0.01120	0.01053	0.01001
1.1	0.01627	0.01520	0.01421	0.01327	0.01249	0.01187
1.2	0.01900	0.01775	0.01659	0.01550	0.01459	0.01387
1.3	0.02191	0.02048	0.01914	0.01788	0.01683	0.01601
1.4	0.02501	0.02337	0.02185	0.02042	0.01922	0.01827
1.5	0.02828	0.02643	0.02471	0.02309	0.02174	0.02068
1.6	0.03173	0.02966	0.02773	0.02592	0.02440	0.02321
1.7	0.03535	0.03305	0.03090	0.02888	0.02719	0.02587
1.8	0.03915	0.03660	0.03422	0.03199	0.03012	0.02865
1.9	0.04311	0.04031	0.03770	0.03524	0.03318	0.03157
2.0	0.04724	0.04417	0.04131	0.03862	0.03637	0.03460
2.1	0.05154	0.04819	0.04508	0.04215	0.03969	0.03776
2.2	0.05600	0.05237	0.04899	0.04580	0.04314	0.04104
2.3	0.06063	0.05669	0.05304	0.04959	0.04671	0.04445
2.4	0.06541	0.06117	0.05723	0.05352	0.05041	0.04797
2.5	0.07036	0.06580	0.06156	0.05757	0.05423	0.05161
2.6	0.07546	0.07058	0.06604	0.06176	0.05818	0.05537
2.7	0.08072	0.07550	0.07065	0.06608	0.06225	0.05924
2.8	0.08614	0.08057	0.07539	0.07052	0.06644	0.06323
2.9	0.09171	0.08579	0.08028	0.07510	0.07075	0.06734
3.0	0.09743	0.09115	0.08530	0.07979	0.07518	0.07156
3.1	0.10331	0.09665	0.09045	0.08462	0.07973	0.07590
3.2	0.10934	0.10229	0.09574	0.08957	0.08440	0.08034
3.3	0.11552	0.10808	0.10116	0.09465	0.08919	0.08490
3.4	0.12185	0.11401	0.10671	0.09985	0.09409	0.08957
3.5	0.12832	0.12007	0.11239	0.10517	0.09911	0.09436
3.6	0.13495	0.12628	0.11821	0.11061	0.10425	0.09925
3.7	0.14172	0.13262	0.12415	0.11618	0.10950	0.10425
3.8	0.14864	0.13910	0.13022	0.12187	0.11486	0.10936
3.9	0.15570	0.14571	0.13642	0.12767	0.12034	0.11458
4.0	0.16291	0.15247	0.14275	0.13360	0.12593	0.11991
4.1	0.17026	0.15935	0.14920	0.13965	0.13164	0.12534
4.2	0.17776	0.16637	0.15578	0.14581	0.13745	0.13089
4.3	0.18540	0.17353	0.16249	0.15209	0.14338	0.13653
4.4	0.19318	0.18082	0.16932	0.15849	0.14942	0.14229
4.5	0.20110	0.18824	0.17627	0.16501	0.15557	0.14815
4.6	0.20916	0.19579	0.18335	0.17164	0.16183	0.15412
4.7	0.21736	0.20348	0.19055	0.17839	0.16819	0.16019
4.8	0.22570	0.21129	0.19788	0.18526	0.17467	0.16636
4.9	0.23418	0.21924	0.20533	0.19224	0.18126	0.17264
5.0	0.24280	0.22731	0.21290	0.19933	0.18795	0.17902
5.1	0.25155	0.23551	0.22059	0.20654	0.19476	0.18550
5.2	0.26045	0.24385	0.22840	0.21386	0.20167	0.19209
5.3	0.26948	0.25231	0.23633	0.22129	0.20868	0.19878
5.4	0.27864	0.26090	0.24439	0.22884	0.21581	0.20557
5.5	0.28794	0.26961	0.25256	0.23650	0.22304	0.21246

PRESSURE LOSS PER FOOT
3/4" MultiCor

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
1.0	0.00449	0.00420	0.00392	0.00366	0.00344	0.00327
1.2	0.00622	0.00581	0.00543	0.00507	0.00477	0.00453
1.4	0.00818	0.00765	0.00714	0.00667	0.00628	0.00597
1.6	0.01038	0.00970	0.00907	0.00847	0.00797	0.00758
1.8	0.01281	0.01197	0.01119	0.01046	0.00984	0.00936
2.0	0.01545	0.01444	0.01350	0.01262	0.01188	0.01130
2.2	0.01832	0.01712	0.01601	0.01497	0.01409	0.01340
2.4	0.02139	0.02000	0.01870	0.01748	0.01646	0.01566
2.6	0.02467	0.02307	0.02158	0.02017	0.01900	0.01808
2.8	0.02816	0.02634	0.02463	0.02303	0.02169	0.02064
3.0	0.03185	0.02979	0.02787	0.02606	0.02455	0.02336
3.2	0.03574	0.03343	0.03128	0.02925	0.02755	0.02622
3.4	0.03983	0.03726	0.03486	0.03260	0.03072	0.02923
3.6	0.04411	0.04126	0.03861	0.03612	0.03403	0.03239
3.8	0.04858	0.04545	0.04253	0.03979	0.03749	0.03568
4.0	0.05324	0.04981	0.04662	0.04362	0.04110	0.03912
4.2	0.05809	0.05435	0.05087	0.04760	0.04486	0.04270
4.4	0.06313	0.05907	0.05529	0.05174	0.04876	0.04642
4.6	0.06835	0.06396	0.05987	0.05603	0.05280	0.05027
4.8	0.07375	0.06902	0.06461	0.06047	0.05699	0.05426
5.0	0.07933	0.07424	0.06951	0.06506	0.06132	0.05839
5.2	0.08509	0.07964	0.07457	0.06979	0.06579	0.06265
5.4	0.09103	0.08521	0.07978	0.07468	0.07040	0.06704
5.6	0.09715	0.09094	0.08515	0.07971	0.07515	0.07156
5.8	0.10344	0.09683	0.09068	0.08489	0.08003	0.07622
6.0	0.10991	0.10289	0.09636	0.09021	0.08505	0.08100
6.2	0.11655	0.10911	0.10219	0.09567	0.09021	0.08592
6.4	0.12336	0.11549	0.10817	0.10128	0.09550	0.09096
6.6	0.13034	0.12203	0.11430	0.10703	0.10093	0.09613
6.8	0.13749	0.12873	0.12059	0.11292	0.10648	0.10143
7.0	0.14481	0.13559	0.12702	0.11894	0.11217	0.10686
7.2	0.15230	0.14261	0.13360	0.12511	0.11800	0.11241
7.4	0.15995	0.14978	0.14032	0.13142	0.12395	0.11808
7.6	0.16777	0.15711	0.14720	0.13786	0.13003	0.12388
7.8	0.17575	0.16460	0.15422	0.14444	0.13624	0.12981
8.0	0.18390	0.17224	0.16138	0.15116	0.14258	0.13585
8.2	0.19221	0.18003	0.16869	0.15801	0.14905	0.14202
8.4	0.20069	0.18797	0.17614	0.16500	0.15565	0.14831
8.6	0.20932	0.19607	0.18373	0.17212	0.16238	0.15472
8.8	0.21812	0.20432	0.19147	0.17937	0.16923	0.16126
9.0	0.22708	0.21271	0.19935	0.18676	0.17620	0.16791
9.2	0.23619	0.22126	0.20737	0.19428	0.18330	0.17468
9.4	0.24547	0.22996	0.21552	0.20193	0.19053	0.18158
9.6	0.25490	0.23880	0.22382	0.20972	0.19788	0.18859
9.8	0.26449	0.24780	0.23226	0.21763	0.20536	0.19572
10.0	0.27424	0.25694	0.24084	0.22568	0.21296	0.20297
10.2	0.28414	0.26623	0.24955	0.23385	0.22068	0.21033
10.4	0.29420	0.27566	0.25840	0.24215	0.22852	0.21781
10.6	0.30442	0.28524	0.26739	0.25059	0.23649	0.22541
10.8	0.31479	0.29496	0.27652	0.25915	0.24457	0.23313
11.0	0.32531	0.30483	0.28578	0.26784	0.25278	0.24096

50% Glycol / Water Solution

PRESSURE LOSS PER FOOT
5/8" MultiCor

	Head (Feet of Water) Per Foot of Tubing					
gpm	**80°F**	**100°F**	**120°F**	**140°F**	**160°F**	**180°F**
0.5	0.00442	0.00394	0.00362	0.00339	0.00321	0.00308
0.6	0.00610	0.00544	0.00501	0.00469	0.00445	0.00426
0.7	0.00803	0.00716	0.00659	0.00617	0.00585	0.00561
0.8	0.01018	0.00908	0.00836	0.00782	0.00743	0.00712
0.9	0.01256	0.01120	0.01031	0.00965	0.00917	0.00879
1.0	0.01515	0.01352	0.01244	0.01165	0.01106	0.01060
1.1	0.01795	0.01602	0.01475	0.01381	0.01311	0.01257
1.2	0.02095	0.01871	0.01722	0.01613	0.01532	0.01469
1.3	0.02416	0.02158	0.01986	0.01861	0.01767	0.01695
1.4	0.02757	0.02462	0.02267	0.02124	0.02017	0.01935
1.5	0.03118	0.02785	0.02564	0.02402	0.02282	0.02189
1.6	0.03497	0.03124	0.02877	0.02696	0.02561	0.02456
1.7	0.03896	0.03481	0.03206	0.03004	0.02854	0.02738
1.8	0.04314	0.03855	0.03551	0.03327	0.03161	0.03032
1.9	0.04750	0.04245	0.03911	0.03665	0.03482	0.03340
2.0	0.05205	0.04652	0.04286	0.04017	0.03817	0.03661
2.1	0.05678	0.05075	0.04676	0.04383	0.04165	0.03995
2.2	0.06169	0.05515	0.05082	0.04763	0.04526	0.04342
2.3	0.06678	0.05970	0.05502	0.05157	0.04901	0.04702
2.4	0.07204	0.06441	0.05936	0.05565	0.05289	0.05074
2.5	0.07748	0.06928	0.06386	0.05986	0.05690	0.05459
2.6	0.08310	0.07431	0.06849	0.06421	0.06103	0.05856
2.7	0.08888	0.07949	0.07328	0.06870	0.06530	0.06266
2.8	0.09484	0.08483	0.07820	0.07332	0.06969	0.06687
2.9	0.10097	0.09031	0.08326	0.07807	0.07421	0.07121
3.0	0.10726	0.09595	0.08846	0.08295	0.07886	0.07567
3.1	0.11372	0.10174	0.09381	0.08796	0.08363	0.08025
3.2	0.12035	0.10768	0.09929	0.09311	0.08852	0.08495
3.3	0.12715	0.11376	0.10491	0.09838	0.09354	0.08977
3.4	0.13410	0.12000	0.11066	0.10378	0.09867	0.09470
3.5	0.14122	0.12638	0.11655	0.10931	0.10393	0.09975
3.6	0.14851	0.13290	0.12258	0.11497	0.10932	0.10492
3.7	0.15595	0.13958	0.12874	0.12075	0.11482	0.11020
3.8	0.16355	0.14639	0.13503	0.12665	0.12044	0.11560
3.9	0.17132	0.15335	0.14145	0.13269	0.12618	0.12111
4.0	0.17924	0.16045	0.14801	0.13884	0.13204	0.12674
4.1	0.18732	0.16769	0.15470	0.14512	0.13801	0.13248
4.2	0.19556	0.17508	0.16152	0.15153	0.14410	0.13833
4.3	0.20395	0.18260	0.16847	0.15805	0.15031	0.14430
4.4	0.21250	0.19026	0.17555	0.16470	0.15664	0.15037
4.5	0.22120	0.19807	0.18275	0.17147	0.16308	0.15656
4.6	0.23006	0.20601	0.19009	0.17835	0.16964	0.16286
4.7	0.23907	0.21409	0.19755	0.18536	0.17631	0.16927
4.8	0.24823	0.22231	0.20514	0.19249	0.18309	0.17578
4.9	0.25754	0.23066	0.21286	0.19974	0.18999	0.18241
5.0	0.26701	0.23915	0.22071	0.20711	0.19700	0.18915
5.1	0.27662	0.24777	0.22867	0.21459	0.20413	0.19599
5.2	0.28639	0.25653	0.23677	0.22219	0.21137	0.20295
5.3	0.29630	0.26543	0.24499	0.22991	0.21872	0.21001
5.4	0.30637	0.27446	0.25333	0.23775	0.22618	0.21717
5.5	0.31658	0.28362	0.26180	0.24570	0.23375	0.22445

PRESSURE LOSS PER FOOT
3/4" MultiCor

	Head (Feet of Water) Per Foot of Tubing					
gpm	**80°F**	**100°F**	**120°F**	**140°F**	**160°F**	**180°F**
1.0	0.00496	0.00442	0.00407	0.00381	0.00362	0.00347
1.2	0.00686	0.00612	0.00563	0.00527	0.00501	0.00480
1.4	0.00902	0.00806	0.00742	0.00694	0.00659	0.00632
1.6	0.01145	0.01022	0.00941	0.00881	0.00837	0.00803
1.8	0.01412	0.01261	0.01161	0.01088	0.01033	0.00991
2.0	0.01703	0.01521	0.01401	0.01313	0.01247	0.01196
2.2	0.02018	0.01803	0.01661	0.01556	0.01479	0.01418
2.4	0.02357	0.02106	0.01940	0.01818	0.01728	0.01657
2.6	0.02718	0.02430	0.02239	0.02098	0.01994	0.01912
2.8	0.03102	0.02773	0.02556	0.02395	0.02276	0.02184
3.0	0.03508	0.03137	0.02891	0.02710	0.02575	0.02471
3.2	0.03936	0.03520	0.03244	0.03041	0.02891	0.02774
3.4	0.04386	0.03922	0.03616	0.03390	0.03222	0.03092
3.6	0.04857	0.04344	0.04005	0.03755	0.03569	0.03425
3.8	0.05348	0.04784	0.04411	0.04136	0.03932	0.03773
4.0	0.05861	0.05244	0.04835	0.04534	0.04310	0.04137
4.2	0.06394	0.05721	0.05276	0.04948	0.04704	0.04515
4.4	0.06948	0.06217	0.05734	0.05377	0.05113	0.04907
4.6	0.07521	0.06731	0.06208	0.05823	0.05537	0.05314
4.8	0.08115	0.07263	0.06700	0.06284	0.05976	0.05736
5.0	0.08729	0.07813	0.07207	0.06761	0.06429	0.06171
5.2	0.09362	0.08381	0.07732	0.07253	0.06898	0.06621
5.4	0.10014	0.08966	0.08272	0.07760	0.07381	0.07085
5.6	0.10686	0.09569	0.08829	0.08283	0.07878	0.07563
5.8	0.11378	0.10188	0.09401	0.08821	0.08390	0.08054
6.0	0.12088	0.10825	0.09989	0.09373	0.08915	0.08559
6.2	0.12817	0.11479	0.10594	0.09941	0.09456	0.09078
6.4	0.13565	0.12150	0.11214	0.10523	0.10010	0.09611
6.6	0.14332	0.12838	0.11849	0.11120	0.10578	0.10157
6.8	0.15117	0.13543	0.12500	0.11731	0.11160	0.10716
7.0	0.15921	0.14264	0.13166	0.12357	0.11756	0.11288
7.2	0.16743	0.15001	0.13848	0.12997	0.12366	0.11874
7.4	0.17583	0.15755	0.14545	0.13652	0.12989	0.12473
7.6	0.18442	0.16526	0.15257	0.14321	0.13626	0.13085
7.8	0.19318	0.17312	0.15984	0.15004	0.14276	0.13710
8.0	0.20213	0.18115	0.16726	0.15702	0.14940	0.14348
8.2	0.21125	0.18934	0.17483	0.16413	0.15618	0.14999
8.4	0.22055	0.19769	0.18255	0.17138	0.16308	0.15663
8.6	0.23003	0.20620	0.19042	0.17877	0.17012	0.16339
8.8	0.23969	0.21486	0.19843	0.18630	0.17729	0.17028
9.0	0.24952	0.22369	0.20659	0.19397	0.18460	0.17730
9.2	0.25952	0.23267	0.21490	0.20178	0.19203	0.18445
9.4	0.26970	0.24181	0.22335	0.20972	0.19959	0.19172
9.6	0.28005	0.25111	0.23194	0.21780	0.20729	0.19911
9.8	0.29057	0.26056	0.24068	0.22601	0.21511	0.20663
10.0	0.30126	0.27016	0.24956	0.23436	0.22307	0.21428
10.2	0.31213	0.27992	0.25859	0.24285	0.23115	0.22204
10.4	0.32316	0.28983	0.26776	0.25147	0.23936	0.22993
10.6	0.33437	0.29989	0.27707	0.26022	0.24769	0.23795
10.8	0.34574	0.31011	0.28652	0.26910	0.25616	0.24608
11.0	0.35728	0.32048	0.29611	0.27812	0.26475	0.25434

50% Glycol / Water Solution

PRESSURE LOSS PER FOOT
5/8" MultiCor

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
0.5	0.00442	0.00394	0.00362	0.00339	0.00321	0.00308
0.6	0.00610	0.00544	0.00501	0.00469	0.00445	0.00426
0.7	0.00803	0.00716	0.00659	0.00617	0.00585	0.00561
0.8	0.01018	0.00908	0.00836	0.00782	0.00743	0.00712
0.9	0.01256	0.01120	0.01031	0.00965	0.00917	0.00879
1.0	0.01515	0.01352	0.01244	0.01165	0.01106	0.01060
1.1	0.01795	0.01602	0.01475	0.01381	0.01311	0.01257
1.2	0.02095	0.01871	0.01722	0.01613	0.01532	0.01469
1.3	0.02416	0.02158	0.01986	0.01861	0.01767	0.01695
1.4	0.02757	0.02462	0.02267	0.02124	0.02017	0.01935
1.5	0.03118	0.02785	0.02564	0.02402	0.02282	0.02189
1.6	0.03497	0.03124	0.02877	0.02696	0.02561	0.02456
1.7	0.03896	0.03481	0.03206	0.03004	0.02854	0.02738
1.8	0.04314	0.03855	0.03551	0.03327	0.03161	0.03032
1.9	0.04750	0.04245	0.03911	0.03665	0.03482	0.03340
2.0	0.05205	0.04652	0.04286	0.04017	0.03817	0.03661
2.1	0.05678	0.05075	0.04676	0.04383	0.04165	0.03995
2.2	0.06169	0.05515	0.05082	0.04763	0.04526	0.04342
2.3	0.06678	0.05970	0.05502	0.05157	0.04901	0.04702
2.4	0.07204	0.06441	0.05936	0.05565	0.05289	0.05074
2.5	0.07748	0.06928	0.06386	0.05986	0.05690	0.05459
2.6	0.08310	0.07431	0.06849	0.06421	0.06103	0.05856
2.7	0.08888	0.07949	0.07328	0.06870	0.06530	0.06266
2.8	0.09484	0.08483	0.07820	0.07332	0.06969	0.06687
2.9	0.10097	0.09031	0.08326	0.07807	0.07421	0.07121
3.0	0.10726	0.09595	0.08846	0.08295	0.07886	0.07567
3.1	0.11372	0.10174	0.09381	0.08796	0.08363	0.08025
3.2	0.12035	0.10768	0.09929	0.09311	0.08852	0.08495
3.3	0.12715	0.11376	0.10491	0.09838	0.09354	0.08977
3.4	0.13410	0.12000	0.11066	0.10378	0.09867	0.09470
3.5	0.14122	0.12638	0.11655	0.10931	0.10393	0.09975
3.6	0.14851	0.13290	0.12258	0.11497	0.10932	0.10492
3.7	0.15595	0.13958	0.12874	0.12075	0.11482	0.11020
3.8	0.16355	0.14639	0.13503	0.12665	0.12044	0.11560
3.9	0.17132	0.15335	0.14145	0.13269	0.12618	0.12111
4.0	0.17924	0.16045	0.14801	0.13884	0.13204	0.12674
4.1	0.18732	0.16769	0.15470	0.14512	0.13801	0.13248
4.2	0.19556	0.17508	0.16152	0.15153	0.14410	0.13833
4.3	0.20395	0.18260	0.16847	0.15805	0.15031	0.14430
4.4	0.21250	0.19026	0.17555	0.16470	0.15664	0.15037
4.5	0.22120	0.19807	0.18275	0.17147	0.16308	0.15656
4.6	0.23006	0.20601	0.19009	0.17835	0.16964	0.16286
4.7	0.23907	0.21409	0.19755	0.18536	0.17631	0.16927
4.8	0.24823	0.22231	0.20514	0.19249	0.18309	0.17578
4.9	0.25754	0.23066	0.21286	0.19974	0.18999	0.18241
5.0	0.26701	0.23915	0.22071	0.20711	0.19700	0.18915
5.1	0.27662	0.24777	0.22867	0.21459	0.20413	0.19599

