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Building Engineering Services Association
Specification for:



KITCHEN VENTILATION SYSTEMS

DW/172



Second Edition 2018

www.theBESA.com



ISBN 0-903783-29-0
First edition 1999
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BESA Publications
Old Mansion House
Eamont Bridge
Penrith CA10 2BX 01768 860405 publications.info@theBESA.com.

Acknowledgements

The BESA 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 expert panel who contributed their time, experience and knowledge.

DW/172 EXPERTS PANEL

Peter Rogers (chairman)

Phil Gibson

Ian Levin

Scott Donoghue

Foreword

Peter Rogers

Chairman of Ventilation Group Technical Committee BESA

In 1999, the BESA (HVCA) Standard for Kitchen Ventilation Systems (DW/171) was introduced to the industry. In 2005 it was revised and rebadged as DW/172 Specification for Kitchen Ventilation Systems. Since then it has sold over 6000 copies. More importantly, it has become widely acknowledged as the authoritative specification for kitchen ventilation design throughout the UK and many parts of the world.

Like any specification, however, it needs to be revised in the light of new thinking, technical advancements and innovation. This review process has now been completed by the BESA Ventilation Group and the 2018 version of DW/172 has been updated to reflect current legislations and the latest cooking techniques and design of catering equipment, by all sections of the catering industry.

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

- The appliance Coefficient Schedule has been significantly expanded and modified
- Modification to Grease Separation
- The lighting section has been modernised
- New section for Solid Fuel Equipment
- New section for Demand Controlled Kitchen Ventilation systems.
- Gas Interlocking
- Modifications to Pollution Control
- New section for Recirculation Systems
- Modifications to Cleaning and Maintenance
- Control Panels

All other sections have been revised and updated in the hope and expectation that BESA's Specification for Kitchen Ventilation Systems DW/172 (2018) will continue to be widely used and respected by all sectors in the catering industry.

Contents

Acknowledgements		3
Foreword		4
Contents		5
Definitions		6
Symbols		7
Objective		8
Quality Assurance		9
SECTION 1	Introduction	10
SECTION 2	Considerations Prior to Design	12
SECTION 3	Design Criteria	14
SECTION 4	Extract Flow Rates	17
SECTION 5	Types of Canopy	23
SECTION 6	Canopy Dimensions	25
SECTION 7	Ventilated Ceilings	28
SECTION 8	Materials	33
SECTION 9	Construction & Polishing	35
SECTION 10	Make-Up-Air	37
SECTION 11	Grease Separation	40
SECTION 12	Spigot Connections	43
SECTION 13	Lighting	44
SECTION 14	Solid Fuel Appliances	47
SECTION 15	Fans	52
SECTION 16	Control Panels	59
SECTION 17	Sound Attenuation	62
SECTION 18	Ductwork	63
SECTION 19	Dampers	66
SECTION 20	Gas Interlocking	67
SECTION 21	Fire Suppression	68
SECTION 22	Demand Controlled Kitchen Ventilation Systems	73
SECTION 23	Services Distribution Units	75
SECTION 24	Pollution Control	77
SECTION 25	Recirculation Systems	80
SECTION 26	Heat Recovery	82
SECTION 27	Installation	83
SECTION 28	Testing & Commissioning	84
SECTION 29	Cleaning & Maintenance	86
APPENDIX A		88
APPENDIX B		89
APPENDIX C		91
APPENDIX D		92
APPENDIX E		95
APPENDIX F		97
APPENDIX G		98
APPENDIX H		99
APPENDIX J		100

Definitions

For the purpose of this document, the following definitions apply.

Aerosol: A special class of particulate consisting of colloidal suspension of liquid or solid particles in air larger than the molecular size, but are not large enough to settle under gravity.

Air change rate: The ratio of the volumetric air supply or extract to a space related to the volume of that space. It is usually measured in air changes per hour (ach) and normally relates to the fresh air change rate.

Air flow rate: The volume or mass flow that takes place in a duct or space.

Air flow: Movement of air usually within boundaries (such as ducts)

Air supply plenum: Either an integral chamber or a chamber connected to the canopy to feed air into the kitchen corresponding with supply air outlets

Canopy: (Receiving hood) a capture hood one or two sided that receives a rising gas from a process. They are located above a process designed to provide a suitable capture velocity to ensure the safe removal of the contaminant.

Ceiling panel: Fixed or removable elements of a ceiling installed horizontally, vertically or at any angle on a sub-construction

Collection area: Free volume within a hood bounded by internal surfaces and lowest hood edge.

Collection channel: Channel worked into the hood to collect the aerosol and cleaning fluid

Compartment: Enclosed area behind the face of the separator which is connected to the outgoing air duct.

Ductwork: Pipe or closed conduit, round, oval square rectangular, constructed from sheet metal, or other suitable material used for conveying air.

Exhaust air flow rate: Volume of air leaving an exhaust air terminal device in unit time.

Extract air: Treated or untreated air that is removed from a space and discharged to outdoors.

Fresh air: Air taken from external atmosphere that is superior to that within the space to which it is being supplied.

Induced air: Secondary air induced by the primary air.

Infiltration: Uncontrolled passage of air into a space through leakage paths in a shell of that space.

Kitchen ventilation ceiling: Ventilation system that incorporates the air inlets, air outlets, separators, light fittings and additional hoods which can be integrated.

Kitchen ventilation canopy: Air terminal device which provides the facility to capture, contain and remove process pollutant and which can also provide a point of supply air back into the room space.

Kitchen: Part of a building where cooking processes are carried out.

Laminar flow: Fluid flow in which the fluid particles move in straight lines parallel to the axis of the pipe or duct.

Make-up air: Air introduced into a space to replace air that is being extracted. Replacement of air lost due to exhaust air requirements.

Negative Pressure: A pressure less than the ambient pressure, it may be due to stack

effect or by mechanical means. This condition exists when less air is supplied to a space than is exhausted from the space. Hence the space air pressure is less than that in surrounding areas. Under this condition, if an opening exists, air will flow from surrounding areas into the negatively pressurised space.

Plenum: Air compartment connected to a duct or ducts. The portions of the air distribution system that makes use of the building structure, and the sheet metal that connects distribution ductwork to an air handling unit. Many buildings use the space above a dropped ceiling as a plenum.

Plume: Effluent discharged from a chimney or exhaust duct, composed of gases alone or gases and particulate. The plume shape depends on temperature difference and turbulence. The flow of visible hot gases or vapour from an outlet.

