Planning Data

January 15, 1999
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**IMPORTANT**  
**KEEP IN STORE FOR FUTURE REFERENCE**  
*Quality that sets industry standards*

**Hussmann Refrigeration Systems**

12999 St. Charles Rock Road • Bridgeton, MO 63044-2483 USA • (314) 291-2000 • FAX (314) 298-6485

2700 Crestridge Court • Suwanee, GA 30024 USA • (770) 921-9410 • FAX (770) 381-0615
Field Fabricated Headers are NOT REQUIRED for Protocol™ Installations

Improper Field Piping

Produce Cooler

Protocol

Produce Cases

Produce Islands

Produce Cases

Suction Line

Discharge Line

Proper Field Piping

Produce Cooler

Protocol

Produce Cases

Produce Islands

Produce Cases
PURPOSE

The following steps should be used to secure Hussmann equipment:

1. Have Hussmann’s sales representative detail design conditions with the customer.

2. These equipment selections and preferences are forwarded to Hussmann Engineering. Based on these conditions, Engineering sizes and selects the best equipment for the customer’s needs.

3. Hussmann Engineering forwards the legend (factory order) to the sales representative with this planning data attached.

Installing Contractors, Architects and Application Engineers require the pre-installation detail that this planning data, the store legend, and the store blueprints provide. Review the Installation and Service Manual for information beyond basic planning, such as installation, operation or maintenance; or contact your Hussmann Field Service Engineer.

SHIPPING INFORMATION

Unless otherwise directed, Protocol™ units will be shipped F.O.B. St. Louis, MO, or Atlanta, GA, via common carrier. Specialized common carriers are used because of their knowledge and experience in trucking industrial equipment, and their proven on-time delivery.

PROTOCOL™ COMPONENTS

Each Protocol™ contains:

1. Two to Six Copeland Scroll Compressors
   a. High Temperature Controls
   b. High Pressure Controls
   c. Primary Overload Protection
   d. Oil Loss Protection System

2. Factory piping with
   a. Suction, Discharge and Liquid Headers
   b. Turba-Shed Oil Separator and oil system*
   c. Receiver Tank with Safety Relief Plug
   d. Liquid Filter Drier and Sightglass
   e. Water Cooled Condenser (on Protocol™)
   or Air Cooled Condenser (on Proto-Aire™)

* The compressors are shipped with oil. Additional oil must be added for the Turba-Shed and oil lines. The Turba-Shed reservoir is filled when oil level is between the sight glasses.

3. Factory-wired control panel with
   a. Individual Component Circuit Breakers and Contactors
   b. Main Disconnect
   c. Single Phase Protector
   d. Communication Interface
   e. Electronic Compressor and Defrost Control
   f. One 120V 5 Amp Service Receptacle
   g. One unit mounted Alarm Light (Amber)

4. Items supplied separately for field installation
   a. Vibration Isolation Pads (4 to 10)
   b. Optional Components if ordered
   c. Suction Filter(s) to be field-installed
   d. Water couplings (Ford coupling)
PROTOCOL™ NOMENCLATURE

All Protocol™ Systems are shown in the legend in modular nomenclature form.

<table>
<thead>
<tr>
<th>O</th>
<th>P</th>
<th>V</th>
<th>I</th>
<th>3</th>
<th>P</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
</tr>
</tbody>
</table>

**COMPRESSOR CODES**

2nd Letter = Size nominal hp

- Standard Models
  - A = 2 hp
  - B = 2.5 hp
  - C = 3 hp
  - D = 3.5 hp
  - E = 4 hp
  - F = 5 hp
  - G = 6 hp

- Vapor Injection Models
  - L = 2 hp
  - M = 2.5 hp
  - N = 3 hp
  - O = 3.5 hp
  - P = 4 hp
  - Q = 5 hp
  - S = 6 hp

1st Letter = Temperature

- H = High*
- M = Medium
- L = Low

**VOLTAGE**

- K = 208-230/3/60
- M = 460/3/60*
- U = 380/3/50*
- P = 575/3/60*

**REFRIGERANT**

- P = R404A
- J = R134A*
- Z = R507*

**NUMBER OF PARALLEL COMPRESSORS (2-6)**

**NUMBER OF SATELLITE or SPLIT-SUCTION COMPRESSORS (0-3*)**

**PROTOCOL™ POSITION**

- H = Horizontal
- V = Vertical

**PROTOCOL™ DESIGNATION** [PV or PH]

**PROTO-AIRE™ DESIGNATION** [OPH]

*Call factory regarding availability.

