



# *Aspirating Systems*

## *Warehouses - Design & Application Guide*



System Sensor Application Design Guide

# Warehouses Application Notes

## Preface

System Sensor Pty Ltd has produced this Design Guide as a reference, to be consulted when designing and specifying System Sensor fire protection solutions for Warehouses. The continuous operation of such facilities, in addition to the presence of large amounts of fuel in the form of stored goods and packaging materials, increases both the risk of fire and its ability to spread rapidly. Common Warehouse features such as their large volume, high ceilings, numerous storage racks and the potential for the creation of smoke stratification all present a significant challenge to smoke detection.

In this Design Guide we will discuss the relevant design considerations and make recommendations regarding the most effective way to install a System Sensor solution in a Warehouse environment.

**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<sup>[1]</sup>. Where applicable, other regional industry practices should also be adhered to.

# Warehouses Application Notes

## Contents

<b>1. Background Information.....</b>	<b>1</b>
1.1 Fire Safety Considerations In Warehouses.....	1
1.2 Performance-Based Design.....	1
1.3 Key Design Considerations .....	2
1.4 Why Use System Sensor Smoke Detection? .....	2
<b>2. Designing For Effective Fire Protection .....</b>	<b>4</b>
2.1 Levels of Protection .....	4
2.2 Warehouse Environmental Considerations .....	4
2.3 Stratification.....	4
2.4 Sampling Pipe Considerations.....	4
<b>3. System Sensor System Design .....</b>	<b>5</b>
3.1 Sampling Pipe Network Configuration Options .....	5
3.2 Sampling Hole Spacing/Location .....	6
3.3 On Ceiling Detection.....	8
3.4 High-Low Alternating Detection.....	8
3.5 Multi-Level Detection .....	9
3.6 In-Rack Detection.....	10
<b>4. Additional Protection.....</b>	<b>10</b>
4.1 Plant Room Protection .....	10
4.2 Ceiling Void Protection .....	11
4.3 Office And Control Area Protection .....	11
4.4 Loading Bay .....	11
<b>5. Commissioning, Service and Maintenance .....</b>	<b>12</b>
5.1 System Commissioning .....	12
5.2 Service And Maintenance .....	12
<b>References .....</b>	<b>13</b>

# Warehouses Application Notes

## 1. Background Information

### 1.1 Fire Safety Considerations In Warehouses

The major fire risks and detection challenges within Warehouses arise as a result of the following:

- Electrical faults in conveyer, processing and other transport equipment.
- Robotic equipment and forklift related faults.
- Electrical overloading due to the continuous operation of many facilities.
- Careless maintenance work (i.e. hot work activities such as welding and cutting).
- Unauthorized smoking.
- Arson.
- Spontaneous ignition.
- The large quantities of stored goods and packing materials amount to a significant fire load leading to a rapid initial growth and subsequent spread of a fire.
- The presence of combustible debris (lint, oil mist, grease, resin etc.) and flammable liquids constitute a fire hazard.
- The vertical arrangement of stored goods and packing materials promote rapid fire growth and spread.
- Deep seated fires are difficult to extinguish and may be allowed to spread.
- There are often very few staff overseeing the automated processes or stored goods, thus, a fire event is less likely to be noticed.
- The large volume of most Warehouses leads to smoke dilution, which makes its detection more difficult.
- Mechanical or natural ventilation may cause airflow patterns, which dilute and direct smoke away from detection points.
- The formation of stratification layers in the air, within the protected area, may prevent or delay the ascent of the smoke plume to the detection points on the ceiling. Refer to section 2.3 for a definition of stratification.

Many buildings can be treated as a Warehouse as they are essentially large open spaces with or without storage racks. Some examples are listed below:

- Refrigerated storage warehouses, which are considered separately due to their unique design requirements.
- Archive storage areas.
- Carousel storage and retrieval facilities.
- Automated storage and retrieval warehouses.
- Retail warehouses for the storage of commodities such as, food, furniture, rubber tyres, oxidizing substances, aerosols, tobacco, alcohol, textiles etc.
- Aircraft Hangers and other large storage and maintenance areas.
- Computer equipment and other assembly plants.
- Supermarkets and other large department stores.
- Indoor Sports Facilities and theatres.

