Aspirating Systems

Refrigerated Storage - Design & Application Guide

System Sensor Application Design Guide

System Sensor

Preface

System Sensor has produced this Design Guide as a reference, to be consulted when designing and specifying System Sensor fire protection solutions for freezers, cold storage areas and loading bays with temperatures ranging from minus 40°C (-40°F) to 18°C (65°F)[1].

Unlike most commonly used passive fire detection devices, System Sensor detectors are able to function in sub-zero climates without losing their very early warning smoke detection capabilities.

In this Design Guide we will discuss the relevant design considerations and make recommendations regarding the most effective way in which to install a System Sensor solution in the particular refrigerated storage facility for which it is being designed.

Important Note: The information contained in this Design Guide should be used in conjunction with specific local fire codes and standards as well as the guidelines provided in the System Sensor System Design Manual[1]. Where applicable, other regional industry practices should also be adhered to.

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1. Background Information

1.1 Fire Safety Considerations in Refrigerated Storage Areas

According to statistics, released by the NFPA[2], the major fire risks within a refrigerated storage facility arise from the following:

- Electrical or mechanical faults in conveyor and other transport equipment.
- Electrical equipment, wiring and other equipment housed in the roof space.
- The lighting system.
- Hot spots resulting from maintenance operations.
- Discarded cigarette butts.
- Arson.

1.2 Performance-Based Design

The unique environments within Refrigerated Storage Facilities present a challenge to both early and reliable fire detection. Detection system performance can be influenced by factors such as air change rate, temperature, humidity and the geometry of the area to be protected. The flexibility of Performance-Based Design concepts, while still following rigorous engineering processes, allows the fire protection system to be tailored to the specific requirements of each individual application's environment, with the commercial drivers to manage the risks.

Detector spacing or, for a System Sensor pipe, sampling hole spacing is traditionally dictated by local prescriptive codes and standards. In a Performance-Based approach, each installation is assessed according to its specific environmental conditions. Sampling hole spacing and location can then be altered to meet the particular design objectives.

The Performance-Based Design approach is widely used since it can provide evidence to justify divergence from prescriptive requirements, particularly in cases where there are practical limitations or a need for an improved level of fire protection. There are some specific guidelines for the use of Performance-Based Design and risk management concepts.

Examples of these codes and standards are listed below:

- AS/NZ 4360 Risk Management Standard[3].
- SFPE Handbook of Fire Protection Engineering Third Edition[4].
- International Fire Engineering Guidelines (Edition 2005)[5].
- British Standard BS7974[6].
- SFPE Engineering Guide to Performance-Based Fire Protection[7].

Note: The SFPE Code Officials' Guide to Performance-Based Design Review[8] is a very good source of information for Authorities Having Jurisdiction (AHJs) reviewing and assessing a System Sensor system design for a refrigerated storage facility.

Performance-Based fire protection solutions can be made to comply with local and national codes and standards for buildings and life safety. Assessments of the environmental risks and performance requirements, specific to the particular Refrigerated Storage Facility, are conducted as part of the design process.

1.3 Key Design Considerations

For the purposes of this Design Guide, the following temperature ranges apply to the various areas to be protected:

- Freezers -40°C to -15°C (-40°F to 5°F).
- Chillers -9°C to 2°C (16°F to 36°F).
- Coolers and Loading Bays 0°C to 18°C (32°F to 65°F).

Important Note: System Sensor Detectors MUST NOT be installed in sub-freezing environments.

The following should be considered when designing a System Sensor system for a refrigerated storage facility:

1. What level of protection is required and how will fire safety be managed?
2. Is the integrity of the sampling pipe network adequate with respect to being air-tight?
3. What temperature range and humidity will be experienced by sampling pipes within the refrigerated storage facility, sampling pipes in any other areas to be protected and the detectors themselves?
4. Are there likely to be any future changes with regard to the function of the area due to demand or operational needs? For example, might a refrigerated storage facility be converted to a cold storage area?
5. What are the airflow characteristics of the protected areas, entrances and loading bays?
6. What are the sampling pipe insulation requirements?
7. What effects might the defrost cycles and associated condensation have on fire protection?
8. What is the possibility of condensation occurring both within and on the outside of the sampling pipe network?
9. What is the configuration of racking within the areas to be protected?
10. How well sealed are the wall and ceiling insulation panels?
11. Is pre-action suppression to be included in the fire protection system and, if so, how will it be integrated with the System Sensor system?

1.4 Why Use System Sensor Smoke Detection?

System Sensor Aspirating Smoke Detection (ASD) systems have been used to protect refrigerated storage facilities for many years. Most fire protection technologies which are designed to operate in freezing conditions are not capable of early warning detection and are prone to being damaged by equipment such as forklift trucks. The very early warning capability of System Sensor detectors means that they are able to detect the incipient (pre-combustion) stage of a fire which drastically reduces business disruption, asset damage and the potential risks to the safety of personnel. The design flexibility of System Sensor systems also allows them to be used for the automatic activation of pre-action suppression, both gaseous and sprinkler.

The combustible nature of the types of materials normally stored in refrigerated environments, combined with the very dry high airflow in such environments, creates a significant fire risk. Fires will spread rapidly between cardboard or plastics packaging, grease impregnated materials, food stuffs and wooden pallets. Hence, the earlier a fire can be detected the better.

The perishable nature of the goods, commonly stored in freezers or coolers, makes it essential that any rise in temperature be avoided. Heat from a fire or a rise in temperature due to refrigeration system down time following a fire, would both result in stock spoilage and hence loss of revenue. Even an incipient fire, in this type of environment, can lead to significant losses if not detected and managed early. Stock exposed to low levels of smoke over an extended period of time will become contaminated.

Other advantages of the System Sensor system are that, with a properly designed system, performance will be reliable and little influenced by condensation or the high airflows caused by blast chillers.

The deficiencies of other detector technologies in low temperatures are recognized by many international codes and standards which regulate against the use of them in environments where the ambient temperature is less than 0°C (32°F)[9]. Linear heat cables are permitted in freezers but are prone to damage by forklift trucks and other common work procedures. Since System Sensor detectors are installed outside the protected area, only the sampling pipe network is exposed to sub zero temperatures. Being on the ceiling and inside voids makes it unlikely that the System Sensor sampling pipes will be damaged.

