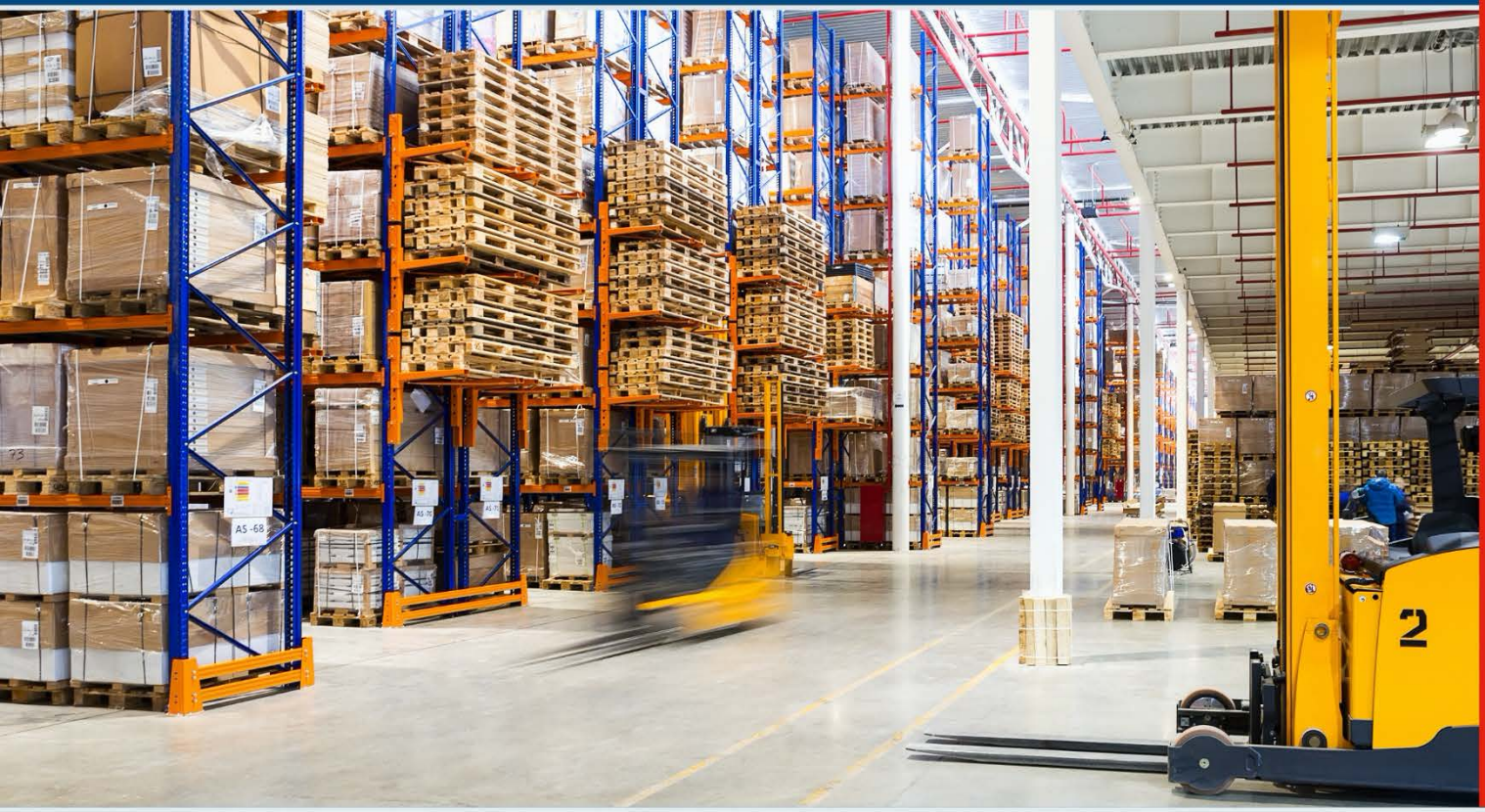
Protec
Fire and Security Group

Aspirating Detection System



# Protec Aspirating Detection System
# **Warehouse Design Guide – Issue 1**

ADDRESSING SAFETY SYSTEMS WITH INTELLIGENCE

## Document Revision Details

| Issue | Modification Detail | Author(s) | Approved | Date |
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| 0 | Original Issue | MAC / AGD | CH | 02/05/2018 |
| 1 | Enhancement of Requirement for 'Performance Testing' section | MAC | CH | 10.12.20 |

## Introduction

This Design Guide has been produced by Protec Fire & Security Group to assist when designing Protec Fire & Smoke Aspirating Detection Systems for warehouse applications.

The aim of the Design Guide is to provide a basic design concept to enable the designer to provide a considered, compliant and correctly functioning detection system using Protec Aspirating Systems solutions.

Warehouses come in many varying dimensions and orientations, therefore each warehouse needs to be designed specifically for its own layout and risk.

Warehouses contain many different combustible materials many of which produce differing amounts of fire and smoke particles. Therefore, it is important to select the correct detection technology for the risk.

Common features within the majority of warehouses are high roof levels, wide open spaces and in some warehouse applications in-rack storage systems.

All aspirating system designers should be fully qualified, competent and conversant with the technical operation and differences of the various aspirating technologies and detectors. Designers should also familiarize themselves with all aspects of local applicable codes and standards.

The following pages offer guidance to the designers and installers of these systems in order to achieve a successful Warehouse Aspirating Detection System.

**Please Note:**

**The information provided within this Design Guide should be used in conjunction with your Local Standards and Fire Codes. Local regional industry practices where relevant should also be observed.**

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## Definition of a Protec Aspirating Detection System

Aspirating detectors provide an 'active' detection system that sample air from a given area or fire zone to detect the presence of combustion particles or smoke.

These combustion and/or smoke particles are transported to the detector via an integral aspirator that continuously draws air from a network of supervised sampling pipes, each containing small holes more commonly known as sampling points.

Having identified an increase in airborne combustion/smoke particle levels this information is presented as a number of staged alarms via the detector display and outputs.

### Introduction to aspirating 'Cloud Chamber Detection' Technology

It is known that particles smaller than the wavelength of visible light occur spontaneously as a material is overheated, and in numbers far above those present in a normal ambient environment. Cirrus Pro & Cirrus Hybrid Detectors utilise the 'Wilson Cloud Chamber' principle to detect the sub-micron particles that are generated at the incipient and all other stages of fire.

A sample of air from the protected space is delivered to the detector via a centrifugal blower, a portion of which is diverted into a humidifier. At approximately 100% relative humidity, the sample is directed to the Cloud Chamber where, because of cooling due to rapid vacuum expansion, water condenses onto all the airborne particles within the sample.

Consequently, the thermally generated particles cause many droplets to form into the cloud, which are then detected by the measuring system of the Cloud Chamber. The density of the cloud formed is directly proportional to the number of particles present.

The result is a continuous signal that corresponds to the particle concentration. This signal is used to provide a staged alarm sequence with four alarm levels.

### Introduction to aspirating 'Optical' & 'Optical/CO' Technology

One alternative technology to cloud chamber based aspirating detectors is 'Optical Smoke' sensing aspirating detectors. Lasers or LED light sources can be used to identify small amounts of visible smoke particles created as material combusts. Generally speaking all optical aspirating detectors should first take the sampled air through a filter to try to remove airborne dust, as this is often the cause of unwanted alarms.

The filtered air then passes into the optical chamber in front of the light source, where reflected light from the visible smoke particles (known as light scatter) is measured by a photo collector.

The optical signal strength (amount of scattered light) is then reported as a measurement of %obs/m on the detector display.

In addition to 'Optical Smoke' sensing, some aspirating detectors also include CO (Carbon Monoxide) sensing elements. Through complex algorithms, the monitoring for CO can help avoid unwanted alarms caused by 'Optical' only detectors. It should be noted that the CO monitoring in aspirating detection systems is generally only suitable for smaller rooms due to dilution.