### 1.2 Performance-Based Design

The unique environments within warehouses present a challenge to both early and reliable fire detection. There is a high likelihood that detection system performance will be dependent on such factors as building geometry, physical obstructions, ventilation, stratification etc. The flexibility of Performance-Based Design, 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, sample hole spacing is traditionally dictated by local prescriptive codes and standards. In a more performance-based approach, each installation is assessed according to its specific environmental conditions. Sample hole spacing and location can then be altered easily to suit the particular performance requirements

# Warehouses Application Notes

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:

- International Fire Engineering Guidelines (Edition 2005)<sup>[5]</sup>.
- British Standard BS 7974<sup>[5]</sup>.
- SFPE Engineering Guide to Performance-Based Fire Protection<sup>[6]</sup>.
- AS/NZ 4360 Risk Management Standard<sup>[5]</sup>.
- SFPE Handbook of Fire Protection Engineering Third Edition<sup>[6]</sup>.

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

## 1.3 Key Design Considerations

The following should be considered when designing a System Sensor system for a Warehouse:

1. What level of protection is required and how will fire events be managed?
2. What aspects of the geometry and dimensions of the area to be protected, particularly the ceiling height and enclosure volume may affect smoke detection?
3. What types of goods will be stored in the protected area and are they susceptible to damage by smoke, heat or water?
4. What is the commodity class and storage capacity of the facility?
5. How are the storage racks arranged and how might this affect smoke movement?
6. What are the airflow characteristics within the area: natural ventilation or mechanical ventilation?
7. Is the building insulation and/or heating method likely to cause stratification of smoke? If so, will the time of day or season of the year affect the extent to which vertical temperature varies?
8. Are there any other features of the area (e.g. catwalks or mezzanines) that may interfere with normal smoke plume development?
9. What is the background airborne particulate level, within the protected area, during operating and non-operating hours?
10. What is the occupant density within the protected area?
11. What are the maintenance and serviceability requirements of the facility?
12. What methods are used to load/unload and move goods?
13. Are there public access areas that will require protection?
14. How long are the escape routes?
15. Will fire suppression be needed as part of the fire protection system?
16. What do local prescriptive codes and standards require?
17. What do Performance-Based Design codes recommend?

## 1.4 Why Use System Sensor Smoke Detection?

It is essential that fire events in Warehouses be detected as early as possible to minimize smoke or heat damage to the goods being stored there.

The limitations of conventional fire and smoke detectors (point (spot) type smoke, heat and beam-type) must be considered, especially with increasing ceiling height. The comparatively low sensitivity and localized detection of point (spot) type detectors, for instance, can mean that fire events will not be detected soon enough in many cases. Warehouse environments present the following challenges to conventional detectors:

# Warehouses Application Notes

- High Warehouse ceilings result in significant smoke dilution (through clean air entrainment) during its ascend to the ceiling. Point (spot) type smoke detectors, which rely on localized detection, may not be able to respond to diluted smoke plumes. Beam-type detectors lack the high sensitivity necessary for the detection of diluted smoke plumes.
- Air movement, resulting from natural or mechanical ventilation, will further dilute and cool the smoke plume, thus, impairing the detection performance of point (spot) type smoke and heat detectors.
- For small fires, the smoke plume may not possess sufficient thermal energy to ascend to the ceiling of the Warehouse. This impedes the detection of both point (spot) type smoke and heat detectors; smoke either does not reach the detection points or is too cool when it does.
- Poor thermal insulation, incident solar radiation (especially on the roof) and lack of ventilation can all contribute to stratification. A warm layer of air at the ceiling level will present a barrier to rising smoke. This will impair the performance of both point (spot) type smoke and heat detectors installed at ceiling height.
- Point (spot) type smoke detectors, being mounted at the ceiling, are subject to continuous environmental changes which may force them to operate outside their recommended range (temperature, humidity etc) and compromise their detection performance leading to false alarms or reduced sensitivity.
- Movement caused by wind loads and the thermal expansion/contraction of the warehouse could misalign the transmitter and receiver of beam-type detectors, either forcing them into a constant alarm state or resulting in a sensitivity loss.
- The maintenance of conventional detectors installed in warehouses involves time consuming and resource intensive tasks.

**Note:** The delayed activation of conventional fire and smoke detectors such as point (spot) type smoke, heat and beam-type detectors, for the reasons outlined above, will most likely render manual and/or automatic attempts to extinguish/control a fire ineffective.

