REFRIGERATED STORAGE

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1.0 SCOPE

This data sheet describes protection for cold storages in refrigerated warehouses. It is primarily concerned with food storage. However, most recommendations are applicable to coolers and freezers used to store other commodities such as pharmaceuticals.

1.1 Changes

May 2007. Editorial changes were made to this document.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Introduction

A wide variety of food products, wrapped or unwrapped, may be stored in a single warehouse, depending on the season of the year and the abundance of certain types of food. ***This may cause the occupancy to vary in combustibility***. In contrast, warehouses associated with processing facilities generally have a stable inventory of items.

When evaluating protection criteria, assume that a warehouse will at times contain combustible materials, unless it is known to be engaged for year-round storage of a noncombustible products not requiring combustible wrapping or supports.

Combustible materials in cold-storage warehouses include: some types of food, wood dunnage, wood pallets, wood boxes containing food, fiberboard food containers, wooden baskets, polystyrene egg cartons, waxed paper, heavy paper wrappings, cloth wrappings, and grease or grease-impregnated materials. Housekeeping is generally good.

2.2 Construction and Location

2.2.1 Use noncombustible or FM Approved (See Appendix A for definition) building materials.

2.2.2 Ensure mechanical refrigeration systems are in accordance with Data Sheet 7-13, *Mechanical Refrigeration*.

2.2.3 Protect plastic insulation (typically expanded polyurethane and polystyrene insulations) in accordance with Data Sheet 1-57, *Plastic Building Materials in Construction.* For insulation protection, dry-pipe sprinkler systems do not exceed 500 gal (1993 L) in volume, and the system is equipped with a quick- opening device as outlined in Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*. Do not use dry-pipe systems with expanded or extruded polystyrene (EPS) materials. When EPS materials are found in the walls ***or*** ceiling have them replaced or covered with a thermal barrier per Data Sheet 1-57.

2.2.4 When cork or other cellulosic insulations are used, the automatic sprinkler protection provided for the occupancy also will protect the insulation. If no sprinklers are needed for the occupancy, install them for the insulation as follows:

1. When insulation that is not FM Approved for use without automatic sprinklers is provided on the walls and ceiling, or just on the ceiling, ensure the sprinkler system provides a minimum of 0.20 gpm/ft^2 (8 mm/min) over an area of 2000 ft^2 (190 m^2). If walls are more than 30 ft (9.2 m) high, provide an intermediate row of sprinklers near the vertical midpoint of the wall; space sprinklers 10 ft (3.1 m) apart, and design them to maintain a minimum flow of 20 gpm (76 L/min) for the 10 most hydraulically remote heads on each line of sprinklers simultaneously. For insulation protection, ensure dry-pipe sprinkler systems do not exceed 500 gal (1993 L) in volume and the system is equipped with a quick-opening device as outlined in Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*.

2. Where insulation that is not FM Approved for use without automatic sprinklers is on the walls only (noncombustible or Class 1 ceiling/roof), provide a horizontal line of sprinklers along the perimeter of the ceiling/roof located 2 ft (0.60 m) from each wall. Space sprinklers 10 ft (3.1 m) apart, and design them to maintain a minimum flow of 20 gpm (76 L/min) for the 10 most hydraulically remote heads. If walls are more than 30 ft (9.2 m) high, provide an intermediate line of sprinklers near the vertical midpoint of the wall. Space sprinklers 10 ft (3.1 m) apart, and design them to maintain a minimum flow of 20 gpm (76 L/min) for the 10 most hydraulically remote heads on each line of sprinklers simultaneously. This also applies to FM Approved ‘‘sandwich’’ panels, which do not normally need sprinkler protection, but which are used on walls exceeding 30 ft (9.2 m) in height. For insulation protection, ensure dry-pipe sprinkler systems do not exceed

500 gal (1993 L) in volume and the system is equipped with a quick-opening device as outlined in Data Sheet 2-0.

2.3 Protection

2.3.1 General

2.3.1.1 Ensure refrigerated storage has the same protection as comparable combustible storage. Room-flooding carbon dioxide or high-expansion foam systems are not acceptable alternatives to automatic sprinklers.

2.3.1.2 Have sprinkler systems in cold-storage areas fabricated so an inspection can be easily made and the system disassembled to remove ice plugs. Keep the systems small. If possible, two small systems are preferable to one large system.

2.3.1.3 Small, walk-in freezers may be protected by up to 20 dry pendent sprinklers supplied from an overhead wet-pipe sprinkler system. Base water demand on the use of a wet-pipe sprinkler system. Extend the piping for dry pendent sprinklers at least 12 in. (0.3 m) above the top of the freezer ceiling before connecting to the wet-pipe system to prevent possible freezing.

This arrangement can cause ‘‘sweating’’ of the portion of the dry pendent sprinkler above the roof, with resultant corrosion of the metal roof surface. If this problem exists, do the following: tightly caulk the hole cut in the roof and wrap thermal mastic tape (or equivalent) around the dry pendent sprinkler nipple above the roof.

2.3.1.4 In coolers and chill rooms, sprinkler systems may be either preaction or dry-pipe sprinkler systems.

1. For preaction systems, base water demand on the use of a wet-pipe sprinkler system when the type of detectors used and the detector spacing allows the preaction system to be qualified for wet-pipe demand per Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*; otherwise, base water demand on the use of a dry-pipe sprinkler system.

2. For dry-type sprinkler systems, always base water demand on the use of a dry-pipe sprinkler system.

2.3.1.5 In freezers, holding rooms, or sharp freezers, use only FM Approved refrigerated area systems. Base water demand for these systems on the use of a dry-pipe sprinkler system, regardless of detector spacing. (See Figs. 1 and 2.)

2.3.2 Sprinkler System Actuation

2.3.2.1 *Refrigerated Area Systems.* Ensure air for the sprinkler piping is taken through an adequately sized dehydrator, regenerative air drier or FM Approved dry air unit system for refrigerated storage. When the detection portion of the refrigerated area system is pneumatic, provide an air supply independent from that of the sprinkler piping.

2.3.2.2 *Dry-Pipe Systems*. Ensure dry-pipe sprinkler systems are pressurized and equipped as described in Data Sheet 2-0. Ensure air is taken through an adequately sized dehydrator. Ensure air pressure above the dry-pipe valve does not exceed that recommended by the manufacturer.

2.3.2.3 *Preaction Systems*. Use FM Approved preaction sprinkler systems. Ensure air for the sprinkler piping is taken through an adequately sized dehydrator.

2.3.3 Fire Detection for Preaction and Refrigerated Area Systems

2.3.3.1 *Detection Devices.* Ensure detection devices for electric, as well as pneumatic, detection systems are of fixed temperature on single-zone class A circuitry. Ensure they have a temperature rating less than that of the sprinklers and as low as possible for the given ambient conditions. Do not use pilot sprinklers as fire detectors. Do not use rate-of-rise type detectors because of false trips when doors are opened or other abrupt local temperature changes occur.