## Introduction to Protec Aspirating Detectors

Aspirating **FIRE** Detection utilising Cirrus Pro 'Cloud Chamber' Aspirating Fire Detectors

Protec Cirrus Pro Series aspirating fire detectors utilise the 'Wilson Cloud Chamber' as its primary source of detection. This unique 'Cloud Chamber' technology enables the Cirrus Pro detectors to be one of the earliest and most versatile fire detection technologies currently available. In addition the Cloud Chamber technology ensures that Cirrus Pro detectors provide the least possible potential for 'false alarms' from dust, steam, condensation, humidity, high airflow and temperature changes, that can create problems for other aspirating detector technologies. The unique cloud chamber measurement scale is in particles per $cm^3$ ($PCM^3$). Protec Cirrus Pro 200 aspirating fire detector is fully compliant with EN54 Part 20.

Aspirating **SMOKE** Detection utilising ProPointPlus 'Optical & CO' Aspirating Smoke Detectors

Protec ProPointPlus aspirating smoke detectors utilise 'optical' LED Scatter Chamber Detectors (SCD's) within each of the four detector sampling ports. Each SCD can be individually pre-set to Class A - high sensitivity (3 holes per pipe), Class B - enhanced sensitivity (5 holes per pipe), Class C - normal sensitivity (8 or 12 holes per pipe) and Prison Cell mode settings. The SCD smoke sensor identifies the visible smoke particles generated as material over-heats. All ProPointPlus aspirating smoke detectors are fully compliant with EN54 Part 20.

Aspirating **FIRE & SMOKE** Detection utilising Cirrus HYBRID Aspirating Fire & Smoke Detectors

Protec Cirrus HYBRID aspirating detector contains two separate detection elements to detect two different phenomenon associated with fire (fire particles and smoke particles). The Cirrus HYBRID detector includes as its primary sensor, a 'Cloud Chamber' fire detector. This is supplemented by high sensitivity 'Optical' detectors provided within each of the four detector sampling ports.

Fire detection – The Cloud Chamber detector identifies invisible sub-micron particles generated during the combustion process when an over-heat condition occurs. The cloud chamber measurement scale is in particles per $cm^3$ ($PCM^3$) and provides the 'Fire' detection element of the Cirrus HYBRID detector.

Smoke detection – Optical smoke sensors identify visible smoke particles generated as material continues to over-heat. The optical measurement scale is percent obscuration per meter (%Obs/m) and provides the 'Smoke' detection element of the Cirrus HYBRID detector.

Combined Fire and Smoke Scale – Cirrus HYBRID detectors indicate these two separate detection element scales ($PCM^3$ & %Obs/m) individually, however as its primary display these two scales are combined and integrated on a bespoke scale known as Combined Fire and Smoke (CFS). All Cirrus HYBRID aspirating fire and smoke detectors are fully compliant with EN54 Part 20.

## Main Aspirating System Components

Protec Aspirating System Detectors technical summary.


**Cirrus Pro 200 Fire Detection**

| | |
|---|---|
| Maximum area of detection allowed: | 2000m$^2$ or a single zone or fire compartment |
| Maximum total length of sampling pipe: | Approx. 200m (subject to calculation program) |
| Maximum number of pipes: | 4 |
| Maximum number of sampling holes: | EN54 Class A – 36 holes/pipe Gain 9 @ 15%<br>EN54 Class B – 36 holes/pipe Gain 8 @ 15%<br>EN54 Class C – 36 holes/pipe Gain 7 @ 15%<br>All designs subject to calculation program verification. |
| Sampling pipe I/D: | 15mm – 25mm |
| Supply Voltage: | 20 – 29 volts DC |
| Current consumption: | 317mA quiescent – 357mA in alarm |
| Dimensions: | W – 360mm, H – 215mm, D – 144mm |

For the aspirating system detector technical summary on Cirrus Pro models not detailed above please r
Fire & Protec Fire & Security Group individual product data sheets


**ProPointPlus Smoke Detection**

| | |
|---|---|
| Maximum area of detection allowed: | 2000m$^2$ or a single zone or fire compartment |
| Maximum total length of sampling pipe: | Approx. 200m (subject to calculation program) |
| Maximum number of pipes: | 4 |
| Maximum number of sampling holes: | EN54 Class A – 3 holes per pipe<br>EN54 Class B – 5 holes per pipe<br>EN54 Class C – 8 holes per pipe<br>All designs subject to calculation program verification |
| Sampling pipe I/D: | 15mm – 25mm |
| Supply Voltage: | 20 – 29 volts DC |
| Current consumption: | Fan speed dependant |
| Dimensions: | W – 380mm, H – 250mm, D – 137mm |


**Cirrus HYBRID Fire & Smoke Detection**

| | |
|---|---|
| Maximum area of detection allowed: | 2000m$^2$ or a single zone or fire compartment |
| Maximum total length of sampling pipe: | 260m (subject to calculation program) |
| Maximum number of pipes: | 4 |
| | EN54 Class A – 36 holes @ 200 CFS<br>EN54 Class B – 44 holes @ 400 CFS<br>EN54 Class C – 44 holes @ 600 CFS<br>All designs subject to calculation program verification |
| Sampling pipe I/D: | 15mm – 25mm |
| Supply Voltage: | 20 – 29 volts DC |
| Current consumption: | Fan speed dependant |
| Dimensions: | W – 380mm, H – 250mm, D – 137mm |

***Important Note:***
The above details reflect the general parameters where EN 54 approved products are required. All aspirating detection systems designs are subject to the local area/country design, installation and performance codes/requirements. Additionally ALL system designs must be verified using Protec 'ProFlow' sampling pipe calculation program.

'ProFlow' sampling pipe calculations confirm acceptability of operational parameters such as type of detector, lengths of sampling pipes, quantity and diameter of sampling holes or capillary sampling points.

## Protec Aspirating Detector Power Supply Units

**9300/EN/18** **9300/EN/24** **9800/EN/38** **9800/EN/65**

The system designers should ensure a suitable and compatible power supply is used for each aspirating detector. Protec Series 9000 3Amp & 8Amp power supplies are a self-contained supply designed to power Protec aspirating detectors and charge the associated batteries simultaneously.

The charger uses power factor correction to ensure a near unity power factor, and switch-mode technology to provide a lightweight and efficient unit.

The designer should ensure the power supply is sized correctly to suit the alarm load, the quiescent load and alarm standby periods. The following tables provides quiescent and alarm power consumption figures for Protec aspirating detectors.

Cirrus Pro Detector Power Consumption

| | STANDING | ALARM LOAD |
|---|---|---|
| DESCRIPTION | UNIT | UNIT |
| Cirrus Pro 100 | 263 | 302 |
| Cirrus Pro 200 | 317 | 357 |
| Cirrus Pro 200D | 414 | 455 |
| Cirrus Pro 200DSC | 487 | 570 |
| Cirrus Pro 200SC | 417 | 521 |
| Cirrus Pro 200+ | 410 | 430 |
| Cirrus Pro 200D+ | 474 | 529 |
| Cirrus Pro 200DSC+ | 564 | 662 |
| Cirrus Pro 200SC+ | 417 | 521 |
| Cirrus Pro X4 | 779 | 856 |
| Cirrus Pro X4ND | 699 | 776 |
| Cirrus Pro RDP | 80 | 80 |