PRESSURE LOSS PER FOOT
3/4" MultiCor

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
1.0	0.00496	0.00442	0.00407	0.00381	0.00362	0.00347
1.2	0.00686	0.00612	0.00563	0.00527	0.00501	0.00480
1.4	0.00902	0.00806	0.00742	0.00694	0.00659	0.00632
1.6	0.01145	0.01022	0.00941	0.00881	0.00837	0.00803
1.8	0.01412	0.01261	0.01161	0.01088	0.01033	0.00991
2.0	0.01703	0.01521	0.01401	0.01313	0.01247	0.01196
2.2	0.02018	0.01803	0.01661	0.01556	0.01479	0.01418
2.4	0.02357	0.02106	0.01940	0.01818	0.01728	0.01657
2.6	0.02718	0.02430	0.02239	0.02098	0.01994	0.01912
2.8	0.03102	0.02773	0.02556	0.02395	0.02276	0.02184
3.0	0.03508	0.03137	0.02891	0.02710	0.02575	0.02471
3.2	0.03936	0.03520	0.03244	0.03041	0.02891	0.02774
3.4	0.04386	0.03922	0.03616	0.03390	0.03222	0.03092
3.6	0.04857	0.04344	0.04005	0.03755	0.03569	0.03425
3.8	0.05348	0.04784	0.04411	0.04136	0.03932	0.03773
4.0	0.05861	0.05244	0.04835	0.04534	0.04310	0.04137
4.2	0.06394	0.05721	0.05276	0.04948	0.04704	0.04515
4.4	0.06948	0.06217	0.05734	0.05377	0.05113	0.04907
4.6	0.07521	0.06731	0.06208	0.05823	0.05537	0.05314
4.8	0.08115	0.07263	0.06700	0.06284	0.05976	0.05736
5.0	0.08729	0.07813	0.07207	0.06761	0.06429	0.06171
5.2	0.09362	0.08381	0.07732	0.07253	0.06898	0.06621
5.4	0.10014	0.08966	0.08272	0.07760	0.07381	0.07085
5.6	0.10686	0.09569	0.08829	0.08283	0.07878	0.07563
5.8	0.11378	0.10188	0.09401	0.08821	0.08390	0.08054
6.0	0.12088	0.10825	0.09989	0.09373	0.08915	0.08559
6.2	0.12817	0.11479	0.10594	0.09941	0.09456	0.09078
6.4	0.13565	0.12150	0.11214	0.10523	0.10010	0.09611
6.6	0.14332	0.12838	0.11849	0.11120	0.10578	0.10157
6.8	0.15117	0.13543	0.12500	0.11731	0.11160	0.10716
7.0	0.15921	0.14264	0.13166	0.12357	0.11756	0.11288
7.2	0.16743	0.15001	0.13848	0.12997	0.12366	0.11874
7.4	0.17583	0.15755	0.14545	0.13652	0.12989	0.12473
7.6	0.18442	0.16526	0.15257	0.14321	0.13626	0.13085
7.8	0.19318	0.17312	0.15984	0.15004	0.14276	0.13710
8.0	0.20213	0.18115	0.16726	0.15702	0.14940	0.14348
8.2	0.21125	0.18934	0.17483	0.16413	0.15618	0.14999
8.4	0.22055	0.19769	0.18255	0.17138	0.16308	0.15663
8.6	0.23003	0.20620	0.19042	0.17877	0.17012	0.16339
8.8	0.23969	0.21486	0.19843	0.18630	0.17729	0.17028
9.0	0.24952	0.22369	0.20659	0.19397	0.18460	0.17730
9.2	0.25952	0.23267	0.21490	0.20178	0.19203	0.18445
9.4	0.26970	0.24181	0.22335	0.20972	0.19959	0.19172
9.6	0.28005	0.25111	0.23194	0.21780	0.20729	0.19911
9.8	0.29057	0.26056	0.24068	0.22601	0.21511	0.20663
10.0	0.30126	0.27016	0.24956	0.23436	0.22307	0.21428
10.2	0.31213	0.27992	0.25859	0.24285	0.23115	0.22204

30% Glycol / Water Solution

PRESSURE LOSS PER FOOT
32mm hePEX (metric dimension)

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
3.0	0.00821	0.00778	0.00719	0.00688	0.00652	0.00630
3.2	0.00921	0.00873	0.00807	0.00772	0.00732	0.00708
3.4	0.01027	0.00973	0.00899	0.00860	0.00816	0.00789
3.6	0.01137	0.01077	0.00996	0.00953	0.00904	0.00874
3.8	0.01252	0.01187	0.01097	0.01050	0.00996	0.00963
4.0	0.01373	0.01301	0.01203	0.01151	0.01092	0.01056
4.2	0.01498	0.01419	0.01313	0.01256	0.01192	0.01152
4.4	0.01627	0.01543	0.01427	0.01365	0.01296	0.01253
4.6	0.01762	0.01670	0.01545	0.01478	0.01403	0.01357
4.8	0.01901	0.01802	0.01668	0.01595	0.01515	0.01464
5.0	0.02045	0.01939	0.01794	0.01716	0.01630	0.01576
5.2	0.02194	0.02080	0.01925	0.01841	0.01749	0.01691
5.4	0.02347	0.02225	0.02059	0.01970	0.01871	0.01809
5.6	0.02505	0.02375	0.02198	0.02103	0.01997	0.01931
5.8	0.02667	0.02529	0.02341	0.02240	0.02127	0.02057
6.0	0.02834	0.02687	0.02487	0.02380	0.02261	0.02186
6.2	0.03005	0.02850	0.02638	0.02524	0.02398	0.02318
6.4	0.03181	0.03016	0.02792	0.02672	0.02538	0.02454
6.6	0.03361	0.03187	0.02951	0.02824	0.02683	0.02594
6.8	0.03546	0.03362	0.03113	0.02979	0.02830	0.02737
7.0	0.03734	0.03542	0.03279	0.03138	0.02982	0.02883
7.2	0.03928	0.03725	0.03449	0.03301	0.03136	0.03033
7.4	0.04125	0.03912	0.03623	0.03468	0.03295	0.03186
7.6	0.04327	0.04104	0.03800	0.03638	0.03456	0.03342
7.8	0.04533	0.04299	0.03982	0.03811	0.03621	0.03502
8.0	0.04743	0.04499	0.04167	0.03988	0.03790	0.03665
8.2	0.04957	0.04702	0.04355	0.04169	0.03962	0.03832
8.4	0.05176	0.04910	0.04548	0.04354	0.04137	0.04001
8.6	0.05399	0.05122	0.04744	0.04542	0.04316	0.04174
8.8	0.05626	0.05337	0.04944	0.04733	0.04498	0.04350
9.0	0.05857	0.05556	0.05148	0.04928	0.04684	0.04530
9.2	0.06092	0.05780	0.05355	0.05126	0.04872	0.04712
9.4	0.06332	0.06007	0.05565	0.05328	0.05064	0.04898
9.6	0.06575	0.06238	0.05780	0.05534	0.05260	0.05087
9.8	0.06822	0.06473	0.05998	0.05743	0.05459	0.05280
10.0	0.07074	0.06712	0.06219	0.05955	0.05661	0.05475

PRESSURE LOSS PER FOOT
40mm hePEX (metric dimension)

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
6.0	0.00995	0.00943	0.00873	0.00835	0.00793	0.00766
6.2	0.01055	0.01000	0.00926	0.00886	0.00841	0.00813
6.4	0.01117	0.01059	0.00980	0.00937	0.00890	0.00861
6.6	0.01180	0.01119	0.01035	0.00991	0.00941	0.00909
6.8	0.01245	0.01180	0.01092	0.01045	0.00992	0.00959
7.0	0.01311	0.01243	0.01150	0.01101	0.01045	0.01011
7.2	0.01379	0.01307	0.01210	0.01158	0.01100	0.01063
7.4	0.01448	0.01373	0.01271	0.01216	0.01155	0.01117
7.6	0.01519	0.01440	0.01333	0.01276	0.01212	0.01172
7.8	0.01591	0.01509	0.01397	0.01337	0.01270	0.01227
8.0	0.01665	0.01579	0.01461	0.01399	0.01329	0.01285
8.2	0.01740	0.01650	0.01528	0.01462	0.01389	0.01343
8.4	0.01817	0.01723	0.01595	0.01527	0.01450	0.01402
8.6	0.01895	0.01797	0.01664	0.01592	0.01513	0.01463
8.8	0.01975	0.01873	0.01734	0.01660	0.01577	0.01525
9.0	0.02056	0.01950	0.01805	0.01728	0.01642	0.01587
9.2	0.02138	0.02028	0.01878	0.01797	0.01708	0.01651
9.4	0.02222	0.02108	0.01952	0.01868	0.01775	0.01716
9.6	0.02307	0.02189	0.02027	0.01940	0.01843	0.01783
9.8	0.02394	0.02271	0.02103	0.02013	0.01913	0.01850
10.0	0.02482	0.02355	0.02181	0.02088	0.01984	0.01918
10.2	0.02572	0.02440	0.02260	0.02163	0.02056	0.01988
10.4	0.02663	0.02526	0.02340	0.02240	0.02129	0.02059
10.6	0.02755	0.02614	0.02421	0.02318	0.02203	0.02130
10.8	0.02849	0.02703	0.02504	0.02397	0.02278	0.02203
11.0	0.02944	0.02793	0.02588	0.02477	0.02354	0.02277
11.2	0.03041	0.02885	0.02673	0.02559	0.02432	0.02352
11.4	0.03139	0.02978	0.02759	0.02641	0.02510	0.02428
11.6	0.03238	0.03072	0.02847	0.02725	0.02590	0.02505
11.8	0.03339	0.03168	0.02935	0.02810	0.02671	0.02583
12.0	0.03441	0.03265	0.03025	0.02896	0.02753	0.02663
12.2	0.03545	0.03363	0.03116	0.02984	0.02836	0.02743
12.4	0.03650	0.03463	0.03209	0.03072	0.02920	0.02825
12.6	0.03756	0.03564	0.03302	0.03162	0.03006	0.02907
12.8	0.03863	0.03666	0.03397	0.03253	0.03092	0.02991
13.0	0.03972	0.03769	0.03493	0.03344	0.03179	0.03075
13.2	0.04082	0.03874	0.03590	0.03438	0.03268	0.03161
13.4	0.04194	0.03980	0.03688	0.03532	0.03357	0.03248
13.6	0.04307	0.04087	0.03788	0.03627	0.03448	0.03336
13.8	0.04421	0.04195	0.03888	0.03723	0.03540	0.03424
14.0	0.04536	0.04305	0.03990	0.03821	0.03633	0.03514
14.2	0.04653	0.04416	0.04093	0.03920	0.03727	0.03605
14.4	0.04771	0.04528	0.04197	0.04020	0.03822	0.03697
14.6	0.04891	0.04642	0.04303	0.04121	0.03918	0.03790
14.8	0.05012	0.04756	0.04409	0.04223	0.04015	0.03884
15.0	0.05134	0.04872	0.04517	0.04326	0.04113	0.03979
15.2	0.05257	0.04990	0.04626	0.04430	0.04212	0.04075
15.4	0.05382	0.05108	0.04736	0.04535	0.04313	0.04172
15.6	0.05508	0.05228	0.04847	0.04642	0.04414	0.04270
15.8	0.05635	0.05349	0.04959	0.04749	0.04516	0.04369
16.0	0.05764	0.05471	0.05072	0.04858	0.04620	0.04469
16.2	0.05894	0.05594	0.05187	0.04968	0.04724	0.04571
16.4	0.06025	0.05719	0.05303	0.05079	0.04830	0.04673
16.6	0.06157	0.05845	0.05419	0.05191	0.04936	0.04776
16.8	0.06291	0.05972	0.05537	0.05304	0.05044	0.04880
17.0	0.06426	0.06100	0.05656	0.05418	0.05153	0.04985

30% Glycol / Water Solution

PRESSURE LOSS PER FOOT
32mm hePEX (metric dimension)

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
3.0	0.00821	0.00778	0.00719	0.00688	0.00652	0.00630
3.2	0.00921	0.00873	0.00807	0.00772	0.00732	0.00708
3.4	0.01027	0.00973	0.00899	0.00860	0.00816	0.00789
3.6	0.01137	0.01077	0.00996	0.00953	0.00904	0.00874
3.8	0.01252	0.01187	0.01097	0.01050	0.00996	0.00963
4.0	0.01373	0.01301	0.01203	0.01151	0.01092	0.01056
4.2	0.01498	0.01419	0.01313	0.01256	0.01192	0.01152
4.4	0.01627	0.01543	0.01427	0.01365	0.01296	0.01253
4.6	0.01762	0.01670	0.01545	0.01478	0.01403	0.01357
4.8	0.01901	0.01802	0.01668	0.01595	0.01515	0.01464
5.0	0.02045	0.01939	0.01794	0.01716	0.01630	0.01576
5.2	0.02194	0.02080	0.01925	0.01841	0.01749	0.01691
5.4	0.02347	0.02225	0.02059	0.01970	0.01871	0.01809
5.6	0.02505	0.02375	0.02198	0.02103	0.01997	0.01931
5.8	0.02667	0.02529	0.02341	0.02240	0.02127	0.02057
6.0	0.02834	0.02687	0.02487	0.02380	0.02261	0.02186
6.2	0.03005	0.02850	0.02638	0.02524	0.02398	0.02318
6.4	0.03181	0.03016	0.02792	0.02672	0.02538	0.02454
6.6	0.03361	0.03187	0.02951	0.02824	0.02683	0.02594
6.8	0.03546	0.03362	0.03113	0.02979	0.02830	0.02737
7.0	0.03734	0.03542	0.03279	0.03138	0.02982	0.02883
7.2	0.03928	0.03725	0.03449	0.03301	0.03136	0.03033
7.4	0.04125	0.03912	0.03623	0.03468	0.03295	0.03186
7.6	0.04327	0.04104	0.03800	0.03638	0.03456	0.03342
7.8	0.04533	0.04299	0.03982	0.03811	0.03621	0.03502
8.0	0.04743	0.04499	0.04167	0.03988	0.03790	0.03665
8.2	0.04957	0.04702	0.04355	0.04169	0.03962	0.03832
8.4	0.05176	0.04910	0.04548	0.04354	0.04137	0.04001
8.6	0.05399	0.05122	0.04744	0.04542	0.04316	0.04174
8.8	0.05626	0.05337	0.04944	0.04733	0.04498	0.04350
9.0	0.05857	0.05556	0.05148	0.04928	0.04684	0.04530
9.2	0.06092	0.05780	0.05355	0.05126	0.04872	0.04712
9.4	0.06332	0.06007	0.05565	0.05328	0.05064	0.04898
9.6	0.06575	0.06238	0.05780	0.05534	0.05260	0.05087
9.8	0.06822	0.06473	0.05998	0.05743	0.05459	0.05280
10.0	0.07074	0.06712	0.06219	0.05955	0.05661	0.05475

PRESSURE LOSS PER FOOT
40mm hePEX (metric dimension)

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
6.0	0.00995	0.00943	0.00873	0.00835	0.00793	0.00766
6.2	0.01055	0.01000	0.00926	0.00886	0.00841	0.00813
6.4	0.01117	0.01059	0.00980	0.00937	0.00890	0.00861
6.6	0.01180	0.01119	0.01035	0.00991	0.00941	0.00909
6.8	0.01245	0.01180	0.01092	0.01045	0.00992	0.00959
7.0	0.01311	0.01243	0.01150	0.01101	0.01045	0.01011
7.2	0.01379	0.01307	0.01210	0.01158	0.01100	0.01063
7.4	0.01448	0.01373	0.01271	0.01216	0.01155	0.01117
7.6	0.01519	0.01440	0.01333	0.01276	0.01212	0.01172
7.8	0.01591	0.01509	0.01397	0.01337	0.01270	0.01227
8.0	0.01665	0.01579	0.01461	0.01399	0.01329	0.01285
8.2	0.01740	0.01650	0.01528	0.01462	0.01389	0.01343
8.4	0.01817	0.01723	0.01595	0.01527	0.01450	0.01402
8.6	0.01895	0.01797	0.01664	0.01592	0.01513	0.01463
8.8	0.01975	0.01873	0.01734	0.01660	0.01577	0.01525
9.0	0.02056	0.01950	0.01805	0.01728	0.01642	0.01587
9.2	0.02138	0.02028	0.01878	0.01797	0.01708	0.01651
9.4	0.02222	0.02108	0.01952	0.01868	0.01775	0.01716
9.6	0.02307	0.02189	0.02027	0.01940	0.01843	0.01783
9.8	0.02394	0.02271	0.02103	0.02013	0.01913	0.01850
10.0	0.02482	0.02355	0.02181	0.02088	0.01984	0.01918
10.2	0.02572	0.02440	0.02260	0.02163	0.02056	0.01988
10.4	0.02663	0.02526	0.02340	0.02240	0.02129	0.02059
10.6	0.02755	0.02614	0.02421	0.02318	0.02203	0.02130
10.8	0.02849	0.02703	0.02504	0.02397	0.02278	0.02203
11.0	0.02944	0.02793	0.02588	0.02477	0.02354	0.02277
11.2	0.03041	0.02885	0.02673	0.02559	0.02432	0.02352
11.4	0.03139	0.02978	0.02759	0.02641	0.02510	0.02428
11.6	0.03238	0.03072	0.02847	0.02725	0.02590	0.02505
11.8	0.03339	0.03168	0.02935	0.02810	0.02671	0.02583
12.0	0.03441	0.03265	0.03025	0.02896	0.02753	0.02663
12.2	0.03545	0.03363	0.03116	0.02984	0.02836	0.02743
12.4	0.03650	0.03463	0.03209	0.03072	0.02920	0.02825
12.6	0.03756	0.03564	0.03302	0.03162	0.03006	0.02907
12.8	0.03863	0.03666	0.03397	0.03253	0.03092	0.02991
13.0	0.03972	0.03769	0.03493	0.03344	0.03179	0.03075
13.2	0.04082	0.03874	0.03590	0.03438	0.03268	0.03161
13.4	0.04194	0.03980	0.03688	0.03532	0.03357	0.03248
13.6	0.04307	0.04087	0.03788	0.03627	0.03448	0.03336
13.8	0.04421	0.04195	0.03888	0.03723	0.03540	0.03424
14.0	0.04536	0.04305	0.03990	0.03821	0.03633	0.03514
14.2	0.04653	0.04416	0.04093	0.03920	0.03727	0.03605
14.4	0.04771	0.04528	0.04197	0.04020	0.03822	0.03697
14.6	0.04891	0.04642	0.04303	0.04121	0.03918	0.03790
14.8	0.05012	0.04756	0.04409	0.04223	0.04015	0.03884
15.0	0.05134	0.04872	0.04517	0.04326	0.04113	0.03979
15.2	0.05257	0.04990	0.04626	0.04430	0.04212	0.04075
15.4	0.05382	0.05108	0.04736	0.04535	0.04313	0.04172
15.6	0.05508	0.05228	0.04847	0.04642	0.04414	0.04270
15.8	0.05635	0.05349	0.04959	0.04749	0.04516	0.04369
16.0	0.05764	0.05471	0.05072	0.04858	0.04620	0.04469
16.2	0.05894	0.05594	0.05187	0.04968	0.04724	0.04571
16.4	0.06025	0.05719	0.05303	0.05079	0.04830	0.04673
16.6	0.06157	0.05845	0.05419	0.05191	0.04936	0.04776
16.8	0.06291	0.05972	0.05537	0.05304	0.05044	0.04880
17.0	0.06426	0.06100	0.05656	0.05418	0.05153	0.04985

30% Glycol / Water Solution

PRESSURE LOSS PER FOOT
32mm hePEX (metric dimension)

