RETURN REGISTER AND DUCT SAMPLING SYSTEMS

Introduction

Sampling air at return air registers and in extract air ducts is an effective, convenient and flexible method of detecting smoke from protected areas that have a constant air flow created by mechanical air handling plant. Typical examples are, computer and related rooms, telephone switch rooms, microelectronics clean rooms, atrium and auditorium areas, etc. This method of sampling can effectively protect large volumes at a relatively low cost. It can also offer unobtrusive coverage, which may be essential for some applications.

The inherently high sensitivity of the Stratos-HSSD® detection system will compensate for the smoke dilution factors that will naturally occur when sampling at relatively few points in a large volume. The likelihood is that the installed system will be capable of offering significantly higher sensitivity than possible with other smoke detection methods, with reduced risk of unwanted alarms.

In rooms where Close Control air conditioning systems are used, this method of sampling may be the only viable method of smoke detection. Examples are EDP areas, telephone switch rooms and clean rooms all of which have a high density of electrical and electronic equipment.

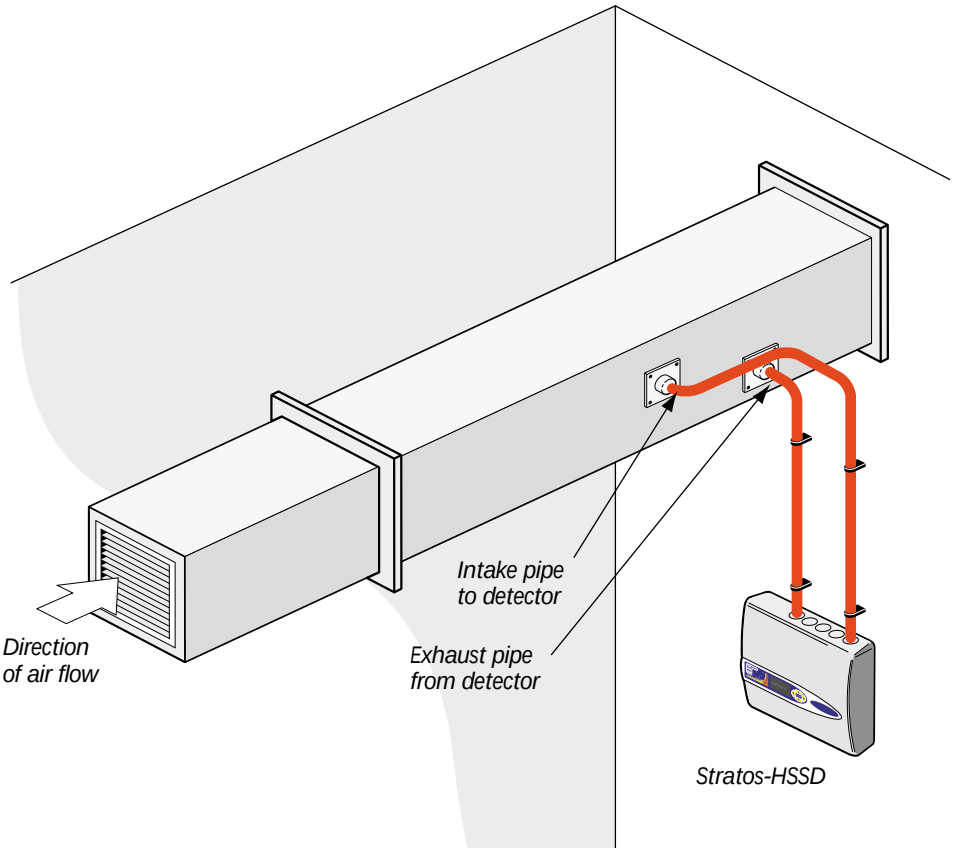


Fig. 1 ***Sampling from an air extract duct***

The problem with using other sampling techniques such as ceiling mounted sampling points in areas having mechanical ventilation is that the relatively cool products of combustion generated by incipient fire will have little thermal buoyancy and are largely unable to rise to ceiling level. This is the position in which 'traditional' smoke detectors are located. High airflows may also be expected to further cool the products of combustion and carry them back to the return air register or extract duct of the air handling plant. It therefore follows that the most effective point of detection will be to sample at these positions.

N.B. If the mechanical ventilation system does not operate continuously, consideration should be given to installing standard sampling pipe networks at ceiling and underfloor level. These should be additional to (secondary), or in place of, a return register or duct sampling system to ensure continuous protection. If additional standard secondary sampling networks are installed, they should not be connected to the detector installed for return air sampling. If this were done, problems should be anticipated relating to excessive sample dilution or as a result of sampling from areas with different air pressures. In some countries it is mandatory to fit this secondary system in order to comply with their Regulations and Codes of Practice.

☜NB

N.B. It is strongly recommended that no attempt be made to sample from air SUPPLY ducts for the following reasons.

☜NB

a). The air supplied from air handling plant, particularly 'close control' systems will often have passed through high efficiency or HEPA filters to remove dust and other airborne particulate. Some of these filters will also remove significant quantities of smoke. A sampling system mounted downstream of such filters will often not be capable of reliably indicating the levels of any smoke returning to the system from the protected area.

b). It is usual to introduce a percentage of fresh air into the ventilation circuit at this point. Any pollution accompanying this air will produce an inaccurate response from the detector intended to monitor the protected area. If this were anticipated it is possible to install a Reference Detector to combat possible nuisance alarms created by this pollution. See section: Reference Detection.

Duct Sampling

Duct sampling uses a sampling pipe or 'duct probe' which penetrates a return air duct in such a way that the sampling holes are placed directly in the path of the air flow. An air sample is taken by the duct probe and drawn back to the detector.

- It must be appreciated that the air pressure at the probe is likely to be negative in relationship to the pressure at the exhaust of the detector. (When sampling for smoke, the position of the duct probe will be on the 'suction' side of the fans circulating air through conditioning plant. Air flow rates will be high but pressure low.) For this reason, it is important that the exhaust of the detector is also connected to the duct or the pressure differential will have a negative effect on system performance. Failure to comply with this guideline will cause air flow monitoring problems and prevent satisfactory detection.

Fig. 2 ***Relative positions and dimensions of probes for duct sampling.***

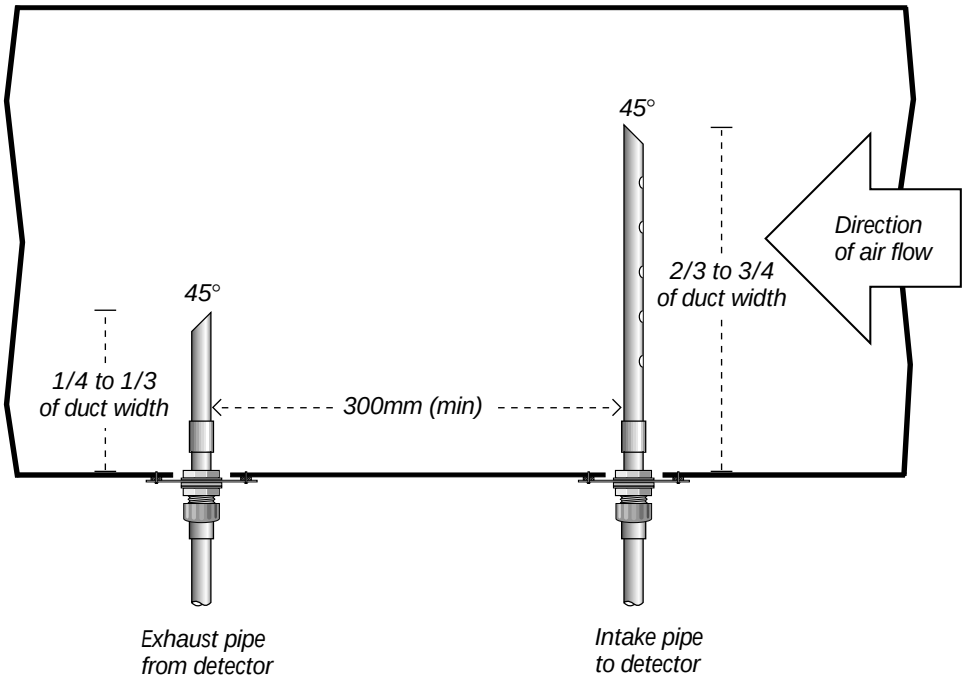
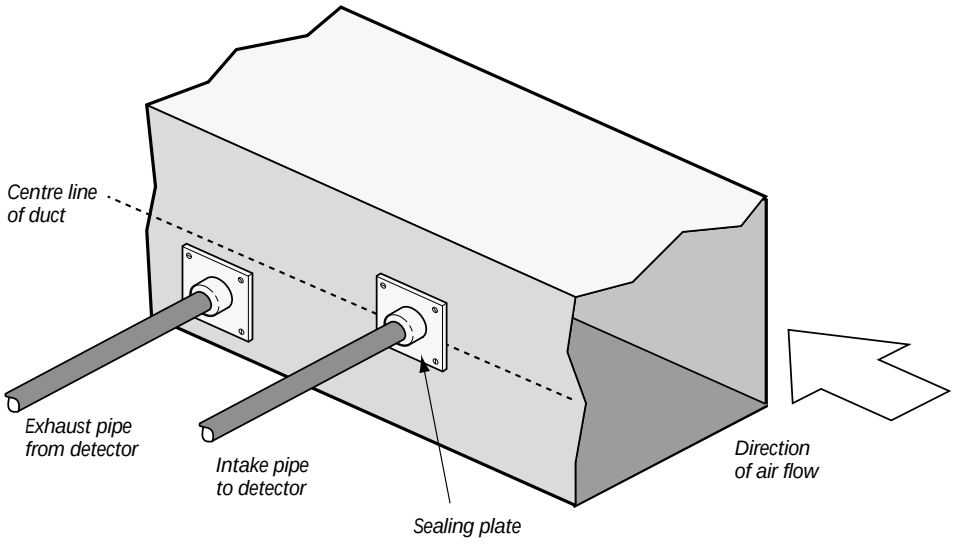


Fig. 3 ***Arrangement of probes and detector for duct sampling***



- The air intake probe should be sited upstream of the exhaust probe.
- The air ducts from which samples are taken are normally at a negative pressure to the surrounding air. It is important to ensure the penetrations made for the purpose of duct sampling are fully sealed.