Note: Unlike the System Sensor system, linear heat cables are specifically for the activation of pre-action suppression and cannot simultaneously provide the very early warning smoke detection which may prevent the need for suppression.

2. Designing for Effective Fire Protection

In this section, design methodologies will be described with consideration for the different requirements depending on the function of the particular area being protected.

Important Note: The latest version of ASPIRE2™, the System Sensor sampling pipe modelling program, should be used for all pipe network designs.

2.1 Levels of Protection

Due to the large amounts of plastic present in this type of facility, in the form of packaging materials, a fire would produce large amounts of highly toxic and corrosive smoke which would damage assets and endanger personnel. The large amounts of fuel available, in the form of stock and the highly flammable light weight sandwich panels from which such facilities are constructed, would also cause fires to spread quickly from one area to another. Table 1 provides guidelines for those areas in a refrigerated storage facility that it is essential to protect.

Table 1 – Guidelines for areas to be protected.

Area	Essential	Recommended	Optional
Freezers/Chiller Rooms	✓		
Coolers	✓		
Plant and Maintenance Areas	✓		
Return Air Path Under the Protected Area		✓	
Loading Bays and Surrounding Areas	✓		
Office/Monitoring Area			✓
Ceiling/Roof Voids	✓		
Within Racks			✓

In cases where a pre-action sprinkler system is to be included as part of the fire protection, the System Sensor system can be used to activate the release mechanisms as discussed in Section 4.5.

2.2 Sampling Pipe Material

The choice of sampling pipe material will depend on where the pipe is to be located. For instance, installation of ceiling mounted sampling pipes can be made easier by using long lengths of pipe material suited to coping with low temperatures and internal temperature fluctuations. Such materials include the Halogen-free Fire-retardant high Temperature (HFT) plastics, Acrylonitrile Butadiene Styrene (ABS) and High Density Polyethylene (HDPE). Suitable materials and their properties are presented in Table 2 below.

Table 2 – Properties and recommended applications for sampling pipe materials[10-13].

Material	Operating Temperature	Thermal Contraction	Recommended Applications
PVC	-18°C (-40 to 120°F)	7.0 mm per 10 m per 10°C (0.28" per 32.8 ft per 18°F)	Above -18°C (0°F)
HFT	-40 to 140°C (-40 to 284°F)	7.0 mm per 10 m per 10°C (0.28" per 32.8 ft per 18°F)	Above -40°C (-40°F)
ABS	-40 to 80°C (-40 to 176°F)	10.1 mm per 10 m per 10°C (0.4" per 32.8 ft per 18°F)	Above -40°C (-40°F)
CPVC	-18 to 94°C (0 to 201°F)	6.7 mm per 10 m per 10°C (0.26" per 32.8 ft per 18°F)	Above -20°C (0°F)
PE-80	-50 to 60°C (-58 to 140°F)	20 mm per 10 m per 10°C (0.79" per 32.8 ft per 18°C)	Above -50°C (-58°F)
PE-100	-50 to 60°C (-58 to 140°F)	13 mm per 10 m per 10°C (0.52" per 32.8 ft per 18°F)	Above -50°C (-58°F)

An added advantage of using a continuous semi-flexible pipe material such as HDPE[13] is the reduction in the number of pipe junctions required.

2.3 Positioning Pipes and Sampling Holes

The various international codes and standards specify detection point spacing or maximum area of coverage per detection point for a variety of different airflow rates, ceiling heights and structures etc. In compliance with these prescriptive regulations, System Sensor sampling holes would be located in the same positions as individual smoke detection devices. Alternatively, with reference to local codes, the sampling pipe and sampling hole configuration can be determined by satisfying performance-based design requirements.

Note: For Factory Mutual (FM) approved, refrigerated storage, System Sensor installations the sampling holes should be placed as for heat detectors as outlined in the latest edition of the FM 8-29 Datasheet and Memorandum 0805[14, 15].

Sampling hole locations are usually represented by a grid like that shown below (Figure 1). The letter X represents the sampling hole spacing required according to local codes and standards.

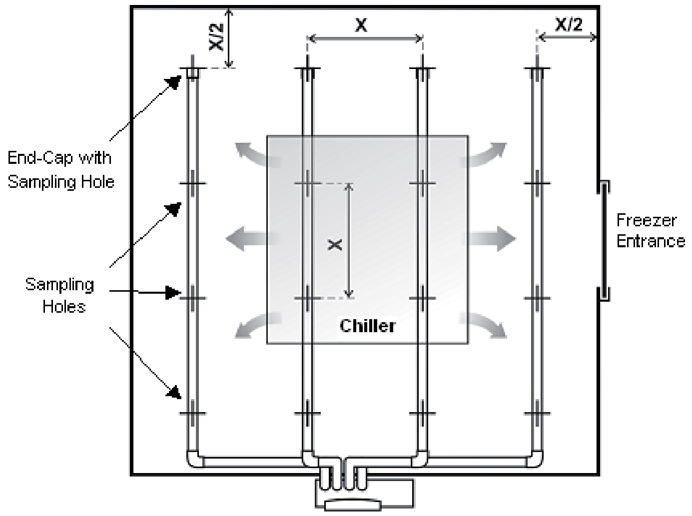


Figure 1 – Top view of a grid layout for System Sensor sampling holes.

In some freezers, depending on the effectiveness and frequency of defrosting management, ice will build up around the entrances. Under these circumstances, System Sensor sampling holes in the immediate proximity may become blocked by ice. This is normal and can be managed by specifying an appropriate system airflow fault threshold. The effects of blocked sampling holes could be compensated for as follows:

- By placing the sampling hole closest to the entrances as far away as is legally permitted by local codes and standards.
- By partial in-rack sampling near the entrances. Ice build-up is usually at the ceiling above the doorways, seldom within the racks.
- By placing System Sensor sampling pipes away from the path of chiller air supplies.

Note: Sampling hole diameter MUST be larger than 3 mm.

