Aspirating Systems

Correctional Facilities - Design & Application Guide

System Sensor Application Design Guide

SYSTEM SENSOR®

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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 Prisons or Correctional Facilities.

- The majority of fires in such facilities are started deliberately.
- Vandalism of equipment causes serious disruption to detection system operation.
- The confinement of inmates makes early detection of fire events essential to the protection of life.
- It is preferable to minimize the need for an evacuation of the facility or parts of the facility because of the security problems that releasing and monitoring large numbers of prisoners would cause.

In this Design Guide we will discuss relevant design considerations and make recommendations regarding the most effective way in which to install a SYSTEM SENSOR solution in the particular prison or other correctional 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. Other regional industry practices, where applicable, should also be adhered to.

Contents

1. Background Information

1.1 Scope

In addition to prisons and jails, the following also come under the umbrella term of 'correctional facility':

- Remand Centers
- Detention Centers
- Community Residential Centers
- Work Camps
- Substance Abuse Centers
- Lock Down Facilities
- Training Schools
- Holding Area
- Police Station

1.2 Fire Safety Considerations in Prisons and Correctional Facilities

The major fire risks and detection difficulties within prisons and correctional facilities arise as a result of the following:

- Arson – deliberately lit fires within prison cells are the most common source of fire in correctional facilities.
- Electrical overheating in distribution equipment or electrical appliances.
- Large amounts of electrical cabling housed in control and equipment room floor voids can overheat and ignite. The detection of fires in these inaccessible areas may be delayed which in turn will facilitate their rapid spread along the cables.
- Cooking accidents in high usage kitchen areas.
- Vandalism of detectors in prison cells seriously compromises the smoke detection system's ability to detect.
- Tampering with detectors can cause false alarms. The ensuing evacuations only serve to increase the risk to staff safety from large numbers of unrestrained inmates.
- The requirement of access to each individual cell makes maintenance problematic due to security and maintenance personnel safety issues, and thus is likely not to be conducted as frequently as required. Some detectors may be dysfunctional for quite some time before this fact is noticed and remedied.

1.3 Performance-Based Design

The unique environments within prisons and correctional facilities present a challenge to both early and reliable fire detection. There is a high likelihood that detection performance will be dependent on system design and the frequency of maintenance. 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 operational and environmental conditions. This allows sample hole spacing and location to be specified to suit the particular performance requirements.

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)[1].
- SFPE Engineering Guide to Performance-Based Fire Protection[2].
- British Standard BS 7974[3].
- AS/NZ 4360 Risk Management Standard[4].
- SFPE Handbook of Fire Protection Engineering, Third Edition[5].

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 correctional facility, are conducted as part of the design process.

1.4 Key Design Considerations

The following should be considered when designing a SYSTEM SENSOR system for a prison or other correctional facility:

1. In what areas other than prison cells, kitchens etc. will fire protection be required (central control room, gatehouse, equipment room etc.)?
2. Are any other fire protection measures such as suppression and smoke management systems required? If so, how is the alarm response to be staged for initiation or activation of these systems?
3. How can life safety be protected, preferably with minimal increase of any security risk?
4. How can the installation best minimize the potential for vandalism of detection equipment?
5. How, if possible, can maintenance of detection equipment be made easier?
6. What do local codes and standards recommend for a detection system?
7. What do prison authority or facility regulations require?

1.5 Why Use SYSTEM SENSOR Smoke Detection?

It is essential that fires in correctional facilities be detected as soon as possible in order to minimize the danger to life. Inmates do not have the freedom to escape smoke or fire by themselves and a large scale evacuation is not ideal due to the potential security and staff safety risks.

The limitations of conventional technologies such as point (spot) type smoke, heat and beam detectors lie mainly in the fact that they are very visible and, when placed in prison cells, are frequently tampered with for the purposes of damaging them or initiating a false alarm. Damaged detection devices can go unnoticed for quite some time since their maintenance is awkward, requiring access to each cell.

None of the conventional types of detector have the ability to detect fire or smoke soon enough to satisfy the requirements of many local codes and standards for prisons and correctional facilities.