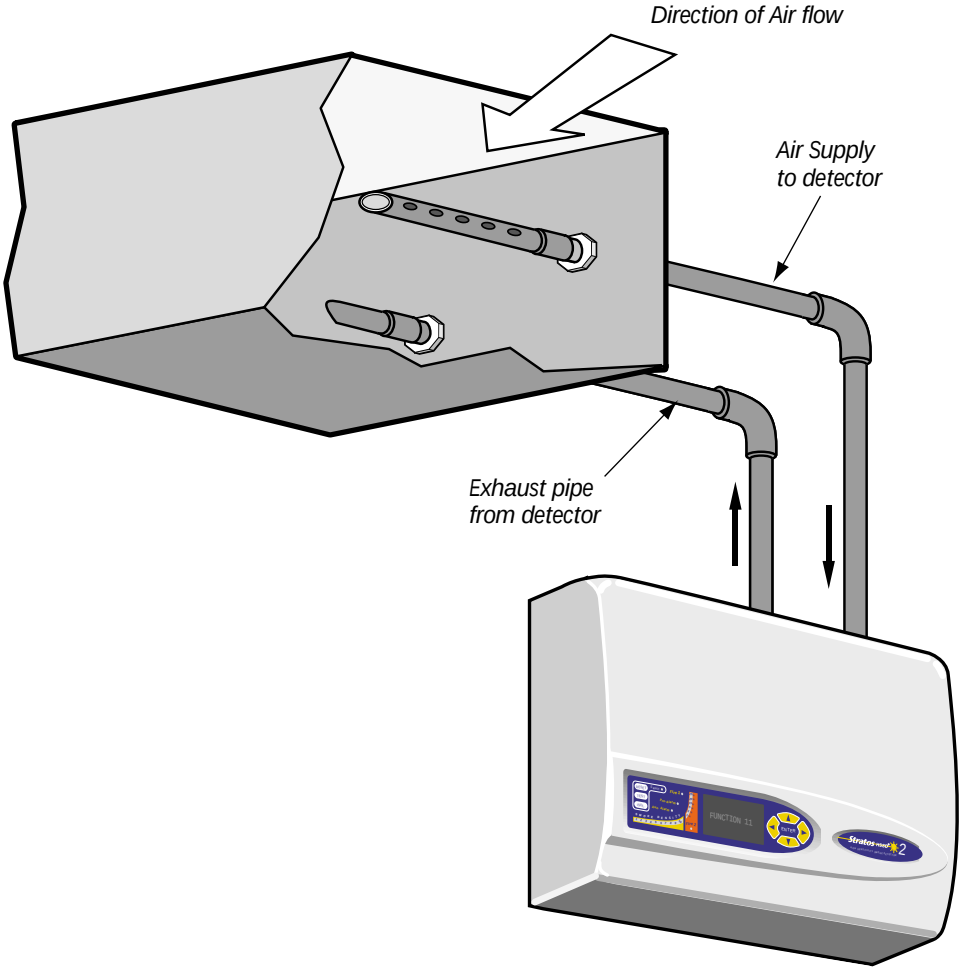


Fig. 3 ***Return air duct sampling - arrangement of probes in relationship to detector enclosure.***

- The inlet and exhaust sampling probes should be offset from each other to avoid the possibility of turbulence around the exhaust probe.
- The far ends of the inlet and exhaust probes should be cut at an angle of 45° (as shown in fig. 2) unless the inlet probe needs to be supported at its furthest end.
- The material used to manufacture the sampling probes should be suitable for the application. If the duct is carrying high temperature air or certain solvent vapours, sampling probes and associated fittings manufactured from plastics are unlikely to be suitable.
- If the sampled air is hot and/or humid, problems are likely to occur if temperature changes cause condensation within the cooler sampling pipe outside the duct-work. Provision should be made to incorporate a condensate trap before the sam-pling pipe enters the detector. Figure 5 illustrates a typical condensate trap.

Fig. 4 ***Typical probe connection to duct using ABS materials***

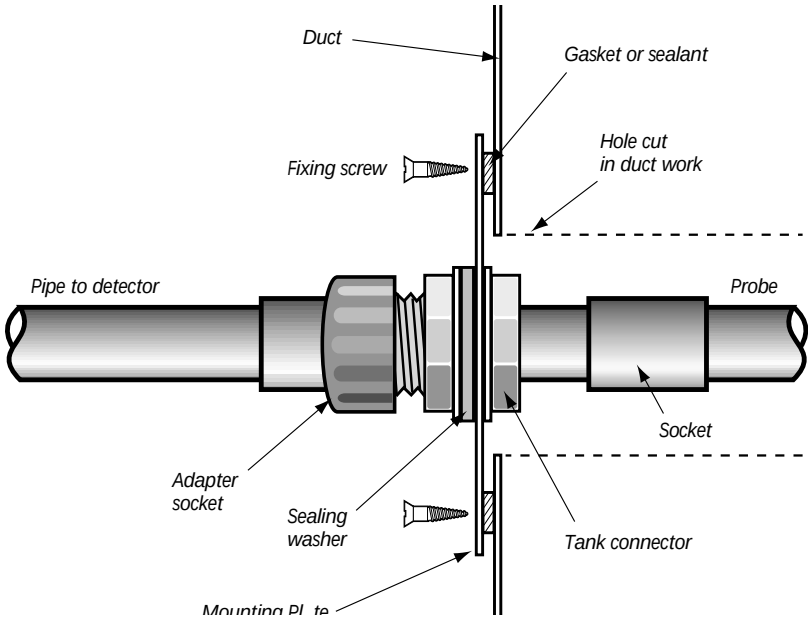
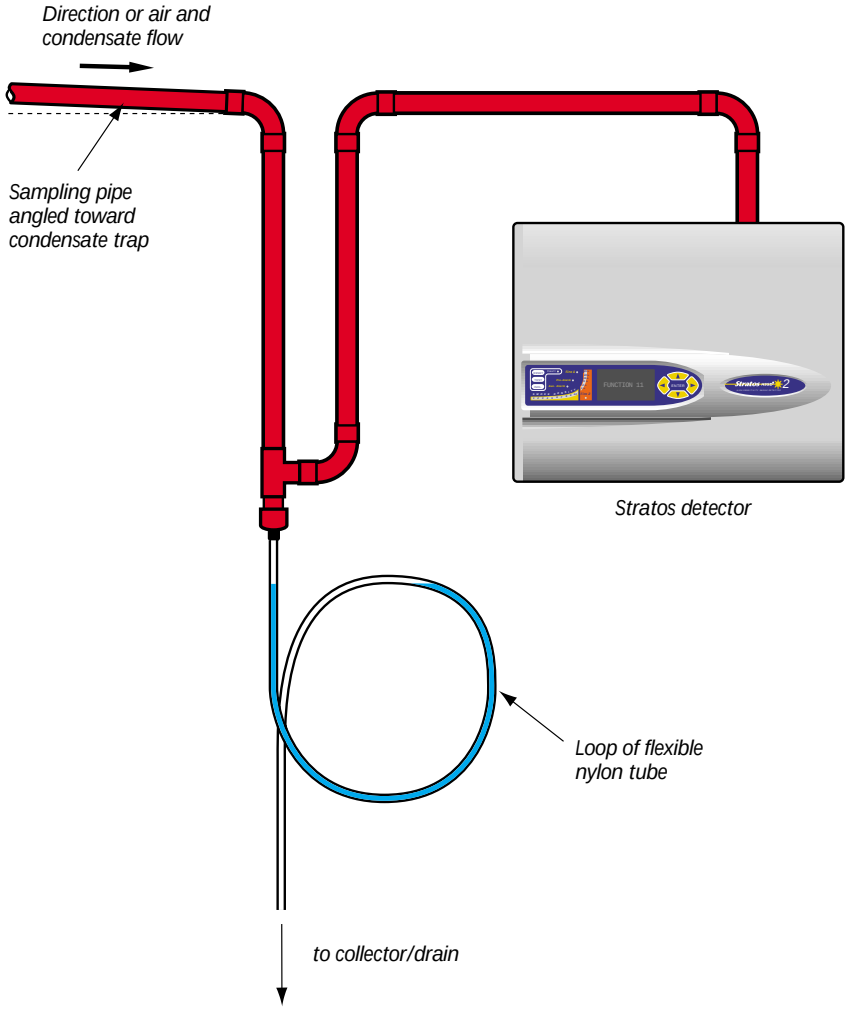


Fig. 5 ***Condensation trap***



- The method of mounting probes shown in illustrations 1-4 is acceptable in smaller ducts. In larger ducts it is advisable to support the sampling probes from two opposing duct walls. (See fig. 6).

