1. SYSTEM DESCRIPTION

The Viking ESFR Cold Storage System is fixed fire protection for refrigerated or cold warehouse storage. This system is also appropriate for unheated storage applications in areas subject to freezing. The piping system is filled with pressurized propylene glycol and water solution maintained from a pressure pump system that controls and maintains the desired solution pressure. This is a wet pipe system that utilizes the Viking Wet Pipe Alarm Valve with special trim to isolate the antifreeze in the system from the water supply.

The sprinklers used in this system are closed heat-sensitive Viking ESFR K25.2 VK510 Pendent Sprinklers having an ordinary temperature rating of 165 °F (74 °C). With this system, ceiling-only sprinklers are required and no in-rack sprinklers are needed. Single row, double row, and multiple row rack storage is required and sprinklers shall be located in accordance with applicable Viking Technical Data and the latest recognized storage installation rules of NFPA or the Authority Having Jurisdiction (AHJ). Open rack storage is required, and sprinklers shall be located in accordance with applicable Viking technical data (refer to the latest issue of NFPA or the Authority Having Jurisdiction (AHJ).)

Viking technical data may be found on The Viking Corporation’s Web site at http://www.vikingcorp.com. The Web site may include a more recent edition of this technical data page.

Limitations of this system include:

- Commodity is limited to Class II or less (limited to wood pallets).
- Storage height up to 35 ft. (10.7 m) with ceiling height up to 40 ft. (12.2 m) with a minimum system design pressure of 40 PSI (278 kPa). OR:
  - Storage height up to 40 ft. (12.2 m) with ceiling height up to 45 ft-3 in. (13.8 m) with a minimum system design pressure of 60 PSI (414 kPa).
- Maximum system volume of the antifreeze water solution is limited to 1,100 gallons (4,163 liters).
- Use of only Viking ESFR K25.2 VK510 Pendent Sprinklers.
- System pressure not to exceed 175 PSI (1,207 kPa) at the sprinklers, including fire pump test procedure at zero flow rate.
- Where the minimum temperature in the area being protected is 8 °F (-13.3 °C) or above, 35% percent by volume of propylene glycol factory premixed with water must be used. Viking requires Firefighter Eliminator C premix 35% propylene glycol/water mixture with a freeze temperature rating (freeze point) of 2.4 °F (-16.4 °C). OR:
  - Where the minimum temperature in the area being protected is between 8 °F (-13.3 °C) and -21 °F (-29.4 °C), the percentage by volume of propylene glycol must be 50%, factory premixed with water for antifreeze solution. Viking requires Firefighter Eliminator F type 50% propylene glycol/water mixture, with a freeze temperature rating (freeze point) of -26 °F (-32.2 °C).
- Min. temperature: -21 °F (-29.4 °C).

NOTE: Verify that any gasket materials used in couplings, etc. are compatible with the antifreeze solution. Refer to the antifreeze solution technical data page.

Upon operation of the sprinkler(s), pressurized propylene glycol/water solution is distributed from the sprinkler. Water from the supply system pushes out the propylene glycol/water solution at a very rapid rate due to the sprinkler orifice size and design pressures. The limited system volume ensures that 100% water will flow from the sprinklers at an appropriate stage of fire development. Upon water replacement of propylene glycol/water solution in the system, 100% water is distributed over the specific area to control or suppress the fire.

The CS-1 Tank and Pump system is designed to maintain normal system static pressure at a higher pressure than the water supply static pressure. As the system operates, a flow switch or alarm pressure switch is used to send a signal to the CS-1 system control to shut off the flow of antifreeze from the reservoir. Upon operation of the system, an alarm is activated due to water flow. Typically, only those sprinklers above or adjacent to the fire operate, minimizing water damage and contamination. Other antifreeze systems within the warehouse would not typically be activated.

In order to effectively apply 100% water as rapidly as possible, the system size must be limited in volume. Full scale fire testing of the 50% propylene glycol and water premix solution and a system volume of 1,100 gallons (4,163 liters) has been performed successfully at Underwriters Laboratories Inc., resulting in UL Listing of the ESFR VK510 Sprinkler for use with 35% or 50% propylene glycol and water solution.

Hydraulic Calculations:

At -21 °F (-29.4 °C), the propylene glycol/water solution will have a viscosity of 200 centipoise, as opposed to water at 1 centipoise at 70 °F (21.1 °C). Two (2) sets of hydraulic calculations will be required for the system piping: one utilizing Hazen-Williams method of determining friction loss, and one utilizing Darcy-Weisbach method of determining friction loss. The Hazen-Williams friction loss factors will be utilized for flowing water through the piping, the Darcy-Weisbach procedure will be used for flowing propylene glycol/water solution.