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
3.0	0.00821	0.00778	0.00719	0.00688	0.00652	0.00630
3.2	0.00921	0.00873	0.00807	0.00772	0.00732	0.00708
3.4	0.01027	0.00973	0.00899	0.00860	0.00816	0.00789
3.6	0.01137	0.01077	0.00996	0.00953	0.00904	0.00874
3.8	0.01252	0.01187	0.01097	0.01050	0.00996	0.00963
4.0	0.01373	0.01301	0.01203	0.01151	0.01092	0.01056
4.2	0.01498	0.01419	0.01313	0.01256	0.01192	0.01152
4.4	0.01627	0.01543	0.01427	0.01365	0.01296	0.01253
4.6	0.01762	0.01670	0.01545	0.01478	0.01403	0.01357
4.8	0.01901	0.01802	0.01668	0.01595	0.01515	0.01464
5.0	0.02045	0.01939	0.01794	0.01716	0.01630	0.01576
5.2	0.02194	0.02080	0.01925	0.01841	0.01749	0.01691
5.4	0.02347	0.02225	0.02059	0.01970	0.01871	0.01809
5.6	0.02505	0.02375	0.02198	0.02103	0.01997	0.01931
5.8	0.02667	0.02529	0.02341	0.02240	0.02127	0.02057
6.0	0.02834	0.02687	0.02487	0.02380	0.02261	0.02186
6.2	0.03005	0.02850	0.02638	0.02524	0.02398	0.02318
6.4	0.03181	0.03016	0.02792	0.02672	0.02538	0.02454
6.6	0.03361	0.03187	0.02951	0.02824	0.02683	0.02594
6.8	0.03546	0.03362	0.03113	0.02979	0.02830	0.02737
7.0	0.03734	0.03542	0.03279	0.03138	0.02982	0.02883
7.2	0.03928	0.03725	0.03449	0.03301	0.03136	0.03033
7.4	0.04125	0.03912	0.03623	0.03468	0.03295	0.03186
7.6	0.04327	0.04104	0.03800	0.03638	0.03456	0.03342
7.8	0.04533	0.04299	0.03982	0.03811	0.03621	0.03502
8.0	0.04743	0.04499	0.04167	0.03988	0.03790	0.03665
8.2	0.04957	0.04702	0.04355	0.04169	0.03962	0.03832
8.4	0.05176	0.04910	0.04548	0.04354	0.04137	0.04001
8.6	0.05399	0.05122	0.04744	0.04542	0.04316	0.04174
8.8	0.05626	0.05337	0.04944	0.04733	0.04498	0.04350
9.0	0.05857	0.05556	0.05148	0.04928	0.04684	0.04530
9.2	0.06092	0.05780	0.05355	0.05126	0.04872	0.04712
9.4	0.06332	0.06007	0.05565	0.05328	0.05064	0.04898
9.6	0.06575	0.06238	0.05780	0.05534	0.05260	0.05087
9.8	0.06822	0.06473	0.05998	0.05743	0.05459	0.05280
10.0	0.07074	0.06712	0.06219	0.05955	0.05661	0.05475

PRESSURE LOSS PER FOOT
40mm hePEX (metric dimension)

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
6.0	0.00995	0.00943	0.00873	0.00835	0.00793	0.00766
6.2	0.01055	0.01000	0.00926	0.00886	0.00841	0.00813
6.4	0.01117	0.01059	0.00980	0.00937	0.00890	0.00861
6.6	0.01180	0.01119	0.01035	0.00991	0.00941	0.00909
6.8	0.01245	0.01180	0.01092	0.01045	0.00992	0.00959
7.0	0.01311	0.01243	0.01150	0.01101	0.01045	0.01011
7.2	0.01379	0.01307	0.01210	0.01158	0.01100	0.01063
7.4	0.01448	0.01373	0.01271	0.01216	0.01155	0.01117
7.6	0.01519	0.01440	0.01333	0.01276	0.01212	0.01172
7.8	0.01591	0.01509	0.01397	0.01337	0.01270	0.01227
8.0	0.01665	0.01579	0.01461	0.01399	0.01329	0.01285
8.2	0.01740	0.01650	0.01528	0.01462	0.01389	0.01343
8.4	0.01817	0.01723	0.01595	0.01527	0.01450	0.01402
8.6	0.01895	0.01797	0.01664	0.01592	0.01513	0.01463
8.8	0.01975	0.01873	0.01734	0.01660	0.01577	0.01525
9.0	0.02056	0.01950	0.01805	0.01728	0.01642	0.01587
9.2	0.02138	0.02028	0.01878	0.01797	0.01708	0.01651
9.4	0.02222	0.02108	0.01952	0.01868	0.01775	0.01716
9.6	0.02307	0.02189	0.02027	0.01940	0.01843	0.01783
9.8	0.02394	0.02271	0.02103	0.02013	0.01913	0.01850
10.0	0.02482	0.02355	0.02181	0.02088	0.01984	0.01918
10.2	0.02572	0.02440	0.02260	0.02163	0.02056	0.01988
10.4	0.02663	0.02526	0.02340	0.02240	0.02129	0.02059
10.6	0.02755	0.02614	0.02421	0.02318	0.02203	0.02130
10.8	0.02849	0.02703	0.02504	0.02397	0.02278	0.02203
11.0	0.02944	0.02793	0.02588	0.02477	0.02354	0.02277
11.2	0.03041	0.02885	0.02673	0.02559	0.02432	0.02352
11.4	0.03139	0.02978	0.02759	0.02641	0.02510	0.02428
11.6	0.03238	0.03072	0.02847	0.02725	0.02590	0.02505
11.8	0.03339	0.03168	0.02935	0.02810	0.02671	0.02583
12.0	0.03441	0.03265	0.03025	0.02896	0.02753	0.02663
12.2	0.03545	0.03363	0.03116	0.02984	0.02836	0.02743
12.4	0.03650	0.03463	0.03209	0.03072	0.02920	0.02825
12.6	0.03756	0.03564	0.03302	0.03162	0.03006	0.02907
12.8	0.03863	0.03666	0.03397	0.03253	0.03092	0.02991
13.0	0.03972	0.03769	0.03493	0.03344	0.03179	0.03075
13.2	0.04082	0.03874	0.03590	0.03438	0.03268	0.03161
13.4	0.04194	0.03980	0.03688	0.03532	0.03357	0.03248
13.6	0.04307	0.04087	0.03788	0.03627	0.03448	0.03336
13.8	0.04421	0.04195	0.03888	0.03723	0.03540	0.03424
14.0	0.04536	0.04305	0.03990	0.03821	0.03633	0.03514
14.2	0.04653	0.04416	0.04093	0.03920	0.03727	0.03605
14.4	0.04771	0.04528	0.04197	0.04020	0.03822	0.03697
14.6	0.04891	0.04642	0.04303	0.04121	0.03918	0.03790
14.8	0.05012	0.04756	0.04409	0.04223	0.04015	0.03884
15.0	0.05134	0.04872	0.04517	0.04326	0.04113	0.03979
15.2	0.05257	0.04990	0.04626	0.04430	0.04212	0.04075
15.4	0.05382	0.05108	0.04736	0.04535	0.04313	0.04172
15.6	0.05508	0.05228	0.04847	0.04642	0.04414	0.04270
15.8	0.05635	0.05349	0.04959	0.04749	0.04516	0.04369
16.0	0.05764	0.05471	0.05072	0.04858	0.04620	0.04469
16.2	0.05894	0.05594	0.05187	0.04968	0.04724	0.04571
16.4	0.06025	0.05719	0.05303	0.05079	0.04830	0.04673
16.6	0.06157	0.05845	0.05419	0.05191	0.04936	0.04776
16.8	0.06291	0.05972	0.05537	0.05304	0.05044	0.04880
17.0	0.06426	0.06100	0.05656	0.05418	0.05153	0.04985

40% Glycol / Water Solution

PRESSURE LOSS PER FOOT
32mm hePEX (metric dimension)

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
3.0	0.00900	0.00841	0.00787	0.00735	0.00692	0.00659
3.2	0.01010	0.00944	0.00883	0.00825	0.00777	0.00739
3.4	0.01125	0.01052	0.00984	0.00920	0.00866	0.00824
3.6	0.01246	0.01165	0.01090	0.01019	0.00960	0.00913
3.8	0.01372	0.01283	0.01200	0.01122	0.01057	0.01006
4.0	0.01504	0.01406	0.01316	0.01230	0.01159	0.01103
4.2	0.01640	0.01534	0.01436	0.01343	0.01265	0.01203
4.4	0.01783	0.01667	0.01560	0.01459	0.01375	0.01308
4.6	0.01930	0.01805	0.01689	0.01580	0.01489	0.01417
4.8	0.02082	0.01948	0.01823	0.01705	0.01606	0.01529
5.0	0.02240	0.02095	0.01961	0.01834	0.01728	0.01645
5.2	0.02402	0.02247	0.02103	0.01968	0.01854	0.01765
5.4	0.02570	0.02404	0.02250	0.02105	0.01984	0.01889
5.6	0.02742	0.02566	0.02402	0.02247	0.02118	0.02016
5.8	0.02920	0.02732	0.02557	0.02393	0.02255	0.02147
6.0	0.03102	0.02903	0.02717	0.02543	0.02397	0.02282
6.2	0.03289	0.03078	0.02882	0.02697	0.02542	0.02420
6.4	0.03481	0.03258	0.03050	0.02855	0.02691	0.02562
6.6	0.03678	0.03442	0.03223	0.03017	0.02843	0.02707
6.8	0.03880	0.03631	0.03400	0.03182	0.03000	0.02856
7.0	0.04086	0.03825	0.03581	0.03352	0.03160	0.03009
7.2	0.04297	0.04022	0.03767	0.03526	0.03324	0.03165
7.4	0.04513	0.04225	0.03956	0.03703	0.03491	0.03325
7.6	0.04734	0.04431	0.04150	0.03885	0.03662	0.03488
7.8	0.04959	0.04642	0.04347	0.04070	0.03837	0.03655
8.0	0.05188	0.04857	0.04549	0.04259	0.04016	0.03825
8.2	0.05423	0.05077	0.04755	0.04452	0.04198	0.03998
8.4	0.05662	0.05301	0.04965	0.04648	0.04383	0.04175
8.6	0.05905	0.05529	0.05179	0.04849	0.04573	0.04355
8.8	0.06153	0.05761	0.05396	0.05053	0.04765	0.04539
9.0	0.06405	0.05998	0.05618	0.05261	0.04961	0.04726
9.2	0.06662	0.06238	0.05844	0.05473	0.05161	0.04917
9.4	0.06924	0.06483	0.06074	0.05688	0.05365	0.05110
9.6	0.07190	0.06733	0.06307	0.05907	0.05571	0.05308
9.8	0.07460	0.06986	0.06545	0.06130	0.05782	0.05508
10.0	0.07735	0.07243	0.06786	0.06356	0.05995	0.05712

PRESSURE LOSS PER FOOT
40mm hePEX (metric dimension)

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
6.0	0.01090	0.01019	0.00954	0.00892	0.00841	0.00800
6.2	0.01156	0.01081	0.01012	0.00946	0.00892	0.00849
6.4	0.01223	0.01144	0.01071	0.01002	0.00944	0.00898
6.6	0.01292	0.01209	0.01131	0.01058	0.00997	0.00949
6.8	0.01363	0.01275	0.01193	0.01117	0.01052	0.01002
7.0	0.01435	0.01343	0.01257	0.01176	0.01108	0.01055
7.2	0.01509	0.01412	0.01322	0.01237	0.01166	0.01110
7.4	0.01585	0.01483	0.01388	0.01299	0.01225	0.01166
7.6	0.01662	0.01556	0.01456	0.01363	0.01285	0.01223
7.8	0.01741	0.01630	0.01526	0.01428	0.01346	0.01281
8.0	0.01822	0.01705	0.01596	0.01494	0.01408	0.01341
8.2	0.01904	0.01782	0.01669	0.01562	0.01472	0.01402
8.4	0.01988	0.01861	0.01742	0.01631	0.01537	0.01464
8.6	0.02074	0.01941	0.01817	0.01701	0.01603	0.01527
8.8	0.02161	0.02022	0.01894	0.01772	0.01671	0.01591
9.0	0.02249	0.02105	0.01971	0.01845	0.01740	0.01657
9.2	0.02339	0.02190	0.02051	0.01920	0.01810	0.01723
9.4	0.02431	0.02276	0.02131	0.01995	0.01881	0.01791
9.6	0.02524	0.02363	0.02213	0.02072	0.01953	0.01860
9.8	0.02619	0.02452	0.02296	0.02150	0.02027	0.01930
10.0	0.02716	0.02542	0.02381	0.02229	0.02102	0.02002
10.2	0.02813	0.02634	0.02467	0.02310	0.02178	0.02074
10.4	0.02913	0.02727	0.02554	0.02392	0.02255	0.02148
10.6	0.03014	0.02822	0.02643	0.02475	0.02334	0.02223
10.8	0.03116	0.02918	0.02733	0.02559	0.02413	0.02299
11.0	0.03220	0.03015	0.02824	0.02645	0.02494	0.02376
11.2	0.03326	0.03114	0.02917	0.02732	0.02576	0.02454
11.4	0.03433	0.03214	0.03011	0.02820	0.02659	0.02533
11.6	0.03541	0.03316	0.03107	0.02909	0.02744	0.02614
11.8	0.03651	0.03419	0.03203	0.03000	0.02829	0.02695
12.0	0.03763	0.03524	0.03301	0.03092	0.02916	0.02778
12.2	0.03876	0.03630	0.03401	0.03185	0.03004	0.02862
12.4	0.03990	0.03737	0.03501	0.03279	0.03093	0.02947
12.6	0.04106	0.03846	0.03603	0.03375	0.03183	0.03033
12.8	0.04224	0.03956	0.03706	0.03471	0.03274	0.03120
13.0	0.04343	0.04067	0.03811	0.03569	0.03367	0.03208
13.2	0.04463	0.04180	0.03917	0.03669	0.03461	0.03297
13.4	0.04585	0.04294	0.04024	0.03769	0.03555	0.03388
13.6	0.04708	0.04410	0.04132	0.03871	0.03651	0.03479
13.8	0.04833	0.04526	0.04242	0.03973	0.03748	0.03572
14.0	0.04959	0.04645	0.04353	0.04077	0.03847	0.03665
14.2	0.05086	0.04764	0.04465	0.04183	0.03946	0.03760
14.4	0.05215	0.04885	0.04578	0.04289	0.04046	0.03856
14.6	0.05346	0.05008	0.04693	0.04397	0.04148	0.03953
14.8	0.05478	0.05131	0.04809	0.04505	0.04251	0.04051
15.0	0.05611	0.05256	0.04926	0.04615	0.04355	0.04150
15.2	0.05746	0.05382	0.05045	0.04726	0.04460	0.04250
15.4	0.05882	0.05510	0.05164	0.04839	0.04566	0.04351
15.6	0.06019	0.05639	0.05285	0.04952	0.04673	0.04453
15.8	0.06158	0.05769	0.05408	0.05067	0.04781	0.04557
16.0	0.06298	0.05901	0.05531	0.05183	0.04890	0.04661
16.2	0.06440	0.06034	0.05656	0.05300	0.05001	0.04766
16.4	0.06583	0.06168	0.05782	0.05418	0.05113	0.04873
16.6	0.06728	0.06304	0.05909	0.05537	0.05225	0.04980
16.8	0.06874	0.06440	0.06037	0.05658	0.05339	0.05089
17.0	0.07021	0.06579	0.06167	0.05779	0.05454	0.05198

40% Glycol / Water Solution

PRESSURE LOSS PER FOOT
32mm hePEX (metric dimension)

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
3.0	0.00900	0.00841	0.00787	0.00735	0.00692	0.00659
3.2	0.01010	0.00944	0.00883	0.00825	0.00777	0.00739
3.4	0.01125	0.01052	0.00984	0.00920	0.00866	0.00824
3.6	0.01246	0.01165	0.01090	0.01019	0.00960	0.00913
3.8	0.01372	0.01283	0.01200	0.01122	0.01057	0.01006
4.0	0.01504	0.01406	0.01316	0.01230	0.01159	0.01103
4.2	0.01640	0.01534	0.01436	0.01343	0.01265	0.01203
4.4	0.01783	0.01667	0.01560	0.01459	0.01375	0.01308
4.6	0.01930	0.01805	0.01689	0.01580	0.01489	0.01417
4.8	0.02082	0.01948	0.01823	0.01705	0.01606	0.01529
5.0	0.02240	0.02095	0.01961	0.01834	0.01728	0.01645
5.2	0.02402	0.02247	0.02103	0.01968	0.01854	0.01765
5.4	0.02570	0.02404	0.02250	0.02105	0.01984	0.01889
5.6	0.02742	0.02566	0.02402	0.02247	0.02118	0.02016
5.8	0.02920	0.02732	0.02557	0.02393	0.02255	0.02147
6.0	0.03102	0.02903	0.02717	0.02543	0.02397	0.02282
6.2	0.03289	0.03078	0.02882	0.02697	0.02542	0.02420
6.4	0.03481	0.03258	0.03050	0.02855	0.02691	0.02562
6.6	0.03678	0.03442	0.03223	0.03017	0.02843	0.02707
6.8	0.03880	0.03631	0.03400	0.03182	0.03000	0.02856
7.0	0.04086	0.03825	0.03581	0.03352	0.03160	0.03009
7.2	0.04297	0.04022	0.03767	0.03526	0.03324	0.03165
7.4	0.04513	0.04225	0.03956	0.03703	0.03491	0.03325
7.6	0.04734	0.04431	0.04150	0.03885	0.03662	0.03488
7.8	0.04959	0.04642	0.04347	0.04070	0.03837	0.03655
8.0	0.05188	0.04857	0.04549	0.04259	0.04016	0.03825
8.2	0.05423	0.05077	0.04755	0.04452	0.04198	0.03998
8.4	0.05662	0.05301	0.04965	0.04648	0.04383	0.04175
8.6	0.05905	0.05529	0.05179	0.04849	0.04573	0.04355
8.8	0.06153	0.05761	0.05396	0.05053	0.04765	0.04539
9.0	0.06405	0.05998	0.05618	0.05261	0.04961	0.04726
9.2	0.06662	0.06238	0.05844	0.05473	0.05161	0.04917
9.4	0.06924	0.06483	0.06074	0.05688	0.05365	0.05110
9.6	0.07190	0.06733	0.06307	0.05907	0.05571	0.05308
9.8	0.07460	0.06986	0.06545	0.06130	0.05782	0.05508
10.0	0.07735	0.07243	0.06786	0.06356	0.05995	0.05712

PRESSURE LOSS PER FOOT
40mm hePEX (metric dimension)

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
6.0	0.01090	0.01019	0.00954	0.00892	0.00841	0.00800
6.2	0.01156	0.01081	0.01012	0.00946	0.00892	0.00849
6.4	0.01223	0.01144	0.01071	0.01002	0.00944	0.00898
6.6	0.01292	0.01209	0.01131	0.01058	0.00997	0.00949
6.8	0.01363	0.01275	0.01193	0.01117	0.01052	0.01002
7.0	0.01435	0.01343	0.01257	0.01176	0.01108	0.01055
7.2	0.01509	0.01412	0.01322	0.01237	0.01166	0.01110
7.4	0.01585	0.01483	0.01388	0.01299	0.01225	0.01166
7.6	0.01662	0.01556	0.01456	0.01363	0.01285	0.01223
7.8	0.01741	0.01630	0.01526	0.01428	0.01346	0.01281
8.0	0.01822	0.01705	0.01596	0.01494	0.01408	0.01341
8.2	0.01904	0.01782	0.01669	0.01562	0.01472	0.01402
8.4	0.01988	0.01861	0.01742	0.01631	0.01537	0.01464
8.6	0.02074	0.01941	0.01817	0.01701	0.01603	0.01527
8.8	0.02161	0.02022	0.01894	0.01772	0.01671	0.01591
9.0	0.02249	0.02105	0.01971	0.01845	0.01740	0.01657
9.2	0.02339	0.02190	0.02051	0.01920	0.01810	0.01723
9.4	0.02431	0.02276	0.02131	0.01995	0.01881	0.01791
9.6	0.02524	0.02363	0.02213	0.02072	0.01953	0.01860
9.8	0.02619	0.02452	0.02296	0.02150	0.02027	0.01930
10.0	0.02716	0.02542	0.02381	0.02229	0.02102	0.02002
10.2	0.02813	0.02634	0.02467	0.02310	0.02178	0.02074
10.4	0.02913	0.02727	0.02554	0.02392	0.02255	0.02148
10.6	0.03014	0.02822	0.02643	0.02475	0.02334	0.02223
10.8	0.03116	0.02918	0.02733	0.02559	0.02413	0.02299
11.0	0.03220	0.03015	0.02824	0.02645	0.02494	0.02376
11.2	0.03326	0.03114	0.02917	0.02732	0.02576	0.02454
11.4	0.03433	0.03214	0.03011	0.02820	0.02659	0.02533
11.6	0.03541	0.03316	0.03107	0.02909	0.02744	0.02614
11.8	0.03651	0.03419	0.03203	0.03000	0.02829	0.02695
12.0	0.03763	0.03524	0.03301	0.03092	0.02916	0.02778
12.2	0.03876	0.03630	0.03401	0.03185	0.03004	0.02862
12.4	0.03990	0.03737	0.03501	0.03279	0.03093	0.02947
12.6	0.04106	0.03846	0.03603	0.03375	0.03183	0.03033
12.8	0.04224	0.03956	0.03706	0.03471	0.03274	0.03120
13.0	0.04343	0.04067	0.03811	0.03569	0.03367	0.03208
13.2	0.04463	0.04180	0.03917	0.03669	0.03461	0.03297
13.4	0.04585	0.04294	0.04024	0.03769	0.03555	0.03388
13.6	0.04708	0.04410	0.04132	0.03871	0.03651	0.03479
13.8	0.04833	0.04526	0.04242	0.03973	0.03748	0.03572
14.0	0.04959	0.04645	0.04353	0.04077	0.03847	0.03665
14.2	0.05086	0.04764	0.04465	0.04183	0.03946	0.03760
14.4	0.05215	0.04885	0.04578	0.04289	0.04046	0.03856
14.6	0.05346	0.05008	0.04693	0.04397	0.04148	0.03953
14.8	0.05478	0.05131	0.04809	0.04505	0.04251	0.04051
15.0	0.05611	0.05256	0.04926	0.04615	0.04355	0.04150
15.2	0.05746	0.05382	0.05045	0.04726	0.04460	0.04250
15.4	0.05882	0.05510	0.05164	0.04839	0.04566	0.04351
15.6	0.06019	0.05639	0.05285	0.04952	0.04673	0.04453
15.8	0.06158	0.05769	0.05408	0.05067	0.04781	0.04557
16.0	0.06298	0.05901	0.05531	0.05183	0.04890	0.04661
16.2	0.06440	0.06034	0.05656	0.05300	0.05001	0.04766
16.4	0.06583	0.06168	0.05782	0.05418	0.05113	0.04873
16.6	0.06728	0.06304	0.05909	0.05537	0.05225	0.04980
16.8	0.06874	0.06440	0.06037	0.05658	0.05339	0.05089
17.0	0.07021	0.06579	0.06167	0.05779	0.05454	0.05198