2.3.3.2 *Detector Location.* Locate detectors as follows:

1. *Ceiling Sprinklers Only.*

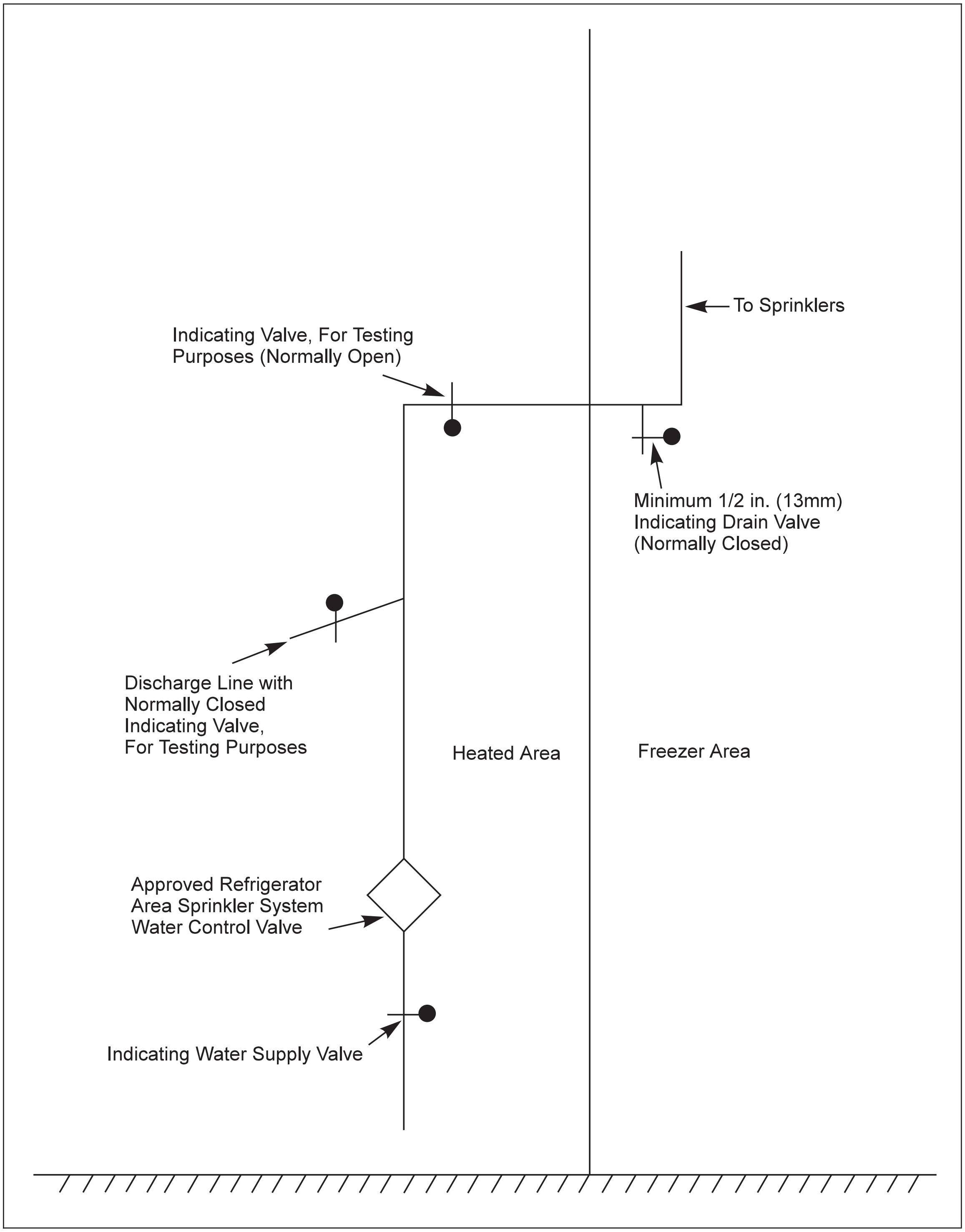

Fig. 1. Arrangement of a refrigerated area system that uses one water control valve

For preaction systems: locate detectors per Data Sheet 2-0. Under smooth ceilings, locate detectors at the ceiling on a spacing not exceeding the listed spacing for the detector. For other than smooth ceilings, space heat detectors not more than one-half of the listed linear detector spacing or the full allowable sprinkler spacing, whichever is greater. Example: for a detector listed for 30 × 30 ft (10 x 10 m), one-half of the listed spacing is 15 × 15 ft (5 x 5 m).

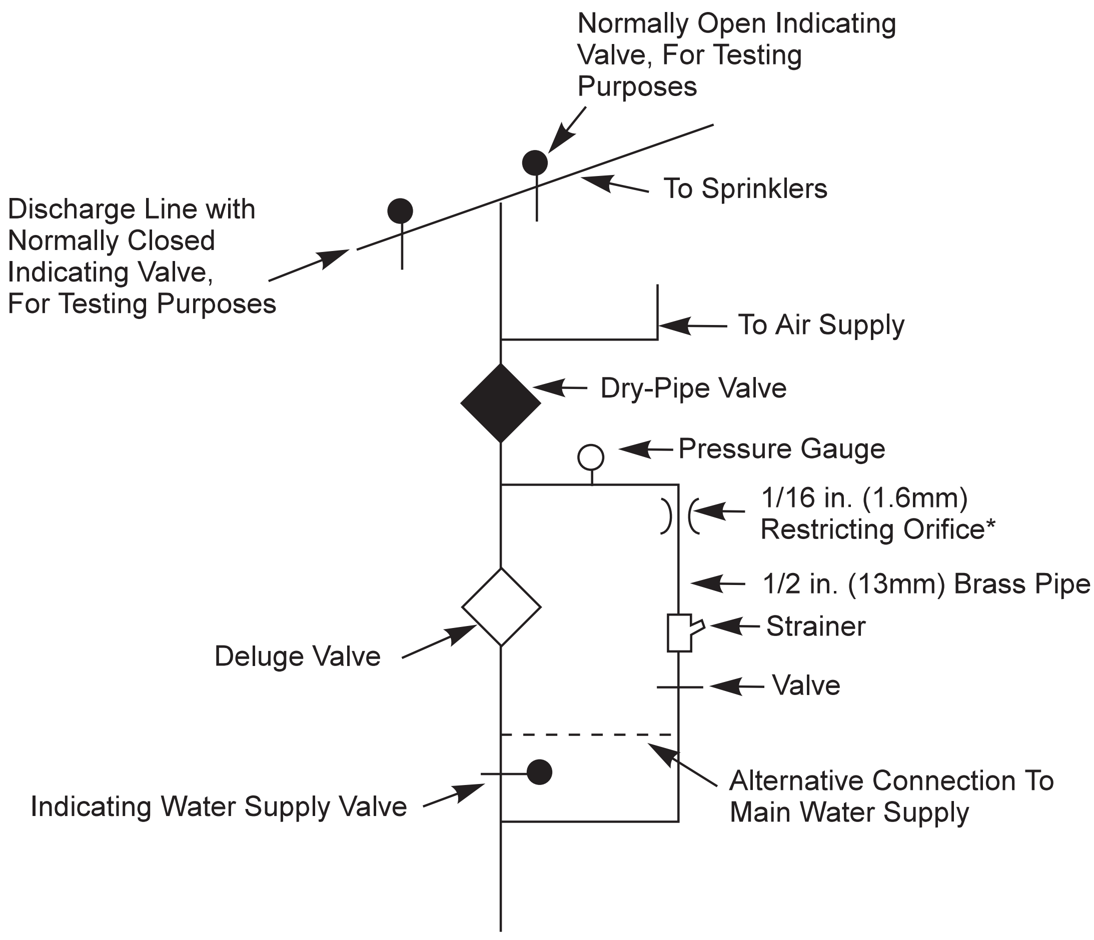

Fig. 2. Arrangement of system using a combination of a deluge valve and a dry-pipe valve. Not FM Approved. (Shown for existing systems only.)

For refrigerated area systems: locate detectors at the ceiling on a spacing not exceeding the allowable spacing for the detector listing in the *Approval Guide*.

2. *Ceiling and In-Rack Sprinklers*. Locate detectors at the ceiling as recommended previously. Locate detectors in the rack flues at the same vertical and horizontal spacing as in-rack sprinklers, and in accordance with the following guidelines:

- For single-row and double-row racks, only one line of detectors is needed at each in-rack sprinkler level. Locate these detectors in the transverse flue in single-row racks, and in the longitudinal flue in double-row racks.
- For multiple-row racks, one line of detectors is needed for each in-rack sprinkler line at each in-rack sprinkler level. Locate these detectors in either the transverse or longitudinal flues.