Separator: Device for the efficient separation of airborne solid or liquid particles, based on the effect of mechanical forces that deflect the particles out of the airflow.

Symbols

The symbols used in this specification are in line with National and European standards covering Ventilation for Buildings by CEN/TC15

NEW	OLD
$\text{m}^3.\text{s}^{-1}$	m^3/s
$\text{m}.\text{s}^{-1}$	m/s
$\text{m}^3.\text{s}^{-1}.\text{m}^{-2}$	$\text{m}^3/\text{s}/\text{m}^2$
$\text{l}.\text{s}^{-1}$	l/s
$\text{kg}.\text{m}^{-2}$	kg/m^2

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 system 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.
- Provide information to assist with compliance of legislative and building insurance conditions.

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 BESA 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, non domestic institutions and facilities where the public is at risk.

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/145 Guide to installation of Fire and Smoke Dampers

DW/154 Specification for Plastics Ductwork

DW/191 Guide to Good Practice - Glass Fibre Ductwork

TR/19 Guide to Good Practice - Cleanliness of Ventilation Systems

TR40 Guide to Good Practice Local Exhaust

DW/146 Fire Resisting Ductwork in Buildings

SECTION 1

Introduction

A cooker canopy is currently defined by the CEN European Standards Committee as being a device which provides the facility to capture and remove process pollutant and which can also provide a point of supply air back into the space.

- 1.1 A working kitchen is a potentially dangerous place at the best of times. It is essential that all staff are provided with an environment which allows them to carry out their tasks in the most efficient and safe way possible. Comfort is a key factor in achieving this and the greatest discomfort in a kitchen is the heat and humidity build up created by the cooking process itself. Radiant heat is particularly difficult to deal with and it cannot be removed; only its effect on the operatives can be relieved.
- 1.2 Long term exposure (LTE) to fumes given off by both the cooking process and from the burning of fuel within the appliance itself can be a major risk to occupational health.
- 1.3 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.
- 1.4 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 separators within the canopy, allowing the cleaner air to be discharged.
- 1.5 Food safety and health and safety regulatory requirements 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.
- 1.6 The HSE 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'.
- 1.7 Every kitchen must have a properly designed and manufactured ventilation system, it follows that every building containing a kitchen must be designed with sufficient space to accommodate such a system.
- 1.8 Consultants, designers, suppliers and owners have a duty of care to ensure that the kitchen ventilation system is fit for purpose. Owners particularly must ensure that the system is cleaned and maintained. See BESA Guide to Good Practice, Internal Cleanliness of Ventilation Systems TR/19 and Fire Protection Association RC44
- 1.9 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.
 - Supply air is required to ensure complete combustion of the fuel and provide safe operation of the gas and solid fuel equipment. Details of these requirements are contained in the Building Regulations, BS 6173 and the CIBSE Guide B2.
- 1.10 The main emissions that require removal are:
- 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.
 - Particulate smoke.
 - Exhaust fumes from combustion appliances such as gas, wood or charcoal.
- 1.11 The capture and removal of cooking vapours from the kitchen space 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.
- 1.12 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. BESA TR40 Guide to Good Practice Local Exhaust provides details on LEV systems.
- 1.13 Burning wood and other solid fuels for commercial cooking is becoming increasingly popular. Ventilation in these situations must go above and beyond standard grease duct ventilation requirements. Inadequate ventilation can put lives at risk. For this reason we have dedicated Section 14 to Solid Fuel Appliances. Ventilation systems serving Solid Fuel Appliances may be considered as LEV (local exhaust ventilation) in so far as statutory thorough examination is required every 14 months. Design of the ventilation shall comply with DW/172.
- 1.14 The symbols used in this specification are In line with National and European standards covering Ventilation for Buildings by CEN/TC15.

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:

- What planning restrictions need to be considered if designing the complete system.
- Ensure compliance with legislative and building insurance conditions.
- Is the ventilation design for the whole kitchen and surrounding areas or just for the cooking equipment.
- The type, size and power source of the appliances being ventilated. If gas, consider the requirements of BS 6173.
- 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 an Open Ceiling Plenum, Closed Ceiling Plenum or Plenum Ceiling 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 separation is to be provided by means of separator, 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 resisting smoke exhaust specification, see Appendix D and whether the fans need to be fire resisting.
- 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.
- 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.
- Whether a level of pollution control will be required at the point of discharge.
- Ensure that the termination point will not present any risk to employees or residents.
- Location of access panels for cleaning and maintenance with building fabric, other services and architectural features considered to ensure full cleaning and maintenance.
- Location of neighbouring buildings and ensure that noise or pollution 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 separators and spigots required.
- Whether approvals from the Local Authority have been obtained.
- Clause 32.5.4 of BS 9999:2017 states that “for non-domestic kitchens,

extract ductwork should be entirely independent of each other and of any ventilation ductwork serving other parts of the building”.

This is interpreted to mean that;

- a. Kitchen canopies or ventilated ceilings on different floor levels cannot be interconnected with the same “common” extract ductwork.
- b. Kitchen canopies or ventilated ceilings in different fire compartments on the same floor cannot be interconnected with the same “common” extract ductwork.

SECTION 3

3.1 Design criteria

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.

3.2 The '**Thermal Convection Method**' of calculation should be the only method used.

3.3 Air-change rates

- Using air change rates for designing most ventilation systems is generally acceptable. However, in the case of commercial kitchen ventilation, it can be dangerous to use such a method.
- Many specifications, particularly Local Authorities, Schools, Government Buildings, have called for commercial kitchens to be ventilated based on a design of 30 to 40 air-changes per hour. In the past this figure might have been acceptable but, with the advent of high-output cooking appliances, vastly varying menus and more compact kitchen designs this figure is no longer appropriate.
- It is not uncommon for air-change rates to be in excess of 120 per hour
- During the very early stages of a design, an M&E Consultant may be asked to provide details of the extract ductwork exiting a proposed commercial kitchen eg in a high-rise building, in order that the vertical services shafts can be sized correctly. Typically, at this stage the style of cooking is unknown and would be a pure guess as to the type and quantity of cooking appliances that will need to be ventilated.
- Based on empirical information gained over many years, it is recommended that, in the absence of more detailed information, a figure of 60 air-changes per hour is a safer way to proceed

3.4 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 °C due to radiant heat from the cooking equipment being converted to convective, sensible heat.