Referring to the grid layout shown above (Figure 1), there are two alternative approaches to sampling pipe network configuration design for optimal air sampling performance:

1. The sampling pipes can be run along the ceiling inside the area to be protected as shown (Figure 2). This technique minimizes the number of pipe penetrations through the walls or ceiling and can be applied in most practical situations. Sampling holes MUST be drilled after installation in this case.
2. The sampling pipes can be positioned outside the area to be protected with smaller diameter capillary tubes (16 mm (3/4 inches) outer diameter) fed through the ceiling insulation into the protected area as shown (Figure 3). This method requires one ceiling penetration per capillary tube and more pipe connections. All penetrations must be adequately sealed to prevent the formation of ice resulting from the entry of humid air or condensation. This approach is only appropriate where the refrigerated storage facility has a ceiling void. The capillary sampling tubes should be as short as possible; less than 4 m (13 ft) being recommended. They MUST also be sealed during installation.

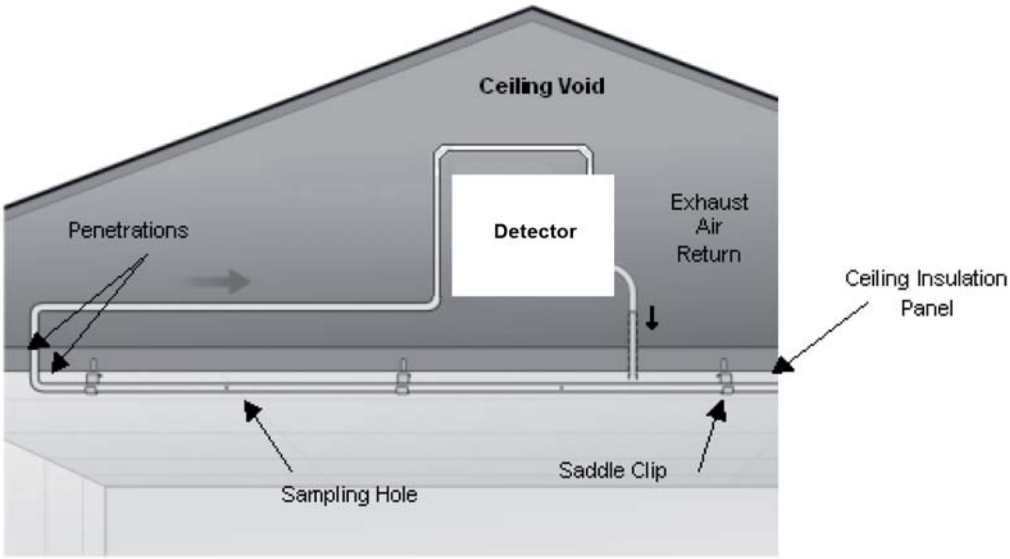


Figure 2 – Ceiling mounted System Sensor sampling pipes.

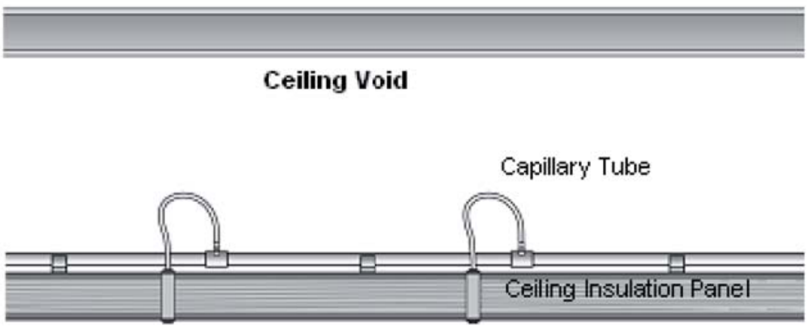


Figure 3 – Example of capillary air sampling.

Note: It is recommended that all drilling of penetration points, and the sealing of such points, be performed by appropriately experienced personnel.

2.4 Sampling Pipe Insulation

Where sampling pipe insulation is needed, use a material such as Armaflex or similar. Armaflex insulation has a temperature range of -40°C (-40°F) to 105°C (221°F), a density of 88 to 105 kg/m^3 and is very flexible. For a 25 mm (0.98") internal bore pipe, a single layer of insulation 9 mm (0.35") thick is adequate.

2.5 Sealing Sampling Pipe Penetrations

Sampling pipe penetrations, through ceiling or wall insulation panels MUST be properly sealed with a solid (Urethane foam) and/or flexible (mastic) material. To enhance air-tightness, a seal and/or insulation boot could also be installed at the penetration point as shown below (Figure 4). Consult local Wall Panel Suppliers for more detailed instructions.

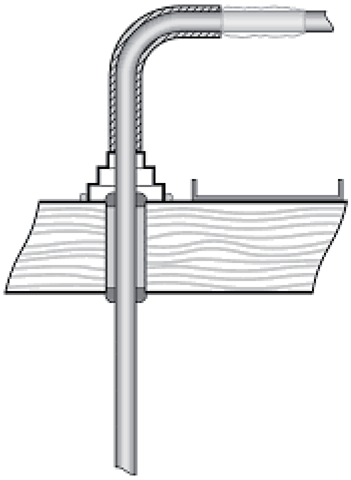


Figure 4 – Example of pipe penetration with an insulation boot and drip tray.

In order to avoid condensation formation at the penetration point, the section of pipe exiting the protected area MUST be insulated as shown (Figure 4). A tray can be used to collect any water condensation on the pipe surface.

2.6 Compensating for Sampling Pipe Contraction

Mounting clips, used to secure System Sensor sampling pipes to the ceiling, MUST not restrict longitudinal movement of the pipes as they expand or contract due to temperature variations. This is especially important where the pipe network is installed before the refrigerators are turned on. For example, according to its thermal expansion coefficient, an ABS pipe will contract by 0.1% for every 10°C (50°F) drop in temperature. This equates to a 40 mm (1.57 inch) reduction in length for a 40 m (131.2 ft) pipe and will result in disconnection of pipe sections in cases where the pipes were installed in temperatures well above the intended operating temperature.

Note: Refer to Table 2 for the thermal properties of other commonly used pipe materials.

To prevent pipe disconnections, make allowance for pipe contraction along the length of the pipes.

Saddle or offset clips should be use to secure the System Sensor sampling pipes to the ceiling as shown below (Figure 5).

Saddle Clip

Offset Clip

Pipe Clip (UK)

Figure 5 – Examples of pipe network supports.

Note: This document is intended only as a guide to the application of fire detection systems.

Reference must be made to relevant national and local standards.

Offset clips are preferable since they attach to the ceiling via an adhesive pad and, if required, can be screwed on to the ceiling. The design of offset clips also allows easy movement of the pipes during expansion or contraction.