### Firefighter Eliminator F

50% Propylene Glycol and Water Solution by Volume

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Specific Gravity</th>
<th>Viscosity Centipoise</th>
<th>Freeze Point</th>
<th>Applicable Temperature</th>
<th>Density (lbs/cu ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 °F (15.6 °C)</td>
<td>1.041</td>
<td>8.13</td>
<td>-26 °F (-32.2 °C)</td>
<td>-21 °F (-29.4 °C)</td>
<td>64.96</td>
</tr>
<tr>
<td>0 °F (-17.8 °C)</td>
<td>1.056</td>
<td>61</td>
<td>-26 °F (-32.2 °C)</td>
<td>-21 °F (-29.4 °C)</td>
<td>65.89</td>
</tr>
<tr>
<td>-10 °F (-23.3 °C)</td>
<td>1.061</td>
<td>96</td>
<td>-26 °F (-32.2 °C)</td>
<td>-21 °F (-29.4 °C)</td>
<td>66.20</td>
</tr>
<tr>
<td>-20 °F (-28.9 °C)</td>
<td>1.085</td>
<td>180</td>
<td>-26 °F (-32.2 °C)</td>
<td>-21 °F (-29.4 °C)</td>
<td>67.70</td>
</tr>
</tbody>
</table>

**Darcy Weisbach procedure**

1. Calculate Reynolds Number
2. Calculate relative roughness of pipe
3. Use Moody Diagram to find "f"
4. Calculate friction loss

**Reynolds Number**

\[ Re = \frac{50.6Q^d \mu}{D} \]

- \( Q \) = flow gpm
- \( \mu \) = density (lbs/cu ft)
- \( D \) = internal pipe diameter (in.)
- \( L \) = pipe length (ft.)
- \( d \) = pipe thickness (in.)
- \( \mu \) = dynamic viscosity (centipoise)

Pipe roughness C-120 steel pipe = \( c = 0.00015 \), relative roughness \( d/D \) (use Moody Chart)

If \( Re > 2000 \), \( f = \) Moody Diagram NFPA 750 fig 6-2.2 or fire pump handbook pg 16
If \( Re < 2000 \), \( f = 64/Re \)

**Fricion Loss = Delta P = PSI**

\[ Re > 2000 = 0.000216 \frac{L}{D} Q \left( \frac{Q}{D} \right)^{3/2} \]

\[ Re < 2000 = 0.000273 \frac{L}{D} Q \left( \frac{Q}{D} \right)^{1/2} \]

**Table 1**

Note: Units of measure in parentheses may be approximations.
2. APPLICATION

In the past, in order to apply ESFR sprinkler technology that allows for ceiling-only sprinkler fire protection for open rack construction storage applications, it has been necessary to limit systems to wet systems. In refrigerated and unheated storage areas, standard spray or large drop sprinklers are typically installed at the ceiling, and in many cases in-rack sprinklers are required to be installed throughout the storage racks per appropriate installation standards.

Air or gas supervised preaction systems are utilized in many cases to supervise the integrity of the piping system. Detection is necessary for preaction systems for cold or freezer storage areas. Many of these systems are double interlock systems to prevent accidental introduction of water into the system.

The Viking ESFR Cold Storage System is designed to protect refrigerated or unheated warehouse areas using ceiling-only sprinkler protection. The system is based on a 35% or 50% (depending on the minimum temperature in the area being protected) by volume mixture of propylene glycol and water premix solution, to protect the system against fire until the water is applied to suppress the fire. The area of coverage for a single system is dependent on the volume of the system required to cover the area being protected. The hydraulic calculations are necessary in order to properly size the system piping. (Refer to paragraph 3-A for tree system hydraulic calculations, and paragraph 3-B for grid type system hydraulic calculations.) For refrigerated area systems, the piping system shall be pitched to drain complete system toward the riser and alarm valve with branch lines at ½” per 10 ft. (4 mm/m) and mains at ¾” per 10 ft. (4 mm/m) run of pipe. For systems in unheated areas subject to freezing, branch lines shall be pitched at ¾” per 10 ft. (4 mm/m) and mains at ¾” per 10 ft. (2 mm/m) run of pipe.

This system shall be designed by qualified fire protection technicians, in conjunction with requirements of the AHJs. Viking ESFR Cold Storage Systems are designed to meet the UL Listing requirements described in Viking technical data for ESFR K25.2 Sprinkler VK510 for use with 35% or 50% propylene glycol and water solution, and the standards of NFPA 13 or other organizations, and also with the provisions of governmental codes, ordinances, and standards where applicable. This system shall meet all requirements of ESFR installations except where specified in this data sheet.

3-A. SYSTEM DESIGN

Hydraulic Calculation Procedure:

Two separate hydraulic calculations will be utilized. A calculation with a design of twelve ESFR K25.2 VK510 Sprinklers and water, using four sprinklers on three most remote lines, discharging at the minimum design pressure for the hazard, with piping friction loss determined by Hazen-Williams method of determining friction loss in piping. A second hydraulic calculation with a design of six K25.2 ESFR sprinklers using Propylene Glycol and the physical properties at the discharge temperature, using four sprinklers on the most remote line and two sprinklers on the second most remote line, discharging at a minimum design pressure for the hazard, with piping friction loss determined by Darcy-Weisbach method of determining friction loss in piping. The 1,100 gallon (4,163 liter) volume restriction for tree type piping configuration is for the piping included in the remote area (12 sprinklers) and the supply main piping back to the base of the sprinkler riser above the Alarm Valve clapper. Additional mains and sprinkler lines attached to the system, but not in the direct path to the sprinkler riser base need not be considered for the system volume limitation if acceptable by the AHJ. The 1,100 gallon (4,163 liter) volume restriction for grided piping systems shall include all piping on the system pipe network above the Alarm Valve Clapper.