3.5 Internal noise level should be: Kitchen 50dBA – 55dBA, Restaurant 40dBA – 55dBA. See Section 17 Sound Attenuation.

3.6 Average lighting levels of 500 lux at the work surface.

3.7 Dedicated make up air systems to be 75% - 95% maximum, of the extract flow rate

3.8 Fan units should be positioned as near as possible to the point of discharge to ensure that the ductwork system remains under negative pressure.

3.9 Automatic speed regulation can also enhance energy efficient use of the system and plant when there is partial or low load cooking conditions. See Section 22 Demand Controlled Kitchen Ventilation.

3.10 Diversity factors shall not be applied to reduce the extract flow rate calculated from Table 2 in anticipation of partial or intermittent use of cooking appliances. However, this diversity factor should not be confused with an efficiency factor which may be applied providing the canopy manufacturer can demonstrate by documented independent testing that a certain range of canopies incorporate technologies that increase their capture and containment capability.

3.11 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.

- 3.12 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 minimum 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 °C
Ventilated ceiling supply air	minimum 16 °C
HVAC general make-up air	minimum 16 °C

- 3.13 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 should 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. See 5.15.9.
- 3.14 Fresh air ventilation rates must be sufficient to ensure that the Carbon Monoxide (CO) long term exposure levels (LTCL) and short term exposure limits (STEL) 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) guidelines of 10 ppm as an average over 8 hours. Carbon Dioxide (CO₂) levels in the kitchen must not exceed 2800ppm (IGEM/UP/19). See appendix F and G
- 3.15 Ancillary Areas

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.

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

- On top of the Cold Room and above the ceiling.
- Built into the Cold Room and discharging into the area.
- 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.

- 3.15.2 Dry Stores - A ventilation rate of 10 air changes per hour is recommended and the system should run continuously.
- 3.15.3 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.
- 3.15.4 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.
- 3.15.5 Refuse Store - The Local Authority should be consulted for their particular requirements, but a dedicated extract ventilation system providing a minimum of 15 air changes per hour is recommended which should run continuously.

- 3.15.6 Chemical / COSHH Stores – A dedicated extract ventilation system is required providing a minimum of 10 air changes per hour is recommended which should run continuously.
- 3.15.7 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.
- 3.15.8 Toilet Areas - Whether for food handling personnel or customers, separate and dedicated extract systems with duplicate fans shall be installed for toilet areas. Building regulations Part F ventilation rates are $0.003\text{m}^3.\text{s}^{-1}.\text{m}^{-2}$ floor area or $0.006\text{m}^3.\text{s}^{-1}$ / cubicle or urinal. Negative pressure should be maintained in all toilet areas at all times.
- 3.15.9 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.
- 3.16 Kitchens with all electric equipment with air volumes below both $0.9\text{m}^3.\text{s}^{-1}$ and 40 air changes per hour do not need mechanical fresh air intake, natural unpowered fresh air ventilation via pre engineered grilles or ductwork is sufficient. Where a natural, unpowered fresh-air ventilation option is selected, the kitchen extract fan(s) should be sized so as to overcome the additional resistance to air flow created by such an unpowered system.
- 3.17 For kitchens without access to an external wall seek professional advice. Care must be taken to ensure that the fresh air requirement of $10\text{ l.s}^{-1}/\text{person}$ is complied with.
- 3.18 Make-up air should be fresh air, not taken from 'dirty' areas such as waste storage areas.
- 3.19 Make-up air shall not be drawn from an adjacent eating area.

SECTION 4

Extract flow rates

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 Figure 1. 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.

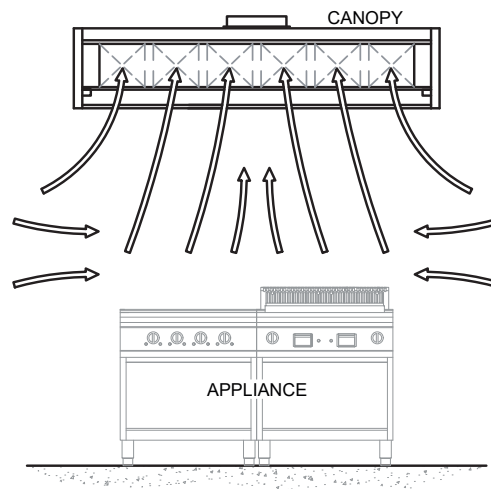


FIG 1 - AIR FLOW PATTERN

- 4.1 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 and the demands of the menu determine the size of the canopy, it is the type of appliance that determines the flow rate of air to be extracted. Those that require ventilation are shown in Table 2.

The 'Thermal Convection Method' of calculation should be the only method used.

- 4.2 A commercial kitchen where no cooking is taking place is classified as a Preparation Area, i.e. 20 air-changes per hour.
- 4.3 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. Details of the equipment to be ventilated shall be allocated a thermal convection coefficient, which is the recommended volume of air to be extracted in $\text{m}^3 \cdot \text{s}^{-1} \cdot \text{m}^{-2}$ 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 coefficient will vary depending on whether the appliance is gas or electric, and these are scheduled in Table 2. Refer to Table 4 for worked example of flow rate calculation.

The theoretical extract flow rate 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 effect upon the amount of air

required. The more enclosed the cooking operation, the less exhaust air is needed to ventilate it, whilst appliances open on all four sides will need a larger flow rate 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 7.

Anticipated figures for usage (diversity factors) cannot be used. For details on Demand Controlled Kitchen Ventilation Systems see Section 22.

