HVCA

Heating and Ventilating Contractors' Association

Specification

For Kitchen Ventilation Systems

DW/172

Specification for Kitchen Ventilation Systems

ACKNOWLEDGEMENTS

The HVCA records its appreciation and thanks to the many people and organisations who gave advice and information during the preparation of this specification, in particular to those members of the drafting panel who contributed their time, experience and knowledge.

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DW/172

FOREWORD

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Since its publication in 1999, the *HVCA's Standard for Kitchen Ventilation Systems* (DW/171) has sold an impressive 2,300 copies. More importantly, it has become widely acknowledged as *the* standard for kitchen ventilation design throughout in the UK.

Like any other standard, however, it must be revised and updated from time to time, in the light of new thinking, new procedures and new developments.

This review process has now been completed by the HVCA Ductwork Group. The result is this new publication– designated DW/172 and re-badged as a *specification* rather than simply a *standard*, in recognition of the authoritative status it has achieved within the kitchen ventilation sector.

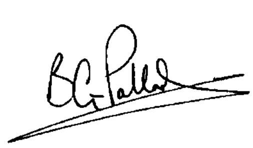
Among the many amendments and clarifications contained in the new document, three are worthy of particular note.

Firstly, the previous publication made reference to the feasibility of establishing a test procedure for grease filters. Since then, the Loss Prevention Council has published – and the Association of British Insurers has endorsed – LPS1263, which sets out the procedures, including the testing and grading of grease filters, required to reduce the risk of fire in commercial kitchens.

Secondly, the section on appliances and their coefficients has been significantly expanded, and now includes advice on the requirement for an interlock between the ventilation system and the gas supply.

And, finally, for the purpose of this specification, stainless steel is the only suitable material for the fabrication of canopies, and mesh filters can only be used as a secondary method of grease extraction. For ventilated ceilings, however, some manufacturers incorporate anodized aluminium into the supporting frame. This form of construction should be agreed with the client or specifier.

All other sections have been revised and updated in the hope and expectation that the HVCA's *Specification for Kitchen Ventilation Systems* (DW/172) will be widely used by all sectors of the catering industry.



CONTENTS

OBJECTIVE

The satisfaction derived from a building by the user comes significantly from the satisfactory performance of the systems, which serve the building. The purpose of the kitchen ventilation systems is to remove contamination from the cooking processes, ventilate the surrounding ancillary areas and provide safe and comfortable conditions for the occupants.

This publication is therefore primarily intended to:

- Provide information for customers who are appointing (by competition or negotiation) a contractor.
- Provide a specification for kitchen ventilation system installation.
- Provide a level of workmanship that may be verified by independent assessment.
- Be a significant aid in producing installations that will, given correct operation and with proper maintenance, provide satisfactory service over many years.

QUALITY ASSURANCE

This specification can be used as one criterion that will assist customers and specifiers in performing their important role of defining the standard of installation they require.

The HVCA anticipates that this specification will be complementary to quality assurance schemes and quality assessment schedules. Where forming the basis of an independent certification scheme, it defines good practice in standards of installation.

SCOPE

This specification covers the type of kitchen ventilation systems usually found in commercial premises.

The specification is not intended for residential premises, although some of its provisions will apply.

This specification makes use of terms "should", "shall" and "must" when prescribing procedures:

- The term "must" identifies a requirement by law at the time of publication.
- The term "shall" prescribes a procedure which it is intended to be complied with, in full and without deviation.
- The term "should" prescribes a procedure which it is intended to be complied with unless, after prior consideration, deviation is considered to be equivalent or better.

PUBLICATION AND REVIEW

User feedback on the wording or the requirements of the specification will be welcomed to assist in continued updating.

OTHER DUCTWORK GROUP PUBLICATIONS

DW/100	Ductwork Publication Pack
DW/143	A Practical Guide to Ductwork Leakage Testing
DW/144	Specification for Sheet Metal Ductwork - Low, Medium & High Pressure/Velocity Air Systems
DW/154	Specification for Plastics Ductwork
DW/172	Specification for Kitchen Ventilation Systems
DW/191	Guide to Good Practice - Glass Fibre Ductwork
TR/19	Guide to Good Practice - Cleanliness of Ventilation Systems

SECTION 1

Introduction

1.1 A cooker canopy is currently defined by the CEN European Standards Committee as being a device intended to collect contaminants from above a cooking appliance and remove them from the room. In practice kitchen canopies have become much more than basic extract systems.

1.2 The prime function of a kitchen canopy is to protect the area surrounding the cooking process from soiled matter and flame to make tolerable and safe the immediate area for people to work in. An air flow shall be created across the cooking process to capture the fumes created, and the by-products of this vapour shall be collected and contained by means of the filters within the canopy, allowing the cleaner air to be discharged.

1.3 The Food Safety (General Food Hygiene) Regulations place an onus on the proprietor of a 'food business' to ensure that all hazards are identified and that steps are taken to ensure that adequate safety features are in place. Part of that process requires that there must be suitable and sufficient means of either natural or mechanical ventilation.

1.4 The Workplace (Health, Safety and Welfare) Regulations also require that 'an effective and suitable provision must be made to ensure that every enclosed workplace is ventilated by a sufficient quantity of fresh air'.

1.5 Ventilation is required in both the kitchen and the adjoining areas because:

- Considerable convective and radiant heat is given off by the cooking equipment.
- The air becomes laden with odours, grease fumes and products of combustion.
- During meal preparation and washing up, humidity is increased over a wide area.
- Air replacement and consistency of temperature are required in adjoining areas.
- Air is required to dilute and replace products of combustion from gas fired appliances.
- Supply air is required to ensure complete combustion of the fuel and provide safe operation of the gas equipment. Details of these requirements are contained in the Building Regulations, BS 6173 and the CIBSE Guide B2.

1.6 The British Standard BS 6173, Installation of gas-fired catering appliances for use in all types of catering establishments (2nd and 3rd family gases), includes a requirement that gas fired catering appliances cannot be operated without the kitchen ventilation system in operation. Therefore an air proving device shall be installed in the kitchen ventilation system and interlocked with the gas supply for the kitchen. The kitchen ventilation contractor shall be specifically responsible for providing the air proving mechanism.

1.7 The four main emissions that require removal are:

- Smoke
- Expanded air from the heat load surrounding the cooking device.
- Precipitation of moistures existing in the food into a vaporous state, primarily consisting of steam, grease and cooking odours.
- Exhaust fumes from combustion appliances such as gas, charcoal or mesquite.

1.8 The removal of these cooking vapours and the supply of make-up air together with details of those ancillary services that can be supplied by the kitchen ventilation contractor, are the topics to be covered by this publication.

1.9 Although this Specification has been written with commercial kitchens in mind, many of the aspects covered and recommendations made, may also apply to domestic kitchen situations.

SECTION 2

Considerations prior to design

2.1 In order for the most economical and effective design to be prepared, it is important that the following information must be made available to the designer:

- The type, size and power source of the appliances being ventilated. If gas, the requirements of BS 6173 shall be met.
- The layout of the appliances and their power consumption where known.
- The dimensions, height and layout of the room that contains the appliances to be ventilated.
- Whether ventilation is to be provided by means of a canopy or ventilated ceiling.
- If a canopy, is it to be at high or low level, wall or island mounted.
- Where a ventilated ceiling is to be used, whether a plenum or modular cassette type is required, at what height it should be set and the level of services running through the ceiling void (to include floor to preferred finished ceiling height and floor to slab height).
- Whether grease is being produced in the cooking process and if so, whether filtration is to be provided by means of baffle filters, cartridges, water wash or cold water mist. If grease is not produced, whether the extraction point can be fitted with a baffle plate or grille.
- Whether the ductwork is to be constructed to either DW/144 or a fire rated/smoke exhaust specification and whether the fans have to be fire rated.
- Whether lighting is required within the canopy or ceiling, and if so what type.
- Whether mechanically powered make-up air is required, and if so whether it is to be supplied through the canopy, through the HVAC system or a combination of both.
- Where air is supplied through the canopy, is it to be by means of front face grilles, perforated plate diffusers or internal slot discharge.
- Details of access into the building so that the number of sections in which the canopy is to be fabricated can be determined. The available headroom and ceiling height where appropriate are essential.
- The position of discharge to ensure that noise or odour does not create a nuisance.
- The amount of air to be handled by the canopy or ceiling. This will determine the type, size and number of filters and spigots required.
- Whether approvals from the Local Authority have been obtained.
- It is now known that some cooking processes, where there is incomplete degradation of certain organic materials, generate fumes which are carcinogenic. This is possible irrespective of size of kitchen, and it is therefore important to ensure that there is an effective ventilation system for all cooking operations to ensure the health and safety of the kitchen personnel. Care shall be taken to avoid drawing extract air through the breathing zones of members of staff operating the cooking equipment. Care shall always be taken if discharging into a public area is necessary.
- The method of internally cleaning the inside surface of the ductwork extract system, which, in turn, will determine the size of access panels and their frequency.

SECTION 3

Design criteria

3.1 Whilst differing design approaches exist to providing a solution which satisfies the ventilation requirements of a kitchen, the following methodology has been found to provide a satisfactory outcome and is proposed as a suitable procedure to adopt to achieve a satisfactory design.

- At the time of publication of this Specification, no legislation exists in the UK regarding maximum permissible room temperatures in the workplace. Even with the most efficient ventilation systems, air temperatures taken in the kitchen in the proximity of the cooking equipment could be well in excess of 28 degC due to radiant heat from the cooking equipment being converted to convective, sensible heat.
- Internal noise level should be from NR40 - NR50.
- Average lighting levels of 500 lux at the work surface.
- Dedicated make up air systems to be 85% maximum, of the extract flow rate.
- Minimum air change rate of 40 per hour - not to be used as a basis of design of the canopy or ventilated ceiling.

3.2 Variable speed regulation can also enhance energy efficient use of the system and plant when there is partial or low load cooking conditions. However, care shall be exercised in maintaining correct velocities through the grease filters when cooking is in process. For recommended face velocities see Table 13.

3.3 Whilst these criteria are ideal, it is unlikely to achieve a controlled environment within a kitchen due to the natural but varying heat gains from the cooking equipment.

3.4 Staff comfort should be a prime consideration when designing a make-up air system. The supply air temperatures should therefore be selected for either room distribution or spot cooling around the canopy or ventilated ceiling. The ideal discharge temperatures for the various supply options are shown in Table 1:

Table 1: Discharge Air Temperatures

Inboard canopy supply air	**outside ambient**
Outboard canopy supply air	**minimum 10 degC**
Ventilated ceiling supply air	**minimum 16 degC**
HVAC general make-up air	**minimum 16 degC**

3.5 Humidity is also difficult and expensive to control, but the ventilation system should be designed to provide a sufficient ventilation rate to maximise comfort. With particular reference to dishwashing machines, unless provided with their own condensers, these machines shall be provided with dedicated extract ventilation to control the amount of vapour being discharged into the environment. Dishwashers shall also be ventilated to avoid the potential health hazards.

3.6 Fresh air ventilation rates must be sufficient to ensure that the CO exposure levels to which the kitchen staff are subjected do not exceed the COSHH limits of 300 parts per million (ppm) for 10 minutes, or the World Health Organisation (WHO) guide-lines of 10 ppm as an average over 8 hours.

3.7 Whilst the ventilation of ancillary areas would normally fall within the scope of the main ventilation system, the following notes are included for the guidance of the designer.

3.7.1 Cold Rooms - It is important to establish whether the compressor/condenser sets are to be located:

a) On top of the Cold Room and above the ceiling.
b) Built into the Cold Room and discharging into the area.
c) Mounted externally and remote from the Cold Room.

When cold room condensers discharge directly into ceilings or rooms, then they should have individual extract and possibly dedicated supply systems.

3.7.2 Dry Stores - A ventilation rate of 10 air changes per hour is recommended. If the room door leads on to the kitchen area, mechanically introduced supply air and a transfer grille at low level in the door should be provided to relieve the air for capture by the kitchen exhaust system.

3.7.3 Servery - A ventilation rate of 12 air changes per hour is recommended but great care should be taken with the position of grilles and diffusers. The servery is usually located between the kitchen and the dining area. The number of people, the heat from the food, display cabinets, and the fact that the ceiling may well be lowered to provide an architectural feature will all affect the design. Too much air movement may cause 'skinning' and cooling of the food. Too little will result in discomfort for both kitchen staff and the customers.

3.7.4 Chef's Office - A ventilation rate of 6 air changes per hour is recommended but comfort cooling may be considered desirable as the area is often used as a dining facility for visitors. Privacy should be maintained by avoiding the use of transfer air grilles.

3.7.5 Refuse Store - The Local Authority should be consulted for their particular requirements, but a dedicated extract system providing a minimum of 15 air changes per hour is recommended.

3.7.6 Preparation Areas - The treatment will depend upon the type of food being prepared and whether these areas are 'open' to the kitchen or whether a separate room is to be provided. Where open to the kitchen then the overall air change rate should be sufficient, with supply air introduced to the preparation area itself. When very low room ambient space temperatures are required then a separate area is required. Where low room temperatures are not required, then a ventilation rate of 20 air changes per hour is recommended.

3.7.7 Toilet Areas - Whether for food handling personnel or customers, separate and dedicated extract systems with duplicate fans shall be installed for toilet areas. A ventilation rate of 10 air changes per hour is recommended. Negative pressure should be maintained in all toilet areas at all times.

3.7.8 Kitchen - For areas within larger kitchens that are not affected by canopies or covered by the areas described in 3.7.1 - 3.7.7, then a general ventilation rate of 40 air changes should be used.

3.7.9 Dishwash and Potwash Areas - In addition to dedicated machine extract, general room extract should also be considered. A ventilation rate of 30 air changes per hour is recommended.

3.8 Mechanically powered make-up air should not be taken from 'dirty' areas such as waste storage areas or pot wash rooms. Care should also be taken that unwelcome draughts are not created around customers. Make-up air shall not be drawn from an adjacent eating area if smoking is permitted.

3.9 Diversity factors shall not be applied to reduce the extract flow rate calculated from Table 2 when partial or intermittent use of appliances is proposed.

SECTION 4

Canopy dimensions

4.1 The dimensions of a canopy are invariably determined by the size of the catering equipment that it is serving.

4.2 Unless restricted by walls, the plan dimensions of the canopy shall always exceed the plan dimensions of the catering equipment by a minimum of 250mm on each free side, and by 250mm at the front and rear. It shall be noted that the overhang dimensions are to the inside of the condensation or stiffening channel, or the supply plenum, the appropriate dimension shall be added when specifying the overall canopy size.

4.5 Canopies less than 400mm high will be less efficient than normal because of a reduced collection volume and therefore, where there is a restricted soffit height, consideration should be given to increasing the face velocity to compensate irrespective of design duty calculated. It is also recommended to increase the size of the canopy to aid capture when the ideal flow rate cannot be achieved.

4.6 With kitchens that have high ceilings, provided that the canopy is installed at the correct height to allow access to the filters and the requirements for minimum hood depth have been achieved, then consideration should be given to providing an infill section to fill the gap between the top of the canopy and the underside of the ceiling.

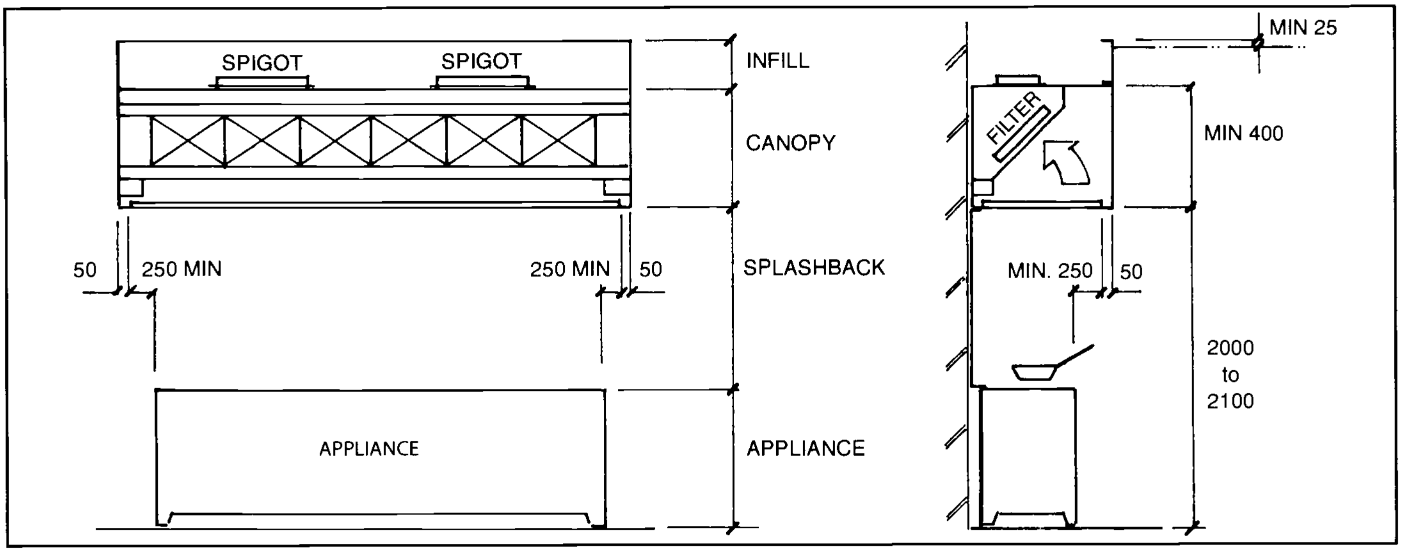


Fig 1 - Typical Canopy Dimensions

4.3 For combination steamers and certain types of baking ovens the overhang at the front should be increased to a minimum of 600mm to cope with the steam or fumes released when the doors of the appliance are opened.

4.4 The height of the canopy is often governed primarily by the ceiling height. The underside of the canopy should be located between 2000 and 2100mm above the finished floor level, the top should project into the ceiling by a minimum of 25mm to allow the false ceiling trim to be attached. (see illustration in fig. 1).

4.7 Where a canopy is installed at a level higher than 2100mm, then overhang dimensions shall be increased at a minimum rate of 1:1, i.e. 100mm vertical + 100mm horizontal.

4.8 The distance between the lowest edge of the grease filter and the top of the cooking surface should be 450mm minimum. This is to avoid the risk of excessive temperatures or fire in the filter which could cause the extracted grease to vaporise and pass through to the ductwork. This dimension will vary with the type of cooking appliance and may be reduced where a fire suppression system is fitted.