Tree Configuration - ESFR Cold Storage System

A tree type piping configuration is recommended for this type system over the grid type system because the type of system is expected to be set up for drainage. Also, with a center feed main supplying branch lines, the flow is directed toward the first open sprinklers. This allows the antifreeze solution to be expelled from lines and mains leading directly to open sprinklers and to be replaced with 100% water much faster than in grid type systems. For tree systems utilizing this system, the mains or lines should not be looped together as done in some dry pipe and preaction systems. The discharge pressure for all sprinklers flowing must maintain at a minimum of the required design. For tree systems utilizing this system, the branch lines or supply mains should not be looped together as done in some dry pipe and preaction systems. The 1,100 gallon (4,163 liter) system volume is established by adding the piping volume from the base of the sprinkler riser above the Alarm Valve Clapper.

TECHNICAL DATA

<table>
<thead>
<tr>
<th>Firefighter Eliminator C</th>
<th>35% Propylene Glycol and Water Solution by Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Temperature</td>
</tr>
<tr>
<td>68 °F (20 °C)</td>
<td>1.033</td>
</tr>
<tr>
<td>6 °F (-14.5 °C)</td>
<td>1.040</td>
</tr>
</tbody>
</table>

Darcy Weisbach procedure

1. Calculate Reynolds Number
   \[
   Re = \frac{50.6Q\rho}{\muD}
   \]
2. Calculate relative roughness of pipe
   \[
   \rho = \left(1 + \frac{0.00015}{LQ/d^4}\right)
   \]
3. Use Moody Diagram to find \( f \)
4. Calculate friction loss

Reynolds Number

Pipe roughness C-120 steel pipe = \( \varepsilon = 0.00015 \), relative roughness \( \varepsilon/D \) (use Moody Chart)

If \( Re > 2000 \), \( f = \) Moody Diagram NFPA 750 fig 6-2.2 or fire pump handbook pg 16
If \( Re < 2000 \), \( f = 64/Re \)

Friction Loss = Delta P = PSI

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<thead>
<tr>
<th>Firefighter Eliminator C</th>
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<tr>
<td></td>
<td>Re = 50.6Q\rho/d\mu</td>
</tr>
<tr>
<td></td>
<td>Q = flow gpm</td>
</tr>
<tr>
<td></td>
<td>\rho = density (lbs/cu ft)</td>
</tr>
<tr>
<td></td>
<td>d = internal pipe diameter (in.)</td>
</tr>
<tr>
<td></td>
<td>D = internal pipe diameter (ft.)</td>
</tr>
<tr>
<td></td>
<td>L = pipe length (ft.)</td>
</tr>
<tr>
<td></td>
<td>\mu = dynamic viscosity (centipoise)</td>
</tr>
</tbody>
</table>

Pipe roughness C-120 steel pipe = \( \varepsilon = 0.00015 \), relative roughness \( \varepsilon/D \) (use Moody Chart)

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</tr>
<tr>
<td></td>
<td>L = pipe length (ft.)</td>
</tr>
<tr>
<td></td>
<td>\mu = dynamic viscosity (centipoise)</td>
</tr>
</tbody>
</table>

Table 2

Weisbach friction loss factors will be utilized for flowing propylene glycol/water solution through the system piping at the lowest operating temperature. The information in Table 1 is provided for Firefighter Eliminator F 50% propylene glycol/water pre-mix solution, while the information in Table 2 is provided for Firefighter Eliminator C 35% propylene glycol/water pre-mix solution.
The remote area to the top of the alarm check valve at the base of the riser. The actual propylene glycol solution requirement for the system is determined by adding all the system piping volume together.

In regards to all other aspects of this system, installation requirements apply as described.

All NFPA 13 installation criteria and AHJ requirements apply to installation of the Viking ESFR Cold Storage System with the following exceptions:

- Commodity limited to Class II or less (limited to wood pallets).
- Maximum ceiling height to bottom of inside upper deck is 40 ft. (12.2 m) with a maximum storage height of 35 ft. (10.7 m) and a minimum sprinkler discharge pressure of 40 PSI (278 kPa). OR:
  - Maximum ceiling height to bottom of inside upper deck is 45 ft-3 in. (13.8 m) with maximum storage height of 40 ft. (12.2 m) and a minimum sprinkler discharge pressure of 60 PSI (414 kPa). OR:  
  - Where the minimum temperature in the area being protected is 8 °F (-13.3 °C) or above, 35% percent by volume of propylene glycol factory premixed with water must be used. Viking requires Firefighter Eliminator C premix 35% propylene glycol/water mixture with a freeze temperature rating (freeze point) of 2.4 °F (-16.4 °C). OR:
    - Where the minimum temperature in the area being protected is between 8 °F (-13.3 °C) and -21 °F (-29.4 °C), the percentage by volume of propylene glycol must be 50%, factory premixed with water for antifreeze solution. Viking requires Firefighter Eliminator F type 50% propylene glycol/water mixture, with a freeze temperature rating (freeze point) of -26 °F (-32.2 °C). OR:
    - Minimum ambient temperature is -21 °F (-29.4 °C). NOTE: The minimum temperature is NOT an average in the freezer, but is the lowest temperature for the system.
    - Maximum system volume is 1,100 gallons (4,163 liters). Refer to calculation to determine volume.
    - Use ordinary temperature rated 165 °F (74 °C) Viking ESFR K25.2 Sprinkler VKS10. Exception: Intermediate temperature rated 205 °F (96 °C) Viking ESFR VKS10 K25.2 Sprinklers that are intended for installation in close proximity to heat sources may be applied only as referenced in NFPA 13.
    - The piping system must be pitched for drainage of the system after operation. For refrigerated area systems, the piping system shall be pitched to drain complete system toward the riser and alarm valve with branch lines at ½ per 10 ft. (4 mm/m) and mains at ¼ per 10 ft. (2 mm/m) run of pipe. For systems in unheated areas subject to freezing, branch lines shall be pitched at ¼ per 10 ft. (4 mm/m) and mains at ¼ per 10 ft. (2 mm/m) run of pipe.
    - The system must be designed so maximum operating pressure of the system does not exceed 175 PSI (1,207 kPa) at the sprinkler, including test pressures of pumps at zero flow.