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### EQUIPMENT PLANNING

<table>
<thead>
<tr>
<th>Protocol™ Nomenclature</th>
<th>Dimensions (inches)</th>
<th>Maximum Weights (lb.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vertical Nomenclature</strong></td>
<td>Length</td>
<td>Height</td>
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<tr>
<td>17FR</td>
<td>30 1/2</td>
<td>80</td>
</tr>
<tr>
<td>18FR</td>
<td>43</td>
<td>80</td>
</tr>
<tr>
<td><strong>Horizontal Nomenclature</strong></td>
<td>Length</td>
<td>Height</td>
</tr>
<tr>
<td>19FR</td>
<td>83</td>
<td>32</td>
</tr>
<tr>
<td>21FR*</td>
<td>96</td>
<td>32</td>
</tr>
<tr>
<td>20FR</td>
<td>122</td>
<td>32</td>
</tr>
<tr>
<td><strong>Proto-Aire™ Nomenclature</strong></td>
<td>Length</td>
<td>Height</td>
</tr>
<tr>
<td>ALL</td>
<td>128</td>
<td>56 1/2</td>
</tr>
</tbody>
</table>

*Optional Oversized Control Panel with 4 Compressors
**Planning Data**

Receiver Capacities are based on 80% liquid fill at 105 deg F.
- Vertical = 55 lb
- Horizontal (Standard) = 72 lb
- Proto-Aire™ = 72 lb

**Minimum Allowable Distances**
All Protocol™ units require 6 inches of air space at the rear.

**Maximum Allowable Distances**
Medium/High Temp have 150 foot maximum allowable piping distance (from Protocol™ to first case connection). Long refrigerant line runs defeat the purpose of the Protocol™ design. Low Temp has a maximum piping run of 50 feet (from Protocol™ to first case connection).

**Accessibility**
Vertical Protocol™ units must be serviceable from the front and the top of the unit; side access is highly recommended. Horizontal Protocol™ units must be serviceable from the front, the right side as viewed facing the unit, and either the top or the back. For 208V units, a minimum of 36 in. clearance is recommended in front of the control panel. For 460V units a minimum of 42 in. is recommended. Follow NEC guidelines.

**Heating, Ventilation, Air Conditioning**
Add 1/2 ton to the air conditioning load per Protocol™ installed in air conditioned space.

**PLANNING FIELD WIRING**

**Maximum Field Wire Size**
Based on the total load Amperes, the largest connectable wire sizes for the power blocks are listed below. (Wire size is based on minimum circuit ampacity listed on the serial plate.)

<table>
<thead>
<tr>
<th>Total Connected RLA</th>
<th>Largest Connectable Wire</th>
</tr>
</thead>
<tbody>
<tr>
<td>200A (max)</td>
<td>3 / 0 per Ø</td>
</tr>
<tr>
<td>320A (max)</td>
<td>2 X (3 / 0) per Ø</td>
</tr>
</tbody>
</table>

Refer to NEC for temperature derating factors.

**Sizing Wire and Overcurrent Protectors**
Check the Legend for Minimum Circuit Ampacity (MCA), Maximum Overcurrent Protective Devices (MOPD), and total RLA’s. Follow NEC guidelines.

Note: A Main Disconnect is provided as part of the unit. A Branch Circuit must be brought to the unit using information supplied on the unit data plate for Minimum Circuit Ampacity (MCA) and Maximum Over Current Protective Device (MOPD).

Protocol™ components are wired as completely as possible at the factory with all work completed in accordance with the National Electrical Code (NEC). All deviations required by governing electrical codes will be the responsibility of the installer.

The lugs on the circuit breaker package in the compressor control panel are sized for copper wire only, with 75 deg C THW insulation. All wiring must be in compliance with governing codes.

**For 208-230/3/60 Compressor Units:**
To each Protocol™ provide
- one 208-230/3/60 branch circuit
- one 120/1/60 neutral
- one ground wire to earth ground
For 380-460/3/60-50 Compressor Units with Remote Mounted Transformer:
To each Protocol™ provide
- one 380-460/3/60-50 branch circuit
- one ground wire to earth ground
To Remote Mounted Transformer
- one 380-460/1/60-50 branch circuit from Protocol™ Fuse Block
- one ground wire to ground wire connection
From remote mounted transformer
- one 240/1/60-50 connection to 240V
- one derived neutral from transformer.

For 380-460/3/60-50 Compressor Units without Remote Mounted Transformer:
To each Protocol™ provide
- one 380-460/3/60-50 branch circuit
- one ground wire to earth ground
- one 208-240/1/60-50 branch circuit
- one 120/1/60-50 neutral.

For 575/3/60 Compressor Units without Remote Mounted Transformer:
To each Protocol™ provide
- one 575/3/60 branch circuit
- one ground wire to earth ground
- one 220/1/60-50 branch circuit
- one ground wire to earth ground.

For Alarm Wiring
Protocol™ provides one NO/NC pilot duty relay for remote alarm.

Additional Circuits
Check the store legend for components requiring electrical circuits to the Control Panel and Case Power Distribution Box. Refer to the Installation and Service Manual for additional information including specific wiring requirements. Protocol™ provides power for all case electrical needs, including:

- Fan and Anti-sweat Heater Circuits
- Satellite Control
- Electric Defrost Heaters
- Case mounted Liquid Line Solenoid
- Defrost Termination Thermostat
- Case Lighting.

Unit cooler electrical needs include:
- Electric Defrost Heaters
- Remote Liquid Line Solenoid
- Fan Circuit
- Defrost Termination and Heater Safety Circuit.

Liquid Line Solenoid
Power for liquid line solenoids at the evaporator comes from the Protocol™ Case Electrical Distribution Box. If the entire lineup defrosts at one time, a single liquid line solenoid will be supplied in the Protocol™. Remote solenoids are fused on the control boards. Follow NEC wiring guidelines.

