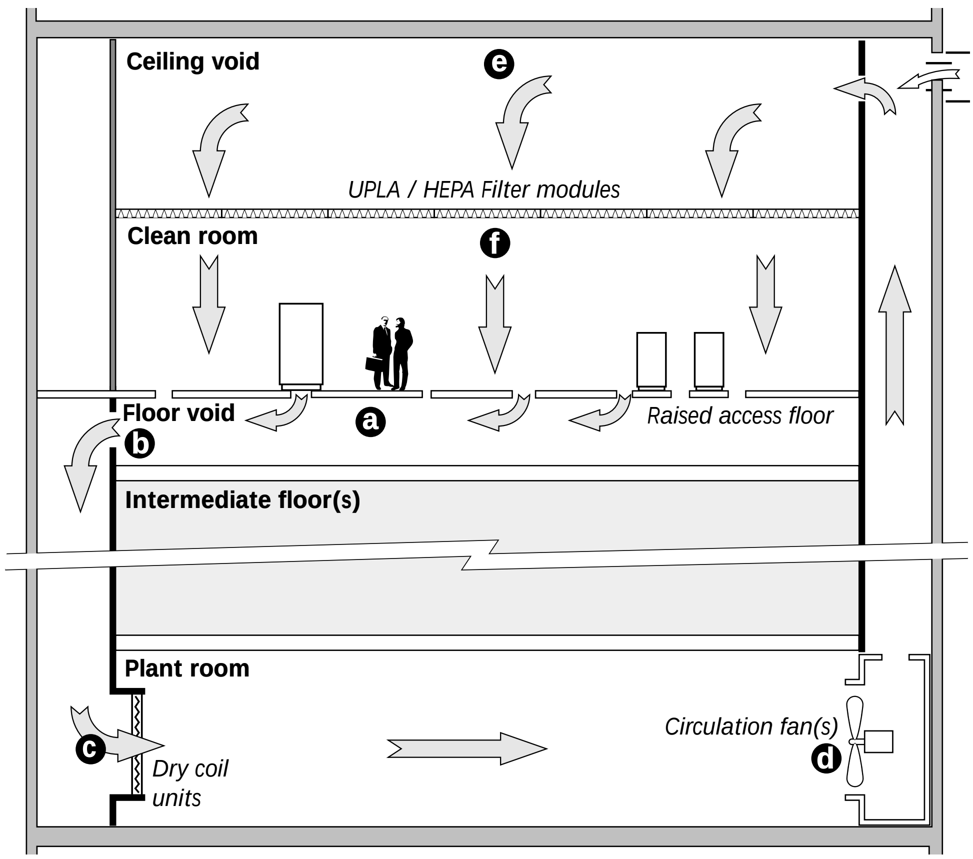
SPECIAL APPLICATIONS
CLEAN ROOMS

The protection of microelectronics clean rooms using aspirating smoke detection systems requires special consideration. The physical configuration of the room(s) and the direction and volume of air flowing through it mean that the probability of detecting a fire in its incipient stages is difficult or unlikely if relying upon traditional smoke detection methods. Experience has proven that only highly sensitive detectors of the aspirating type are likely to provide an adequate degree of protection

The by-products of combustion are particularly damaging to many of the manufacturing processes undertaken in a clean room environment. The consequential cost of having an undetected fire develop within a microelectronics clean room far outweigh the cost of providing an efficient early warning smoke detection system. For example, in a Class 100 clean room the air management systems is designed to restrict the number of particles within a specific measurable band to 100 particles in each cubic foot of air (approx. 3,500/m^3). By comparison, in a typical office environment it is likely to have a thousand times more than that figure. Even a small fire emits a huge quantity of visible and invisible particulate matter.

For this reason a very sensitive and fast reacting smoke detection system will be required.

Fig. 1 ***Simplified section through one typical clean room***



It should be remembered that a purpose-built clean room facility would often occupy several levels within a building.

Starting with the air handling unit, the airflow pattern through the facility is as follows. Air is forced into the duct(s) and into the ceiling plenum above the Clean Room. A proportion of fresh air may be added at this point. In the plenum, the air dissipates and passes down through a filter bed fitted with high efficiency filter modules (HEPA or ULPA type) where any particulate matter in the air is removed. The air passes through the clean room and leaves through strategically placed vents or grilles in the raised floor. The air passes through the floor void and into ducts leading down the building. At the base of the duct the air passes over dry coil units, into the plant room plenum, then back into the air handling unit.

The ventilation system would be designed to give a certain number of complete air changes within the room each minute. (e.g. 3). Within the room itself the air would enter from virtually the whole surface area of the ceiling to provide a gentle laminar flow. However the flow through slots, vents and ducts would be at a much higher velocity and turbulent in nature.