2.3.3.3 Separate heat actuated devices (HADs) are normally needed for ceiling and in-rack sprinkler systems in refrigerated areas. However, in-rack HADs are not needed when FM Approved refrigerated area systems are used and all the following conditions are met:

- Maximum storage height is 35 ft (10.7 m).
- Maximum building height is 40 ft (12.2 m).

- Maximum hazard of storage is Class III.
- No solid shelves are present.
- In-rack and ceiling sprinklers are installed per Data Sheet 8-9 with respect to all facets of design.
- One refrigerated area sprinkler system is used for both ceiling and in-rack sprinklers, with separate, accessible indicating control valves provided downstream of the refrigerated area system for ceiling and in-rack sprinkler systems. This will allow detectors to activate both systems, while allowing separate control to be maintained.
- Electric HADs or heat detection wire at the ceiling are spaced at a maximum of one-half the listed detector spacing, but not less than the sprinkler spacing. If pilot sprinklers are used for detection, they should be spaced at 10 by 10 ft (3.1 by 3.1 m) maximum. For other than smooth ceilings or steel deck on open joists, detector spacings may need to be adjusted downward to compensate for the presence of beams, girders, channels, etc.
- No gridded piping systems are used for ceiling or in-rack sprinkler systems.
- Maximum water delivery time to both ceiling and in-rack sprinklers is one minute after the refrigerated area system valve trips, as verified by acceptance tests.

2.3.3.4 *Fire Alarm Control Panels.* For reliability, use one control panel for each sprinkler system. Do not use one control panel to activate multiple systems.

2.3.4 Sprinkler Piping

2.3.4.1 Arrange feedmains, riser, and cross main fittings as described in Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers,* under ''Cold Storage Rooms.'' Design the system with fittings located to facilitate inspection and disassembly to remove ice plugs.

2.3.4.2 When flexible couplings are used, ensure they are FM Approved. Obtain the manufacturer's name and product designation. Proper gaskets are FM Approved for a range of temperatures from -40° to 225°F (-40° to 107°C) as part of the unit. Use only gaskets that are FM Approved and recommended by the manufacturer for use in dry systems.

2.3.4.3 Ensure piping is properly pitched. Pipe pitch should be at least ½ in. for every 10 ft (4 mm/m) in branch lines, cross and feedmains, and piping in rack sprinkler systems.

2.3.4.4 Ensure in-rack sprinkler systems have valves and alarms separate from ceiling systems.

2.3.4.5 Ensure in-rack sprinkler piping has a degree of flexibility to avoid breakage caused by rack movement. Do not use cast iron fittings.

2.3.4.6 Provide each sprinkler system with a 2 in. (50 mm) diameter test discharge line located a few pipe diameters above (downstream) the sprinkler system valve assembly. Equip the trip test discharge line with a normally closed indicating valve.

2.3.4.7 Ensure each sprinkler system has a normally open trip test cut-off valve installed on the system riser above (downstream) the intake for the trip test discharge line.

2.3.4.8 Have sprinkler piping follow a tree or looped arrangement. Do not use gridded systems.

2.3.5 Prevention of Ice Plugs

2.3.5.1 Check all existing refrigerated sprinkler systems for ice plugs that form from frost accumulation. (see Figs. 3 and 4).

2.3.5.2 For new refrigerated systems, and if ice plugs are found in existing systems, implement the following recommendations to avoid formation of ice plugs.

1. Use an FM Approved air supply package for freezers; alternatively, use a regenerative air dryer to dehumidify the compressed air supplied to the sprinkler system so its pressure dew point is 20°F (11.1°C) lower than the nominal freezer temperature. This will result in about 30% relative humidity for the compressed air within the freezer sprinkler system. In addition to providing a safety factor, this requirement will result in a slow drying out of any ice accumulations already in the pipes.

Fig. 3. Ice plug inside elbow

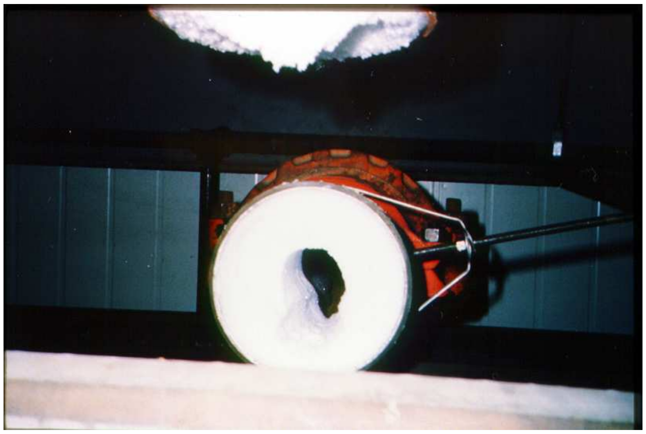

Fig. 4. Ice plug inside feedmain

Fig. 4a. Ice plug on feedmain removed from the freezer.

2. Ensure air intake for compressed air is taken directly from the freezer with the lowest temperature. FM Approved air supply packages can use air intake at room temperature provided the system has been tested with air intake at room temperature and the pressure dew point recommended above is met.

3. Feed the compressed air into the sprinkler pipes in the freezer through separate duplex lines that can be easily removed for inspection and removal of ice accumulations. Eliminate the compressed air input just above the deluge valve. (Fig. 5.) This recommendation ensures the compressed air is fully chilled to the freezer temperature and has deposited all its frost before it enters the sprinkler water line.

Exception: Compressed air can still be fed just above deluge valves after being routed inside the freezer as recommended above when: (1) there is no water accumulating above the system valves or (2) the connection is made just above the additional check valve recommended in item 4 below. When the air supply is connected above the system deluge valve, install a check valve on the air supply line, at the point of connection to the riser, to prevent water from entering the air lines during system testing or operation.

4. Install an additional check valve (with a 3/32 inch (2.4 mm) bleed hole in it) between the Refrigerated Area System valve assembly (which includes a rubber faced check valve in some systems) and the discharge line with a normally closed check valve. This additional valve will help block moisture migration coming from either the priming water pool located on top of the Refrigerated Area System or from water collected above the refrigerated area valve assembly after trip test activities.

(See Fig. 6.)