For tree system configuration, see Figure 1. For grid systems, see Figure 3.

Piping System to Sprinklers
Tree type piping configurations vary. There are side or end feeds, offset feeds, and center feeds. Many times the configuration of the tree system piping is dictated by building features or by hydraulic calculations.

The maximum system volume must be maintained and is calculated at a maximum 1,100 gallons (4,163 liters). Refer to calculation to determine volume.
mum from the alarm check valve, including all piping to the remote sprinklers (refer to calculation to determine volume). The propylene glycol/water solution will be expelled from a tree type system faster than in a gridded piping system of the same total volume, as the main supply and affected line will be supplied and drained in one direction. A tree system allows for a larger area of coverage than a grid system because the direct path from remote branch lines and supply main from Alarm Valve is included in the volume calculation versus the total system volume for a grid type system. Furthermore, a tree type piping configuration will facilitate drainage to the riser better than a grid piping system.

The Viking Model J-1 Alarm Valve with ESFR Cold Storage System Vertical Trim (see Figure 4 and data page 48 a-c) should be installed as close as possible to the inlet of the freezer main and as high as practical in order to maximize system antifreeze in the freezer. The alarm valve and trim, along with all antifreeze and supply piping must be installed in a heated area that is maintained at or above 40 °F (4 °C). Insulating the fire sprinkler riser may be considered to eliminate condensation from developing on the piping in the heated area. If the alarm valve is close enough to freezer separation wall to cause freezing of water and condensation on piping to alarm valve, then a heat trace heating system may be required for the riser piping above the alarm valve to maintain a temperature under the insulation of 70 °F to eliminate condensation and maintain internal temperature of solution above freezing for water below the alarm valve. Due to difficulty in servicing and insulating the alarm check valve, it is recommended to install the alarm valve near floor level at the base of the main riser in the heated area.

Air vent valves or manual bleed valves must be installed at the highest and most remote points on the tree piping system in order to vent out all air during fill of the 35% or 50% premix of propylene glycol/water solution in the system. Additional vent or bleed valves shall be installed on the end of each branch line piping to ensure air is vented from the system. This is required in order to eliminate compressible gas (air) from the system when setting supervisory pressure from the antifreeze CS-1 pump system. Also, the manual vent valves may be used for multiple sample points of the system for quality testing of the antifreeze solution.

The Main Drain

The main drain outlet should be directed to an appropriate location and the drain valve shall be installed at an accessible level so it can be operated from the floor level. Installing the alarm check valve at an elevation near the horizontal mains supplying the system will reduce the volume of propylene glycol solution in the system piping. The main drain valve can be installed at an accessible level, as the solution will be trapped in the drop leg to the drain valve and will not affect the total calculation for the system. The main drain valve will be used to drain the system piping downstream of the alarm check valve. Propylene glycol/water solutions are designed to be installed on systems supplied by potable water supplies. Local authorities should be consulted prior to draining system to storm sewers or to natural drainage areas. In the main drain line between the valve and alarm valve inlet, a tee is provided on the alarm

![Figure 2: Antifreeze System Schematic](image-url)
Valve trim with a 1” NPT connection for supply and maintenance of the antifreeze solution to the system above the alarm check valve.

Reclaim Tank
An atmospheric storage tank is to be installed for the system(s) that is of adequate capacity of the largest system volume installed. The tank shall be utilized as a reclaim tank for the propylene glycol solution in the system piping when the system(s) are drained for system service and for discharge of propylene glycol solution if system pressure exceeds 175 PSI (1 207 kPa) at the sprinklers. A means of relieving system pressure due to pressure buildup can be provided through a specialized pressure switch and solenoid valve on the downstream side of the alarm check valve. See data page 47 a-c.