40% Glycol / Water Solution

PRESSURE LOSS PER FOOT
32mm hePEX (metric dimension)

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
3.0	0.00900	0.00841	0.00787	0.00735	0.00692	0.00659
3.2	0.01010	0.00944	0.00883	0.00825	0.00777	0.00739
3.4	0.01125	0.01052	0.00984	0.00920	0.00866	0.00824
3.6	0.01246	0.01165	0.01090	0.01019	0.00960	0.00913
3.8	0.01372	0.01283	0.01200	0.01122	0.01057	0.01006
4.0	0.01504	0.01406	0.01316	0.01230	0.01159	0.01103
4.2	0.01640	0.01534	0.01436	0.01343	0.01265	0.01203
4.4	0.01783	0.01667	0.01560	0.01459	0.01375	0.01308
4.6	0.01930	0.01805	0.01689	0.01580	0.01489	0.01417
4.8	0.02082	0.01948	0.01823	0.01705	0.01606	0.01529
5.0	0.02240	0.02095	0.01961	0.01834	0.01728	0.01645
5.2	0.02402	0.02247	0.02103	0.01968	0.01854	0.01765
5.4	0.02570	0.02404	0.02250	0.02105	0.01984	0.01889
5.6	0.02742	0.02566	0.02402	0.02247	0.02118	0.02016
5.8	0.02920	0.02732	0.02557	0.02393	0.02255	0.02147
6.0	0.03102	0.02903	0.02717	0.02543	0.02397	0.02282
6.2	0.03289	0.03078	0.02882	0.02697	0.02542	0.02420
6.4	0.03481	0.03258	0.03050	0.02855	0.02691	0.02562
6.6	0.03678	0.03442	0.03223	0.03017	0.02843	0.02707
6.8	0.03880	0.03631	0.03400	0.03182	0.03000	0.02856
7.0	0.04086	0.03825	0.03581	0.03352	0.03160	0.03009
7.2	0.04297	0.04022	0.03767	0.03526	0.03324	0.03165
7.4	0.04513	0.04225	0.03956	0.03703	0.03491	0.03325
7.6	0.04734	0.04431	0.04150	0.03885	0.03662	0.03488
7.8	0.04959	0.04642	0.04347	0.04070	0.03837	0.03655
8.0	0.05188	0.04857	0.04549	0.04259	0.04016	0.03825
8.2	0.05423	0.05077	0.04755	0.04452	0.04198	0.03998
8.4	0.05662	0.05301	0.04965	0.04648	0.04383	0.04175
8.6	0.05905	0.05529	0.05179	0.04849	0.04573	0.04355
8.8	0.06153	0.05761	0.05396	0.05053	0.04765	0.04539
9.0	0.06405	0.05998	0.05618	0.05261	0.04961	0.04726
9.2	0.06662	0.06238	0.05844	0.05473	0.05161	0.04917
9.4	0.06924	0.06483	0.06074	0.05688	0.05365	0.05110
9.6	0.07190	0.06733	0.06307	0.05907	0.05571	0.05308
9.8	0.07460	0.06986	0.06545	0.06130	0.05782	0.05508
10.0	0.07735	0.07243	0.06786	0.06356	0.05995	0.05712

PRESSURE LOSS PER FOOT
40mm hePEX (metric dimension)

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
6.0	0.01090	0.01019	0.00954	0.00892	0.00841	0.00800
6.2	0.01156	0.01081	0.01012	0.00946	0.00892	0.00849
6.4	0.01223	0.01144	0.01071	0.01002	0.00944	0.00898
6.6	0.01292	0.01209	0.01131	0.01058	0.00997	0.00949
6.8	0.01363	0.01275	0.01193	0.01117	0.01052	0.01002
7.0	0.01435	0.01343	0.01257	0.01176	0.01108	0.01055
7.2	0.01509	0.01412	0.01322	0.01237	0.01166	0.01110
7.4	0.01585	0.01483	0.01388	0.01299	0.01225	0.01166
7.6	0.01662	0.01556	0.01456	0.01363	0.01285	0.01223
7.8	0.01741	0.01630	0.01526	0.01428	0.01346	0.01281
8.0	0.01822	0.01705	0.01596	0.01494	0.01408	0.01341
8.2	0.01904	0.01782	0.01669	0.01562	0.01472	0.01402
8.4	0.01988	0.01861	0.01742	0.01631	0.01537	0.01464
8.6	0.02074	0.01941	0.01817	0.01701	0.01603	0.01527
8.8	0.02161	0.02022	0.01894	0.01772	0.01671	0.01591
9.0	0.02249	0.02105	0.01971	0.01845	0.01740	0.01657
9.2	0.02339	0.02190	0.02051	0.01920	0.01810	0.01723
9.4	0.02431	0.02276	0.02131	0.01995	0.01881	0.01791
9.6	0.02524	0.02363	0.02213	0.02072	0.01953	0.01860
9.8	0.02619	0.02452	0.02296	0.02150	0.02027	0.01930
10.0	0.02716	0.02542	0.02381	0.02229	0.02102	0.02002
10.2	0.02813	0.02634	0.02467	0.02310	0.02178	0.02074
10.4	0.02913	0.02727	0.02554	0.02392	0.02255	0.02148
10.6	0.03014	0.02822	0.02643	0.02475	0.02334	0.02223
10.8	0.03116	0.02918	0.02733	0.02559	0.02413	0.02299
11.0	0.03220	0.03015	0.02824	0.02645	0.02494	0.02376
11.2	0.03326	0.03114	0.02917	0.02732	0.02576	0.02454
11.4	0.03433	0.03214	0.03011	0.02820	0.02659	0.02533
11.6	0.03541	0.03316	0.03107	0.02909	0.02744	0.02614
11.8	0.03651	0.03419	0.03203	0.03000	0.02829	0.02695
12.0	0.03763	0.03524	0.03301	0.03092	0.02916	0.02778
12.2	0.03876	0.03630	0.03401	0.03185	0.03004	0.02862
12.4	0.03990	0.03737	0.03501	0.03279	0.03093	0.02947
12.6	0.04106	0.03846	0.03603	0.03375	0.03183	0.03033
12.8	0.04224	0.03956	0.03706	0.03471	0.03274	0.03120
13.0	0.04343	0.04067	0.03811	0.03569	0.03367	0.03208
13.2	0.04463	0.04180	0.03917	0.03669	0.03461	0.03297
13.4	0.04585	0.04294	0.04024	0.03769	0.03555	0.03388
13.6	0.04708	0.04410	0.04132	0.03871	0.03651	0.03479
13.8	0.04833	0.04526	0.04242	0.03973	0.03748	0.03572
14.0	0.04959	0.04645	0.04353	0.04077	0.03847	0.03665
14.2	0.05086	0.04764	0.04465	0.04183	0.03946	0.03760
14.4	0.05215	0.04885	0.04578	0.04289	0.04046	0.03856
14.6	0.05346	0.05008	0.04693	0.04397	0.04148	0.03953
14.8	0.05478	0.05131	0.04809	0.04505	0.04251	0.04051
15.0	0.05611	0.05256	0.04926	0.04615	0.04355	0.04150
15.2	0.05746	0.05382	0.05045	0.04726	0.04460	0.04250
15.4	0.05882	0.05510	0.05164	0.04839	0.04566	0.04351
15.6	0.06019	0.05639	0.05285	0.04952	0.04673	0.04453
15.8	0.06158	0.05769	0.05408	0.05067	0.04781	0.04557
16.0	0.06298	0.05901	0.05531	0.05183	0.04890	0.04661
16.2	0.06440	0.06034	0.05656	0.05300	0.05001	0.04766
16.4	0.06583	0.06168	0.05782	0.05418	0.05113	0.04873
16.6	0.06728	0.06304	0.05909	0.05537	0.05225	0.04980
16.8	0.06874	0.06440	0.06037	0.05658	0.05339	0.05089
17.0	0.07021	0.06579	0.06167	0.05779	0.05454	0.05198

50% Glycol / Water Solution

PRESSURE LOSS PER FOOT
32mm hePEX (metric dimension)

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
3.0	0.00992	0.00886	0.00816	0.00765	0.00727	0.00697
3.2	0.01112	0.00994	0.00916	0.00858	0.00816	0.00782
3.4	0.01239	0.01108	0.01021	0.00957	0.00909	0.00872
3.6	0.01372	0.01227	0.01130	0.01060	0.01007	0.00966
3.8	0.01511	0.01351	0.01245	0.01167	0.01109	0.01064
4.0	0.01656	0.01481	0.01365	0.01279	0.01216	0.01166
4.2	0.01807	0.01615	0.01489	0.01396	0.01327	0.01273
4.4	0.01963	0.01755	0.01618	0.01517	0.01442	0.01384
4.6	0.02125	0.01900	0.01752	0.01643	0.01561	0.01498
4.8	0.02292	0.02051	0.01890	0.01773	0.01685	0.01617
5.0	0.02466	0.02206	0.02034	0.01907	0.01813	0.01740
5.2	0.02644	0.02366	0.02181	0.02046	0.01945	0.01866
5.4	0.02829	0.02531	0.02334	0.02189	0.02081	0.01997
5.6	0.03018	0.02701	0.02491	0.02336	0.02221	0.02131
5.8	0.03213	0.02876	0.02652	0.02487	0.02365	0.02270
6.0	0.03414	0.03055	0.02818	0.02643	0.02513	0.02412
6.2	0.03620	0.03240	0.02988	0.02803	0.02665	0.02558
6.4	0.03831	0.03429	0.03163	0.02967	0.02821	0.02708
6.6	0.04047	0.03623	0.03342	0.03135	0.02981	0.02862
6.8	0.04269	0.03821	0.03525	0.03307	0.03145	0.03019
7.0	0.04495	0.04025	0.03713	0.03483	0.03313	0.03180
7.2	0.04727	0.04233	0.03905	0.03664	0.03485	0.03345
7.4	0.04964	0.04445	0.04102	0.03848	0.03660	0.03514
7.6	0.05207	0.04662	0.04302	0.04037	0.03839	0.03686
7.8	0.05454	0.04884	0.04507	0.04229	0.04022	0.03862
8.0	0.05706	0.05110	0.04716	0.04425	0.04209	0.04041
8.2	0.05963	0.05341	0.04929	0.04626	0.04400	0.04224
8.4	0.06226	0.05577	0.05147	0.04830	0.04594	0.04411
8.6	0.06493	0.05816	0.05368	0.05038	0.04792	0.04601
8.8	0.06765	0.06061	0.05594	0.05250	0.04994	0.04795
9.0	0.07043	0.06309	0.05824	0.05466	0.05200	0.04993
9.2	0.07325	0.06562	0.06058	0.05685	0.05409	0.05194
9.4	0.07612	0.06820	0.06296	0.05909	0.05622	0.05398
9.6	0.07904	0.07082	0.06538	0.06136	0.05838	0.05606
9.8	0.08200	0.07348	0.06784	0.06368	0.06058	0.05818
10.0	0.08502	0.07619	0.07034	0.06603	0.06282	0.06033

PRESSURE LOSS PER FOOT
40mm hePEX (metric dimension)

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
6.0	0.01200	0.01073	0.00989	0.00928	0.00882	0.00846
6.2	0.01272	0.01138	0.01049	0.00984	0.00935	0.00898
6.4	0.01346	0.01204	0.01110	0.01041	0.00990	0.00950
6.6	0.01422	0.01272	0.01173	0.01100	0.01046	0.01004
6.8	0.01500	0.01342	0.01238	0.01161	0.01104	0.01059
7.0	0.01580	0.01414	0.01304	0.01223	0.01162	0.01116
7.2	0.01661	0.01486	0.01371	0.01286	0.01223	0.01173
7.4	0.01744	0.01561	0.01440	0.01350	0.01284	0.01232
7.6	0.01829	0.01637	0.01510	0.01416	0.01347	0.01293
7.8	0.01916	0.01715	0.01582	0.01484	0.01411	0.01354
8.0	0.02005	0.01795	0.01655	0.01553	0.01477	0.01417
8.2	0.02095	0.01876	0.01730	0.01623	0.01543	0.01482
8.4	0.02187	0.01958	0.01806	0.01695	0.01612	0.01547
8.6	0.02281	0.02042	0.01884	0.01768	0.01681	0.01614
8.8	0.02377	0.02128	0.01963	0.01842	0.01752	0.01682
9.0	0.02474	0.02215	0.02044	0.01918	0.01824	0.01751
9.2	0.02573	0.02304	0.02126	0.01995	0.01897	0.01821
9.4	0.02674	0.02394	0.02209	0.02073	0.01972	0.01893
9.6	0.02776	0.02486	0.02294	0.02153	0.02048	0.01966
9.8	0.02881	0.02580	0.02381	0.02234	0.02125	0.02040
10.0	0.02986	0.02675	0.02468	0.02316	0.02203	0.02115
10.2	0.03094	0.02771	0.02557	0.02400	0.02283	0.02192
10.4	0.03203	0.02869	0.02648	0.02485	0.02364	0.02269
10.6	0.03314	0.02969	0.02740	0.02571	0.02446	0.02348
10.8	0.03427	0.03070	0.02833	0.02659	0.02529	0.02429
11.0	0.03541	0.03172	0.02928	0.02748	0.02614	0.02510
11.2	0.03657	0.03276	0.03024	0.02838	0.02700	0.02592
11.4	0.03774	0.03381	0.03121	0.02929	0.02787	0.02676
11.6	0.03893	0.03488	0.03220	0.03022	0.02875	0.02761
11.8	0.04014	0.03597	0.03320	0.03116	0.02965	0.02847
12.0	0.04137	0.03707	0.03422	0.03212	0.03056	0.02934
12.2	0.04261	0.03818	0.03525	0.03308	0.03148	0.03023
12.4	0.04386	0.03931	0.03629	0.03406	0.03241	0.03112
12.6	0.04514	0.04045	0.03734	0.03506	0.03335	0.03203
12.8	0.04642	0.04161	0.03841	0.03606	0.03431	0.03295
13.0	0.04773	0.04278	0.03950	0.03708	0.03528	0.03388
13.2	0.04905	0.04396	0.04059	0.03811	0.03626	0.03482
13.4	0.05039	0.04516	0.04170	0.03915	0.03725	0.03578
13.6	0.05174	0.04638	0.04282	0.04020	0.03826	0.03674
13.8	0.05311	0.04760	0.04396	0.04127	0.03927	0.03772
14.0	0.05449	0.04885	0.04511	0.04235	0.04030	0.03871
14.2	0.05589	0.05010	0.04627	0.04344	0.04134	0.03971
14.4	0.05731	0.05137	0.04745	0.04455	0.04239	0.04072
14.6	0.05874	0.05266	0.04863	0.04566	0.04346	0.04174
14.8	0.06019	0.05396	0.04984	0.04679	0.04453	0.04277
15.0	0.06165	0.05527	0.05105	0.04793	0.04562	0.04382
15.2	0.06313	0.05660	0.05228	0.04909	0.04672	0.04487
15.4	0.06462	0.05794	0.05352	0.05025	0.04783	0.04594
15.6	0.06613	0.05930	0.05477	0.05143	0.04895	0.04702
15.8	0.06765	0.06066	0.05604	0.05262	0.05008	0.04811
16.0	0.06919	0.06205	0.05732	0.05382	0.05123	0.04921
16.2	0.07075	0.06344	0.05861	0.05504	0.05238	0.05032
16.4	0.07232	0.06485	0.05991	0.05626	0.05355	0.05144
16.6	0.07390	0.06628	0.06123	0.05750	0.05473	0.05258
16.8	0.07550	0.06772	0.06256	0.05875	0.05592	0.05372
17.0	0.07712	0.06917	0.06390	0.06001	0.05712	0.05488

50% Glycol / Water Solution

PRESSURE LOSS PER FOOT
32mm hePEX (metric dimension)

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
3.0	0.00992	0.00886	0.00816	0.00765	0.00727	0.00697
3.2	0.01112	0.00994	0.00916	0.00858	0.00816	0.00782
3.4	0.01239	0.01108	0.01021	0.00957	0.00909	0.00872
3.6	0.01372	0.01227	0.01130	0.01060	0.01007	0.00966
3.8	0.01511	0.01351	0.01245	0.01167	0.01109	0.01064
4.0	0.01656	0.01481	0.01365	0.01279	0.01216	0.01166
4.2	0.01807	0.01615	0.01489	0.01396	0.01327	0.01273
4.4	0.01963	0.01755	0.01618	0.01517	0.01442	0.01384
4.6	0.02125	0.01900	0.01752	0.01643	0.01561	0.01498
4.8	0.02292	0.02051	0.01890	0.01773	0.01685	0.01617
5.0	0.02466	0.02206	0.02034	0.01907	0.01813	0.01740
5.2	0.02644	0.02366	0.02181	0.02046	0.01945	0.01866
5.4	0.02829	0.02531	0.02334	0.02189	0.02081	0.01997
5.6	0.03018	0.02701	0.02491	0.02336	0.02221	0.02131
5.8	0.03213	0.02876	0.02652	0.02487	0.02365	0.02270
6.0	0.03414	0.03055	0.02818	0.02643	0.02513	0.02412
6.2	0.03620	0.03240	0.02988	0.02803	0.02665	0.02558
6.4	0.03831	0.03429	0.03163	0.02967	0.02821	0.02708
6.6	0.04047	0.03623	0.03342	0.03135	0.02981	0.02862
6.8	0.04269	0.03821	0.03525	0.03307	0.03145	0.03019
7.0	0.04495	0.04025	0.03713	0.03483	0.03313	0.03180
7.2	0.04727	0.04233	0.03905	0.03664	0.03485	0.03345
7.4	0.04964	0.04445	0.04102	0.03848	0.03660	0.03514
7.6	0.05207	0.04662	0.04302	0.04037	0.03839	0.03686
7.8	0.05454	0.04884	0.04507	0.04229	0.04022	0.03862
8.0	0.05706	0.05110	0.04716	0.04425	0.04209	0.04041
8.2	0.05963	0.05341	0.04929	0.04626	0.04400	0.04224
8.4	0.06226	0.05577	0.05147	0.04830	0.04594	0.04411
8.6	0.06493	0.05816	0.05368	0.05038	0.04792	0.04601
8.8	0.06765	0.06061	0.05594	0.05250	0.04994	0.04795
9.0	0.07043	0.06309	0.05824	0.05466	0.05200	0.04993
9.2	0.07325	0.06562	0.06058	0.05685	0.05409	0.05194
9.4	0.07612	0.06820	0.06296	0.05909	0.05622	0.05398
9.6	0.07904	0.07082	0.06538	0.06136	0.05838	0.05606
9.8	0.08200	0.07348	0.06784	0.06368	0.06058	0.05818
10.0	0.08502	0.07619	0.07034	0.06603	0.06282	0.06033

