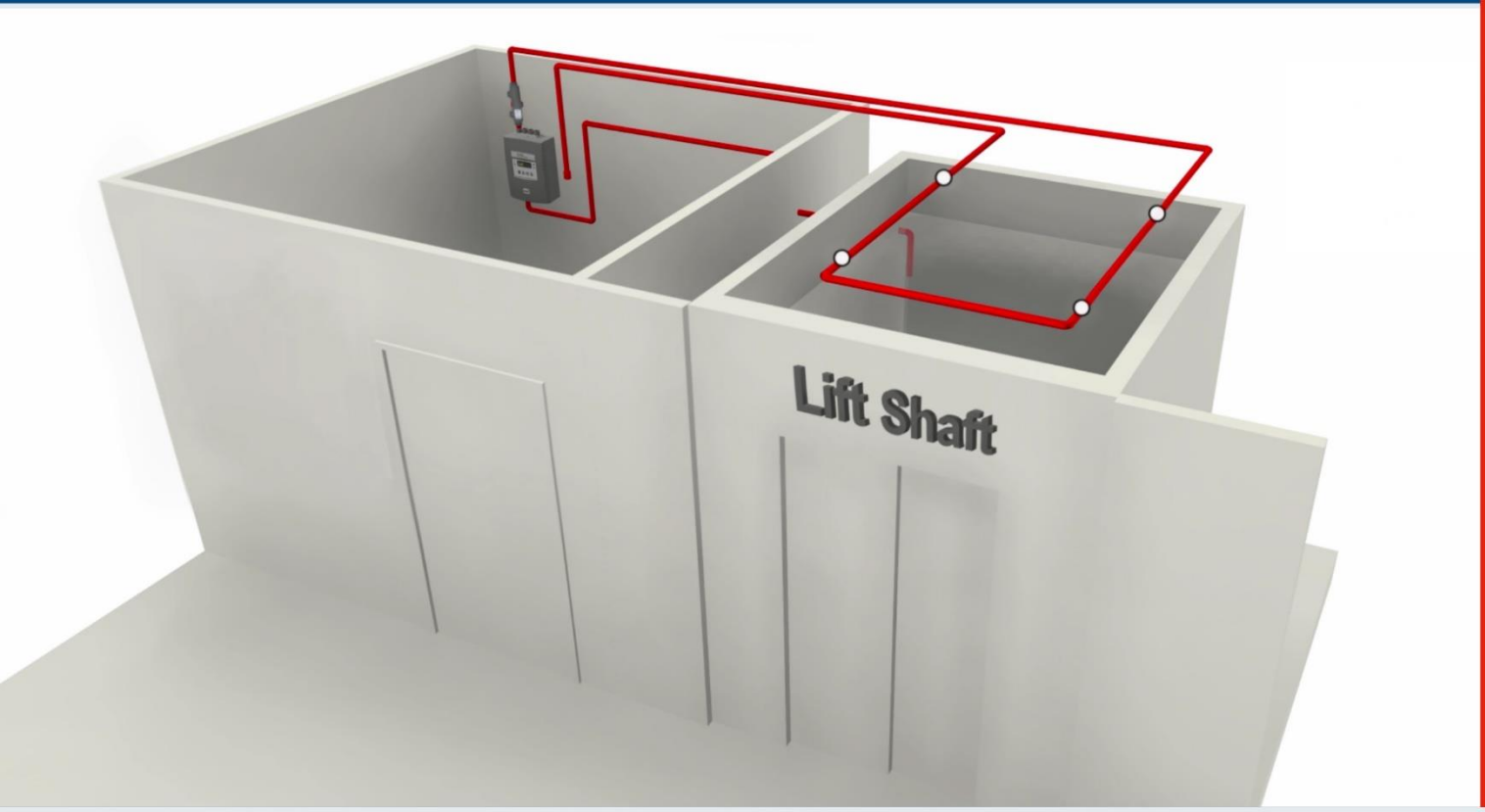
Protec
Fire and Security Group

Aspirating Detection System



Protec Aspirating Detection System
Lift Shaft Design Guide

Document Revision Details

Issue	Modification Detail	Author(s)	Approved	Date
0	Original Issue	MAC / AGD	CH	02/05/2018

Introduction

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

Lift shafts (also referred to as elevator shafts) come in many varying dimensions and heights, therefore each lift shaft needs to be designed specifically for its own layout and risk.

Lift shafts may contain different combustible materials and differing amounts of fire and smoke particles. Therefore, it is important to select the correct detection technology for the risk.

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 Lift Shaft 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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Why Use Aspirating Systems for Smoke Detection in Lift/Elevator Shafts?

For many years it has been the fire industry standard practice to install a wired point type smoke detector at the top of most lift/elevator shafts. However experience shows this practice generally leads to some practical and expensive difficulties with regards to ongoing servicing and the correction of any fault conditions of the detection devices in these applications.