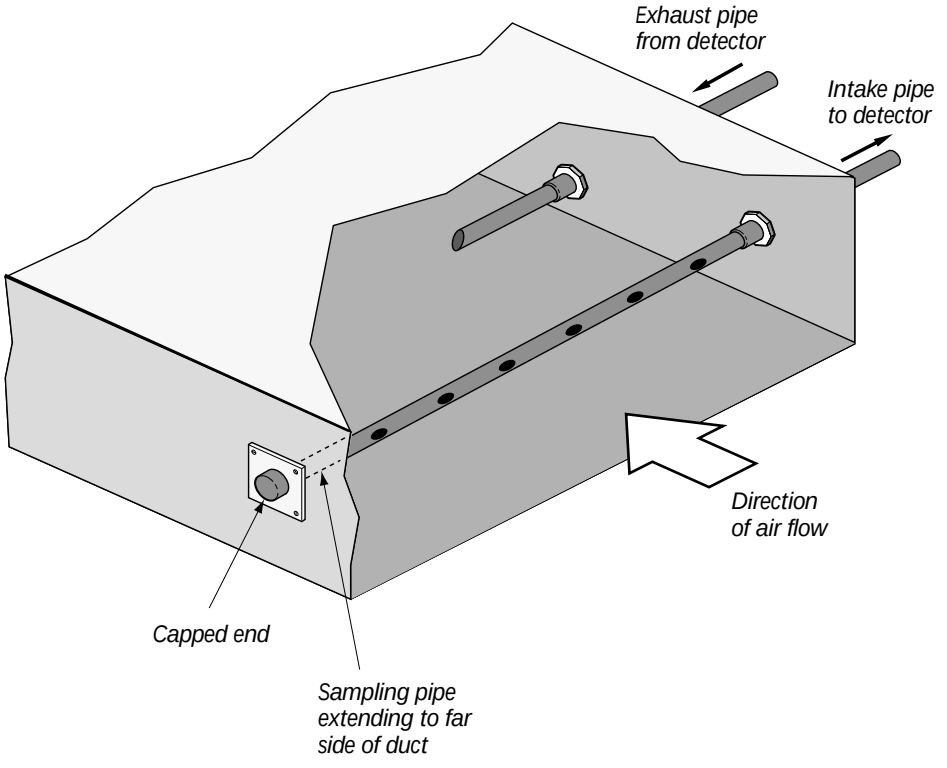


Fig. 6 ***Sampling probe supported by both walls of the duct***

- Care should be taken with ducts insulated for noise or heat retention that penetrating or cutting the insulation and fitting sampling probes and pipework does not affect the performance of that insulation. If in any doubt, consult with the appropriate specialist.

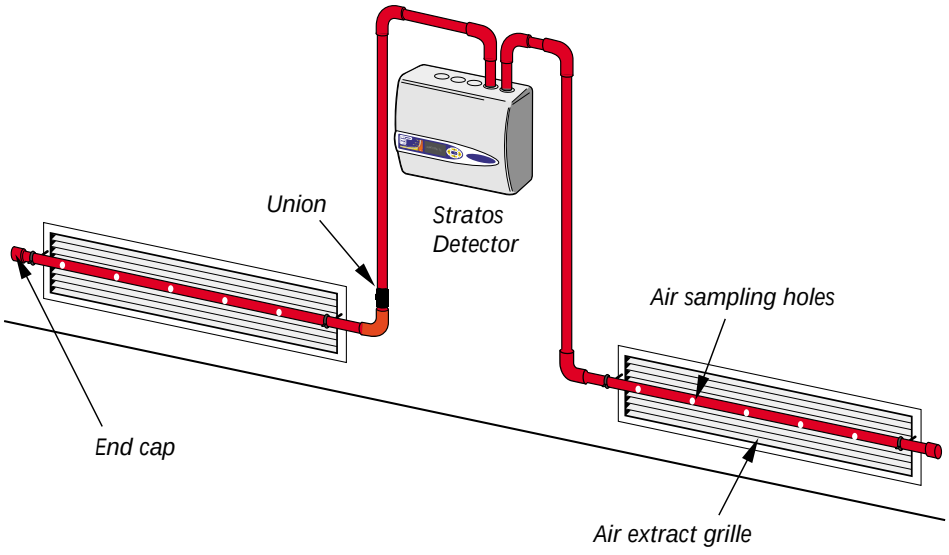
NB: If there is <u>any</u> suspicion that duct insulation is asbestos based, consult a specialist <u>before</u> attempting any work. ☜NB

- When sampling in ductwork that has bends or offsets in any plane, it is advisable to install the sampling probes before the changes in direction. These changes in direction can affect the air flow through the duct causing turbulence or stratification. The ideal position for the sampling probe under these conditions may not be predictable as varying flow rates and temperature may also affect the air stream.
- Care should be taken when sampling from more than one duct that flow through all ducts should remain continuous. If the air flow in one of a series of ducts should stop then variations would occur in the air flow through the Stratos-HSSD® and this may cause air flow fault signals to be generated.
- If a single detector is sampling air from ducts with different airflow rates, it is recommended that the detector exhaust is piped to the duct having the highest flow rate.
- Sampling holes should face into the incoming air flow.

Extract or Exhaust grille sampling

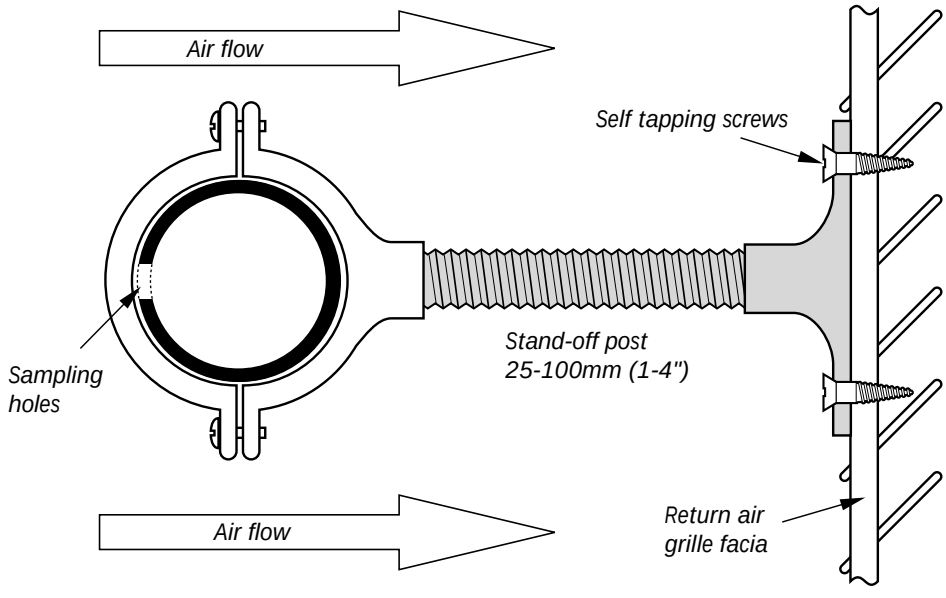
This technique can be used where air is drawn from an area via extract ductwork from a centralised or remote plant room. It is sometimes used where duct sampling proves difficult or impossible and though not as aesthetically pleasing, this method can be equally effective. The sampling pipe is routed, in one or more runs, across the grille with sampling holes facing outwards into the protected space. Figure 7 shows a typical arrangement for extract ducts fitted at low level in a room.

Fig. 7 ***Sampling across low level extract ducts***



- The air velocity would be at its highest (and air pressure at its lowest) in close proximity to the grille. This negative pressure is working against the aspirating fan in the Stratos detector and it is advisable to position the sampling pipe away from the grille by mounting it on stand-off posts. A distance of just a few centimetres will make a significant difference to the negative air pressure affecting the sampling holes. A typical stand-off is shown in figure 8.

Fig. 8 ***Typical mounting to stand sampling pipe away from high-velocity low pressure air at entrance to return air grille.***



- The end of the sampling should be fitted with an undrilled end cap. Sampling holes should be positioned so that air may be sampled from the flow.
- Sampling holes should be drilled approximately every 150 - 300 mm along the section of pipework crossing the grille.
- Where a larger area extract grille requires protection, two or more sampling pipes may be necessary to give adequate coverage. (Fig. 9) In this example the sampling pipes have been run vertically to avoid installing a central support.