Table 2: Appliance, Coefficient and Temperature Schedule			
Appliances	CANOPIES & VENTILATED CEILINGS		Surface Temp.
	GAS	ELECTRIC	
	m³.s⁻¹.m⁻²		°C
MISCELLANEOUS			
Benches, Spreaders & Worktops	0.03		25
Sink	0.15		25
Pass Through Dishwasher	0.40		61
Pan / Utensil Wash Machine	0.40		42
Rack & Flight Dishwasher	see manufacturers literature		58
Coffee Maker	—	0.03	25
Light Duty Microwave Oven / Toaster	—	0.03	25
Bains Marie / Hot Cupboard	0.20	0.15	57
Chip Scuttle	—	0.15	35
Servery Counter - Hot Food	0.24	0.24	73
Water Boiler / Still / Beverage Unit	0.25	0.20	78
Refrigeration Unit	see manufacturers literature		—
BOILING / ROASTING / STEAMING			
Induction Hob / Ceramic Stove	—	0.20	30
Combination Microwave Ovens	—	0.15	35
Open-Top Range & Oven	0.40	0.30	190
★see Important Note at the end of this Table & Table 2a.			
Solid Top Oven Range	0.60	0.51	420
Boiling Table / Hob Top / Stock Pot Stove	0.35	0.25	190
★see Important Note at the end of this Table & Table 2a.			
Boiling Pan / Steam Kettle	0.35	0.25	146
Bratt Pan	0.60	0.50	240
Heavy Duty Multi/Bulk Cooking Pan	—	0.90	240
Pasta Cooker	0.30	0.20	120
Roasting Oven (with worktop)	0.25	0.20	98
Tandoori Oven (not solid fuel)	0.50	0.33	90
Combination Ovens (Combis): (if stacked, use larger value)			
Stand-Mounted 6 grid.	0.35	0.30	92
Stand-Mounted 10 grid.	0.45	0.32	92
Floor-Mounted 12 grid.	0.50	0.35	92
Floor-Mounted 20 grid.	0.60	0.40	92
Floor-Mounted 40 grid.	0.75	0.55	92
Atmospheric Steamer	0.35	0.20	125
Pressure Steamer	0.30	0.20	120
Dim Sum Steamer	0.30	0.20	123
Fan-Assisted Convection Oven	0.40	0.30	86
Holding Oven	—	0.10	57
FRYING			
Deep Fat Fryer	0.50	0.45	190
★see Important Note at the end of this Table & Table 2a.			
Pressure Fryer	0.50	0.45	170

Table 2: Appliance, Coefficient and Temperature Schedule (Cont'd)			
Appliances	CANOPIES & VENTILATED CEILINGS		Surface Temp.
	GAS	ELECTRIC	
↓	m³.s⁻¹.m⁻²		°C
GRILLING & BROILING			
Mild Steel Griddle	0.30	0.25	190
Chrome Griddle / Plancha	0.45	0.40	290
Induction Griddle	—	0.27	62
Clam Shell / Contact Grill	0.45	0.34	105
Upright or Chain Broiler	0.75	0.55	410
Salamander Grill	0.75	0.55	260
Rotisserie (not solid fuel)	0.75	0.55	195
Shawarma Kebab Machine	0.75	0.55	195
Chargrill / Charbroiler	0.95	0.52	350
Vapourising Grill (less than 16kW/m2)	0.75	—	170
Chinese Wok Range (Induction)	—	0.40	88
Chinese Wok Range	0.90	—	280
Chinese Wok Range (Turbo)	1.00	—	370
PIZZA COOKING & BAKING (gas or elecric only. No solid fuel)			
Conveyor Pizza Oven			
Single Deck	0.30	0.25	90
Double Deck	0.60	0.50	90
Triple Deck	0.90	0.75	90
Deck Pizza Oven:			
Single Deck	0.20	0.15	90
Double Deck	0.40	0.30	90
Triple Deck	0.60	0.45	90
Pastry / Baking Ovens			
Single Deck	0.15	0.10	90
Double Deck	0.30	0.20	90
Triple Deck	0.45	0.30	90
SOLID FUEL COOKING (including gas ovens that have solid fuel capability)			
Open Grill / BBQ / Charcoal Pit	0.96		420
Enclosed Charcoal Oven	1.24		210
Stone Hearth Oven	0.45		90
Smoker	see manufacturers literature		—
Tandoori Oven	0.55		90
Rotisserie	0.85		95

★ **IMPORTANT NOTE:**

IGEM/UP/19 (in association with the HSE and GAS SAFE) states that Carbon Dioxide (CO₂) levels within a commercial kitchen, that includes one or more gas-fired appliance, must not exceed 2800ppm. Experience has shown that this is not a problem for the vast majority of projects. However, occasionally a design involves the incorporation of multiple gas appliances of a certain type and if the standard coefficients as shown above in Table 2 are used to calculate the extract flow rate, then there exists a clear risk that the 2800ppm threshold could be exceeded. For projects such as Food Technology Training Kitchens, which should be treated as commercial kitchens even if domestic-type equipment is installed as stated in IGEM/UP/11, there might be upwards of, say, 16 x 6-burner gas ranges, then to mitigate the risk of excessive levels of CO₂ in the space, it is suggested that the coefficients in Table 2a below are used. This only applies to the appliances marked with ★.

Table 2a: Appliance, Coefficient and Temperature Schedule for CO2 Reduction where Multiple Appliance Selection is Required.

Appliances		CANOPIES & VENTILATED CEILINGS		Surface Temp.
		GAS	ELECTRIC	
		$\text{m}^3.\text{s}^{-1}.\text{m}^{-2}$		$^{\circ}\text{C}$
Open-Top Range & Oven	(3 No.)	0.50	0.30	190
	(4 No. & above)	0.60	0.30	190
Boiling Table / Hob Top / Stock Pot Stove	(3 No.)	0.45	0.25	190
	(4 No. & above)	0.55	0.25	190
Deep Fat Fryer	(3 No.)	0.60	0.45	190
	(4 No. & above)	0.75	0.45	190

GENERAL NOTES:

1. Other Gas Thermal Coefficients have been analysed and modified to reflect GAS SAFE suggestions for the control of Carbon Dioxide (CO2) in commercial kitchens. Ref. IGEM/UP/19.
2. Application of Canopy / Ventilated Ceiling Factors must be applied.
3. Treat LPG appliances the same as "gas".
4. It is the responsibility of catering equipment manufacturers to test new models and provide ventilation requirements, such as they would for water, gas & electrical services, to a recognised international standard.
5. Designers should always be aware that it is essential to consider the context in which the catering equipment is being used and that exceptional circumstances call for special consideration.
6. The coefficients for Combination Ovens assume that the recommended two-stage door opening procedure is utilised by operatives, so allowing proper capture of the steam plume and that doors on "stacked" Combis would never be opened simultaneously.