***Important Note:***
Within the European market the only Cirrus Pro Product available will be the Cirrus Pro200 model.

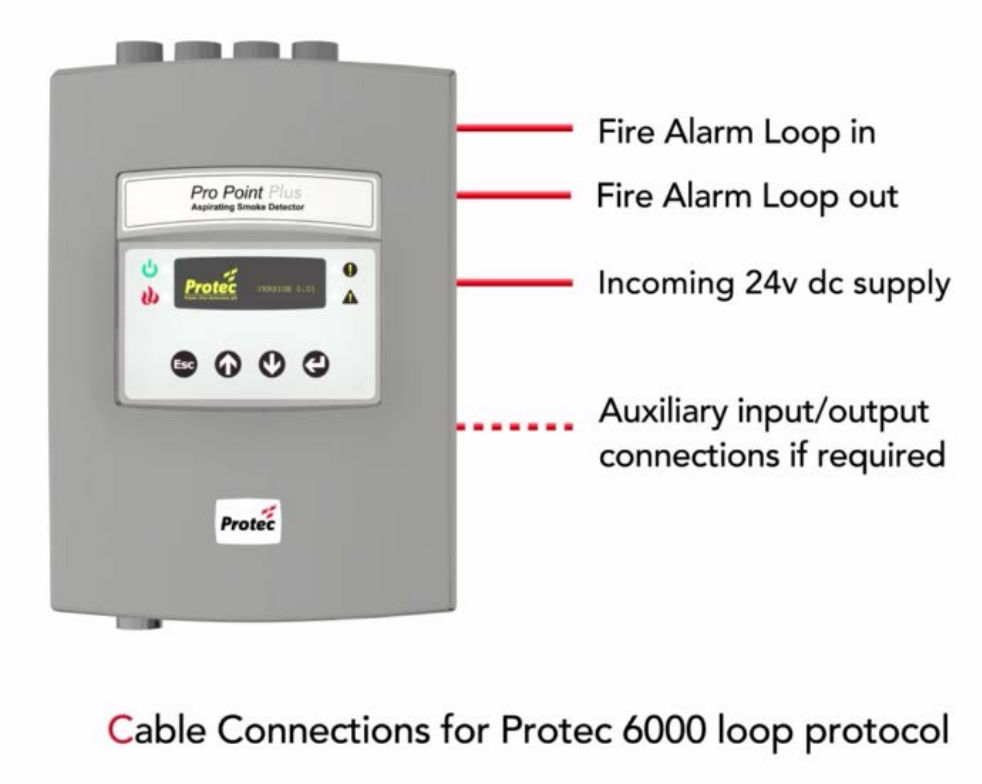
## ProPointPlus Detector Power Consumption

| | ProPoint Plus | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Blower Speed (%) | Quiescent | | | | Alarm | | | |
| | *SCD 1x* | *SCD 2x* | *SCD 3x* | *SCD 4x* | *SCD 1x* | *SCD 2x* | *SCD 3x* | *SCD 4x* |
| 100 | 360 | 400 | 425 | 455 | 410 | 450 | 475 | 505 |
| 95 | 347 | 387 | 411 | 440 | 397 | 437 | 461 | 490 |
| 90 | 334 | 374 | 397 | 425 | 384 | 424 | 447 | 475 |
| 85 | 321 | 361 | 383 | 410 | 371 | 411 | 433 | 460 |
| 80 | 308 | 348 | 369 | 395 | 358 | 398 | 419 | 445 |
| 75 | 295 | 335 | 355 | 380 | 345 | 385 | 405 | 430 |
| 70 | 282 | 322 | 341 | 365 | 332 | 372 | 391 | 415 |
| 65 | 269 | 309 | 327 | 350 | 319 | 359 | 377 | 400 |
| 60 | 256 | 296 | 313 | 335 | 306 | 346 | 363 | 385 |
| 55 | 243 | 283 | 299 | 320 | 293 | 333 | 349 | 370 |
| 50 | 230 | 270 | 285 | 305 | 280 | 320 | 335 | 355 |
| 45 | 220 | 259 | 274 | 293 | 270 | 309 | 324 | 343 |
| 40 | 210 | 248 | 263 | 281 | 260 | 298 | 313 | 331 |
| 35 | 200 | 237 | 252 | 269 | 250 | 287 | 302 | 319 |
| 30 | 190 | 226 | 241 | 257 | 240 | 276 | 291 | 307 |
| 25 | 180 | 215 | 230 | 245 | 230 | 265 | 280 | 295 |
| 20 | 170 | 204 | 219 | 233 | 220 | 254 | 269 | 283 |
| 15 | 160 | 193 | 208 | 221 | 210 | 243 | 258 | 271 |
| 10 | 150 | 182 | 197 | 209 | 200 | 232 | 247 | 259 |
| 5 | 140 | 171 | 186 | 197 | 190 | 221 | 236 | 247 |

## Cirrus HYBRID Detector Power Consumption

| | CirrusHYBRID | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Blower Speed (%) | Quiescent | | | | Alarm | | | |
| | *SCD 1x* | *SCD 2x* | *SCD 3x* | *SCD 4x* | *SCD 1x* | *SCD 2x* | *SCD 3x* | *SCD 4x* |
| 100 | 522 | 590 | 626 | 685 | 622 | 690 | 726 | 785 |
| 95 | 504 | 572 | 608 | 649 | 604 | 672 | 708 | 749 |
| 90 | 485 | 558 | 595 | 640 | 585 | 658 | 695 | 740 |
| 85 | 463 | 545 | 572 | 604 | 563 | 645 | 672 | 704 |
| 80 | 449 | 531 | 554 | 590 | 549 | 631 | 654 | 690 |
| 75 | 431 | 495 | 535 | 567 | 531 | 595 | 635 | 667 |
| 70 | 417 | 481 | 522 | 549 | 517 | 581 | 622 | 649 |
| 65 | 404 | 467 | 504 | 535 | 504 | 567 | 604 | 635 |
| 60 | 390 | 454 | 485 | 517 | 490 | 554 | 585 | 617 |
| 55 | 376 | 440 | 472 | 504 | 476 | 540 | 572 | 604 |
| 50 | 372 | 417 | 454 | 485 | 472 | 517 | 554 | 585 |
| 45 | 363 | 408 | 445 | 472 | 463 | 508 | 545 | 572 |
| 40 | 349 | 395 | 431 | 458 | 449 | 495 | 531 | 558 |
| 35 | 335 | 381 | 417 | 445 | 435 | 481 | 517 | 545 |
| 30 | 322 | 367 | 422 | 435 | 422 | 467 | 522 | 535 |
| 25 | 317 | 363 | 395 | 417 | 417 | 463 | 495 | 517 |
| 20 | 308 | 354 | 372 | 395 | 408 | 454 | 472 | 495 |
| 15 | 299 | 345 | 358 | 381 | 399 | 445 | 458 | 481 |
| 10 | 295 | 335 | 345 | 367 | 395 | 435 | 445 | 467 |
| 5 | 290 | 317 | 331 | 358 | 390 | 417 | 431 | 458 |

## Typical Electrical Connections for a Protec Aspirating Detector




Cable Connections for Protec 6000 loop protocol

Fire alarm loop connections

The fire alarm loop connections shown above are for integration into a Protec 6000 protocol main building fire alarm system. Each ProPointPlus/Cirrus HYBRID detector is manufactured with a 1 – 4 address 6000 protocol interface. This allows up to four address (four pipes), from the ProPointPlus/Cirrus HYBRID detector, to be individually identified at the Protec 6000 protocol main building fire alarm panel. If using the Cirrus Pro 200 EN54 unit the system will connect to the addressable Loop via a dedicated interface unit.

24vDC Power supply

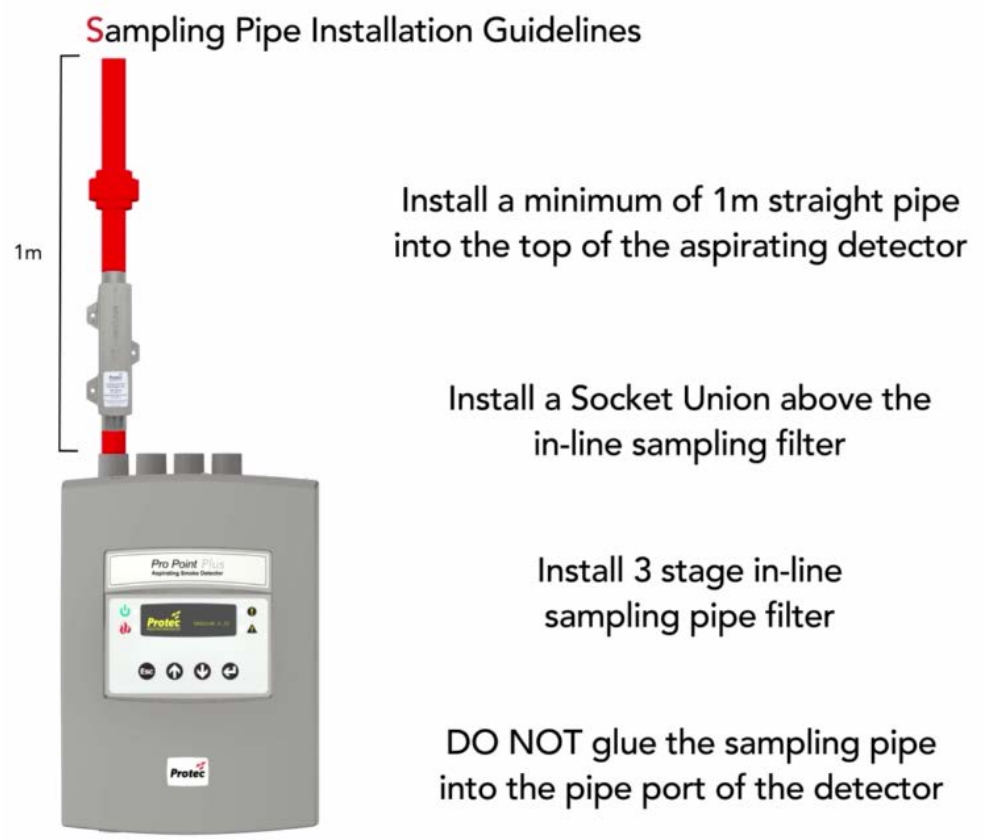
ProPointPlus detectors can be configured to monitor the incoming 24vdc standby power supply and report this directly to a Protec 6000 protocol main building fire alarm panel. Examples of compatible Protec power supply units are given above.