The Very Early Warning Fire Detection (VEWFD) capability of the System Sensor system allows it to minimize fire risks and combat detection challenges in the following ways:

- A System Sensor system has a better chance of detecting smoke in high ceiling Warehouses than a point (spot) type detector, due to its very sensitive alarm settings and the aggregation of smoke-laden air collected through sampling holes at different locations. This is particularly important in Warehouse environments due to the significant dilution of the smoke plume during its ascend to the ceiling.
- The System Sensor system can be designed to protect it against temperature fluctuations and humidity variations, which may lead to water condensation, by using water traps etc.
- A System Sensor system actively draws air through its sampling holes, which ensures a consistent detection performance in varying airflow conditions. The performance of point (spot) type smoke detectors relies on the direction and magnitude of airflows, in their vicinity, to carry smoke particulates to the sensing chambers. Consequently, point (spot) type smoke detector performance constantly changes due to alterations in airflow conditions caused by either mechanical or natural ventilation.
- The very early warning capability of the System Sensor system allows it to detect small energy fires very early. This provides staff with an opportunity to investigate and take action, before smoke contamination can irreversibly damage the stored goods.
- The very early warning capability of the System Sensor system also minimizes the rapid fire growth and spread that would be facilitated by the closely packed and abundant fuel sources.
- Should it be necessary, very early warning would increase the time available for the execution of an evacuation and other emergency plans.
- There is a comparatively low incidence of false alarms with a System Sensor system.
- In cases where gaseous or sprinkler fire suppression is to be included, as part of the overall fire protection system, the System Sensor detectors' wide sensitivity range of 0.005 to 20%Obs/m (0.0015 to 6%Obs/ft) means that appropriate alarm thresholds can be set for both early detection and, at a later stage in the fire event, the activation of the suppression release mechanisms.
- Certain maintenance requirements of the System Sensor system, for example, back flushing of the sampling pipe network can be conducted at the easily accessible location of the System Sensor detector.

# Warehouses Application Notes

## 2. Designing For Effective Fire Protection

### 2.1 Levels of Protection

A summary of the various areas, within a Warehouse, and the appropriate levels of protection for those areas are presented in Table 1.

Table 1 – Levels of protection for areas within Warehouses.

Area	Essential	Recommended	Optional
Storage areas	•		
Racking			✓
Public Areas (corridors, office and control areas)		•	
Loading Bay		•	
Ceiling Void	•		
Plant Room		✓	

### 2.2 Warehouse Environmental Considerations

The following internal Warehouse conditions should be assessed as part of the fire protection system design process:

- Temperature and Humidity Profile – how temperature and vertical temperature gradients vary throughout the day and across the seasons.
- Airborne particulate levels – the type of operation or processing taking place, the wash down process used and how particulate levels relate to ceiling height.
- Ventilation – how the area is ventilated (mechanical, air conditioning, exhaust fans, natural ventilation, building leakages, rolling doors opening/closing etc).
- Commodity Classification. Future alterations in commodity storage.
- The presence of high storage racks

### 2.3 Stratification

Stratification occurs when the hot smoke and gases, emitted by a fire, run out of thermal energy before they ascend all the way to the top of the enclosure<sup>[7]</sup>. This phenomenon frequently occurs in the high ceiling environments of warehouses, where the thermal buoyancy of the smoke is not sufficient to carry it up to the detection points on the ceiling. What results are horizontal layers of air and smoke of varying temperatures.

The formation of stratification layers will also be influenced by ventilation and external environmental conditions. For example, during summer, the sun striking a steel Warehouse roof can cause temperatures in excess of 60 to 70°C (140 to 158°F) just below the roof. Should a small incipient fire start at the ground level, its smoke would not have enough energy to breach this higher temperature air barrier and the majority of smoke particulates would not reach the detection points on the ceiling. Instead a smoke layer would form beneath the upper hot air layer.

To increase the chance that sampling points will be within the smoke plume layer, where they can detect the majority of smoke particulates, it is recommended that sampling be conducted at different heights. A number of multiple height sampling techniques are discussed in the next section. Smoke tests can be used to determine the extent to which stratification is likely to occur in the Warehouse environment.

### 2.4 Sampling Pipe Considerations

In most normal Warehouse applications, plastic pipes are used. In extreme cases, large temperature variations can cause pipes to expand or contract; a possibility, which must be considered during sampling pipe network design.

The thermal characteristics of commonly used pipe materials are presented in Table 2 below.

Table 2 – Thermal characteristics of pipe materials commonly used in Warehouse applications<sup>[8,9]</sup>.

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

Reference must be made to relevant national and local standards.

# Warehouses Application Notes

<b>ABS</b>	-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)
<b>CPVC</b>	-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)

## 3. System Sensor System Design

### 3.1 Sampling Pipe Network Configuration Options

The System Sensor sampling pipe network layout can be either Branched or Non-Branched as shown (Figure 1).