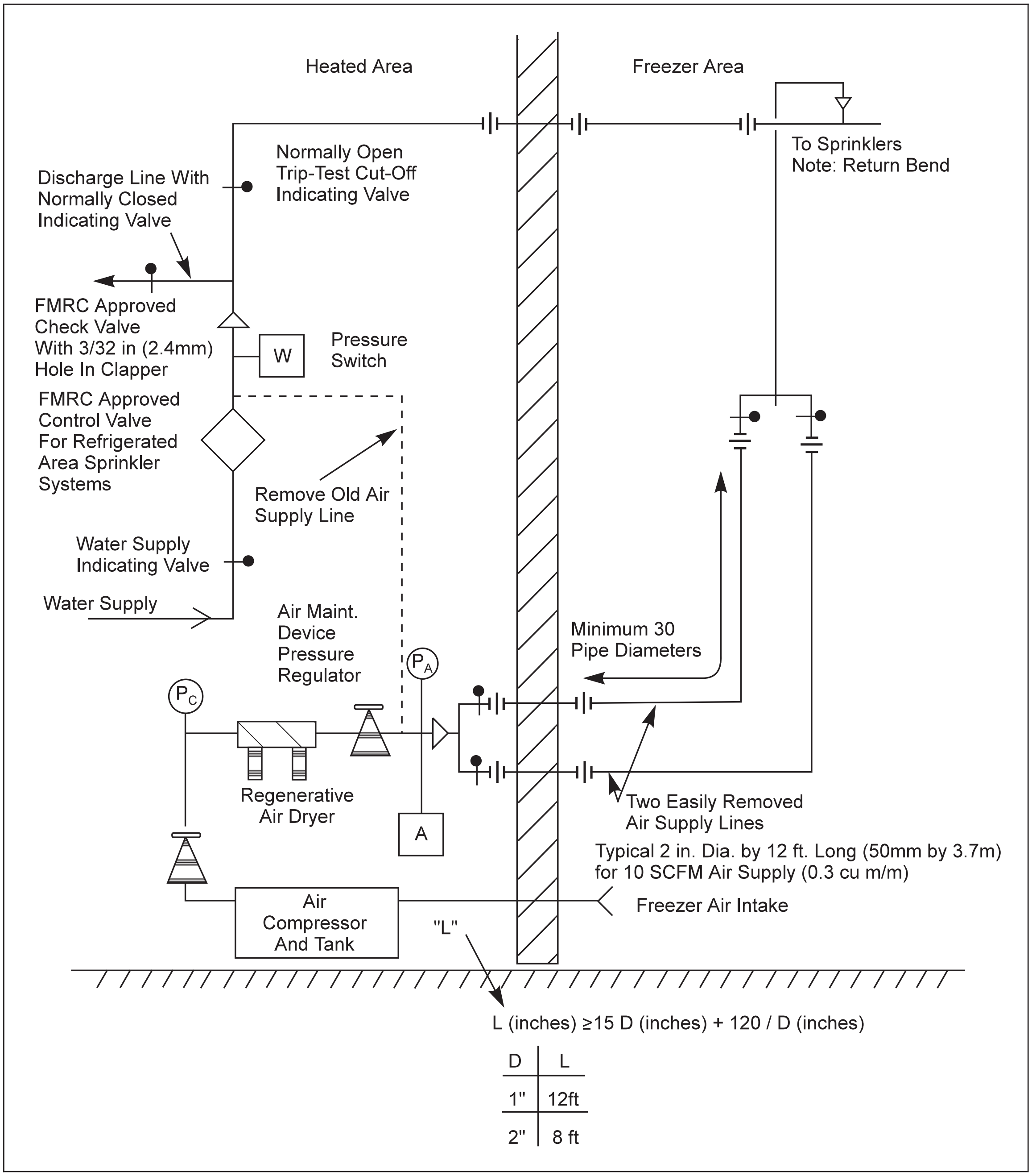

Fig. 5. Modification of refrigerator area sprinkler systems to avoid ice plugs.

1. The compressor should draw air from the freezer because of its much lower humidity.
2. Any frost deposit in the removable air supply line(s) implies a malfunctioning air dryer.
3. Each removable air line should have an exterior surface area in freezer of at least 0.7 ft^2 (0.06m^2) per scfm (28 l/min) air supply.
4. If either pressure switch W or A reads high while the other reads low, it means the system is malfunctioning.

Install an additional check valve (with a 3⁄32 in. [2.4 mm] bleed hole in it) between Refrigerated Area System assembly (including its rubber faced check valve) and discharge line with normally closed indicating valve to block moisture migration coming from the: 1) priming pool sitting on top of Refrigerated Area System, and 2) trip-test activities. This recommendation allows for continued use of existing Refrigerated Area control valve assemblies. The check valve contained in the existing Refrigerated Area Assemblies is still needed because the Refrigerated Area control valve sitting below it does not hold air pressure.

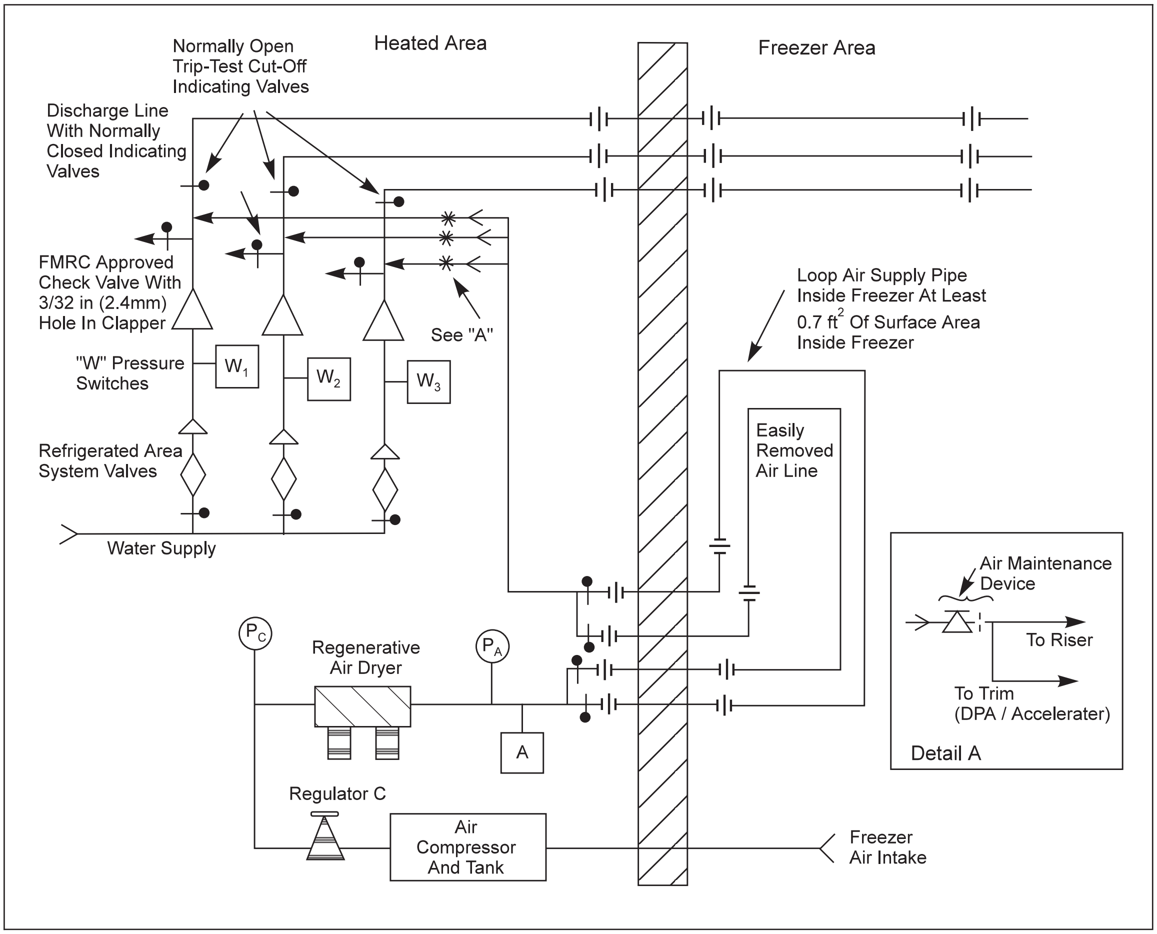

Fig. 6. An arrangement that minimizes compressor cycling and the number of wall penetrations for multiple systems

Notes:

1. Pressure switch A turns on when P_A drops below the lowest allowed system air pressure, P_L, and remains on until P_A exceeds the highest allowed system air pressure, P_H, at which time it turns off.