PRESSURE LOSS PER FOOT
40mm hePEX (metric dimension)

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
6.0	0.01200	0.01073	0.00989	0.00928	0.00882	0.00846
6.2	0.01272	0.01138	0.01049	0.00984	0.00935	0.00898
6.4	0.01346	0.01204	0.01110	0.01041	0.00990	0.00950
6.6	0.01422	0.01272	0.01173	0.01100	0.01046	0.01004
6.8	0.01500	0.01342	0.01238	0.01161	0.01104	0.01059
7.0	0.01580	0.01414	0.01304	0.01223	0.01162	0.01116
7.2	0.01661	0.01486	0.01371	0.01286	0.01223	0.01173
7.4	0.01744	0.01561	0.01440	0.01350	0.01284	0.01232
7.6	0.01829	0.01637	0.01510	0.01416	0.01347	0.01293
7.8	0.01916	0.01715	0.01582	0.01484	0.01411	0.01354
8.0	0.02005	0.01795	0.01655	0.01553	0.01477	0.01417
8.2	0.02095	0.01876	0.01730	0.01623	0.01543	0.01482
8.4	0.02187	0.01958	0.01806	0.01695	0.01612	0.01547
8.6	0.02281	0.02042	0.01884	0.01768	0.01681	0.01614
8.8	0.02377	0.02128	0.01963	0.01842	0.01752	0.01682
9.0	0.02474	0.02215	0.02044	0.01918	0.01824	0.01751
9.2	0.02573	0.02304	0.02126	0.01995	0.01897	0.01821
9.4	0.02674	0.02394	0.02209	0.02073	0.01972	0.01893
9.6	0.02776	0.02486	0.02294	0.02153	0.02048	0.01966
9.8	0.02881	0.02580	0.02381	0.02234	0.02125	0.02040
10.0	0.02986	0.02675	0.02468	0.02316	0.02203	0.02115
10.2	0.03094	0.02771	0.02557	0.02400	0.02283	0.02192
10.4	0.03203	0.02869	0.02648	0.02485	0.02364	0.02269
10.6	0.03314	0.02969	0.02740	0.02571	0.02446	0.02348
10.8	0.03427	0.03070	0.02833	0.02659	0.02529	0.02429
11.0	0.03541	0.03172	0.02928	0.02748	0.02614	0.02510
11.2	0.03657	0.03276	0.03024	0.02838	0.02700	0.02592
11.4	0.03774	0.03381	0.03121	0.02929	0.02787	0.02676
11.6	0.03893	0.03488	0.03220	0.03022	0.02875	0.02761
11.8	0.04014	0.03597	0.03320	0.03116	0.02965	0.02847
12.0	0.04137	0.03707	0.03422	0.03212	0.03056	0.02934
12.2	0.04261	0.03818	0.03525	0.03308	0.03148	0.03023
12.4	0.04386	0.03931	0.03629	0.03406	0.03241	0.03112
12.6	0.04514	0.04045	0.03734	0.03506	0.03335	0.03203
12.8	0.04642	0.04161	0.03841	0.03606	0.03431	0.03295
13.0	0.04773	0.04278	0.03950	0.03708	0.03528	0.03388
13.2	0.04905	0.04396	0.04059	0.03811	0.03626	0.03482
13.4	0.05039	0.04516	0.04170	0.03915	0.03725	0.03578
13.6	0.05174	0.04638	0.04282	0.04020	0.03826	0.03674
13.8	0.05311	0.04760	0.04396	0.04127	0.03927	0.03772
14.0	0.05449	0.04885	0.04511	0.04235	0.04030	0.03871
14.2	0.05589	0.05010	0.04627	0.04344	0.04134	0.03971
14.4	0.05731	0.05137	0.04745	0.04455	0.04239	0.04072
14.6	0.05874	0.05266	0.04863	0.04566	0.04346	0.04174
14.8	0.06019	0.05396	0.04984	0.04679	0.04453	0.04277
15.0	0.06165	0.05527	0.05105	0.04793	0.04562	0.04382
15.2	0.06313	0.05660	0.05228	0.04909	0.04672	0.04487
15.4	0.06462	0.05794	0.05352	0.05025	0.04783	0.04594
15.6	0.06613	0.05930	0.05477	0.05143	0.04895	0.04702
15.8	0.06765	0.06066	0.05604	0.05262	0.05008	0.04811
16.0	0.06919	0.06205	0.05732	0.05382	0.05123	0.04921
16.2	0.07075	0.06344	0.05861	0.05504	0.05238	0.05032
16.4	0.07232	0.06485	0.05991	0.05626	0.05355	0.05144
16.6	0.07390	0.06628	0.06123	0.05750	0.05473	0.05258
16.8	0.07550	0.06772	0.06256	0.05875	0.05592	0.05372
17.0	0.07712	0.06917	0.06390	0.06001	0.05712	0.05488

50% Glycol / Water Solution

PRESSURE LOSS PER FOOT 32mm hePEX (metric dimension)

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
3.0	0.00992	0.00886	0.00816	0.00765	0.00727	0.00697
3.2	0.01112	0.00994	0.00916	0.00858	0.00816	0.00782
3.4	0.01239	0.01108	0.01021	0.00957	0.00909	0.00872
3.6	0.01372	0.01227	0.01130	0.01060	0.01007	0.00966
3.8	0.01511	0.01351	0.01245	0.01167	0.01109	0.01064
4.0	0.01656	0.01481	0.01365	0.01279	0.01216	0.01166
4.2	0.01807	0.01615	0.01489	0.01396	0.01327	0.01273
4.4	0.01963	0.01755	0.01618	0.01517	0.01442	0.01384
4.6	0.02125	0.01900	0.01752	0.01643	0.01561	0.01498
4.8	0.02292	0.02051	0.01890	0.01773	0.01685	0.01617
5.0	0.02466	0.02206	0.02034	0.01907	0.01813	0.01740
5.2	0.02644	0.02366	0.02181	0.02046	0.01945	0.01866
5.4	0.02829	0.02531	0.02334	0.02189	0.02081	0.01997
5.6	0.03018	0.02701	0.02491	0.02336	0.02221	0.02131
5.8	0.03213	0.02876	0.02652	0.02487	0.02365	0.02270
6.0	0.03414	0.03055	0.02818	0.02643	0.02513	0.02412
6.2	0.03620	0.03240	0.02988	0.02803	0.02665	0.02558
6.4	0.03831	0.03429	0.03163	0.02967	0.02821	0.02708
6.6	0.04047	0.03623	0.03342	0.03135	0.02981	0.02862
6.8	0.04269	0.03821	0.03525	0.03307	0.03145	0.03019
7.0	0.04495	0.04025	0.03713	0.03483	0.03313	0.03180
7.2	0.04727	0.04233	0.03905	0.03664	0.03485	0.03345
7.4	0.04964	0.04445	0.04102	0.03848	0.03660	0.03514
7.6	0.05207	0.04662	0.04302	0.04037	0.03839	0.03686
7.8	0.05454	0.04884	0.04507	0.04229	0.04022	0.03862
8.0	0.05706	0.05110	0.04716	0.04425	0.04209	0.04041
8.2	0.05963	0.05341	0.04929	0.04626	0.04400	0.04224
8.4	0.06226	0.05577	0.05147	0.04830	0.04594	0.04411
8.6	0.06493	0.05816	0.05368	0.05038	0.04792	0.04601
8.8	0.06765	0.06061	0.05594	0.05250	0.04994	0.04795
9.0	0.07043	0.06309	0.05824	0.05466	0.05200	0.04993
9.2	0.07325	0.06562	0.06058	0.05685	0.05409	0.05194
9.4	0.07612	0.06820	0.06296	0.05909	0.05622	0.05398
9.6	0.07904	0.07082	0.06538	0.06136	0.05838	0.05606
9.8	0.08200	0.07348	0.06784	0.06368	0.06058	0.05818
10.0	0.08502	0.07619	0.07034	0.06603	0.06282	0.06033

PRESSURE LOSS PER FOOT 40mm hePEX (metric dimension)

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
6.0	0.01200	0.01073	0.00989	0.00928	0.00882	0.00846
6.2	0.01272	0.01138	0.01049	0.00984	0.00935	0.00898
6.4	0.01346	0.01204	0.01110	0.01041	0.00990	0.00950
6.6	0.01422	0.01272	0.01173	0.01100	0.01046	0.01004
6.8	0.01500	0.01342	0.01238	0.01161	0.01104	0.01059
7.0	0.01580	0.01414	0.01304	0.01223	0.01162	0.01116
7.2	0.01661	0.01486	0.01371	0.01286	0.01223	0.01173
7.4	0.01744	0.01561	0.01440	0.01350	0.01284	0.01232
7.6	0.01829	0.01637	0.01510	0.01416	0.01347	0.01293
7.8	0.01916	0.01715	0.01582	0.01484	0.01411	0.01354
8.0	0.02005	0.01795	0.01655	0.01553	0.01477	0.01417
8.2	0.02095	0.01876	0.01730	0.01623	0.01543	0.01482
8.4	0.02187	0.01958	0.01806	0.01695	0.01612	0.01547
8.6	0.02281	0.02042	0.01884	0.01768	0.01681	0.01614
8.8	0.02377	0.02128	0.01963	0.01842	0.01752	0.01682
9.0	0.02474	0.02215	0.02044	0.01918	0.01824	0.01751
9.2	0.02573	0.02304	0.02126	0.01995	0.01897	0.01821
9.4	0.02674	0.02394	0.02209	0.02073	0.01972	0.01893
9.6	0.02776	0.02486	0.02294	0.02153	0.02048	0.01966
9.8	0.02881	0.02580	0.02381	0.02234	0.02125	0.02040
10.0	0.02986	0.02675	0.02468	0.02316	0.02203	0.02115
10.2	0.03094	0.02771	0.02557	0.02400	0.02283	0.02192
10.4	0.03203	0.02869	0.02648	0.02485	0.02364	0.02269
10.6	0.03314	0.02969	0.02740	0.02571	0.02446	0.02348
10.8	0.03427	0.03070	0.02833	0.02659	0.02529	0.02429
11.0	0.03541	0.03172	0.02928	0.02748	0.02614	0.02510
11.2	0.03657	0.03276	0.03024	0.02838	0.02700	0.02592
11.4	0.03774	0.03381	0.03121	0.02929	0.02787	0.02676
11.6	0.03893	0.03488	0.03220	0.03022	0.02875	0.02761
11.8	0.04014	0.03597	0.03320	0.03116	0.02965	0.02847
12.0	0.04137	0.03707	0.03422	0.03212	0.03056	0.02934
12.2	0.04261	0.03818	0.03525	0.03308	0.03148	0.03023
12.4	0.04386	0.03931	0.03629	0.03406	0.03241	0.03112
12.6	0.04514	0.04045	0.03734	0.03506	0.03335	0.03203
12.8	0.04642	0.04161	0.03841	0.03606	0.03431	0.03295
13.0	0.04773	0.04278	0.03950	0.03708	0.03528	0.03388
13.2	0.04905	0.04396	0.04059	0.03811	0.03626	0.03482
13.4	0.05039	0.04516	0.04170	0.03915	0.03725	0.03578
13.6	0.05174	0.04638	0.04282	0.04020	0.03826	0.03674
13.8	0.05311	0.04760	0.04396	0.04127	0.03927	0.03772
14.0	0.05449	0.04885	0.04511	0.04235	0.04030	0.03871
14.2	0.05589	0.05010	0.04627	0.04344	0.04134	0.03971
14.4	0.05731	0.05137	0.04745	0.04455	0.04239	0.04072
14.6	0.05874	0.05266	0.04863	0.04566	0.04346	0.04174
14.8	0.06019	0.05396	0.04984	0.04679	0.04453	0.04277
15.0	0.06165	0.05527	0.05105	0.04793	0.04562	0.04382
15.2	0.06313	0.05660	0.05228	0.04909	0.04672	0.04487
15.4	0.06462	0.05794	0.05352	0.05025	0.04783	0.04594
15.6	0.06613	0.05930	0.05477	0.05143	0.04895	0.04702
15.8	0.06765	0.06066	0.05604	0.05262	0.05008	0.04811
16.0	0.06919	0.06205	0.05732	0.05382	0.05123	0.04921
16.2	0.07075	0.06344	0.05861	0.05504	0.05238	0.05032
16.4	0.07232	0.06485	0.05991	0.05626	0.05355	0.05144
16.6	0.07390	0.06628	0.06123	0.05750	0.05473	0.05258
16.8	0.07550	0.06772	0.06256	0.05875	0.05592	0.05372
17.0	0.07712	0.06917	0.06390	0.06001	0.05712	0.05488

Notes

30% Glycol / Water Solution

PRESSURE LOSS PER FOOT 2" HDPE (SDR 11)

	Head Loss Per Foot of Tubing			
gpm	**80°F**	**100°F**	**120°F**	**140°F**
14	0.00708	0.00672	0.00622	0.00596
15	0.00801	0.00760	0.00704	0.00674
16	0.00900	0.00853	0.00791	0.00757
17	0.01003	0.00951	0.00882	0.00844
18	0.01111	0.01054	0.00977	0.00935
19	0.01224	0.01162	0.01076	0.01031
20	0.01342	0.01274	0.01180	0.01130
21	0.01465	0.01390	0.01288	0.01234
22	0.01592	0.01511	0.01401	0.01341
23	0.01724	0.01637	0.01517	0.01453
24	0.01861	0.01766	0.01638	0.01569
25	0.02002	0.01901	0.01763	0.01688
26	0.02148	0.02040	0.01891	0.01812
27	0.02299	0.02183	0.02024	0.01939
28	0.02454	0.02330	0.02161	0.02070
29	0.02614	0.02482	0.02302	0.02205
30	0.02778	0.02637	0.02447	0.02344
31	0.02946	0.02797	0.02595	0.02487
32	0.03119	0.02962	0.02748	0.02633
33	0.03296	0.03130	0.02904	0.02783
34	0.03478	0.03303	0.03065	0.02937
35	0.03663	0.03479	0.03229	0.03094
36	0.03854	0.03660	0.03397	0.03255
37	0.04048	0.03845	0.03569	0.03420
38	0.04247	0.04034	0.03744	0.03588
39	0.04450	0.04227	0.03924	0.03760
40	0.04657	0.04424	0.04107	0.03936
41	0.04868	0.04625	0.04294	0.04115
42	0.05084	0.04830	0.04484	0.04298
43	0.05303	0.05038	0.04678	0.04484
44	0.05527	0.05251	0.04876	0.04674
45	0.05755	0.05468	0.05078	0.04867
46	0.05987	0.05689	0.05283	0.05064
47	0.06223	0.05913	0.05492	0.05265
48	0.06463	0.06142	0.05704	0.05468
49	0.06707	0.06374	0.05920	0.05676
50	0.06956	0.06610	0.06140	0.05886

PRESSURE LOSS PER FOOT 3" HDPE (SDR 11)

	Head Loss Per Foot of Tubing			
gpm	**80°F**	**100°F**	**120°F**	**140°F**
28	0.00382	0.00362	0.00336	0.00321
30	0.00432	0.00410	0.00380	0.00364
32	0.00485	0.00460	0.00427	0.00409
34	0.00541	0.00513	0.00476	0.00456
36	0.00599	0.00569	0.00527	0.00505
38	0.00660	0.00626	0.00581	0.00557
40	0.00724	0.00687	0.00637	0.00610
42	0.00790	0.00750	0.00696	0.00666
44	0.00859	0.00815	0.00756	0.00725
46	0.00930	0.00883	0.00819	0.00785
48	0.01004	0.00953	0.00884	0.00847
50	0.01080	0.01026	0.00952	0.00912
52	0.01159	0.01101	0.01022	0.00979
54	0.01240	0.01178	0.01093	0.01048
56	0.01324	0.01258	0.01167	0.01119
58	0.01410	0.01340	0.01244	0.01192
60	0.01499	0.01424	0.01322	0.01267
62	0.01590	0.01510	0.01402	0.01344
64	0.01683	0.01599	0.01485	0.01423
66	0.01779	0.01690	0.01570	0.01505
68	0.01877	0.01784	0.01656	0.01588
70	0.01977	0.01879	0.01745	0.01673
72	0.02080	0.01977	0.01836	0.01760
74	0.02185	0.02077	0.01929	0.01849
76	0.02293	0.02179	0.02024	0.01941
78	0.02402	0.02283	0.02121	0.02034
80	0.02514	0.02390	0.02220	0.02129
82	0.02629	0.02498	0.02321	0.02226
84	0.02745	0.02609	0.02425	0.02325
86	0.02864	0.02722	0.02530	0.02426
88	0.02985	0.02837	0.02637	0.02529
90	0.03108	0.02955	0.02746	0.02633
92	0.03234	0.03074	0.02857	0.02740
94	0.03361	0.03196	0.02970	0.02849
96	0.03491	0.03319	0.03085	0.02959
98	0.03623	0.03445	0.03202	0.03071
100	0.03757	0.03573	0.03321	0.03186
102	0.03894	0.03703	0.03442	0.03302
104	0.04033	0.03834	0.03565	0.03420
106	0.04173	0.03968	0.03690	0.03539
108	0.04316	0.04104	0.03817	0.03661
110	0.04461	0.04243	0.03945	0.03784
112	0.04609	0.04383	0.04076	0.03910
114	0.04758	0.04525	0.04208	0.04037
116	0.04909	0.04669	0.04342	0.04166
118	0.05063	0.04815	0.04479	0.04297
120	0.05219	0.04964	0.04617	0.04429

30% Glycol / Water Solution

PRESSURE LOSS PER FOOT
2" HDPE (SDR 11)

	Head Loss Per Foot of Tubing			
gpm	80°F	100°F	120°F	140°F
14	0.00708	0.00672	0.00622	0.00596
15	0.00801	0.00760	0.00704	0.00674
16	0.00900	0.00853	0.00791	0.00757
17	0.01003	0.00951	0.00882	0.00844
18	0.01111	0.01054	0.00977	0.00935
19	0.01224	0.01162	0.01076	0.01031
20	0.01342	0.01274	0.01180	0.01130
21	0.01465	0.01390	0.01288	0.01234
22	0.01592	0.01511	0.01401	0.01341
23	0.01724	0.01637	0.01517	0.01453
24	0.01861	0.01766	0.01638	0.01569
25	0.02002	0.01901	0.01763	0.01688
26	0.02148	0.02040	0.01891	0.01812
27	0.02299	0.02183	0.02024	0.01939
28	0.02454	0.02330	0.02161	0.02070
29	0.02614	0.02482	0.02302	0.02205
30	0.02778	0.02637	0.02447	0.02344
31	0.02946	0.02797	0.02595	0.02487
32	0.03119	0.02962	0.02748	0.02633
33	0.03296	0.03130	0.02904	0.02783
34	0.03478	0.03303	0.03065	0.02937
35	0.03663	0.03479	0.03229	0.03094
36	0.03854	0.03660	0.03397	0.03255
37	0.04048	0.03845	0.03569	0.03420
38	0.04247	0.04034	0.03744	0.03588
39	0.04450	0.04227	0.03924	0.03760
40	0.04657	0.04424	0.04107	0.03936
41	0.04868	0.04625	0.04294	0.04115
42	0.05084	0.04830	0.04484	0.04298
43	0.05303	0.05038	0.04678	0.04484
44	0.05527	0.05251	0.04876	0.04674
45	0.05755	0.05468	0.05078	0.04867
46	0.05987	0.05689	0.05283	0.05064
47	0.06223	0.05913	0.05492	0.05265
48	0.06463	0.06142	0.05704	0.05468
49	0.06707	0.06374	0.05920	0.05676
50	0.06956	0.06610	0.06140	0.05886

PRESSURE LOSS PER FOOT
3" HDPE (SDR 11)