Typically these practical and expensive difficulties include the following:-

- To service a smoke detector in a lift/elevator shaft the shaft itself must be isolated. For this reason in many modern busy buildings this is usually carried out during the evening or weekend periods when isolating the shaft is not too disruptive.

- In order to facilitate this practice it is a requirement that the fire alarm system service provider attends during this 'out of hours' period. Typically this has an additional labour cost implication of around 40% for the time taken to carry out these works.

- Also in order to facilitate this practice it is a requirement that the lift/elevator manufacturer or service provider also attends during this 'out of hours' period. This ensures the lift is isolated correctly and is safe to work on, as personnel often climb on top of the lift car to access the detector. Depending on the number of detectors to be serviced this can easily create further costs of £500 to £1,500.00 per visit by the lift/elevator manufacturer or service provider.

- In addition to the extra service costs that the end client has to bear and for the reasons given above, the client themselves also have their own 'hidden' costs to absorb. These can include making special provision to open the building in the evenings or weekends, having responsible persons present when these works are carried out, ensuring the correct permit to work forms are completed and overseeing all the works are carried out in a safe and correct manner.

- The action of climbing onto the top of a lift car raises yet more problems and requirements. Problems being of operative's safety and requirements being for safe working practices. All operatives doing this work usually have to be harness trained, which often limits the workforce of the service providing company. Additionally all personnel must be aware of safe electrical working practices.

- By the time the permit to work forms are completed and safe access to the lift/elevator shaft is obtained it can take up to an hour to service a single smoke detector is a single shaft. Most other smoke detectors with easy access take only a few minutes to service.

- Then there is the issue of a suspected faulty smoke sensor or wiring connection on a detector in a lift/elevator shaft. Essentially all of the above procedures must be carried out if the device is suspected to be faulty. This makes this situation a very expensive problem and sometimes it is proven after all this time and effort that the device or wiring fault is not even in the lift/elevator shaft.

All this to service a small number of smoke detectors and sometimes only a single smoke detector. For the above reasons, on many occasions smoke detectors in lift/elevator shafts are just not serviced, even though this is a requirement under regulations.

An aspirating detection system can provide an alternative to alleviate these problems, time and expense.

More recently aspirating detection systems have been employed as a solution to point type smoke detectors in lift/elevator shafts. This alternative detection technology offers many benefits to all parties, these include:-

- Aspirating detectors are usually wall mounted detectors and are placed in a secure area adjoining the lift/elevator shafts. Industry standard 25mm red ABS pipe is installed from the aspirating detector into the lift/elevator shaft. Holes are drilled into this pipe within the shaft to allow the aspirating detector to draw air from the shaft to be checked for smoke by the remote detector. A typical 'good practice' installation should also include the extension of this sampling pipe out of the shaft to a 'safe access' area to a dedicated sampling pipe test point, together with the extension of the detector exhaust pipe being returned to the lift/elevator shaft, to alleviate and pressure differential issues.

- This simple solution removes any electrical wiring, electrical components (smoke detectors) and more importantly any requirements for servicing or fault finding from within the lift/elevator shaft compartment.

- This allows the servicing to be carried out by the service provider at the aspirating detector and dedicated sampling pipe test point only. More importantly this can be done without isolating the lift car, without access required to the lift car, without harnesses etc.., without additional personnel, without permit to work procedures and can be completed during normal working hours while the remainder of the fire alarm system devices are being serviced.

Should it be a requirement that the sampling pipes need to be cleaned (on the inside) after a number of operational years, then again this can be carried out from the aspirating detector and dedicated sampling pipe test point, without the need for access to the lift/elevator shaft. Typically this cleaning process would be carried out using an air compressor or similar.

Protec Fire & Security Group would recommend where possible, a simple aspirating detection system for all lift/elevator shafts as this is proven to be the most practical, cost effective and safest solution for these difficult environments.

Definition of a Protec Aspirating Detection System

Aspirating detectors provide an 'active' detection system that samples 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 which 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 both the detector display and outputs and is often integrated into the main building fire alarm system.

ProPointPlus Aspirating Smoke Detection

Protec ProPointPlus aspirating smoke detectors utilise 'optical' LED Scatter Chamber Detectors (SCD's) within each of up to 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) or Class C - normal sensitivity (8 or 12 holes per pipe). 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.

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 EN54 Class B – 5 holes per pipe EN54 Class C – 8 holes per pipe 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 an EN 54 approved ProPointPlus detector is required. All aspirating detection system 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 the 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.