4.9 Where gas-fired salamander grills are mounted at high-level in close proximity to the grease filters/extract plenum of a canopy, the manufacturer of the grill should supply a deflector cowl for the flue opening on top of the grill. This will encourage products of combustion to be directed away from the canopy and cool prior to being drawn through the filters. This will reduce the potential of fire-flares, which are known to occur with such appliances, being drawn into the grease filters to possibly ignite grease and oil deposits beyond. It will also help to prevent discolouration of the stainless steel surfaces immediately above these grills and carbonisation of deposits on the grease filters.

SECTION 5

Extract flow rates

Extract and Supply Air Flow Rates

5.1 Whilst systems extracting from equipment producing contaminant such as dust depend upon air streams of sufficient velocity being created to enable capture to take place, this concept cannot be applied to a heat producing process such as cooking. All cooking processes create approximately 35% radiant and 65% convected heat which, in the absence of cross-draughts, rises vertically in a thermal updraught called a 'plume'. This is shown in fig 2. Most of the contaminant released from the food and heat source is entrained with additional air which causes the plume to enlarge and the average temperature and velocity to decrease. The rate of exhaust from the hood shall equal or slightly exceed the flow rate of the plume, additional extract air (see Table 3; Canopy Factors) will be required to resist the cross-draughts that would otherwise carry the plume away from the canopy.

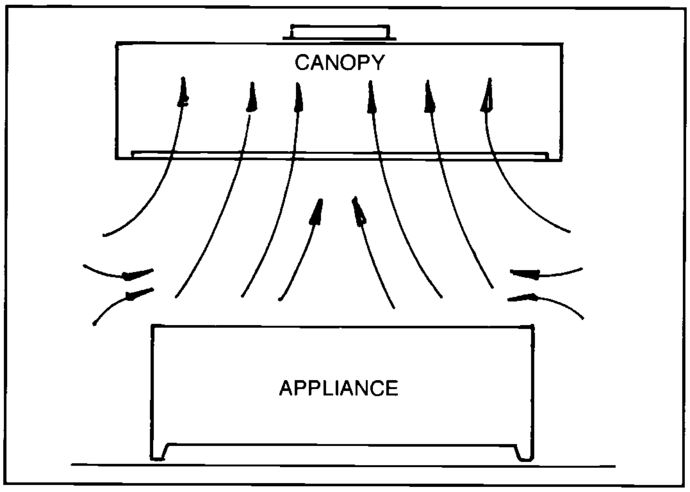


Fig 2 - Air Flow Pattern

5.2 The calculation of the optimum extract flow rate is the most important element of canopy design as too much air will cause as many problems as too little. Whilst the size of the cooking appliances determines the size of the canopy to be supplied, it is the type of appliance that determines the volume of air to be extracted. Those that require ventilation are shown in Table 3.

The 'Thermal Convection Method' of calculation should be the only method used. Other methods have been included in this document for use only when insufficient information is available at the design stage (see sections 5.5 to 5.8).

5.3 Method 1 - Thermal Convection Method

This method follows the procedure covered in the CIBSE Guide B2 but has been expanded to include a wider range of equipment. When details of the equipment to be ventilated are known, then each cooking appliance shall be allocated a thermal convection coefficient, which is the recommended volume of air to be extracted in m3/s per m2 of surface area of the appliance. The area of each appliance is multiplied by the factor for that appliance, the total value for each item of equipment under the canopy/ventilated ceiling shall be added together to determine the total volume to be extracted. The factor will vary depending on whether the appliance is gas or electricity, and these are scheduled in Table 2. Refer to 5.4 for worked example of flow rate calculation.

The theoretical extract air volume would only be achieved under draught-free laboratory conditions. The type, location of the canopy/ventilated ceiling and the likelihood of cross-draughts will also have an affect upon the amount of air required. The more enclosed the cooking operation, the less the exhaust air needed to ventilate it, whilst appliances open on all four sides will need a larger volume of exhaust air than where only one side is open. The canopy factors given in Table 3 shall therefore be multiplied by the calculated volume to determine the actual extract flow rate. Consideration shall also be given to the 'active area' of ventilated ceilings when the height increases. See Section 8.5.2.

Table 2: Appliance, Coefficient and Temperature Schedule

Appliance	Coefficient Gas	Coefficient Electric	Surface Temp
MISCELLANEOUS	m^3/s per m^2		^0C
Benches, Spreaders and Worktops	**0.03**	**0.03**	**25**
Sink	**0.15**	**0.15**	**25**
Pass Through Dishwasher*	**0.30**	**0.30**	**61**
Pan/Utensil Wash Machine	**0.40**	**0.40**	**42**
Rack and Flight Dishwasher	**see manufacturer's literature**		**58**

**NB - the figures quoted are for the machine only; the room in which they are located needs to be treated separately.*

HEATING/WATER	Gas	Electric	Surface Temp
Coffee Maker	**-**	**0.03**	**25**
Microwave Oven/Toaster	**-**	**0.03**	**25**
Bains Marie, Hot Cupboard	**0.20**	**0.15**	**57**
Servery Counter - Hot Food	**0.24**	**0.24**	**73**
Water Boiler/Still/Beverage Unit	**0.25**	**0.20**	**78**
Light Duty Boiling Pan, Tilting Kettle	**0.30**	**0.25**	**98**
Refrigeration Unit	**see manufacturer's literature**		**-**

continued overleaf

GENERAL COOKING			
Induction Hob, Ceramic Stove	**-**	**0.10**	**30**
Pastry and High Output Bakery Oven**	**0.25**	**0.20**	**86**
Steamer/Pressure Cooker	**0.30**	**0.20**	**125**
Pasta Cooker	**0.30**	**0.20**	**120**
Bratt Pan, Tilt Skillet	**0.32**	**0.26**	**190**
Boiling Table, Hob Top, Stock Pot Stove	**0.35**	**0.25**	**190**
Heavy Duty Boiling Pan	**0.35**	**0.25**	**146**
Open Top Range and Oven	**0.35**	**0.25**	**190**
Steaming and Roasting Oven	**0.35**	**0.30**	**98**
Combination Steaming Ovens**	**0.35**	**0.30**	**92**
Tandoori Oven	**0.35**	**0.30**	**90**
Fan Assisted Convection Oven**	**0.38**	**0.30**	**86**
Pizza Oven**	**0.38**	**0.30**	**92**
Low/Med Duty Deep Fat Fryer	**0.45**	**0.35**	**190**
Low/Med Duty Grill	**0.50**	**0.30**	**220**

***NB - multiply the coefficient factors by 2 if ovens are double stacked.*

FLAME COOKING			
Griddle (mild steel)	**0.30**	**0.25**	**190**
Griddle (chrome)	**0.45**	**0.40**	**290**
Conveyor Pizza Oven	**0.45**	**0.40**	**90**
Heavy Duty Deep Fat Fryer	**0.50**	**0.45**	**190**
Heavy Duty Bratt Pan	**0.55**	**0.45**	**240**
Solid Top Oven Range	**0.60**	**0.51**	**420**
Upright or Chain Broiler	**0.75**	**0.55**	**190**
Salamander or Steakhouse Grill	**0.75**	**0.55**	**260**
Rotisserie	**0.75**	**0.55**	**190**
Chargrill/Charbroiler	**0.95**	**0.52**	**350**
Chinese Wok Range	**1.10**	**-**	**280**
Chinese Wok Range (induction)	**-**	**0.40**	**50**
Mesquite Grill	**1.20**	**-**	**420**

Table 3: Canopy factors

Type	Open Both Ends	Open One End	Closed Both Ends
Low Level	**1.15**	**1.10**	**1.05**
Passover	**1.15**	**1.10**	**1.05**
Overhead Wall	**1.25**	**1.20**	**1.15**
Overhead Wall, Island Mounted	**1.50**	**1.40**	**1.30**
Island	**1.35**	**1.25**	**1.15**

5.4 Example of flow rate calculation: Method 1

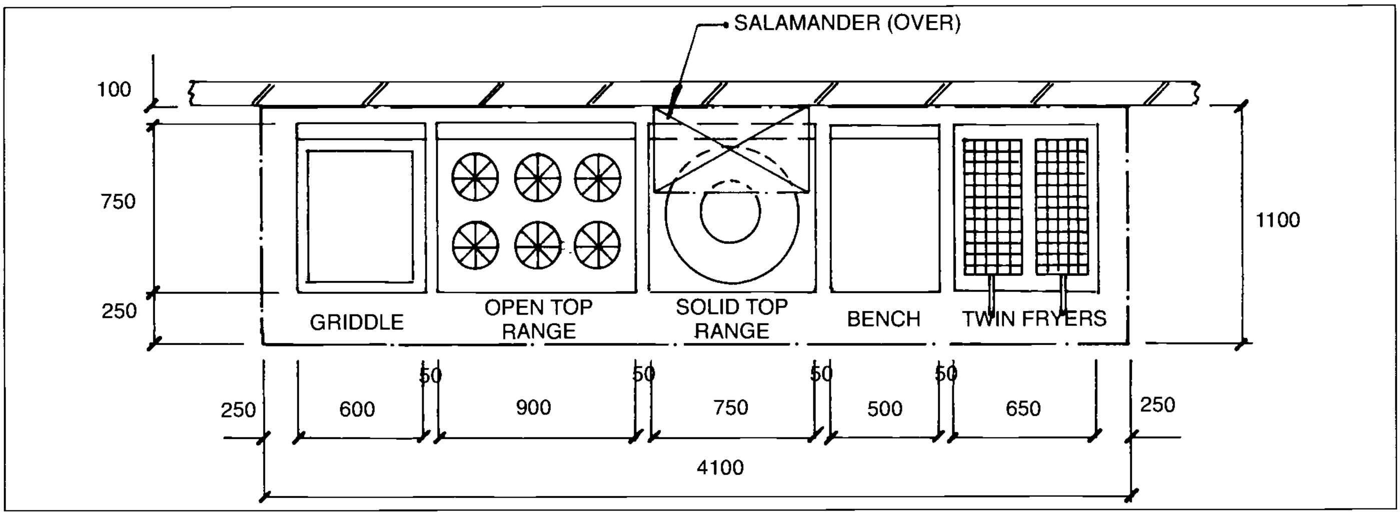


Fig 3 - Typical Cooking Equipment Line-Up

1. Determine the model type, plan size and power source for each item of cooking equipment located under the canopy.
2. Calculate the plan area of the cooking equipment from Fig 3 and from Table 2, allocate a thermal coefficient for each item of equipment.
3. Multiply the area by the coefficient to obtain a theoretical extract flow rate for each item.
4. Add the individual rates to arrive at a total extract flow rate for the canopy.
5. Select the appropriate canopy factor to suit the type and location of canopy.
6. Multiply the total by the canopy factor to arrive at the total extract flow rate.

Table 4: Calculations for method 1 (based on the equipment illustrated in fig. 3):

Item	Plan Size	Power	Area	Coefficient	Flow Rate
Griddle	**600 x 750**	**gas**	**0.4500**	**0.30**	**0.135**
Open top range	**900 x 750**	**gas**	**0.6750**	**0.35**	**0.236**
Solid Top Range	**750 x 750**	**gas**	**0.5625**	**0.60**	**0.338**
Bench	**500 x 750**	**-**	**0.3750**	**0.03**	**0.011**
Twin Fryers	**650 x 750**	**Elec**	**0.4875**	**0.35**	**0.171**
Salamander Grill	**750 x 400**	**gas**	**0.3000**	**0.75**	**0.225**
Theoretical extract volume required				**=**	**1.116 m3/s**
Canopy Factor - overhead wall open both ends					**x 1.25**
Specific extract flow rate required				**=**	**1.395 m3/s**

The calculation of extract flow rates for ventilated ceilings should be in accordance with the procedures set out above.

Where concentrated high-heat cooking appliances create a possible 'hot spot' within a canopy or ventilated ceiling area, partitioning of the grease filter plenum shall be considered to provide a higher dedicated extract duty above such equipment. In such circumstances care shall be taken to ensure maximum air duties are not exceeded for the particular filter bank selected. Make up air and extract spigots shall be sized and positioned accordingly.

Following the determination of the required extract flow rate, the number and type of filters shall be selected.

5.5 **Method 2 - Face Velocity Method** (This is a provisional method when there is insufficient information available regarding the cooking equipment)

The volume of air to be extracted may be determined by selecting a velocity across the face area of the canopy that is appropriate for the type of appliances expected to be used. The capture velocity is multiplied by the canopy area to determine the volume of air to be extracted.

The capture velocity should be selected to ensure an even distribution of air across the canopy face, this velocity will vary according to the cooking application and whether the canopy is either wall or island mounted.

- Light loading - 0.25 m/s. Applies to steaming ovens, boiling pans, bains marie and stock-pot stoves.
- Medium loading - 0.35 m/s. Applies to deep fat fryers, bratt pans, solid and open top ranges and griddles.
- Heavy Loading - 0.5 m/s. Applies to chargrills, mesquite and specialist broiler units.

5.6 **Method 3 - Appliance Power Input** (This is a provisional method when there is insufficient information available regarding the cooking equipment)

When details of the cooking equipment to be used is limited to the amount of power required rather than the physical size of the appliance, then the power input method may be used. Each type of appliance is allocated a recommended flow rate in m3/s which is then multiplied by the power input in kW to determine the flow rate required for each appliance. The total air required is then determined by adding together the recommended extract rate for each item of equipment.

5.7 **Method 4 - Air Changes** (This is a provisional method when there is insufficient information available regarding the cooking equipment)

These can vary widely depending on the size of kitchen, type of cooking, number of people present, and therefore not recommended as a method of calculating air volumes. Whilst 40 air changes per hour should be regarded as a minimum for comfort in the absence of any other information, it is not unusual for rates as high as 60 - 120 to be created when high-output equipment is densely located in a relatively small space.

5.8 **Method 5 - Linear Extract** (This is a provisional method when there is insufficient information available regarding the cooking equipment)

Favoured in the United States, this method depends upon selecting a flow rate to suit a particular type of canopy. The figures, which are listed in the Table 5, do not vary with the canopy width and are given in m3/s per linear metre of active filter length.

Table 5: Flow rates (m^3/s per linear metre of canopy)

Type of Canopy	Light Duty	Medium Duty	Heavy Duty	Extra Heavy Duty
Wall Mounted	**0.23 - 0.31**	**0.31 - 0.46**	**0.31 - 0.62**	**0.54 +**
Single Island	**0.39 - 0.46**	**0.46 - 0.62**	**0.46 - 0.93**	**0.85 +**
Double Island	**0.23 - 0.31**	**0.31 - 0.46**	**0.39 - 0.62**	**0.77 +**
Eyebrow	**0.23 - 0.39**	**0.23 - 0.39**	—	—
Passover/Backshelf	**0.15 - 0.31**	**0.31 - 0.46**	**0.46 - 0.62**	**not recommended**

NB - Extract rates for double island canopies are for active filter length, i.e. double the rate for an equivalent length wall Canopy.

SECTION 6

Make-up Air

6.1 In order for the kitchen extract system to function correctly, it is essential that an allowance shall be made for the provision of replacement air. This should be achieved either by introducing mechanical supply air, or by making provision for natural infiltration.

Where a natural ducted inlet for relief air is selected it should be as short as possible, at high level and with filtration since the incoming air is likely to be contaminated.

6.2 Where mechanical input is selected, the system shall provide a maximum 85% of the total extracted volume, with the remaining 15% infiltrating naturally into the kitchen from surrounding areas. The mechanical or 'fan assisted' method should ensure that the kitchen remains under negative pressure thus preventing the potential transfer of kitchen odours to areas outside the kitchen.

6.3 Make-up air may be introduced into the kitchen by means of the canopy or ventilated ceiling, or through the ventilation system or by a combination of all three. Where air is introduced through the canopy, the various options are shown in Figs 4 and 5.

6.4 The fan powered system provides positive control and therefore should be the preferred method used. With natural infiltration the following problems may occur:

- unfiltered air will enter the kitchen.
- air may otherwise be drawn from dirty areas.
- draughts and discomfort may be caused in cold weather.
- uncontrolled air movement may affect the cooking process.
- 'cooling' cannot be provided to persons adjacent to the canopy.