Reasons why a SYSTEM SENSOR system is the most appropriate solution for the prison environment are as follows:

- The SYSTEM SENSOR system underpins the protect-in-place strategy. The detector's very early warning capability allows the detection of fires in their incipient (smoldering) stage or developing flaming state. At this stage the fire is small, has not spread far and can be easily extinguished or controlled. Detection at this point protects life (less smoke inhalation) and reduces the need for a large scale evacuation.
- SYSTEM SENSOR detectors' active and high sensitivity sampling allows them to detect smoke faster than conventional detectors in areas with high air movement due to natural or mechanical ventilation (e.g. exhaust ducts, behind grills). Many areas of prisons and correctional facilities are air-conditioned. This can interfere with the normal dispersion of smoke, diluting and diverting it away from ceiling mounted smoke detectors, or can cool it to an extent that it no longer possesses sufficient thermal energy to rise towards heat or smoke detectors.

- The multiple alarm levels that can be set on SYSTEM SENSOR detectors allows for investigation before an actual fire alarm is issued and provides options for a staged response, including the activation of smoke control and/or fire suppression systems.
- The SYSTEM SENSOR sampling pipes can be concealed in ceiling voids or false ceilings, making them less of a target for vandalism. A sampling hole that has been deliberately blocked will be able to be identified immediately since the associated detector will issue a flow fault.
- SYSTEM SENSOR detectors are resistant to attempts to initiate a false alarm. Any particulate matter intentionally directed through the sampling holes would be filtered out by the on-board filter (mechanically) and by software algorithms (electronically).
- Only the SYSTEM SENSOR sampling pipes are run through the prison cells, with the detector mounted elsewhere. This improves the ease of installation and maintenance of the system. Sampling pipe maintenance only requires compressed air to be blown through the system, which can be done at the detector. Therefore, no staff access to cells is required.
- In operational areas, installation of the detector outside protected areas will allow maintenance to take place without disruption.
- A SYSTEM SENSOR detector can be designed to protect a small number of cells where the fire event location can then be singled out when an alarm is issued. With a SYSTEM SENSOR LaserSCANNER, a more precise fix on the general location of a fire event is possible, since this type of detector can determine which of its four sampling pipes smoke has been drawn into.

2. Designing For Effective Fire Protection

2.1 Levels of Protection

A summary of the various areas, within prisons and correctional facilities, and the appropriate levels of protection for those areas are presented in the table below.

Table 1 – Levels of protection recommended for areas within prisons and correctional facilities.

Area	Essential	Recommended
Visitors Reception, Gatehouse		
CCR and Equipment Rooms	✓	
Other		✓
External Administration Areas		✓
Storage and Plant Rooms		✓
Pistol Range	✓	
Prisoner Reception		
Holding Cells	✓	
Other		✓
Visitors Center		✓
Health Center		
Observation Cells	✓	
Other		✓
Operational Management Center		
Management Areas	✓	
Holding Cells	✓	
Other		✓

Table 1 (Continued).

Area	Essential	Recommended
Recreation/Discharge Areas		
Holding Cells	✓	
Other		✓
Neighborhood & Cottage Accommodation		
Holding Cells	✓	
Other		✓
Educational Areas		✓
Mainstream accommodation	✓	
Younger prisoners accommodation	✓	
Vulnerable prisoner accommodation	✓	
Detox/At-risk Accommodation		
Holding and Muirhead Cells	✓	
Other		✓

2.2 Other Design Considerations

Sampling hole spacing for ceiling mounted SYSTEM SENSOR detectors is usually specified by local prescriptive codes and standards. In this Design Guide, the recommended sampling hole spacing for all other sampling locations is based on typical values from fire codes, industry-wide Performance-Based Design guidelines or on System Sensor's extensive applications research and in-situ test results.

Alarm threshold values will depend on the particular area being protected.

Important Note: All pipe network designs must be verified by ASPIRE2, System Sensor's Pipe Network Modelling Tool.