Unlike normal commercial applications where smoke will normally recirculate or linger, any smoke entering the air stream in this application will quickly disperse because of the high air flow rates and high efficiency filtration.

To provide efficient detection of incidents within the Clean Room itself it is recommended:-

1. To place sampling pipework as close as practical to the actual risk. The further away the sampling pipe and its holes (detection points) are from the source of any smoke the greater will be the dilution and the slower the response.

2. To keep the length of sampling pipe networks as short as possible. The longer the sampling pipes the longer it will take the system to raise an alarm. Fires may grow very quickly in this application

3. To restrict the area covered by a single aspirating smoke detection system. - In normal commercial systems where airflows are static or comparatively slow moving, the efficiency of a detector is normally directly proportional to the volume of the space it protects. In a Clean Room application it is necessary to restrict the area/volume covered because of the volume of air flowing through that area at any moment in time.

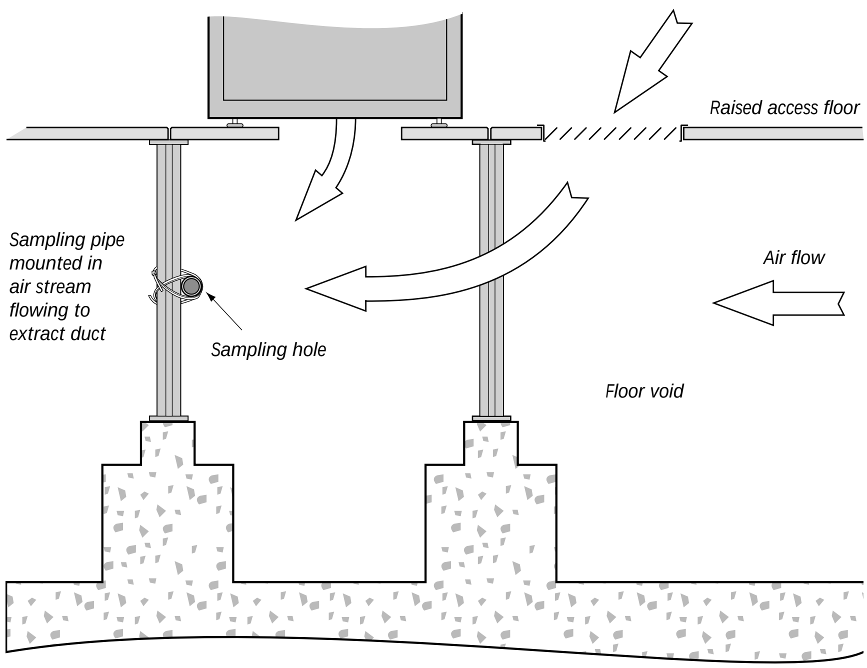
Typically we would recommed the following :

- A maximum sampling pipe length of 80 metres spread evenly over the four pipe inlets of the detector. Any one pipe should be no longer than 25 metres.
- A maximum of 24 sampling holes for each detector.
- The area a single detector should cover is dependent on the air change rates in the space and the level of performance specified. As an example consider a Stratos-HSSD® detector with sampling pipe configured to cover an area of 100m^2 in a room 4 metres high having three air changes a minute*. Although the area covered appears to be very small the actual volume protected is area x height x air change rate. i.e. 100 x 4 x 3 = 1200m^2.
  *(*60 seconds is possibly the longest time we would normally allow for smoke to travel from the source to a sampling point. This is a figure over which there is little control.)*
- The Stratos-HSSD® should be set to give its highest potential sensitivity. (i.e. Alarm Factor 0). In this configuration, Stratos-HSSD® is the most sensitive smoke detection system available world-wide.
- The Laser Dust Discrimination function should be disabled to minimise response delays.

In the facility described in Figure 1 there are six possible recommended positions for aspirating smoke detection. All comply with the requirements of NFPA 318 except position (e) which offers protection above the filter beds, yet is after the make-up air inlet and position (f) below the filter beds in this example.

(a). Beneath the raised access floor. In this example the space beneath the raised access floor is an open void. Slots or adjustable vents in the raised access floor allow air to flow from the room. The sampling pipes from the Stratos-HSSD® should be strategically positioned such that sampling holes are in the air stream leading from the slots or vents in the raised floor. Special consideration should be paid to what equipment is sited in the Clean Room itself and the probability of a fire starting within it. A typical risk example is wet stations.

Fig. 2 Position of sampling pipe below raised access floor



This position, being closest to the risk, will give the earliest possible warning of an incident but it is relatively difficult to give good overall coverage. In larger rooms there are many floor slots or vents in different densities distributed throughout the room. If the detectors are also sited within the floor void there may also be difficulty gaining access to them when the room is operational.