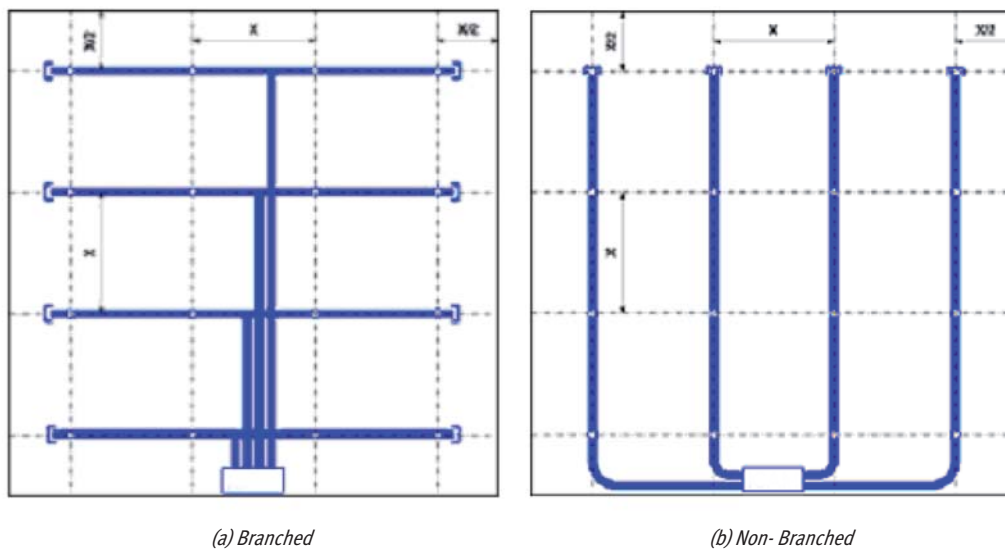


Figure 1 – System Sensor Pipe Layout Configurations.

# Warehouses Application Notes

There are five design options for the configuration and location of System Sensor sampling pipes. The selection of sampling pipe configuration is dependent upon the application and internal requirements of the warehouse facility, that is, operational activity, high-bay racking, access to voids and aesthetics.

1. On Ceiling Detection – sampling pipes are located on the ceiling (Figure 4).
2. Below Ceiling Detection – sampling pipes, located on the ceiling, have drop-down pipes with sampling holes.
3. High-Low Alternating Detection – sampling pipes are located on the ceiling with alternating sampling holes on the ceiling and drop-down pipes (Figure 5).
4. Multi-Level Detection – this detection method applies to Warehouses comprising high bay storage racks and utilizes more than one System Sensor system for ceiling and intermediate level protection (Figure 6).
5. In-rack Detection – the sampling pipes run horizontally or vertically between back-to-back racks at various heights (Figure 7). Drop-down pipes from the ceiling can also be used for in-rack detection (Figure 8).

The System Sensor sampling pipes should not be placed underneath or in close proximity (<1 m (3.3 ft)) to lighting fixtures, heaters, skylights or other heat emitting objects. Local code requirements will influence the location of sampling pipes.

For ceiling protection, when drilling into the roof decking is not allowed, sampling pipes can be installed directly onto the roof trusses. If there are beams on the ceiling, the System Sensor pipe network can be fastened to the beams using suitable fixings. Where neither of the above two methods is feasible, an alternative approach is to use catenary wire to support the pipe network.

Local codes and standards governing the installation of sampling pipes on sloped ceilings should also be taken into account.

For Warehouses comprising storage rack areas, sampling pipes can run perpendicular (Figure 2) or parallel (Figure 3) to the rack orientation. For intermediate level protection, sampling pipes should be installed on the underside of catwalks (mezzanines). Where catwalks (mezzanines) are not present, the pipes can be fitted to the sheltered side of the racking, fixed to the rack frame. It is important to ensure that the pipes are not installed in locations where they could be damaged by forklifts or be in close proximity to the stored goods.

Wind loads and temperature fluctuations may cause expansion or contraction of the warehouse's structural beams and pipes so conduit saddles should be used to allow for small pipe length variations. Possible expansions or contractions also make it necessary to install airtight expansion joints to allow for pipe movement without jeopardizing the integrity of the sampling pipe network.

System Sensor detectors can be mounted wherever it is most convenient - on walls, columns or rack frames.

**Important Note:** To reduce installation costs, it is recommended that System Sensor detectors be mounted in close proximity to each other. For example, the detector units can be located in the center of a warehouse, with the pipe network extending outward towards the walls. This minimizes the distance between detectors and therefore wiring costs.

**Important Note:** All sampling pipe network configurations should be verified using the ASPIRE2™ Pipe Network Modeling Program.

## 3.2 Sampling Hole Spacing/Location

Most global codes and standards recommend an area of coverage per detector. Sampling hole spacing for System Sensor detectors is usually determined by a grid layout. Standards define different areas of coverage depending on certain criteria so you should refer to the relevant standards.

For Warehouses comprising open space areas, sampling holes and/or drop-down pipes are placed in accordance with local codes and standards (Figure 1).