To further minimise the possibility of pipe disconnections, pipe mounting clips MUST not be positioned next to pipe joiners. Clips MUST also be more than 300 mm from the ends of the pipes so that a pipe contraction will not cause its end caps to be forced off.

2.7 In-rack Protection

In most cases, placing a System Sensor sampling pipe network on the ceiling is all that is needed. However, sampling pipes can also be located along the racks used for storage in the refrigerated area as shown below (Figure 6).

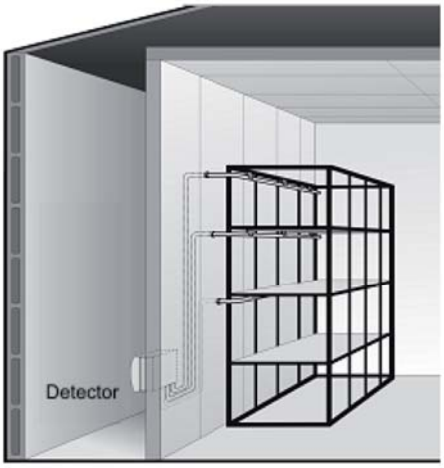


Figure 6 – Example of in-rack air sampling.

Wherever possible, the in-rack sampling pipe should enter the protected area through the wall at the height that the pipe will be positioned in the rack.

Note: Capillary air sampling is not recommended for in-rack sampling.

2.8 Ceiling Void Protection

Very early smoke detection is essential due to the high incipient fire risk presented by the electrical cabling and refrigeration control equipment normally housed in the ceiling void. Some local codes and standards specify that ceiling void protection must be a component of the fire protection system.

The sampling hole spacing is determined, with reference to local codes and standards, according to the grid presented earlier (Figure 1) and is shown below (Figure 7).

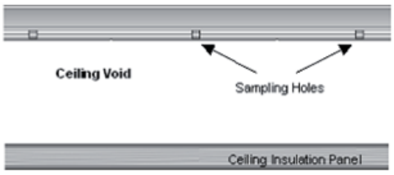


Figure 7 – Example of ceiling void air sampling.

The System Sensor detectors used to protect the ceiling void MUST be configured as individual fire zones. Ceiling void pipes MUST NOT enter any other areas, nor should ceiling void detectors be used to simultaneously monitor areas outside the ceiling void.

2.9 Other Areas to be Protected

For non-refrigerated storage areas such as those used for control, monitoring, loading and office space, the sampling hole spacing and pipe network layout are identical to those for the general office environment described in the System Sensor System Design Guide[1], with reference to local codes and standards where applicable. Detector sensitivity can be adjusted to meet performance requirements.

Note: It is worth considering high sensitivity smoke detection in the areas containing refrigeration control and support equipment, since smoke or fire damage in these areas would disrupt business.

3. Preventing Condensation and Crystallization

3.1 The Effects of a Temperature Drop

Condensation will occur when the air temperature drops below its due point. The result is the formation of water droplets (if the due point is above 0°C (32°F)) or ice crystals (if the due point is below 0°C (32°F))[16]. Inside the System Sensor sampling pipe network, condensation is unlikely and will only occur if the sampled air is cooled as it passes along the pipe through an area of lower temperature than that from which it was sampled. On the outer surface of sampling pipes, condensation is expected and can be tolerated.

During system design, all areas to be protected must be categorised according to the criteria listed below:

- The temperature and humidity changes that will occur if the function of the protected area is changed, for example, from a chiller to a cooler.
- The points in the pipe network which are most likely to be prone to condensation. This is done by assessing the temperature of the sampled air and the temperature of the air surrounding the sampling pipe network.
- The air-tightness of the pipe network, including the detector exhaust pipe.
- The distances, from both the protected area entrances and chiller air supply paths, of both the sampling pipe and sampling holes.

3.2 Condensation on the Sampling Pipe Outer Surface

Condensation occurs on the outer surface of the sampling pipes and capillary tubes where they exit the cold storage area and enter warmer environments such as a ceiling void or other non-freezer areas. Depending on the temperature of the pipe surface, in these areas, water droplets or ice crystals will form. A water tray should be used to collect any liquid before it spills over the ceiling insulation panels as shown below (Figure 8).

Note: The water tray must be large enough to allow evaporation to occur at an acceptable rate to prevent overflow.

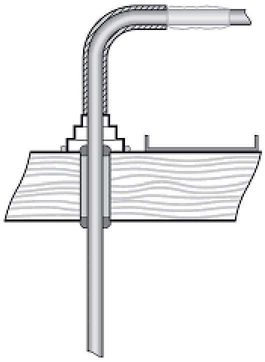


Figure 8 – Example of a water tray.

3.3 Crystallization on the Sampling Pipe Outer Surface

Occasionally, ice will form on the exterior of the sections of sampling pipe close to the refrigerator entrances as shown below (Figure 9). This ice build up is normal and has no adverse effect on the operation of the System Sensor system, provided that sampling holes are not located in the susceptible sections of pipe where they can become blocked. Sampling holes nearest to the entrances should be sprayed with silicone to prevent ice formation.

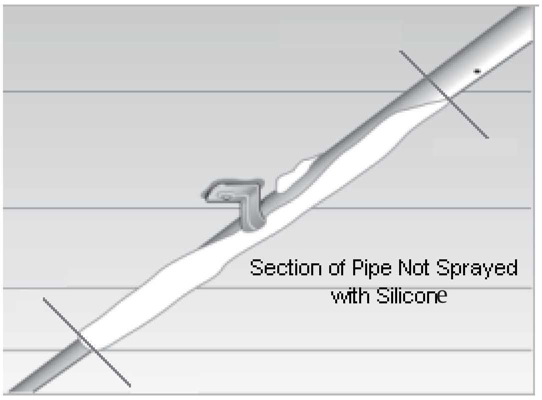


Figure 9 – Example of ice formation on sampling pipes close to the refrigerator entrance.

3.4 Condensation Inside Sampling Pipes

Condensation inside sampling pipes, outside the protected area is rare. However, it can occur if the function of the protected area changes and/or as a result of seasonal temperature variations. For example, if a chiller (-9°C, 16°F) is converted to a cooler (8°C, 46°F), condensation may form inside the pipes outside the cooler during winter when the temperature could conceivably drop below 8°C (46°F) .