(b). Across the entry to extract ducts. In this example the entry to air extract ducts is along one side of the Clean Room floor void. It is the first common point for detection of smoke within the air stream leaving the Clean Room space. Running sampling pipe networks across them is relatively simple and the Stratos-HSSD® detectors could be mounted in adjacent service corridors allowing easy access for routine maintenance. Because the air velocity at the entrance to these ducts will be high and air pressure low when compared to the service corridor, it is imperative that the exhaust from the detector is piped back into the duct to maintain the efficiency of the aspirating system.

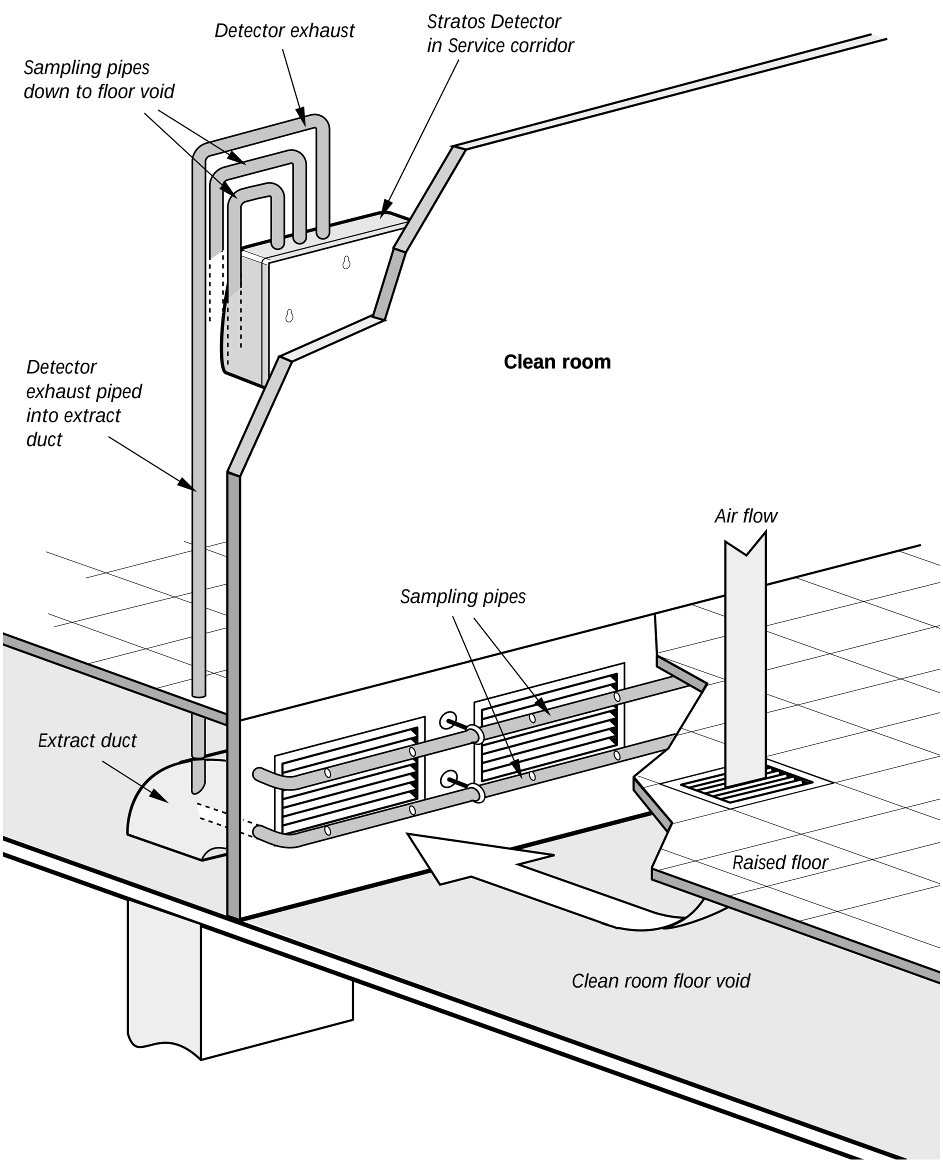
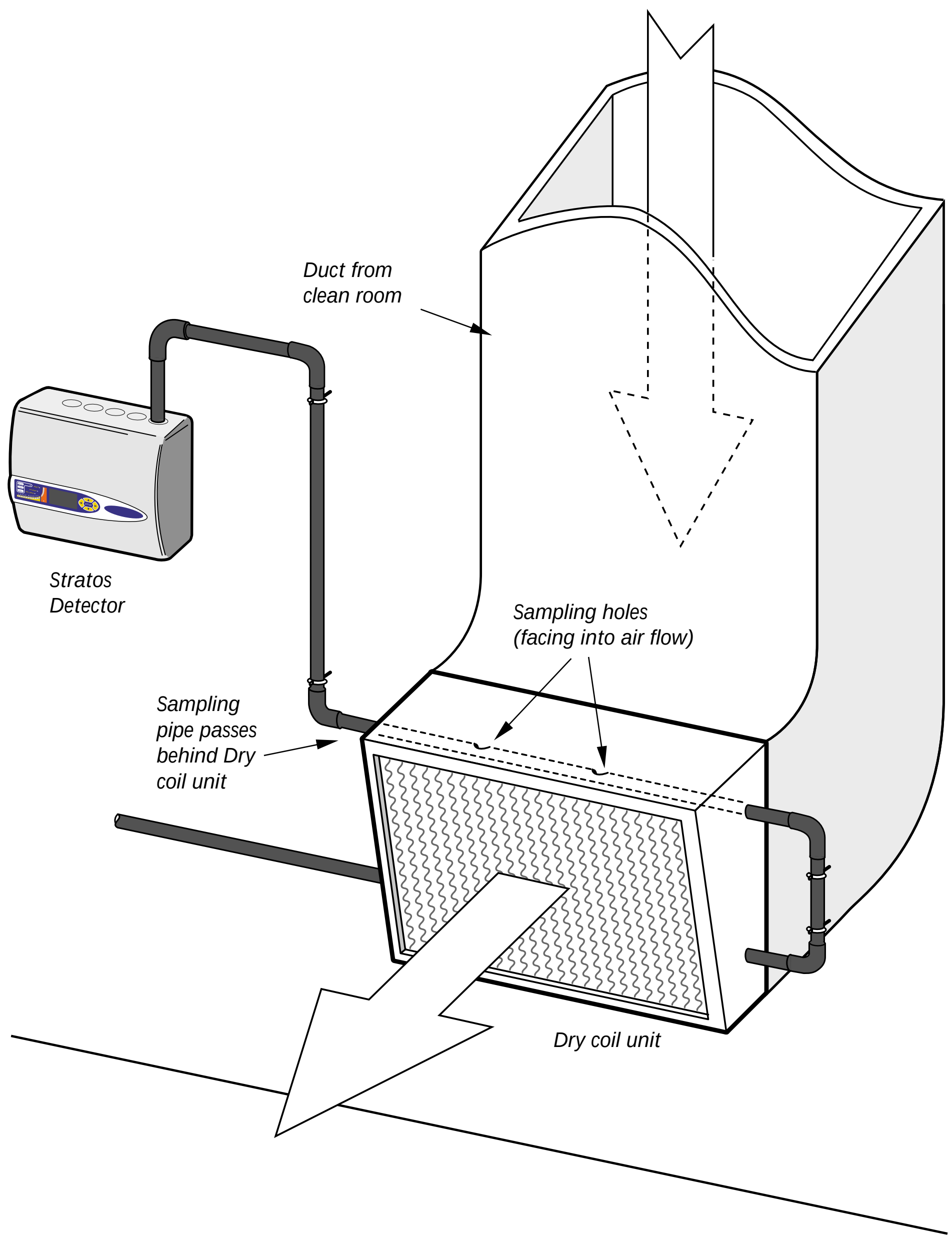