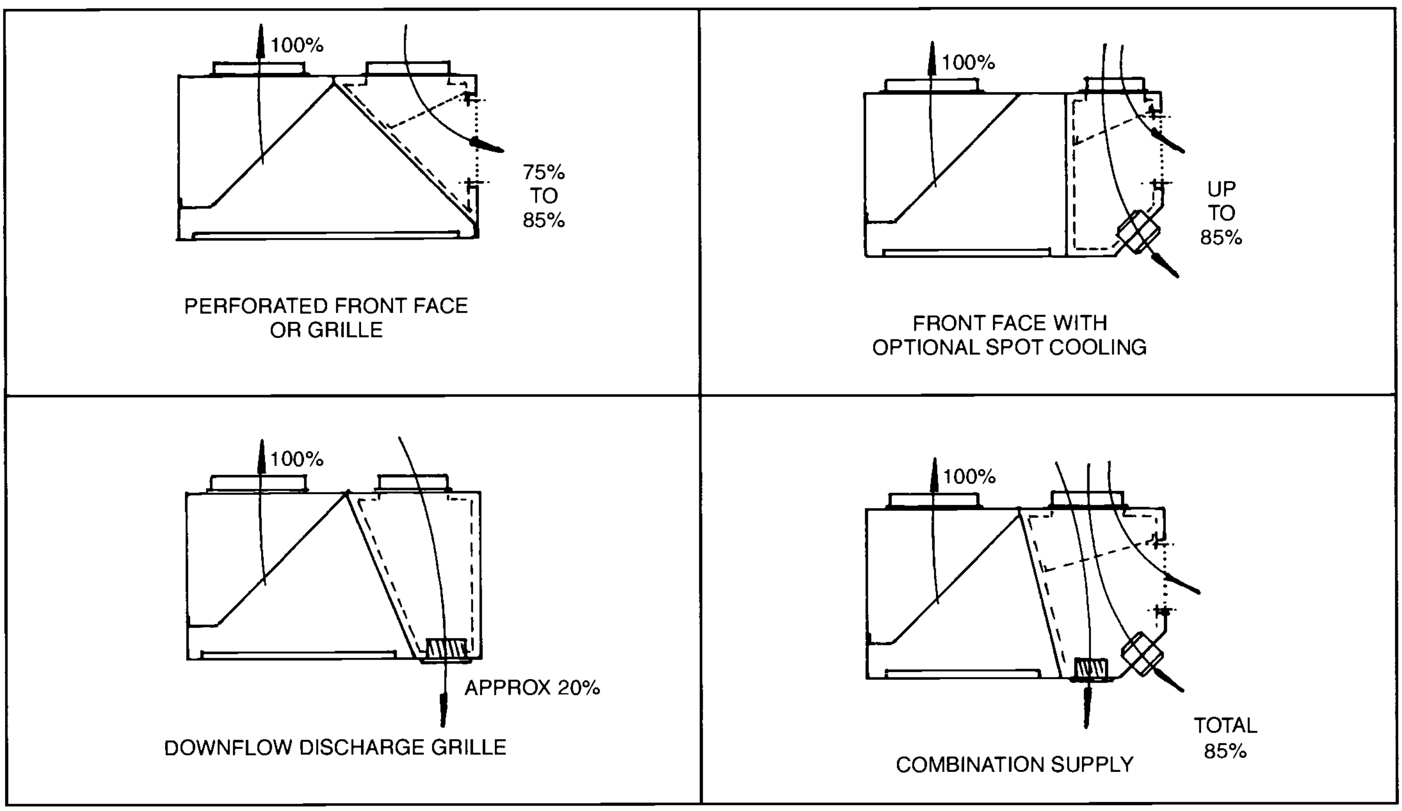


Fig 4 - Outboard Supply Systems

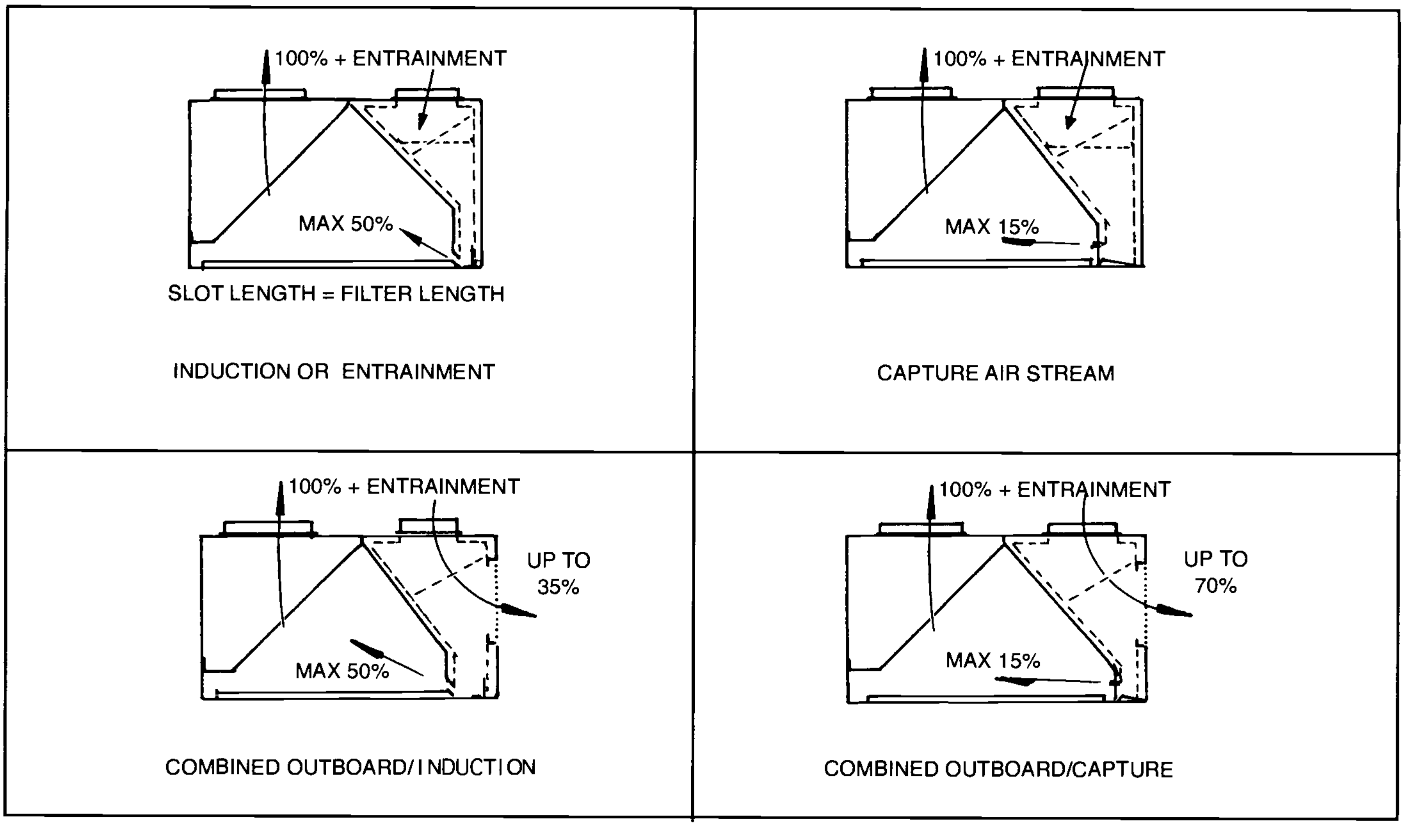


Fig 5 - Inboard Combined Supply Systems

NB: When the air is inboard then that duty shall be added to the calculated extract flow rate to determine the volume handled by the fan.

6.5 **Make- Air Temperatures**

6.5.1 A minimum air entry temperature of 10°C shall be selected for canopies and 16°C for ventilated ceilings.

6.5.2 For general make-up air, standard temperatures as specified in Section 3 should be used.

6.6 When selecting plant for kitchen make-up air, the following shall form part of the ventilation system:

- Filters made of synthetic materials and having a minimum efficiency of F6 (see Appendix A). Glass fibre products shall not be used.
- Means of varying the fan duty shall be provided to give the flexibility to accommodate future changes in room usage, occupancy and types of cooking undertaken. An electrical interlink with the extract plant shall be installed.
- Where located within the kitchen, plant shall be accessible for cleaning. A packaged air handling unit is preferable as individual plant items will present hygiene problems.
- A natural ducted airway allowing outside air into the kitchen shall be provided. This again should be positioned at high level, be as short as possible and shall be filtered. Care shall be taken with the location of the discharge grille because with low external temperatures, discomfort may be experienced by the kitchen users. This option should not be selected when large air volumes are involved.
- Whilst door transfer grilles may be used in conjunction with other input systems, there is usually inadequate space to accommodate sufficient grilles to handle the large volumes of air required with kitchen extract systems. Transfer grilles in doors however, help to minimise air pressure influences on opening and closure.

- Visible or audible means of proving the existence and indicating the supply air filter condition shall be installed, as dirty filters will adversely affect the air balance.

6.7 Where a natural make-up air system is selected, the resistance shall be included in the overall system resistance against which the extract fan will have to operate.

6.8 Care shall be taken with re-circulated air to ensure that it is not taken from 'dirty' areas.

6.9 Whilst air conditioned kitchens are the exception in the United Kingdom, where it is decided to cool the make-up air, further details are given in Appendix E.

6.10 Details of the various types of natural air transfer systems are shown in Figs. 6-8 below:

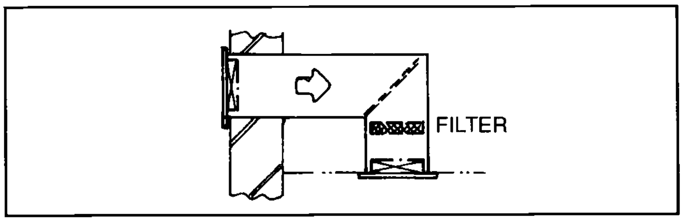


Fig 6 - Outside Air

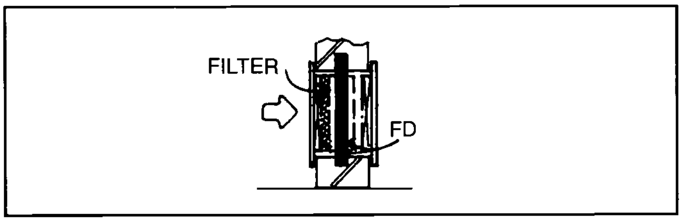


Fig 7 - Low Level Wall

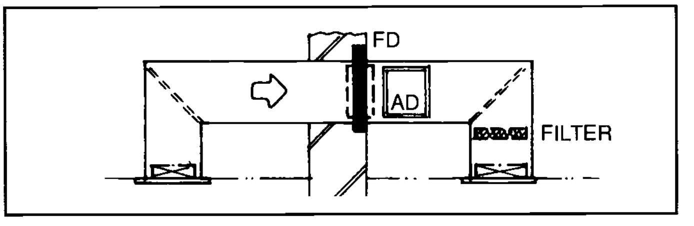


Fig 8 - Internal Air Transfer

NB. Fire dampers should only be required in fire compartment walls.

SECTION 7

Types of Canopy

7.1 The only material to be used in the fabrication of canopies in accordance with this specification shall be type 304, ultra-fine grained stainless steel.

7.2 There are a number of types and style of extract canopy that have been developed; these can be broadly classified as follows:

- Overhead wall type canopy - wall or island mounted
- Overhead island type canopy
- Low level wall type canopy
- Passover type canopy
- Counter type canopy
- Eyebrow canopy
- Condensation canopy

7.3 Most styles of canopy can be provided with an integral make-up air facility; these can take the form of:

- Front face perforated diffuser
- Front face grille
- Internal slot - Induction, entrainment, capture, compensating or short circuit.
- Grille or louvres for spot cooling

7.4 Examples of the various types and combinations available are shown in Figs.9-11:

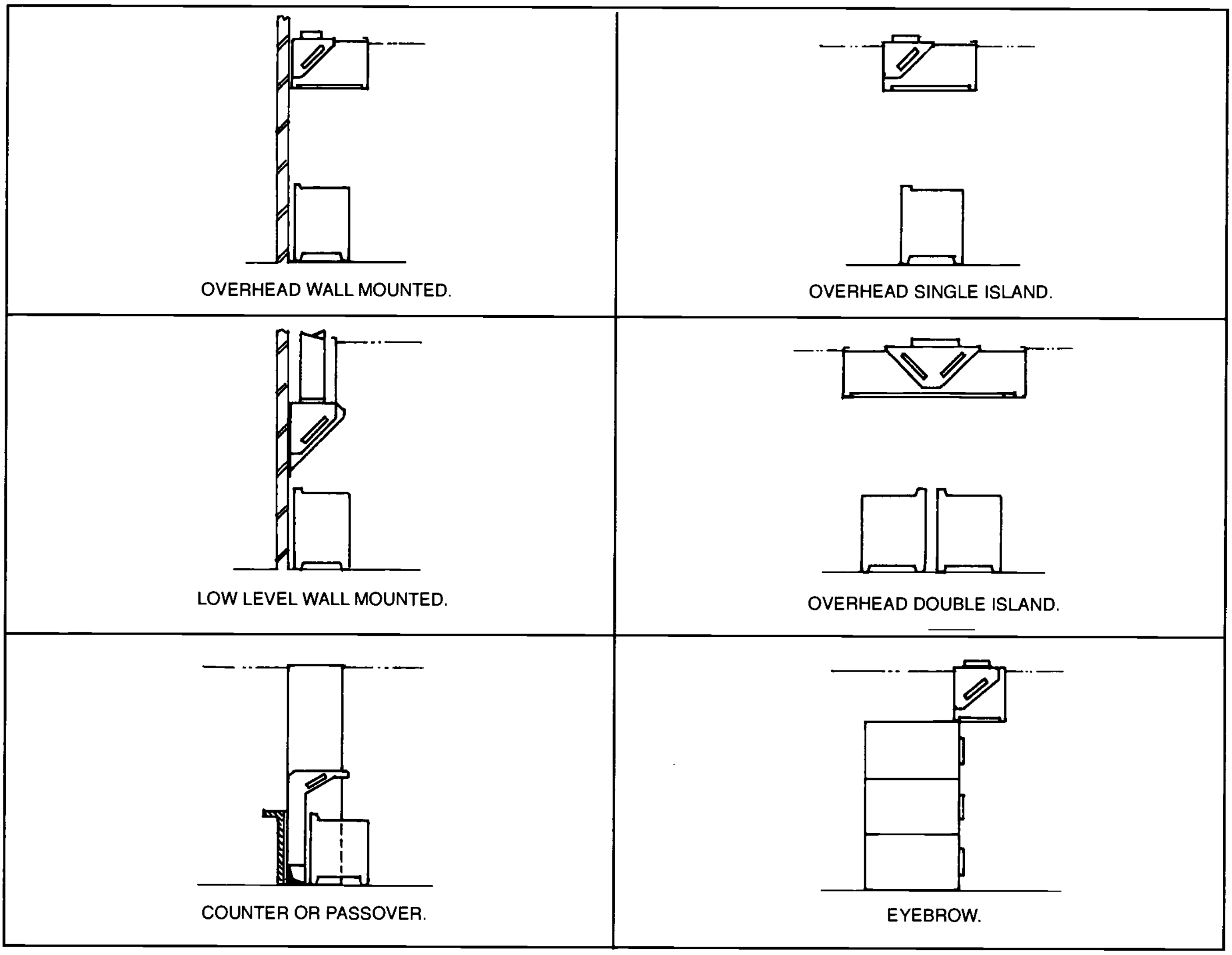


Fig 9 - Typical Extract Only Filter Canopies.

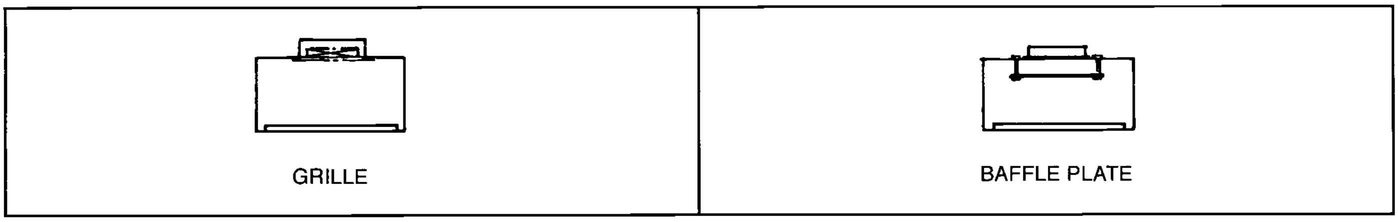


Fig 10 - Non-Filter Canopies

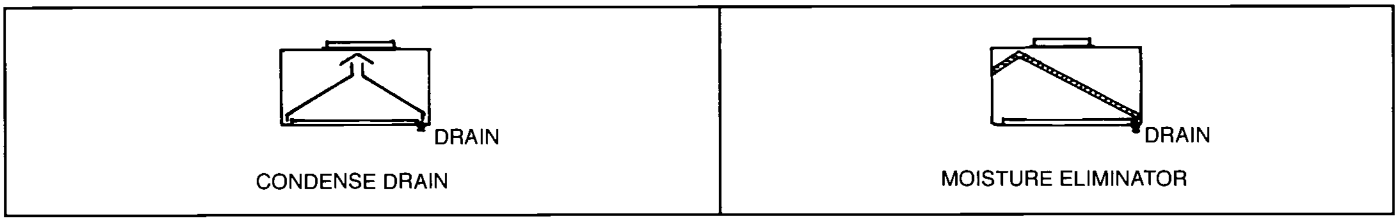


Fig 11 - Condensation Canopies

Section 8

Ventilated Ceilings

8.1 Whilst the use of canopies is ideal for handling contaminants produced in concentrated areas, where the cooking equipment generates grease and water vapour over a wider area, the use of ventilated ceilings should be considered as a viable option.

Ventilated ceilings should also be considered:-

- Where due to structural limitations, low floor to finished ceiling levels make the use of canopies impractical.
- Where false ceiling aesthetics are important and visibility cannot be impaired by canopies.
- Where cooking equipment generates low levels of discharge over large areas, such as food production and food preparation kitchens.

8.2 The calculation of minimum extract flow rates for ventilated ceilings shall be in accordance with the procedures set out in Section 5 of this document. The supply system shall be designed to provide the conditions set out in section 3 and 6.

8.3 There are two types of ventilated ceiling system available:-

- Modular Cassette Ceiling
- Plenum Ceiling

8.4 **Modular Cassette System**

8.4.1 The Modular Cassette type ceiling is a totally integrated system incorporating dedicated extract, partitioned or dedicated supply, and flush mounted luminaires. The ceiling comprises a grid system which supports extract and supply cassettes, and luminaires. The extract filters, of proprietary design, filter and separate the contaminant from the air before passing into the ceiling void for central collection and discharge to atmosphere. The grease is collected both inside the extract cassette and in a non-drip integral or perimeter trough for removal and cleaning.

8.4.2 The extract cassettes should be designed for easy removal and sized for cleaning in conventional commercial dishwashers. Extract cassettes shall be located over the cooking appliances with blank, supply filters, or luminaires being fitted in the non-active areas of the kitchen.

8.4.3 Supply cassettes may be integrated into the ceiling design to provide make up air, comfort ventilation or spot cooling.

8.4.4 For secure installations, panels should be lockable.

8.5 Calculating Size of "Active" Exhaust Zones

8.5.1 The dimensions of exhaust zones shall be determined by the size of the catering equipment that it is serving.

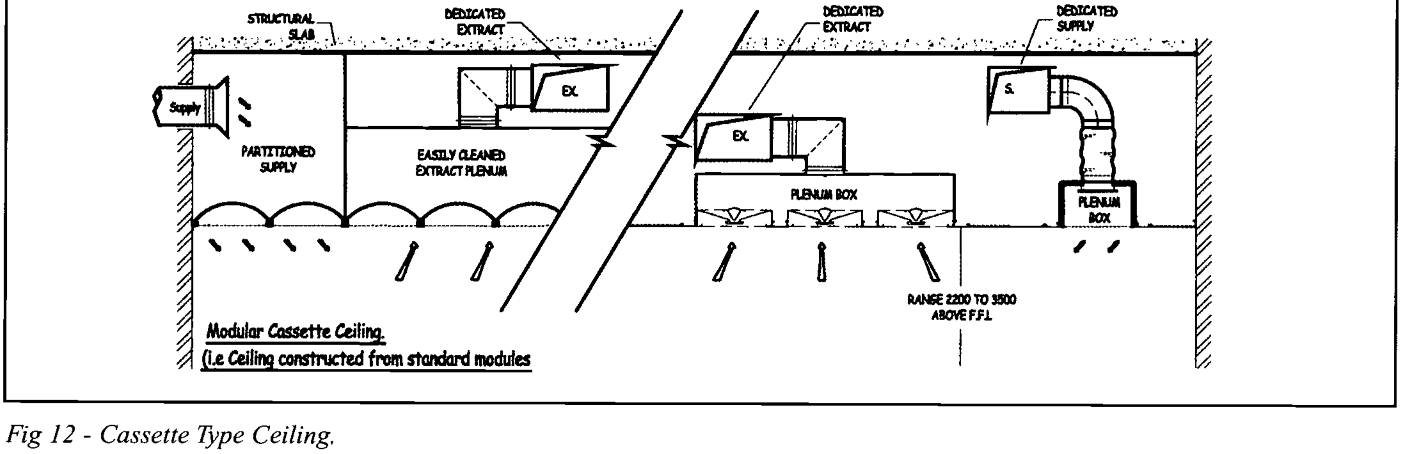


Fig 12 - Cassette Type Ceiling.