The following measures will ensure that condensation forming in the pipes does not enter the detector:

- Install the detector with the pipe running below the detector. Rise the pipe above the detector as close as practicable to enter from the top(Figure 2).
- Install a water trap as discussed later in Section 4.4.

3.5 Crystallization Inside Sampling Pipes

In order to minimise the possibility of ice plug formation inside the sampling pipe, 90° elbow junctions between pipe sections should be avoided. Where it is essential to change the orientation of the pipe from horizontal to vertical, or vice versa, large radius bends should be used.

The chiller air supply is several degrees lower than the air in the rest of the chiller so, to prevent ice from forming and blocking the sampling holes, sampling pipes MUST NOT be installed in the direct path of the chiller's supply air vent. Doing so will lead to crystallisation when the warmer ambient air in the protected area enters the cool pipe. If for practical reasons, this cannot be avoided, the pipe MUST be insulated as shown below (Figure 10).

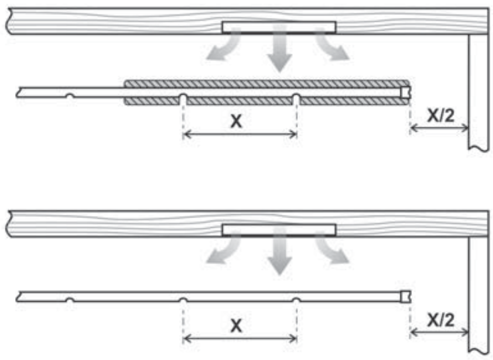


Figure 10 – Example of pipe insulation to combat ice formation in pipes directly in the path of the chiller air supply (the top is a good design, the bottom is not).

Important Note: Sampling pipes MUST NOT run from a high temperature area into a lower temperature area. Separate System Sensor detectors should be installed in the chiller, cooler, ceiling void, and office areas.

4. Installation Considerations

4.1 Sampled Air Warming

For optimum detection and ease of maintenance access, the System Sensor detector MUST be installed in a location where it is unlikely to experience sub-zero temperatures. Low temperature sampled air can be easily warmed up, before it reaches the detector, by extending the sample pipe length beyond its point of exit from the cooler protected area. The warmer air outside the pipe near the detector will heat the cold sampled air within it. Usually, only a short pipe extension is necessary.

The charts below (Figure 11 to Figure 13) provide conservative estimates of the pipe extensions required, to raise the temperature of the sampled air to an acceptable value, for a number of commonly used pipe materials and range of flow rates. All calculations assume an external ambient temperature of 20°C (68°F) and a sampled air temperature of 4°C (39°F).

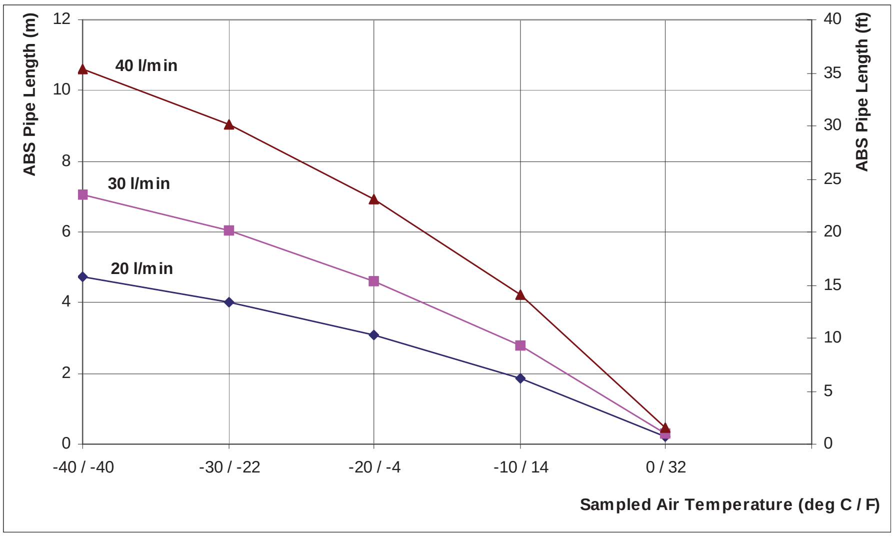


Figure 11 – Chart showing the estimated required ABS pipe extension for sampled air warming.

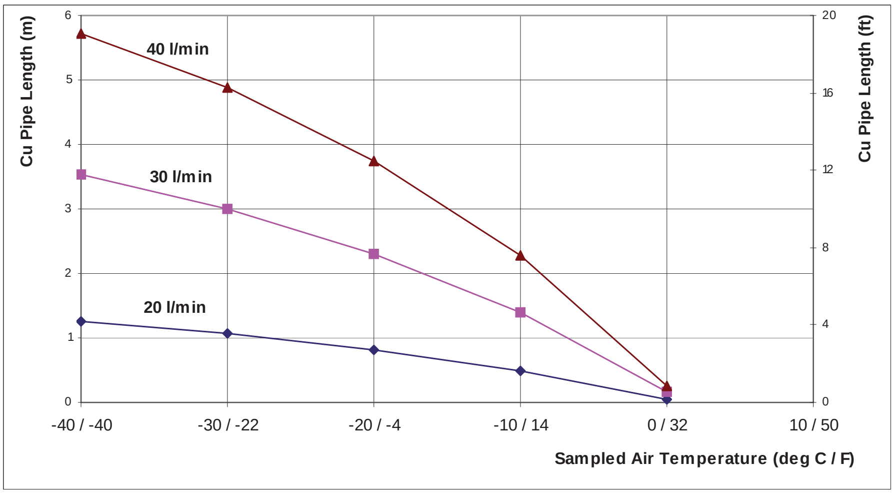


Figure 12 – Chart showing the estimated required Copper pipe extension for sampled air warming.