Storage areas that are expected to fluctuate more than 10 degrees from nominal temperature will experience increased pressure in the system piping due to expansion of the propylene glycol when the temperature rises in the storage area. In order to prevent the pressure relief valve (PRV) on the alarm valve trim from operating the pressure control system is set to maintain pressure below the set point of PRV and above the system maintenance pressure. Prior to installation of system, maximum temperature changes are required to be considered to determine possible expansion and contraction rate of propylene glycol solution. If the contraction rate is greater than the storage tank that accompanies excess pressure pump, an additional supply tank to supplement excess pressure pump shall be installed.

Solution Test Valves - Tree Type Configuration
Multiple propylene glycol/water solution test valves are to be installed on the system piping for semi-annual testing with a refractometer. The testing stated in this section is more restrictive than the required test frequency indicated in NFPA 25. Solution test valves should be located in several areas of the system piping:

- The most practical location immediately downstream of the alarm check valve.
- The most remote location from the alarm check valve.
- One valve located at the end of 50% of the line piping.
- A test valve shall be located at the end of the nearest line on the tree system and the last line on the tree system.

If the propylene glycol/water solution becomes diluted or does not pass the refractometer test, the entire system is to be drained. All sections of trapped piping are to be drained. Five percent (5%) of the pendent ESFR sprinklers are to be removed and inspected for frozen solution. If any of the pendent ESFR sprinklers are found with frozen solution, then all the pendent ESFR sprinklers are to be removed and replaced with new Viking K25.2 Pendent ESFR VK510 Sprinklers prior to re-charging the system with new 35% or 50% premix propylene glycol/water solution. If the 5% of removed sprinklers are not damaged, they can be re-installed in the system. (Refer to the system service schedule for additional solution tests.)

Re-Charging System Piping with 35% or 50% Premix Propylene Glycol/Water Solution
A suitable portable pump can be utilized to fill the system to the static water pressure. (The CS-1 pump can be used for filling the system initially at 15 GPM (56 l/min) to 100 ft. head pressure or system static pressure, however, it is a less efficient pump for filling the system because of the duration of time required to do so.

The CS-1 pump is to be utilized to bring the solution to maintenance pressure, (normally 15-20 PSI (103-138 kPa) greater than static water pressure at the alarm valve) and is designed to maintain system pressure once the system is initially filled. Also, repeat air bleed from the system as described above.

Hydro-testing Sprinkler System Piping
All piping and attachments subject to the operating pressure of the system working pressure shall be hydrostatically tested. After filling the system with antifreeze solution and eliminating all air from the system through the bleed and vent valves, it is recommended that the system be hydro-tested at 200 PSI (1 379 kPa) at the alarm valve location for two hours using a small hydro pump. It is recommended to use antifreeze solution in place of air or water in order to eliminate the possible collection of water moisture in the drop nipples of the sprinklers. The relief valve located on the alarm valve outlet trim should be removed or isolated prior to hydro-test. No leakage shall be allowed from pipe joints, threaded connections etc. The hydro-pressure shall hold for two hours. The temperature of the system and piping shall also be held at a constant temperature for this period or the pressure could fluctuate based on thermal expansion or contraction of the system fluid and piping. Visual inspection of joints is recommended.

Expansion of Antifreeze in the System
In a freezer system, the atmospheric temperature is typically controlled at a pre-determined desired temperature year round. The most likely time over-pressurization of the system might occur due to temperature fluctuation is in a warm-up mode of the freezer, which is very rare once it is put into service. Propylene glycol at 50% by volume mixture with water is very similar to the total pressure versus temperature of water (approximately 0.4 PSI/deg F change in temperature). Also, variation in system due to temperature differential can be substantial. When filling the system with antifreeze solution, all air must be bleed from the system in order to make certain the maintained antifreeze solution pressure non-compressible. A ½ pressure relief valve is required to be purchased separately with the ESFR Cold Storage System Trim. The proper relief valve setting shall be selected at 10 PSI (69 kPa) above the maximum static pressure at the valve location for constant temperature freezers or coolers. This valve is required to protect the sprinklers from over-pressurization. At the sprinklers, the maximum of 175 PSI (1 207 kPa) is required, at the ceiling location. This valve must be directed to a proper drain location, as it is an automatic valve and will operate without warning.

Pressure relief valves operate at 90-105% of design set pressure and close at 80% or greater than design set pressure. The pressure relief valve set pressure must be at least 120% of the static water pressure at inlet of the alarm valve in order to not allow water to enter the system. For freezers or coolers that fluctuate in temperature, an automatic pressure control system may be required that utilizes a special pressure switch and solenoid valve that allows antifreeze to be relieved back into the CS-1 tank. Calculation of volume fluctuation of the largest system where multiple systems are installed must be made in order to make sure the tank volume of antifreeze supply is large enough to contain the volume differential. The PRV set point shall be 5 PSI (34.5 kPa) greater than the maximum setting of the pressure control system. The PRV will be utilized as a safety back-up to the pressure control system in case of power loss and non presence of back-up power system to the freezer temperature control system.

If the pressure should increase due to warm-up above the rated static pressure...
of the system, the pressure relief valve or automatic control system will bleed off antifreeze solution and maintain the maximum pressure of 175 PSI (1,207 kPa) or below at the sprinkler. It is recommended to allow the piping system to establish a normal ambient temperature when filling the system with antifreeze. Slight warming will occur during the fill process. Another option is to fill the system while warm. Monitor tank level and add more solution as needed as temperature cools.