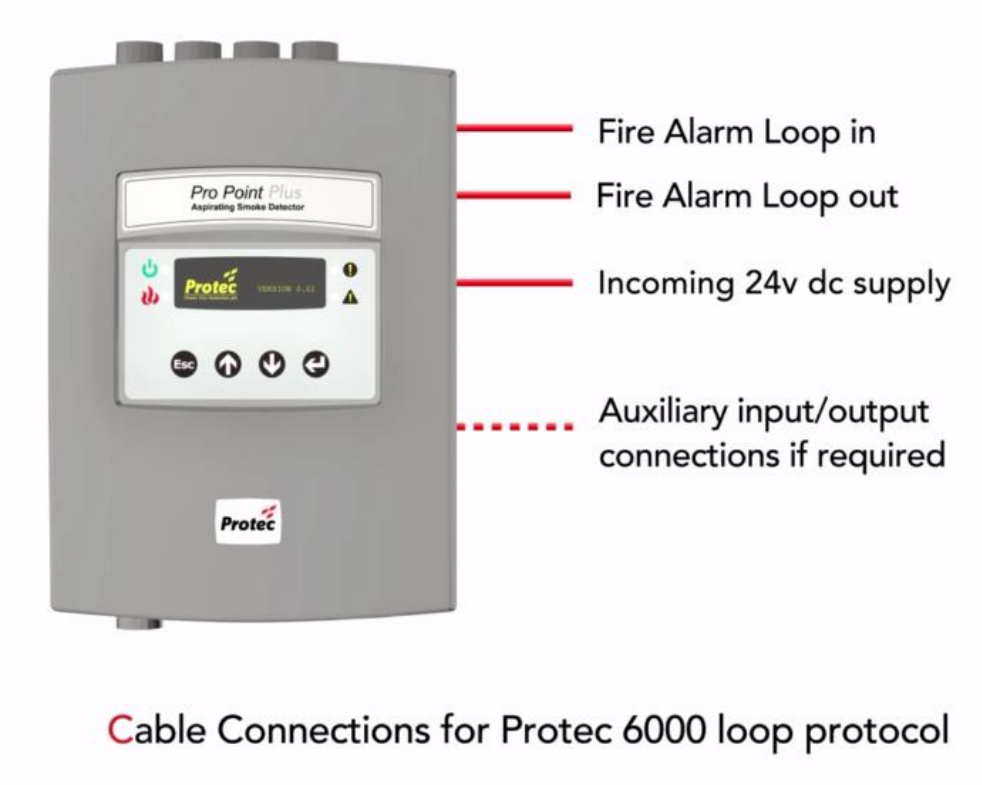
The charger uses power factor correction to ensure a near unity power factor, and switch-mode technology to provide a lightweight and efficient unit.

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

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

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 detector is manufactured with a 1 – 4 address 6000 protocol interface. This allows up to four addresses (four pipes), from the ProPointPlus detector, to be individually identified at the Protec 6000 protocol fire alarm panel.

24vDC Power supply

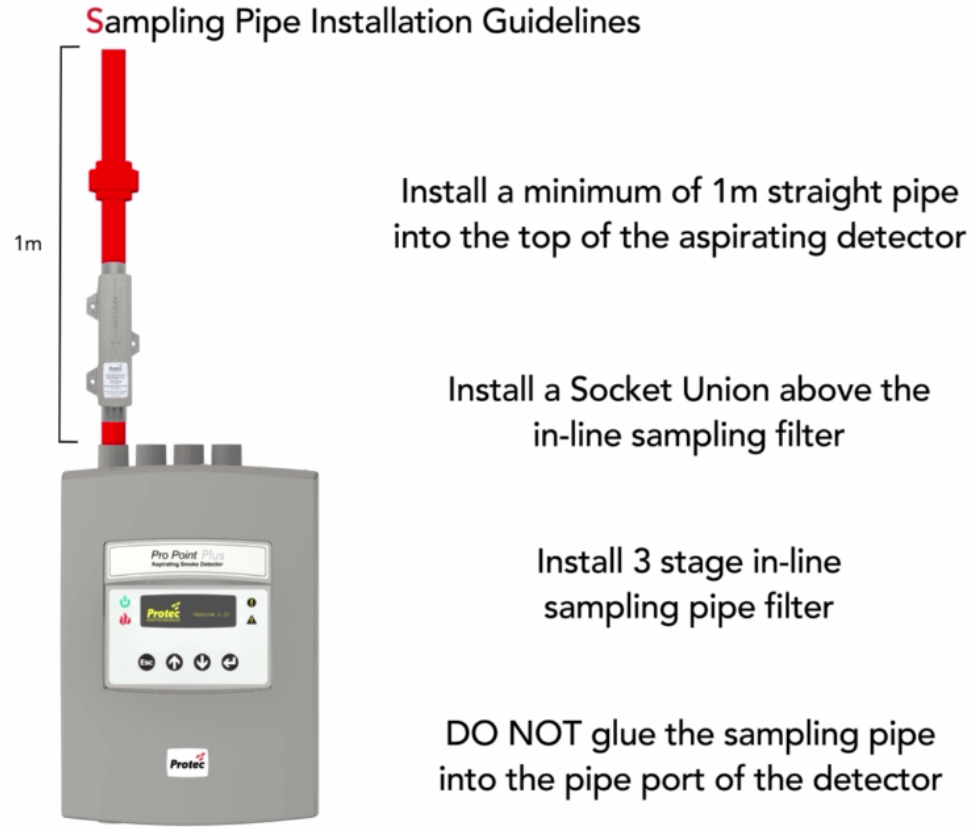
ProPointPlus detectors can be configured to monitor the incoming 24vdc standby power supply and report this directly to a Protec 6000 protocol fire alarm panel. Examples of compatible Protec power supply units are given on page 7.