2. Both air dryer and compressor (or solenoid) are powered when pressure switch A is on.

3. If any pressure switch W_i or A reads high while the other reads low, it means that the system is malfunctioning.

4. Pressure regulator P_{HH} prevents excessive sprinkler system pressure. P_{HH} set higher than P_H.

5. Pressure regulator C needed for setting air dryer operating conditions.

2.3.6 Portable Fire Extinguishers

2.3.6.1 Provide suitable portable fire extinguishing equipment for cold-storage areas.

2.4 Operation and Maintenance

2.4.1 Procedures Following Fire or False Trip

2.4.1.1 Whenever fire protection is out of service, take suitable precautions as outlined in Data Sheet 2-81, *Fire Safety Inspections and Sprinkler System Maintenance.*

2.4.1.2 In freezers, holding rooms, or sharp freezers, the formation of ice plugs will occur when water enters sections of piping where no sprinklers are opened during a fire. Therefore, an inspection for ice plugs is necessary after such an occurrence. Inspect each branch line and cross main to ascertain whether ice has formed.

2.4.1.3 If ice plugs have formed, disassemble the entire system and move it to a warm area for thawing, unless the area can be isolated by partitions and heated.

2.4.1.4 Do not use electric welding machines or open torches to thaw frozen sprinkler pipe in place, due to the potential fire hazard.

2.4.2 Testing Sprinkler Systems

2.4.2.1 Make trip tests of dry-pipe valves, preaction systems, refrigerated area systems, and associated equipment annually.

2.4.2.2 During such tests, ensure dry-pipe system and refrigerated area system piping in heated areas are arranged to keep water from entering the system. Close the trip test cut off valve on the system riser, and open the indicating valve on the discharge test line. Immediately following the test, return the system to normal position. Use FM Global's Red Tag permit system when the trip test cut off valve is closed, and follow the precautions of fire protection out of service outlined in Data Sheet 2-81.

2.4.3 Ice Build-Up on Structural Members

2.4.3.1 Remove ice build-up on the ceiling, structural members above or below the ceiling or on rack members to reduce the possibility of collapse.

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 Issues in Refrigerated Warehouse Loss Prevention

3.1.1 Ice Plugs

Recommendations for preventing ice plugs are not particularly costly considering the severity of the problem. Cost of implementing the recommendations varies for different systems and averages from US$7,000 to US$10,000. If an FM Approved air package is not used, compressor and regenerative air drier design and installation should be done by a contractor who is familiar with freezer systems to minimize problems associated with the engineering of the system.

It is important that freezer sprinkler systems have a trip-test cut-off valve (Fig. 5) to reduce the chance of water entering the system, and to eliminate the long time delays involved in re-pressurizing the system when performing the annual system trip test. Such delays can invite the bypassing of the air dryer, defeating the frost-control provisions.

Both valves in one of the duplex air lines should be closed while air is passed through the other air line. If an ice plug forms in the air line in use, the valves in the other air line should be opened to place it in service. The plugged air line should be disassembled and thawed, then re-assembled and placed in stand-by (both valves closed).

The air supply to the system should be as dry as possible. The drying equipment should be capable of providing air with a dew point 20°F (11.1°C) lower than the coldest freezer temperature. This will require a desiccant type regenerative air dryer in most cases. These units are commonly available with dewpoint ratings of -40°F (-40°C) and can be purchased with ratings of -100°F (-73°C). These units require little maintenance but each should be confirmed to be operating. Power should be on to the unit and the desiccant should show no sign of discoloring. If it shows signs of discoloration, the desired dewpoint is not being achieved.

There should be no pool of priming water exposed to the air inside the sprinkler piping. Unless it is blocked by a check valve this water will evaporate, migrate toward the area of cold temperature and condense in the piping.

Where the air supply to the sprinkler piping passes near the priming water, the air supply inlet must be rearranged to introduce the air well away from the water.

One means of reducing moisture levels in freezer piping systems is by drawing the air supply for the compressor from the freezer of lowest temperature. While this is better than drawing the air from the room or outside where moisture levels are higher, it still exposes the system to ice plug formation. The following is a brief explanation of how this arrangement can allow ice plugs to form.

Inside the freezer, the frost accumulations on the structure and the contents are in equilibrium with the moisture in the air. In other words, the relative humidity of the freezer air is 100%. The moisture content of the air is low (in parts per million) but it is at the maximum that can exist at this temperature, 100% relative humidity (Fig. 7). At this equilibrium the dewpoint of the air equals the temperature of the air. Any increase in the moisture content or decrease in the temperature will result in condensation to achieve equilibrium at the new conditions.

Compressing air also raises the vapor pressure of the moisture present in it. Raising the vapor pressure raises the dewpoint. When the dewpoint exceeds the air temperature, condensation occurs (Fig. 8).

As shown in Figure 9, when the air drawn from the freezer is compressed to 100 psig (6.9 bar) and raised to room temperature of 80°F (26.7°C), the moisture content remains the same (in PPM) because no moisture is added or removed. However, the compressing and changing of the temperature lowers the relative humidity to 9.5% and raises the dewpoint to 19.1°F (-7.2°C). If this air were fed back into the sprinkler pipes without further drying, condensation would occur on the low temperature pipes until the conditions again were in equilibrium, and the dewpoint matched the freezer temperature. Thus, an ice plug has formed. It forms in the transition zone from hot to cold, as this is where the moisture first reaches the cold temperature and attempts to reach equilibrium. Insulating the piping would have little effect on the frost formation other than changing the location where the cold temperature is first encountered and thereby relocating the ice plug. If a system has a leakage rate of 3 ft^3/min 0.084 m^3/min over the course of a year, a -10°F (-23°C) freezer will accumulate 34 lbs (15 kg) of frost from the compressed air supply alone if the air is drawn from the freezer without further drying.

If the air dryer is installed after the compressor described above, the moisture content (in PPM) is lowered. The desired result is that the air entering the freezer pipes has a dewpoint less than the freezer temperature. To achieve a reasonable safety factor it is recommended that a dewpoint 20°F (11.1°C) lower than the freezer temperature be chosen. This results in 30% relative humidity of the air at the temperature of the freezer.

The increase in vapor pressure during compression also is important in understanding the operation of the air dryers. The desiccant in these dryers operates more efficiently at the high vapor pressures. It is, therefore, important that the pressure be maintained on the dryers at all times during operation, and that wide variations in pressure be avoided. For example, the restricting orifice present in the pressure maintenance device on a sprinkler system may help to maintain the pressure on the dryer during normal operation, but when the system is refilled through the bypass line after having bled the system pressure down to atmospheric, a demand may be created that exceeds compressor capacity and the pressure on the air dryer may drop to very low levels. At this pressure, the efficiency of the dryer is considerably reduced and the desired dewpoint is likely not being achieved.

Regenerative air dryers operate using two desiccant columns (commonly referred to as twin tower dryers). Air is passed through one column drying it. After it is dried a small amount of the dried air (about 15% of the unit's rated capacity) is directed through the second tower in the reverse direction to dry the desiccant. The amount of air flow to the idle column is controlled by a restricting orifice and pressure regulator on the air dryer. If the regulator is set to maintain a higher pressure, more airflow is directed to the idle tower and the result is drier air. There is a timer that alternates the columns approximately every 2-½ minutes. When observed in operation the pressure gauge for the idle tower will read zero while it is regenerating and the tower in use will read normal operating pressure. When the timer switches between columns a short burst of compressed air will be heard.

If the air dryer is set up to run continuously the air demand it creates will cause frequent cycling of the compressor leading to possible compressor problems. As long as the ft^3/min (m^3/min) rating of the air dryer exceeds the ft^3/min (m^3/min) rating of the compressor, the dryer should be achieving sufficient purge time if the power to it is arranged to operate the dryer only when the compressor is running. This will reduce the cycling frequency of the compressor to just satisfy the demand of the dryer.

To avoid impairments caused by ice plugs in refrigerated area systems it is important that both new and existing systems be carefully evaluated to detect ice plugs, and to make appropriate recommendations to prevent their formation. At the earliest convenience and at lest annually thereafter all systems should be visually examined internally at the point where the sprinkler piping first enters the freezer space to determine that it is clear. Recommendations should be made for the installation of regenerative air dryers capable of reducing the pressure dewpoint to at least 20°F (-6.7°C) below the lowest freezer temperature. Existing regenerative air dryers should be checked for proper operation and for discolored desiccant. Bypass valves around the air dryers should be sealed closed.