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	1.60	1.50	1.40
Island	1.35	1.25	1.15

4.4 Example of flow rate calculation: Method 1

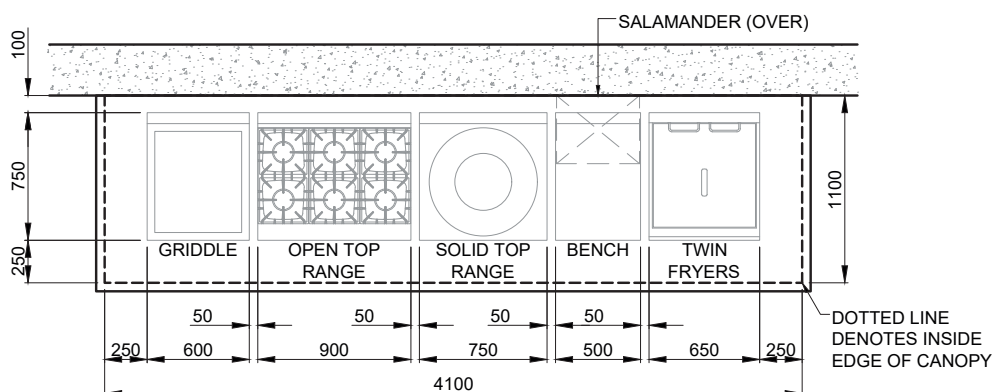


FIG 2a - TYPICAL COOKING EQUIPMENT LINE-UP WITHOUT OVEN

- 4.4.1 Determine the model type, plan size and power source for each item of cooking equipment located under the canopy.
- 4.4.2 Calculate the plan area of the cooking equipment from Figure 2a and from Table 2, allocate a thermal coefficient for each item of equipment.
- 4.4.3 Multiply the area by the coefficient to obtain a theoretical extract flow rate for each item.
- 4.4.4 Add the individual rates to arrive at a total extract flow rate for the canopy.
- 4.4.5 Select the appropriate canopy factor to suit the type and location of canopy.
- 4.4.6 Multiply the total by the canopy factor to arrive at the total extract flow rate.

Table 4 Calculations – Thermal Convection Method					
Item	Plan Size mm	Power kW	Area m2	Coefficient	Flow Rate m ³ .s ⁻¹
Griddle (mild steel)	600 x 750	gas	0.450	0.30	0.135
Open top range	900 x 750	gas	0.675	0.40	0.270
Solid Top Range	750 x 750	gas	0.562	0.60	0.338
Bench	500 x 750	-	0.375	0.03	0.011
Twin Fryers	650 x 750	Elec	0.487	0.45	0.219
Salamander Grill	500 x 400	gas	0.200	0.75	0.150
Theoretical extract flow rate required					1.123
Canopy Factor - overhead wall open both ends					x 1.25
Specific extract flow rate required					1.404

- 4.5 The calculation of extract flow rates for ventilated ceilings should be in accordance with the procedures set out above.
- 4.6 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.
- 4.7 Following the determination of the required extract flow rate, the number and type of separators shall be selected.

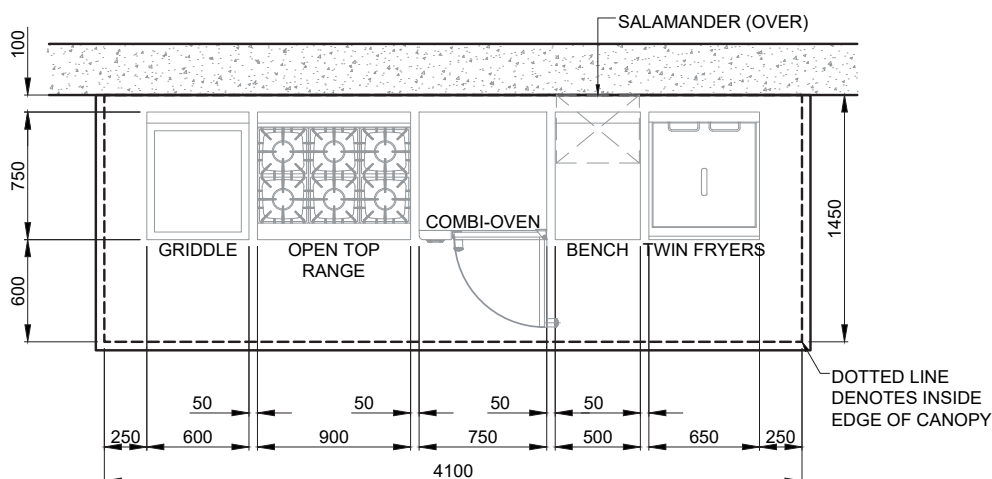


FIG 2b - TYPICAL COOKING EQUIPMENT LINE-UP WITH COMBINATION OVEN

SECTION 5

Types of Canopy

5.1 There are several 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
- Counter type canopy
- Eyebrow canopy
- Condensation canopy

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

- Front face perforated diffuser
- Internal entrainment or capture.
- Grille or louvres for spot cooling

Examples of the various types and combinations available are shown in Section 10 Figs. 7a - 7d.