Programmable Input/Outputs

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

ProPointPlus 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. Other more heavy duty filter options are available on request.

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. This will 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

Detector Sensitivity Settings often referred to as 'Detector Class'

The sensitivity setting of the aspirating detector is primarily determined by the lift shaft height. Local country design codes should be referenced for clarification on this. For UK projects generally a 'Class C' detection system is acceptable for lift shafts up to 10.5m high, for lift shafts above this height a 'Class B' detection system would be required. In lift shaft applications where the lift shaft is particularly high (above 25m), a 'Class A' detection should be considered.

Class A Detection System

Definition:- Aspirating smoke detector providing very high sensitivity. These systems are often employed in areas so that evasive measures can be initiated before any significant damage is incurred to areas containing mission critical or high value artefacts or operations.

Class B Detection System

Definition:- Aspirating smoke detector providing enhanced sensitivity. These systems are often employed in areas where fire and smoke particles are difficult to detect. This would include areas where there is dilution from high airflow movements or where there are high ceiling spaces.

Class C Detection System

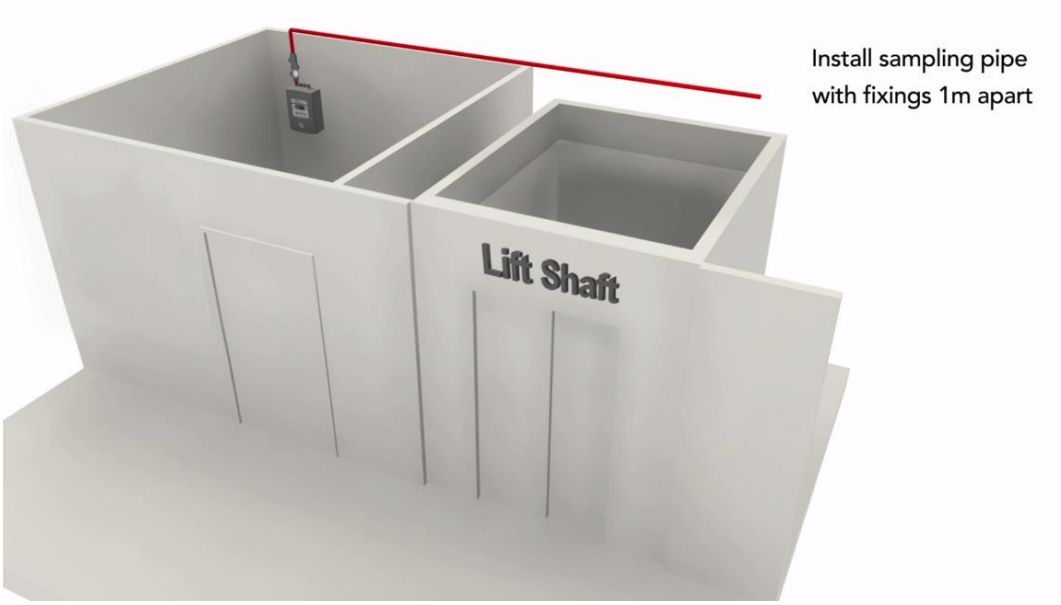
Definition:- Aspirating smoke detector providing normal sensitivity. These systems are often employed as an alternative to point type smoke detectors or beam detectors for reasons such as building deflection or where perhaps servicing is made easier using aspirating system pipe installations.

Note:

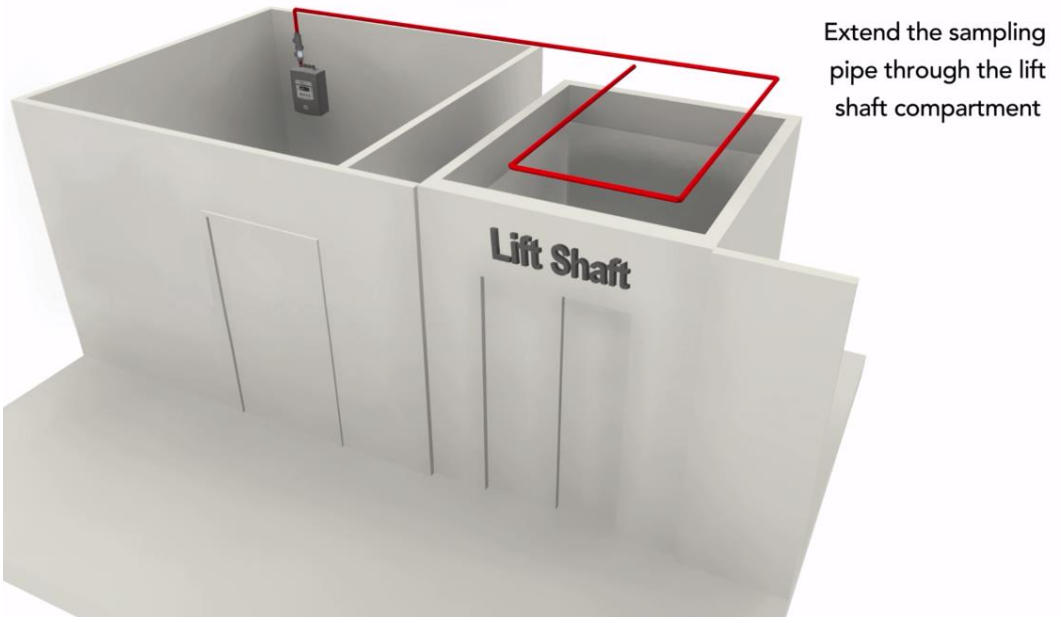
Where the lift shaft 'background particle levels' will not allow the aspirating detector to be set to one of the above categories, it is important to introduce an extended 'soak test period' where the background pollutant variations can be determined. Having logged this information for an appropriate time period, the alarm thresholds can then be configured to avoid unwanted alarms.

Having established the ambient background environment and detector alarm thresholds, a suitable 'performance test' is recommended. Any tests should be agreed by all concerned parties and appropriate health and safety procedures should be adhered to. See Note below on 'Requirement for Aspirating Detection System Performance Testing.'

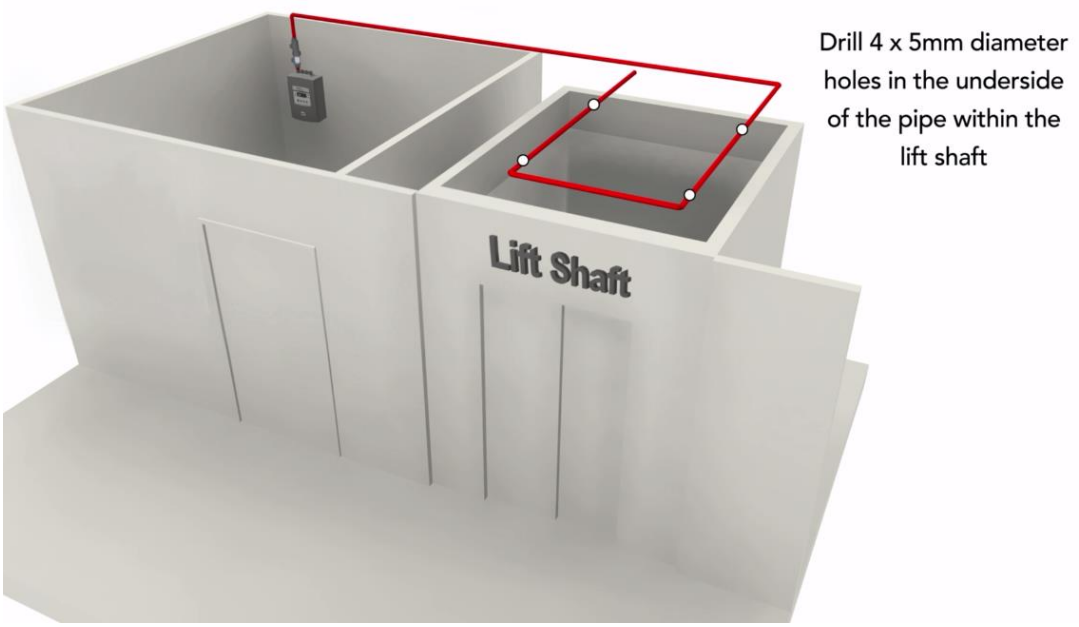
General Design Guidelines for Lift Shaft Applications