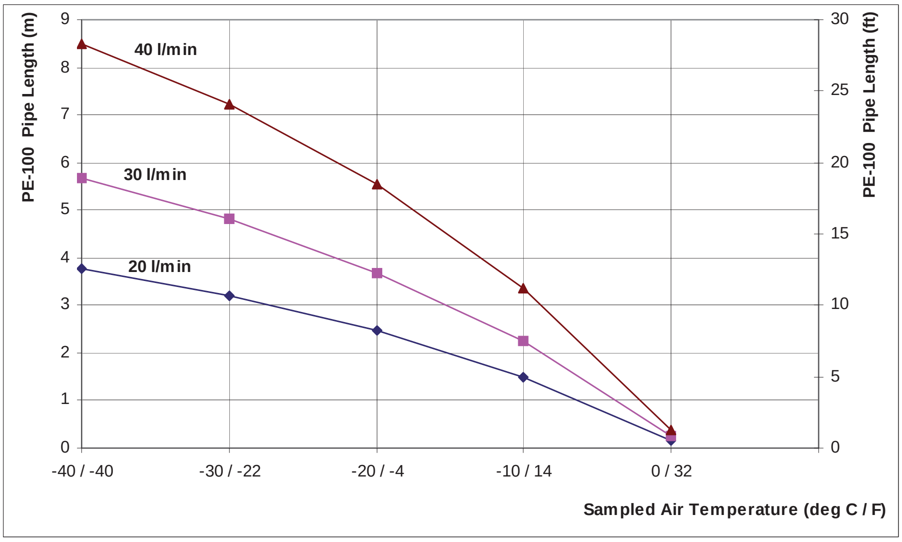


Figure 13 – Chart showing the estimated required PE-80/PE-100 pipe extension for sampled air warming.

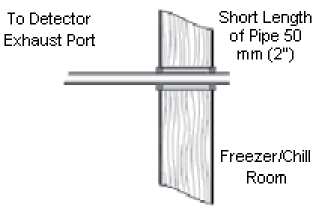
4.2 Heat Tracing

In extreme cases where there is no space to run pipe extensions or the external temperature varies widely, heat tracing may be employed for sampled air warming. However, this approach to warming sampled air is NOT recommended by System Sensor as it has not been validated by Factory Mutual (FM).

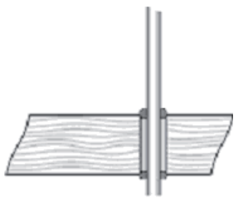
Important Note: The Appendix contains information on the copper pipe and heat tape lengths required for sampled air warming. No design guidelines will be given here. If wishing to use heat tracing, appropriately qualified Engineers MUST be consulted as to the most suitable method to be used.

4.3 Exhaust Air Treatment

Air from the System Sensor exhaust pipe MUST be returned to the area from which it was sampled as shown below (Figure 14).



Wall penetration



Ceiling Penetration.

Figure 14 – Examples of a System Sensor exhaust pipe being fed back into the area from which the air sample was taken.

This closed loop system will prevent pressure differences, caused when the System Sensor detector is powered down for any length of time, from introducing warm and humid air into the refrigerated storage area via the System Sensor exhaust port. Pressure differences will also result in unwanted airflow faults.

The return pipe from the exhaust should be as short as possible and its penetration, into the protected area MUST be air-tight.

Important Note: All inlet and exhaust pipes MUST be closed off whenever the system is powered down or detectors are removed for maintenance.

4.4 Water Traps

Water traps are not a requirement of the System Sensor smoke detection system. As discussed previously, they are only necessary under vastly varying environmental conditions where internal sampling pipe condensation is a possibility. An example of a water trap is shown below (Figure 15).

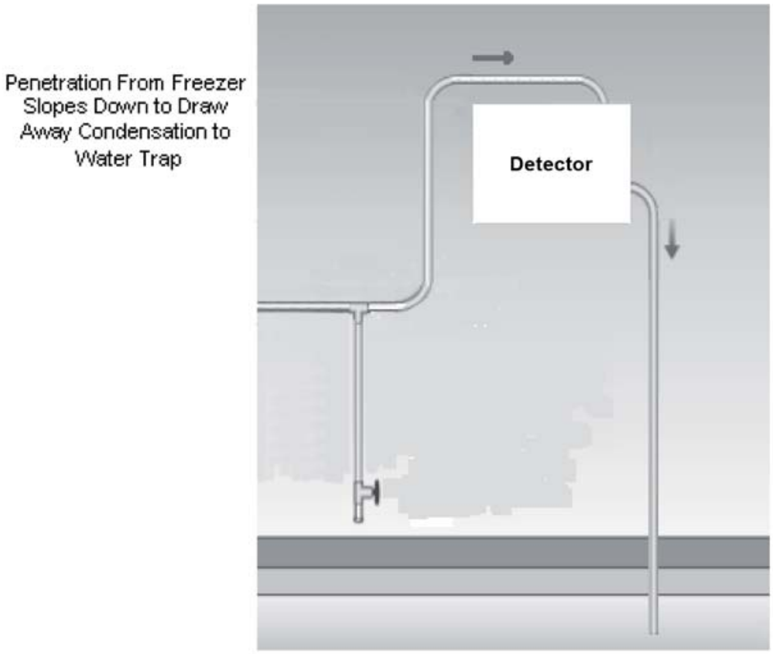


Figure 15 – Example of a water trap.

To install a water trap, a T section of pipe must be fitted to the pipe entering the detector. Water will pool at the stop valve on the downwards pointing arm of the T. The transparent section of pipe allows maintenance personnel to see when water is building up, before it rises above the intersection with the main sampling pipe, and release it via the stop valve. Alternatively, an end cap can be put on the pipe in place of a stop valve. If no condensation is evident after some time, the need for a water trap can be dismissed.

The water trap is intended to catch sampling pipe condensation and prevent water from reaching the detector. If the water trap fills up and water enters the main sampling pipe, a major flow fault will be raised in the System Sensor system, which should then prompt the operator to check the status of the water trap before investigating the sampling holes in the freezer.

Important Note: Water trap stop valves and end caps MUST be replaced as soon as the water has been drained. Leaving the pipe open will affect the airflow.

Important Note: Water traps that involve use of a u-bend in the pipe and rely upon condensate to reduce air-flow in the pipe network have benefits in terms of maintenance where a large amount of condensate gathers, but are generally not recommended because of the risk of all condensate evaporating, causing air entry into the pipe network and a system imbalance.

4.5 Integration with Pre-action Sprinklers

The System Sensor smoke detection system can also be used to activate pre-action sprinklers, if installed. For the purposes of pre-action sprinkler activation, System Sensor protection in-rack is usually not required even where there are in-rack sprinklers. However, it is important to refer to the FM memorandum 0805[15] for further details.