Fig. 3 ***Sampling across the entry to extract ducts***

(c). Across dry coil units. In this example the dry coil units are installed at the exit from the air circulation ductwork leading down from the Clean Room. Being further from the room a small additional delay will occur. Ideally the sampling pipes should be sited in front of the unit (i.e. upstream). The detector(s) can be mounted within the plant room.

Fig. 4 Sampling across dry coil units



(d). Across dry coil units (alternative). Where the coil units are in close proximity to the air circulation fans, a sampling pipe network can be run across them. It should be remembered however that air velocities will be higher in this position and as a consequence, the air pressure will be much lower. As in (b), it is recommended the exhaust air from the Stratos-HSSD® detector(s) is piped back (returned) into this low pressure air stream.

(e). In ceiling void above air filters. Siting the air sampling systems in the feed air plenum directly above the Clean Room offers protection should their be any problems in the mechanical air movement plant, overhead lighting, auxiliary services or make-up air supply circuit. The room filtration will effectively remove any of the smoke so a Stratos-HSSD® system below this level is unlikely to give any warning. It should be remembered that external pollution may enter the air flow circuit via the fresh air make-up supply and it may be necessary to install a reference detector to compensate for this. Detection in this area should be considered complimentary to systems closer to the Clean Room and the area covered by each detector could be increased.

(f). Below the false ceiling/filter bed. Detection at this level would be inefficient whilst the air handling systems were in operation. It would be effective when the room was not operational and should be considered as complimentary to other aspirating smoke detection systems. The area covered by each detector could be increased.