# Warehouses Application Notes

For Warehouses comprising storage rack areas, it is recommended that ceiling sampling holes are located above each aisle in a staggered layout (Figure 2a). When the storage racks extend to the ceiling, each aisle is treated as a smoke compartment and, therefore, ceiling sampling holes should be located above each aisle in the standard rectangular grid layout (Figure 2b). In both of these layouts, the spacing between the pipes can extend up to the maximum distance permitted by local codes and standards. The spacing between sampling holes on the same pipe section will depend on the rack depth.

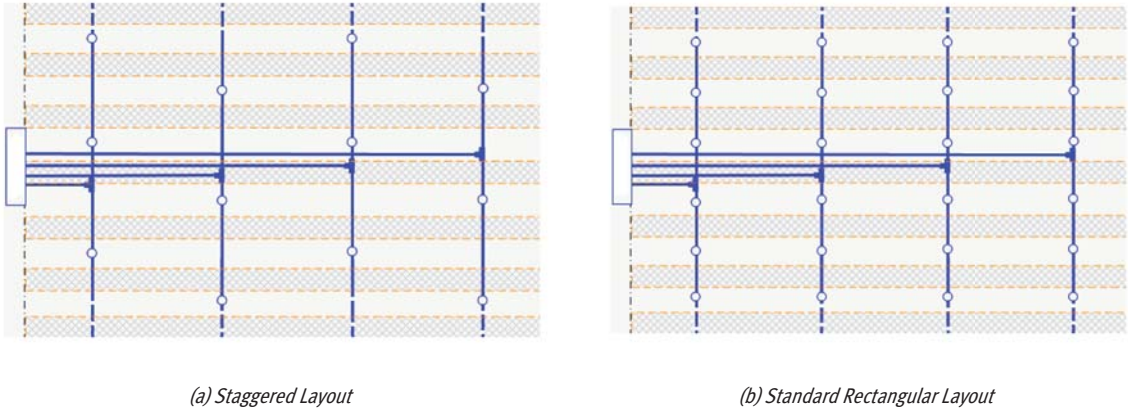


Figure 2 – Storage rack area ceiling System Sensor sampling Pipe Layout (Branched, pipes perpendicular to rack orientation).



Figure 3 – Storage rack area ceiling System Sensor sampling Pipe Layout (Non-Branched, pipes parallel to rack orientation).

# Warehouses Application Notes

## 3.3 On Ceiling Detection

On ceiling installation, where the sampling pipes are installed directly on the underside of the warehouse roof structure or trusses, is the most common. An example of a branched layout, ceiling sampling pipe network configuration is presented below (Figure 4).

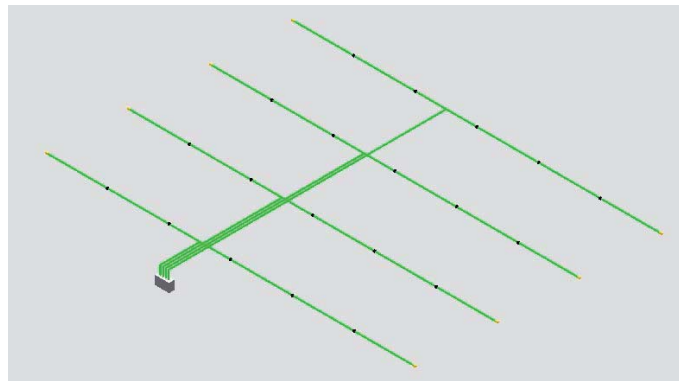


Figure 4 – Example of On Ceiling Detection (Branched Layout).

On ceiling detection is used in most Warehouses as it provides the following:

- Lower Installation cost (materials, labor etc).
- An unobtrusive detection system.

**Important Note:** Local codes will indicate limitations and height coverage specifications. Positioning System Sensor sampling pipes at intermediate heights will overcome any such restrictions.

## 3.4 High-Low Alternating Detection

This option comprises ceiling sampling holes that alternate with drop down pipes and is used to penetrate the hot air layer at the roof level. This allows for optimal sampling when the air at the roof level is either hot or cold. Local codes and standards should be consulted to determine the correct length of drop down pipes for individual facility configurations.

An example of this type of sampling pipe network (branched) is presented below (Figure 5).