8.5.2 The plan dimensions of the exhaust zones should exceed the plan dimensions of the catering equipment. As the finished ventilated ceiling height increases, consideration should be given to either increasing the 'active' area of the ceiling to avoid migration of vapour, or increasing the volume flow. The increase in the extract rate should also reduce the possibility of 'thermal cooling' of the rising particles back to solid matter, thus stopping the grease returning to work surfaces.

8.5.3 Modular Cassette and Plenum Systems shall have the following extract cassette overhang as a minimum.

TABLE 6 - Extract Cassette Overhang

CENTRAL COOKING ISLAND & WALL MOUNTED COOKING EQUIPMENT	
Grease Producing Equipment	**At Least 500mm Overhang of Equipment**
Steam Producing Equipment	**At Least 750mm Overhang of Equipment**

TABLE 7 - Ventilated Ceiling Factors

FINISHED CEILING HEIGHT / FACTOR EXTRACT FLOW RATE

AFFL (m)	FACTOR
2.2	**1.10**
2.5	**1.00**
2.7	**1.08**
2.9	**1.16**
3.1	**1.24**
3.3	**1.32**
3.5	**1.40**

As the finished ventilated ceiling height increases, the extract flow rate shall also be increased.

NB The optimum ceiling height for ventilated ceilings should be 2.5m. This ceiling height therefore has a multiple factor of 1.00. As with ceilings above this height, those below require an increase in extract volume because of problems created with potential cross draughts (i.e. 2.2m height = 1.1 factor).

8.6 Plenum System

8.6.1 With no proprietary components, the plenum system comprises a series of filter plenum modules which allow

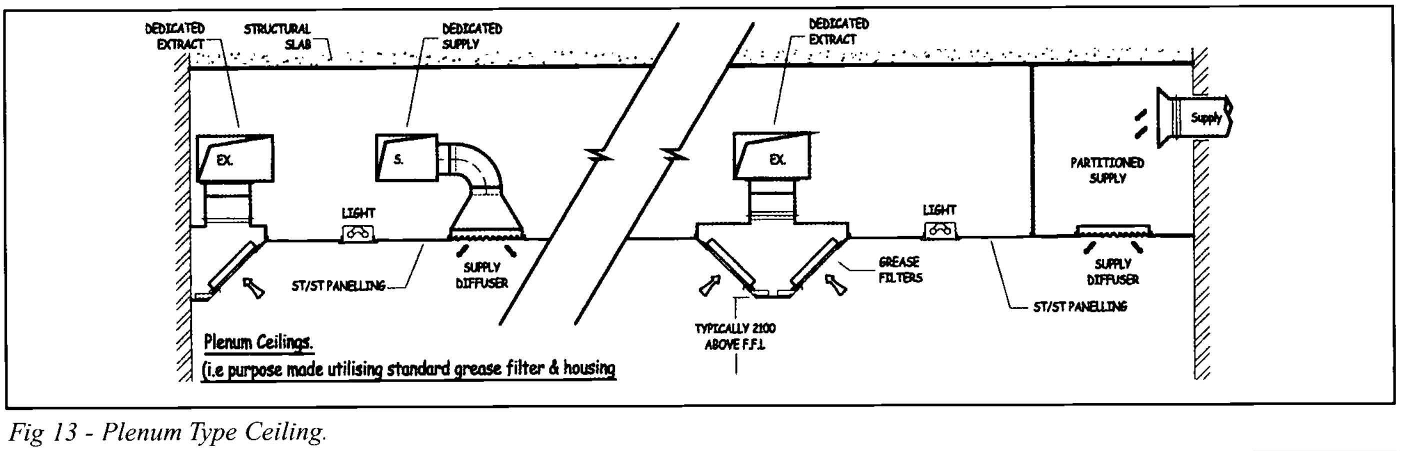


Fig 13 - Plenum Type Ceiling.

the extract air to pass through a single or double bank grease filter for contaminant separation before passing into a plenum box and duct system and discharge to atmosphere.

8.6.2 Supply grilles are integrated into the ceiling design to provide make up air comfort ventilation or spot cooling.

8.6.3 Secure installations are not achievable with plenum systems.

8.6.4 Grease filters shall be located in accordance with procedures set out in Section 13.

8.7 Supply and Extract Ductwork

8.7.1 The alternatives for removing extract air and supplying intake air should be:

- via partitioned voids
- totally ducted system.

8.7.2 Where partitioned voids are selected there should be no direct duct/spigot connection to the extract filters. Extract should be by means of bellmouths in a sealed plenum connected to a ductwork system. Supply air should be introduced via a duct system through bellmouths into the supply void.

8.7.3 For most efficient operation bellmouths should be not more than 3m apart in each plenum zone. Velocities at the face of a bellmouth shall not exceed 3m/s.

8.7.4 Where a ducted system is selected it comprises separate dedicated ductwork with connections to both supply and extract cassettes, via plenum boxes.

8.7.5 Where a plenum design is selected open voids above the ceiling shall be sealed. Void depths shall be 200mm minimum to 1250mm maximum. For voids exceeding 1250mm a top cover (galvanised steel) shall be fitted at maximum 1250mm above finished ceiling height.

8.7.6 Open builders work plenums shall not be used as any part of an extract system where grease laden air is being extracted. In these areas, the exhaust zone shall be top capped. Open builders work plenums may be used for supply air plenums and extract air plenums for steam laden air only. Where open builder work plenums are selected for extract of steam laden air, services passing through this void should be contained within a galvanised duct/trunking.

8.8 Construction

8.8.1 The material to be used in the manufacture of ventilated ceilings should typically be 304 grade stainless steel. Some manufacturers incorporate anodized aluminium into the supporting frame; this form of construction should be agreed with the client or specifier.

8.8.2 The structure that supports the ventilated ceiling shall be adequate for the total weight imposed. As a guide the average installed weight of both types of ventilated ceiling, ranges between $18kg/m^2$ - $25kg/m^2$.

8.8.3 Services, other than ductwork, shall not pass through the extract void where grease laden air is being carried.

8.8.4 Where other services are routed through voids that carry supply or steam laden air, access arrangements shall be provided so that adequate and regular cleaning can be achieved. Steam extract and supply air voids, builders-work partitions, etc. shall be painted with an anti-fungicidal, dispersion coating to avoid the collection of airborne dust and dirt particles.

8.8.5 The ceiling void shall be sealed to the building structure to ensure that an airtight plenum is created in order to avoid any short-circuiting of the air systems.

8.8.6 Where gas services are run through the ventilated ceiling void, the installation must comply with Building Regulations or run within a ventilated sleeve to atmosphere.

8.8.7 All mechanical and electrical services, other than ductwork, shall be run outside the extract zone, except for electrical services to lights which shall be fitted with heat resistant cabling. The services columns shall extend through the zone and terminate outside the extract zone.

8.8.8 Installed height of ventilated ceilings can vary from 2200mm to 3500mm above finished floor level depending upon structural limitations and the type of appliances being ventilated.

8.8.9 To minimise potential fire risks, it is recommended that:

- The ventilated ceiling should be cleaned and maintained regularly.
- All partitions in the ceiling void should be constructed from 'smooth' cleanable surface materials that are easy to clean and will not harbour growth of bacteria. Material thickness of partitioning should be at least 0.80mm.
- Where there is grease producing equipment, the ceiling zone shall be completely segregated from any adjacent zone by non-combustible imperforate downstands extending from the structural soffit to the ceiling. This partition shall be manufactured from galvanised steel. The perimeter of each zone shall be segregated by cavity barriers from any other conventional ceiling void with the barrier being fire rated to a standard determined by the building owners risk assessment, but with a minimum integrity of 30 minutes and fire stopped.

8.8.10 With both ventilated ceiling options, care should be taken if future modifications to the kitchen layout are considered. It is important to ensure that the provision of extract zoning within the ceiling void is revised to comply with the modified requirements and also that sufficient extract and supply air is available to accommodate changes. The guidance of the ventilated ceiling supplier shall be sought prior to modifications taking place to ensure the integrity of the system is not compromised.

8.9 Lighting

8.9.1 Integral lighting may be incorporated into either ventilated ceiling system. Illumination levels shall follow the recommendations of Section 14. Minimum requirement shall be IP55-rated luminaire, achieving an average of 500 lux at working height throughout the area to be served by the ventilated ceiling. For areas other than the kitchen refer to CIBSE Lighting Codes.

8.9.2 Care should be taken with the selection of lighting components as general lighting as well as task lighting should be considered. The introduction of supply air through the light fitting should be considered to extend the life of the capacitors, improve illumination efficiency and assist in maintaining the cleanliness of the tubes reflectors and diffusers. Emergency lighting shall be to BS 5266-1.

8.9.3 The ventilated ceiling supplier should supply photometric data on each project to ensure the optimum luminance levels will be achieved.

8.10 Cleaning and Maintenance

For the cleaning and maintenance of ventilated ceilings see the relevant notes under Section 25.

SECTION 9

Spigot Connections

9.1 The size of the spigots serving both the supply and extract plenums, should be determined by selecting a size appropriate for the air velocity.

9.2 The extract spigot area should be determined by dividing the total extract flow rate by a design velocity of 5-7 m/s. and the supply air volume a velocity of 3-5 m/s.

9.3 The width of the spigots should depend on the size and shape of the filter housing, the angle of the filters and whether a wall or island style canopy is used.

9.4 The number of spigots shall be determined by the length and width of the canopy and any restrictions in the ductwork layout but, as a general rule, there should be at least one spigot for every 3m of canopy to ensure an even air flow.

SECTION 10

Materials

10.1 Stainless Steel

10.1.1 Unless indicated to the contrary in any particular project specification, all visible surfaces of the canopy and ventilated ceilings shall have the fine grained finish on view, with all unpolished surfaces concealed.

10.1.2 All polished sheet surfaces shall be protected with a removable, laminated film.

10.1.3 For special canopy applications for the offshore and food process industries type 316 acid resistant stainless steel should be required (manufacture reference: EN 10088). Where such specialised stainless steel is necessary, the client shall indicate this requirement from the outset.

10.1.4 Abbreviations

DP2 = Dull polished both sides.
DP1 = Dull polished one side.
2A = Bright Annealed
2B = Descaled or unpolished

TABLE 8 - Material Weights (in kg/m²)

	Stainless Steel
2.0mm or 14g	**16.04 kg/m²**
1.6mm or 16g	**12.87 kg/m²**
1.2mm or 18g	**10.30 kg/m²**
1.0mm or 20g	**7.77 kg/m²**
0.8mm or 22g	**6.40 kg/m²**

10.2 Perforated Sheet

10.2.1 For the diffusion or equalisation of air within the supply plenum of a canopy, 0.8mm perforated sheet should be used.

10.2.2 For the fabrication of front face discharge grilles, 1.0mm perforated stainless steel sheet shall be used, the free area selected to suit the design conditions. This arrangement will not provide directional control of the air discharge

10.3 Insulation

10.3.1 To avoid condensation, canopies that are provided with a supply plenum shall have all internal surfaces of that plenum thermally insulated. The insulant shall be a rigid foil faced non fibrous slab, with a class 1 spread of flame.

10.3.2 Insulating boards are available in various thicknesses and should be fixed to the plenum with a combination of adhesive, tape and stick pins.

10.3.3 Fibre based insulating materials must not be used in a food environment.

SECTION 11

Construction

11.1 General

11.1.1 The canopy should be easy to clean, be constructed of non-combustible materials and be located so as not to interfere with the cooking process.

11.1.2 Canopy sections shall be manufactured in an all-formed, folded and welded construction with joints made such that there are no obstructions or obtrusions likely to cause injury or encourage growth of bacteria.

11.1.3 All external canopy surfaces should be vertical to facilitate cleaning, match the ceiling line and maximise the internal collection volume.

11.1.4 A minimum 50mm x 25mm channel should be formed as an integral part of the valance to provide rigidity to the exposed edge for the full perimeter of the canopy. Provided that the air flow rate has been correctly selected, condensation should not form and with the exception of 'condensation' canopies, there will be no requirement for drain plugs.

For ventilated ceiling construction, refer to Section 8.

11.2 Canopies and ventilated ceilings should be fabricated using the material thicknesses shown in Table 9. The material thickness shall be selected to ensure that no distortion occurs through either welding or the weight of the panel itself.

TABLE 9 - Sheet Thicknesses

	Stainless Steel
Valance up to 600mm high	**0.9mm**
Valances over 600mm high	**0.9mm - 1.2mm**
Filter Housing	**0.9mm - 1.2mm**
Flat Panel Ventilated Ceilings	**0.9mm - 1.2mm**
Coffered Ventilated Ceilings	**0.55mm - 1.1mm**
Supply plenums	**0.9mm - 1.2mm**
Spigots	**0.7mm**

11.3 Fabrication

11.3.1 Cut blanks should be notched and folded into sub sections. These folded joints shall be contained 'inboard' of the canopy construction to ensure concealment on completion of the final assembly.

11.3.2 Consideration should be given to minimise the number of components in which a canopy is delivered to site. This will depend upon both the size of canopy, site access and conditions.

11.3.3 Canopies which in length exceed that which can be made from a standard sheet, shall be made in sections which are joined by means of a 20-25mm wide full height internal flange or standing seam. After erection, standing seams shall be covered by a full height cover trim to provide a smooth surface to facilitate cleaning.

11.3.4 Canopies that are made using extruded section must not be used as the joint between the sheet and section provides a natural harbour for the growth of bacteria.

11.4 Sealant

11.4.1 The use of sealant shall be limited to joints or those areas where a hygienic seal is required. The sealant must be of silicon type foodservice quality.

11.4.2 For site use, a clear, white or grey sealant should be used for making a seal between the canopy and a tiled wall or ceiling.

11.4.3 Conventional sealant should be used for spigot and ductwork joints.

11.4.4 All products shall be installed in accordance with the manufacturers' recommendations.

SECTION 12

Polishing

12.1 All visible welds shall be ground to a smooth surface and reinstated to the finish of the base material by polishing.

12.2 The type of disc used for the grinding and polishing processes may vary according to the grade of material and joint being polished.

12.3 The polished areas should be covered with a low tack vinyl tape to replace the original laminated pvc protection destroyed by the welding.

12.4 Abrasive discs that have been used on other materials shall not be used with stainless steel.

SECTION 13

Grease Filtration

13.1 A UK standard for the testing of grease filters has been set by the publication of the Loss Prevention Certification Board's document LPS 1263 - REQUIREMENTS FOR THE LPCB APPROVAL AND LISTING OF THE FIRE PERFORMANCE OF KITCHEN EXTRACT SYSTEMS. All grease filters used in commercial kitchen ventilation systems should comply with LPS 1263.

Filters are used primarily in commercial kitchen extract systems for the removal of flammable grease deposits.

The grease extracted by the filters shall be collected and removed so that it will not accumulate in either the canopy plenum or the ductwork system, or fall back onto the cooking surface. In the event of fire the filter shall also limit the penetration of flame downstream into the canopy plenum.

The filter shall be constructed so that there are no sharp edges or projections and shall be easily removable for regular cleaning.

Primary filters that retain grease within the filtration matrix until cleaned, shall not be used (not to be confused with those designed with purpose made integral collection reservoirs). The mesh type filter shall not be suitable except for secondary filtration.

LPS 1263 describes tests to determine both the grease removal efficiency and the flame resistance of grease filters. The tests are based on procedures that are already in place and are based on the American UL 1046 (F Class) for flame arrestance, and the German VDI 2052 (G Class) for the grease extraction efficiency.

The main requirements of the UL1046 test are that;

- There shall be no flame extension of more than 450mm beyond the filter. (MFL)

- The filter remains intact throughout the test
- There is no ignition of collected grease on the downstream side of the filter
- No grease falls back onto the cooking surface
- No flame exists downstream beyond a time of 120 seconds (DFP)

The results of the VDI test for grease removal efficiency will be:

50% of the smallest particle size will be removed from the air stream.

This removal will be achieved at plus or minus 20% of the specified airflow.

The required performance of the filter will be based on the results of both tests and to the risk factor of the cooking and building type.

Table 10 - Cooking Risks

Risk Level	Examples of type of cooking equipment
Light	**Boiling with no risks of vapour**
Medium	**Conventional frying or processes emitting steady vapour flow**
Heavy	**Open flame grilling, flame cooking and sudden emissions of hot vapour**

Table 11 - Building Risk

Risk Level	Example of type of building in which kitchen is located
K1	**Small commercial building of single occupancy type**
K2	**Small commercial building of multi-occupancy type**
K3	**Medium size commercial building of single occupancy type**
K4	**Medium size building of multi-storey**
K5	**Large size commercial building of single occupancy type**
K6	**Large size commercial building of multi-occupancy type**
K7	**Special risks including large shopping complexes and airport terminals**

Table 12 - Recommended Performance of Filters to comply with LPS1263

		Risk Assessment (GF Class Required)		
		Cooking Risk		
		Light	Medium	Heavy
BUILDING RISK	**K1**	**GF20**	**GF52**	**GF80**
	K2	**GF28**	**GF58**	**GF85**
	K3	**GF36**	**GF64**	**GF90**
	K4	**GF44**	**GF70**	**GF94**
	K5	**GF52**	**GF80**	**GF98**
	K6	**GF60**	**GF85**	**GF101**
	K7	**GF68**	**GF90**	**GF104**

Where the 'G' represents the grease removal efficiency, and 'F'; represents the capacity of the filter to restrict the length of flame.

The designer shall specify the class of filter required based on the building and cooking risk factors, and it shall be the responsibility of the canopy contractor to provide a filter of the appropriate GF rating.

Details of test procedures do not fall within the scope of this document, and further information should be obtained from the Loss Prevention Council.

13.2.1 Grease filters fall into two main categories; primary and secondary. Typically, most canopies incorporate only primary grease filters and these shall be specified in accordance with LPS 1263. Primary grease filters should be flame retardant and capable of removing as much airborne particulate (i.e. grease, oil etc) from the air stream as possible, to maximise the filtration process within the canopy. Secondary mesh type impingement filters can be incorporated to the rear of the primary filters providing they do not affect the fire arrestance criteria as required by LPS1263. Inclusion of secondary mesh type impingement filters shall not reduce the LPS1263 requirement for the primary grease filter.

13.2.2 The use of secondary filters, sometimes referred to as coalescers, serves to encourage airborne gases to condense on the surfaces and thereby substantially reduce the moisture content of the air being extracted.