Cooler Door Switch Wiring
Check the store legend for door switch kits (M115 or M116). The switch is mounted to the cooler door frame, and controls the field installed liquid line solenoid and evaporator fans. For Gas Defrost applications, M116 includes a check valve to bypass the liquid line solenoid valve.

REFRIGERANT PIPING
Use only clean, dehydrated, sealed refrigeration grade copper tubing. Use dry nitrogen in the tubing during brazing to prevent the formation of...
copper oxide. All joints should be made with silver alloy brazing material, and use 35% silver solder for dissimilar metals.

Liquid lines and suction lines must be free to expand and contract independently of each other. Do not clamp or solder them together. Pipe supports must allow tubing to expand and contract freely. Do not exceed 100 feet without a change of direction or an offset. Plan proper pitching, expansion allowance, and P-traps at the base of all suction risers. Use long radius elbows to reduce line resistance and breakage. Avoid completely the use of 45 deg elbows. Install service valves at several locations for ease of maintenance and reduction of service costs. These valves must be UL approved for 450 psig minimum working pressure.

All Protocol™ units have a one inch drip pan at the very bottom of the unit. DO NOT run piping through the bottom of this pan.

**ISOLATION VALVES ARE RECOMMENDED FOR INDIVIDUAL DISPLAY CASES.**

**Note:** Return gas superheat should be 10 to 30 deg F for all applications.

Do not use threaded connections when connecting plastic and metal pipe because of leak potential. A compression type fitting (such as the Ford couplings supplied with each Protocol™ unit) should be used. For larger pipe sizes, a flanged connection may be used.

**Suction Line**

- Pitch in direction of flow. A P-trap is required for all vertical risers.

- May be reduced by one size at one third of case run load and again after the second third. Do not reduce below evaporator connection size.

- Suction Returns from evaporators enter at the top of the line.

- Suction filter(s) supplied with each Protocol™ unit must be field installed.

**Liquid Line**

- Take-offs to evaporators exit the bottom of the liquid line. Provide an expansion loop for each evaporator take-off. (Minimum 3 inch diameter.)

**OFFTIME AND ELECTRIC DEFROST**

- May be reduced by one size after one half the case run. Do not reduce below evaporator connection size.

**REVERSE CYCLE GAS DEFROST**

**IMPORTANT**

- Increase the liquid line size inside the case by two sizes over the branch size when reverse cycle defrost is used.

<table>
<thead>
<tr>
<th>Branch Size</th>
<th>In-Case Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/8</td>
<td>1 1/8</td>
</tr>
<tr>
<td>7/8</td>
<td>1 3/8</td>
</tr>
<tr>
<td>1 1/8</td>
<td>2 1/8</td>
</tr>
</tbody>
</table>

Also, increase the liquid line between the Protocol™ and the case run by one size.

**FIELD SUPPLIED AND INSTALLED WATER COMPONENTS**

A flow control/shutoff valve is factory-piped in each Protocol™. Compression couplings are factory supplied for connecting PVC field water piping to copper piping in the Protocol™. These couplings must be field installed. All other water components are field supplied and installed. A 16-20 mesh strainer (1-mm) is required immediately upstream of the Protocol™ in all applications.
Water in the closed loop system must be properly inhibited and/or contain sufficient glycol to prevent internal scaling and corrosion. Some plastic pipe manufacturers place restrictions on the levels of glycol used and their liability regarding product failure. Before selecting pipe and glycol check for the products compatibility.

**Important:** Freeze protection for the water loop must be provided. Also, if reverse cycle gas defrost is used, glycol or other means of protection must be used in the water loop to prevent freezing in the condenser during defrost when the condenser serves as the evaporator.

The open side of the Evaporative Cooler requires some kind of bacterial and water treatment. Governing codes should be followed. Local suppliers can assist with water treatment best for your area.

**WATER PIPING GUIDELINES**

**Type of Pipe**
Evaporative fluid coolers, Protocol™ condensing temperature of 105 deg F or less, pipe sizes up to 6 inch: use Schedule 40 PVC pipe and fittings.

Dry fluid coolers, Protocol™ condensing temperature of 120 deg F or less, pipe sizes up to 6 inch: use Schedule 80 PVC pipe and fittings.

For other applications, please consult factory.

**Pipe Sizing**
Pipe should be sized such that the maximum fluid velocity is 5 ft/sec and the maximum head loss is 5 ft head per 100 linear feet of pipe.

**Isolation Valves**
Install isolation valves at inlet and outlet of each Protocol™ unit.

It is good practice to include isolation valves at a few locations throughout the piping. For example, valves should be used where branches tie into main supply and return lines.

PVC plastic ball valves may be used.

**Strainers**
Use a 16-20 mesh strainer at inlet of each Protocol™ unit. Position isolation valves so that this strainer can be opened for cleaning.

**Air Vent Valves**
Manual air vent valves are recommended. Air vent valves should be located at piping high points where air will tend to collect. Momentarily open these vents and release trapped air a few times during startup.

**Tie-Ins to Supply Headers**
Branch supply pipes SHOULD NOT tie into the bottom of main supply pipes. Always tie into the top of a main supply pipe; that is, the "T" fitting should point UP, NOT DOWN.