Programmable Input/Outputs

ProPointPlus/Cirrus HYBRID aspirating detectors have 3no. programmable 'Input' connections for remote Isolate, Silence, Reset, Mains Fault and Battery Fault monitoring.

ProPointPlus/Cirrus HYBRID aspirating detectors have 5no. programmable 'Output' connections for common Fault, common Pre-Alarm, common Fire, Pipe 1 Fire, Pipe 2 Fire, Pipe 3 Fire, Pipe 4 Fire and Double Knock signals., usually used to connect to non Protec main building fire alarm panels.

## Typical Mechanical Connections for a Protec Aspirating Detector.




Do not glue the sampling pipes directly to the ProPointPlus detector inlet ports

Each sampling pipe port utilises a reducing diameter pipe entry designed for 25mm o/d sampling pipe. The installer should ensure the sampling pipe is cut squarely and pushed firmly into the pipe port until held securely within the port. If the above is installed correctly there should be no requirement for the sampling pipe to be glued into the sampling pipe port, thereby allowing removal for future servicing requirements if necessary.

In-line Filters

All optical based aspirating detectors can provide unwanted (false) alarms from dust. Protec would therefore recommend an in-line sampling pipe dust filter for all lift shaft applications. The Protec 3 stage in-line dust filter contains a fine particle filter (greater than 5 micron), a medium particle filter (greater than 10 micron) and a course particle filter (greater than 16 micron). The Protec 3 stage in-line filter (part code 61-986-F01), should be suitable for most lift shaft applications.

Socket Unions

Protec would recommend the installation of a socket union pipe accessory on each sampling pipe above the in-line sampling pipe filter. This allows removal of the complete filter for cleaning should this be required during system servicing.

1m straight pipe at entry to aspirating detector

Protec would recommend a 1m straight length of sampling pipe at the point of entry to the aspirating detector to assist with linear airflow being provided to the airflow monitoring components.

## Protec Aspirating System Sampling Pipe and Accessories

**37-550-68**
3 Metre Length 25mm o/d
Red ABS Sampling Pipe

**37-550-68-SR**
50m Length of 25mm o/d
Flexible Red Sampling Pipe

**37-552-70**
25mm Red ABS 90°. Long Radius Bend

**37-555-73**
25mm Red ABS 45 deg. Elbow

**37-554-72**
25mm Red ABS 'Tee' Piece

**37-553-71**
25mm Red ABS End Cap

**37-559-77**
25mm Red ABS Socket Union

**37-558-76**
Red ABS Pipe Clips

**37-551-69**
25mm Red ABS Jointing Socket

**37-560-70**
Conical Head Capillary Sampling point
2mtrs of 10mm sampling tube

**37-561-71**
Flush Disc Capillary Sampling point
2mtrs of 10mm sampling tube

**37-562-72**
Discrete Capillary Sampling point
2mtrs of 10mm sampling tube

**37-563-73**
T piece for use with 10mm Capillary
Sampling tube

**37-564-74**
30mtr coil RED 10mm Capillary
Sampling Tube

**37-564-74W**
30mtr coil OPAQUE 10mm Capillary
Sampling Tube


**37-566-76**
Conical Head Capillary Sampling Point


**37-567-77**
Flush Disc Capillary Sampling Point

**37-568-78**
Discrete Capillary Sampling Point


**37-585-15**
25mm Red ABS End Cap 'Test Point'

**37-586-16**
Flush Disc Capillary 'Test Point' c/w 2mtrs of 10mm sampling tube.

**37-545-71**
1m x 25mm o/d Flexible Expansion Loop


**37-556-74**
S250ml Tin Solvent Cement


**23-039-37**
Sample Hole Warning Labels. Roll of 100
1no Label required per Sampling Point

**37-534-68** - 2.0mm Purple
**37-535-69** - 2.5mm Grey
**37-536-70** - 3.0mm Yellow
**37-537-71** - 3.5mm Blue
**37-538-72** - 4.0mm Green
**37-539-73** - 4.5mm Black
**37-540-74** - 5.0mm W hite
**37-541-75** - 6.0mm Brown

Hole Identification Tags
(See Datasheet - MED2123)

**61-986-F01** - 25mm In-line Pipe Filter
**61-986-28** - 3 Stage Replacement Filter Mesh (See Datasheet - MED2125)

**45-023-04**
Heavy Duty Dust & Humidity Filter
(See Datasheet - MED2124)

**45-023-07** - Heavy Duty Dust & Humidity Filter c/w Self Drain Flexible Loop
(See Datasheet - MED2124)

**37-584-14-BIS**
Condensation Trap


**37-599-29**
Flush Disc Capillary Test Point

**37-590-20**
Pipe Cutter

## General Design Guidelines for Warehouse Applications

### Warehouse Fire Risks

- Unauthorised Smoking
- Arson
- Faulty Electrical Equipment
- Robotic Equipment
- Forklift Trucks
- Spontaneous Ignition
- Electrical Faults with Conveyors/Plant/Machinery
- Electrical Overloads
- Careless Maintenance Works
- There is a significant fire load with stored goods and materials; especially when using in-rack storage systems. These goods have the possibility of providing a fast initial growth to a fire condition, leading to the spread of the fire.
- It has been proven that deep seated fires are difficult to extinguish and rapid growth occurs due to the stored materials.

### Design Considerations

The sensitivity setting of the aspirating detector is primarily determined by the fire risk of the Warehouse.

Local country design codes should be referenced for clarification on detector sensitivity and expected performance. For UK projects generally a 'Class B' or 'Class C' detection system is considered appropriate for warehouse buildings. In high ceiling spaces above 25m a 'Class A' detection should be considered.

The operational environment of a warehouse should be given consideration as this can provide a number of issues when designing aspirating detection systems.
Warehouse application Detector Sensitivity 'Classification':
The FIA Code of Practice for Design, Installation, Commissioning and Maintenance of Aspirating Smoke Detector (ASD) Systems Issue 3 February 2012, advises of three separate Classifications of detector sensitivity:-
The following classifications assume that the final 'end user environment' is suitable for the proposed design and detector sensitivity at commissioning stage and for the general operation of the warehouse.

Class A Detection System
*Definition:-* Aspirating smoke detector providing very high sensitivity.

Class B Detection System
*Definition:-* Aspirating smoke detector providing enhanced sensitivity.

Class C Detection System
*Definition:-* Aspirating smoke detector providing normal sensitivity.

Note:
The operational processes carried out in some warehouse applications enforce a detrimental effect on the aspirating detector sensitivity. Where this is the case a Classification of an 'Undefined Detector Sensitivity' is sometimes used and this Classification sits outside Class A, B or C, requiring special consideration as detailed below.

Undefined Detector Sensitivity
*Definition:-* Aspirating smoke detector providing sensitivity applicable to the operational environment.