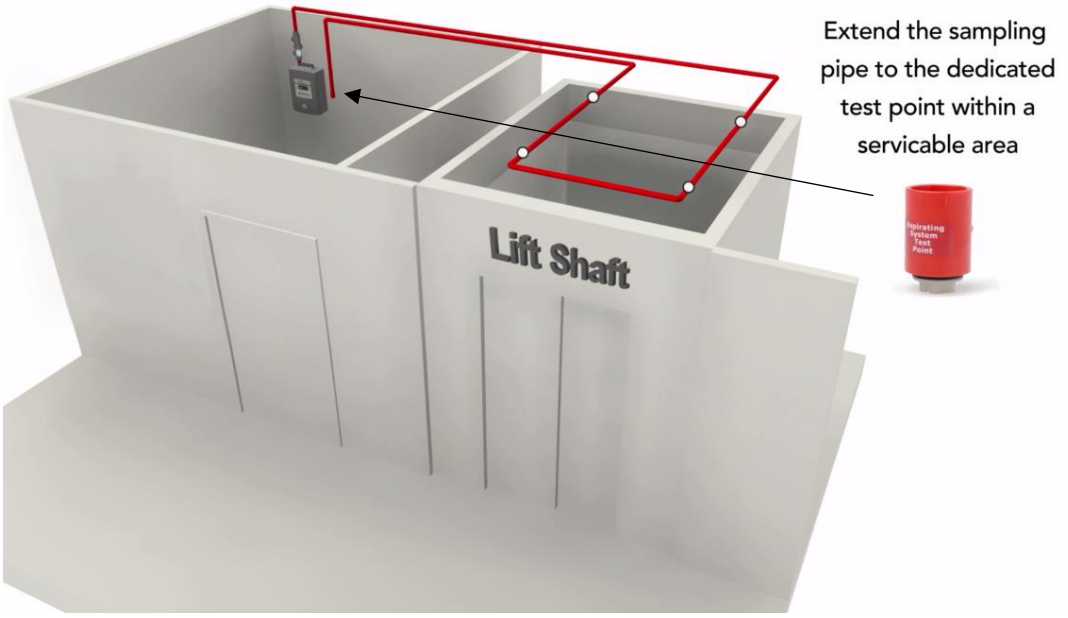
For standard ABS pipe installations Protec would recommend sampling pipe fixings at 1m intervals.



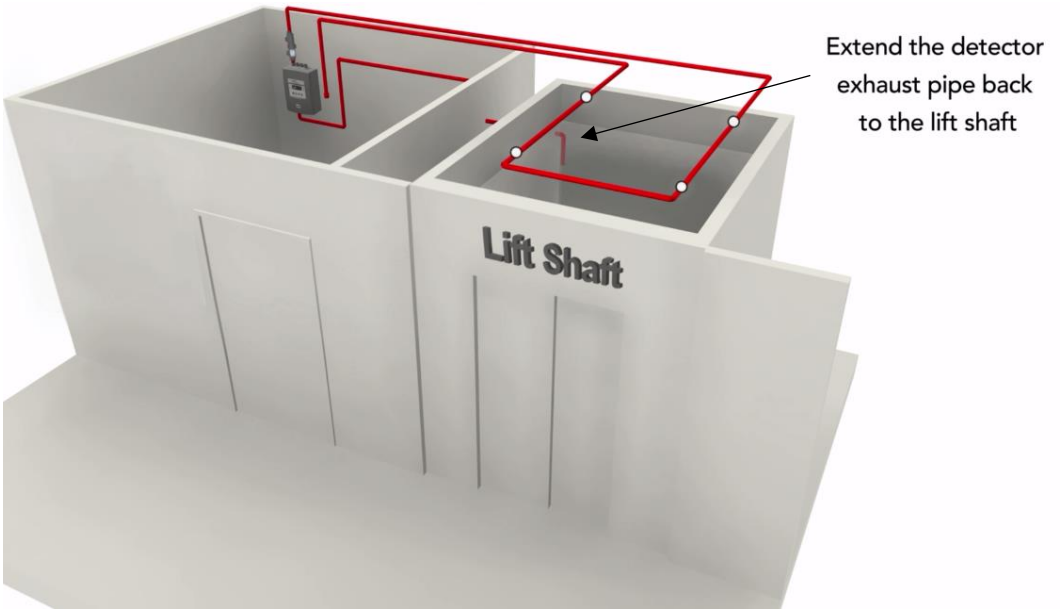
Extend the sampling pipe through the lift shaft compartment and ensure the sampling pipe is secured with suitable fixings as sampling pipe installations in lift shafts can be exposed to regular forced air movement, thereby stressing the installation within these applications.