	Head Loss Per Foot of Tubing			
gpm	80°F	100°F	120°F	140°F
28	0.00382	0.00362	0.00336	0.00321
30	0.00432	0.00410	0.00380	0.00364
32	0.00485	0.00460	0.00427	0.00409
34	0.00541	0.00513	0.00476	0.00456
36	0.00599	0.00569	0.00527	0.00505
38	0.00660	0.00626	0.00581	0.00557
40	0.00724	0.00687	0.00637	0.00610
42	0.00790	0.00750	0.00696	0.00666
44	0.00859	0.00815	0.00756	0.00725
46	0.00930	0.00883	0.00819	0.00785
48	0.01004	0.00953	0.00884	0.00847
50	0.01080	0.01026	0.00952	0.00912
52	0.01159	0.01101	0.01022	0.00979
54	0.01240	0.01178	0.01093	0.01048
56	0.01324	0.01258	0.01167	0.01119
58	0.01410	0.01340	0.01244	0.01192
60	0.01499	0.01424	0.01322	0.01267
62	0.01590	0.01510	0.01402	0.01344
64	0.01683	0.01599	0.01485	0.01423
66	0.01779	0.01690	0.01570	0.01505
68	0.01877	0.01784	0.01656	0.01588
70	0.01977	0.01879	0.01745	0.01673
72	0.02080	0.01977	0.01836	0.01760
74	0.02185	0.02077	0.01929	0.01849
76	0.02293	0.02179	0.02024	0.01941
78	0.02402	0.02283	0.02121	0.02034
80	0.02514	0.02390	0.02220	0.02129
82	0.02629	0.02498	0.02321	0.02226
84	0.02745	0.02609	0.02425	0.02325
86	0.02864	0.02722	0.02530	0.02426
88	0.02985	0.02837	0.02637	0.02529
90	0.03108	0.02955	0.02746	0.02633
92	0.03234	0.03074	0.02857	0.02740
94	0.03361	0.03196	0.02970	0.02849
96	0.03491	0.03319	0.03085	0.02959
98	0.03623	0.03445	0.03202	0.03071
100	0.03757	0.03573	0.03321	0.03186
102	0.03894	0.03703	0.03442	0.03302
104	0.04033	0.03834	0.03565	0.03420
106	0.04173	0.03968	0.03690	0.03539
108	0.04316	0.04104	0.03817	0.03661
110	0.04461	0.04243	0.03945	0.03784
112	0.04609	0.04383	0.04076	0.03910
114	0.04758	0.04525	0.04208	0.04037
116	0.04909	0.04669	0.04342	0.04166
118	0.05063	0.04815	0.04479	0.04297
120	0.05219	0.04964	0.04617	0.04429

40% Glycol / Water Solution

PRESSURE LOSS PER FOOT
2" HDPE (SDR 11)

	Head Loss Per Foot of Tubing			
gpm	80°F	100°F	120°F	140°F
14	0.00775	0.00725	0.00679	0.00636
15	0.00877	0.00821	0.00769	0.00720
16	0.00984	0.00921	0.00863	0.00808
17	0.01097	0.01027	0.00962	0.00901
18	0.01215	0.01138	0.01066	0.00998
19	0.01338	0.01253	0.01174	0.01100
20	0.01467	0.01374	0.01288	0.01206
21	0.01601	0.01500	0.01405	0.01317
22	0.01740	0.01630	0.01528	0.01431
23	0.01884	0.01765	0.01655	0.01550
24	0.02034	0.01905	0.01786	0.01673
25	0.02188	0.02050	0.01922	0.01801
26	0.02347	0.02199	0.02062	0.01932
27	0.02511	0.02353	0.02206	0.02068
28	0.02681	0.02512	0.02355	0.02208
29	0.02855	0.02675	0.02509	0.02352
30	0.03033	0.02843	0.02666	0.02499
31	0.03217	0.03015	0.02828	0.02651
32	0.03406	0.03192	0.02994	0.02807
33	0.03599	0.03374	0.03164	0.02967
34	0.03797	0.03559	0.03339	0.03130
35	0.03999	0.03750	0.03517	0.03298
36	0.04207	0.03944	0.03700	0.03470
37	0.04419	0.04143	0.03887	0.03645
38	0.04635	0.04346	0.04077	0.03824
39	0.04856	0.04554	0.04272	0.04007
40	0.05082	0.04766	0.04471	0.04194
41	0.05312	0.04982	0.04675	0.04385
42	0.05547	0.05202	0.04882	0.04579
43	0.05786	0.05427	0.05093	0.04778
44	0.06030	0.05656	0.05308	0.04980
45	0.06278	0.05889	0.05527	0.05185
46	0.06531	0.06126	0.05750	0.05395
47	0.06788	0.06368	0.05977	0.05608
48	0.07050	0.06613	0.06207	0.05825
49	0.07316	0.06863	0.06442	0.06045
50	0.07586	0.07117	0.06681	0.06269

PRESSURE LOSS PER FOOT
3" HDPE (SDR 11)

	Head Loss Per Foot of Tubing			
gpm	80°F	100°F	120°F	140°F
28	0.00417	0.00391	0.00366	0.00343
30	0.00472	0.00442	0.00414	0.00388
32	0.00530	0.00496	0.00465	0.00436
34	0.00591	0.00553	0.00519	0.00486
36	0.00591	0.00553	0.00519	0.00486
38	0.00721	0.00676	0.00633	0.00594
40	0.00790	0.00741	0.00694	0.00651
42	0.00863	0.00808	0.00758	0.00711
44	0.00938	0.00879	0.00824	0.00773
46	0.01015	0.00952	0.00893	0.00837
48	0.01096	0.01027	0.00964	0.00903
50	0.01179	0.01106	0.01037	0.00972
52	0.01265	0.01186	0.01113	0.01043
54	0.01354	0.01269	0.01191	0.01117
56	0.01445	0.01355	0.01271	0.01192
58	0.01539	0.01443	0.01354	0.01270
60	0.01636	0.01534	0.01439	0.01350
62	0.01735	0.01627	0.01527	0.01432
64	0.01836	0.01722	0.01616	0.01516
66	0.01941	0.01820	0.01708	0.01603
68	0.02048	0.01921	0.01803	0.01691
70	0.02157	0.02023	0.01899	0.01782
72	0.02269	0.02129	0.01998	0.01875
74	0.02383	0.02236	0.02099	0.01970
76	0.02500	0.02346	0.02202	0.02067
78	0.02620	0.02458	0.02308	0.02166
80	0.02742	0.02573	0.02415	0.02267
82	0.02866	0.02689	0.02525	0.02370
84	0.02993	0.02809	0.02637	0.02475
86	0.03122	0.02930	0.02751	0.02583
88	0.03254	0.03054	0.02868	0.02692
90	0.03388	0.03180	0.02986	0.02803
92	0.03525	0.03308	0.03107	0.02917
94	0.03664	0.03439	0.03229	0.03032
96	0.03805	0.03571	0.03354	0.03150
98	0.03949	0.03707	0.03481	0.03269
100	0.04095	0.03844	0.03610	0.03390
102	0.04243	0.03983	0.03742	0.03514
104	0.04394	0.04125	0.03875	0.03639
106	0.04547	0.04269	0.04010	0.03766
108	0.04702	0.04415	0.04148	0.03896
110	0.04860	0.04563	0.04287	0.04027
112	0.05020	0.04714	0.04429	0.04160
114	0.05183	0.04867	0.04572	0.04295
116	0.05348	0.05022	0.04718	0.04432
118	0.05515	0.05179	0.04866	0.04571
120	0.05684	0.05338	0.05016	0.04712

40% Glycol / Water Solution

PRESSURE LOSS PER FOOT 2" HDPE (SDR 11)

	Head Loss Per Foot of Tubing			
gpm	80°F	100°F	120°F	140°F
14	0.00775	0.00725	0.00679	0.00636
15	0.00877	0.00821	0.00769	0.00720
16	0.00984	0.00921	0.00863	0.00808
17	0.01097	0.01027	0.00962	0.00901
18	0.01215	0.01138	0.01066	0.00998
19	0.01338	0.01253	0.01174	0.01100
20	0.01467	0.01374	0.01288	0.01206
21	0.01601	0.01500	0.01405	0.01317
22	0.01740	0.01630	0.01528	0.01431
23	0.01884	0.01765	0.01655	0.01550
24	0.02034	0.01905	0.01786	0.01673
25	0.02188	0.02050	0.01922	0.01801
26	0.02347	0.02199	0.02062	0.01932
27	0.02511	0.02353	0.02206	0.02068
28	0.02681	0.02512	0.02355	0.02208
29	0.02855	0.02675	0.02509	0.02352
30	0.03033	0.02843	0.02666	0.02499
31	0.03217	0.03015	0.02828	0.02651
32	0.03406	0.03192	0.02994	0.02807
33	0.03599	0.03374	0.03164	0.02967
34	0.03797	0.03559	0.03339	0.03130
35	0.03999	0.03750	0.03517	0.03298
36	0.04207	0.03944	0.03700	0.03470
37	0.04419	0.04143	0.03887	0.03645
38	0.04635	0.04346	0.04077	0.03824
39	0.04856	0.04554	0.04272	0.04007
40	0.05082	0.04766	0.04471	0.04194
41	0.05312	0.04982	0.04675	0.04385
42	0.05547	0.05202	0.04882	0.04579
43	0.05786	0.05427	0.05093	0.04778
44	0.06030	0.05656	0.05308	0.04980
45	0.06278	0.05889	0.05527	0.05185
46	0.06531	0.06126	0.05750	0.05395
47	0.06788	0.06368	0.05977	0.05608
48	0.07050	0.06613	0.06207	0.05825
49	0.07316	0.06863	0.06442	0.06045
50	0.07586	0.07117	0.06681	0.06269

PRESSURE LOSS PER FOOT 3" HDPE (SDR 11)

	Head Loss Per Foot of Tubing			
gpm	80°F	100°F	120°F	140°F
28	0.00417	0.00391	0.00366	0.00343
30	0.00472	0.00442	0.00414	0.00388
32	0.00530	0.00496	0.00465	0.00436
34	0.00591	0.00553	0.00519	0.00486
36	0.00591	0.00553	0.00519	0.00486
38	0.00721	0.00676	0.00633	0.00594
40	0.00790	0.00741	0.00694	0.00651
42	0.00863	0.00808	0.00758	0.00711
44	0.00938	0.00879	0.00824	0.00773
46	0.01015	0.00952	0.00893	0.00837
48	0.01096	0.01027	0.00964	0.00903
50	0.01179	0.01106	0.01037	0.00972
52	0.01265	0.01186	0.01113	0.01043
54	0.01354	0.01269	0.01191	0.01117
56	0.01445	0.01355	0.01271	0.01192
58	0.01539	0.01443	0.01354	0.01270
60	0.01636	0.01534	0.01439	0.01350
62	0.01735	0.01627	0.01527	0.01432
64	0.01836	0.01722	0.01616	0.01516
66	0.01941	0.01820	0.01708	0.01603
68	0.02048	0.01921	0.01803	0.01691
70	0.02157	0.02023	0.01899	0.01782
72	0.02269	0.02129	0.01998	0.01875
74	0.02383	0.02236	0.02099	0.01970
76	0.02500	0.02346	0.02202	0.02067
78	0.02620	0.02458	0.02308	0.02166
80	0.02742	0.02573	0.02415	0.02267
82	0.02866	0.02689	0.02525	0.02370
84	0.02993	0.02809	0.02637	0.02475
86	0.03122	0.02930	0.02751	0.02583
88	0.03254	0.03054	0.02868	0.02692
90	0.03388	0.03180	0.02986	0.02803
92	0.03525	0.03308	0.03107	0.02917
94	0.03664	0.03439	0.03229	0.03032
96	0.03805	0.03571	0.03354	0.03150
98	0.03949	0.03707	0.03481	0.03269
100	0.04095	0.03844	0.03610	0.03390
102	0.04243	0.03983	0.03742	0.03514
104	0.04394	0.04125	0.03875	0.03639
106	0.04547	0.04269	0.04010	0.03766
108	0.04702	0.04415	0.04148	0.03896
110	0.04860	0.04563	0.04287	0.04027
112	0.05020	0.04714	0.04429	0.04160
114	0.05183	0.04867	0.04572	0.04295
116	0.05348	0.05022	0.04718	0.04432
118	0.05515	0.05179	0.04866	0.04571
120	0.05684	0.05338	0.05016	0.04712

50% Glycol / Water Solution

PRESSURE LOSS PER FOOT
2" HDPE (SDR 11)

	Head Loss Per Foot of Tubing			
gpm	80°F	100°F	120°F	140°F
14	0.00852	0.00763	0.00704	0.00661
15	0.00964	0.00864	0.00797	0.00748
16	0.01082	0.00969	0.00895	0.00840
17	0.01206	0.01080	0.00997	0.00936
18	0.01335	0.01197	0.01105	0.01037
19	0.01471	0.01318	0.01217	0.01143
20	0.01612	0.01445	0.01334	0.01253
21	0.01759	0.01577	0.01456	0.01367
22	0.01912	0.01714	0.01583	0.01487
23	0.02070	0.01856	0.01715	0.01610
24	0.02234	0.02003	0.01851	0.01738
25	0.02403	0.02155	0.01991	0.01870
26	0.02578	0.02312	0.02136	0.02007
27	0.02758	0.02474	0.02286	0.02147
28	0.02943	0.02641	0.02440	0.02292
29	0.03134	0.02812	0.02599	0.02442
30	0.03330	0.02989	0.02762	0.02595
31	0.03532	0.03170	0.02930	0.02752
32	0.03738	0.03355	0.03101	0.02914
33	0.03950	0.03546	0.03278	0.03080
34	0.04167	0.03741	0.03458	0.03250
35	0.04389	0.03940	0.03643	0.03424
36	0.04616	0.04145	0.03832	0.03601
37	0.04849	0.04354	0.04026	0.03783
38	0.05086	0.04567	0.04223	0.03969
39	0.05328	0.04785	0.04425	0.04159
40	0.05576	0.05007	0.04631	0.04353
41	0.05828	0.05234	0.04841	0.04551
42	0.06085	0.05466	0.05056	0.04752
43	0.06347	0.05702	0.05274	0.04958
44	0.06614	0.05942	0.05497	0.05168
45	0.06886	0.06187	0.05723	0.05381
46	0.07163	0.06436	0.05954	0.05598
47	0.07444	0.06689	0.06189	0.05819
48	0.07731	0.06947	0.06428	0.06044
49	0.08022	0.07209	0.06671	0.06272
50	0.08318	0.07475	0.06917	0.06505

PRESSURE LOSS PER FOOT
3" HDPE (SDR 11)

	Head Loss Per Foot of Tubing			
gpm	80°F	100°F	120°F	140°F
28	0.00459	0.00411	0.00380	0.00356
30	0.00519	0.00465	0.00429	0.00403
32	0.00582	0.00522	0.00482	0.00453
34	0.00649	0.00582	0.00538	0.00505
36	0.00719	0.00645	0.00596	0.00559
38	0.00792	0.00710	0.00656	0.00616
40	0.00868	0.00779	0.00720	0.00676
42	0.00947	0.00850	0.00785	0.00738
44	0.01030	0.00924	0.00854	0.00802
46	0.01115	0.01000	0.00925	0.00869
48	0.01203	0.01080	0.00998	0.00938
50	0.01294	0.01162	0.01074	0.01009
52	0.01389	0.01247	0.01153	0.01083
54	0.01486	0.01334	0.01233	0.01159
56	0.01586	0.01424	0.01317	0.01238
58	0.01689	0.01516	0.01402	0.01318
60	0.01794	0.01612	0.01491	0.01401
62	0.01903	0.01709	0.01581	0.01486
64	0.02014	0.01810	0.01674	0.01574
66	0.02129	0.01912	0.01769	0.01663
68	0.02246	0.02018	0.01867	0.01755
70	0.02365	0.02126	0.01967	0.01849
72	0.02488	0.02236	0.02069	0.01945
74	0.02613	0.02349	0.02173	0.02044
76	0.02741	0.02464	0.02280	0.02144
78	0.02872	0.02582	0.02389	0.02247
80	0.03006	0.02702	0.02501	0.02352
82	0.03142	0.02824	0.02614	0.02459
84	0.03280	0.02949	0.02730	0.02568
86	0.03422	0.03077	0.02848	0.02679
88	0.03566	0.03207	0.02969	0.02793
90	0.03713	0.03339	0.03091	0.02908
92	0.03862	0.03473	0.03216	0.03025
94	0.04014	0.03610	0.03343	0.03145
96	0.04169	0.03750	0.03472	0.03267
98	0.04326	0.03891	0.03603	0.03391
100	0.04486	0.04035	0.03737	0.03516
102	0.04648	0.04182	0.03873	0.03644
104	0.04813	0.04330	0.04011	0.03774
106	0.04980	0.04481	0.04151	0.03906
108	0.05150	0.04635	0.04293	0.04040
110	0.05323	0.04790	0.04437	0.04176
112	0.05498	0.04948	0.04584	0.04314
114	0.05676	0.05108	0.04732	0.04454
116	0.05856	0.05271	0.04883	0.04596
118	0.06038	0.05435	0.05036	0.04740
120	0.06224	0.05602	0.05190	0.04886

50% Glycol / Water Solution

PRESSURE LOSS PER FOOT
2" HDPE (SDR 11)

	Head Loss Per Foot of Tubing			
gpm	80°F	100°F	120°F	140°F
14	0.00852	0.00763	0.00704	0.00661
15	0.00964	0.00864	0.00797	0.00748
16	0.01082	0.00969	0.00895	0.00840
17	0.01206	0.01080	0.00997	0.00936
18	0.01335	0.01197	0.01105	0.01037
19	0.01471	0.01318	0.01217	0.01143
20	0.01612	0.01445	0.01334	0.01253
21	0.01759	0.01577	0.01456	0.01367
22	0.01912	0.01714	0.01583	0.01487
23	0.02070	0.01856	0.01715	0.01610
24	0.02234	0.02003	0.01851	0.01738
25	0.02403	0.02155	0.01991	0.01870
26	0.02578	0.02312	0.02136	0.02007
27	0.02758	0.02474	0.02286	0.02147
28	0.02943	0.02641	0.02440	0.02292
29	0.03134	0.02812	0.02599	0.02442
30	0.03330	0.02989	0.02762	0.02595
31	0.03532	0.03170	0.02930	0.02752
32	0.03738	0.03355	0.03101	0.02914
33	0.03950	0.03546	0.03278	0.03080
34	0.04167	0.03741	0.03458	0.03250
35	0.04389	0.03940	0.03643	0.03424
36	0.04616	0.04145	0.03832	0.03601
37	0.04849	0.04354	0.04026	0.03783
38	0.05086	0.04567	0.04223	0.03969
39	0.05328	0.04785	0.04425	0.04159
40	0.05576	0.05007	0.04631	0.04353
41	0.05828	0.05234	0.04841	0.04551
42	0.06085	0.05466	0.05056	0.04752
43	0.06347	0.05702	0.05274	0.04958
44	0.06614	0.05942	0.05497	0.05168
45	0.06886	0.06187	0.05723	0.05381
46	0.07163	0.06436	0.05954	0.05598
47	0.07444	0.06689	0.06189	0.05819
48	0.07731	0.06947	0.06428	0.06044
49	0.08022	0.07209	0.06671	0.06272
50	0.08318	0.07475	0.06917	0.06505

PRESSURE LOSS PER FOOT
3" HDPE (SDR 11)

	Head Loss Per Foot of Tubing			
gpm	80°F	100°F	120°F	140°F
28	0.00459	0.00411	0.00380	0.00356
30	0.00519	0.00465	0.00429	0.00403
32	0.00582	0.00522	0.00482	0.00453
34	0.00649	0.00582	0.00538	0.00505
36	0.00719	0.00645	0.00596	0.00559
38	0.00792	0.00710	0.00656	0.00616
40	0.00868	0.00779	0.00720	0.00676
42	0.00947	0.00850	0.00785	0.00738
44	0.01030	0.00924	0.00854	0.00802
46	0.01115	0.01000	0.00925	0.00869
48	0.01203	0.01080	0.00998	0.00938
50	0.01294	0.01162	0.01074	0.01009
52	0.01389	0.01247	0.01153	0.01083
54	0.01486	0.01334	0.01233	0.01159
56	0.01586	0.01424	0.01317	0.01238
58	0.01689	0.01516	0.01402	0.01318
60	0.01794	0.01612	0.01491	0.01401
62	0.01903	0.01709	0.01581	0.01486
64	0.02014	0.01810	0.01674	0.01574
66	0.02129	0.01912	0.01769	0.01663
68	0.02246	0.02018	0.01867	0.01755
70	0.02365	0.02126	0.01967	0.01849
72	0.02488	0.02236	0.02069	0.01945
74	0.02613	0.02349	0.02173	0.02044
76	0.02741	0.02464	0.02280	0.02144
78	0.02872	0.02582	0.02389	0.02247
80	0.03006	0.02702	0.02501	0.02352
82	0.03142	0.02824	0.02614	0.02459
84	0.03280	0.02949	0.02730	0.02568
86	0.03422	0.03077	0.02848	0.02679
88	0.03566	0.03207	0.02969	0.02793
90	0.03713	0.03339	0.03091	0.02908
92	0.03862	0.03473	0.03216	0.03025
94	0.04014	0.03610	0.03343	0.03145
96	0.04169	0.03750	0.03472	0.03267
98	0.04326	0.03891	0.03603	0.03391
100	0.04486	0.04035	0.03737	0.03516
102	0.04648	0.04182	0.03873	0.03644
104	0.04813	0.04330	0.04011	0.03774
106	0.04980	0.04481	0.04151	0.03906
108	0.05150	0.04635	0.04293	0.04040
110	0.05323	0.04790	0.04437	0.04176
112	0.05498	0.04948	0.04584	0.04314
114	0.05676	0.05108	0.04732	0.04454
116	0.05856	0.05271	0.04883	0.04596
118	0.06038	0.05435	0.05036	0.04740
120	0.06224	0.05602	0.05190	0.04886