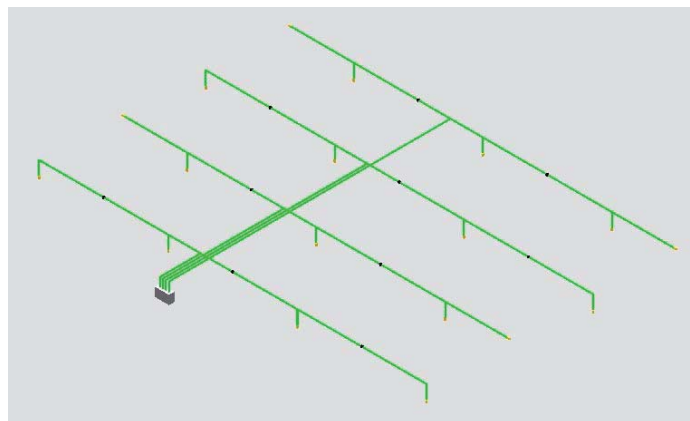


Figure 5 – Example of High-Low Alternating Detection.

# Warehouses Application Notes

## 3.5 Multi-Level Detection

The multi-level detection option is used in any of the following circumstances:

- Where there are high bay storage racking areas
- Where high stratification levels are expected
- Where mezzanines (catwalks) consist of solid flooring that will impede/delay the ascend of the smoke plume

This design option requires on ceiling and multiple intermediate level System Sensor systems (Figure 6).

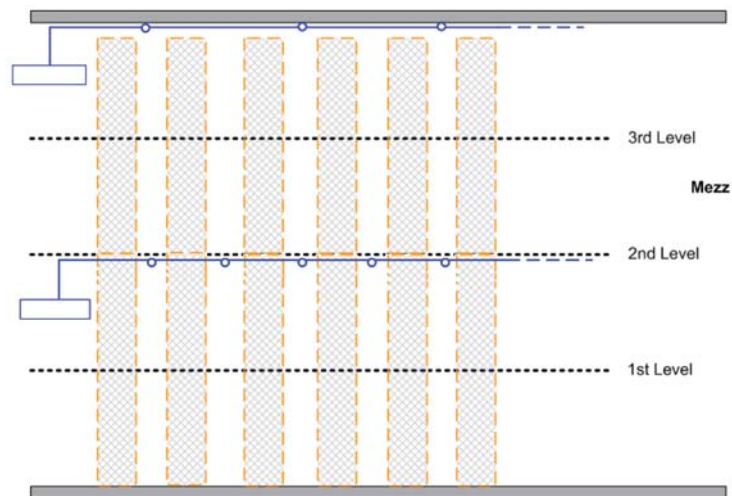


Figure 6 – Example of Multi-Level Detection (Ceiling and Intermediate Level).

**Important Note:** System Sensor systems intended for intermediate level protection should have sampling holes in every aisle.

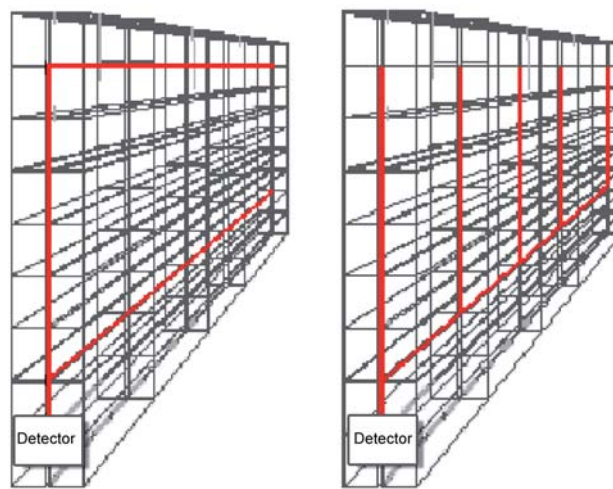
# Warehouses Application Notes

## 3.6 In-Rack Detection

In-rack detection may be used in installations where the following conditions apply:

- There is high-bay racking.
- Stratification occurs.
- Localized detection is required.

The sampling pipe can either have a horizontal or vertical in-rack detection configuration as shown (Figure 7). The detector is installed at the end of the rack at an accessible level. As a safeguard against mechanical damage from forklift trucks, sampling pipes are located between back-to-back racks out of harms way.



(a) Horizontal in-rack detection.

(b) Vertical in-rack detection.

Figure 7 – In-rack Detection.

In the case of non-high-bay racking, drop-down pipes from the ceiling may also be used for in-rack detection. When installing drop-down pipes, it is important to ensure that they will not be damaged by forklifts or be in close proximity to the stored goods. The drop-down pipes can be fitted to the sheltered side of the racking, which can be fixed to the rack frame as shown (Figure 8). In-rack drop-down pipes normally have two or three sampling holes drilled in them to provide sampling at different heights within the racking system.



Figure 8 – Example of drop-down pipes for In-rack Detection.

## 4. Additional Protection

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

Reference must be made to relevant national and local standards.

# Warehouses Application Notes

## 4.2 Ceiling Void Protection

It is especially important to protect ceiling voids containing cabling and/or any other equipment, which present an increased risk of fire. The spacing of the System Sensor sampling holes is again determined using the grid method (Figure 1).