Other Room Configurations

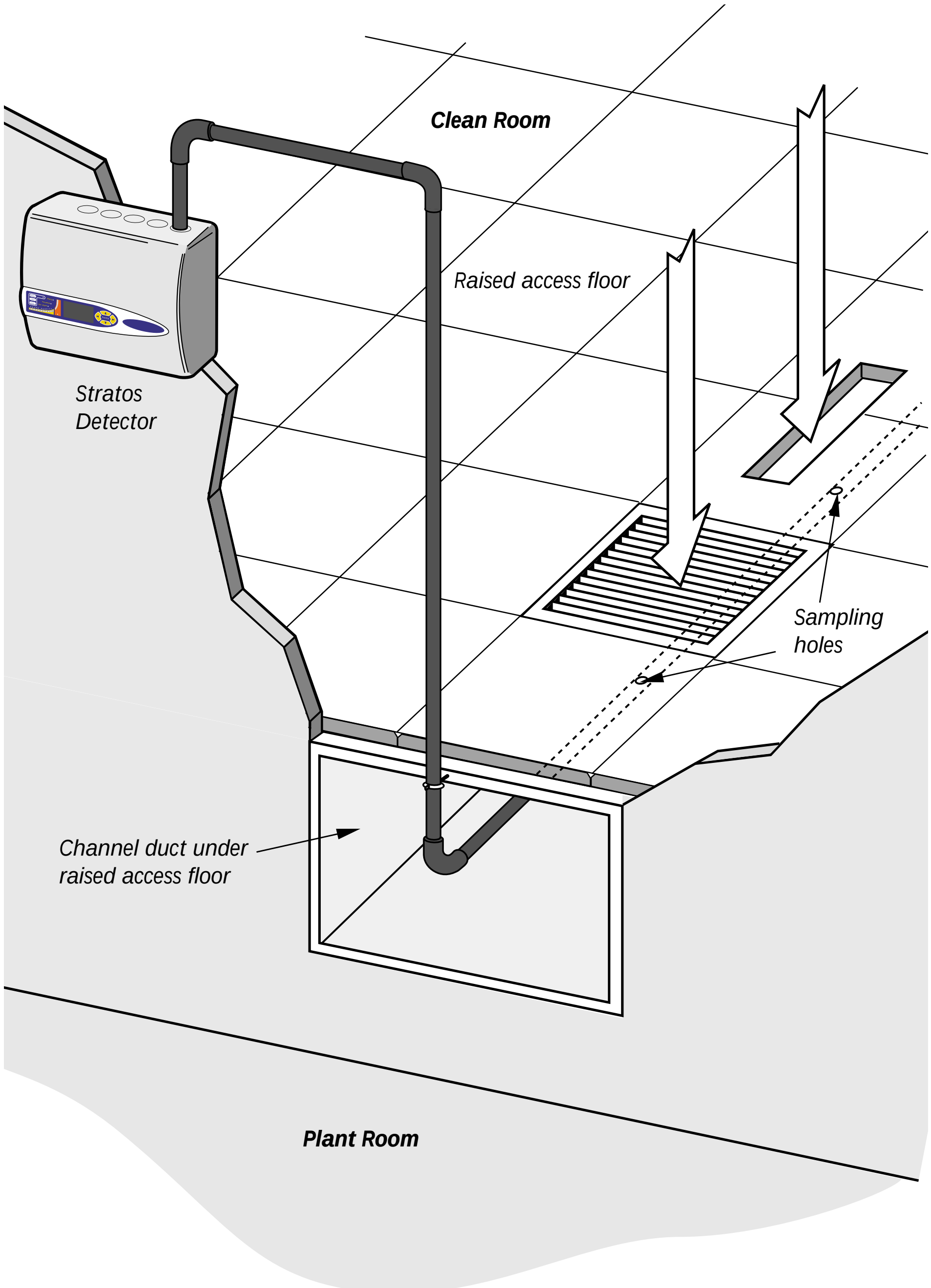
The above examples are a few of many possible configurations of Clean Rooms. Many Clean Room facilities are constructed within existing buildings and all the components are assembled on a single level. The following are other possible variations but the basic principles of providing efficient early warning using Stratos-HSSD® apply.

Ducted Air Extracts below the Raised Access Floor

To improve efficiency, balance and control of the air flow within a larger room the air extracts slots or grilles in the raised access floor may lead directly into extract ductwork. Under these circumstances the sampling pipe networks should be installed at the first available access point. In some configurations it is possible to install the sampling pipe within the duct itself which can prove very efficient (See Fig 5) but care must be taken to ensure the air leaving the Stratos-HSSD® detector is exhausted in the same pressure zone.

Using the ‘Duct Probe’ method is not recommended. The position of air streams within high velocity ductwork is difficult to predict and variations in temperature and flow rates mean extensive trials ought to be undertaken to optimise the position of the sampling probe(s).