2.3 Protecting Cells

In general, cells will be small enough to require only one sampling hole. If there is a ceiling void, SYSTEM SENSOR sampling pipes can be installed in it with a capillary tube sampling hole on the ceiling of the cell (Figure 1). In cases where a service cylinder is present, it is acceptable to run the SYSTEM SENSOR pipe inside it with a capillary sampling hole high up on the cell wall (Figure 2). Sampling holes must be concealed to protect them against vandalism. This is discussed later.

Where neither ceiling nor wall installation is possible, SYSTEM SENSOR sampling pipes can be installed inside the exhaust vent duct behind the grills as shown (Figure 2). In-duct sampling is most effective when the HVAC system is in operation. Although SYSTEM SENSOR detectors are perfectly capable of detecting smoke without forced ventilation, the system performance under this condition should be tested and taken into consideration.

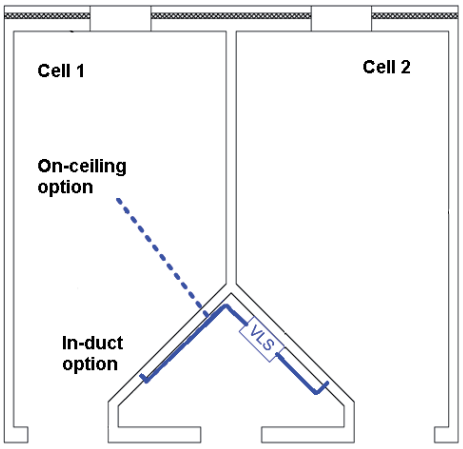

Figure 1 – SYSTEM SENSOR On-ceiling protection (for two adjacent prison cells).

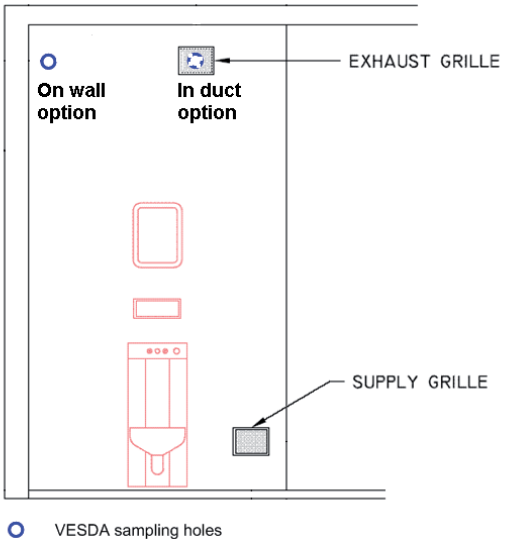

Figure 2 – Sampling pipes on the wall and in the exhaust duct of a prison cell.

Protection Methods For Other Areas

The location of sampling holes, in other areas within the prison or correctional facility, will depend on the particular features of that area. There are several sampling options:

- On-ceiling Sampling
- Floor/Ceiling Void Sampling
- Return Air Vent Sampling
- In/On-Cabinet Sampling

2.4 On-Ceiling Sampling

SYSTEM SENSOR sampling pipes should be installed on the ceiling such that the sampling holes form a grid pattern as shown (Figure 3). Each sampling hole should be positioned at the intersections of the grid lines; in the same location as a conventional point (spot) type detector would occupy if it were being installed. The distance between sampling holes will be dependant on local codes and standards.

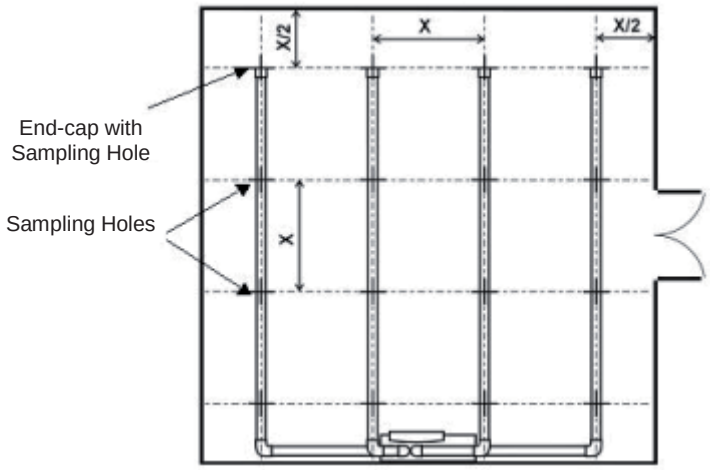

Figure 3 – Example of the grid used to determine detection point (SYSTEM SENSOR sampling hole) locations on the ceiling.