The procedure for integrating System Sensor with pre-action sprinklers is outlined below:

Refrigerated Storage Application Notes

1. Use ASPIRE2 to design the pipe network and determine Maximum permissible Transport Time. For FM approved, refrigerated storage, System Sensor installations, sampling hole spacing should be the same as heat detector spacing as per the latest edition of the FM8-29 Datasheet and Memorandum 08-05[14, 15].
2. Install the System Sensor sampling pipe network on the ceiling as shown below (Figure 16).

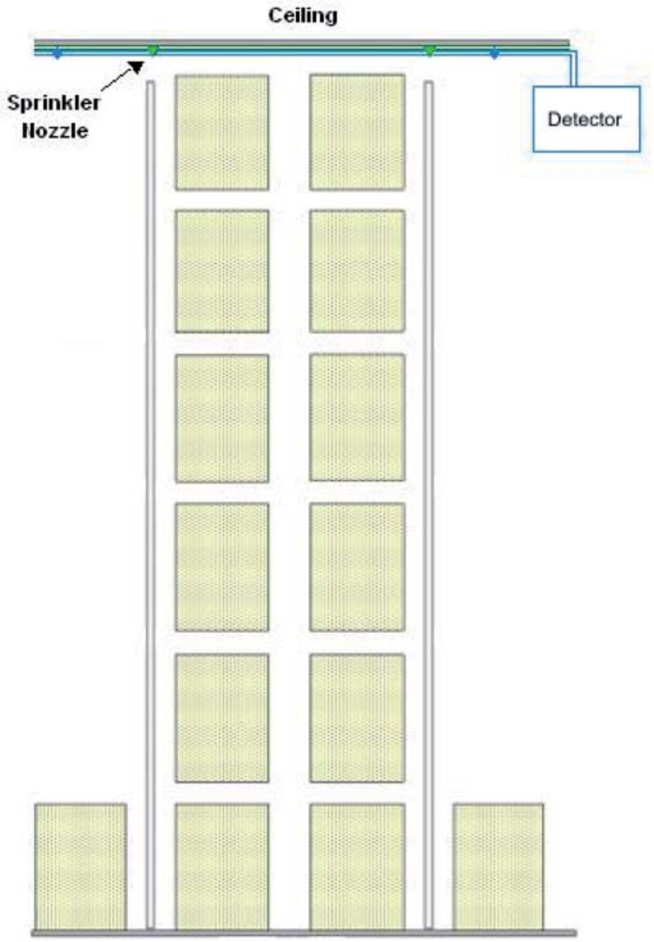


Figure 16 – Arrangement of the System Sensor sampling pipe network and sprinkler heads on the ceiling.

3. Set the ***Alert*** alarm threshold for early detection and intervention.
4. Set the ***Fire 1*** alarm threshold for pre-action sprinkler activation as indicated in Table 3.

Note: Delays can be configured for both of these alarms.

The smoke thresholds in Table 3 are absolute values, hence the environmental background level must be taken into account. All values are recommendations only, actual values being dependent on individual site conditions such as air change rate, storage rack height etc. Before using any values, the system performance MUST be verified by the commissioning test (refer to section 6.2).

Any Fire 1 alarm shall put all sprinkler valves, in that particular fire zone, into armed mode.

Table 3 – Design guidelines for System Sensor fire alarm settings[17].

Enclosure Size	Small < 500 m² (5400 sq.ft)	Medium 500 – 1000 m² (5400 – 10800 sq.ft)	Large 1000 – 1500 m² (10800 – 16200 sq.ft)	Extra Large > 1500 m² (16200 sq.ft)
Fire Alarm (General 10 m (30 ft) or less)	2%obs/m (0.61%obs/ft)	2%obs/m (0.61%obs/ft)	1.5%obs/m (0.46%obs/ft)	1%obs/m (0.31%obs/ft)
Fire Alarm (High Ceiling more than 10 m (30 ft))	1.5%obs/m (0.46%obs/ft)	1.5%obs/m (0.46%obs/ft)	1%obs/m (0.31%obs/ft)	1%obs/m (0.31%obs/ft)
Maximum Transport Time Allowed per Zone (s)	See Note Below and consult local codes.	110	110	110

Note: For small enclosures, the Maximum Transport Time Allowed is a function of the ceiling height H and equals 0.14H – 0.8H + 80. If the Maximum Transport Time Allowed cannot be achieved, install additional detectors in the area. If the Transport Time is close to the maximum allowed, consider reducing the fire alarm threshold by 10 to 20% to compensate. Ceiling height restrictions are for FM approval. Remember also to consult local codes and standards for Transport Time requirements.

4.6 Battery Backup

When using a System Sensor system for pre-action suppression activation, in the event of a power outage, a secondary power supply MUST be available. This power supply needs to be capable of running a single System Sensor detector for a total of 90 hours. This is in compliance with the fact that approved control panels for the automatic release of pre-action or deluge sprinkler systems must have 90 hours of standby power plus 10 minutes worth of power to operate the sprinkler system and alarms[17].

Where the System Sensor system is being used for very early warning smoke detection alone, refer to local codes and standards for the battery backup required.

5. Ongoing Considerations

5.1 Running the System Sensor System

For a new refrigerated storage facility, it is preferable that the System Sensor system be powered up and running while the refrigerators are being commissioned. This allows the detectors to adjust gradually to the decreasing sampled air temperature.

If installing System Sensor detectors in an existing facility, it is recommended that the pipe network inside the refrigerated areas be installed first and that all points where pipes exit these areas be blocked off. This prevents humid air being transferred into the protected area from outside. The blockages can be removed once the rest of the pipe network and detectors, outside the refrigerated areas, have been installed and connected.

Note: It may be necessary to construct enclosures around detectors to protect them from the weather or mechanical damage.

5.2 System Commissioning

Once the System Sensor system has been installed, its performance and pipe network integrity can be verified using the ASPIRE2 pipe modelling program. A range of sampled air temperatures may be input to determine Maximum Transport Times for each zone. Calculated Transport Times should be applied conservatively. Smoke tests can then be used to check system performance for both smoke detection and pre-action suppression activation.

5.3 Service and Maintenance

The System Sensor system shall be serviced and maintained according to both the local codes and standards and the instructions provided in the Maintenance section of the System Sensor System Design Manual[1].

The frequency of sampling pipe inspection and testing can be determined by the rate of ice build-up to ensure that sampling holes do not become blocked.