**Pipe Supports**
Pipe supports should be provided as follows:

<table>
<thead>
<tr>
<th>Nominal Pipe Size, in.</th>
<th>Distance Between Supports, ft @ 100 Deg F</th>
<th>Distance Between Supports, ft @ 120 Deg F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>4.5</td>
<td>3.5</td>
</tr>
<tr>
<td>1.5</td>
<td>5.0</td>
<td>3.5</td>
</tr>
<tr>
<td>2.0</td>
<td>5.0</td>
<td>4.0</td>
</tr>
<tr>
<td>3.0</td>
<td>6.0</td>
<td>4.5</td>
</tr>
<tr>
<td>4.0</td>
<td>6.5</td>
<td>5.0</td>
</tr>
<tr>
<td>6.0</td>
<td>7.5</td>
<td>6.0</td>
</tr>
</tbody>
</table>

**Exposure to Direct Sunlight**
Piping that will be exposed to direct sunlight should be shaded or covered. A thin layer of insulation is adequate for this.
Filling
The water loop MUST have adequate corrosion protection. In most situations, corrosion protection can be provided by using fully inhibited, industrial grade ethylene glycol or propylene glycol 30% by volume with water. For most installations, 30% glycol by volume will also provide BURST protection to –20 deg F.

If the store location has particularly hard water, with a total hardness greater than 100 ppm, the water used to fill the loop should be softened or distilled. Local water treatment vendors such as Nu-Calgon can provide information on local water quality.

If any Protocol™ unit has reverse cycle gas defrost, at least 30% glycol by volume MUST be used to prevent condenser freezing.

Use only industrial grade, fully inhibited ethylene or propylene glycol such as Dow Chemical's Dowtherm SR-1 or Dowfrost. Consult local regulations as to which type—ethylene or propylene—to use. Propylene glycol is generally considered non-toxic, while ethylene glycol is somewhat toxic. DO NOT USE AUTOMOTIVE GRADE GLYCOLS such as Prestone.

Design Considerations
These guidelines are general in nature and are not intended to be a comprehensive application guide. Several factors need to be considered in designing Protocol™ water loops for a store. Two that stand out are:

1- The water flow rate (Gallons Per Minute – GPM) in the closed loop necessary to effectively remove heat from the store.

2- The pressure loss the circulating pumps must overcome, caused by friction in pipes and other components in the system—is called Total Dynamic Head (TDH). TDH is measured in Ft of fluid. For water, the following conversion factor may be used:

\[ 2.31 \text{ Ft of } H_2O = 1 \text{psi} \]

Water piping must accommodate the minimum pressure rating of the system; typically: 100 deg F fluid at 75 psi.

Pump Selection
TDH and GPM are the two key elements used in selecting the pumps and motors.

Other factors include:
1- Water velocity should not exceed 5 feet per second.

2- Piping size and type will be determined by Total Dynamic Head Loss (TDH) and local codes.

3- In finding Head Loss, both supply and return lines must be included.

4- Main Water Line Size may be reduced as Branch Circuit takeoffs reduce flow (GPM).

5- In closed loop systems, static head in vertical rise and drop cancel each other out.

Note: Dynamic Head Loss for the length of rise and drop must still be figured.

6- Use 20 ft of H2O to cover Head Loss across the Protocol™ Condensers, regardless the number of Protocol™ units applied.

7- Data regarding the Head Loss of the Fluid Cooler should be obtained from the manufacturer. Its Head Loss must be included when calculating the total water loop TDH.

8- Data regarding the Head Loss of Heat Reclaim Coils should be obtained from the manufacturer. Head Loss must be included when calculating the water loop TDH.
9- If Heat Pumps are installed using the Closed Loop System, Heat of Rejection, GPM Requirements, and Head Loss must be accounted for.

10- Allow for expansion of piping.

11- All Protocol™ units have a one inch drip pan at the very bottom of the unit. Do not run piping through the bottom of this pan.

The following example demonstrates the major concepts in determining water line sizes. It is not intended to be an application engineering manual for the water loop of the store. Tables 1 and 2 have been constructed to provide information specific enough to complete planning, while removing several steps normally associated with the detailed engineering process. The example shows a store with 15 Protocol™ units.

WATER LINE SIZING

Once the fluid cooler, pumps, and Protocol™ units have been positioned on the store floor plan, and piping routes drawn, water line sizing has two steps. First, determine the GPM and hook up line size requirements of each Protocol™. Second, determine the water line size required to carry the needed volume of water along the routes.

**STEP 1**

Refer to store legend for GPM.
### Table 1

**Recommended Water Pipe Sizes**

<table>
<thead>
<tr>
<th>Water Flow (GPM)</th>
<th>Pipe I/D (in.)</th>
<th>Velocity (ft/sec)</th>
<th>Head Loss/100 ft of Pipe (ft of H₂O)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>1</td>
<td>2.2</td>
<td>2.7</td>
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<tr>
<td>8</td>
<td>1</td>
<td>3.0</td>
<td>4.5</td>
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<tr>
<td>10</td>
<td>1½</td>
<td>1.6</td>
<td>0.8</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>1.9</td>
<td>1.2</td>
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<td>1.5</td>
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<td>2.8</td>
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<td>3.2</td>
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<td>25</td>
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<td>3.9</td>
<td>4.4</td>
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</tr>
<tr>
<td>600</td>
<td></td>
<td>6.7</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Schedule 40 new steel pipe.