13.2.3 Disposable panel type filters shall not be used for grease extraction. Where high levels of contaminant are produced, then higher degrees of grease separation can be achieved by the use of cartridge, water wash or water mist systems.

13.3 Examples of type of grease filter currently available and their main properties are shown in Table 13.

13.4 Mesh Impingement Filters

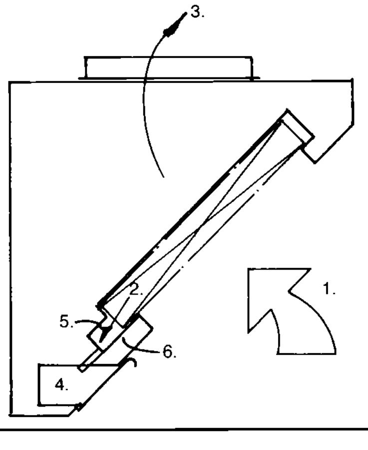
13.4.1 There is no barrier to flame within these filters; therefore mesh filters shall not be used as a primary grease filter.

13.5 Baffle Filters

13.5.1 Baffle filters comprise a number of interlocking vanes which when assembled form a two-pass grease removal device. The pressure drop remains constant and the blades provide a barrier in the event of a flash fire. Baffle filters should be fabricated entirely from stainless steel.

13.5.2 The grease laden air passes through the filter and by a series of forced changes in direction and velocity, the grease becomes separated in the air stream and is deposited on the vertical vanes. The deposited grease is then drained off through a number of weep holes spaced at adequate intervals into a collection drawer which shall be regularly cleaned.

13.5.3 The capacity of the collection drawer shall be sufficient to suit the type of cooking and frequency of cleaning and because the grease is retained, care shall be taken to ensure that the grease collection drawer is isolated from the extract air stream as illustrated in figure 14 to prevent re-entrainment.



1. CONTAMINATED AIR
2. GREASE SEPARATION
3. CLEANED AIR
4. GREASE COLLECTION DRAWER AT END OF FILTER BANK.
5. GREASE COLLECTION ISOLATED FROM AIR MOVEMENT
6. SLOPING GREASE COLLECTION CHANNEL WITH LOW POINT AT DRAWER

Fig 14 – Typical Airflow Through Filter Housing

13.5.4 For plenums that contain more than one filter, supports may be required to ensure that the housing remains stable. Filters shall be easily removable and installed so as to minimise air leakage around the perimeter.

13.5.5 Where installations are being refurbished, baffle filters shall not be installed in a plenum previously used with mesh filters unless a collection drawer and grease run is added and the plenum is revised to avoid re-entrainment. Any increase in resistance shall be taken into account when selecting a new fan or considering the adequacy of the existing one.

13.6 Baffle filters shall be installed at an angle of not less than 45 deg from the horizontal.

13.7 Cartridge Filters

13.7.1 Cartridges filters comprise a high velocity slot opening onto a series of baffles which cause multiple direction changes to the air flow.

13.7.2 Available in a combination of size and length to suit the air flow, cartridge filters shall be installed over the full length of the extract plenum, with an integrally designed slope to allow the trapped grease to fall through a drain to a grease drawer.

13.7.3 Should be for used with moderate to heavy grease load applications.

13.8 Water Wash

13.8.1 The water-wash system comprises an extract plenum similar to the one used with cartridge filters, but also incorporates an inbuilt self cleaning system that has the dual function of catering for routine maintenance as well as providing fire protection to the plenum and duct.

13.8.2 Water-wash canopies are operated by a control panel. The basic panel is a manual system where the operator pushes a start and stop button at the beginning and end of the cooking process each day. Automatic systems are also available which allow the control of a set number of systems with pre-set sequencing of water cycles, and automatic starting and stopping.

13.8.3 Cleaning is achieved by spraying the interior of the canopy extract chamber with pressurised hot water via an integral pipe work system, automatically injecting the plenum with a predetermined amount of detergent. The waste water flows from the system through a plumbed drain.

13.8.4 The wash cycle is generally activated for between 2 and 3 minutes at the end of the day after the cooking equipment and fans have been turned off.

13.9 Continuous Cold Water Mist

13.9.1 In addition to the water wash system a cold water mist can be incorporated to enhance grease extraction. The water mist system runs continuously during the cooking operation. The vapour entering the canopy passes through the mist which causes the grease particles in suspension to drop in temperature, solidify, increase in size and drop to a drainage trough from which it is flushed to a drain.

13.9.2 The mist system has an additional advantage in that the continuous flow of cold water cools both the canopy and the exhaust air, is particularly suitable for solid fuel appliances where the mist will also extinguish hot embers that may be drawn up into the canopy.

13.10 The bacterium legionella occurs naturally in water sources and, when in sufficient numbers, can cause 'legionnaires disease' by the inhalation of water laden air in an aerosol form by susceptible individuals. This is unlikely to occur with water wash and water mist systems due to the fact that the water supply to the system is constantly changing and the confined nature of the spray. If it is thought that there is cause for concern, then further guidance must be obtained from either:

- HSC document - "The prevention and control of legionellosis - Approved Code of Practice L8"
- CIBSE Technical Memorandum: Minimising the risk of legionnaires disease (TM13:1991)
- The Institute of Plumbing publication - "Legionnaires' Disease - Good Practice Guide for Plumbers"

13.11 **Typical wash plenums are illustrated in fig 15.**

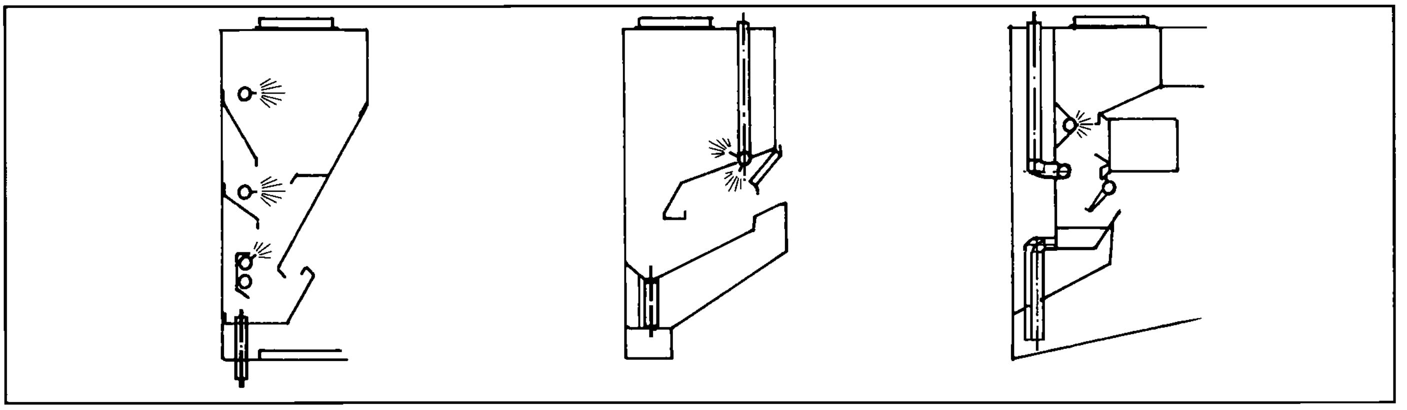


Fig 15 - Typical Water Wash Plenums.

Table 13 - Types of Canopy Grease Filter and Their Main Properties

Type	Recommended Face Velocity	Advantages	Disadvantages
Baffle	**4.5 - 5.5 m/s (at slot)**	**Inexpensive Non - over Loading pressure drop**	**Higher pressure drop than mesh filters**
Cartridge	**4.0 - 5.5 m/s (at entry)**	**Higher efficiency Non overloading pressure drop**	**Higher pressure drop than baffle filters Special plenum fabrication required**
Water Wash	**4.0 - 5.5 m/s (at entry)**	**Higher efficiency Non overloading Low maintenance**	**Expensive. Very high pressure drop. Hot water supply and drains required.**
Cold Water	**4.0 - 5.5 m/s (at entry)**	**Very efficient. Low maintenance. Non overloading**	**Expensive. Very high pressure drop Hot and cold water supplies and drains required**

For types and properties of ventilated ceiling filters, refer to Section 8

SECTION 14

Canopy Lighting

14.1 Lighting in a kitchen canopy should provide an average illumination level of approximately 500 lux at the working surface and standard fluorescent type fittings, installed at a height of 1200mm above the cooking surface should fulfil this requirement. In comparison with other systems of lighting, the fluorescent fitting is generally the most efficient and economical option with the best life expectancy. They should be incorporated into a suitable housing to isolate them from the cooking process. See CIBSE Code for Lighting, Lighting at Work, BS ISO 8995 and BS EN 12464 - 1.

14.2 The lighting housing should be recessed into the canopy to provide an easily cleanable surface devoid of unnecessary, inaccessible joints and seams. Where surface mounted canopy lights are unavoidable, then smooth surfaces and good 'clean-down' properties should be provided.

14.3 The light enclosure shall be sealed against the ingress of grease and moisture. Surfaces facing the cooking area shall be designed to achieve a rating of IP55 - see appendix C for details of IP ratings.

14.4 All sealing gaskets between the removable reflector and the light housing shall be of food quality neoprene and be able to withstand temperatures up to 100 deg C.

14.5 The lighting lens shall be made from a temperature resistant material such as polycarbonate sheet or safety glass. In both cases, the outer surface should be of a smooth and easy to clean finish. Care shall be taken to ensure that where polycarbonate sheet is used it shall be capable of withstanding the temperatures generated by the cooking processes.

14.6 The light housing shall have an easily removable cover for easy access and replacement of the fluorescent tubes.

14.7 The light housing should be designed with adequate ventilation, especially at either end.

14.8 Wiring from the light fittings to any junction point on the canopy must be heat resistant and installed in a low smoke and fume (LSF) material. The power supply should be part of the electrical services contract.

14.9 The light housing shall be manufactured from a material or colour which will ensure maximum light reflection downwards towards the working surface.

14.10 The following formulae should be used to determine the level of illumination achieved when details of the lighting components are known.

14.10.1 The level of illumination in lux should be calculated as follows

$$\frac{\text{No. of tubes x average tube life x uf x mf}}{\text{canopy area}}$$

14.10.2 The number of fittings required should be calculated as follows

$$\frac{\text{Canopy area x required level of illumination}}{\text{average tube life x uf x mf}}$$

The inclusion of double tube fittings does not necessarily double the level of illumination. A factor of 1.5 times higher should be used to give the correct level of illumination when using double tube fittings.

14.10.3 Where mf = maintenance factor = 0.70
uf = utilisation factor = 0.38
and average tube life is given in Table 14.

TABLE 14 - Average Tube Life

Tube Length	Output	Average Life
600mm	**18 Watt**	**1100 hours**
1200mm	**36 Watt**	**2800 hours**
1500mm	**58 Watt**	**4550 hours**
1800mm	**70 Watt**	**5600 hours**

14.10.4 These figures are based on information supplied by manufacturers of 'warm white' tubes. Should alternative products be selected, then different factors may apply.

14.10.5 Where standard light tubes are used, these shall be encapsulated within a protective sheath to render them shatterproof.

14.10.6 Natural deterioration in illumination occurs to all fluorescent tubes. Annual replacement should ensure the original lighting level is maintained.

14.10.7 The CIBSE Code for Lighting shall be complied with (see Appendix F).

14.11 Where surface mounted lighting is to be used all electrical wiring shall be concealed above the canopy.

14.12 Alternative positions for the location of light fittings are shown in fig 16.

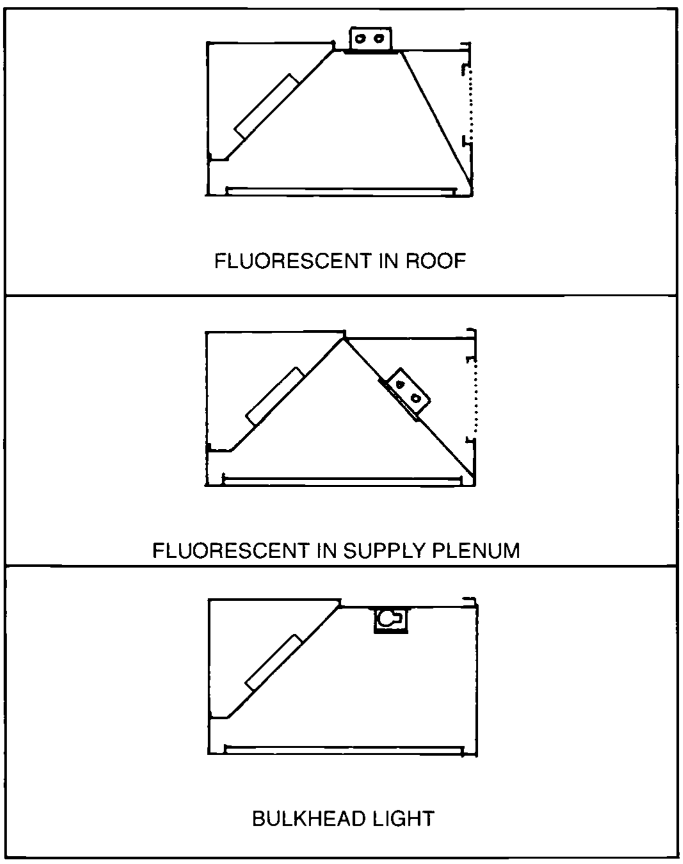


Fig 16 - Location of Lighting.

SECTION 15

Ductwork

15.1 The correct standard of ductwork selected to complete the installation is as important as the selection of the canopies themselves.

15.2 For the distribution of supply air to the canopy, the ductwork has no special requirements other than the application of thermal insulation where the supply air is tempered and the installation at a minimum F6 filtration level for the incoming air. Bird mesh screens to the rear of any inlet louvre shall be incorporated. Insect mesh shall not be used as it can become easily blocked.

15.3 Under normal circumstances and providing it runs within the fire compartment of the kitchen itself, extract ductwork shall also have no special requirements.

15.4 All ductwork as described in 15.2 and 15.3 shall be low pressure Class A and be in accordance with HVCA Specification number DW/144 with a minimum thickness of 0.8mm.

15.5 Where it is not possible to immediately discharge the captured air within the confines of the kitchen fire zone, fire rated ductwork must be used to comply with BS 3476 part 24/BS 5588 part 9. For further information see Appendix D.

15.6 Where total 'grease tightness' is required within the kitchen fire zone, all ductwork within the kitchen compartment and not discharging directly to atmosphere shall be constructed from either 1.2mm stainless steel or 1.6mm zintec, be of fully welded construction with welded angle iron flanges and use full faced gaskets. Gaskets shall be non porous, impervious to grease and cooking oils and capable of withstanding the higher temperatures experienced in kitchen extract systems. Mild steel ductwork should also be painted externally with 2 coats of protective paint before leaving the manufacturers works.

15.7 Where a waterwash or watermist type filtration system is used, horizontal ductwork shall slope back to the canopy with a fall of 1:50.

15.8 Grease filters do not remove all of the airborne grease produced therefore care should be taken against staining the fabric of the building at the discharge point.

15.9 Particular attention shall be paid to the design of ductwork to extract steam from dishwasher and pot washing machines due to the very high level of humidity present. With the risk of condensation, the following precautions shall be considered to prevent leakage through the duct joints.

- Use of stainless steel ductwork with slip joints in the direction of the flow of condensation.
- Ductwork installed with a fall back to the machine.
- Apply external thermal insulation to minimise the condensation.
- Ensure that longitudinal joints are not on the bottom of the ductwork.
- Site-weld cross joints on stainless steel ductwork, particularly across the bottom and for 50mm up each side.
- Ensure that cleaning doors are not on the underside of the ductwork.
- Consider the use of all-welded plastic ductwork.

15.10 No system shall be connected into the kitchen extract system where the route selected does not minimise the number of changes in direction and possible grease traps. Where ducts from more than one canopy are joined together, then branch connections should be flush on the underside.

Internal thermal or acoustic lining should not be used, and turning vanes should be avoided wherever possible.

Where it is not possible to immediately discharge the captured air within the kitchen fire compartment, fire rated ductwork shall be required. For further information see Appendix D.

15.11 When designing kitchen supply and extract systems the duct velocities shown in Table 15 shall be followed.

Table 15 - Duct Velocities

	Supply	Extract
Main Runs	**6-8 m/s**	**6-9 m/s**
Branch Runs	**4-6 m/s**	**5-7 m/s**
Spigots	**3-5 m/s**	**5-7 m/s**

15.12 All interior surfaces of the ductwork shall be accessible for cleaning and inspection purposes. In the absence of a detailed cleaning specification/method, access doors shall be installed at 3m centres. The panels shall be of at least the same thickness material as the ductwork, be grease tight using a heat-proof gasket and contain minimum projections into the duct. For recommended cleaning procedures refer to section 25 and the HVCA publication TR/19 - "Guide to Good Practice - Cleanliness of Ventilation Systems" (see Appendix F).

15.13 On horizontal duct runs, access doors should be installed on the side of the duct, with the underside of the door at least 40mm above the underside of the duct. On vertical ducts, cleaning doors shall be provided at each floor level.

15.14 Discharge points shall be positioned such that the extracted air cannot be entrained into a supply system. The ductwork shall discharge at least 1.0m above any openable window.

15.15 The discharge terminal shall be open without mesh and designed to achieve an exhaust or efflux velocity of 12-15 m/s or as required by the Local Authority from whom approval shall be sought. However, consideration should be given to situations where the lack of a mesh/guard might allow hand access to operating fan blades.

15.16 All exterior ductwork should be supported with fixings that do not penetrate the duct wall. Where this is not possible, the duct wall shall be made good with sealant and steel washers.

15.17 The use of a 'chinaman's hat' type of cowl should not be used due to the potential downdraught caused and the risk of re-entry of the extract air back into the building. Alternative types of discharge terminal are shown in fig 17 and 18.