In cases where an area possesses a false ceiling, it is a common practice to install the SYSTEM SENSOR pipe network in the ceiling void with capillary tubes suspended through the ceiling tiles into the room (Figure 4). The capillary tubes must be short and must enter the room at the locations determined by the line intersections on the grid (Figure 3).

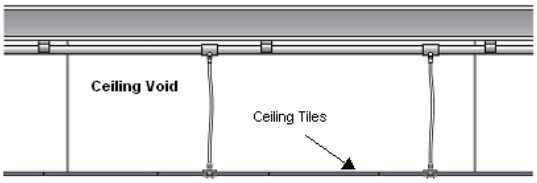

Figure 4 – Example of capillary air sampling.

2.5 Floor/Ceiling Void Sampling

The floor voids, and sometimes the ceiling voids, of control and equipment rooms often contain large amounts of electrical cabling. To protect these areas, SYSTEM SENSOR sampling pipes are installed on the upper surface of the inside of the void (Figure 5) with their sampling holes arranged in a grid with spacing requirements dependant on local codes and standards.

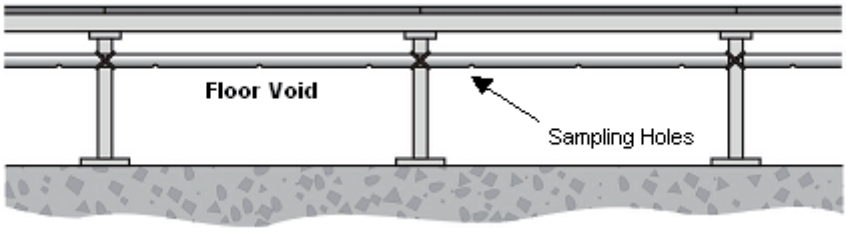

Figure 5 – Example of floor void protection.

2.6 Return Air Vent Sampling

In areas where there is high air movement, more reliable detection can be achieved by complementing on-ceiling sampling with sampling across the return air vent of the Air Handling Unit (AHU) as shown (Figure 6). Since all air in the area will pass through this vent, any smoke present will be detected quickly.

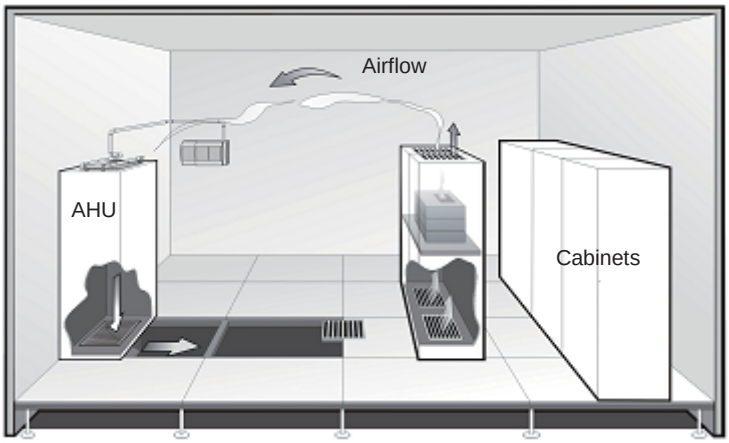

Figure 6 – Example of sampling across the return air vent of the AHU.

For this type of sampling, NFPA 76[6] recommends a maximum area of coverage per sampling hole of 0.4 m^2 (4 sq.ft). Where the vent is small, the SYSTEM SENSOR detector recommended maximum area of coverage per sampling hole may be reduced to 0.2 m^2 (2 sq.ft). For example, a vertical return air vent of dimensions 1.5 by 0.8 m (5 by 2.6 ft) would require six sampling holes as shown (Figure 7).