### Table 2

**Head Loss per Component (Ft of H₂O)**

<table>
<thead>
<tr>
<th>Pipe Size Nominal ID</th>
<th>90˚ Std Radius or Std 45˚ Long Thru Branch Bend Flow</th>
<th>90˚ Tee Flow</th>
<th>Tee Branch Flow</th>
<th>Return Bend</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.12</td>
<td>0.06</td>
<td>0.08</td>
<td>0.24</td>
</tr>
<tr>
<td>1½</td>
<td>0.18</td>
<td>0.09</td>
<td>0.12</td>
<td>0.35</td>
</tr>
<tr>
<td>2</td>
<td>0.24</td>
<td>0.13</td>
<td>0.16</td>
<td>0.48</td>
</tr>
<tr>
<td>3</td>
<td>0.35</td>
<td>0.18</td>
<td>0.23</td>
<td>0.69</td>
</tr>
<tr>
<td>4</td>
<td>0.43</td>
<td>0.23</td>
<td>0.29</td>
<td>0.86</td>
</tr>
<tr>
<td>6</td>
<td>0.35</td>
<td>0.19</td>
<td>0.23</td>
<td>0.70</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pipe ID</th>
<th>Gate</th>
<th>Butterfly</th>
<th>Angle</th>
<th>Globe</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.03</td>
<td>—</td>
<td>0.59</td>
<td>1.34</td>
</tr>
<tr>
<td>1½</td>
<td>0.05</td>
<td>—</td>
<td>0.88</td>
<td>2.01</td>
</tr>
<tr>
<td>2</td>
<td>0.06</td>
<td>0.36</td>
<td>1.21</td>
<td>2.75</td>
</tr>
<tr>
<td>3</td>
<td>0.09</td>
<td>0.52</td>
<td>1.73</td>
<td>3.91</td>
</tr>
<tr>
<td>4</td>
<td>0.12</td>
<td>0.65</td>
<td>2.16</td>
<td>4.90</td>
</tr>
<tr>
<td>6</td>
<td>0.09</td>
<td>0.52</td>
<td>1.74</td>
<td>3.96</td>
</tr>
</tbody>
</table>

Note: Ball Valves are figured as operating completely open and account for head loss equivalent to an equal run of straight pipe. **Table 2** is based on highest Head Loss obtained from **Table 1**.
Step 2

Use Table 1, Recommended Water Pipe Sizes (on page 9), to select pipe sizes by GPM water flow. Begin with the most distant Protocol™ from the pump. Call its circuit to the pump the Main. In the example, “O” is most distant from the pump. Eight Branches join its circuit to the pump. Protocol™ “N” adds 14.4 GPM to the flow and requires a 2 inch Main. “A” adds 32.7 GPM to the flow and requires a 3 inch Main. For multiple unit branches start at the last Protocol™ and add up GPM moving toward the Main. Branch “B, C, D, G” starts at Protocol™ B with 1½ inch pipe. It requires 2 inch pipe at Protocol™ C, and 3 inch at Protocol™ D and G. At the Main, the GPM water flow requires a 6 inch pipe.
TOTAL DYNAMIC HEAD (TDH)

Head Loss may be figured for pipes by the following formula.

\[
\text{Head Loss for Pipes} = \frac{\text{Length of Run} \times \text{Head Loss per 100 ft of pipe}}{100}
\]

**Table 1** lists Head Loss for applicable GPM and pipe sizes. Figure the pipe lengths from the store blue print. Both supply and return runs are the same size. Figure the feet of one pipe and double it to get the Length of Run.

To find the circuit with the highest Head Loss in the system, follow the same route used for figuring required pipe sizes. Each branch should be figured from the final Protocol™ in it to assure that the circuit with the highest head loss is used. Generally, the most distant Protocol™ will have the highest head loss.

**Head Loss in Pipes of Highest Loss Circuit.**

By listing each section of piping and figuring its particular head loss, the highest head loss circuit can be determined. Remember other piping components such as elbows and valves must be accounted for.

**Important Notes:**

This example assumes a 25% Head Loss for Tees, Elbows and Valves. The 25% figure is used because the number of piping components are unique to a specific installation. These components should be accounted for in determining the Head Loss in the System by using **Table 2.** Multiply the number of each component used by the value listed for it. Add the Head Loss for all piping components when figuring TDH.

<table>
<thead>
<tr>
<th>Protocol™ GPM GPM</th>
<th>Branch Line Size</th>
<th>Main Line Size</th>
<th>Ft of Run</th>
<th>Head Loss per foot</th>
<th>Head Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>O 12.57 1½</td>
<td>12.57 1½</td>
<td>26.99 2</td>
<td>340</td>
<td>0.015</td>
<td>6.12</td>
</tr>
<tr>
<td></td>
<td>132.94 3</td>
<td>115'</td>
<td>75'</td>
<td>0.045</td>
<td>10.35</td>
</tr>
<tr>
<td></td>
<td>245.47 4</td>
<td>170'</td>
<td>115'</td>
<td>0.037</td>
<td>1.85</td>
</tr>
<tr>
<td></td>
<td>321.90 6</td>
<td>170'</td>
<td>75'</td>
<td>0.008</td>
<td>1.20</td>
</tr>
</tbody>
</table>

Piping Head Loss = 19.64
Both the Protocol™ units and the Fluid Cooler must be accounted for once the piping has been figured. Since Protocol™ units are piped in parallel, 20 Ft of H₂O may be used for the total of all the Protocol™ units in the system. The Fluid Cooler Head Loss should be obtained from the manufacturer. This example uses 9.24 Ft of H₂O for the Fluid Cooler.