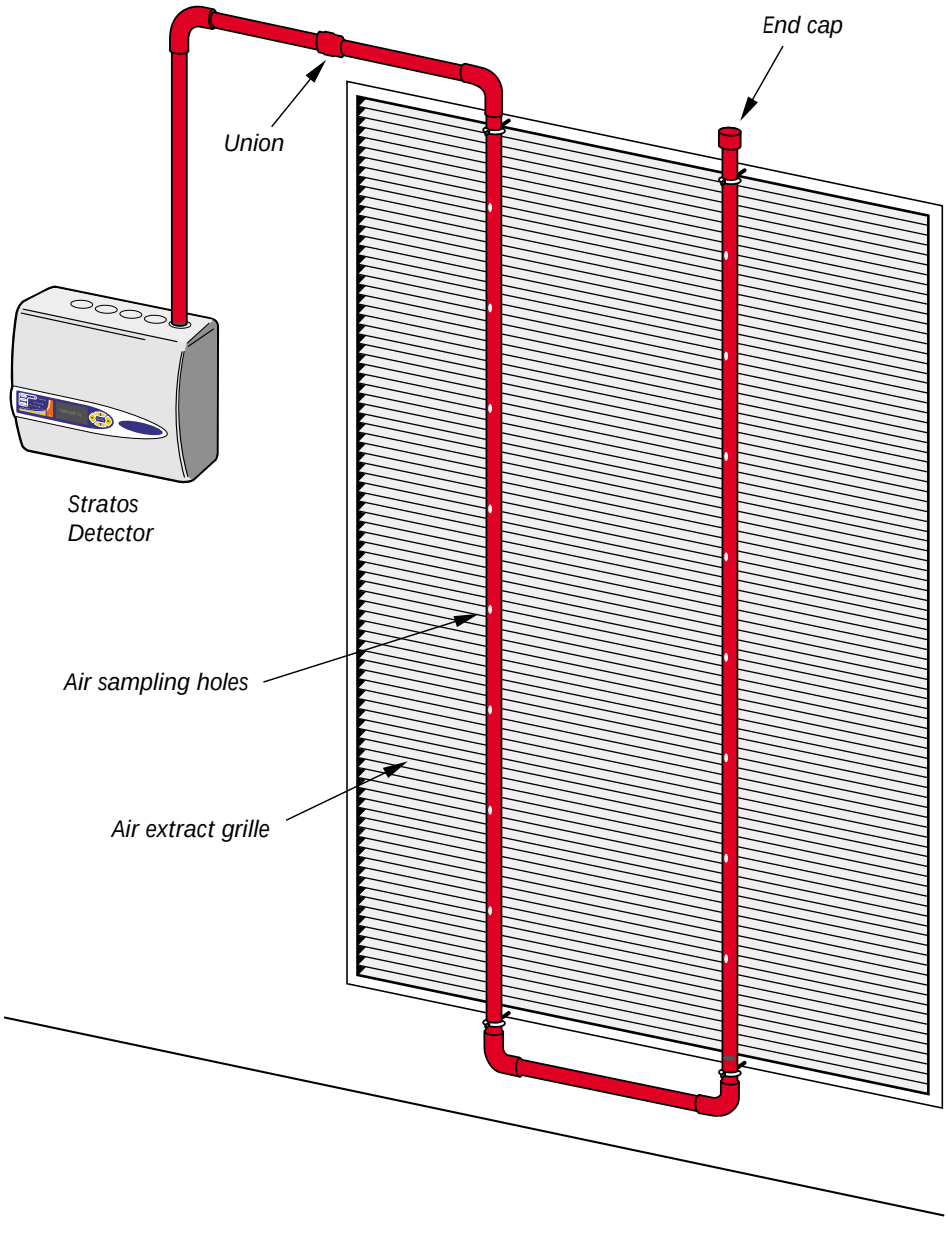


Fig. 9 ***Covering a large exhaust grille with a pipe network***

- Air extract ducts within floor voids require careful consideration. A shallow void often means high air velocities and consequent negative pressures are present at considerable distances away from the void exit point. The sampling pipe network should be installed as far as practical from this point. (Figures 10 & 11).

Fig. 10 ***Sampling at a return air duct within a floor void***

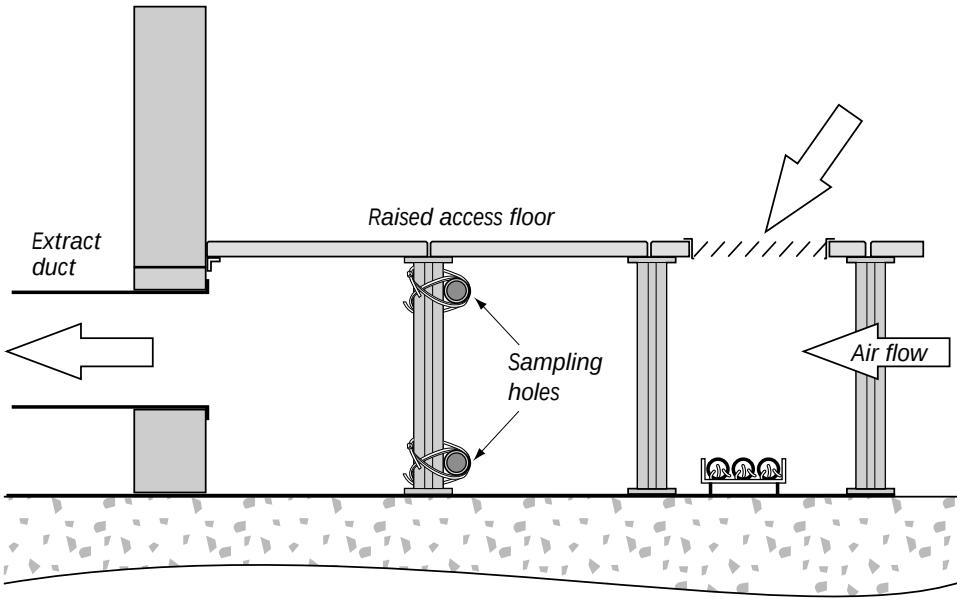
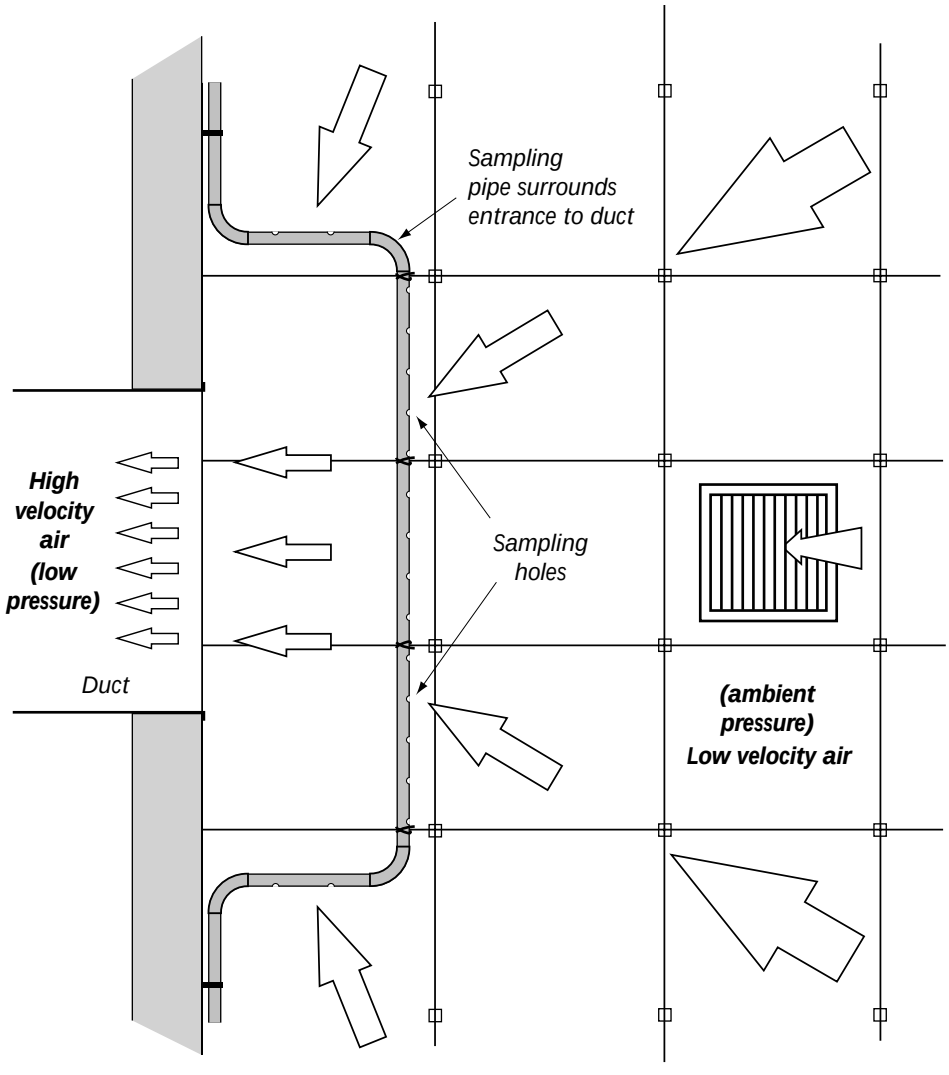


Fig. 11 ***View in plan***



Pressure relief vents

There are applications for Stratos, particularly in telecommunications areas, where there is a requirement to both cool the equipment within the room and maintain the room itself at a given pressure above ambient. This pressure is designed to prevent pollution from the surrounding environment from entering the room and the number and capacity of Air Handling Units is calculated to maintain this positive pressure.

To relieve any excess pressure, vents are installed within the room. These could be sited as a number of small vents replacing existing window glass, as one or more large vent units, or be integrated into the air handling units themselves. Figure 12 illustrates a typical example.