CS-1 Pump
In the past, an excess pressure pump was installed on alarm valve trim where it took a suction from the upstream side of the alarm check valve clapper and discharged it to the system side or downstream side of the alarm check valve clapper at a pressure of 15-20 PSI (103-138 kPa) higher than the static water pressure. The purpose of an excess pressure pump is to allow static pressure. This prevents contamination of antifreeze solution with water, which would migrate into the system(s) that are low on pressure. When pressure is established, the solenoid valve will shut off. Where multiple systems are supplied from a single CS-1 pump, a reserve tank with a minimum size of 160 gallons (606 liters) constructed of cross-linked polyethylene shall be utilized for the storage of premix propylene glycol/water solution to supply the CS-1 pump. The system must include a supervised system isolation valve at floor level in the heated room. The system design shall determine the maximum expansion and contraction rate of the propylene glycol solution to establish if an additional supply tank is required to be added to the reserve tank and excess pressure pump. This applies when using the automatic pressure control system that is filled from the riser back into the CS-1 tank. Where multiple systems are supplied from a single CS-1 pump, a reserve tank with a minimum size of 160 gallons (606 liters) constructed of cross-linked polyethylene shall be utilized for the storage of premix propylene glycol/water solution to supply the CS-1 pump. Where multiple riser systems exist, the antifreeze solution system can be supplied to multiple risers from a single pump system and the pressure switch for each system must be controlled through the pump system control panel. When the pressure drops below set point, a solenoid valve supplied from the CS-1 pump shall open to allow flow of antifreeze solution into the system(s) that are low on pressure. When pressure is established, the solenoid valve will shut off. Where multiple systems are supplied from a single CS-1 pump and a single system operates due to water flow from open sprinkler, the control panel is signaled by the alarm or flow switch of operating riser and shuts off the supply solenoid to that riser. The remaining systems maintain supervisory pressure above the water supply static pressure. This prevents contamination of antifreeze solution with water during operation of a single system. See Figure 2 for a system schematic.

Propylene Glycol and Water Solution Premix
Premix 35% or 50% propylene glycol and water solution that is certified by the manufacturer or a third-party agency is to be installed in the system piping. Field mixing of propylene glycol and site water is strictly prohibited as the control of the mixture cannot be assured. Firefighter Eliminator C 35% premix solution or Firefighter Eliminator F 50% premix solution (refer to data pages 49 a-b and 50 a-b) are required by Viking, as they are mixed in the proper proportion and were utilized for the research fire tests. Firefighter Eliminator C and Firefighter Eliminator F include corrosion inhibitors and de-ionized water to prevent the minerals in site water from reacting with the corrosion inhibitors. This extends the usable life of the propylene glycol/water solution. Improper field mixing of solution can result in reduced capability to prevent freezing or to control a fire. The corrosion inhibitors included in the premix provide corrosion control and microbiological control of the system piping and components.

Riser System
The arrangement of the riser system shall include a Viking Model J-1 Alarm Check Valve with ESFR Cold Storage System Trim (see Figure 4 and data pages 26 a-f and 48 a-c). Due to the limitations of system volume or antifreeze solution from the alarm check into the freezer area, it is recommended to install the alarm check valve as high and close as practical to the outside wall of the freezer area. The alarm valve and antifreeze supply system must be installed in a heated area that is maintained at or above 40 °F (4 °C). Due to alarm valve servicing and insulation requirements to prevent frost and potential convective cold transfer potential freezing of water below the alarm valve clapper, it is recommended to install the valve at floor level in the heated room. The system must include a supervised system control valve upstream of the alarm valve and a supervised system isolation valve downstream of the alarm check valve. The downstream system isolation valve is required to facilitate maintenance of the system and isolation of antifreeze solution during maintenance and testing. A pressure relief valve on the antifreeze side of the alarm valve shall be pre-set to protect the sprinklers at 175 PSI (1,207 kPa) and piped to drain. This will handle overpressurization due to thermal differentials in the area of the antifreeze piping and system operation. The alarm line of the alarm valve shall be attached to an alarm pressure switch (and mechanical water motor alarm, if required) that activates an alarm due to activation of the system. It is recommended that a retard chamber NOT be used on these systems so an alarm can sound immediately when water is flowing in the system, which would migrate into the system antifreeze solution.

Fluid Sampling

TECHNICAL DATA

ESFR COLD STORAGE SYSTEM

September 16, 2005

Page 45 of the document contains information about the Technical Data for the ESFR Cold Storage System.

Viking Fire Equipment
Sampling shall be taken from multiple points within the freezer system. When draining sample antifreeze solution from the system, be sure to shut off the system control valve directly upstream of the alarm check valve so that water doesn't enter the system. Ensure that the water supply control valve is returned to the fully open position once fluid sampling is completed. Antifreeze solution shall be checked semi-annually with a refractometer to detect the concentration of antifreeze solution and effectiveness against freezing.

The testing stated in this section is more restrictive than the required test frequency indicated in NFPA 25. For this purpose, multiple propylene glycol/water solution test valves are to be installed in several areas of the system piping at the following locations:

- The most practical location immediately downstream of the alarm check valve.
- The most remote location from the alarm check valve.
- One vent valve located at the end of 100% of the line piping.