Aspirating detection systems are often employed in difficult, high or harsh environment applications. This is usually after consideration is given to other detection technologies such as point type heat and smoke detectors, beam detectors or linear heat detection, etc…

When aspirating detection systems are employed in these difficult applications, it is important to consider the effectiveness of the detector sensitivity, as this is usually determined by the varying background environment.

Influences from the building height, dust, humidity, temperature, steam, vehicle emissions and other pollutants will all influence the operational sensitivity of the aspirating detector. Therefore, the detector sensitivity is configured to accommodate the background environment and to avoid, where possible, unwanted alarms from non-fire events.

To allow the correct sensitivity setting of these detection systems it is important to introduce an extended 'soak test period' (with the warehouse in its final operational state), where the background pollutant variations can be determined and recorded. Having logged this information for an appropriate time period, the alarm thresholds can then be configured to avoid unwanted alarms.

Once the ambient background environment and detector alarm thresholds have been established, a suitable 'performance test' is recommended. These tests should be agreed to by all concerned parties and the appropriate health and safety procedures should be adhered to. Additionally, Protec require a 'Live Fire Test Indemnity Form' to be signed by the client in advance of any Performance Testing being carried out.

Other significant design considerations include (but are not limited to) the following:-

- High roof levels
- Full extent of the detection coverage
- Internal heating systems
- Stratification
- In-rack storage/shelving producing compartmentation
- How any in-rack storage/shelving will affect air movement
- High fire load
- Type of materials to be stored & how are they to be loaded
- External and internal pollutants
- Will the building have mechanical or natural ventilation
- Any additional storage areas within the building (mezzanine levels, offices etc)
- Difference between background air particles during operating and non-operating hours
- Future maintenance access requirements

**Protec Aspirating Detector Choice for Warehouse Applications**

Protec ProPointPlus, Cirrus Pro200 EN54 and Cirrus HYBRID aspirating detectors are all suitable aspirating detectors for warehouse applications, however the following points should be noted.

Any forced air movement from the heating units within the warehouse will create dilution of the smoke from an overheat condition. The cloud chamber technology within the Cirrus Pro and the Cirrus HYBRID aspirating detectors have shown to be more resilient to the effects of dilution than optical only aspirating detection systems.

## Use of Aspirating Fire and Smoke Detection

Local Standards and Code of Practice documents often highlight the benefit of using Aspirating Detection Systems within warehouse environments in order to detect fires at earlier stages than point type smoke detectors would. Furthermore, point type smoke detection is limited to the height the Local Standards allow these devices to be installed and are therefore not an option as a solution for higher ceiling warehouse applications.

During a fire condition, the smoke rises to the higher levels of the roof and the smoke becomes diluted due to clean air mix and the volume space of the area.

The FIA Fact file 0045; Smoke Detection for High Ceilings 2011; compared aspirating smoke detection with optical beam detection. One significant conclusion from this comparison was that the higher sensitivity offered by aspirating systems may provide an earlier response to a fire condition. This ensures increased time for the evacuation of personnel and for firefighting to be carried out, whilst reducing client stock loss and building damage.

Building deflection created during external temperature changes often causes beam detection systems to become misaligned producing either full fire conditions or fault conditions due to poor signals.

One significant advantage of an aspirating detection system is that maintenance may be undertaken at ground floor level reducing costs to the client for access equipment hire. This is generally achieved by the installation of dedicated low level sampling pipe ‘Test Points’ as these should always be installed when deemed necessary.

## Fire Detection & Stratification Fire Risks

### Environmental Considerations within a Warehouse

Warehouse environmental conditions need to be assessed as part of the fire detection design process:-

- How will temperature differ throughout the day and night time periods, and throughout the year? Temperature changes can create stratification layers and cause sampling pipe expansion and contraction issues?
- How will ventilation and heating systems affect the airflows within the warehouse?
- What airborne particulates could be expected due to the end users operating processes and how will these affect detector sensitivity?
- What effect will high level racking present?

### Stratification

Stratification occurs when air containing smoke particles or gaseous combustion products is heated by smouldering or burning material. Whilst becoming less dense than the surrounding cooler air, it rises until it reaches a level at which there is no longer a difference in temperature between it and the surrounding air. The smoke plume, as it rises, encounters colder air from above which absorbs heat and slows the upward movement of the smoke.

As this stratified gas layer moves away from the fire, cooling and dilution will eventually produce a well-mixed flow of combustion products.

Stratification can also occur during hot days when the sun has heated the roof structure to a high temperature producing a much hotter air layer just below the roof. A small fire starting at ground level may not have the thermal energy to push the smoke particles through the higher temperature air barrier. This would result in the smoke not reaching the detection points on the roof level until the fire is considerably larger.

Testing has indicated that 'cloud chamber' based detection system such as Protec Cirrus HYBRID or Cirrus CCD are slightly less susceptible to stratification when compared to 'optical' only aspirating detectors, however this phenomenon should not be ignored and must still be a design consideration.

**Sampling Pipe Considerations**

The type of sampling pipe should be approved to local standards (if applicable) and be suitable for the application. Consideration should be given to the mechanical rigidity required for the application, mechanical fixings to the building structure and very importantly any sampling pipe expansion or contraction due to temperature changes within the environment.

## System Design

### Configuration Options for Sampling Pipe Layouts

Local design codes and standards should to be confirmed and followed for all designs.

Consideration should be given to the building length, width, height and roof layout. Particular attention should be given to the warehouse height, as this will influence the Classification of the aspirating detection system required (Class A, Class B or Class C – see section 1.2).

Note:
*The FIA Code of Practice for Design, Installation, Commissioning and Maintenance of Aspirating Smoke Detector (ASD) Systems Issue 3 February 2012 and British Standard BS5839-1:2013 now permit that aspirating detection systems can be installed up to 40m high, subject to the correct detector sensitivity and number of sampling holes being utilised for the protected area. Please refer to your Local Standards and Approvals where required.*

The height of the racked storage shelving should be assessed for its proximity to the main roof structure. Racking systems may create 'corridors' to be formed at high levels thus compartmenting the roof area and therefore requiring specific and additional design requirements from the generic 'area of coverage' per detection point.

Aspirating pipe and therefore sampling points should not to be installed adjacent to heat sources i.e. skylights, heaters, light fittings etc.

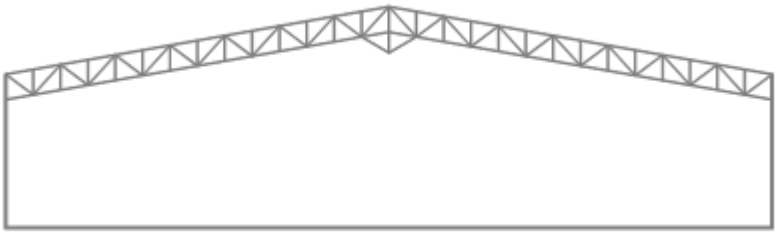
All aspirating detectors should be installed as close to the protected area as possible to reduce pipe lengths and keep sampling point transport times to a minimum.

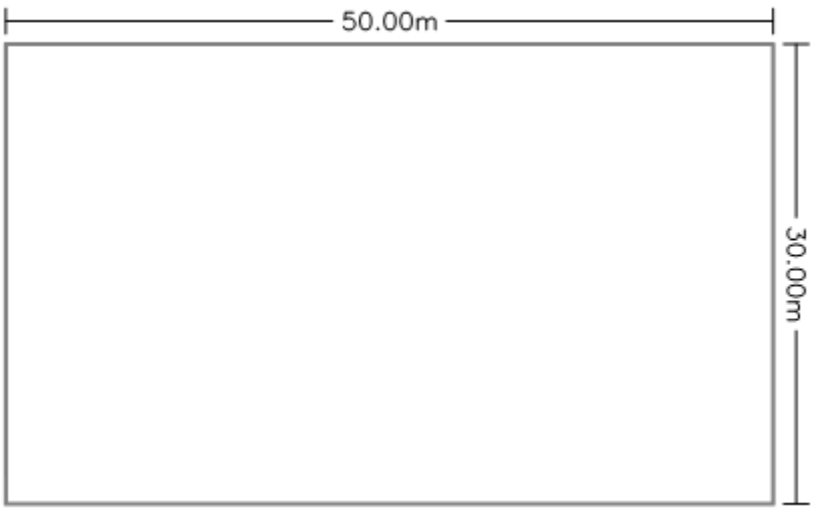
Maintenance Test Points should be installed at 'low level' for use during the service engineer visits to test the integrity of the complete sampling pipe installation. It is not necessary for Maintenance Test Points to comply with the transport time restrictions of general sampling holes.