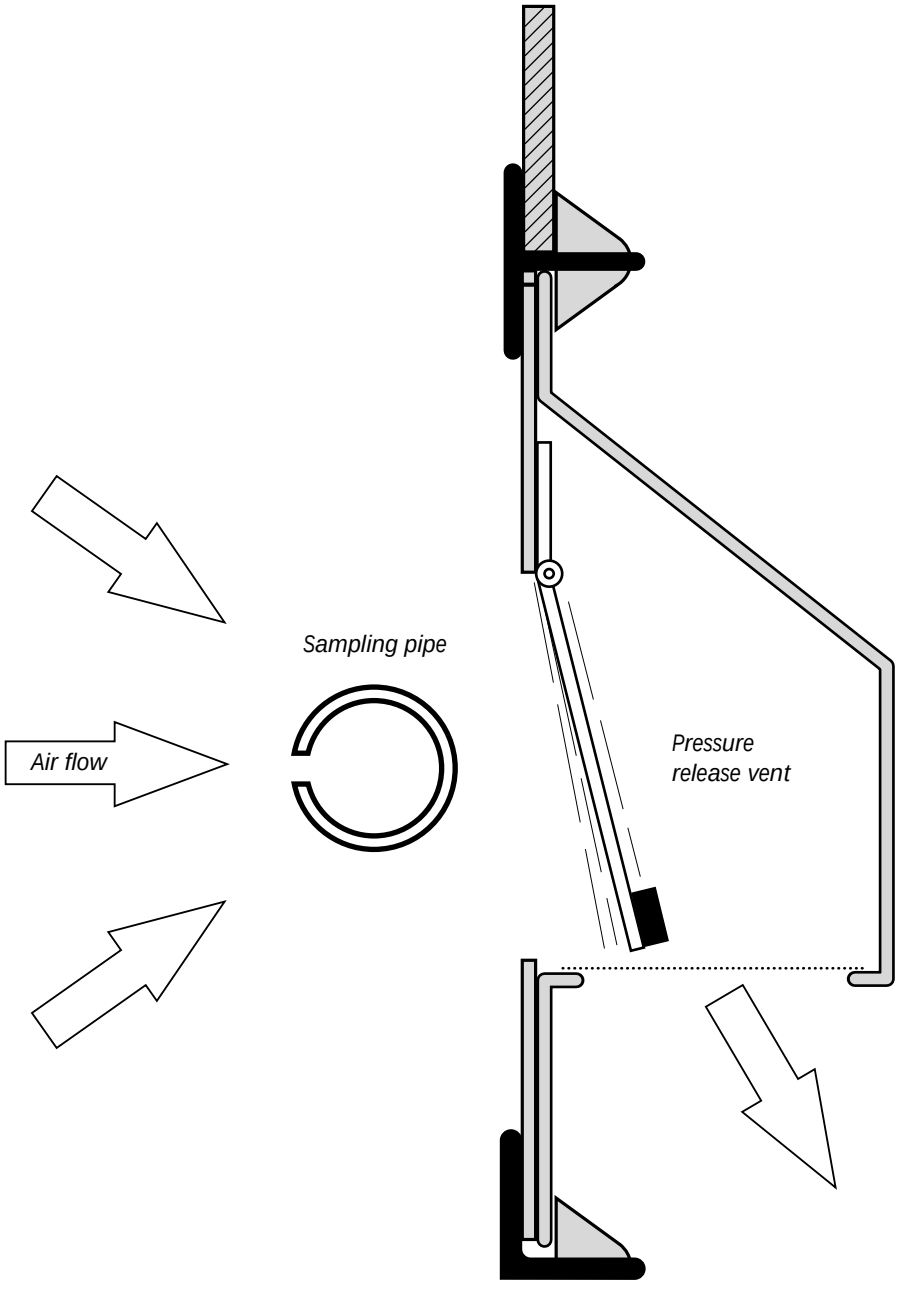
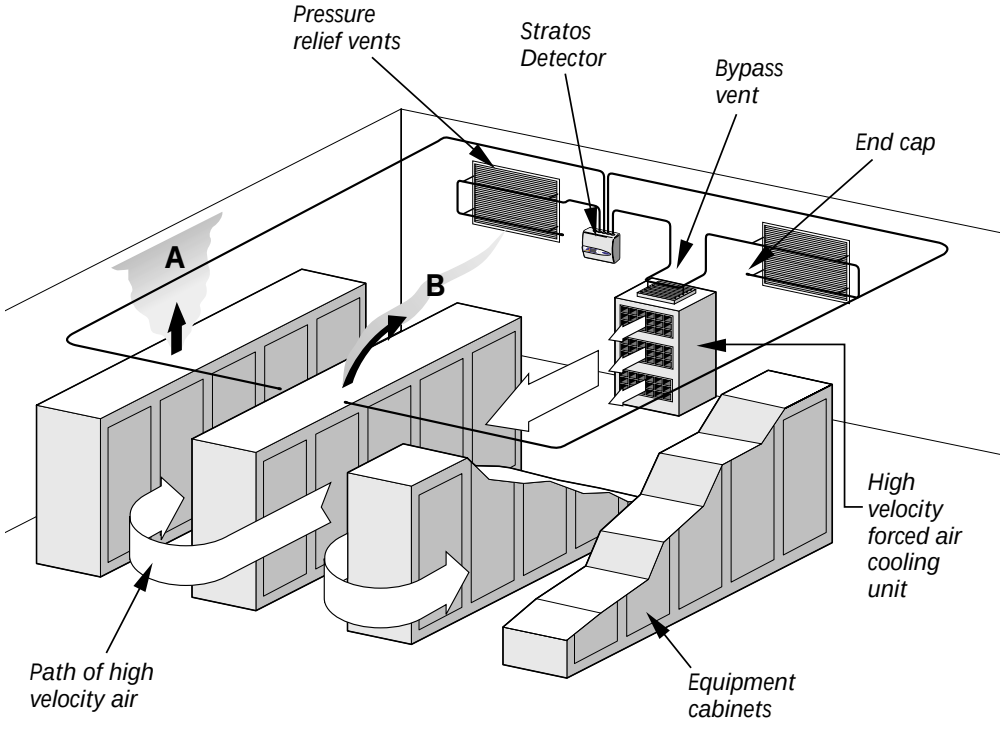


Fig. 12 ***Typical pressure relief vent found in a total or partial loss ventilation system***

- When protecting an area fitted with pressure relief vents it is important that each pressure relief vent is covered by the air sampling network.
- The sampling pipe should be spaced a short distance away from smaller pressure relief vents.
- For large vents the sampling pipework should be spaced away from the pressure relief vent.
- Many modern telephone equipment rooms (normally unmanned) use forced air cooling to maintain an acceptable environment. With this system one or more large fan units draw air at ambient temperature from outside the building, filter it, and eject it into the equipment room at high velocity. (Typically 2.5 m/sec) Large pressure relief vents are fitted to accompany the fan units. Figure 13 is a typical illustration of how a Stratos-HSSD® sampling pipe network should be installed.
- The airflow varies according to demand and under certain circumstances it may be static. The sampling pipe network should be designed to accommodate these variations.
- If a bypass vent is fitted to the unit, it should be included in the sampling pipe network. This vent will open automatically when outside air temperatures are very low to avoid possible thermal shock damage to the warm equipment. The bypass vent will automatically close once the cooling system management has determined any risk of thermal shock has passed.

Fig. 13 ***Stratos-HSSD installed to protect room with forced air cooling system***



A = *Smoke path - static air*
B = *Smoke path - maximum ventilation*

Packaged Air Handling Units

'Packaged', 'Self-contained' or 'Close control' air handling units, of the type used for mechanical ventilation and air conditioning in Electronic Data Processing areas, typically have a return air path that enters the unit via grille either on the top or at the face of the unit.

The method of detection used with these units is essentially the same as for return grille sampling. Figure 14 is an illustration of a typical application. High rates of smoke dilution are likely to be encountered in mechanically ventilated environments, particularly where high air change rates are necessary. For these applications a Stratos system adjusted to allow potentially higher levels of sensitivity. (e.g. Alarm Factor 0 or 1 should be used) .

If higher levels of pollution can be expected because of the site location or cigarette smoking, the detector should be set with a lower level of potential sensitivity. (e.g. Alarm Factor 2 or 3).

Sampling at the return to air handling units does impose constraints. The designer should be aware that system performance will be affected by the position of sampling pipes and the number of units monitored by each Stratos detector.

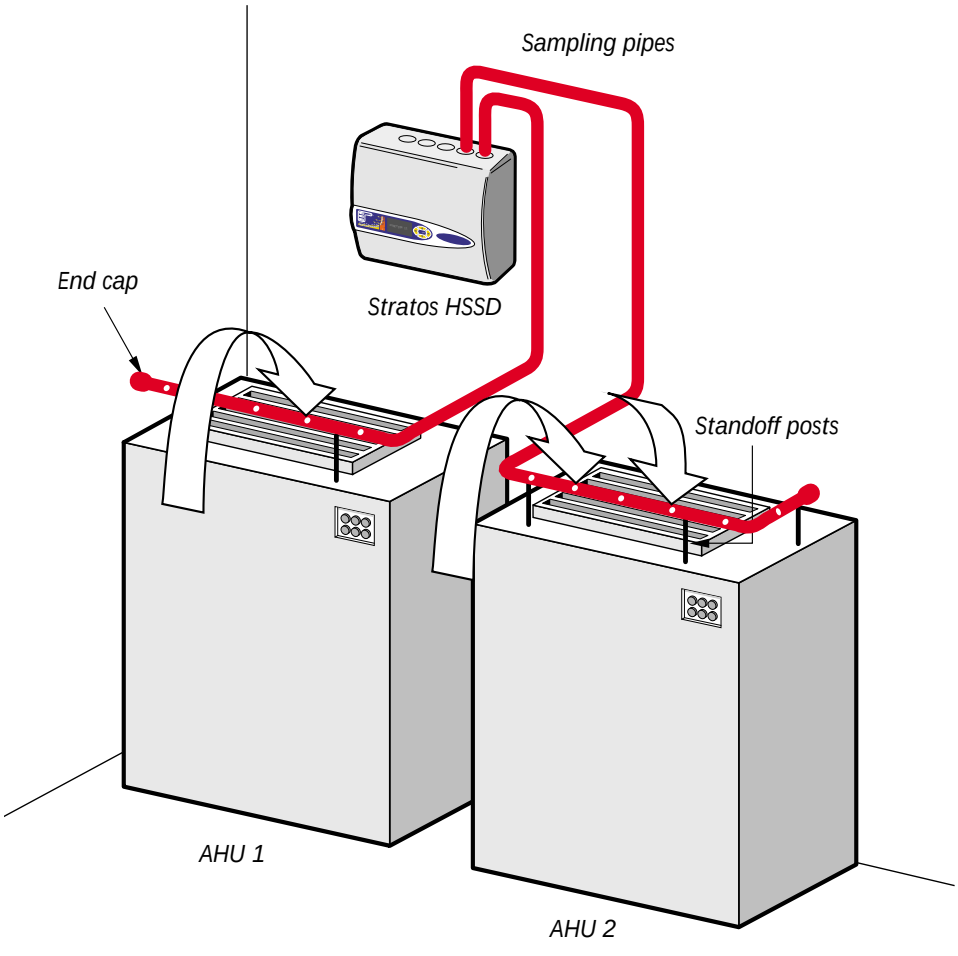


Fig. 14 ***Sampling from air handling units (AHU's).***

☜NB *Note use of stand-offs to lift the sampling pipe clear of the AHU's. Sampling points must only be located along the section of sampling pipe that runs above the AHU inlet vents*