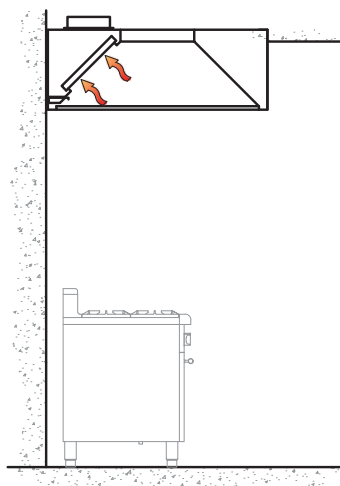


FIG 3a - WALL MOUNTED CANOPY

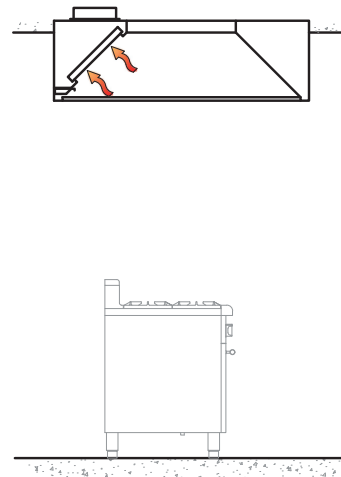


FIG 3b - SINGLE-SIDED ISLAND CANOPY

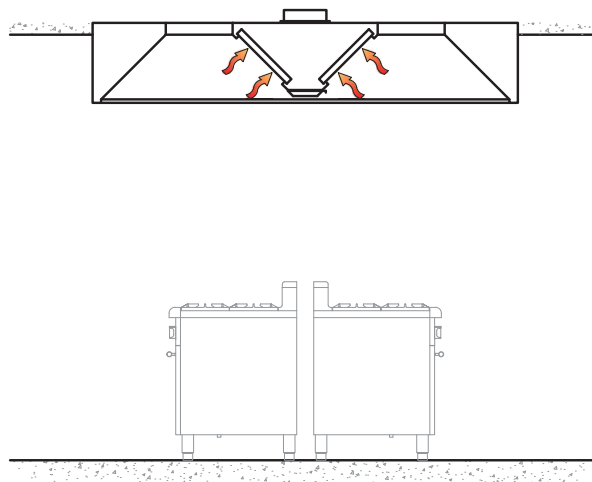


FIG 3c - DOUBLE-SIDED ISLAND CANOPY

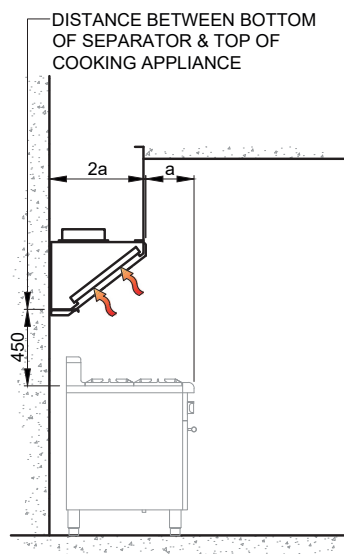


FIG 3d - LOW LEVEL WALL MOUNTED CANOPY

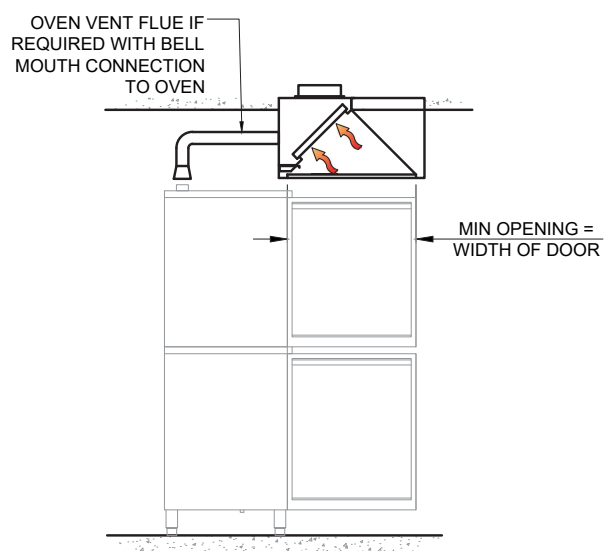


FIG 3e - EYEBROW CANOPY WITH OPEN BELLMOUTH CONNECTION ON OVEN

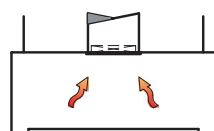


FIG 4a - DISHWASH CANOPY WITH GRILLE

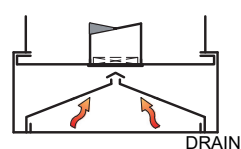


FIG 4b - DISHWASH CANOPY WITH CONDENSE DRAIN

SECTION 6

Canopy dimensions

- 6.1 The dimensions of a canopy are invariably determined by the size of the catering equipment that it is serving.
- 6.2 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. 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.

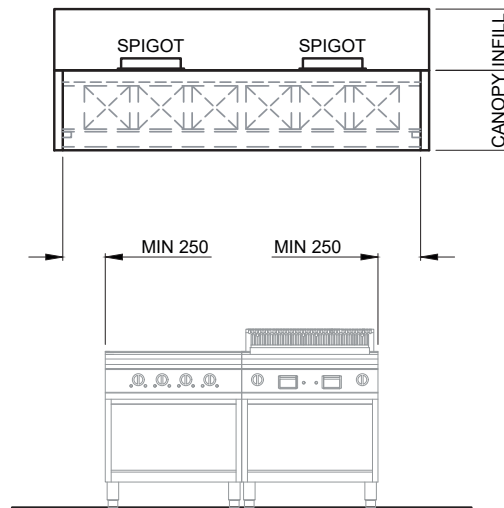


FIG 5a - TYPICAL CANOPY DIMENSIONS
FRONT ELEVATION ON CANOPY

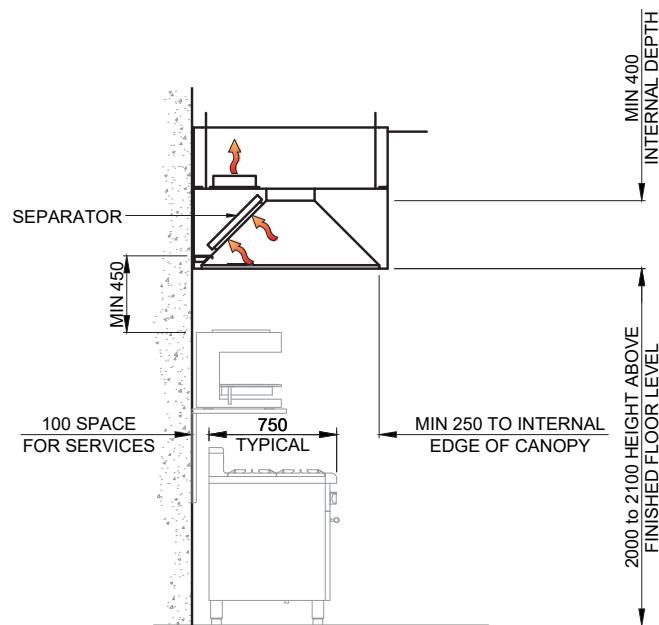
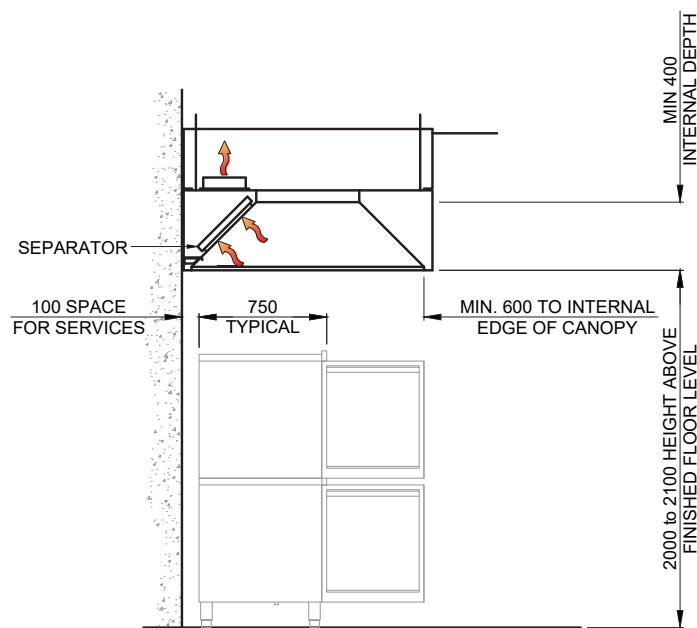