15.18 Drains shall be installed at the base of all risers (see Fig 17).

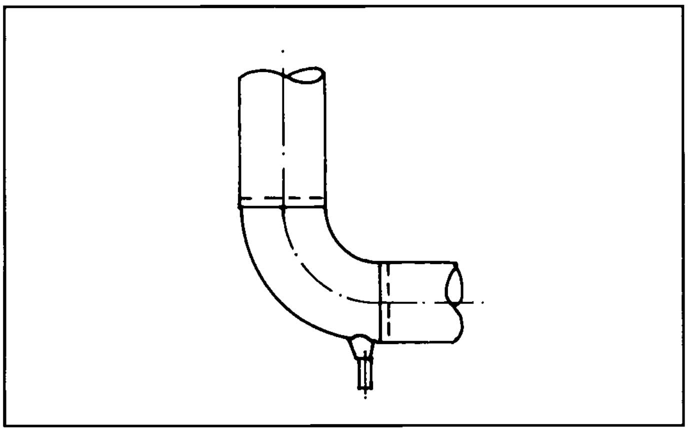


Fig 17 - Drain

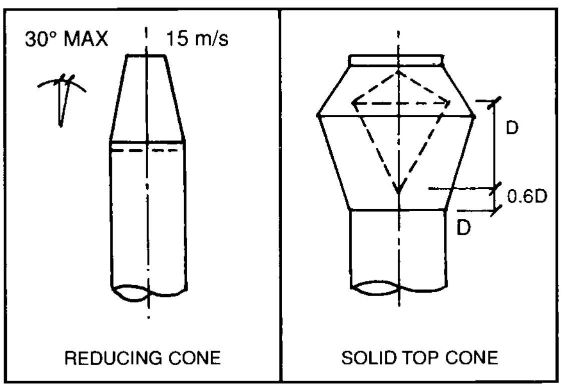


Fig 18- Alternative Terminals without internal drains

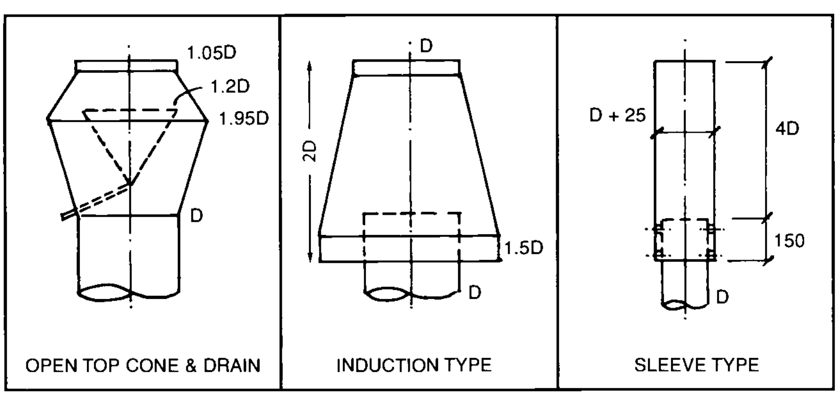


Fig 19- Alternative Terminals with internal drains

SECTION 16

Installation

16.1 To ensure the smooth running of an installation, the following items shall be established at an early stage of the contract.

16.2 Canopies and ventilated ceilings are usually a second fix item. The installation should be programmed to follow completion of the mechanical services first fix, but before either the cooking equipment or false ceilings are installed.

16.3 Because of the many canopy sizes, access routes should be established to ensure that components can be easily manoeuvred into the building at the appropriate stage of construction. Consideration shall be given by all parties to special access or lifting provisions that may be required.

16.4 The canopy clearance from the finished floor level to its underside is usually set at 2000 - 2100mm. If alternative levels are required, they shall be stipulated prior to the production of the manufacturing drawings.

16.5 Canopies and ventilated ceilings are usually installed before the catering equipment which can make setting out points difficult to establish. Pre-determined datum points agreed formally with the catering equipment installation contractor should ensure that the canopy or ventilated ceiling can be suspended precisely over the intended equipment position and in line with service distribution units.

16.6 The canopy and ventilated ceiling manufacturer should be advised at an early stage on the type of fixings to be used and whether any secondary support provisions are required. Various suspension methods may be used, but the number of fixing points shall be selected to carry the weight, maintain both the shape, integrity of the finished installation and include provision to overcome any site discrepancies.

16.7 The canopy and ventilated ceiling manufacturer shall be advised of any wall finishes to be applied such as tiles or plastic facings. It shall also be established whether the canopy is to be installed prior to these finishes. If the canopy is to be installed first then dimensional tolerances shall be agreed with the main contractor. Where a canopy is recessed between two walls then a finished dimension needs to be established before manufacture is started. Ventilated ceilings are usually installed after the wall finishes are complete. As such the finish should extend to at least 50mm above the installed height of the ventilated ceiling. The provision of ceiling trims will then be undertaken by the ventilated ceiling contractor, with care exercised to avoid breaching the air-tight integrity of the ventilated ceiling system.

16.8 Canopies are fabricated to specific geometric shapes and dimensions. During the installation, inaccuracies in the building structure may be highlighted. For complex installations the canopy supplier should provide templates prior to the delivery of the canopy.

16.9 Protective finishes such as vinyl film, impact-type wrapping, protective boarding and tape shall be left in place until the final cleaning programme. The canopy and ventilated ceiling contractor would not normally be expected to return at later date to undertake this work unless specifically instructed to do so at tender stage.

16.10 For canopies, the provision of ceiling trims will normally be undertaken by the false ceiling contractor. Care should exercised when fastening trims to a canopy to avoid fixings penetrating the canopy skin. Even greater care shall be taken on waterwash canopies to avoid breaching the watertight integrity. Ventilated ceiling installers should fit wall trims and site measure infill pieces to tie in to their system.

16.11 Prior to leaving site the canopy and ventilated ceiling installer shall arrange for the canopy / ventilated ceiling to be inspected by the client to ensure that the installation has been completed to his satisfaction.

16.12 The supplier shall ensure that the canopy/ventilated ceiling performance rating plate has been fitted.

SECTION 17

Fans

17.1 Care shall always be taken with the location of the supply and extract fans to ensure that there is sufficient space for regular cleaning and maintenance. Limited space shall not restrict selection of the correct fan.

17.2 Kitchen ventilation systems have relatively high resistances against which a fan has to operate. The fan should be selected to handle the design resistance with up to an additional 10% pressure margin allowed to suit possible extensions to the original kitchen plan. Regulation of the air flow should be achieved by either variable speed control if the selected fan is suitable, or by the use of balancing dampers.

17.3 Backward curved centrifugal, mixed flow or axial flow impellers are preferred as they are less prone to unbalance and are more easily maintained and cleaned due to their open construction. Fixed or adjustable metal impellers with a robust and open construction shall be used, as lightweight multi-vane or plastic-type impellers can warp and are prone to collecting concentrations of grease. Plastic bladed fans can however be used where the canopy extracts non-grease producing, low temperature fumes.

17.4 Conditions within the kitchen in which the fan has to operate are normally between 40 and 60 degC at 95% relative humidity. Most motors are rated to IP55 and are capable of operating within these conditions without the necessity to mount the motor out of the airstream.

17.5 For fans that have the motor within the airstream and are ventilating from cooking equipment that produces higher levels of temperature and humidity indicated in 17.4, then the specification for the motor shall be upgraded to withstand more onerous conditions.

17.6 An audible and/or visual indicator should be included to warn of fan failure. This should to operate on pressure difference rather than air movement because of the possibility of grease build-up on the vanes.

17.7 The provision of drain holes at the lowest point of the motor to allow condensation to drain freely is recommended, these shall be of the porous type to avoid downgrading the Index of Protection (IP) of the motor.

17.8 Both variable and two speed regulation are now common features, but it is essential that when grease is being produced, the system shall operate at its design duty. A minimum extract level shall be set within the regulator to ensure that, even when set at low speeds, an acceptable ventilation rate is maintained as reduced speeds may cause the carry-over of grease through the filter. This facility is a standard feature of the controller with proprietary speed regulators.

17.9 Where a make-up air system is selected, the speed regulators for both the supply and extract fans shall be electrically interlocked to ensure that the desired balance is maintained.

17.10 BS 6173 states that an interlock of the ventilation system to the gas supply serving the cooking equipment shall be installed so that, in the event of air flow failure, the gas supply is switched off. The supply fan shall also be isolated when a fire suppression system is activated in fire mode. This will involve the fitting of an automatic solenoid valve in the gas supply pipe work and an airflow-sensing device such as a pressure switch, vane switch or torque switch. The inclusion of this interlock is a requirement for all new powered extract systems. For existing installations where cooking equipment replacement is like for like, no action is required. However, the contractor shall quote for the inclusion at all times; failure to do so could lead to legal issues. If an existing kitchen has any form of upgrade, then the contractor shall quote for the inclusion. The Client's insurance company may have a requirement that this work is done; this may reduce the premium paid.

17.11 Fans selected for use with dishwasher systems shall be fitted with 'tropicalised' motors that are capable of operating in the saturated atmosphere, or a fan with a motor out of the airstream. The fan should be electrically linked to start with the washer and include an automatic run-on timer to disperse residual moisture as the system cools down. Another option is to specify anti-condensation heaters for larger motors, or for smaller motors to connect a single phase 24 volt supply to a winding when the motor is idle to provide a little heat and thus prevent condensation build-up.

17.12 Flexible connections shall be suitable for use with a grease laden atmosphere, positively fixed by clamps or bonding to prevent air leakage. Under fire conditions the material must have a minimum integrity of at least 15 minutes and be selected to suit the temperature of the flumes being exhausted. Table 16 lists materials with the maximum temperatures at which they are suitable for continuous operation:

Table 16: Flexible Connections - Temperature Ratings

Fire retardant PVC coated nylon	**40°C**
Loaded PVC coated glass fibre (acoustic)	**40°C**
Neoprene coated glass cloth	**120°C**
Aluminised glass cloth	**150°C**
Silicon coated glass cloth	**200°C**

17.13 The following table compares the advantages and disadvantages of the various types of fan.

Table 17: Types of Fan

FAN TYPES	ADVANTAGES	DISADVANTAGES
1. Centrifugal Fan Sets	**1) Large range of pressure and volume characteristics** **2) No temperature limitations** **3) Robust and easily maintained** **4) Adaptable changes in system requirements with pulley/motor changes** **5) Standby motors can be more readily fitted**	**1) An expensive option** **2) Requires more space than is usually available in the kitchen** **3) Requires regular maintenance to check drive belt wear unless direct driven fans are used** **4) Forward curved fans should only be used for supply systems**
2. Bifurcated Fans	**1) Robust with no temperature limitations** **2) With motor out of air stream this fan is still considered one of the safest options with high temperatures** **3) Easily installed into a ductwork system** **4) Robust and easily maintained**	**1) Less expensive than the centrifugal fan but not a cheap option** **2) Heavy in construction and therefore not always easy to support** **3) This fan is best situated within a plantroom since on large duties, the fan can be bulky in size and too noisy for siting within a working environment** **4) In-duct noise - will probably require attenuation** **5) Restricted range of resistance capability** **6) Standard unit not readily available with speed regulation.**

Table 17: Types of Fan

FAN TYPES	ADVANTAGES	DISADVANTAGES
3. Belt Driven Axial Fans	**1) Compact with an extensive duty range especially when operating in contra-rotation.** **2) Few temp limitations** **3) Easily installed into a ductwork system** **4) A less expensive option**	**1) This fan needs regular maintenance - in hot environments the drive belts are likely to fail more regularly (visual or audible alarm for fan failure is an option)** **2) Not as robust as the above fans but suitable for most kitchen applications**
4. Axial Fans (Metal Impellers)	**1) Compact with an extensive duty range especially when operating in series** **2) Easily removed for maintenance and cleaning** **3) A cheaper option than the above unless dual fans are necessary**	**1) High temperature limitations but will serve for most general kitchen vent systems** **2) Not as robust as items 1 and 2 but still suitable for most kitchen applications**
5. 'In-Line' Centrifugal and Mixed Flow Impellers	**1) Compact with a good duty range which can serve many kitchen vent systems** **2) Generally less expensive than the above options.** **3) Easily removed for maintenance and cleaning**	**1) High temperature limitations but will generally serve the majority of kitchen systems** **2) Not as robust as items 1 and 2 but still suitable for most kitchen applications** **3) Forward curved fans should only be used for supply systems**
6. Roof Extract Fans (Vertical Jet Discharge with Centrifugal Impellers)	**1) Compact and, where the motor is encased outside the air stream, has a good temperature range** **2) Easily removed for maintenance and cleaning** **3) No space restrictions** **4) Good external appearance**	**1) High temperature limitations but will generally serve the majority of kitchen vent systems** **2) With poor roof access this type of fan can be a problem to maintain** **3) More expensive than in-line/axial fans but dispenses with necessity of discharge ductwork**

SECTION 18

Attenuation

18.1 Kitchen extract systems usually operate at sensitive times such as early in the morning and late at night, so the amount of noise generated shall be kept to a minimum. The level of noise and vibration from the plant shall not be transmitted through either the structure of the building or the ductwork so as to be a nuisance for those either working in the conditioned space, or in adjoining premises.

18.2 The average human cannot distinguish between two sound pressure levels up to 2dB apart. Above this level there a perceptible increase in the overall level of noise. Acoustic equipment shall therefore be selected to limit the increase in level to 2dB above ambient.

18.3 Tolerance of noise levels is subjective, but within the conditioned space a level between NR40 and NR50 would normally be acceptable. The atmospheric side of any system requires individual examination but Local Authorities will usually advise on their specific noise requirements. Local Authorities usually refer to BS 4142 - "Rating of Industrial Noise Affecting Mixed Residential and Industrial Areas" as the basis of their criteria. Generally, the maximum acceptable noise level at the discharge point of the system is that which should not increase the overall level by more than 2dB(A). This is difficult to achieve in residential areas and wherever possible, vertical discharge of ducts, slower running fans and lower duct discharge velocities should be selected. Where this is not possible, then in-line attenuators shall be installed.

18.4 Where in-line attenuators are used, they shall be constructed so that there is no grease impregnation into the acoustic media. A protective membrane shall be specified for this purpose, this will reduce the design performance of the attenuator. This should be taken into account when selection is made.

18.5 Isolation of vibration using correctly specified resilient mountings or pads, together with heat re sistant flexible connections to the ductwork should ensure minimum transmission to the structure.

SECTION 19

Dampers

19.1 Volume control dampers are often necessary but should be kept to a minimum and incorporate the following features:

- For extract systems, the damper blades shall be fabricated from stainless steel.
- The operating mechanism shall be outside the airstream and be capable of withstanding the higher air temperatures associated with kitchen extract systems.

19.2 If a fire suppression system is incorporated within the system and a volume control damper is used in an extract spigot, then the duct protection nozzle shall be downstream of the damper.

19.3 In accordance with BS 5588, fire dampers shall not be used in the extract system from a kitchen as the fire authorities may use the extract fan to clear smoke from the kitchen.

19.4 When fire dampers are required on the supply side, the following points should be considered:

- The damper shall be of a robust construction suitable for its application and be complete with an installation frame where appropriate.
- A visual or audible alarm to signal damper closure should be considered if the fire damper is in a remote location.

19.5 Back-draught dampers should not be used as they are difficult to clean and prevent a natural 'stack' effect from the kitchen which would otherwise release overnight lingering smells.

19.6 For Ventilated Ceilings volume control dampers shall be installed either in the dedicated ductwork or on the plenum boxes.

SECTION 20

Fire Suppression

20.1 The significant presence of flammable grease and related particles contained within kitchen extract systems, combined with the possibility of fire ignition caused by the cooking equipment, creates a hazard level above that which is normally encountered in other ventilation systems.

20.2 Where ventilation systems exhaust grease laden air and vapour mixtures from a kitchen, the design must provide a level of protection to ensure the well being of occupants and fire fighting personnel, and limit the damage to the property and cooking equipment.

20.3 Whilst the correct maintenance and use of cooking appliances and ventilation systems will help prevent potential fires, it is equally important that in the event of a fire it is immediately detected and extinguished and prevented from spreading to other areas of the building.

20.4 Where a surface fire suppression system is specified, manufacturers instructions shall be followed. See Fig 20 for a typical system layout.

20.5 Suppression may be achieved by using carbon dioxide, chemicals or water. Carbon dioxide is not generally used due to the high initial cost and the lack of cooling capability.

20.6 **Chemical Systems**

20.6.1 Almost all fire suppression or extinguishing systems use special chemical agents which provide protection to the kitchen canopy. Chemically based systems can be in a liquid or dry agent form, but the liquid type is preferable as a greater level of cooling to the seat of the fire is provided and post activation clean-up time is much quicker.

20.6.2 These systems are activated either manually or automatically in the event of a fire. Thermal fusible links, which can be calibrated for varying temperatures, are strategically located in the extract air path above the cooking equipment to be protected.

20.6.3 When the fire suppression system is activated, mains energy supplies such as gas or electricity serving the appliances, must immediately be automatically shut off and isolated.

20.6.4 The chemical agent stored within the

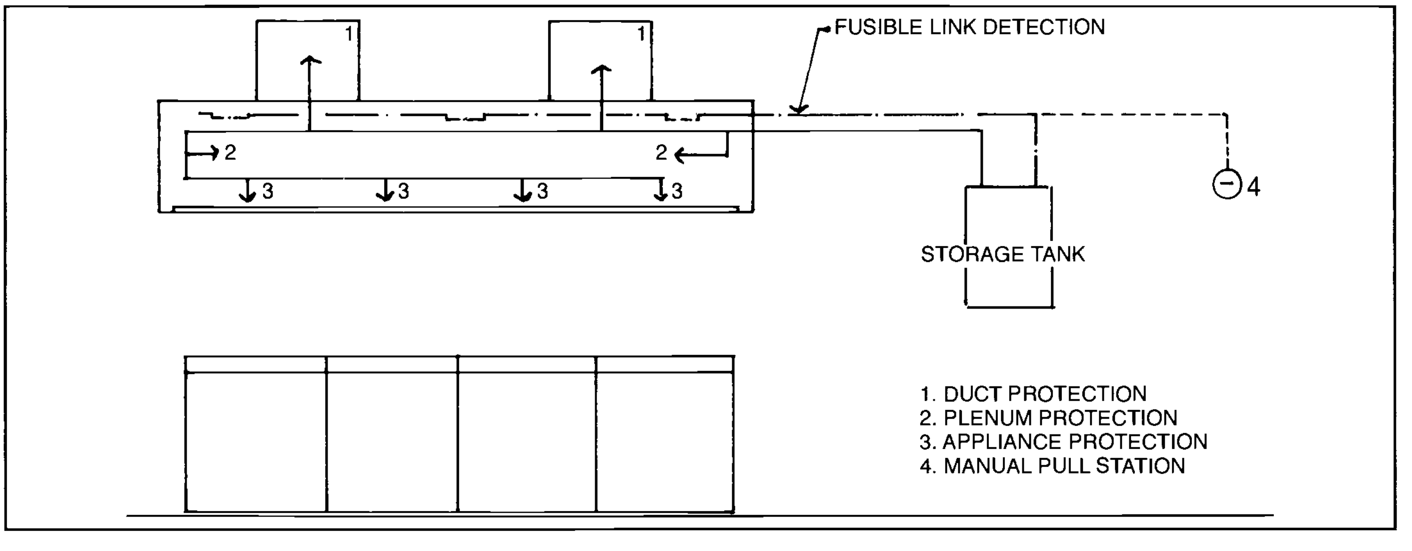


Fig 20 - Fire Suppression Schematic

system is released along the distribution pipework and discharged at high velocity through spray nozzles toward the appliances that require protection. When the extinguishing agent comes into contact with hot greasy surfaces foam is formed which suppresses the combustible vapours and prevents the fire restarting. This process is called saponification.