Fig. 5 Sampling in a clean room air extract duct



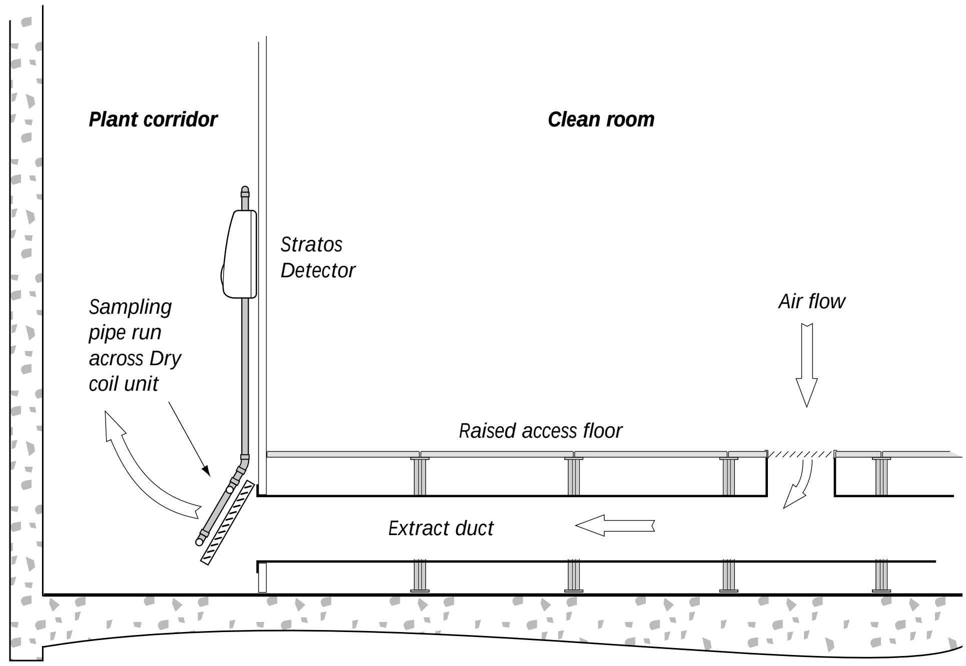


Fig. 6. Sampling at end of extract duct

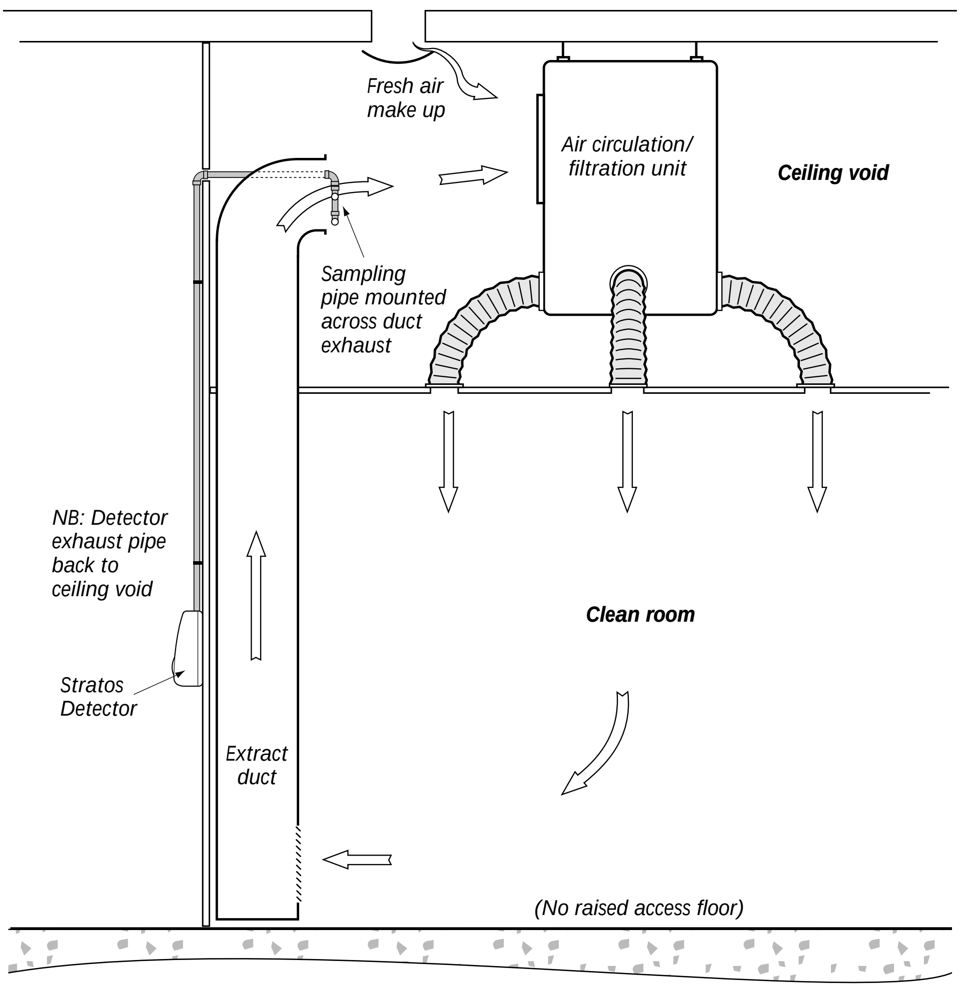
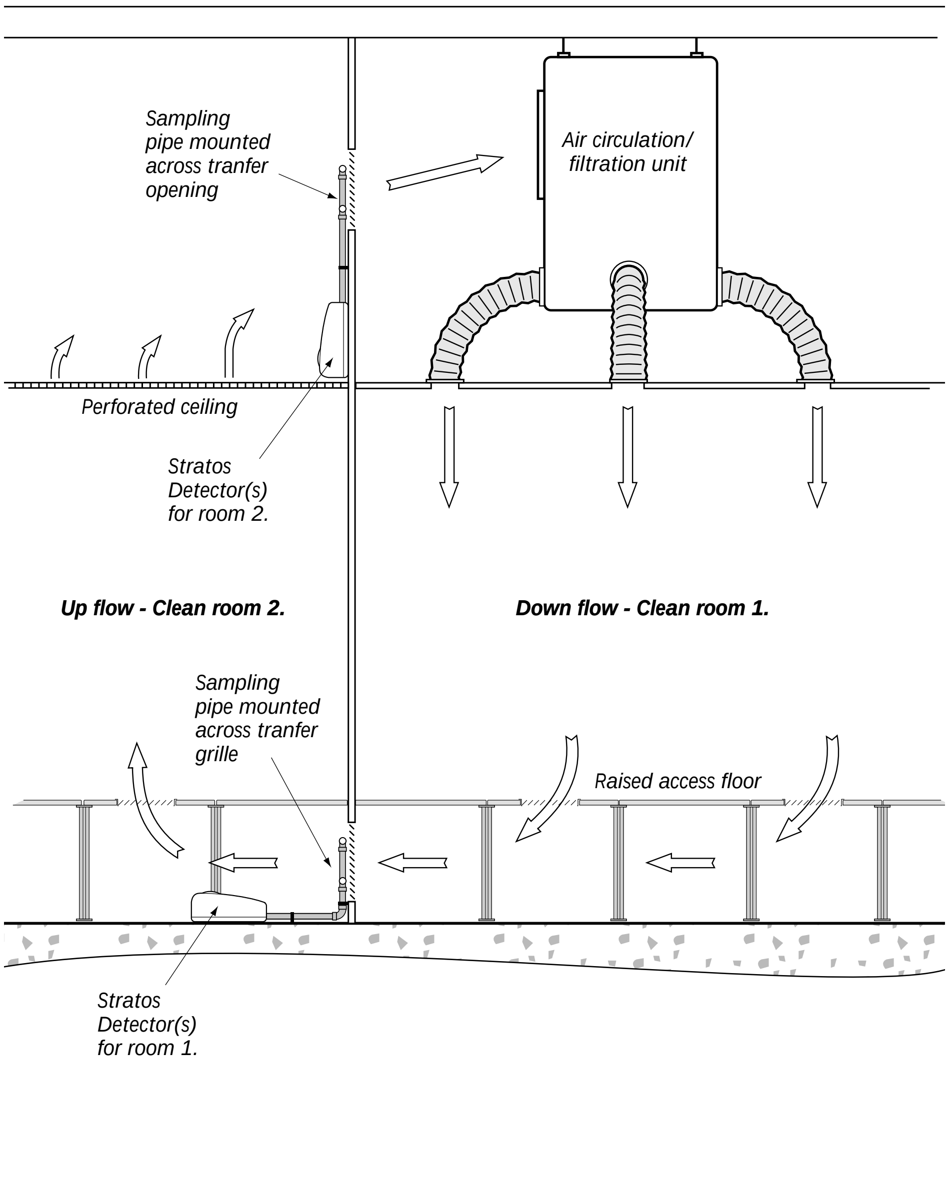


Fig. 7. Sampling pipe mounted at outlet of exhaust duct

Shared systems

There are facilities where two adjacent clean rooms use the same filtered air, one with the air stream flowing downwards the other with the air flowing upwards. The room having the up flow air path is likely to have a lower classification but this configuration makes efficient use of the clean air available.