**Positioning and Spacing of Sampling Pipes and Holes**

Local Standards and Codes provide details relating to area coverage of sampling holes and positioning. Sampling hole spacing for aspirating systems installed in warehouses are generally based upon a grid layout. Please also note; the areas of coverage per sampling point may reduce with height depending upon the applicable design code.

Measure the warehouse and check the roof layout to see which way any apex may run.

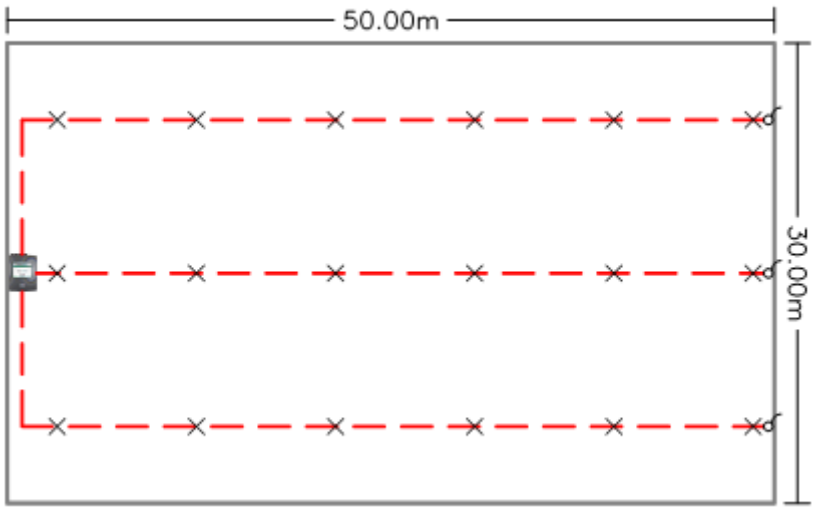




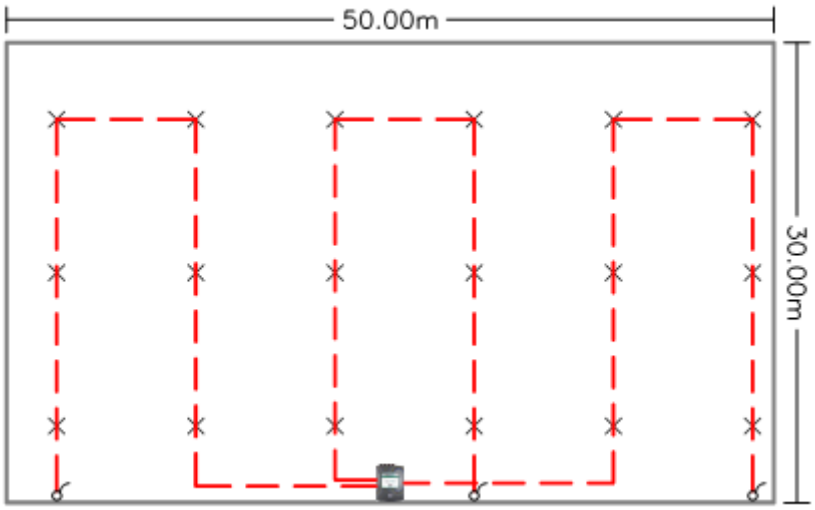
**Installation Designs to Roof Level**

When laying out the sampling point positions use the correct design tools to prove full coverage is achieved. The following drawing shows the aspirating detector at one end of the warehouse with the sampling pipe running the length of the building, fixed to the purlin structures. Note: The building central apex is covered by a sampling pipe.

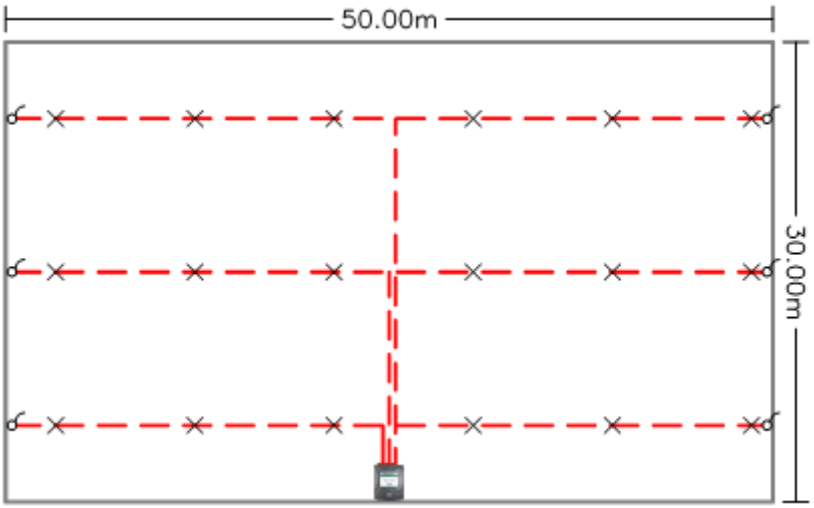
Pipes are extended down to low level Maintenance Test Points.




An alternative layout would be to go across the width of a warehouse if this is more suitable. All sampling pipes should be extended to the perimeter wall with low level Maintenance Test points being fitted. Sampling pipes should be supported as per the recommendations of the sampling pipe manufacturer. This method of installation will likely require additional mechanical pipe supports between purlins.



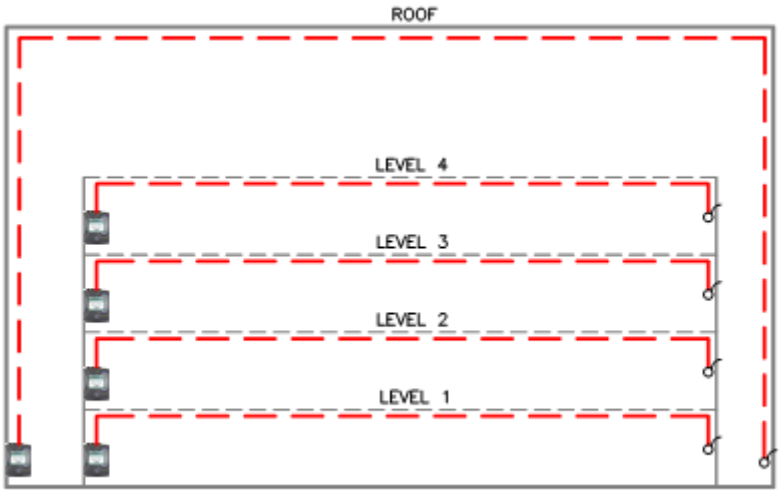
Another option could be to utilise “T or U” pipe connections as below.




**Mezzanine Considerations**

Warehouses where mezzanine floors are installed with solid flooring will obstruct the fire and smoke plume from reaching the roof, therefore additional aspirating detection should be installed at each level.

The roof level aspirating will still be required.




When designing within Mezzanine areas please be aware of additional compartments which may be formed by storage racking, client stock or structural beams.