20.6.5 Some systems can also be activated manually by remote located pull stations normally positioned adjacent to exit doors along escape routes. This may be the requirement of the local fire officer or design engineer.

20.7 Water Systems

20.7.1 The principle of this system is almost identical to the chemical type with the same design philosophy, installation characteristics, mains shut off action and alarm status. However, the system can only be used where there is a sprinkler main available.

20.7.2 Special 'sprinkler' style nozzles with suitable temperature ratings supplied with water directly from the main sprinkler storage system are used to spray a fine water mist discharge onto the cooking appliances. This system has the advantage of a plentiful supply of water and less 'down-time' after a fire as only the area where the fire occurs is sprayed, whereas with a chemical system, the whole canopy is flooded.

20.7.3 The water spray performs a dual function when fighting a fire. The sprayed mist first absorbs the heat generated and becomes steam. This in turn displaces the air locally and hence starves the fire of the oxygen necessary for combustion.

20.8 System Design

20.8.1 The size and extent of a fire suppression system will depend on the type of kitchen in question, the type of equipment requiring protection and whether extraction is by means of a canopy or ventilated ceiling. In all cases, the relevant manufacturer's recommendations shall be strictly followed as they will advise on nozzle requirements and if single or multiple systems are needed.

20.8.2 The following are typical grease producing appliances requiring protection, but it is good practice to seek the advice of the fire suppression system manufacturer or installer.

- Fat fryer, fat cooker
- Griddle
- Salamander and chargrill
- Oven ranges
- Bratt pans
- Pizza ovens
- Char broiler
- Chinese Wok Ranges
- Mesquite Grill
- Rotisserie
- Open Tandoori

20.9 Installation Considerations

20.9.1 A layout drawing of the proposed system shall be provided for co-ordination purposes and used during the installation works.

20.9.2 An approved fire suppression contractor, who is also capable of preparing the design and obtaining his equipment from a single source shall be appointed. All work shall be carried out in accordance with the technical manuals of the equipment manufacturer/supplier to ensure that warranties are not invalidated.

20.9.3 For successful and correct operation, the internal temperature shall not fall below 0 degC or rise above 54 deg C.

20.9.4 Chemical fire suppressant is an alkaline compound, all due care and attention must be taken when handling such a substance. Contact with eyes and skin must be avoided and COSHH Regulations complied with.

20.10 Testing and Commissioning

20.10.1 Once the system has been completely installed it shall be commissioned and tested in accordance with the manufacturer's recommendations.

20.10.2 There is normally a requirement to test the release assembly mechanism before the gas cartridges are installed. Also individual components like pull stations, mechanically or electrically activated valves, electrical switches, pressure switches and the detection system shall be fault tested in-situ.

20.10.3 Once the system testing and commissioning process is complete, acceptance certificates for the installation shall be completed for approval and signature. The customer or end user is then in a position to arrange financial cover with a recognised insurance company against loss or serious damage to the kitchen or the building as a whole.

20.11 Maintenance

20.11.1 Following handover of the system, it is recommended that a 12 month maintenance contract with the fire suppression installation contractor is entered into. The agreement should normally include 12 month guarantee for provision of spare parts required and labour against any installation or manufacturing fault. Subsequent maintenance should be required at regular six-monthly intervals with major system overhaul every 3 years maximum.

20.11.2 Good housekeeping shall be practised and the following check list is suggested as a general guide:

- Keep the hazard area clean
- Flammable and corrosive cleaners must be avoided.
- The kitchen exhaust ventilation system should always be running when the kitchen is in use.
- Grease Filters should always be in place when the ventilation systems are running to minimise grease build up in the ductwork and restrict the spread of flame into the ductwork.
- System efficiency should always be maintained by regular monitoring.
- System tampering should be avoided
- Regular visual checks on the whole system undertaken by the owner/kitchen head
- For further information refer to the ABI/BSRIA document, "Fire Risk Assessment for Catering Extract".

SECTION 21

Service Distribution Units

21.1 Service distribution units are purpose made self-supporting stainless steel enclosures designed to house the various piped and electrical services between the point at which they enter the kitchen and the cooking appliance. (see Fig 21) They are increasingly specified as part of the 'canopy ventilation' package to ensure that interface problems are kept to a minimum, especially where the vertical columns connect to the underside of the grease tight extract housing. Ventilated ceilings shall be co-ordinated with vertical columns in order to minimise the loss of active extract filters.

21.2 Each element shall be sized to suit the particular services being used in the kitchen, to ensure compatibility and be totally integrated with the installed canopy.

21.3 Each unit normally comprises two columns, one to house the electrical works and one to provide the piped services such as hot and cold water, drinking water, steam, condense, waste, gas and compressed air. The vertical column should have adjustable plinths to accommodate uneven or sloping floor finishes.

21.4 For columns containing gas services a ventilation grille is required at high and low level.

21.5 Controls for the fire suppression system are normally housed within the electrical column and if a water-wash system is fitted, then the control panel should be housed within the pipework riser.

21.6 The horizontal raceway or spine running between the columns is the section of the distribution unit from which the connections to the cooking equipment are made. To prevent damage from mobile catering equipment a 'bumper' rail should be considered, which should be either be fabricated in stainless steel or preferably supplied in rubber.

21.7 The units, which can be either wall-mounted or island type, provide for single point connections for all site services. Space can be allocated to allow for future expansion and access is provided to the interior of the distribution unit by either hinged or removable panels with quick release fixings.

21.8 All pipework connections between the spine and the cooking equipment should be made by using quick-release or proprietary connections. It is essential that integral services are carried out by competent tradesmen and in accordance with the relevant codes of practice.

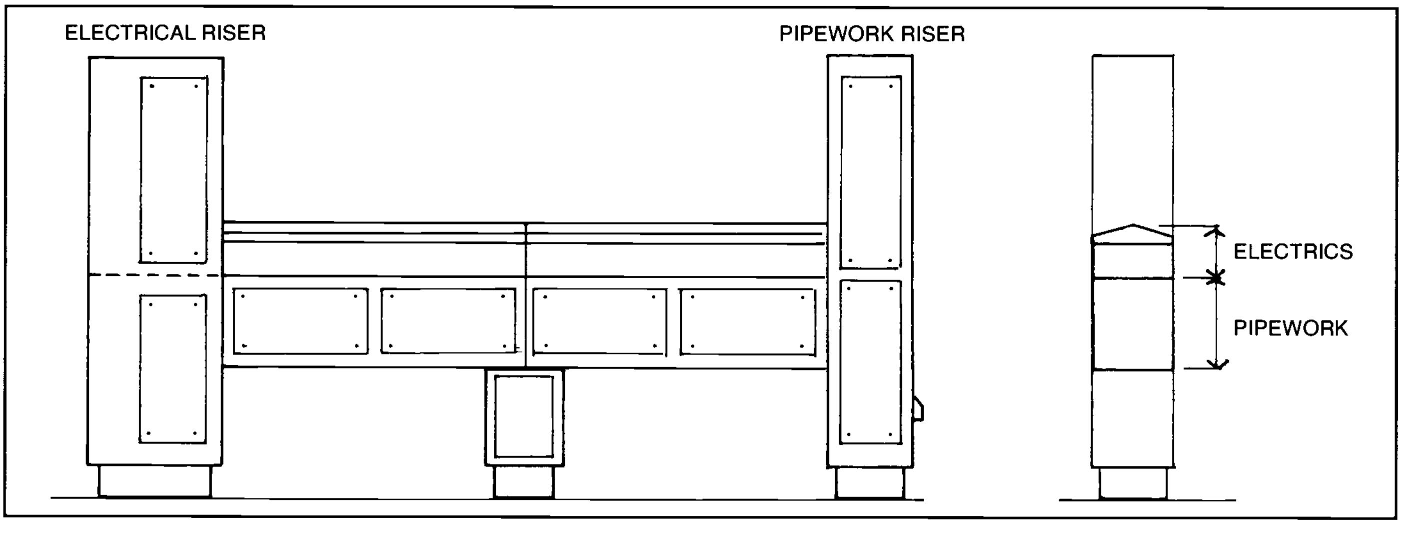


Fig 21 - Typical Services Distribution Unit

21.9 Mains isolators, circuit breakers, sockets, plugs and internal wiring can all be fitted at manufacturer's works to minimise coordination problems at site. Combined gas and electricity 'knock-off' buttons shall be provided on the end of each vertical column.

21.10 When the integral services are factory fitted, then the supplier shall be responsible for testing and certification and for the provision of earth bonding.

21.11 Service distribution units can be supplied as a simple stainless steel housing for the installation of plumbing, electrical, and fire protection services by others or as a fully fitted pre-fabricated system complete with all mechanical and electrical services.

SECTION 22

Odour Control

22.1 Odour pollution problems are particularly difficult to solve, as the level of odour produced can vary dependant upon the cooking process involved, such as the cooking cycle, the position of the discharge and the wind speed and direction. All systems should be offered therefore on the basis of odour reduction rather than elimination.

22.2 Whilst conventional systems should normally discharge at least 1m above roof eaves level, with an effective odour control system installed, it should be possible for the discharge to be made at a low level.

22.3 When low level discharge is considered, the following shall be taken into consideration:

- Whether the discharge is into confined areas such as courtyards.
- Whether it is positioned too close to air intake systems.
- The discharge velocity.
- The height above external ground level.
- Approval has been obtained from the Local Authority to comply with Building Regultaions.

22.4 Molecules of cooking odours are generated by the combustion of animal and vegetable matter which results in a particulate and gaseous mixture. The particulate phase comprises small food deposits and hydrocarbons or smoke, the concentration level of which will vary with the type of cooking. Whilst smoke can be reduced by removing the particulate, it is the gaseous or vapour phase which contains the odour and therefore needs to be treated.

22.5 These molecules are too small to be removed by filtration alone, the solution is found by selecting a combination of equipment from the following options, the extent of which will vary according to the problem.

- A basic filtration unit for use with low odour problems may be supplied containing three stages of progressively more efficient filters. Disposable pleated filters precede a 95% efficient bag filter, followed by a 99% efficient absolute filter. This system will not deal with the gaseous phase but is intended to reduce the visible particulate, i.e.smoke, to a maximum level of 0.3 microns and all components should to be monitored closely and replaced when required. This system should only be used where a high efficiency canopy filtration has been installed such as water wash or mist system.

- An alternative to the 3-stage disposable filtration, as described above, is the Electrostatic Precipitator and, like the disposable filters, is only intended to remove visible smoke particles from the exhaust airstream rather than the gaseous phase that tends to account for most of the cooking odours. Therefore, this should not be considered as a prime source of odour control. Where installed, panel filters should be fitted both upstream and downstream of the electrostatic filter to provide some protection from larger contaminant that may have passed through the grease filters. It should be noted that electrostatic filters become ineffective at temperatures over 60°C and are not suitable for relative humidity levels above 75%.

- Activated carbon provides an effective medium for eliminating odour but can be easily rendered disfunctional through the impregnation of contaminants within its porous granule composition. Grease is the worst such contaminant; it is therefore essential to protect the carbon cells with multi-stage pre-filters upstream of the system. The maximum operating efficiency of carbon filters is very much dependant upon them working within defined conditions - an air temperature not exceeding 40 deg C and a maximum relative humidity of 60%. To maximise best use of carbon cells a strict maintenance regime for changing all filters shall be adopted. Local Authority approval shall be sought before carbon filters are used in any kitchen extract system.

- As an alternative to using activated carbon, odour absorbing granular chemicals such as potassium permanganate or metal iron salts may be used. The chemical oxidises the odorous gases into a solid form and retains them. However, compliance with Local Authority regulations shall be ensured before the use of these systems, as they are prone to the same limitations that exist with activated carbon.

- Providing staged pre-filters are installed, odour neutralising liquid spray systems can be injected upstream of the extract fan. The cooking odours are neutralised by starving the odour molecules of oxygen. This makes a recirculation system possible for electric cooking equipment whereby, after passing through the neutralising section the air is cooled to remove excess heat, 20% is discharged at low level as clean air to atmosphere and the remaining 80% can be reintroduced into the kitchen as make-up air.

- Special ultra violet lights can be installed, either within the filter housing, ventilated ceiling plenum or as a remote unit, which generate trace quantities of ozone. In the presence of ultra violet light, the ozone reacts with the organic compounds in the fat, odour by photolysis and ozonolysis to leave an end product of primarily only carbon dioxide and water.

22.6 Whatever type of pollution control is implemented, the increase in system resistance shall be included when selecting the fan.

SECTION 23

Heat Recovery

23.1 Whilst the initial capital cost may be high, the use of heat recovery for its energy efficiency and conservation value is becoming an increasingly important design feature. If a specific payback period has to be achieved, then calculations should be made to evaluate an economic timescale.

23.2 There are two main methods of recovering heat in a kitchen environment:

Air to Air - The removal of heat from the exhaust air which is transferred to the incoming supply air.

Air to Water - The removal of heat from the exhaust air which is transferred to a domestic water supply.

23.3 The selection of waste heat recovery plant should be from the following types:

- Heat Recuperator - Plate heat exchangers of the 'cross flow' type having adjacent plates forming narrow ducts for alternate supply and exhaust air to pass. Heat is transferred through the plates with no cross-contamination between the air passages (60 - 80% efficient). A face and by-pass damper shall always be included to allow fresh air to by-pass the recuperator when further heating to the room being served is no longer required.

- Run Around Coils - Coils can be fitted across the extract and supply ducts whereby the higher temperature of the extract air transfer heat to a water/ethylene glycol mix in the interconnecting pipework (50 - 60% efficient). A circulating pump and pressurisation provisions are required for the pipework system.

- Rotary Recuperator - (Heat Wheel) - Consists of a revolving cylinder divided into segments packed with coarsely-knitted metal mesh. As the cylinder rotates, the mesh absorbs heat from the exhaust and alternately transfers it to the supply air. (Approx 80% efficient)

- Heat Pipes - These are self contained units operating on a vaporising / condensing cycle. Hot exhaust air causes fluid in the lower part of the pipes to evaporate and transfer heat to the supply air passing over the upper section. The vapour cools and condenses for the cycle to start again (approx 55 to 70% efficient).

It should be noted that, with the exception of the run around coils, these arrangements require the supply and extract ductwork to be run in close proximity.

23.4 It is important that whichever heat recovery option is incorporated, it shall be protected from grease build-up by the installation of air filters upstream of the equipment.

SECTION 24

Testing and Commissioning

24.1 This section covers the requirements for testing the completed installation. The responsibility for this will depend upon the particular contract provisions.

24.2 The following information shall be recorded during the testing and commissioning process. The supply and extract systems shall be operating simultaneously when commissioning is carried out.

- The velocity through the grease filters and grilles.
- The velocity in the ductwork and at the bell mouths.
- The supply and extract flow rates.
- Ambient and air temperatures in the ductwork.
- The total pressure drop for the system.
- Starting and running currents used by the fan(s).
- Illumination levels.
- Sound levels in the kitchen and at the point of discharge.

24.3 The manufacturer's data shall be consulted to establish the technical information on the filters and the three most important items are:

- Flow rate for each filter size used.
- Recommended velocity passing through the filter.
- The pressure drop across the filter.
- Whilst the grease extraction rate may be stated, this is not relevant to testing.

24.4 The air velocity passing through the filter or grille shall be first determined by using an anemometer. This figure is then multiplied by the face area of the filter or grille to arrive at the extract flow rate. The flow rate through each filter is then added to give the total quantity of air being extracted through each canopy. This is then checked to ensure that the design conditions are being achieved.

24.5 Manometers and pitot tubes should be used to determine the air volume flow rates through the ductwork, but care shall be taken to ensure that readings are taken in areas where there is little turbulence such as in straight runs of ductwork so that the results do not become distorted.

24.6 Noise levels shall be checked to ensure that a maximum internal noise level of NR40-50 is not exceeded and the maximum level at the point of discharge of the extract should not increase the overall ambient noise level by more than 2db(A) on completion of the installation. The use of vertical discharge, slow running fans and low duct velocities should help to achieve these levels.

24.7 Each installed canopy or ventilated ceiling shall be fitted with a 'rating plate'. For canopies this shall be on the inside left end of each canopy on which the following information shall be recorded.

- Name, address and telephone number of the canopy supplier.
- Date of installation and canopy serial number.
- Design extract and supply flow rates.
- Design pressure drop across the canopy when measured at the extract spigot.
- Similar information for any supply system fitted to the canopy.

This information will be invaluable at a future date when upgrades to either the cooking equipment, canopy or ventilated ceiling are being considered.

24.8 Further advice on commissioning may be obtained from the CIBSE and BSRIA application manuals (see Appendix F).

SECTION 25

Cleaning and Maintenance

25.1 For the efficient operation of a kitchen ventilation system the following maintenance procedures shall be implemented. For detailed requirements refer to the HVCA publication TR/19 Guide to Good Practice - Cleanliness of Ventilation Systems.

25.2 The interval between visual inspections of elements of the system incorporated in the kitchen should be determined by the particular cooking process, but shall never be more than once a week. All metal surfaces shall be checked to ensure that there is no accumulation of grease or dirt and that there is no surface damage.

25.3 Checks shall be made to ensure that the stiffening channel is free from debris and that installed lights are working. Filters shall be easily removable and the inside of all housings and grease collection drawers, where fitted, should be cleaned regularly.

25.4 Typically the minimum cleaning period for baffle type self draining filters and collection drawers is once each week, for secondary mesh filters at least twice each week. By the nature of their construction, secondary mesh type filters have a limited life and shall be replaced when necessary. However, specific manufacturers' information should be complied with.

25.5 It should be considered that the area immediately above any cooking appliances, including extract plenums, pose the greatest risk of the ignition of any accumulated grease. Extract plenums for both canopies and ventilated ceilings are considered as a specific section of the grease extract system; in the course of a scheduled specialist duct clean, extract plenums should be included by them as part of the clean. Frequency of cleaning is defined in TR/19 Guide to Good Practice – Cleanliness of Ventilation Systems.

25.6 All metal surfaces shall be cleaned with a suitable metal cleaner. Caustic or abrasive materials shall not be used as they will scratch the surface which will encourage the growth of harmful bacteria. Compliance with the appropriate COSHH Regulations must be ensured with all cleaning materials.