Velocity Chart in Feet per Second

hePEX plus / AQUAPEX Tubing

gpm	5/8"	3/4"
0.2	0.25	0.18
0.4	0.50	0.36
0.6	0.74	0.54
0.8	0.99	0.73
1.0	1.24	0.91
1.2	1.49	1.09
1.4	1.74	1.27
1.6	1.98	1.45
1.8	2.23	1.63
2.0	2.48	1.81
2.2	2.73	2.00
2.4	2.98	2.18
2.6	3.22	2.36
2.8	3.47	2.54
3.0	3.72	2.72
3.2	3.97	2.90
3.4	4.22	3.09
3.6	4.46	3.27
3.8	4.71	3.45
4.0	4.96	3.63
4.2	5.21	3.81
4.4	5.46	3.99
4.6	5.70	4.17
4.8	5.95	4.36
5.0	6.20	4.54
5.2	6.45	4.72
5.4	6.70	4.90
5.6	6.94	5.08
5.8	7.19	5.26
6.0	7.44	5.44
6.2	7.69	5.63
6.4	7.94	5.81
6.6	8.18	5.99
6.8	8.43	6.17
7.0	8.68	6.35
7.2	8.93	6.53
7.4	9.18	6.71
7.6	9.42	6.90
7.8	9.67	7.08
8.0	9.92	7.26
8.2	10.17	7.44
8.4	10.42	7.62
8.6	10.66	7.80
8.8	10.91	7.99
9.0	11.16	8.17
9.2	11.41	8.35
9.4	11.66	8.53
9.6	11.90	8.71
9.8	12.15	8.89
10.0	12.40	9.07

gpm	1"	1 1/4"	1 1/2"
4.0	2.20	1.47	1.06
4.2	2.31	1.54	1.11
4.4	2.42	1.62	1.16
4.6	2.53	1.69	1.21
4.8	2.64	1.77	1.27
5.0	2.75	1.84	1.32
5.2	2.86	1.91	1.37
5.4	2.97	1.99	1.43
5.6	3.08	2.06	1.48
5.8	3.19	2.13	1.53
6.0	3.30	2.21	1.58
6.2	3.41	2.28	1.64
6.4	3.52	2.35	1.69
6.6	3.63	2.43	1.74
6.8	3.74	2.50	1.80
7.0	3.85	2.57	1.85
7.2	3.96	2.65	1.90
7.4	4.07	2.72	1.95
7.6	4.18	2.80	2.01
7.8	4.29	2.87	2.06
8.0	4.40	2.94	2.11
8.2	4.51	3.02	2.16
8.4	4.62	3.09	2.22
8.6	4.73	3.16	2.27
8.8	4.84	3.24	2.32
9.0	4.95	3.31	2.38
9.2	5.06	3.38	2.43
9.4	5.17	3.46	2.48
9.6	5.28	3.53	2.53
9.8	5.39	3.60	2.59
10.0	5.50	3.68	2.64
10.2	5.61	3.75	2.69
10.4	5.72	3.82	2.75
10.6	5.83	3.90	2.80
10.8	5.94	3.97	2.85
11.0	6.05	4.05	2.90
11.2	6.16	4.12	2.96
11.4	6.27	4.19	3.01
11.6	6.38	4.27	3.06
11.8	6.49	4.34	3.12
12.0	6.60	4.41	3.17
12.2	6.71	4.49	3.22
12.4	6.82	4.56	3.27
12.6	6.93	4.63	3.33
12.8	7.04	4.71	3.38
13.0	7.15	4.78	3.43
13.2	7.26	4.85	3.48
13.4	7.37	4.93	3.54
13.6	7.48	5.00	3.59
13.8	7.59	5.08	3.64
14.0	7.70	5.15	3.70

(Light shading) Maintain a minimum velocity of 1.5 ft/sec.

(Dark shading) Velocities in excess of 8 ft/sec may cause erosion to metal components in the system.

Velocity Chart in Feet per Second

MultiCor Tubing

gpm	5/8"	3/4"	1"
0.1	0.10	0.07	0.04
0.2	0.21	0.13	0.08
0.3	0.31	0.20	0.12
0.4	0.42	0.26	0.16
0.5	0.52	0.33	0.20
0.6	0.62	0.39	0.24
0.7	0.73	0.46	0.28
0.8	0.83	0.52	0.32
0.9	0.94	0.59	0.36
1.0	1.04	0.65	0.40
1.1	1.14	0.72	0.44
1.2	1.25	0.78	0.48
1.3	1.35	0.85	0.52
1.4	1.45	0.91	0.56
1.5	1.56	0.98	0.60
1.6	1.66	1.04	0.64
1.7	1.77	1.11	0.68
1.8	1.87	1.17	0.72
1.9	1.97	1.24	0.75
2.0	2.08	1.30	0.79
2.1	2.18	1.37	0.83
2.2	2.29	1.43	0.87
2.3	2.39	1.50	0.91
2.4	2.49	1.56	0.95
2.5	2.60	1.63	0.99
2.6	2.70	1.69	1.03
2.7	2.81	1.76	1.07
2.8	2.91	1.82	1.11
2.9	3.01	1.89	1.15
3.0	3.12	1.95	1.19
3.1	3.22	2.02	1.23
3.2	3.33	2.08	1.27
3.3	3.43	2.15	1.31
3.4	3.53	2.21	1.35
3.5	3.64	2.28	1.39
3.6	3.74	2.34	1.43
3.7	3.85	2.41	1.47
3.8	3.95	2.48	1.51
3.9	4.05	2.54	1.55
4.0	4.16	2.61	1.59
4.1	4.26	2.67	1.63
4.2	4.36	2.74	1.67
4.3	4.47	2.80	1.71
4.4	4.57	2.87	1.75
4.5	4.68	2.93	1.79
4.6	4.78	3.00	1.83
4.7	4.88	3.06	1.87
4.8	4.99	3.13	1.91
4.9	5.09	3.19	1.95
5.0	5.20	3.26	1.99

gpm	5/8"	3/4"	1"
5.2	5.40	3.39	2.07
5.4	5.61	3.52	2.15
5.6	5.82	3.65	2.23
5.8	6.03	3.78	2.30
6.0	6.24	3.91	2.38
6.2	6.44	4.04	2.46
6.4	6.65	4.17	2.54
6.6	6.86	4.30	2.62
6.8	7.07	4.43	2.70
7.0	7.27	4.56	2.78
7.2	7.48	4.69	2.86
7.4	7.69	4.82	2.94
7.6	7.90	4.95	3.02
7.8	8.11	5.08	3.10
8.0	8.31	5.21	3.18
8.2	8.52	5.34	3.26
8.4	8.73	5.47	3.34
8.6	8.94	5.60	3.42
8.8	9.15	5.73	3.50
9.0	9.35	5.86	3.58
9.2	9.56	5.99	3.66
9.4	9.77	6.12	3.74
9.6	9.98	6.25	3.81
9.8	10.18	6.38	3.89
10.0	10.39	6.51	3.97
10.2	10.60	6.64	4.05
10.4	10.81	6.77	4.13
10.6	11.02	6.90	4.21
10.8	11.22	7.03	4.29
11.0	11.43	7.16	4.37
11.2	11.64	7.29	4.45
11.4	11.85	7.43	4.53
11.6	12.06	7.56	4.61
11.8	12.26	7.69	4.69
12.0	12.47	7.82	4.77
12.2	12.68	7.95	4.85
12.4	12.89	8.08	4.93
12.6	13.09	8.21	5.01
12.8	13.30	8.34	5.09
13.0	13.51	8.47	5.17
13.2	13.72	8.60	5.25
13.4	13.93	8.73	5.32
13.6	14.13	8.86	5.40
13.8	14.34	8.99	5.48
14.0	14.55	9.12	5.56
14.2	14.76	9.25	5.64
14.4	14.97	9.38	5.72
14.6	15.17	9.51	5.80
14.8	15.38	9.64	5.88
15.0	15.59	9.77	5.96

(light shading) Maintain a minimum velocity of 1.5 ft/sec.

(dark shading) Velocities in excess of 8 ft/sec may cause erosion to metal components in the system.

Velocity Chart in Feet per Second

Large Dimension hePEX Tubing (Metric Dimension)

gpm	32mm	40mm	50mm	63mm
4	1.54	0.99	0.63	0.40
6	2.30	1.49	0.95	0.60
8	3.07	1.98	1.27	0.80
10	3.84	2.48	1.58	1.00
12	4.61	2.98	1.90	1.20
14	5.38	3.47	2.22	1.40
16	6.14	3.97	2.53	1.60
18	6.91	4.46	2.85	1.80
20	6.91	4.46	2.85	1.80
22	8.45	5.46	3.48	2.19
24	8.45	5.46	3.48	2.19
26	9.98	6.45	4.12	2.59
28	10.75	6.94	4.43	2.79
30	11.52	7.44	4.75	2.99
32	12.29	7.94	5.07	3.19
34	13.06	8.43	5.38	3.39
36	13.82	8.93	5.70	3.59
38	14.59	9.42	6.02	3.79
40	15.36	9.92	6.33	3.99
42	16.13	10.42	6.65	4.19
44	16.90	10.91	6.97	4.39
46	17.66	11.41	7.28	4.59
48	18.43	11.91	7.60	4.79
50	19.20	12.40	7.92	4.99
52	19.97	12.90	8.23	5.19
54	20.74	13.39	8.55	5.39
56	21.50	13.89	8.87	5.59
58	22.27	14.39	9.18	5.79
60	23.04	14.88	9.50	5.99
62	23.81	15.38	9.82	6.19
64	24.58	15.87	10.13	6.39
66	25.34	16.37	10.45	6.58
68	26.11	16.87	10.77	6.78
70	26.88	17.36	11.08	6.98
72	27.65	17.86	11.40	7.18

(light grey) Maintain a minimum velocity of 1.5 ft/sec.

(dark grey) Velocities in excess of 8 ft/sec may cause erosion to metal components in the system.

Velocity Chart in Feet per Second

High Density Polyethylene (HDPE) SDR 11

gpm	2"	3"	4"
15	1.71	0.79	0.48
20	2.29	1.05	0.64
25	2.86	1.31	0.80
30	3.43	1.58	0.95
35	4.00	1.84	1.11
40	4.57	2.10	1.27
45	5.14	2.37	1.43
50	5.71	2.63	1.59
55	6.28	2.89	1.75
60	6.86	3.15	1.91
65	7.43	3.42	2.07
70	8.00	3.68	2.23
75	8.57	3.94	2.39
80	9.14	4.20	2.54
85	9.71	4.47	2.70
90	10.28	4.73	2.86
95	10.85	4.99	3.02
100	11.43	5.26	3.18
105	12.00	5.52	3.34
110	12.57	5.83	3.50
115	13.14	6.04	3.66
120	13.71	6.31	3.82
125	14.28	6.57	3.98
130	14.85	6.83	4.13
135	15.42	7.10	4.29
140	16.00	7.36	4.45
145	16.57	7.62	4.61
150	17.14	7.88	4.77
155	17.71	8.15	4.93
160	18.28	8.41	5.09
165	18.85	8.67	5.25
170	19.42	8.94	5.41
175	19.99	9.20	5.57
180	20.57	9.46	5.73
185	21.14	9.72	5.88
190	21.71	9.99	6.04
195	22.28	10.25	6.20
200	22.85	10.51	6.36
205	23.42	10.78	6.52
210	23.99	11.04	6.68
215	24.56	11.30	6.84
220	25.14	11.56	7.00
225	25.71	11.83	7.16
230	26.28	12.09	7.32
235	26.85	12.35	7.47
240	27.42	12.61	7.63
245	27.99	12.88	7.79
250	28.56	13.14	7.95

(Light grey) Maintain a minimum velocity of 1.5 ft/sec.

(Dark grey) Velocities in excess of 8 ft/sec may cause erosion to metal components in the system.

The purpose of this appendix is to discuss the use of variable speed injection mixing to precisely transfer heat from the high temperature boiler (primary) loop to the lower temperature radiant (secondary) loop in hydronic heating systems.

Various devices and plumbing arrangements can be used to accomplish this transfer. In the past, it was common to use a mixing valve in order to temper the water between the primary and secondary loops in a system. In some instances, the heat source (condensing or electric boiler, geo-thermal heat pump, etc.) can be operated at lower temperatures and dedicated solely to operating a low temperature radiant heating system. In the vast majority of systems, mixing is required because:

- A boiler minimum operating temperature is required.
- High temperature water is required for other system needs.
- Water temperatures vary over a wide range (e.g. solar heat sources, waste heat utilization, wood fired boilers, etc.).

When the available heat source produces higher water temperatures than is required by the snow and ice melting system, a tempering device is required. To achieve the lower water temperature required for the system, the high temperature boiler water must be blended or injected into the return side of the snow and ice melting system to a level that meets the required supply water temperature for the radiant side. Technologies have evolved to the point of using small wet-rotor pumps to accurately adjust the secondary radiant supply water temperature regardless of the flow activities on either primary or secondary loops (see **Figure I-1**).

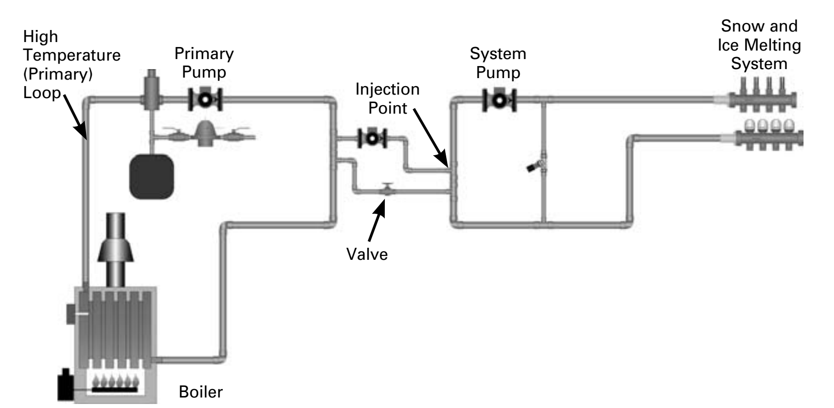
The speed of the injection pump is automatically adjusted to deliver the desired volume of hot boiler water to the lower temperature radiant loop. The injection pump speed is constantly adjusted as the snow and ice melting system demand and the supply water temperature change. If the boiler return temperature becomes too cold, the injection pump can be slowed down to reduce the heat injection rate, resulting in an increased boiler return temperature.

Wirsbo offers a variety of controls that use variable speed injection pump output. This output modulates the power supply to the circulator to vary its rotational speed. For residential and many commercial systems, the controls have a 120VAC 50/60Hz output to directly power small circulators.

A permanent capacitor, impedance-protected motor (no start switch) on the circulator is required. The maximum allowable amperage for this output is 2.2 amps, which limits the allowable circulator size to ⅙ HP.

This type of system can use a small circulator to inject a high BTU/h input into a relatively large system flow. Typically, the injection pump need only deliver ⅙ to ¼ of the system flow for low temperature radiant panels if high temperature water is available for injection. In small hydronic systems, the smallest available circulator for variable speed injection may be too large. It is important to properly size the injection pump and use a globe valve on the return injection leg.

Figure I-1 Mixing with variable speed pump



For proper injection pump sizing, the designer must know the following information (see **Figure I-2**).

F_V = Flow Rate (Injection Loop) in gpm

F_1 = Radiant (Secondary Loop) Flow Rate in gpm

T_1 = Boiler (Primary Loop) Supply Temperature

T_2 = Radiant (Secondary Loop) Supply Temperature

T_R = Radiant (Secondary Loop) Return Temperature

T_D = Radiant (Secondary Loop) Temperature Differential (T_2 - T_R)

Note: All values are to be given at design conditions. The formula used for sizing the injection pump is shown below.

$F_V = (F_1 \times T_D) / (T_1 - T_R)$

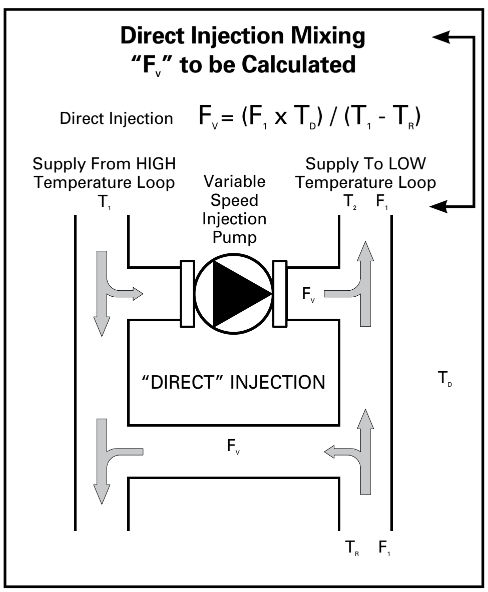


Figure I-2

Example
If values at design conditions are:

F_1 = Radiant (Secondary) Flow = 30 gpm

T_1 = Boiler (Primary) Supply = 180°F

T_2 = Radiant (Secondary) Supply = 140°F

T_R = Radiant (Secondary) Return = 120°F

T_D = Radiant (Secondary) Differential = 20°F

To find the injection pump flow rate:

$F_V = (30 \times 20) / (180 - 120)$

$F_V = (600) / (60)$

$F_V = 10$ gpm

In order to provide the proper amount and temperature of supply water on the radiant heating loop, the variable speed injection pump needs only to inject 10 gpm at design conditions.

Figures I-3 and **I-4** show the two most common piping layouts for variable speed injection mixing. Pay particular attention to the drop lines (or thermal traps) shown in the injection legs. These are particularly important to prevent "thermal siphoning" from the primary loop into the secondary loop. Consult the pump manufacturers' chart (below) to assist in the selection of the proper injection pump for the project.

In the piping arrangement shown, the variable speed injection pumps are plumbed this way to limit head pressure in the injection legs to only a few feet at most. Use standard pressure drop calculations and equivalent length of feet charts for exact calculations, if required.

Figure I-3 Injection into a Horizontal Loop

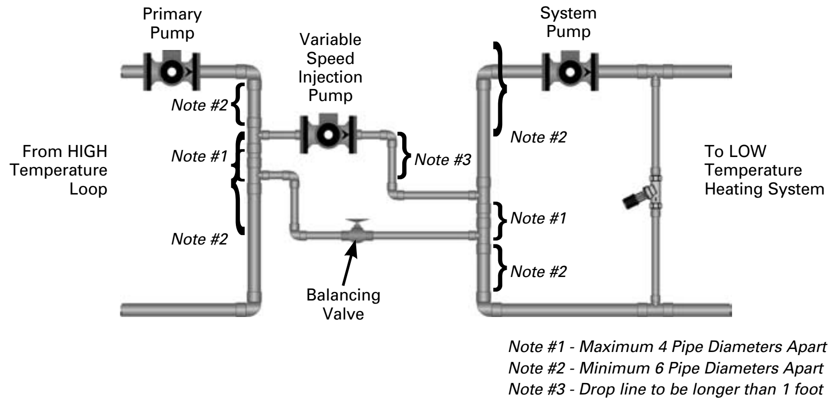
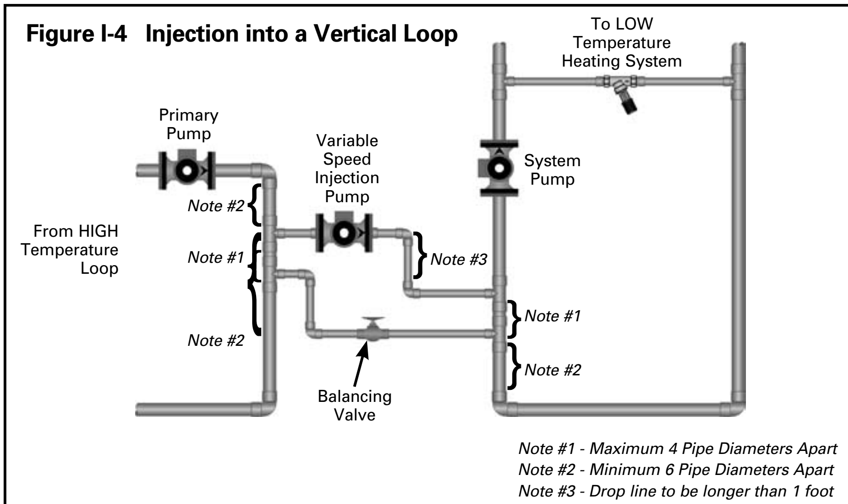


Figure I-4 Injection into a Vertical Loop



Variable Speed Injection Design Flow Rates

Design Injection Without Globe Valve	Flow Rate (gpm) With Globe Valve	Turns Open of the Globe Valve (%)	Nominal Pipe Diameter (inches)	Manufacturer Approved Pump Models												
				Grundfos (F)				Taco				B&G			Armstrong	
				15-42		26-64	43-75	003	007	0010	0012	NRF 9	NRF 22	NRF 33	Astro	
				2*	3**										30	50
–	1.5–2.0	20	0.5	X	X				X				X		X	
2.5	2	100	0.5					X								
4–5.5	3.0–4.5	100	0.5	X	X				X			X	X		X	
4.5–6.5	4–5.5	100	0.75					X				X				
9–10.5	7.5–8.5	100	0.75		X				X				X		X	
9	8	100	1									X				
14–15	12–13	100	1		X				X				X			
19	17	100	1.25													X
22–24	19–21	100	1.25			X				X				X		
26–28	–	100	1.5			X				X				X		
35–37	31–32	100	1.5				X				X					
33	30	100	2											X		
41–45	39–42	100	2				X				X					

* Speed 2, ** Speed 3 (Brute)
Table courtesy of tekmar - This table assumes 5 feet of pipe, four elbows and branch trees of the listed diameter.
These circulators have been tested and approved by the manufacturers for use with the Wirsbo pro Series controls.