Fig. 15 ***Sampling pipe mounted on stands around perimeter of air return register***

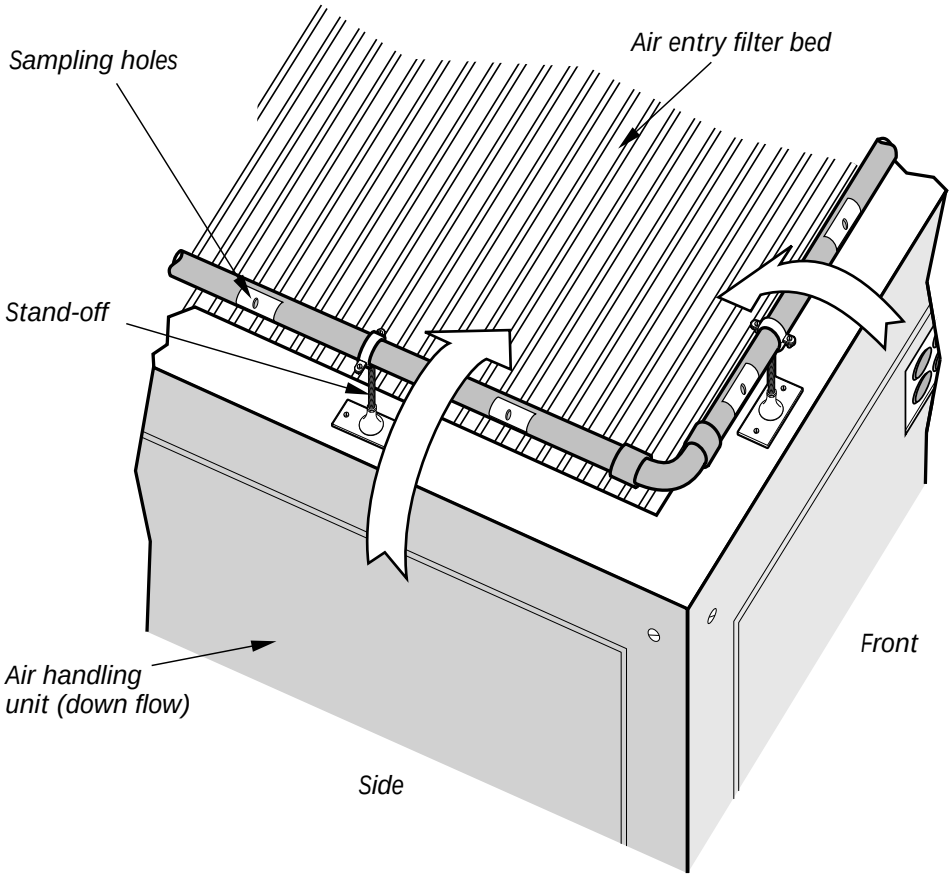
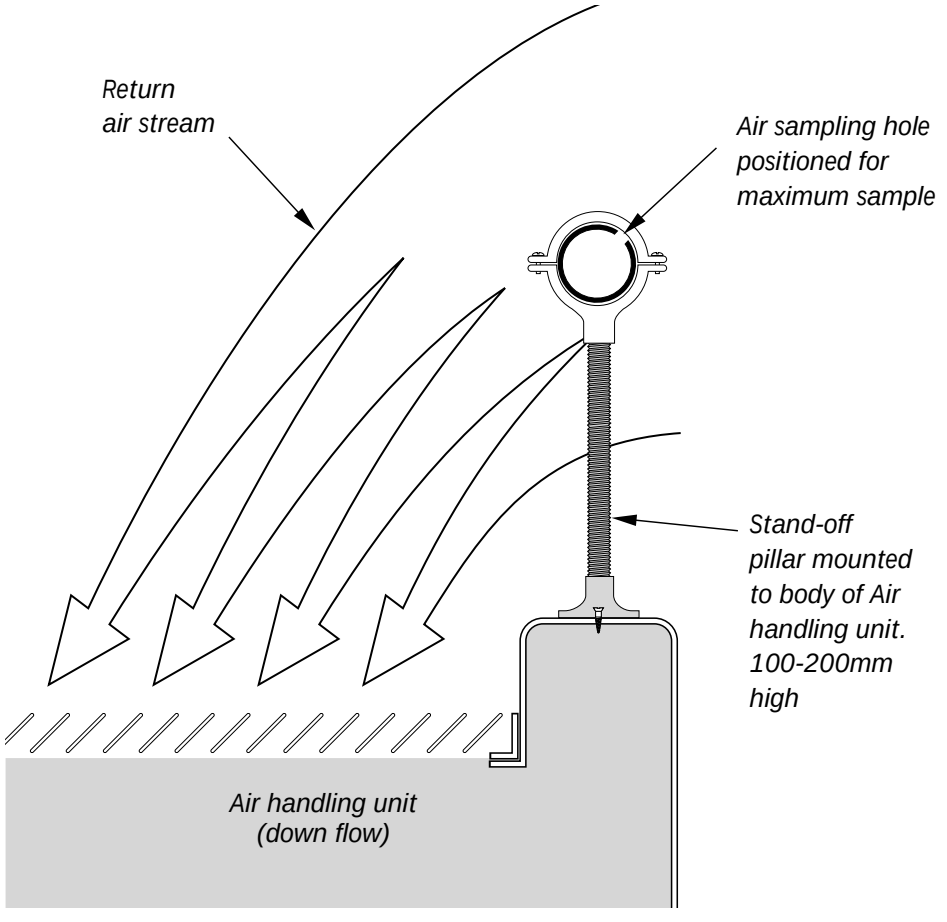


Fig. 16 ***How sampling pipe is installed in a position to effectively monitor the return air.***



- When choosing the position of the sampling pipe above a packaged air handing unit, it should ideally be determined by observing the path of the air returning to the air handling unit. Smoke generators are available to assist in this process. See figure 17a + b.
- It is recommended the sampling pipe should also be run across the sides of the air handling unit. The air returning to the unit does not only pass over the front edge and extending the sampling pipe along the sides will offer better coverage.
- For very large air return registers, two sampling pipes may be required to achieve effective coverage.