By totaling the Head Losses of the highest loss branch and the other components in the system, the TDH can be determined for the system.

**TOTAL DYNAMIC HEAD (TDH)**

<table>
<thead>
<tr>
<th>System Components</th>
<th>Ft of H₂O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piping</td>
<td>19.64</td>
</tr>
<tr>
<td>Tees, Elbows and Valves</td>
<td>4.91</td>
</tr>
<tr>
<td>(Piping x 25%)</td>
<td></td>
</tr>
<tr>
<td>Protocol™(s)</td>
<td>20.00</td>
</tr>
<tr>
<td>Heat Reclaim</td>
<td>0.00</td>
</tr>
<tr>
<td>(from Manufacturer)</td>
<td></td>
</tr>
<tr>
<td>Heat Pumps</td>
<td>0.00</td>
</tr>
<tr>
<td>(from Manufacturer)</td>
<td></td>
</tr>
<tr>
<td>Fluid Cooler</td>
<td>9.24</td>
</tr>
<tr>
<td>(from Manufacturer)</td>
<td></td>
</tr>
<tr>
<td><strong>Total Dynamic Head (TDH)</strong> (100% Water)</td>
<td>53.79</td>
</tr>
</tbody>
</table>

Glycol Head Loss

Since glycol has a higher viscosity than water, the Head Loss should be increased by the multiplying factors listed below. The per cent glycol used will be determined by design winter outdoor Dry Bulb temperature. Fully inhibited, industrial grade ethylene or propylene glycol 30% by volume with water will provide BURST protection to -20 deg F, and will give adequate corrosion protection in most situations. The factors listed are for BURST PROTECTION, not freeze protection. Consult suppliers in your area regarding requirements for closed loop systems and the use of inhibitors/glycol.

<table>
<thead>
<tr>
<th>Lowest Winter Dry Bulb</th>
<th>% Glycol</th>
<th>Multiplying Factor for Head Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>- 20 deg F</td>
<td>30</td>
<td>1.10</td>
</tr>
<tr>
<td>0 deg F</td>
<td>25</td>
<td>1.07</td>
</tr>
<tr>
<td>+ 22 deg F</td>
<td>10</td>
<td>1.03</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TDH @ 100% Water (Ft of H₂O)</th>
<th>x Multiplying Factor</th>
<th>TDH @ 30% Glycol (Ft of H₂O)</th>
</tr>
</thead>
<tbody>
<tr>
<td>53.79</td>
<td>1.10</td>
<td>59.17</td>
</tr>
</tbody>
</table>

This system would be sized for 322 GPM and 59.2 Ft of H₂O TDH.
WATER PIPING

FIELD SUPPLIED AND INSTALLED WATER COMPONENTS
Each Protocol™ is equipped with a Schrader Valve on the water outlet, for the purpose of venting trapped air. Each Protocol™ also comes equipped with a flow control/shutoff valve for adjusting the water flow. The Hussmann Pumping Station has an Automatic Air Vent and an Expansion Tank. All other water components are field supplied and installed.

A 16-20 mesh strainer (1-mm) is required immediately upstream of each Protocol™ unit in all applications.

CLOSED LOOP AIR SEPARATOR
Air separators are optional for Protocol™ closed loop systems. Once up and running the system is essentially hermetic, unless it is opened for service or modification. In a static system, air tends to rise to the highest point it can. In a circulating system, air tends to pocket where pipes turn in a downward direction. As a result, a vent is needed at high points when filling the loop, and at turn downs during start up.

AIR VENT CONSTRUCTION
Vents will vary with materials and local codes. Manual vents are recommended.

In PVC, after the joint is assembled, drill and tap for a threaded 3/8-ID PVC pipe to PVC cemented fitting. Use PVC cement on the threads and do not over-tighten. Install a PVC Ball Valve on the fitting.

To provide an air trap and assure that pipe cuttings do not get into the closed loop, install the 3/8-inch threaded to PVC Fitting in a TEE plug. Use a TEE at the turndown instead of an elbow. Install the plug and ball valve assembly after the joint is complete.

When a turndown is not going to be accessible, a remote ball valve may be used.
Hussmann Protocol™ - Water Side Components

Store Piping Layout

Fluid Cooler

Protocol™ Condenser
**COMPONENTS**

1 – Protocol™ Condenser – transfers heat from refrigerant to the circulating water/glycol.

2 – Flow Control/Shutoff Valve – used to balance water/glycol flow across all Protocol™ units.

3 – Hot Water Return Piping – carries heat laden water/glycol to Fluid Cooler.

4 – Fluid Cooler – discharges unwanted heat into the ambient air through evaporation of an expendable water supply.

5 – Cooled Water Supply Piping – carries cooled water/glycol back to the Protocol™ units to pick up more heat.

6 – Pump and Motor Assembly – circulates the water/glycol. Two are used, with one always in standby.

7 – Triple Duty Valve – acts as check valve, flow control, and shutoff valve. One Valve is immediately down stream of each pump.