FIG 5b - TYPICAL CANOPY DIMENSIONS OVER SURFACE
COOKING APPLIANCE SECTION THROUGH CANOPY



**FIG 5c - TYPICAL CANOPY DIMENSIONS OVER COMBINATION OVEN
SECTION THROUGH CANOPY**

- 6.3 For combination 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. Solid fuel appliances must have an overhang of 300mm from the door open position. (See Figure 5c above)
- 6.4 Where a Low Level type of canopy (Section 5 Fig 3d) is proposed, there is no requirement for any overhangs at the ends and front edge shall extend forward such that it covers 2/3rds of the cooking equipment in plan. On these types of canopy there is very little expansion of the rising effluent plume before the air enters the exhaust plenum. Care shall be exercised to ensure that the bottom of any grease separators within low level canopies are 450mm above the cooking surface. (see 6.9)
- 6.5 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).
- 6.6 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 plan size of the canopy to aid capture when the ideal flow rate cannot be achieved.
- 6.7 With kitchens that have high ceilings, provided that the canopy is installed at the correct height to allow access to the separators 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. See Figure 1.
- 6.8 In order to contain the ever expanding rising plume when 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.
- 6.9 The distance between the lowest edge of the separator and the top of the cooking surface should be 450mm minimum. This is to minimise the risk of excessive temperatures or fire in the separator which could cause the extracted grease to vapourise and pass through to the ductwork.

- 6.10 Where gas-fired salamander grills are mounted at high-level in close proximity to the grease separators/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 separators. This will reduce the potential of fire-flares, which are known to occur with such appliances, being drawn into the separator 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 separators.

SECTION 7

Ventilated Ceilings

- 7.1 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. Occasionally it may be necessary to build a canopy into the ventilated ceiling to ventilate a particular cooking process.

Ventilated ceilings should also be considered:-

- Where due to structural limitations, low floor to finished ceiling levels make the use of ventilated ceilings a viable option.
- 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.

- 7.2 The calculation of minimum extract flow rates for ventilated ceilings shall be in accordance with the procedures set out in Section 2 of this document. The supply system shall be designed to provide the conditions set out in Section 4 and 10.

- 7.3 There are three types of ventilated ceiling system available:-

- Open Ceiling System
- Closed Ceiling System
- Plenum Ceiling System

- 7.4 Open Ceiling System

7.4.1 The Open Ceiling System is a totally integrated system incorporating dedicated extract, partitioned supply, and flush mounted luminaires. The ceiling comprises a grid system which supports extract and supply cassettes, and luminaires. The extract separators, 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.

7.4.2 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.

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

7.4.4 For secure installations, panels should be lockable.

- 7.5 Calculating Size of “Active” Exhaust Zones

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

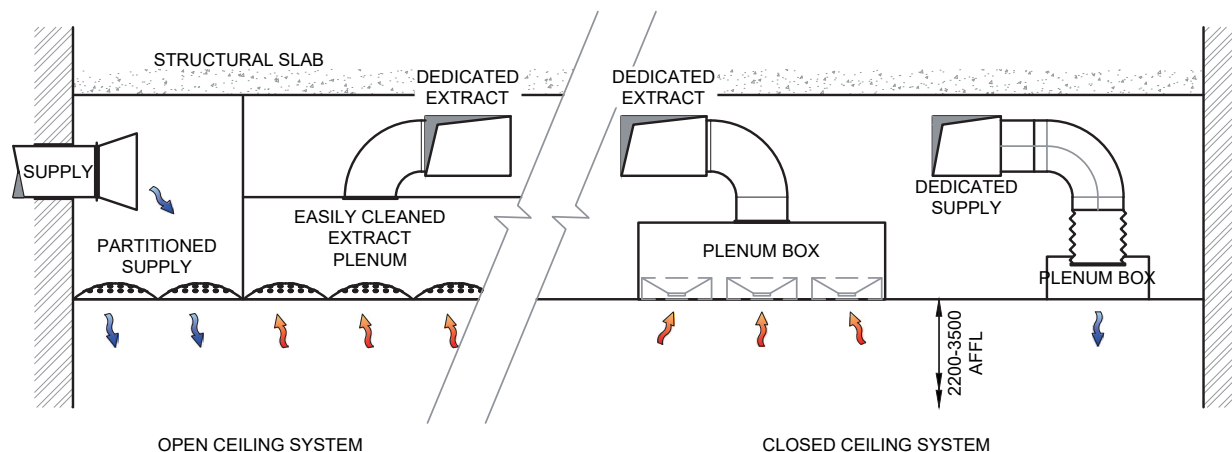


FIG 6a - CASSETTE TYPE CEILING SYSTEMS

- 7.5.2 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 gases back to liquid droplets, thus stopping the grease returning to work surfaces.
- 7.5.3 Modular Cassette and Plenum Systems shall have the following extract cassette overhang as a minimum.

Table 5 - 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 6 - Ventilated Ceiling Factors	
FINISHED CEILING HEIGHT / FACTOR EXTRACT FLOW RATE	
AFFL (m)	FACTOR RANGE
2.2	1.10 - 1.45
2.5	1.00 - 1.35
2.7	1.08 - 1.45
2.9	1.16 - 1.55
3.1	1.24 - 1.65
3.3	1.32 - 1.75
3.5	1.40 - 1.85

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. Designers should always be aware that it is essential to consider the context in which the catering equipment is being used and that exceptional circumstances call for special consideration.