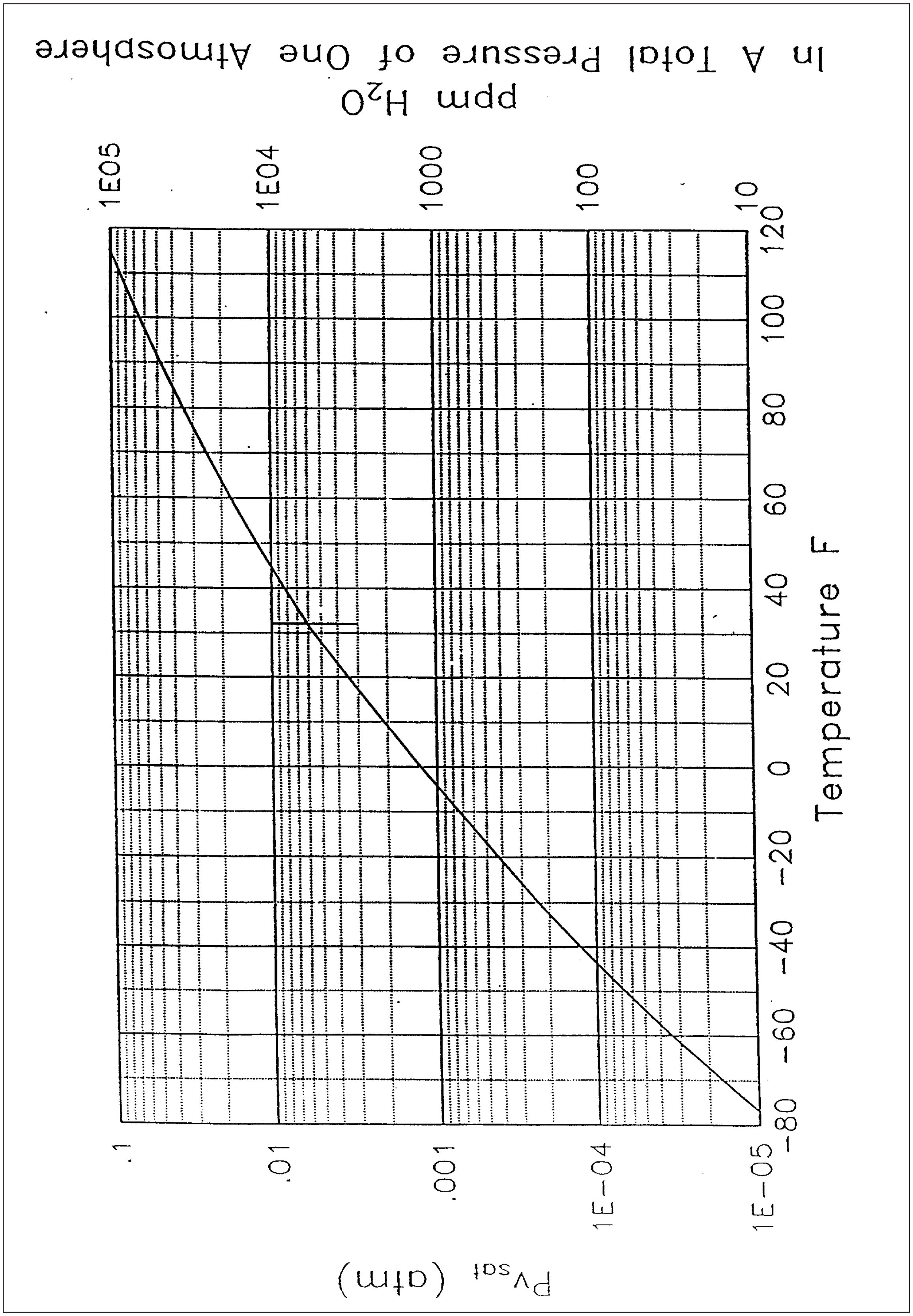

Fig. 7. Saturation vapor pressure of ice/water.