## 4.3 Office And Control Area Protection

For aesthetic reasons, sampling in these areas is usually conducted via capillary tubes fed through the ceiling from the main sampling pipes, which are located in the ceiling void (Figure 9).

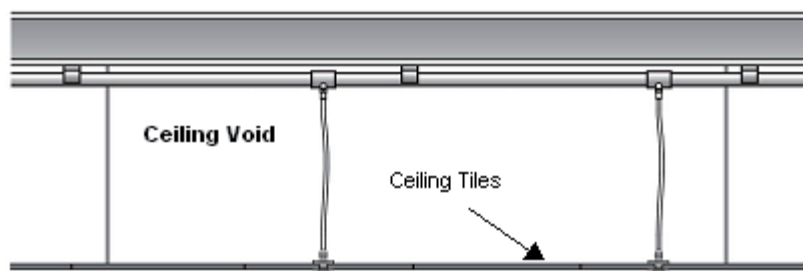


Figure 9 – Example of capillary air sampling through the ceiling.

## 4.4 Loading Bay

System Sensor detectors sensitivity should be lowered to account for the truck exhaust fumes, regularly present in the loading bay environment.

# Warehouses Application Notes

## 5. Commissioning, Service and Maintenance

### 5.1 System Commissioning

The commissioning process is designed to systematically check and validate all aspect of System Sensor system operation, for example, performance and sampling pipe network integrity. Smoke tests are used to test the following:

- System performance – smoke detection.
- Verification of ASPIRE2 calculated smoke transport times.
- Alarm (Fire, fault) signal relay to Fire Indicating Panels (FIP), when used.

In situations where the System Sensor system is interfaced with pre-action sprinkler systems the user should consider one of the System Sensor smoke alarm thresholds (Fire 1 for example) as the required interface signal.

### 5.2 Service And Maintenance

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

**Note:** Instead of performing smoke transport time tests at inaccessible ceiling sampling holes, the pipe branches could be extended to bring the end of the pipes close to catwalks (mezzanines) or ground level.

The design concept for a vertically extended pipe branch, supported by a wall or storage rack, is shown below (Figure 10). Two points are noted:

- Point 1 indicates the location of the furthest (from the detector) ceiling sampling hole during the “normal operation” of the System Sensor ceiling mounted system.
- Point 2 indicates the location of either a blocked end-cap or a ‘maintenance test hole’ (4 mm (5/32 ”)). The blocked end-cap is used during the “normal operation” of the System Sensor ceiling mounted system. The ‘maintenance test hole’ is used for the “maintenance” (smoke transport time test) of the System Sensor ceiling mounted system.

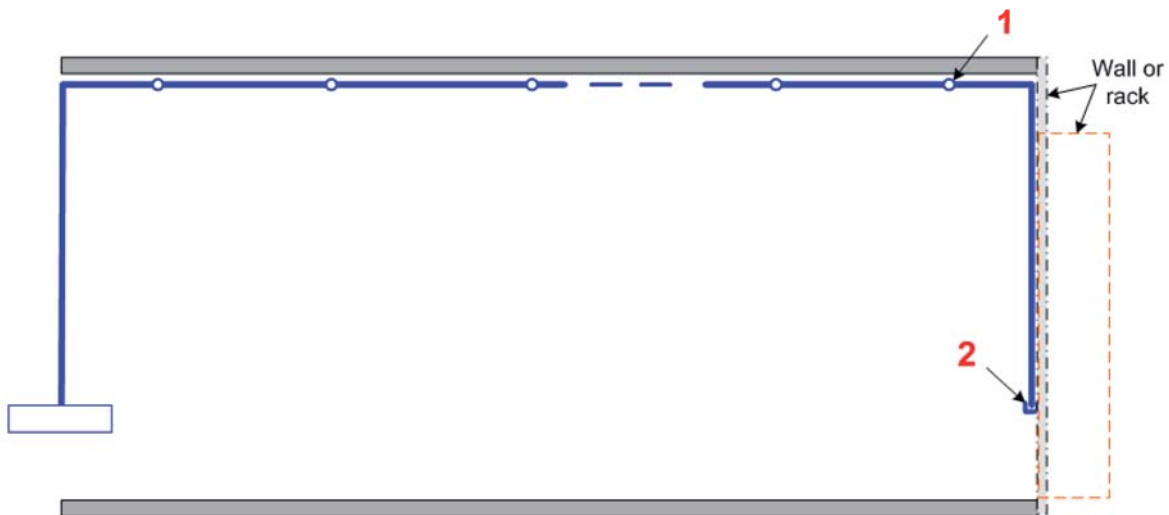


Figure 10– Extended Pipe Arrangement.