**In-Rack Detection**

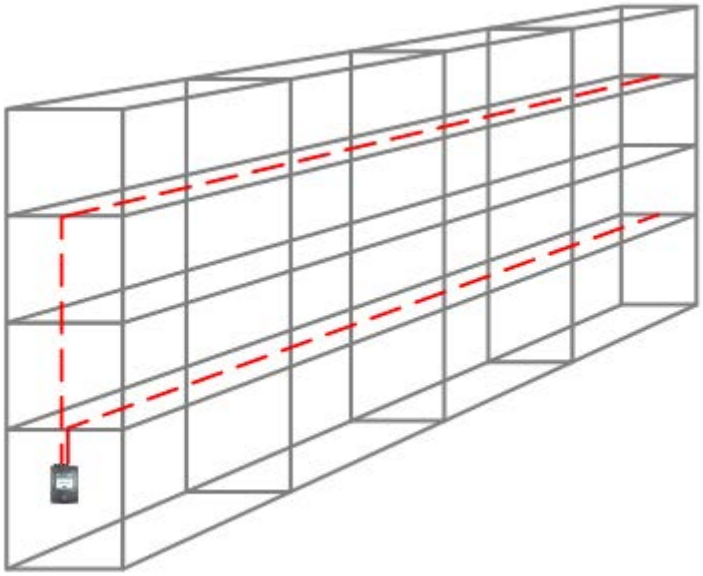
In-rack detection is often used to detect fire/smoke particles at an earlier stage than a roof level only detection system would provide. Please note that roof detection coverage is still a requirement.

Some general rules for In-rack detection from The FIA Code of Practice for Design, Installation, Commissioning and Maintenance of Aspirating Smoke Detector (ASD) Systems Issue 3 February 2012 include (but not limited to):-

*When protecting warehouses with high racking storage systems over 8m in height, sample points should be provided within the racks. A higher density of sampling holes are required in the horizontal run to reduce the possibility of fire particles/smoke passing between sampling holes. Additionally the sampling holes could be interlaced between the alternate horizontal layers.*

*A maximum horizontal spacing of 6m is recommended. The top level of in-rack sampling should be within the top 25% of the rack height and no less than 10m from the ceiling. Additional levels of in-rack sampling should be installed to ensure a maximum vertical spacing of 8m. Racks that exceed 10.5m are likely to require two levels of detection and racks over 21m are likely to require three levels.*

However, it is recommend that Local Codes and Standards are confirmed and adopted for all designs.



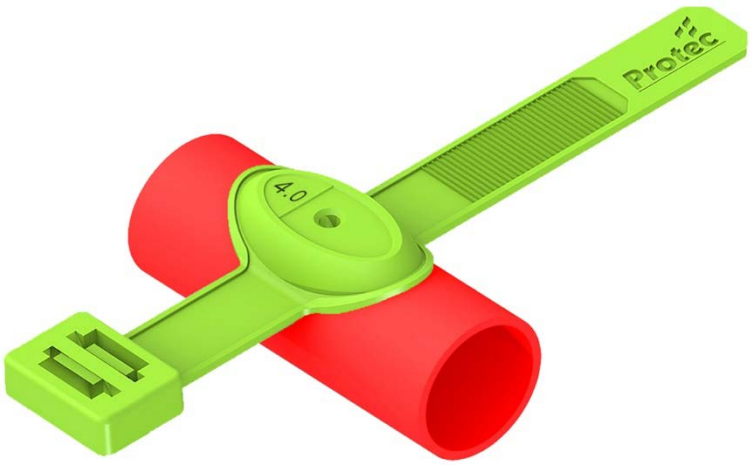
## ‘HIT’s’ Hole Identification Tags

Protec would recommend the installation of ‘Hole Identification Tags’ (HIT’s) for all Warehouse applications.

Each HIT is colour coded to identify its specific sampling hole diameter. This colour coding allows accurate identification of the various sampling hole locations and true hole size for the benefit of commissioning & servicing engineers, clients and even project auditors.

Additionally a build-up of debris and dust around a standard drilled sampling hole is can take place in warehouse applications. This is due to the friction created by the airflow through the sampling hole. Each HIT incorporates a chamfered hole entry which is proven to significantly reduce this dust loading effect.

To assist the installers a common, 8mm diameter drill is all that is required for every sampling hole location.




HIT Product Codes:

| Product Code | Description |
|---|---|
| 37-534-68 | 2.0mm - Purple HIT |
| 37-535-69 | 2.5mm - Grey HIT |
| 37-536-70 | 3.0mm - Yellow HIT |
| 37-537-71 | 3.5mm - Blue HIT |
| 37-538-72 | 4.0mm - Green HIT |
| 37-539-73 | 4.5mm - Black HIT |
| 37-540-74 | 5.0mm - White HIT |
| 37-541-75 | 6.0mm - Brown HIT |

As previously detailed **all** system designs must be verified using Protec ‘ProFlow’ sampling pipe calculation program.

**Dilution Effect on Aspirating System Designs**

Dilution can affect aspirating detection systems and therfore this should be considered at design stage. Dilution is affected by the detector sensitivity and the number of sampling holes required for the protected area.

When combustion/smoke particles are only drawn through a single sampling hole these particles are diluted when they reach the detector by the clean air drawn through the remaining holes. Given that this is the case, the more sampling holes used on the design the greater the potential for dillution.

Aspirating systems should be designed (and proved by a sampling pipe calculation program) and actual sampling hole testing, to ensure a similar amount of airflow is drawn through each sampling hole.

Where Protec EN54 part 20 approved aspirating detectors are used the restrictions on the number of sampling holes has been determined as an integral part of the approval process. The following should be applied by all designers to these designs.

**Design Verification**

It is a requirement that upon completion of every aspirating system design confirmation of all the design parameters is verified by the use of a compatible sampling pipe design calculation programme.

This programme should confirm the following:

- The model number, type and fan speed of the selected detector
- The relevant approvals of the selected detector
- The minimum and maximum pipe lengths and number of sampling holes proposed
- The airflow rates, parameters and pressures at each part of the installation
- The time taken from all the sampling holes to the detector (transport time).

This programme will confirm the sampling hole dimensions and will indicate if there are any errors with the overall design.

Protec provide ProFlow 2 and ProFlow 3D sampling pipe design calculation programme software to assist the system designers to provide verified designs.

## Requirement for 'Performance Testing'

Section 5.3 of the FIA Code of Practice Issue 3 February 2012 states that the decision as to whether performance tests should be conducted during commissioning depends on the classification of the ASD system being deployed. Generally there is only one situation where a performance test can be omitted; when an approved ASD system is deployed (and is fully compliant with the specific requirements of the product approval) with sampling hole spacing that falls within the full requirements of the relevant prescriptive code (e.g. BS5839-1 2017). In all other situations it is recommended that a 'suitable performance test' is specified and carried out during commissioning to verify the system.

Therefore the designer should be conversant with the type of test likely to be applied to each particular design/application.

Note: Any performance test should only be carried out when the building is its final environmental and operational state, with any air conditioning, production machinery, environmental conditions etc. active.

What is a 'Suitable Performance Test' for a Warehouse Application?

To verify the response of the system, a test should be selected that simulates a credible fire situation according to the risk to be protected and the type of response specified by the performance test.

Tests that do not resemble credible or realistic fires for the application, such as those that use pyrotechnic elements to simulate fire for example, should not be considered. The Potassium Chlorate & Lactose Performance Test is one such test, as this produces very high temperatures; much higher than those generally expected in the early stages of a developing fire.

The following are believed by Protec Fire & Security Group Ltd to be 'Suitable Performance Tests' for Warehouse Applications and are as detailed within the FIA Code of Practice for Design, Installation, Commissioning and Maintenance of Aspirating Smoke Detector (ASD) Systems Issue 3 February 2012.

**Appendix A – ASD System Performance Tests** (Adaptation of)

**Commissioning – ASD System Performance Tests**
The table below presents a matrix of performance tests according to the desired response of the system (Class A, Class B or Class C) and the type of application (Warehouse). This table should be used **as a guide** to select the most appropriate performance test to be carried out during commissioning and maintenance of a specific ASD system.

| Type | Application | Response Class A | Response Class B | Response Class C |
|---|---|---|---|---|
| Secondary Detection | Normal ceilings (up to 20m unless otherwise stated) | 7-9g pellet (B.1)<br>Paper Bin (C.2) – *(see note re 30% test material)* | 13-18g pellets (B.2)<br>Paper Bin (C.2) – *(see note re 50% test material)* | 2x13-18g pellets (B.3)<br>Paper Bin (C.2) |
| | High ceilings (>20m) | Paper Bin (C.2) – *(see note re 30% test material)* | 2x13-18g pellets (B.3)<br>Paper Bin (C.2) – *(see note re 50% test material)* | Paper Bin (C.2) |

**Appendix B - Smoke Pellet performance test**

(ProPoint Plus Optical Smoke Detection Systems)

B.1 System Performance Test Using a Single 7-9g Smoke Pellet

B.1.1 Apparatus

B.1.1.1 Butane gas burner (or equivalent electrical heater) with an output of 5.8 KW.
Note: A 5.8 KW burner burns ~10 g of butane in 70 s.