• A test valve at the end of the nearest line on the tree system and the last line on the tree system.

If the propylene glycol/water solution becomes diluted or does not pass the refractometer test, the entire system is to be drained. All sections of trapped piping are to be drained. Five percent (5%) of pendent ESFR sprinklers in all locations throughout the freezer are to be removed and inspected for frozen solution. If any of the pendent ESFR sprinklers are found with frozen solution, all pendent ESFR sprinklers are to be removed and replaced (with new VK510 ESFR Pendant Sprinklers) prior to re-charging system with new 35% or 50% premix propylene glycol/water solution.

Inspectors Test Connection

An alarm test connection is provided on the alarm check valve trim. Do not install a remote test connection for testing alarm functions. The use of a remote test connection would allow water to be added to the antifreeze system, causing contamination or dilution of the solution and rendering it ineffective against freezing. The Viking cold trim option of the alarm valve includes a downstream flow test valve that is used for testing the system alarm. When testing the alarm, the downstream isolation valve and the alarm check valve shall be closed to prevent water from entering the antifreeze system.

After testing for alarm, drain all water from the system between the system isolation valve and the alarm check. Open the antifreeze supply isolation valve and pressurize the system equal to the static system pressure above the isolation valve. Then open the system isolation valve and the system should be re-set. A bleed valve should be placed just below the system isolation valve to bleed out all air when recharging with antifreeze solution.

Flow Test Valve

Annual flow tests are required for every sprinkler system. When performing annual water flow tests through the main drain valve located on the alarm test valve, the supervised system isolation valve is to be closed during the water flow test. Record the water supply pressure on
the water supply pressure gauge upstream of the alarm check valve clapper. Open the main drain fully. Once the pressure gauge has settled to flowing pressure, record the pressure on the water supply pressure gauge upstream of the alarm check valve clapper. (The water pressure gauge above the alarm check valve will initially indicate propylene glycol/water solution pressure that is to be maintained a minimum of 15-20 PSI (103-138 kPa) above the highest static water pressure. Do not utilize the excess pressure above the alarm check valve for historical water flow tests.)

After the water flow test is completed, close the water supply control valve upstream of the alarm check valve, drain the water location between the alarm check valve, and the system isolation valve. Close the main drain once water is completely drained. Open the antifreeze supply isolation valve. The CS-1 pump will supply propylene glycol/water solution from the maintenance solution supply tank. The CS-1 pump will stop running when the pressure in the section of piping is 15-20 PSI (103-138 kPa) minimum above the static water pressure. Ensure there is no trapped air in the section piping by bleeding through a vent/bleed valve. After system pressure is built, the CS-1 pump will stop running. Open system isolation valve. When system antifreeze pressure is at desired pressure and the CS-1 pump stops, then open the system shut-off valve. Any supervisory alarm switches silenced for system maintenance must be reset. The system is now in service. For Service Procedures, refer to section 4 on pg. 45.

Material Requirements

If grooved couplings are utilized in the system piping installation, “flush seal” gaskets, low temperature EPDM rubber and lube are required. Pooling of propylene glycol solution shall be eliminated. Vent valves shall be minimum ½” ball valves with ᵃ/₁₆” plug. Vent valves can double as solution test points as well. Material installed on the system shall be compatible with propylene glycol solution. A re-claim tank with adequate capacity of the largest system(s) shall be located near the system riser(s). System drain piping shall be arranged to discharge to the re-claim tank.

Gridded ESFR Cold Storage System

Please refer to all appropriate ESFR Sprinkler installation standards and AHJ codes and standards that apply to storage of Class II Commodities in rack storage including open rack design (no solid shelves). All installation criteria stated above apply to installation of the Viking ESFR Cold Storage System with grid type piping system arrangement with the following exception: Maximum system volume is 1,100 gallons (4,163 liters).

System Volume

The system capacity of a grid type piping arrangement for the cold storage system is determined by total volume of piping installed on the system to the clapper of the riser alarm valve. Grid type piping systems will be limited in area due to this requirement. The maximum system volume shall be 1,100 gallons (4,164 liters) total.

For tree system configuration, see Figure 1. For grid systems, see Figure 3.

Piping System to Sprinklers

A grid type piping system is common when using wet pipe systems. This type of system is primarily applied when using ESFR Sprinklers in high storage applications so water supply to each open sprinkler will flow from multiple directions. These systems typically have a main feed at the riser end of the system and secondary mains along the sides to multiple branch lines that all tie together to allow flow from two directions to open the sprinkler.

When applying a grid system with the Viking ESFR Cold Storage System, it is important that the system be pitched for proper drainage maintenance of the system after operation and to prevent freezing of water in the piping. Additional auxiliary drains may be required on secondary mains. The maximum system volume must be maintained and is calculated at a maximum from the alarm check valve, including all piping to the sprinklers. This is required for this system in order to expel the anti-freeze solution as quickly as possible. In a grid system, the complete system volume will be required to be expelled before 100% water flows from the open sprinklers. Therefore, the maximum volume limit of antifreeze in the system is very important.