During commissioning of the System Sensor ceiling mounted system two smoke tests should be performed:

1. Smoke Transport Time Test at Point 1. Since Point 2 is comprised of a blocked end-cap, this measurement will validate the compliance of the “normal operation” of the System Sensor ceiling mounted system with regulatory requirements.
2. Smoke Transport Time Test at Point 2 (maintenance test hole). This measurement can be used to ascertain whether there are any discrepancies between the ASPIRE2 calculated values and the real results. Consistent smoke transport time measurements will indicate stable flow conditions and, hence, the compliance of the “normal operation” of the System Sensor ceiling mounted system with regulatory requirements.

**Note:** The validation of the “normal operation” and “maintenance” pipe arrangements for the System Sensor system is performed during the commissioning phase, by establishing the simulated (ASPIRE2) and empirical smoke transport times.

# Warehouses Application Notes

## References

- [1] System Sensor (2008) SYSTEM SENSOR System Design Manual, Ed. 1.0.
- [2] Australian Government State and Territories of Australia (2005) *International Fire Engineering Guidelines*.
- [3] British Government (2001) *British Standard BS 7974: Application of Fire Engineering Principles to the Design of Buildings*.
- [4] SFPE (2000) *Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings*.
- [5] Australian Standard AS/NZ 4360 (1999) *Risk Management Standard*.
- [6] SFPE (2002) *Handbook of Fire Protection Engineering*, 3<sup>rd</sup> Edition.
- [7] NFPA (1999) *National Fire Alarm Code*, 72.
- [8] The Plastics Pipe Institute, Inc.(1999) "*Suggested Temperature Limits for the Operation and Installation of Thermoplastic Piping in Non-Pressure Applications, TN-11/99*". [www.plasticpipe.org](http://www.plasticpipe.org).
- [9] Plastic Pipe and Fittings Association (2003) "Information & Technical Guide – ABS Plastic Pipe & Fittings [www.ppfahome.org](http://www.ppfahome.org)."

# Warehouses Application Notes

## Disclaimer On The Provision Of General System Design Recommendations

Any recommendation on system design provided by System Sensor is an indication only of what is considered to be the most suitable solution to meet the needs of the common application environments described.

In some cases the recommendations on system design provided may not suit the unique set of conditions experienced in a particular application environment. System Sensor has made no inquiry nor undertaken any due diligence that any of the recommendations supplied will meet any particular application. System Sensor makes no warranty as to the suitability or performance of any recommendation on system design. System Sensor has not assessed the recommendation on system design for compliance with any codes or standards that may apply nor have any tests been conducted to assess the appropriateness of any recommendations on system design. Any person or organization accessing or using a recommendation on system design should, at its own cost and expense, procure that the recommendation on system design complies in all respects with the provision of all legislation, acts of government, regulations, rules and by-laws for the time being in force and all orders or directions which may be made or given by any statutory or any other competent authority in respect of or affecting the recommendation on system design in any jurisdiction in which it may be implemented.

System Sensor products must only be installed, configured and used strictly in accordance with the General Terms and Conditions, User Manual and product documents available from System Sensor. System Sensor accepts no liability for the performance of the recommendation on system design or for any products utilized in the implementation of the recommendation on system design, aside from the General Terms and Conditions, User Manual and product documents.

No statement of fact, drawing or representation made by System Sensor either in this document or orally in relation to this recommendation on system design is to be construed as a representation, undertaking or warranty.

To the extent permitted by law, System Sensor excludes liability for all indirect and consequential damages however arising. For the purposes of this clause, 'consequential damage' shall include, but not be limited to, loss of profit or goodwill or similar financial loss or any payment made or due to any third party.

Recommendations on system design are provided exclusively to assist in design of systems using System Sensor products. No portion of this recommendation on system design can be reproduced without the prior approval in writing of System Sensor. Copyright and any associated intellectual property in any such recommendations on system design or documentation remains the property of System Sensor.

### *System Sensor Europe (Technical Services)*

Charles Avenue  
Burgess Hill  
RH15 9TQ  
United Kingdom

Tel: +44 (0)1444 238820  
Fax: +44 (0)1444 248123  
Email: [sse.technical@systemsensor.com](mailto:sse.technical@systemsensor.com)

### *European Manufacturing Centre*

System Sensor  
Via Caboto 19/3  
34147 Trieste  
Italy

Tel: +39 040 949 0111  
Fax: +39 040 382 137  
Email: [sse.sales@systemsensor.com](mailto:sse.sales@systemsensor.com)

[www.systemsensoreurope.com](http://www.systemsensoreurope.com)