8 – Expansion Tank – allows for expansion of water/glycol to prevent system safety shut down.

**OTHER COMPONENTS WHICH HAVE DIFFERENT LOCATIONS**

Shutoff Valves – placed in the lines so components may be isolated.

1-inch Hose Coupling – water fill – generally located at one of the lowest points in the system. It may be used to fill the system at start-up.

Manual Air Bleeds – are located at the high points in the system and are used at start-up to remove air.
DESIGNING THE WATER LOOP PIPING

The variations of effective water piping design and layout are so numerous that a comprehensive discussion is beyond the scope of this document. The local suppliers of pumps, pipe, valves, cooling towers, chemicals and controls are familiar with what works best in your area. Only two basic design concepts are applicable to Protocol™ installations. They are:

- Direct Return Piping; and
- Reverse Return Piping

**DIRECT RETURN PIPING**

Direct Return Piping uses supply trunk lines which decrease in size as branches reduce the water flow requirements through the trunk. The return trunk lines increase in size as branches join the trunk.

**Disadvantages**

- System balancing may be difficult since it must account for piping length, reductions in pipe size, and plate condenser flow requirements. The Protocol™ with the longest water supply line will also have the longest return line.

**Advantages**

- Initial cost of the pipe may be less than the Reverse Return system.
Reverse Return Piping uses equal sized supply and return lines throughout the installation. Because of the pipe layout, the Head Loss due to piping is nearly identical at any point along the water loop.

Disadvantages
• Initial cost of the pipe may be more than the Direct Return system.

Advantages
• This design reduces or eliminates the need for reduction fittings and allows use of larger quantities of one size pipe.

• Little or no balancing of water flow is required.

• The Protocol™ condenser is constructed of parallel passages with large surface areas. As the need for more heat removal increases, more passages are added to supply more surface area. The additional passages increase the flow through the condenser. A Reverse Return Piping system will be essentially self-balancing.

• With proper prior planning, additional units may be added along the loop without the need to change pipe sizes.
**Vertical Protocol™**
All Measurements given in Inches

- Water Lines = 1 1/2 ID
- Suction Line:
  - 2, 3 or 4 compressors = 1 3/8 OD
  - 5 or 6 compressors = 1 5/8 OD
- Liquid Line = 7/8 OD
- Sat. Suction = 7/8 OD
- Gas Defrost = 5/8 OD
- Split Suction = 1 3/8 OD
Vertical Protocol™
Typical Piping and Electrical Hookup

- Liquid Supply Line
- Suction Line
- Water Outlet
- Gas Defrost
- Water Inlet
- Split Suction Line
- Satellite Suction Line
- Electrical Conduit Connection

Disconnect and Field Connections
Case Electrical Distribution Box; Field Connections Enter Through Kickplate

Drip Pan 1" Deep
Liquid Dryer

Electrical Conduit Connection
208V 2" Nipple up thru 200 Amps
3" Nipple above 200 Amps
460V (2) 2" Nipples
Horizontal Protocol™

Plan View
All Measurements given in Inches

Water Lines = 1 1/2 ID
Suction Line = 1 3/8 OD
Liquid Line = 7/8 OD
Sat. Suction = 7/8 OD
Gas Defrost = 5/8 OD
Split Suction = 1 3/8 OD

2, 3 & 4 Compressor Units

5 & 6 Compressor Units
Horizontal Protocol™
Typical Piping and Electrical Hookup

Electrical Conduit Connection
- 208V 2" Nipple up thru 200 Amps
- 3" Nipple above 200 Amps
- 460V (2) 2" Nipples

Disconnect and Field Connections

Case Electrical Distribution Box for Field Connections

Back of Protocol

Liquid Dryer

Drip Pan 1" Deep

Water Outlet

Gas Defrost

Suction Line (Insulated)

Satellite Suction Line (Insulated)

Liquid Supply Line

Water Inlet

Split Suction Line (Insulated)
**Vertical Air Cooled Protocol™**

All Measurements given in Inches

Suction Line:
- 2, 3 or 4 compressors = 1 3/8 OD
- 5 or 6 compressors = 1 5/8 OD

Liquid Line = 7/8 OD *

Sat. Suction = 7/8 OD

Gas Defrost = 5/8 OD

Split Suction = 1 3/8 OD

Liquid Injection = 3/8 OD

Discharge = 1 3/8 OD *

* See Notes on Typical Piping and Electrical Hookup drawing
**Vertical Air-Cooled Protocol™**
*(Remote Condenser)*

**Typical Piping and Electrical Hookup**

- **Discharge**
- **Liquid Return from Remote Receiver** (Optional – See Notes)
- **Electrical Conduit Connection**
  - 208V 2" Nipple up thru 200 Amps
  - 3" Nipple above 200 Amps
  - 460V (2) 2" Nipples
- **Split Suction Line** Insulated
- **Liquid Supply for Liquid Injection** (Optional – See Note 1)
- **Satellite Suction Line** Insulated
- **Gas Defrost**
- **Liquid Supply Line** (Optional – See Notes)
- **Suction Line** Insulated

**Notes:**
1) On units with liquid injection, liquid refrigerant must be piped to this connection.
2) Liquid refrigerant from remote receiver may be piped through the unit as an option. If so, liquid injection piping will be factory installed inside the unit.
**Horizontal Air Cooled Protocol™**