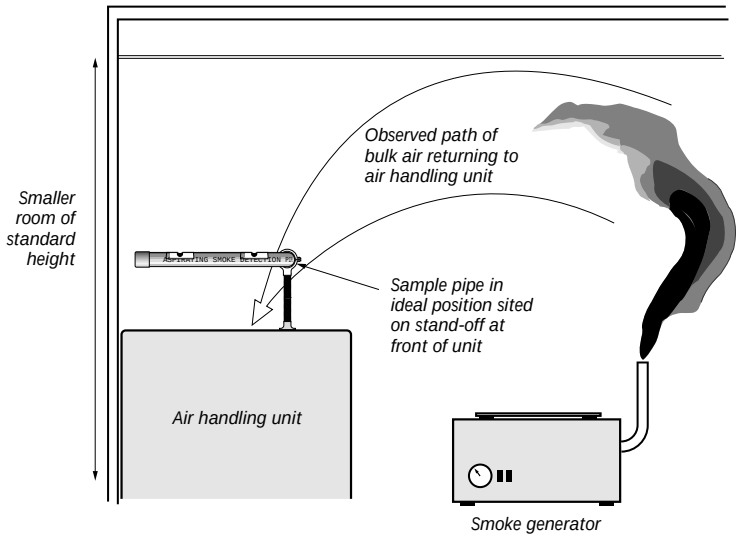


Fig. 17a

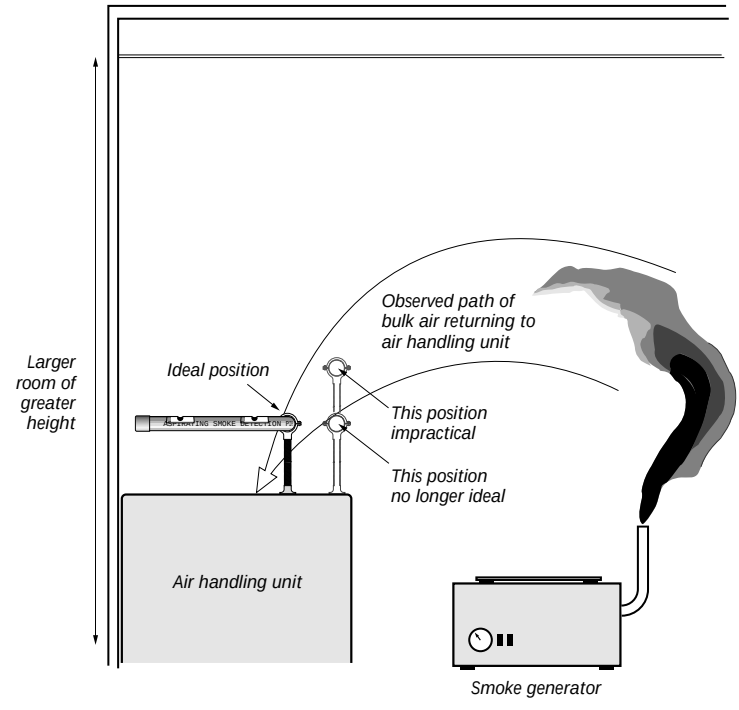


Fig. 17b

Fig. 18 ***Sampling across a small split system room unit***

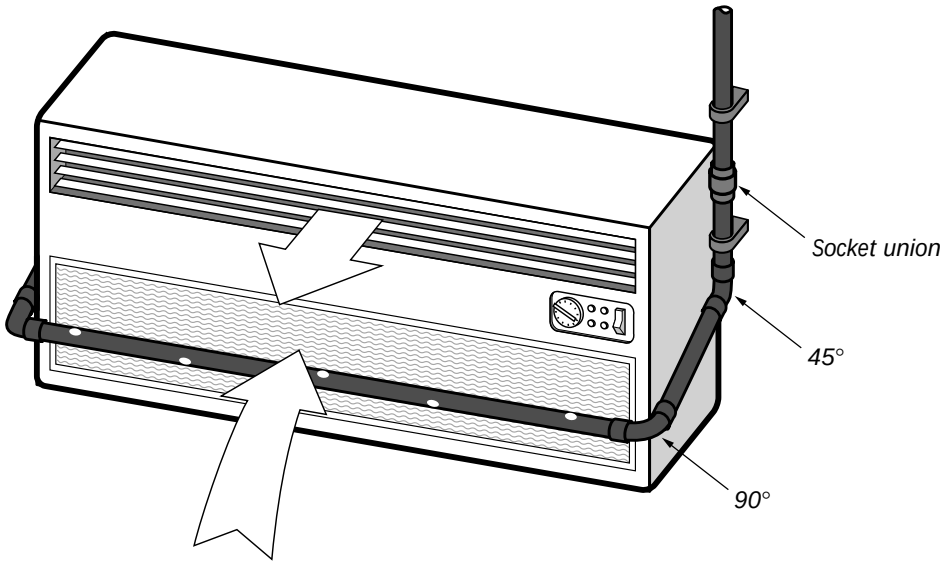
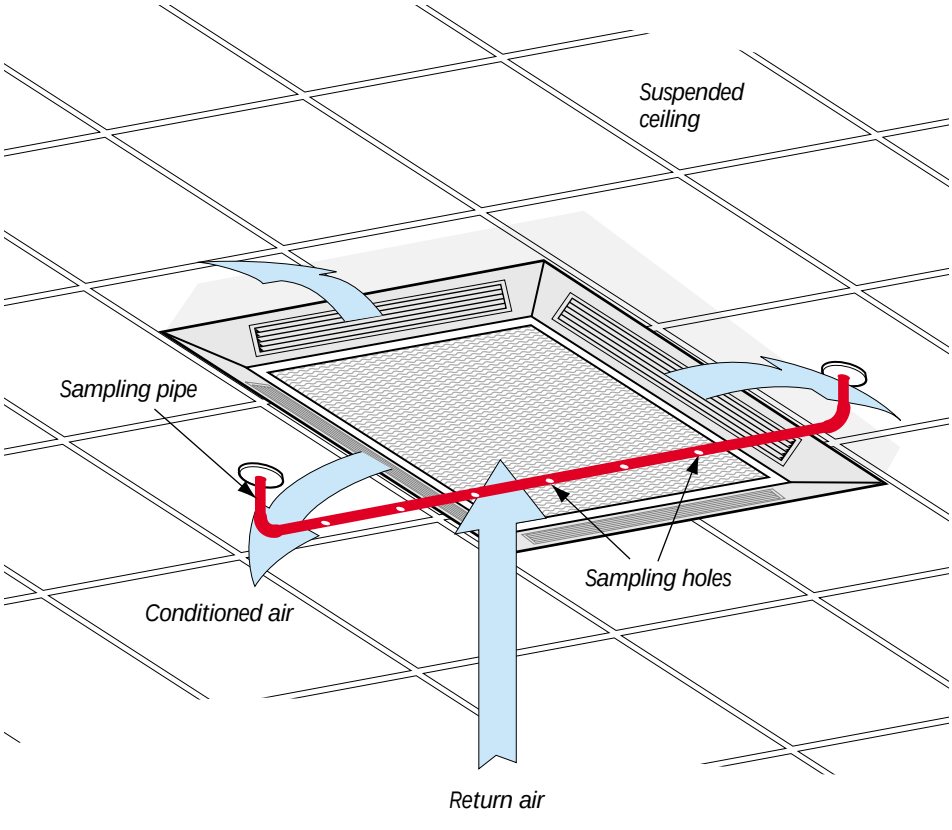


Fig. 19 ***Sampling across a ceiling mounted cassette air conditioning unit***



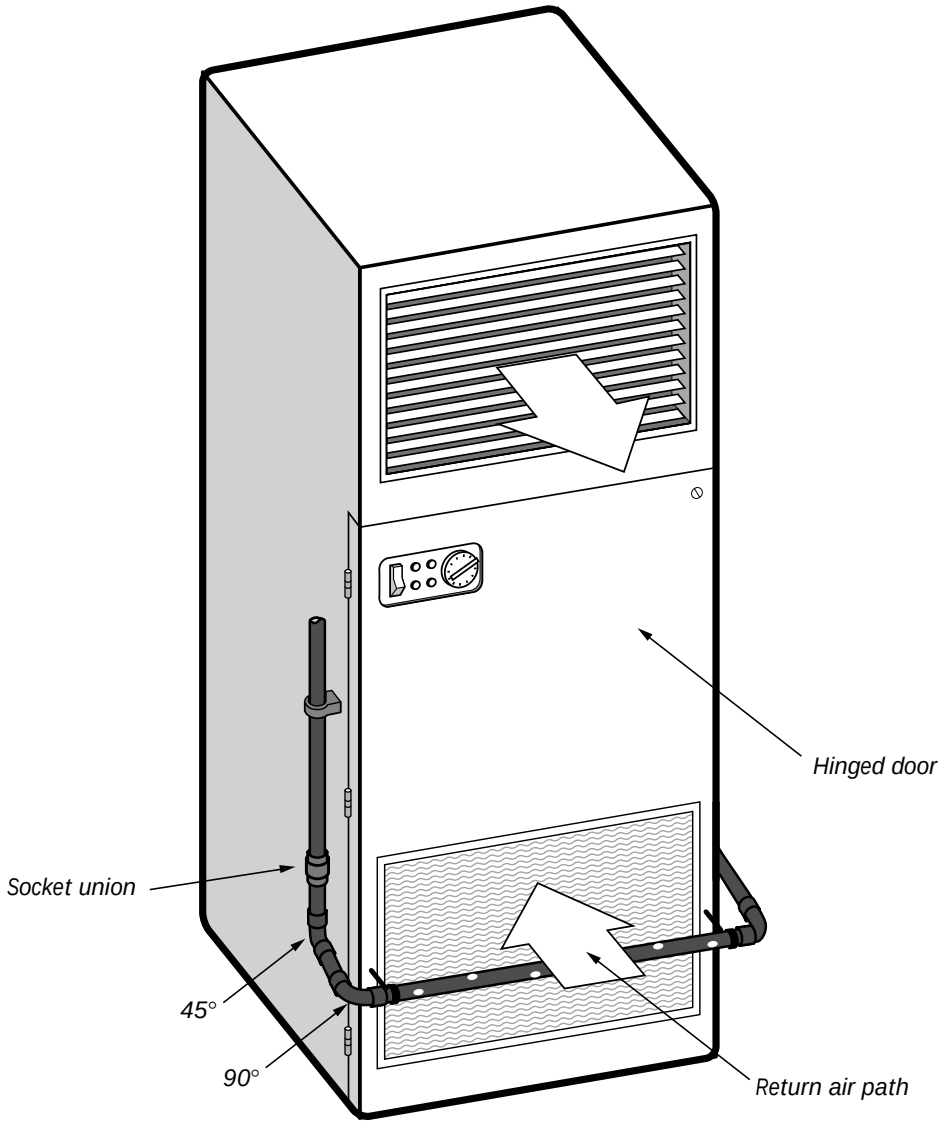


Fig. 20 ***Sampling across a small split system room unit***

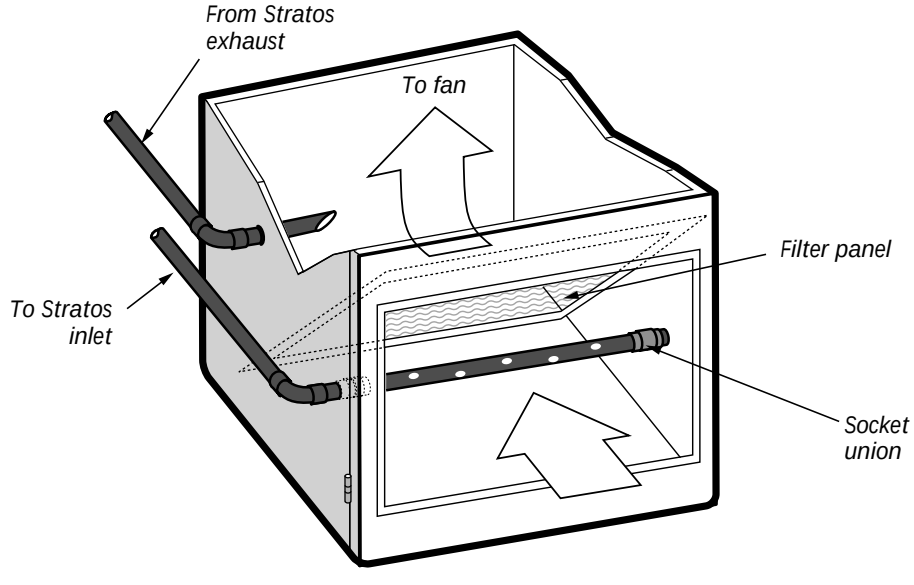


Fig. 21 ***Mounting the sampling pipe behind air grille***

- When installing pipework across or over a packaged air handling unit it is important that the sampling pipe should not unduly hinder access to the equipment for maintenance of the unit. If sampling pipework does obstruct access, socket unions should be installed in the pipework as necessary to allow the obstructing section of pipework to be removed. The socket unions and/or pipe fittings should be installed such that the section of pipework can only be replaced to its original orientation.
- Where it is necessary to install sampling pipe and its associated holes in high velocity (low pressure) air streams, careful checks should be made to determine whether this is having a detrimental effect on the response time of the Stratos system. If there are significant effects, then it is recommended the detector exhaust is piped back to the same air pressure zone. (see fig. 2 and the section on Duct Monitoring).