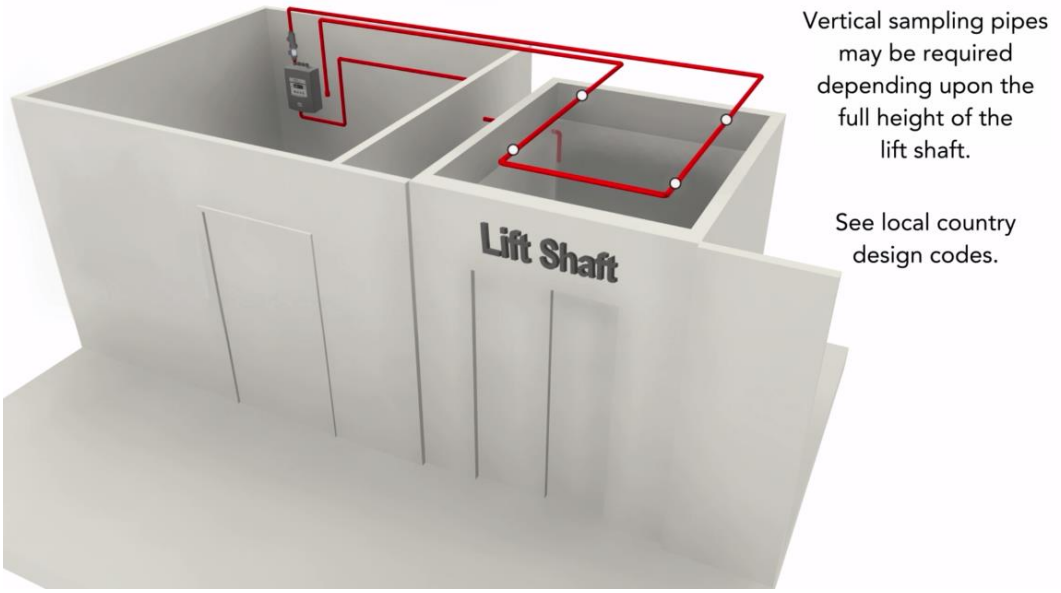
Theoretically, only one sampling hole could be installed within the lift shaft application. However, it is good practice to install more than one sampling hole. Should one hole become restricted or blocked the other hole may still be operational. Protec would recommend a minimum of 4 x 5mm diameter sampling holes be installed in each lift shaft installation to allow adequate airflow to be presented to the aspirating detector, for the purposes of airflow monitoring.



Extending the lift shaft pipe installation into the lift motor room or other 'serviceable' area allows the installation of a dedicated sampling pipe test point. This Test Point is not a sampling point and is only used during service visits. Theoretically, this means little access into the actual lift shaft should be required for future system serving.

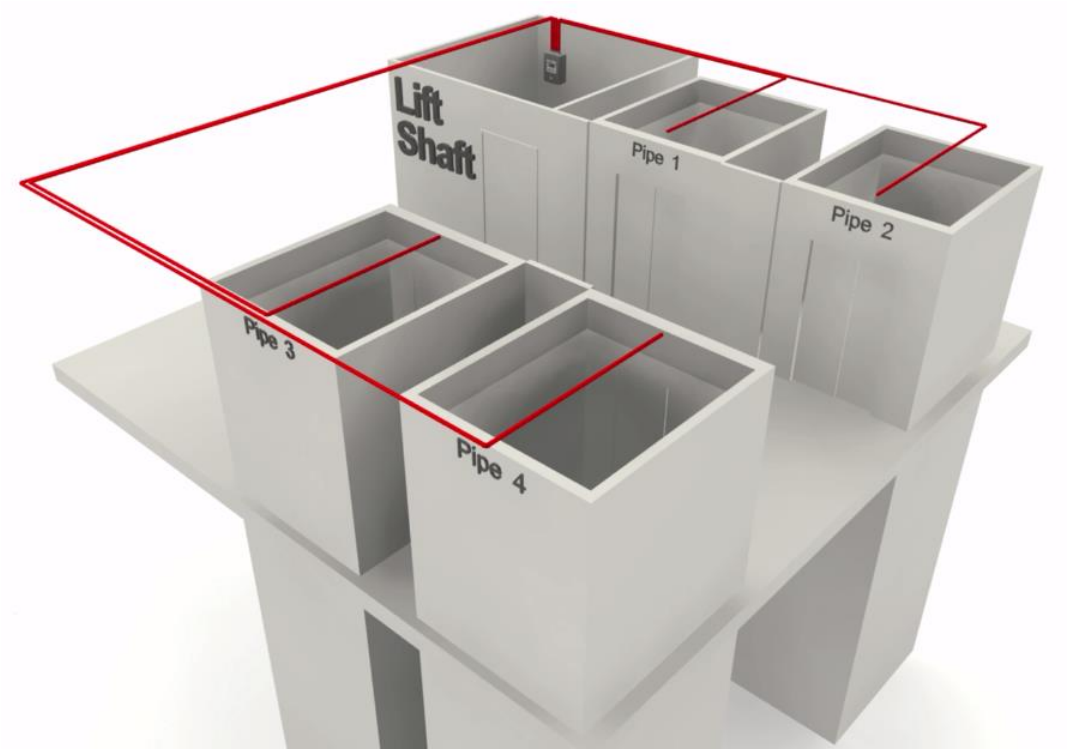


It is a requirement for **ALL** lift shaft applications that the aspirating detector exhaust pipe be returned to, and be terminated within, the actual lift shaft compartment. This should allow any pressure differentials between the lift shaft compartment and the location of the aspirating detector to be equalised.



On installations typically above 10m it may be a requirement that a vertical sampling pipe is installed throughout the full height of the lift shaft, with sampling holes spaced at regular intervals. Please check the local country design codes for this requirement. All sampling pipes in lift shafts should be installed away from any possible mechanical damage from the lift car or other moving machinery.

Multiple lift shafts from a single ProPointPlus aspirating detector.