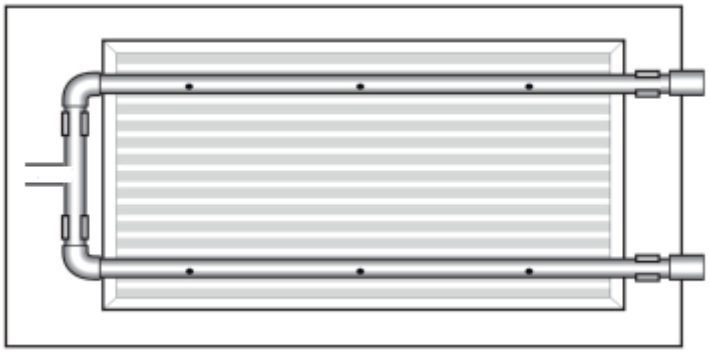

Figure 7 – Example of the required sampling hole location on a return air vent 1.5 by 0.8 m (5 by 2.6 ft).

Note: The ASPIRE2 pipe network modeling software should be used to verify that the transport time for any return air vent sampling system is within acceptable limits.

2.7 In/On-Cabinet Sampling

Cabinets containing electrical equipment are usually ventilated either vertically (from bottom to top) or horizontally (from front to back). Some cabinets are fully enclosed and have internal cooling and ventilation.

There are two methods for protecting cabinets:

1. In-Cabinet Sampling
   a) With sampling pipe inside the cabinet
   b) With capillary tubes or drop/riser pipes penetrating the cabinet
2. On-Cabinet Sampling

In-cabinet sampling with the sampling pipe inside the cabinet is suitable for both sealed and ventilated cabinets. Each cabinet has its own dedicated detector. This method provides optimal protection and is favored by many cabinet OEM's (Original Equipment Manufacturers). For ventilated cabinets, air is sampled just before it exits the cabinet.

When using capillary tubes, drop pipes or riser pipes for in-cabinet sampling, the sampling holes of the main SYSTEM SENSOR sampling pipe are extended into the top or bottom of the cabinet using the capillary tube or drop/riser pipes (Figure 8).

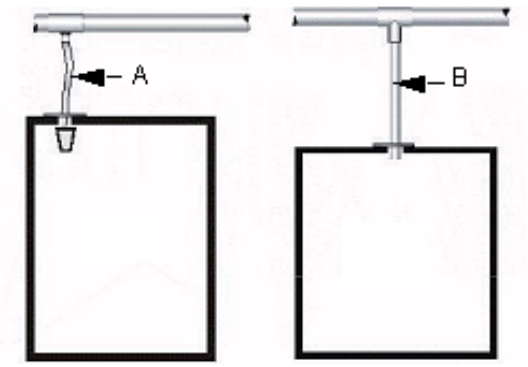

Figure 8 – Example of a capillary tube (A) and drop pipe (B) used for in-cabinet sampling.

Sampling holes are always near the top of the cabinet and should be a distance of 25 to 50 mm (1 to 2 inches) from the cabinet top. This sampling method is only suitable for sealed cabinets or cabinets with little ventilation. Where a riser pipe enters a cabinet from below, the sampling hole should be arranged such that it faces downwards at the recommended distance from the top of the cabinet. End-caps with appropriately sized sampling holes should be used on drop/riser pipes.

On-cabinet sampling is achieved by running the SYSTEM SENSOR pipe above one or more cabinets with at least one sampling hole facing into the path of the exhausted air (Figure 9). This method is only suitable for vertically ventilated cabinets.

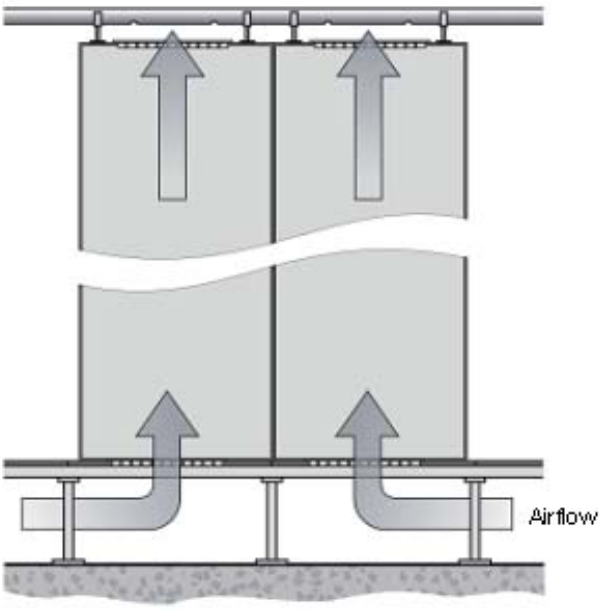

Figure 9 – Example of on-cabinet sampling.