Solution Test Valves

Multiple propylene glycol/water solution test valves are to be installed on the system piping for quarterly testing with a refractometer. The testing stated in this section is more frequent than the required test frequency indicated in NFPA 25. Solution test valves should be located in several areas of the system piping:

- The most practical location immediately downstream of the alarm check valve.
- The most remote location from the alarm check valve.
- One valve near the center of 25% of the grid line piping, (one valve every fourth line).
- A test valve on the first and last grid line.

If the propylene glycol/water solution becomes diluted or does not pass the refractometer test, the entire system is to be drained. All sections of trapped piping are to be drained. Five percent (5%) of the pendant ESFR sprinklers are to be removed and inspected for frozen solution. If any of the pendant ESFR sprinklers are found with frozen solution, all the pendant ESFR sprinklers are to be removed and replaced with new VK510 ESFR Pendant Sprinklers prior to re-charging the system with new 35% or 50% factory premix propylene glycol/water solution.

Fluid Sampling

Sampling shall be taken from multiple points within the freezer system (see paragraph below for solution test valve locations). When draining sample antifreeze solution from the system, be sure to shut off the system control valve directly upstream of the alarm check valve so water doesn’t enter the system. Anti-freeze solution shall be periodically checked with a refractometer to detect the concentration of antifreeze solution and effectiveness against freezing. Multiple propylene glycol/water solution test valves are to be installed on the system piping for quarterly testing with a refractometer. The testing stated in this section is more frequent than the required test frequency indicated in NFPA 25. Solution test valves should be located in several areas of the system piping:

- The most practical location immediately downstream of the alarm check valve.
- The most remote location from the alarm check valve.
- One valve near the center of 25% of the grid line piping, (one valve every fourth line).
- A test valve on the first and last grid line.

If the propylene glycol/water solution becomes diluted or does not pass the refractometer test, the entire system is to be drained. All sections of trapped piping are to be drained. Five percent (5%) of the pendant ESFR sprinklers in all locations throughout the freezer are to be removed and inspected for frozen solution. If any of the pendant ESFR sprinklers are found with frozen solution, all the pendant ESFR sprinklers are to be removed and replaced with new Viking VK510 Pendant ESFR Sprinklers prior to re-charging the system with new 35% or 50% factory premix propylene glycol/water solution.

4. SERVICE PROCEDURES

Drain-down of the individual system shall be done in the following manner. If system operation has occurred:
1. After system trip or sprinkler(s) have operated and water has entered the system, the complete system must be drained down immediately and solution within the piping system disposed of.

2. All sprinklers are pendent type and must be removed and replaced with new sprinklers. This is due to possible collection of water at each sprinkler and creation of a small ice plug in each sprinkler.

Taking the System Out of Service

If the system has to be taken out of service for maintenance on the system piping, follow these instructions:
1. Close the water supply control valve to the riser being serviced.
2. Close the antifreeze supply valve to the riser being serviced.
3. If the system is being serviced, then the solution in the system can be drained into clean containers or reclaim tank and reused as long as water has not entered the systems. Solution should be checked at various points while draining for proper refractometer readings to verify freeze-protection properties.
4. Open vent/bleed valves at high points of the system.
5. Open the main drain and collect solution in clean containers for re-use in system.
6. After the system is completely drained from the main drain, open any low-point drains to remove the remaining solution from the system.

Placing the System in Service

Placing the system in service after it has been completely drained:
1. Close the main drain valve on the riser.
2. Connect the propylene glycol/water solution fill pump (NOT the CS-1 pump) to the connection located on the main drain assembly.
3. Close the main drain valve, vent/bleed valves, and low-point drains if opened. Ensure there are no openings on system piping.
4. Fill system with Firefighter Eliminator C or Eliminator F propylene glycol/water solution. While filling, periodically open the vent/bleed valves on system piping to ensure air is eliminated from system piping.
5. Fill and pressurize system piping 15-20 PSI (103-138 kPa) above static water supply pressure.
6. Check for trapped air by cracking open vent/bleed valves. Ensure all trapped air is eliminated from the system.
7. After system pressure is attained, the water supply control valve can be opened.
Note 1: When using a water alarm, a strainer is required. Circuit closer vent trim may be required with an alarm pressure switch.

Note 2: Location for non-interruptible pressure switch. When water flow through the alarm valve occurs, supply to this location cannot be shut off until water flow through the alarm valve stops.

Note 3: 300 PSI (7 620 kPa) water pressure gauges are provided with trim 600 PSI (15 240 kPa) pressure gauges are available. Order separately when needed. Refer to current Viking Price Book.

Note 4: Pressure relief valve must be selected based on height position of the valve and static pressure to restrict pressure at the sprinkler to 175 PSI (1 207 kPa). The pressure relief valve shall be selected at 10 PSI (69 kPa) greater than the valve static pressure. The relief valve shall be ordered separately.

Note 5: In cold storage areas where the temperature can fluctuate, the Automatic Pressure Control System (APCS) is required to maintain a safe operating pressure below the set point of the PRV and above the normal set pressure range of the CS-1 anti-freeze pump system.

Figure 4: Model J-1 Alarm Valve Cold Trim - ESFR Cold Storage System

Replaces page 45 a-j, dated June 17, 2005
(made a correction in Table 1).