B.1.1.2 Metal plate, at least 200 mm square.

B.1.1.3 Metal chimney, 2 mm to 6 mm thick, formed into a cylinder of at least 100 mm diameter and at least 150 mm high. Either the base of the chimney or the metal plate should have holes to provide ventilation for the chimney.

B.1.1.4 Calibrated stop clock or stopwatch, capable of measuring in 1 s intervals.

B.1.1.5 One smoke pellet of weight 7 g to 9 g

B.1.2 Procedure

B.1.2.1 Place the metal platen upon the burner and place the pellet(s) centrally on the platen.

B.1.2.2 Place the chimney centrally around the pellet.

B.1.2.3 Ignite the burner and start the timer when the pellet starts producing smoke.

B.1.2.4 Operate the burner for the appropriate length of time as indicated by Table B.1.

B.1.2.5 When the determined time (see Table B.1) has elapsed, extinguish the burner.

Note: The pellet will continue to produce smoke when the burner has been extinguished (typically, 30 s to 60 s) but thermal lift will not occur.

B.1.3 Pass/fail criteria

The system is deemed to have passed the test if the detection system registers a response within 180 s of the burner being switched off.

The response should be a full fire condition (of the ASD) unless agreed otherwise by the relevant parties, e.g. a response (equivalent to at least a 15% increase in smoke reading over the background level, where 100% is the fire threshold) sufficient to signal a pre-alarm or warning.

Table B1 – Burner operating times for smoke pellet tests
*Burner Operation Times:*

| Height (m) | Temperature Differential (°C) | | | | |
|---|---|---|---|---|---|
| | <3°C | 3 to 6°C | 6 to 9°C | 9 to 12°C | 12 to 15°C |
| 3 -5 | 3s | 6s | 9s | 12s | 17s |
| 5-10 | 7s | 13s | 20s | 27s | 34s |
| 10-15 | 10s | 20s | 30s | 40s | 51s |
| 15-20 | 13s | 27s | 40s | 54s | 67s |

Note 1 No heat input is required for applications with a height of less than 3 metres when conducting these tests.

Note 2 Temperature differential is the temperature difference between the level at which the test is conducted and the level at which the aspirating sampling points are mounted.

Note 3 The times in the above table are based upon 5.8KW burner, a smaller burner can be used i.e. 1.2KW but the times may need to be extended to reach the same end of test criteria.

B.2 System Performance Test Using a Single 13-18g Smoke Pellet
The test is identical to that specified in Clause B.1 but a smoke pellet with a weight of 13-18g is used at clause B.1.5

B.3 System performance Test Using Two 13-18g Smoke Pellets
The test is identical to that specified in Clause B.1 but two smoke pellets with an individual weight of 13-18g are used at clause B.1.5

**C.2 System Performance Test Using Paper in an Incinerator**

(ProPoint Plus Optical Smoke, Cirrus CCD Cloud Chamber Fire and Cirrus HYBRID Cloud Chamber & Optical Fire & Smoke Detection Systems)

This paper incinerator test is used for performance-based testing of ASD systems installed to protect spaces with high ceiling (not less than 8m) as this test provides thermal lift due to the heat created by the burning material. The test produces white smoke.

C.2.1 Apparatus:

C.2.1.1 Tabloid sized newspaper pages (typically 580mm x 370mm)

C.2.1.2 Steel Incinerator Bin approximately 90litres in volume with ‘stand-off’ feet, and a number of low-level ventilation holes. The Incinerator Bin should be fitted with a chimney lid with a coarse wire mesh (typically 10mm grid) to contain any embers.

C.2.1.3 Long Taper

C.2.1.4 Lighter/Matches

C.2.1.5 Stopwatch

C.2.1.6 Suitable Fire Extinguisher

C.2.2 Test Procedure:

C.2.2.1 The Incinerator Bin should be positioned at the test location with suitable precautions taken to ensure that heat generated does not damage the flooring.

C.2.2.2 The newspaper sheets should be loosely rolled and/or crumpled and placed lightly so that they are well oxygenated and burn fully in the incinerator. The number of newspaper sheets required is based on the following formula:

**Class C**

1 sheet per meter of height + 10 sheets for ceiling heights up to 20m
1½ sheets per meter for ceiling heights above 20m

*Note: For Class B and Class A applications the following 'reduced fuel' Performance Test fires have been adopted for this test and are based on the philosophy of percentage fuel reductions for other Performance Tests, as detailed within the FIA Code of Practice.*

| | Class C | Class B | Class A |
|---|---|---|---|
| Normal ceilings (up to 20m unless otherwise stated) | 1 sheet per meter of room height + 10 sheets. | 50% of Class C test material | 30% of Class C test material |
| High ceilings (>20m) | 1½ sheets per meter of room height | 50% of Class C test material | 30% of Class C test material |

Note: the above formula is suitable for ambient conditions of $5^0$C to $25^0$C. Temperatures outside these conditions may require additional sheets to accommodate the effects of excessive cooling (colder areas) or thermal stratification (warmer areas).

C.2.2.3 The newspaper should be carefully lit through one of the low-level ventilation holes with the chimney lid in place using the Long Taper.

C.2.3 Pass/fail criteria

The system is deemed to have passed the test if the detection system registers a response within 300 s of ignition.

The response should be a full fire condition (of the ASD) unless agreed otherwise by the relevant parties, e.g. a response (equivalent to at least a 15% increase in smoke reading over the background level, where 100% is the fire threshold) sufficient to signal a pre-alarm or warning.

## Commissioning, Service and Maintenance

The commissioning of the system should be carried out in accordance with BS 5839-1:2013, Local Codes and Standards and in line with the Manufactures recommendations.
The purpose of commissioning is to configure and verify that the system operates correctly as per the specification, fire strategy document, performance testing and any other agreed information.

Maintenance should be carried out as described within Section 15 of the FIA Code of Practice for Design, Installation, Commissioning and Maintenance of Aspirating Smoke Detector (ASD) Systems Issue 3 February 2012 and in line with the Manufactures recommendations or other applicable local regulations.

## Warehouse Design Checklist

- Confirm and implement Local Country Design Standards and Fire Codes
- Confirm aspirating detection system detector, sensitivity and performance requirements
- Confirm aspirating standby requirement period for correct power supply unit
- Confirm full dimensions of the area protected by the aspirating detection system
- Confirm full use of finished warehouse with regards to fire load, any racking systems, mezzanine levels, internal heating systems, potential for stratification, any natural or forced air ventilation systems and if any vehicle or plant movements etc. are expected
- Ensure all aspirating detectors are designed to be installed in a safe, clean, ambient temperature area ($+5^0$C. to $+25^0$C)
- Confirm all sampling pipe layouts can achieve fixings every 1000mm. Amend orientation of sampling pipe to achieve this if required.
- Confirm all sampling pipe designs are verified by the appropriate sampling pipe design calculation program and to provide sampling hole dimensions
- Ensure consideration is given to the sampling hole orientation to prevent Venturi Effect issues from any fan heater units
- Ensure all required low level Maintenance Test Points are installed in safe working positions for future use
- Ensure suitable condensation traps are designed/installed into the pipe installation prior to connection to the aspirating detector if condensation is expected.
- Ensure the design information instructs that each sampling point is individually tested for correct operation and tested fully with regards to Local Country Fire Codes

## References


1. British Standards BS5839-1:2017
2. FIA Code of Practice Issue 3 February 2012
3. FIA Fact file 0045 Smoke Detection for High Ceilings 2011
4. Protec Generic Design & Installation Guide
5. Protec Design Guides & Disclosures (located on www.protec.co.uk)

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Any recommendation provided by Protec Fire & Security Group Ltd is merely an indication of the system design considered to be good practice to provide the most suitable solution to meet the needs of the common application environments described.

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