Note: If addressability is required, a SYSTEM SENSOR LaserSCANNER (VLS) detector can be used to protect specific cabinets or rows of cabinets. This type of detector can distinguish into which of its four sampling pipes smoke has been drawn.

WARNING: When installing capillary tube sampling in cabinets with extraction fans, the low pressure caused by the fan may prevent air and, hence, smoke entering the SYSTEM SENSOR sampling pipe. If this is found to be occurring, sampling outside the cabinet, downstream from the exhausted air, may be more appropriate.

2.8 Concealing Sampling Pipes

SYSTEM SENSOR sampling pipes can be disguised as electrical conduits and their sampling holes can be concealed inside tamperproof housings (Figure 10).

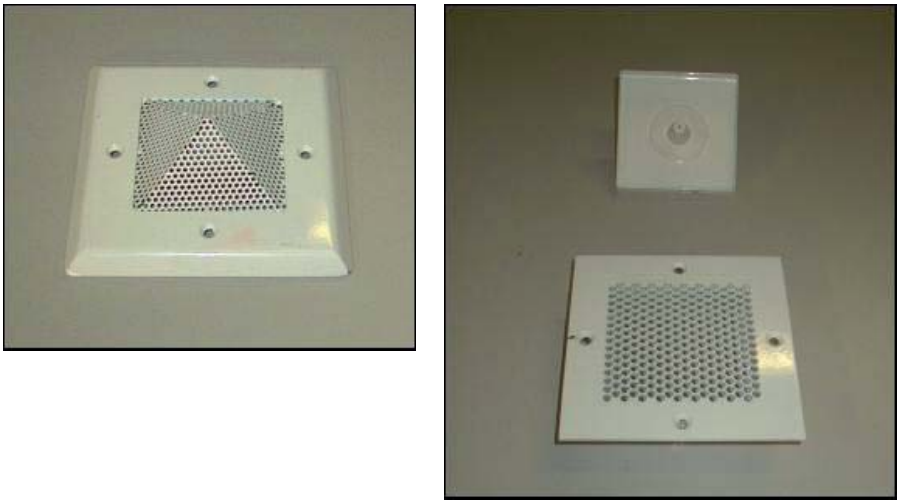

Figure 10 –Vandalism resistant sampling hole housings.

3. Ongoing Considerations

3.1 System Commissioning

Once the SYSTEM SENSOR system has been installed it must be commissioned prior to release. The commissioning procedure will verify system performance and sampling pipe network integrity with ASPIRE2 results.

The process of commissioning should follow standard SYSTEM SENSOR practices as described in the SYSTEM SENSOR System Design Manual[7].

3.2 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[7].

Important Note: A shorter service period may be applied to maintain efficient smoke sampling since the mesh screen in front of the sampling holes may deliberately be tampered with.

Important Note: Due to the excessive amount of dust and lint, an appropriate SYSTEM SENSOR filter replacement program needs to be put in place.

References

[1]. Australian Government State and Territories of Australia (2005) *International Fire Engineering Guidelines.*

[2]. SFPE (2000) *Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings.*

[3]. British Government (2001) British Standard BS 7974: *Application of Fire Engineering Principles to the Design of Buildings.*

[4]. Australian Standard AS/NZ 4360 (1999) *Risk Management Standard.*

[5]. SFPE (2002) Handbook of Fire Protection Engineering, 3rd Edition.
[6]. NFPA76 (2005) Standard for the Fire Protection of Telecommunications Facilities.
[7]. System Sensor (2006) SYSTEM SENSOR System Design Manual, Ed. 4.5.

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.

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