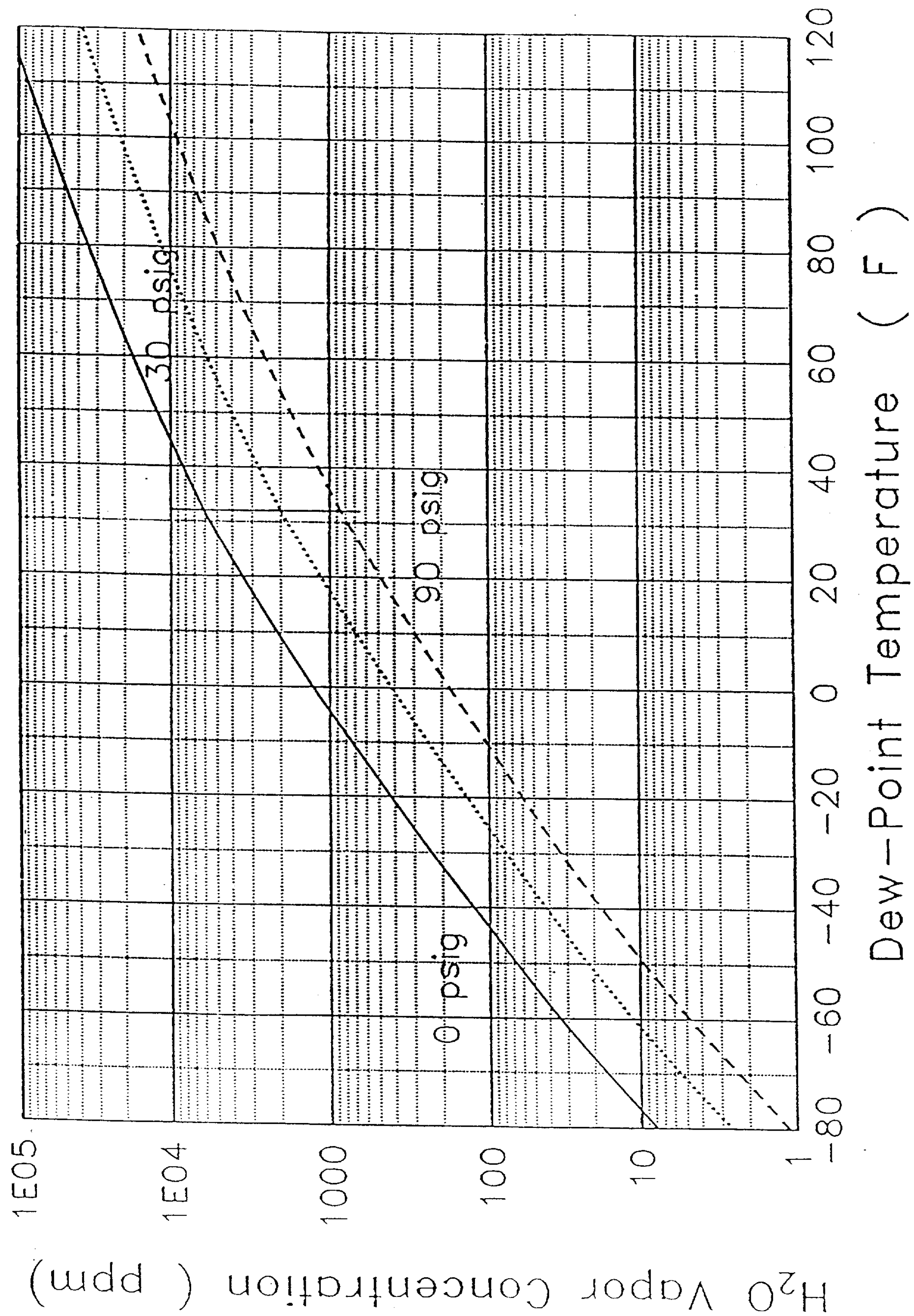

Fig. 8. Water concentration vs. dewpoint

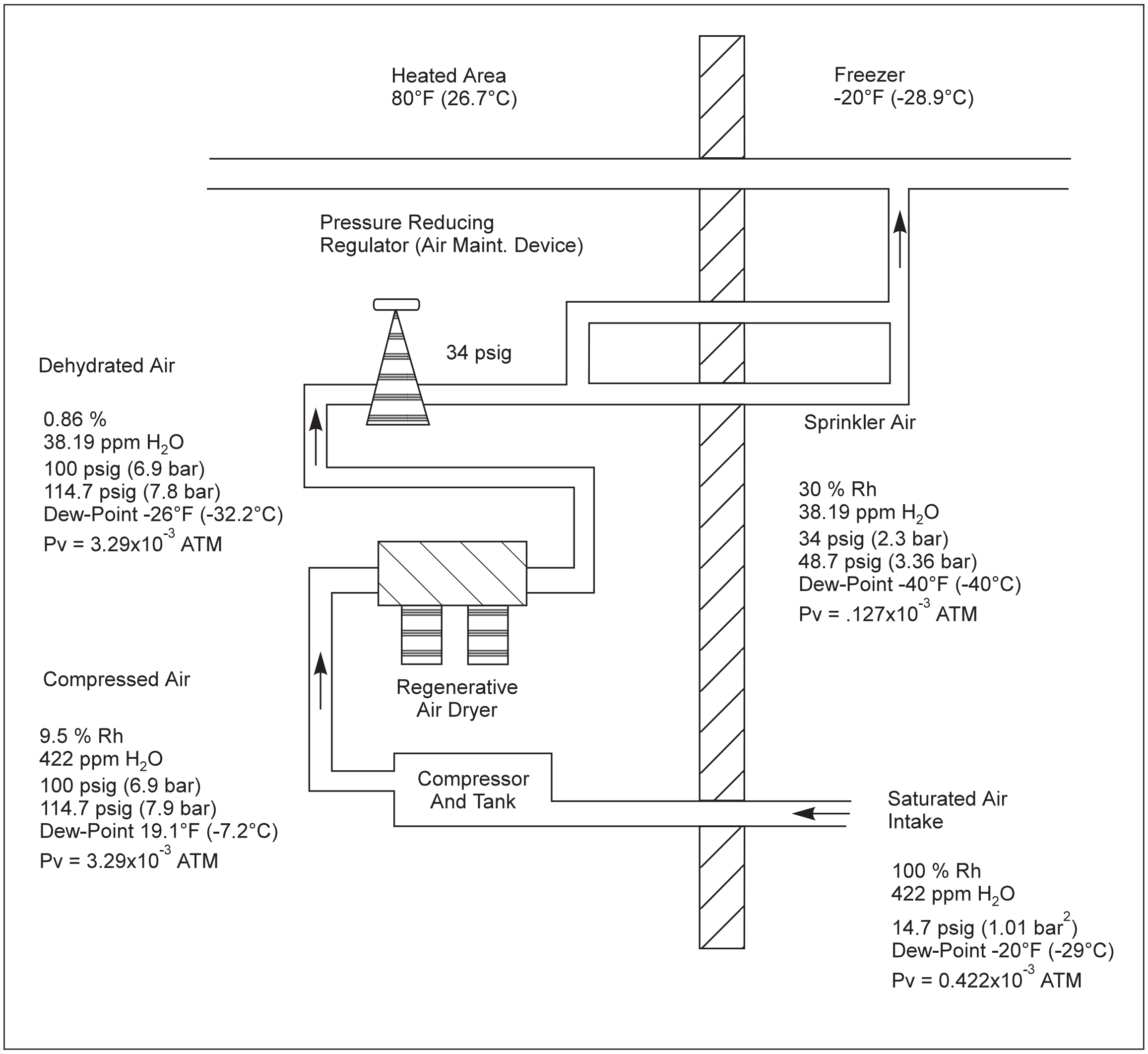

Fig. 9. Sample humidity calculation

If in subsequent investigations ice plugs continue to be found, the source of the moisture should be determined and corrected.

3.1.1.1 Locating Ice Plugs

Ice plugs can form rapidly inside piping systems in freezers unless proper precautions are taken to prevent them. When warm air enters the freezer and rapidly cools, moisture present in the air condenses and accumulates in the interior of the piping. As the accumulation becomes larger, it can fill the entire section of the pipe preventing water flow. Field examinations of existing freezers have shown ice plugs in over 50% of the freezers examined. The ice plugs are generally found in the feedmain inside the freezer, at a distance of 10 to 15 ft (3 to 5 m) from the point where the pipe enters the freezer. Due to the tendency of moisture to migrate to the coldest part of the system, it also is possible to have frost accumulation near the evaporator coils, where the pipes may reach the coldest temperatures.

Data collected during inspections indicates ice is more likely to form in sprinkler systems that are not air tight and in in-rack sprinkler systems.

If a system has been flooded with water, such as during a test or false trip, potential for ice plugs exists in any area and any piping, but is most likely in low points and in undrained areas.

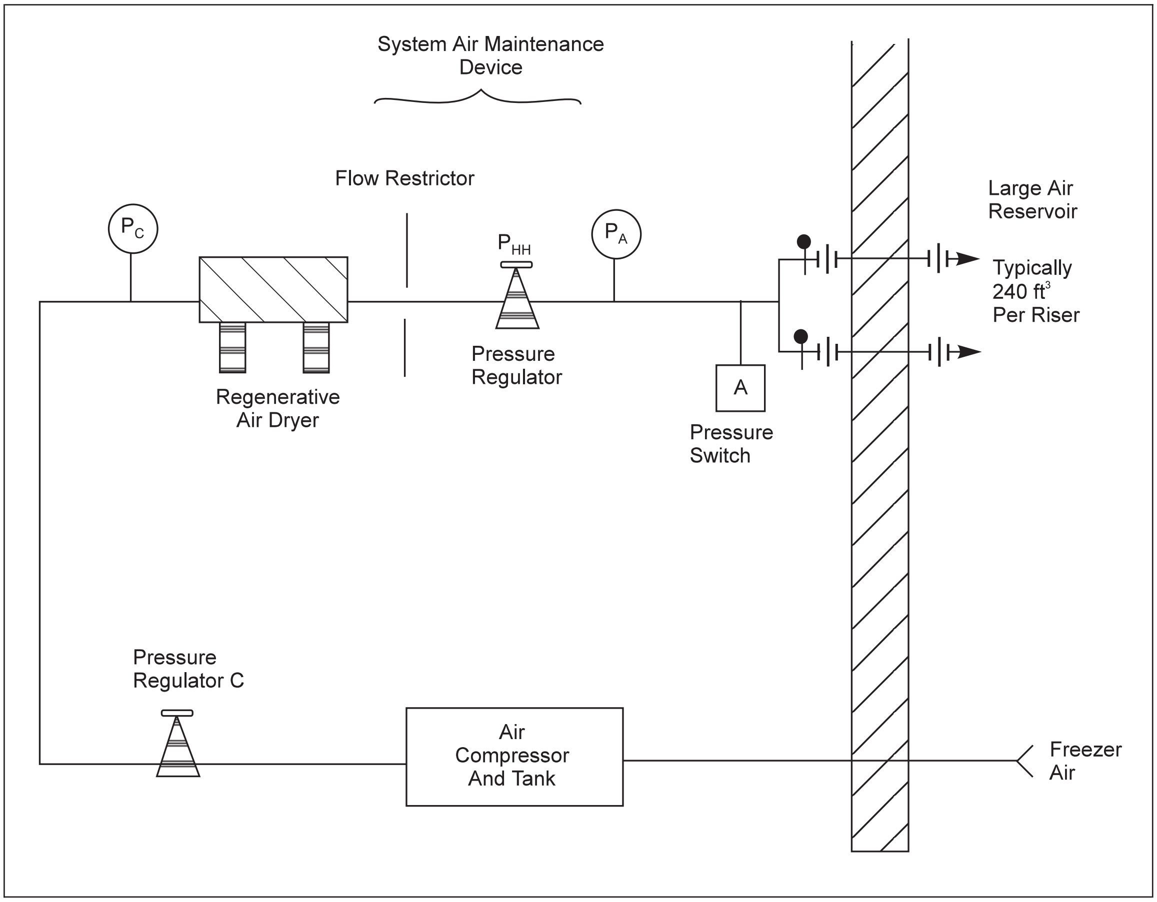

Fig. 10. Air supply to minimize cycling and conserve energy

Notes:

1. Pressure switch A turns on when P_A drops below the lowest allowed system air pressure, P_L, and remains on until P_A exceeds the highest allowed system air pressure, P_H, at which time it turns off.
2. Both air dryer and compressor are powered when pressure switch A is on.
3. Flow restrictor (if not provided with air dryer) is needed to prevent excessive flow through air dryer.
4. Pressure regulator P_{HH} prevents excessive sprinkler system pressure. P_{HH} set higher than P_H-
5. Pressure regulator C needed for setting and maintaining proper air dryer operating conditions.

To locate ice plugs, the traditional method has been to disassemble the piping and visually inspect for internal ice formation. The piping also can be inspected using ultrasound technology without the need for disassembling the piping system. This method is both accurate and efficient.

3.1.1.2 Removal of Ice Plugs

To remove ice plugs, piping should be disassembled and brought to a warm area to thaw. If ice plugs are small they can be broken up by hammering and then removed from the pipe. Some contractors have successfully used steam or hot water to remove ice without removing the pipe; with the sprinkler system depressurized, a hose is introduced into the piping; steam or hot water is fed into the frozen pipe and thaws the ice ahead of it. The water and thawed ice discharges through the open end of the pipe where the hose is inserted. Care must be taken to ensure all ice is removed and no blockages or blocked branches remain.

The use of torches, welders, or other electrical resistance heating methods should be prohibited due to the ignition source they represent.

3.1.1.3 Arrangement of Compressor and Dryer to Reduce System Cycling

Typical regenerative air dryers continuously release to atmosphere 15% of their rated air capacity, even when they provide no output flow. This can waste energy and result in excessive compressor cycling when there is minimal demand for air. The problem can be particularly annoying after having made a special effort to eliminate air leaks.

The system shown in Figures 5 and 10 eliminates the problem by taking advantage of the large air storage volume of a refrigerated area sprinkler system (typically 240 ft^3 [6.7 m^3] per riser) to increase the cycle time. Both the regenerative air dryer and compressor are periodically turned off by the pressure switches. While they are off the sprinkler system pressure, P, slowly decreases due to sprinkler system air leaks. The air dryer and compressed air supply are turned on and operated at full rated capacity when the pressure, P, drops below some preset minimum pressure, P_L. The air supply system then continues to operate until the pressure, P, exceeds some preset maximum P_H.

For example, if the cycle amplitude (i.e., pressure difference) $P_H - P_L$ is set at 5 psi (.34 bar) (1/3 atmosphere), then a low leakage rate of 1 ft^3/m (0.028 m^3) per riser will allow the air supply system to remain off for typically

$$\left(\frac{240 \text{ ft}^3}{1 \, \mathit{ft}^3/\mathit{ATM}/\text{min}} \right) (1/3 \, \mathit{ATM}) = 80 \, \mathit{minutes\ (off)}$$

$$\left(\frac{6720 \text{ l}}{28 \, \mathit{l/ATM}/\text{min}} \right) (1/3 \, \mathit{ATM}) = 80 \, \mathit{minutes\ (off)}$$

Subsequently, if the compressor/air dryer air supply system provides 5 ft^3/m (140 l/m) per riser (above the leakage rate at the rated capacity) then they will remain on for typically

$$\left(\frac{240 \text{ ft}^3}{5 \, \mathit{ft}^3/\mathit{ATM}/\text{min}} \right) (1/3 \, \mathit{ATM}) = 16 \, \mathit{minutes\ (on)}$$

$$\left(\frac{6720 \text{ l}}{140 \, \mathit{l/ATM}/\text{min}} \right) (1/3 \, \mathit{ATM}) = 16 \, \mathit{minutes\ (on)}$$

while the system pressure is being restored. The long total cycle time of this example is quite attractive, and it minimizes energy waste by only operating the compressor and air dryer at their full rated capacity.

During normal system operation the air supply pressure will be equal to the pressure on top of the refrigerated area control valve (plus a small pressure drop across the check valves in the freezer). When the system functions correctly, both the air and water pipe pressures will be above their common safety alarm setpoint, so that both switches A and W are high.

The pressure switch W will go low during the annual trip test when the trip-test cut-off valve is closed and the drain line is opened. Upon restoring service, if W does not go high (while A remains high), then there is a serious blockage somewhere in the loop (blocked bleed hole, closed cut-off valve, blocked water line, and/or blocked air supply line) and there should be an alarm.

During normal operation the compressor and air dryer are cycled by a separate pressure switch (located near A) to maintain the pressure above the safety alarm setpoint. If for some reason pressure drops below the setpoint and A goes low, then (1) the compressor has failed, (2) there is a leak somewhere upstream of (one of) the **check** valve(s) in the freezer, and/or (3) there is a sizeable leak in (one of) the dry-pipe freezer systems; and there should be an alarm.

The safety alarm in the system should never activate unless there is a serious problem or a trip test is being conducted.

Note: The check valve(s) in the air supply piping shown in Figures 5 and 6 prevent the cross flow of air from a stagnant system into an activated system responding to a fire. They also prevent water from entering the air lines. Ordinary mechanical check valves will function reliably in a freezer.

4.0 REFERENCES

4.1 FM Global

Data Sheet 1-57, *Rigid Plastic Building Materials*
Data Sheet 2-0, *Installation Guidelines for Automatic Sprinklers*
Data Sheet 2-81, *Fire Safety Inspections and Sprinkler System Maintenance*
Data Sheet 7-13/12-61, *Mechanical Refrigeration*
Data Sheet 8-0, *Commodity Classification*
Data Sheet 8-9, *Storage of Class 1,2,3,4 and Plastic Commodities*

4.2 Other

NFPA 13, *Installation of Sprinkler Systems*

APPENDIX A GLOSSARY OF TERMS

FM Approved: references to "FM Approved" in this data sheet mean the product or services have satisfied the criteria for FM Approvals. Refer to the *Approval Guide*, a publication of FM Approvals for a complete listing of products and services that are FM Approved.

Refrigerated warehouses have four classes of cold-storage areas. They are:

Coolers (32° to 65°F [0° to 18°C]) for the storage of foods such as apples, eggs or nuts.

Chill rooms (16° to 35°F [-9° to 2°C]) for curing meat.

Freezers or holding rooms (-10° to 5°F [-23° to -15°C]) for storage of frozen foods (such as meats, poultry, fish or vegetables).

Sharp freezers (-35° to 0°F [-37° to -17°C]) for initial freezing. Also used for normal storage of frozen foods.

APPENDIX B DOCUMENT REVISION HISTORY

May 2007. Editorial changes were made to this document.

September 2000. This revision of the document has been reorganized to provide a consistent format.