Sampling over multiple air handling units

In larger rooms a Stratos detector may be required to protect more than one packaged or close control air handling unit. The question is then how many air handling units can a single Stratos detector cover. There are no hard and fast rules that can be applied as there are many different models of air handling systems with various operating principles, capacities and duty cycles.

It is a certainty that under normal room circumstances, a suite of air handling units would generate vigorous air movement that would rapidly dilute any smoke from an incipient fire. Assuming each unit is circulating 2 - 3m^3 /sec it is recommended that a single Stratos detector protects no more than four (4) air handling units. For best system performance it is recommended the air handling units are distributed equally between the four pipe branches that can be fitted to the Stratos-HSSD® detector. The figure of four AHUs is given for guidance only for the reasons given above. The air handling units may also have return air paths that make the application of standard recommendations impractical. Therefore it is the designers' responsibility to ensure the proposed installation meets the project specification or relevant Codes, Standards or Regulations.

Suites of air handling units have a tendency to localise air movement within a room, i.e. the air in one section of a room circulates between the feed and return points of one particular air handling unit. The result is that there is minimal cross migration between main air circulation paths and any products of combustion from an incipient fire in the same area will tend to remain concentrated in that area.

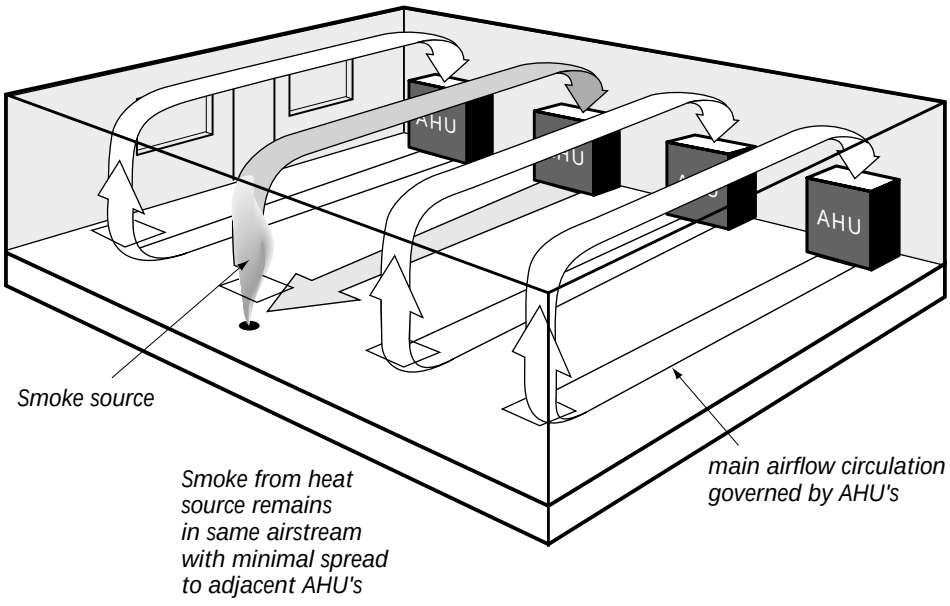


Fig. 23 ***Predominant air movement provided by AHU's***

If a single pipe branch is used to monitor a number of air handling units it should be remembered smoke dilution may have a significant effect on detector response. In the illustration given on this page, smoke generated by an incident is drawn into the sampling holes over air handling unit 2. The less polluted air circulating through air handling unit no. 1, 3 and 4 will dilute the original heavily polluted sample. This dilution and the effect of negative pressures generated by the air handling units will reduce detector response to the smoke and also increase the time taken to respond.

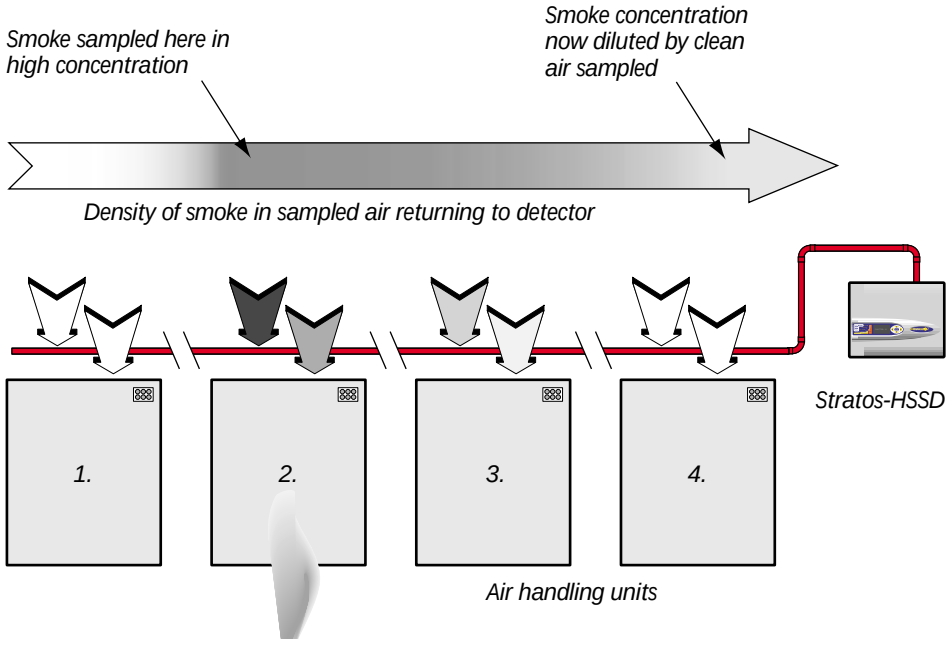


Fig. 24 ***The dilution effect across several air handling units***

As mentioned earlier in this section, the main reason for spacing the sampling pipe away from the air return register(s) is to prevent the negative pressure generated in the high velocity air flows working against the aspirating fan fitted to the Stratos detector.

If sampling holes are placed too close to high velocity air flows the negative pressure outside the sampling hole will approach the negative pressure generated by the detector aspirating fan and render the sampling hole ineffective...almost as if the sampling hole were non-existent or blocked. In extreme circumstances, air could be drawn out of the sampling hole.

It is also unlikely that the flow rates through each air handling unit will be equal. Referring back to figure 24 and assuming the sampling pipe were placed in identical positions, the air handling unit with the lowest volume of air flowing through it will have most air drawn into the sampling holes above it. If air handling unit no. 2 were stopped then the absence of any negative pressure at its inlet would allow an greater volume of air to pass through the sampling holes to satisfy the negative pressure created by the detector aspirator. This would reduce the volume of air drawn in through the sampling holes above the working air handling units. The net result would be to reduce the efficiency of the detection system.

Piping the detector exhaust to two or more of the air handling units as shown in figure 25 would improve the efficiency of the aspirating system.

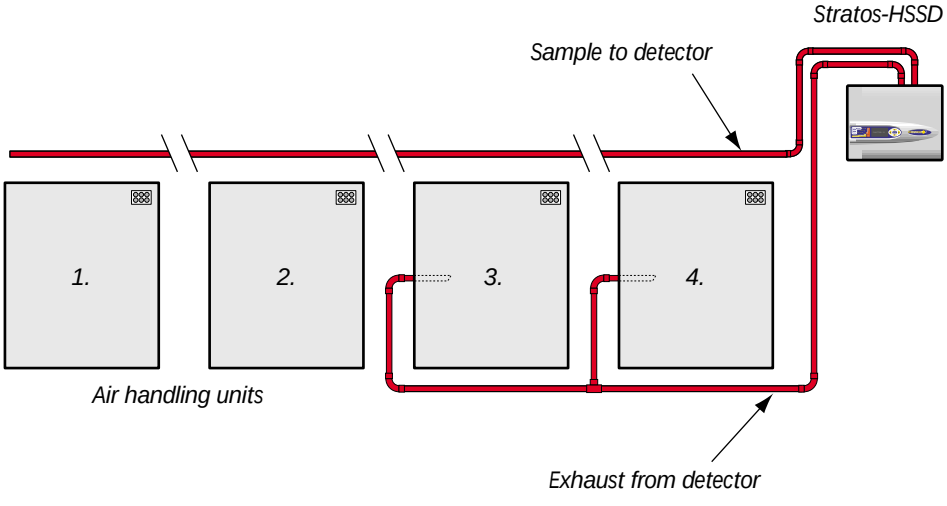


Fig. 25 ***Theoretical illustration of how the Stratos detector exhaust can be piped back to the air handling units to improve aspirating performance***