Appendix – Heat Tracing

There are several techniques for warming sampled air including water heaters, electrically heated tape and passing the pipe through an area that has been heated to 5-10°C (41-50°F). Electrically heated tape is preferred as it is easy to install. An example of a pipe covered with heat tape is shown below (Figure 17). If the surface temperature is over 30°C (86°F), the pipe must be insulated.

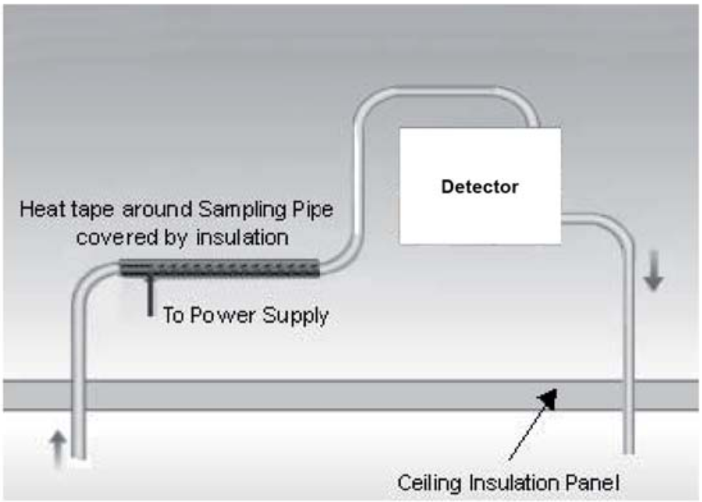


Figure 17 – Example of heat tracing with heat tape.

Raychem heat tape 5BTV2-CT or 3BTV1-CR can be used.

The following charts provide estimates of copper pipe and heat tape lengths required for heat tracing. Variations in ambient temperature are assumed to be negligible due to pipe insulation. The surface of the pipe is kept at a temperature of 35°C (95°F) and the tape is wound around it at 100 mm (4") intervals along its length.

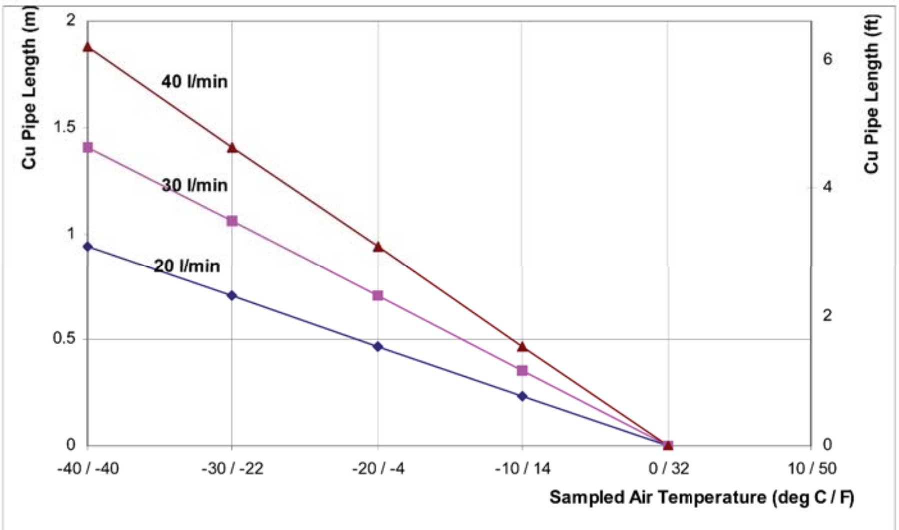


Figure 18 – Estimates of copper pipe length for heat tape.

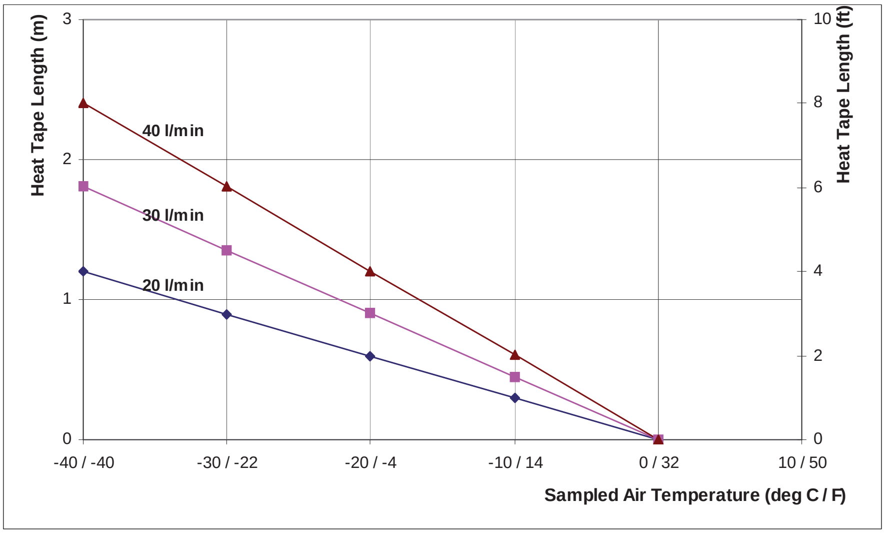


Figure 19 – Estimated heat tape length.

References

[1] System Sensor System Design Manual

[2] NFPA Fire Analysis & Research Division (2003) *Selections from the U.S. fire problem overview report. Leading causes and other patterns and trends Storage properties excluding dwelling garages.*

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[9] NFPA (2002) *National Fire Alarm Code (72)*

[10] The Plastics Pipe Institute, Inc. (1999) *Suggested Temperature Limitations for the Operation and Installation of Thermoplastic Pipes in Non-pressure Applications,* TN-11/99. www.plasticpipes.org.

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[13] Fisher, G. (2002) *Planning Fundamentals Industrial Piping Systems,* www.piping.georgefisher.com.

[14] FM Global (2000) *Property Loss Prevention Datasheets 8-29.*

[15] FM (2006) *Memorandum - Engineering Bulletin 08-05.*

[16] ASHRAE (2003) *Psychometric Chart,* www.ashrae.com.

[17] FM Global (2003) *Property Loss Prevention Data Sheet 5-40 Fire Alarm Systems.*

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Installation information: in order to ensure full functionality, refer to the installation instructions as supplied.