All Measurements given in Inches

- Suction Line = 1 5/8 OD
- Liquid Line = 7/8 OD *
- Sat. Suction = 7/8 OD
- Gas Defrost = 5/8 OD
- Split Suction = 1 3/8 OD
- Liquid Injection = 3/8 OD
- Discharge = 1 3/8 OD *

* See Notes on Typical Piping and Electrical Hookup drawing

---

**2, 3 & 4 Compressor Units**

**5 & 6 Compressor Units**
Horizontal Air Cooled Protocol™
(Remote Condenser)
Typical Piping and Electrical Hookup

Notes:
1) On units with liquid injection, liquid refrigerant must be piped to this connection.
2) Liquid refrigerant from remote receiver may be piped through the unit as an option. If so, liquid injection piping will be factory installed inside the unit.
Proto-Aire™

Plan View
All Measurements given in Inches

Suction Line = 1 5/8 OD
Liquid Line = 7/8 OD
Sat. Suction = 7/8 OD
Gas Defrost = 5/8 OD
Split Suction = 1 3/8 OD
Proto-Aire™
Typical Piping and Electrical Hookup

Disconnect and Field Connections

Case Electrical Distribution Box for Field Connections

Back of Proto-Aire

Electrical Conduit Connection
208V 2” Nipple up thru 200 Amps
3” Nipple above 200 Amps
460V (2) 2” Nipples

Gas Defrost

Suction Line Insulated

Satellite Suction Line Insulated

Split Suction Line Insulated

Liquid Supply Line
OPTIONAL
HUSSNET™ PLANNING DATA

Installation of Communications Cable

Each Protocol™ contains two modular phone jacks to aid in connecting the main control boards to the HUSSNET™ computer. Each modular phone jack located on the main control board is a 6 pin connector with the center four pins loaded (the two outside pins are not used). It is important that polarity is maintained throughout the store (i.e. pin #1 must be in the same position at each Protocol™ and at the HUSSNET™ computer). The left to right order of the wire colors at the phone jacks must be identical for every connection in the store.

It is recommended that the installing contractor, or local phone company, install a wall jack (RJ11 connection) at each Protocol™. Appropriate twisted pair cable should be used to connect all the wall jacks together and at the HUSSNET™ computer. To aid in troubleshooting connections, you may want to group 3 to 5 Protocol™ units together along a single communications drop and terminated at the HUSSNET™ computer.

You should purchase twisted pair cable which contains at least 4 conductors and contain a 300 volt rated insulation, such as Belden #9502, or a cable of equivalent specifications. When using shielded cable, you should connect all the shields together and attach them to earth ground at only one point.

**CAUTION: Do not attach the ground at multiple points. This will produce ground loops and cause the electronic controls to be subjected to excessive electrical noise.**
Once the communications link has been established at all wall jacks, you may use flat telephone patch cords to connect the Protocol™ units to the wall jacks. The patch cords should also be rated for 300 volts and contain 4 conductor 26 AWG wire. A word of caution: using premade purchased cables such as those from Radio Shack or other distributors of phone cable, will typically have one end of the cable reversed (e.g. pin #1 on one end will match up with pin #4 on the other). This reversed connection will not be compatible with the required HUSSNET™ connection.

Do not run any communications cable with high voltage wires. Do not run any communications cable along building support structures which may act as conductors.

Installation of Dedicated Phone Line

In addition to the communications cable described above, you may have a dedicated phone line installed for the HUSSNET™ computer. The phone line will be used to access the computer from a remote site. You will need to consult your local telephone installer/contractor to coordinate the phone line installation. The phone line must be dedicated solely for the HUSSNET™ computer and not shared with other computers or modems.

Installation of Computer

Location of the computer should be considered for functionality, ease of accessibility and indication of potential alarms. HUSSNET™ contains a remote alarm output option wherein an alarm box can be placed in the store to signal the occurrence of alarms. Typically, the remote alarm box is placed where there will always be store personnel within hearing distance.

Examples of where you might locate the computer:

- Store or night manager’s office.
- Computer room with other equipment used for store purposes.

Examples of where you might locate the remote alarm box:

- Courtesy service counter located in front of the store
- In back of the store on a wall near store inter-com or inventory receiving desk.

These examples illustrate that the computer and remote alarm box do not have to be located in the same room. When choosing the location for the computer, you should consider accessibility for service personnel and any departmental managers that you wish to have access. A two-wire, 18 gauge wire is sufficient for connecting the computer to the remote alarm box. Shielded cable is not necessary.

The remote alarm box should be located within reaching distance. This box contains a silence button which temporarily suspends the alarm buzzer. If the alarm condition is still present after 30 minutes, the alarm buzzer will re-trigger.

You should consider the following when selecting the computer:
HUSSNET™ REQUIREMENTS

Recommended Minimum Hardware
• IBM-PC or compatible PC
  • 486 processor with
    8 Meg RAM
• 300+ Meg hard drive
• 2 serial ports
• 1 parallel port
• Microsoft or compatible Bus mouse
• Hayes or compatible 14400 baud modem for remote communications
• DOS 6.2 or newer
• 600K of Free RAM
• Uninterruptible power supply
  if used for data collection

Required Software
• PC Norton Anywhere