25.7 Where the canopy/ventilated ceiling contains removable filters or cartridges the filter manufacturers cleaning instructions shall be followed. They shall only be removed for cleaning after the system has been shut-down to avoid grease contaminated air depositing on the internal surfaces of the ductwork and therefore causing a future potential fire hazard. Extreme caution shall be exercised if removing filters from above hot appliances. In general most filters are designed to fit inside, and be put through the cleaning cycle of most commercial dishwashers. In heavy duty applications decarbonising and/or soak tanks may prove to be a more effective cleaning method, whilst in lighter applications hand washing in hot water using a standard dilution of a proprietary de-greasing agent or washing-up liquid may be adequate.

25.8 When excessive residue remains following routine cleaning, then a heavy duty detergent or proprietary stainless steel cleaner may be required.

25.9 Where a cartridge system has been installed, then the plenum forms an integral part of the design, it shall be cleaned at the same time as the cartridge. The efficiency of these systems will depend upon the extracted grease that is collected in the plenum being removed by regular cleaning at least twice a week.

25.10 Where canopies/ventilated ceilings are provided with an integral make-up air system, the airways and supply filters should be kept clean to maintain airflow. Dirt accumulation and blockages will increase resistance and affect the system performance.

25.11 In addition to daily cleaning and a weekly maintenance programme, periodic ‘deep hygiene cleaning’ shall be undertaken by a specialist contractor to ensure that the food environment maintains a safe and clean standard. Due to the fact that standard techniques and chemicals used for daily cleaning do not remove the accumulations of carbon fat grease deposits and limescale in many normally inaccessible areas, all accessible main ductwork runs and branches, including fitted equipment shall be inspected and cleaned. To assist in the inspection of ductwork, cleaning doors shall be installed at regular intervals (see section 15.13).

25.12 Manufacturers shall be consulted for maintenance procedures for proprietary plant and fire suppression systems where fitted.

25.13 Where grilles are fitted, they shall have easily removable cores to facilitate cleaning.

25.14 Failure to implement these maintenance procedures, will cause an accumulation of grease and dirt in the ventilation system which will promote the growth of harmful bacteria, increase the risk of fire, reduce airflow through the kitchen and impair the overall system performance and efficiency (see section 15.12).

Appendix A

Filter Classifications

A1 Table 18 is included to show the filter classifications based on the European Normalisation standard (EN 779) and their relation to the old EU rating (Eurovent 4/5).

A2 The EN standard is more stringent than the old Eurovent classification, and was adopted throughout Europe from January 1994. The new British Standard reference becomes BS EN 779 and the main changes are:

- Filters with an initial dust spot efficiency below 20% are classified as 'arrestance filters' (formerly 'coarse G filters') and have a 'G' rating of from G1 - G4 with a test pressure of 250 pascals.

- Filters with an initial dust spot efficiency above 20% and an average dust spot efficiency above 40%, are classified as 'efficiency filters' (formerly 'fine F filters') and have an 'F' rating of F5 - F9.

Table 18 - Filter Types and Classifications

Type	EN 779	New Class	Efficiency	Test Standard
Coarse	**EN 1 (EU)**	**G1**	**65%**	**Gravametric**
Dust	**EN 2 (EU)**	**G2**	**65% - 80%**	**Arrestance**
Filter	**EN 3 (EU)**	**G3**	**80% - 90%**	
	EN 4 (EU)	**G4**	**90%**	
Fine	**EN5 (EU)**	**F5**	**40% - 60%**	**Dust Spot**
Dust	**EN6 (EU)**	**F6**	**60% - 80%**	**Efficiency**
Filter	**EN7 (EU)**	**F7**	**80% - 90%**	
	EN8 (EU)	**F8**	**90% - 95%**	
	EN9 (EU)	**F9**	**95%**	
High	**EN10 (EU)**	**H10**	**85%**	**D.O.P.**
Efficiency	**EN11 (EU)**	**H11**	**95%**	**Efficiency**
Particulate	**EN12 (EU)**	**H12**	**99.5%**	
Air Filter	**EN13 (EU)**	**H13**	**99.95%**	

APPENDIX B

Conversion Factors

LENGTH

FROM	*TO*	*MULTIPLY BY*
Feet	Metres	0.3048
Metres	Feet	3.281
Inches	Millimetres	25.4
Millimetres	Inches	0.0394

FLOW RATE

FROM	*TO*	*MULTIPLY BY*
cfm	m^3/s	0.0004719
m^3/s	cfm	2119
cfm	litres/sec	0.4719
litres/sec	cfm	2.119
cfm/ft	m^3/s per m	0.001548
m^3/s per m	cfm / ft	646
fpm	m/s	0.00508
m/s	fpm	196.85

PRESSURE

FROM	*TO*	*MULTIPLY BY*
Inches wg	Pascals	249
Pascals	Inches wg	0.00402

WEIGHT

FROM	*TO*	*MULTIPLY BY*
Pounds	Kilograms	0.4536
Kilograms	Pounds	2.2046

POWER

FROM	*TO*	*MULTIPLY BY*
Horsepower	Kilowatts	0.746
Kilowatts	Horsepower	1.34

CAPACITY

FROM	*TO*	*MULTIPLY BY*
Gallons	Litres	4.546
Litres	Gallons	0.22
US Gallons	Litres	3.785
Litres	US Gallons	0.264

HEAT

FROM	*TO*	*MULTIPLY BY*
Btu / Hr	Watts	0.2931
Watts	Btu / Hr	3.412

TEMPERATURE

To Convert Deg C to Deg F: x 1.8 + 32

To Convert Deg F to Deg C: -32 x 0.556

Appendix C

Indices of Protection

An index of protection known as an IPrating, is an indication of the degree of protection that is provided by the enclosure to a piece of electrical equipment. There are two numbers in an IP rating, the first of which indicates the protection against the ingress of solids and the second its protection against the ingress of liquids.

First Figure		**Second Figure**	
IP No	Protection	IP No	Protection
0	No protection	0	No protection
1	Protection against solid bodies larger than 50mm	1	Protection against vertically falling drops of water
2	Protection against solid bodies larger than 12mm.	2	Protection against drops of rain water at 15deg from the vertical.
3	Protection against solid bodies larger than 2.5mm.	3	Protection against drops of rain water at 60deg from the vertical.
4	Protection against solid bodies larger than 1mm.	4	Protection against projections of water from all directions.
5	Protection against dust (no harmful deposits).	5	Protection against jets of water from all directions.
6	Complete protection against dust.	6	Protection against jets of water similar to heavy seas.
		7	Protection against the effects of immersion.
		8	Protection against prolonged effects of immersion under pressure.

These indices are provided in accordance with IEC529, BS5490 and DIN400 50.

Appendix D

Fire Rated and Smoke Extract Ductwork

D1 When new kitchens are planned, it is important that the Local Authority Building Control Officer is consulted to ensure compliance with the Building Regulations and the Fire Precautions Act. The interpretation of these statutes may vary according to the Local Authority and early consultation will clarify any special requirements with regard to fire rated and smoke extract ductwork. A written record of all advice given should be recorded and retained.

D2 The main fire hazard arises from the overheating of oils and fats in frying equipment and the failure of temperature monitoring devices. Safe cooking in fats and oils generally takes place below 200 degC. Flammable vapours are given off at 200 - 230 degC and spontaneous ignition occurs at 310 - 360 degC. The timescale in moving from a safe to dangerous condition is quite short and the flash point of oil is reduced by repeated oxidation caused through repeated use. Further advice is available from the Fire Protection Association's guides to safe practice.

D3 Careless procedures while cooking, poor planning of the kitchen layout, failure to maintain equipment and poor waste disposal procedures all lead to an increased risk of fire.

D4 The mechanical ventilation to a kitchen, although essential, can exacerbate the consequences of a fire and it must be purpose designed to contain damage or injury that may occur from smoke and toxicity. The system must be separate from and independent of all other systems in the building.

D5 Fire involving a deep fat fryer and its extraction system will develop rapidly, produce considerable quantities of heat and smoke, it may reach a stage of such violence that it cannot be contained within the kitchen area. Due to the fact that equipment damage may be significant and disruption to normal service may last for days, automatically operated fire suppression systems are recommended for cooking equipment involving the use of oils and fats where the capacity exceeds 10 litres, whether as a single appliance or a combination of adjacent appliances.

D6 The extract from equipment using oils or fats should be as short as possible and discharge to atmosphere directly above the equipment it serves. Where this is not possible, the design shall comply with the requirements of BS 5588 where compartmentation is breached. This currently requires that in all non-domestic kitchens:

- Ductwork carrying polluted air must have separate and independent extraction with no recirculation.
- No fire dampers are to be installed in the extract ductwork.
- If immediate discharge to atmosphere is not possible and the ductwork needs to pass through an adjacent fire compartment, then the ductwork system must be satisfactorily constructed and supported in order to maintain the required level of fire separation between compartments.
- It is essential that the installed system complies with BS 476. Fire inside (Type B) is rated for stability, integrity and insulation for the same period of time as the compartment through which the duct passes. In addition the duct shall also be tested for fire outside (Type A) with the additional requirement that the internal surface of the ductwork within the compartment shall also meet the insulation criteria.
- Where canopies are installed on separate floors, then they shall be served by separate extraction systems

D7 There are three ways of protecting ductwork recommended in BS 5588 where compartmentation is breached. These are defined in DW/144 Appendix D and summarised as follows:

Method 1 covers the provision of fire dampers located where the duct penetrates fire resisting compartments such as walls or floors. The ductwork itself is not fire resistant but the fire is not transferred through the system. Due to the fact that fire dampers are not permitted in kitchen extract systems, this method shall not be used.

Method 2 is where the duct runs within a fire rated service duct from the kitchen directly to the outside of the building. The service duct forms a compartment known as a protected shaft which must not contain any other services or have fire dampers fitted. This method may be used.

Method 3 is where the duct is in itself fire resistant and this is achieved by either the ductwork being constructed from fire rated materials, or where a protective material is applied to suitably constructed and supported conventional ductwork. Care shall be taken when providing extract ductwork which is fabricated from fire rated boards, as the boarding itself may absorb grease and be incapable of being cleaned.

D8 In all cases where fire rated ductwork is supplied, particular care shall be taken with the design of both fixings and supports to ensure that they are suitable for the specified duration of fire protection . If a fire originates in or is transferred to the ductwork system, then it may spread beyond its original location due to heat radiation or direct contact between the ductwork material and an adjacent combustible material. The ductwork route shall therefore take account of this risk, have a minimum separation of 500mm between uninsulated ductwork and any combustible material.

D9 For both fire rated and smoke extract ductwork, the periods of stability, integrity and insulation to which the ductwork is constructed, must be the same as the rating of the compartment that is being breached. The construction of fire rated ductwork, which shall comply with BS 476, can either be provided by specialist companies producing proprietary systems, or by the addition of fire insulating materials to suitably constructed and supported ductwork. General purpose ductwork cannot be converted into a fire rated system unless the materials and construction of the whole system is in accordance with the requirements of BS 3476.

D10 The fire rating of kitchen extract ductwork shall also include insulation, to ensure that a fire outside the duct does not cause any grease that has built up on the inside of the duct to ignite. The insulation shall ensure that temperatures on the outside of the duct shall not exceed 140 degC average above ambient at any one point.

D11 The requirements for smoke extract ductwork will vary from Authority to Authority and will generally depend upon the size of the building, the area of openable windows, the number of occupants and whether the area to be ventilated is located in the basement. With the use of motorised volume control dampers, it may be possible to use either the supply or extract ductwork as smoke extract ductwork provided that it is constructed to the same standards as fire rated ductwork with additional care taken over the selection of the plant. Where the supply ductwork is used as smoke extract, then any filters installed will need to be by-passed. Smoke extract ductwork must also be constructed so that in the event of a fire, it will retain at least 75% of its design cross sectional area.

D12 A natural make-up air system shall be installed to provide the equivalent amount of air as the design volume for the smoke extract system and the discharge shall be located to avoid any risk of recirculation of smoke back into the building.

D13 Smoke extract fans need to be located within 1 hour fire rated compartments and motors must be rated to a minimum of 300degC for 1 hour (varies with Local Authority). Wiring shall be installed within protected circuits with power supplied by a back-up generator in the event of failure of the main source of power.

D14 Further information on fire rated and smoke extract ductwork can be found in the Association of Specialist Fire Protection's publication "Fire Rated and Smoke Outlet Ductwork - An Industry Guide to Design and Installation" (aka the Blue Book).

Appendix E

Air Conditioned Kitchens

E1 Section 5 showed that the two main sources of heat into a kitchen space comprised:

	Radiant - 35%	(Qrad)
and	Convective - 65%	(Qconv)

E2 For estimating the air conditioning load however, it is also necessary to consider other heat gains such as those caused by lighting, solar, and people - (Qgen).

E3 The amount of Qrad and Qconv will vary with the type of cooking equipment and the extract flow rate through the hood shall be equal to or higher than the convection flow from the appliances to ensure that the Qconv and the associated impurities are captured by the canopy (see fig 22).

E4 Depending on the efficiency of the extraction system, there may also be an amount of convective heat that is not captured by the canopy (Qesc), together with the radiant heat (Qrad) and general gains (Qgen), can be treated by means of an air conditioning system (see fig 23).

E5 An inefficient canopy with a low capture efficiency (Heff) will therefore have a significant effect on the air conditioning load, and the relationship between canopy efficiency and the amount of convective heat not being captured can therefore be expressed as:

Qesc = (1-Heff) x Qconv.

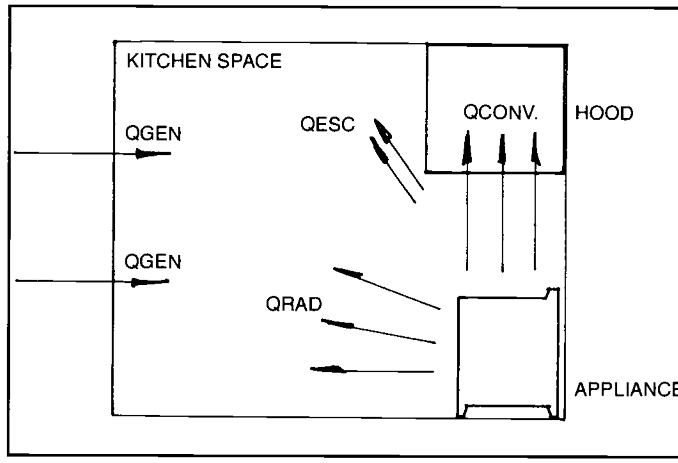


Fig 23 - Pattern of Heat Gain in Kitchen

E6 Once these variables are established, the total heat load (Qtot) can be calculated by using the following energy balance equation:

Qtot = Sensible Heat (Qsens)+Latent Heat (Qlat)

It should be noted that the latent heat element is normally insignificant in relation to the total heat gain in a kitchen environment and if air conditioning is provided, then it is usually in the form of comfort cooling as opposed to total control of both temperature and humidity, as the capacity and cost of the plant required may not be in proportion to the benefit derived.

E7 However, when the total load is required for air conditioning assessment, then each element can be calculated using the energy balance equation shown in Fig. 24.

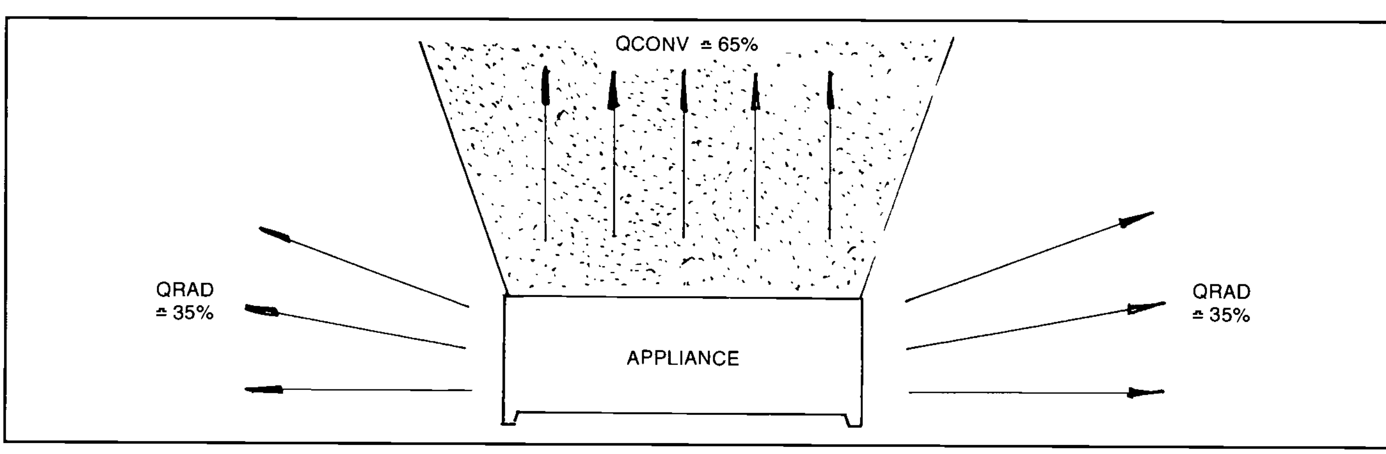


Fig 22 - Proportion of Appliance Heat Emission

E8 Where the amount of supply air required exceeds that which may be supplied through the canopy, then additional grilles and diffusers should be provided as part of the main HVAC system and positioned to provide optimum comfort cooling for the staff.

E9 To summarise, both the extract flow rate and the supply air volume shall be calculated to ensure that both the convective and radiant heat generated is removed to maintain an acceptable level of comfort for the occupants of the kitchen.
(NB - air conditioning of the kitchen will not remove the direct discomfort caused by radiant heat emanating from the cooking equipment)

Sensible Heat Qsens=P x cpm x At x qs (kW)
Latent Heat Qlat = P x Hfg x Ag x qs (kW)
(specific latent heat of evaporating heating from tables for properties of water and steam)

where:
Qsens = Qrad + Qesc + Qgen. (kW)
(where Qesc = (1-Heff) x Qconv)

Qlat = latent heat given off by occupants etc. (kW)
P = density of air. (kg/m3)
Cp = specific heat capacity of air. (kj/kg degC)
A = temperature difference between supply air
Ts) and room condition (Tr) (deg C)
(normally 8 - 10 degC)
(Printers note A = Delta)
Ag = moisture content difference between supply
air (Gs) and room condition (Gr) (kg/kg)
(Printers note - A = Delta)
qs = supply air flow rate (m3/s)
Hfg = latent heat energy of moisture at room conditions (kj/kg)
(latent heat of vaporisation from steam tables)

Fig 24 - Heat gain calculation

Appendix F

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NOTE: *The European/British Standards and other documents listed above are those available at the date of publication. Users should ensure that they consult the latest version.*

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