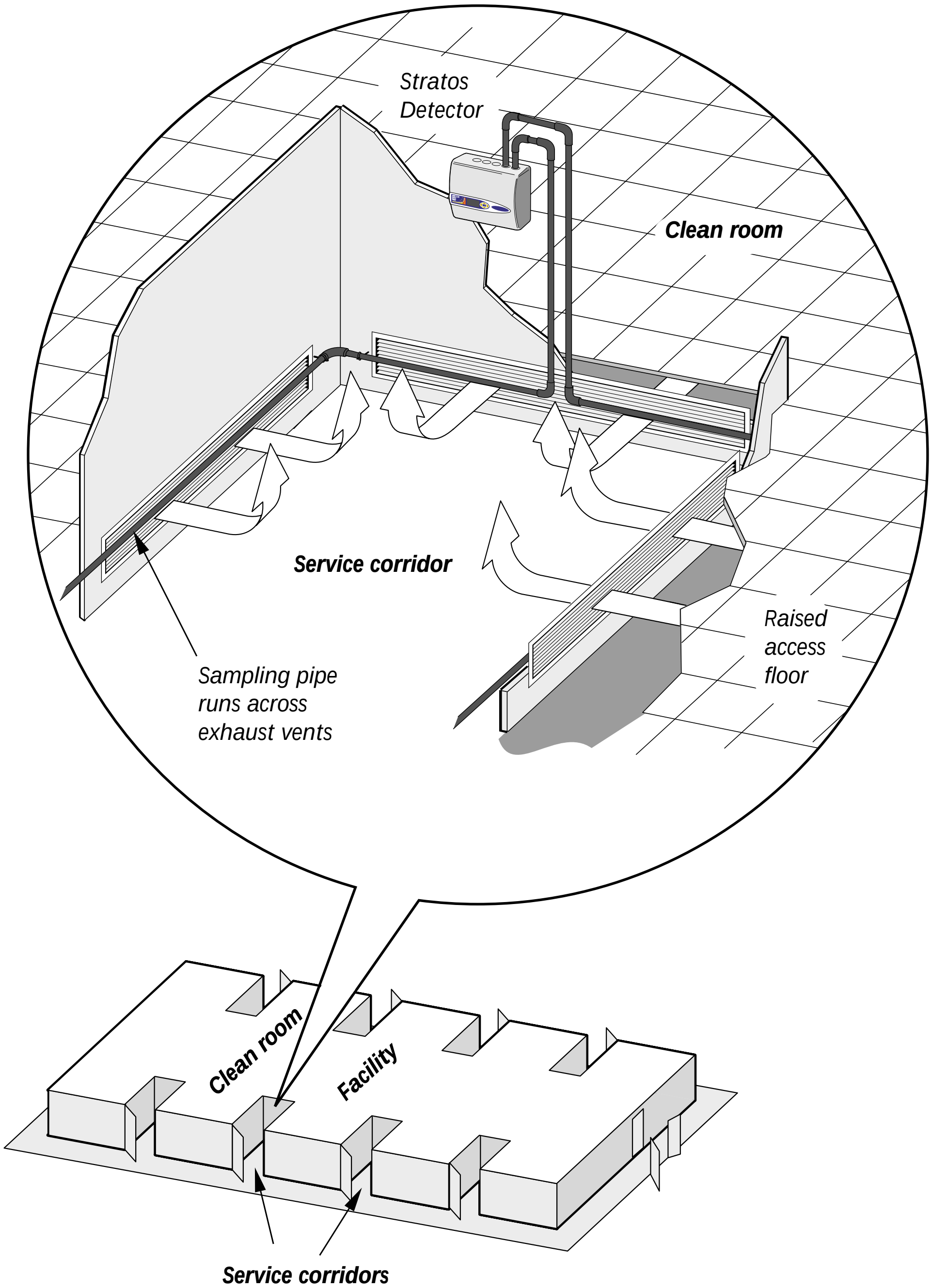
Fig. 8 ***Two clean rooms sharing clean air***



Service Corridors

In larger facilities the floor plan may be divided into different sections by a network of service corridors. These corridors serve as the air return path for air from the clean room. Being dedicated to support services, these corridors are ideal sites for the Stratos-HSSD® .

Fig. 9 ***Sampling within clean room service corridors***



Performance testing

It is unusual for performance testing to be permitted because there is the potential hazard of area contamination, particularly if the room is in operation, or ready for operation. If possible though, the installed systems should be performance tested to verify the systems respond as required to very small amounts of precombustion particles. A suitable test is described in BS 6266: 1992 (Fire Detection in Electronic Data Processing Environments) in Appendix A.3 where a length of PVC wire is overheated in a controlled test such that very small quantities of smoke and vapours are generated. The surface temperature reached by the wire during this test is intended to be relatively low and it is unlikely hydrogen chloride vapours would be released.