Notes

				BOILER SYSTEM @ 30°F △t (180ºF In / 150ºF Out)			SNOWMELT @ 25°F △t (110ºF In / 135ºF Out)		
Part Number	**Exchanger Size**	**Connection Size**	**Output BTU/h**	**gpm**	**ft hd**	**psi**	**gpm**	**ft hd**	**psi**
A5301010	B10x10	1" NPT	15,000	1.02	0.537	0.233	1.29	0.652	0.283
A5301010	B10x10	1" NPT	20,000	1.36	0.924	0.401	1.72	1.108	0.481
A5301010	B10x10	1" NPT	25,000	1.70	1.412	0.613	2.15	1.700	0.738
A5301010	B10x10	1" NPT	30,000	2.04	1.998	0.867	2.58	2.419	1.050
A5301010	B10x10	1" NPT	35,000	2.38	2.673	1.160	3.02	3.226	1.400
A5301010	B10x10	1" NPT	40,000	2.72	3.456	1.500	3.45	4.171	1.810
A5301016	B10x16	1" NPT	30,000	2.04	0.698	0.303	2.58	0.993	0.431
A5301016	B10x16	1" NPT	35,000	2.38	0.935	0.406	3.02	1.334	0.579
A5301016	B10x16	1" NPT	40,000	2.72	1.207	0.524	3.45	1.724	0.748
A5301016	B10x16	1" NPT	45,000	3.06	1.509	0.655	3.88	2.159	0.937
A5301016	B10x16	1" NPT	50,000	3.40	1.843	0.800	4.31	2.650	1.150
A5301016	B10x16	1" NPT	55,000	3.75	2.210	0.959	4.74	3.157	1.370
A5301016	B10x16	1" NPT	60,000	4.09	2.604	1.130	5.17	3.733	1.620
A5301016	B10x16	1" NPT	65,000	4.43	3.041	1.320	5.60	4.355	1.890
A5301016	B10x16	1" NPT	70,000	4.77	3.502	1.520	6.03	5.023	2.180
A5301016	B10x16	1" NPT	75,000	5.11	3.986	1.730	6.46	5.737	2.490
A5301016	B10x16	1" NPT	80,000	5.45	4.493	1.950	6.89	6.475	2.810
A5301016	B10x16	1" NPT	85,000	5.79	5.046	2.190	7.32	7.281	3.160
A5301016	B10x16	1" NPT	90,000	6.13	5.645	2.450	7.75	8.111	3.520
A5301016	B10x16	1" NPT	95,000	6.47	6.244	2.710	8.18	9.009	3.910
A5301016	B10x16	1" NPT	100,000	6.81	6.889	2.990	8.62	9.931	4.310
A5301016	B10x16	1" NPT	105,000	7.15	7.558	3.280	9.05	10.899	4.730
A5301016	B10x16	1" NPT	110,000	7.49	8.249	3.580	9.48	11.912	5.170
A5301026	B10x26	1" NPT	60,000	4.09	0.970	0.421	5.17	1.530	0.664
A5301026	B10x26	1" NPT	65,000	4.43	1.129	0.490	5.60	1.786	0.775
A5301026	B10x26	1" NPT	70,000	4.77	1.300	0.564	6.03	2.058	0.893
A5301026	B10x26	1" NPT	75,000	5.11	1.482	0.643	6.46	2.350	1.020
A5301026	B10x26	1" NPT	80,000	5.45	1.677	0.728	6.48	2.650	1.150
A5301026	B10x26	1" NPT	85,000	5.79	1.882	0.817	7.32	2.972	1.290
A5301026	B10x26	1" NPT	90,000	6.13	2.097	0.910	7.75	3.318	1.440
A5301026	B10x26	1" NPT	95,000	6.47	2.327	1.010	8.18	3.687	1.600
A5301026	B10x26	1" NPT	100,000	6.81	2.558	1.110	8.62	4.078	1.770
A5301026	B10x26	1" NPT	105,000	7.15	2.811	1.220	9.05	4.470	1.940
A5301026	B10x26	1" NPT	110,000	7.49	3.065	1.330	9.48	4.885	2.120
A5301026	B10x26	1" NPT	115,000	7.83	3.341	1.450	9.91	5.323	2.310
A5301026	B10x26	1" NPT	120,000	8.17	3.618	1.570	10.34	5.783	2.510
A5301026	B10x26	1" NPT	125,000	8.51	3.917	1.700	10.77	6.244	2.710
A5301026	B10x26	1" NPT	130,000	8.85	4.217	1.830	11.20	6.728	2.920
A5301026	B10x26	1" NPT	135,000	9.19	4.539	1.970	11.63	7.235	3.140
A5301026	B10x26	1" NPT	140,000	9.53	4.862	2.110	12.06	7.765	3.370
A5301026	B10x26	1" NPT	145,000	9.87	5.207	2.260	12.49	8.295	3.600
A5301026	B10x26	1" NPT	150,000	10.21	5.553	2.410	12.92	8.848	3.840
A5301026	B10x26	1" NPT	155,000	10.55	5.899	2.560	13.35	9.424	4.090
A5301026	B10x26	1" NPT	160,000	10.89	6.267	2.720	13.78	10.023	4.350
A5301026	B10x26	1" NPT	165,000	11.24	6.659	2.890	14.22	10.622	4.610

				BOILER SYSTEM @ 30°F △t (180ºF In / 150ºF Out)			SNOWMELT @ 25°F △t (110ºF In / 135ºF Out)		
Part Number	Exchanger Size	Connection Size	Output BTU/h	gpm	ft hd	psi	gpm	ft hd	psi
A5301010	B10x10	1" NPT	15,000	1.02	0.537	0.233	1.29	0.652	0.283
A5301010	B10x10	1" NPT	20,000	1.36	0.924	0.401	1.72	1.108	0.481
A5301010	B10x10	1" NPT	25,000	1.70	1.412	0.613	2.15	1.700	0.738
A5301010	B10x10	1" NPT	30,000	2.04	1.998	0.867	2.58	2.419	1.050
A5301010	B10x10	1" NPT	35,000	2.38	2.673	1.160	3.02	3.226	1.400
A5301010	B10x10	1" NPT	40,000	2.72	3.456	1.500	3.45	4.171	1.810
A5301016	B10x16	1" NPT	30,000	2.04	0.698	0.303	2.58	0.993	0.431
A5301016	B10x16	1" NPT	35,000	2.38	0.935	0.406	3.02	1.334	0.579
A5301016	B10x16	1" NPT	40,000	2.72	1.207	0.524	3.45	1.724	0.748
A5301016	B10x16	1" NPT	45,000	3.06	1.509	0.655	3.88	2.159	0.937
A5301016	B10x16	1" NPT	50,000	3.40	1.843	0.800	4.31	2.650	1.150
A5301016	B10x16	1" NPT	55,000	3.75	2.210	0.959	4.74	3.157	1.370
A5301016	B10x16	1" NPT	60,000	4.09	2.604	1.130	5.17	3.733	1.620
A5301016	B10x16	1" NPT	65,000	4.43	3.041	1.320	5.60	4.355	1.890
A5301016	B10x16	1" NPT	70,000	4.77	3.502	1.520	6.03	5.023	2.180
A5301016	B10x16	1" NPT	75,000	5.11	3.986	1.730	6.46	5.737	2.490
A5301016	B10x16	1" NPT	80,000	5.45	4.493	1.950	6.89	6.475	2.810
A5301016	B10x16	1" NPT	85,000	5.79	5.046	2.190	7.32	7.281	3.160
A5301016	B10x16	1" NPT	90,000	6.13	5.645	2.450	7.75	8.111	3.520
A5301016	B10x16	1" NPT	95,000	6.47	6.244	2.710	8.18	9.009	3.910
A5301016	B10x16	1" NPT	100,000	6.81	6.889	2.990	8.62	9.931	4.310
A5301016	B10x16	1" NPT	105,000	7.15	7.558	3.280	9.05	10.899	4.730
A5301016	B10x16	1" NPT	110,000	7.49	8.249	3.580	9.48	11.912	5.170
A5301026	B10x26	1" NPT	60,000	4.09	0.970	0.421	5.17	1.530	0.664
A5301026	B10x26	1" NPT	65,000	4.43	1.129	0.490	5.60	1.786	0.775
A5301026	B10x26	1" NPT	70,000	4.77	1.300	0.564	6.03	2.058	0.893
A5301026	B10x26	1" NPT	75,000	5.11	1.482	0.643	6.46	2.350	1.020
A5301026	B10x26	1" NPT	80,000	5.45	1.677	0.728	6.48	2.650	1.150
A5301026	B10x26	1" NPT	85,000	5.79	1.882	0.817	7.32	2.972	1.290
A5301026	B10x26	1" NPT	90,000	6.13	2.097	0.910	7.75	3.318	1.440
A5301026	B10x26	1" NPT	95,000	6.47	2.327	1.010	8.18	3.687	1.600
A5301026	B10x26	1" NPT	100,000	6.81	2.558	1.110	8.62	4.078	1.770
A5301026	B10x26	1" NPT	105,000	7.15	2.811	1.220	9.05	4.470	1.940
A5301026	B10x26	1" NPT	110,000	7.49	3.065	1.330	9.48	4.885	2.120
A5301026	B10x26	1" NPT	115,000	7.83	3.341	1.450	9.91	5.323	2.310
A5301026	B10x26	1" NPT	120,000	8.17	3.618	1.570	10.34	5.783	2.510
A5301026	B10x26	1" NPT	125,000	8.51	3.917	1.700	10.77	6.244	2.710
A5301026	B10x26	1" NPT	130,000	8.85	4.217	1.830	11.20	6.728	2.920
A5301026	B10x26	1" NPT	135,000	9.19	4.539	1.970	11.63	7.235	3.140
A5301026	B10x26	1" NPT	140,000	9.53	4.862	2.110	12.06	7.765	3.370
A5301026	B10x26	1" NPT	145,000	9.87	5.207	2.260	12.49	8.295	3.600
A5301026	B10x26	1" NPT	150,000	10.21	5.553	2.410	12.92	8.848	3.840
A5301026	B10x26	1" NPT	155,000	10.55	5.899	2.560	13.35	9.424	4.090
A5301026	B10x26	1" NPT	160,000	10.89	6.267	2.720	13.78	10.023	4.350
A5301026	B10x26	1" NPT	165,000	11.24	6.659	2.890	14.22	10.622	4.610

Part Number	Exchanger Size	Connection Size	Output BTU/h	BOILER SYSTEM @ 30°F △t (180ºF In / 150ºF Out) gpm	ft hd	psi	SNOWMELT @ 25°F △t (110ºF In / 135ºF Out) gpm	ft hd	psi
A5301010	B10x10	1" NPT	15,000	1.02	0.537	0.233	1.29	0.652	0.283
A5301010	B10x10	1" NPT	20,000	1.36	0.924	0.401	1.72	1.108	0.481
A5301010	B10x10	1" NPT	25,000	1.70	1.412	0.613	2.15	1.700	0.738
A5301010	B10x10	1" NPT	30,000	2.04	1.998	0.867	2.58	2.419	1.050
A5301010	B10x10	1" NPT	35,000	2.38	2.673	1.160	3.02	3.226	1.400
A5301010	B10x10	1" NPT	40,000	2.72	3.456	1.500	3.45	4.171	1.810
A5301016	B10x16	1" NPT	30,000	2.04	0.698	0.303	2.58	0.993	0.431
A5301016	B10x16	1" NPT	35,000	2.38	0.935	0.406	3.02	1.334	0.579
A5301016	B10x16	1" NPT	40,000	2.72	1.207	0.524	3.45	1.724	0.748
A5301016	B10x16	1" NPT	45,000	3.06	1.509	0.655	3.88	2.159	0.937
A5301016	B10x16	1" NPT	50,000	3.40	1.843	0.800	4.31	2.650	1.150
A5301016	B10x16	1" NPT	55,000	3.75	2.210	0.959	4.74	3.157	1.370
A5301016	B10x16	1" NPT	60,000	4.09	2.604	1.130	5.17	3.733	1.620
A5301016	B10x16	1" NPT	65,000	4.43	3.041	1.320	5.60	4.355	1.890
A5301016	B10x16	1" NPT	70,000	4.77	3.502	1.520	6.03	5.023	2.180
A5301016	B10x16	1" NPT	75,000	5.11	3.986	1.730	6.46	5.737	2.490
A5301016	B10x16	1" NPT	80,000	5.45	4.493	1.950	6.89	6.475	2.810
A5301016	B10x16	1" NPT	85,000	5.79	5.046	2.190	7.32	7.281	3.160
A5301016	B10x16	1" NPT	90,000	6.13	5.645	2.450	7.75	8.111	3.520
A5301016	B10x16	1" NPT	95,000	6.47	6.244	2.710	8.18	9.009	3.910
A5301016	B10x16	1" NPT	100,000	6.81	6.889	2.990	8.62	9.931	4.310
A5301016	B10x16	1" NPT	105,000	7.15	7.558	3.280	9.05	10.899	4.730
A5301016	B10x16	1" NPT	110,000	7.49	8.249	3.580	9.48	11.912	5.170
A5301026	B10x26	1" NPT	60,000	4.09	0.970	0.421	5.17	1.530	0.664
A5301026	B10x26	1" NPT	65,000	4.43	1.129	0.490	5.60	1.786	0.775
A5301026	B10x26	1" NPT	70,000	4.77	1.300	0.564	6.03	2.058	0.893
A5301026	B10x26	1" NPT	75,000	5.11	1.482	0.643	6.46	2.350	1.020
A5301026	B10x26	1" NPT	80,000	5.45	1.677	0.728	6.48	2.650	1.150
A5301026	B10x26	1" NPT	85,000	5.79	1.882	0.817	7.32	2.972	1.290
A5301026	B10x26	1" NPT	90,000	6.13	2.097	0.910	7.75	3.318	1.440
A5301026	B10x26	1" NPT	95,000	6.47	2.327	1.010	8.18	3.687	1.600
A5301026	B10x26	1" NPT	100,000	6.81	2.558	1.110	8.62	4.078	1.770
A5301026	B10x26	1" NPT	105,000	7.15	2.811	1.220	9.05	4.470	1.940
A5301026	B10x26	1" NPT	110,000	7.49	3.065	1.330	9.48	4.885	2.120
A5301026	B10x26	1" NPT	115,000	7.83	3.341	1.450	9.91	5.323	2.310
A5301026	B10x26	1" NPT	120,000	8.17	3.618	1.570	10.34	5.783	2.510
A5301026	B10x26	1" NPT	125,000	8.51	3.917	1.700	10.77	6.244	2.710
A5301026	B10x26	1" NPT	130,000	8.85	4.217	1.830	11.20	6.728	2.920
A5301026	B10x26	1" NPT	135,000	9.19	4.539	1.970	11.63	7.235	3.140
A5301026	B10x26	1" NPT	140,000	9.53	4.862	2.110	12.06	7.765	3.370
A5301026	B10x26	1" NPT	145,000	9.87	5.207	2.260	12.49	8.295	3.600
A5301026	B10x26	1" NPT	150,000	10.21	5.553	2.410	12.92	8.848	3.840
A5301026	B10x26	1" NPT	155,000	10.55	5.899	2.560	13.35	9.424	4.090
A5301026	B10x26	1" NPT	160,000	10.89	6.267	2.720	13.78	10.023	4.350
A5301026	B10x26	1" NPT	165,000	11.24	6.659	2.890	14.22	10.622	4.610

Notes

TO CONVERT FROM	TO	MULTIPLY BY
PRESSURE		
Atmospheres	feet of water	33.9
Atmospheres	mm. of mercury	760.0
Atmospheres	pounds/sq. in.	14.696
Feet of water (40°F)	pounds/sq. in.	0.4335
Inches of mercury (32°F)	feet of water (40°F)	1.133
Inches of mercury (32°F)	pounds/sq. in.	0.49116
Inches of water (40°F)	pounds/sq. in.	0.03614
mm. of mercury (32°F)	pounds/sq. in	0.1934
Pounds/sq. in.	feet of water (40°F)	2.3066
Pounds/sq. in.	inches of mercury (32°F)	2.036
VOLUME		
Barrels (oil)	gallons	42.0
Barrels (brewery)	gallons	31.0
Cubic cm	cubic inches	0.061023
Cubic feet	cubic inches	1728.0
Cubic feet	cubic meters	0.02832
Cubic feet	gallons	7.481
Cubic meters	gallons	264.17
Gallons	cubic feet	0.1337
Gallons	cubic inches	231.0
Gallons	gallons (British)	0.83268
Gallons	liters	3.7853
Liters	gallons	0.2642
Liters	quarts	1.0567
HEAT		
Boiler horsepower (BHP)	BTU/h	33479.0
BTU/h	calories (gram)	252.0
BTU/h	calories (kg.)	0.252
Calories (gram) gram/°C	BTU/lb/°F	1.0
Calories (gram) per gram	BTU/lb	1.8
Horsepower	BTU/h	2545.0
K.W. hours	BTU	3413.0

TO CONVERT FROM	TO	MULTIPLY BY
TEMPERATURE		
Centigrade degrees	Fahrenheit degrees	1.8 and add 32°
Fahrenheit degrees	Centigrade degrees	Subtract 32° and multiply by 0.5555
MEASUREMENT		
Centimeters	inches	0.3937
Feet	meters	0.3048
Inches	centimeters	2.54
Kilometers	miles	0.6214
Meters	feet	3.2808
Microns	millimeters	0.001
Sq. meters	sq. feet	10.764
WEIGHT		
Cubic ft. of water (60°F)	pounds	62.37
Gallons	pounds of water (60°F)	8.34
Grains	pounds	1/7000
Grains/gallon	parts per million	17.12
Grams	grains	15.43
Kilograms	pounds	2.2046
Pounds	grams	453.59
Pounds	kilograms	0.4536
Tons (long)	tons (short)	1.12
VOLUMETRIC RATE		
Cubic ft/sec	gallons/min	448.83
Gallons/min	cu. ft/sec	0.00223
POWER		
Horsepower	ft lbs/sec	550.0
Horsepower	K.W.	0.745
VISCOSITY		
Centipoises	lbs/sec/ft	0.000672
Poises	centipoises	0.01
VELOCITY		
ft/sec	meters/sec	0.3048
Meters/sec	ft/sec	3.2808

Notes

Notes

Notes

Uponor, Inc.
5925 148th Street West
Apple Valley, MN 55124 USA
Tel: 800.321.4739
Fax: 952.891.2008
Web: www.uponor-usa.com

Uponor Ltd.
2000 Argentia Rd., Plaza 1, Ste. 200
Mississauga, ON L5N 1W1 CANADA
Tel: 888.994.7726
Fax: 800.638.9517
Web: www.uponor.ca

uponor