In general, Protec would only recommend a single ProPointPlus aspirating detector be used for a single lift shaft application. However, there are some adjoining lift shaft applications where the movement of air and pressure differentials within the various shafts are not sufficient to create unwanted airflow faults on the aspirating detector. An example would be; where there is more than one “slow moving” lift car operating on only a small number of floor levels.

It is the designer’s responsibility to consider all aspects of covering multiple lift shaft compartments with a single aspirating detector with regards to local country codes and any potential airflow issues in these applications.

Should a ProPointPlus detector be used for multiple adjoining lift shaft applications the detector exhaust should be returned to **EVERY** lift shaft compartment.

Stratification Effect on Aspirating System Designs

Stratification can occur 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 may have heated the lift shaft structure of a building 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.

One option when stratification is considered to be relevant, would be to allow sampling holes to be dropped from the main lift shaft ceiling detection level to a height where they would not be affected by the stratification, (these are known as vertical sampling points). These vertical pipes would be in addition to the main ceiling detection sampling points.

Dilution Effect on Aspirating System Designs

Dilution can affect aspirating detection systems and therfore this should be considered at design stage. The amount of dilution is affected by the detector sensitivity and the number of sampling holes within 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 proven by a sampling pipe calculation program) to ensure a similar amount of airflow is drawn through each sampling hole. Additionally, verification testing of detector response and transport time is required for 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. See detector specifications.

Venturi Effect around Sampling Holes

The aspirating system designer should consider any natural or forced air movement likely to be prevalent around the areas where the sampling holes are located. One effect of excessive natural or forced air movement could be to create areas where a Venturi Effect would reduce or possibly prevent, air entering the sampling points thus restricting the efficiency of one or more sampling holes.

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.

Requirement for 'Commissioning/Function Testing'

Any commissioning or functionality testing required by any design code or local country legislation, should be carried out when the installation works are fully electrically and mechanically complete. Testing should include the individual testing/proving of ALL sampling holes of the aspirating detection system, using only the correct test material and in conjunction with the relevant Protec product manuals. The results of these tests should be recorded on the appropriate commissioning documentation.

The designer should therefore confirm at design stage the possible requirements of any functionality testing with regards to any cause and effects of the installed aspirating detection system, should this be required.

Requirement for 'Performance Testing'

Any performance testing required by any design code or local country legislation should only be carried out when the lift shaft is in its final environmental and operational state, ensuring any air conditioning, pressurisation or ventilation systems, etc are active.

The designer should therefore confirm with the client at design stage the most suitable 'performance test' for the installed aspirating detection system, should this be required.

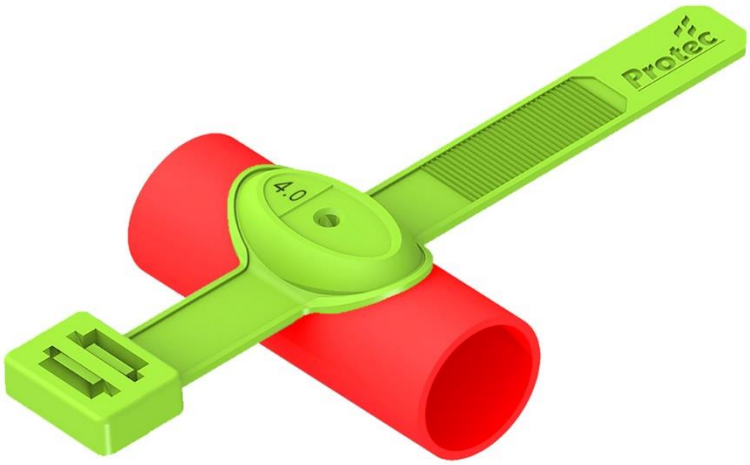
‘HIT’s’ Hole Identification Tags.

Protec would recommend the installation of ‘Hole Identification Tags’ (HIT’s) for lift shaft 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.

A build-up of dust around a standard drilled sampling hole is common place in lift shaft applications, 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.

Lift Shaft Design Checklist

- Confirm and implement Local Country Design Standards and Fire Codes
- Confirm aspirating detection system detector, sensitivity and performance requirements
- Confirm full dimensions of the area protected by the aspirating detection system
- Confirm Aspirating standby requirement period for correct power supply unit
- Ensure all aspirating detectors are designed to be installed in a safe, clean, ambient temperature area ($+5^0$C. to $+25^0$C)
- Confirm and implement the aspirating design with regards to the dimensions of the lift shaft and any natural or forced air ventilation/extract systems
- Confirm all sampling pipe designs are verified by the appropriate sampling pipe design calculation program and to provide sampling hole dimensions
- Ensure the design allows for the aspirating detector exhaust to be returned to the same lift shaft where the detection originates
- Ensure consideration is given to the sampling hole orientation to prevent Venturi Effect issues from the lift car
- Ensure any required Maintenance Test points are installed within a local serviceable area
- 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. Protec Generic Design & Installation Guide
4. Protec Design Guides & Disclosures (located on www.protec.co.uk)

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Aspirating Detection System

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