7.6 Closed Ceiling System

The Closed Ceiling system has a dedicated extract system and supply air system and flush mounted luminaires. The ceiling comprises a grid system which supports extract and supply grilles / diffusers and luminaires

7.7 Plenum System

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

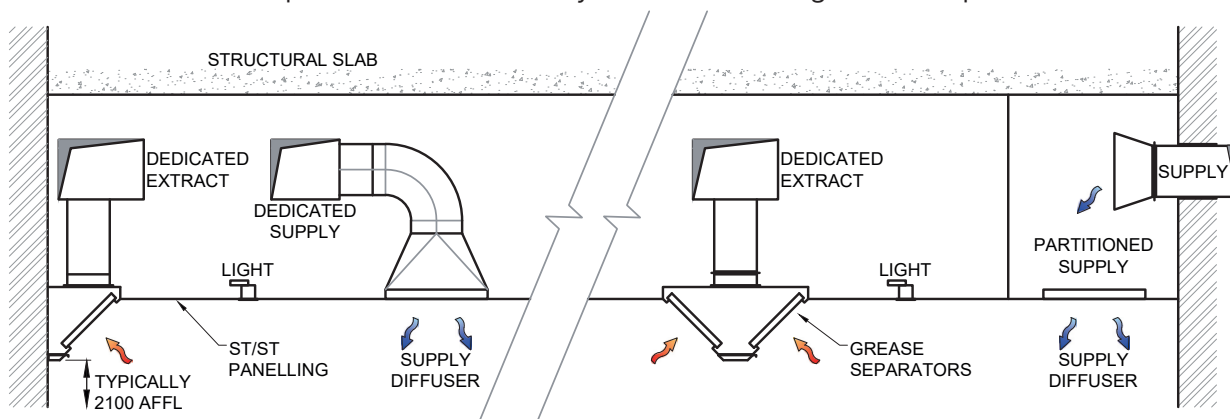


FIG 6b - PLENUM CEILING SYSTEMS
(I.E. PURPOSE MADE UTILISING STANDARD GREASE SEPARATOR AND HOUSING)

- 7.7.2 Supply grilles are integrated into the ceiling design to provide make up air comfort ventilation or spot cooling.
- 7.7.3 Secure installations are not achievable with plenum systems.
- 7.7.4 Grease separators shall be located in accordance with procedures set out in Section 11.

7.8 Supply and Extract Ductwork

- 7.8.1 Extract air should be removed by a total ductwork system.
The alternatives for supplying intake air should be:
- totally ducted system
 - via partitioned voids
- 7.8.2 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^{-1} .
- 7.8.3 Where a ducted system is selected it comprises separate dedicated ductwork with connections to both supply and extract cassettes, via plenum boxes.
- 7.8.4 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
- 7.8.5 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.

7.9 Construction

- 7.9.1 The material to be used in the manufacture of ventilated ceilings should typically be 304 grade stainless steel.
- 7.9.2 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.
- 7.9.3 Services, other than ductwork, shall not pass through the extract void where grease laden air is being carried.
- 7.9.4 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.
- 7.9.5 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.
- 7.9.6 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.
- 7.9.7 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.
- 7.9.8 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.
- 7.9.9 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 resisting to a standard determined by the building owners risk assessment, but with a minimum integrity of 30 minutes and fire stopped.
- 7.9.10 With all 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.

7.10 Lighting

- 7.10.1 Integral lighting may be incorporated into either ventilated ceiling system. Illumination levels shall follow the recommendations of Section 13.

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.

7.10.2 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.

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

7.11 Cleaning and Maintenance

For the cleaning and maintenance of ventilated ceilings see the relevant notes under Section 29.

SECTION 8

Materials

- 8.1 Material to be used in the fabrication of canopies and ventilated ceilings in accordance with this specification should be type 1.4301 (304) ultra-fine grained stainless steel EN 10088. See Section 9 Table 9 for sheet thickness.
- 8.1.1 Other grades of stainless steel are available but care should be exercised in the use of such materials and should be selected to suit the circumstances of the kitchen environment.
- 8.1.2 Unless indicated to the contrary in any particular project specification, all visible surfaces of the canopy and ventilated ceilings should have the fine grained finish on view, with all unpolished surfaces concealed.
- 8.1.3 All polished sheet surfaces shall be protected with a removable, laminated film.
- 8.1.4 For special canopy applications for the offshore and food process industries type 1.4401 (316) acid resistant stainless steel should be required. EN 10088. Where such specialised stainless steel is necessary, the client shall indicate this requirement from the outset.
- 8.1.5 Abbreviations
- DP2 = Dull polished both sides.
- DP1 = Dull polished one side.
- 2B = Descaled or unpolished.

Table 7 Stainless Steel

Old BS Nr.	EN Nr.	EN Name	Type of stainless	EN Standard
316 (S31)	1.4401	X5CrNiMo17012-2	Austenitic	EN 10088
430 (S17)	1.4016	X6Cr17	Ferritic	EN 10088
304 (S31)	1.4301	X5CrNi18-10	Austenitic	EN 10088
N/A	1.4622	X2CrTiNbVCu22	Ferritic	EN 10088

Table 8 - Weights (in kg.m⁻²)

	stainless steel
2.0mm	16.04 kg.m ⁻²
1.6mm	12.87 kg.m ⁻²
1.2mm	10.30 kg.m ⁻²
1.0mm	8.58 kg.m ⁻²
0.90mm	7.77 kg.m ⁻²
0.80mm	6.40 kg.m ⁻²

- 8.2 Perforated Sheet
- 8.2.1 For the diffusion or equalisation of air within the supply plenum of a canopy, 0.8mm perforated sheet should be used.
- 8.2.2 For the fabrication of front face discharge grilles, 1.0mm perforated stainless steel sheet shall be used, the free area selected as detailed in section 10.4. This arrangement will not provide directional control of the air discharge but will avoid unwanted draughts.
- 8.3 Insulation
- 8.3.1 To avoid condensation, canopies that are provided with a supply plenum

should have all internal surfaces of that plenum thermally insulated. The insulation shall be a rigid foil faced non fibrous slab, with a class 1 spread of flame.

- 8.3.2 Insulating boards are available in various thicknesses and should be fixed to the plenum with a combination of adhesive, tape and stick pins.
- 8.3.3 Fibre based insulating materials must not be used in a food environment.

SECTION 9

Construction & Polishing

9.1 General

- 9.1.1 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.
- 9.1.2 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. Lap joints and visible fixings are not acceptable.
- 9.1.3 All external canopy surfaces should be vertical to facilitate cleaning, match the ceiling line and maximise the internal collection volume.
- 9.1.4 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.
- 9.1.5 Occasionally a project specification may be encountered that refers to the construction being in accordance with NFPA 96 or 97. This is a North American specification calling for all welded construction. Seek advice before proceeding.

For ventilated ceiling construction, refer to Section 7.

- 9.2 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
Panel Ventilating Ceilings	0.9mm - 1.2mm
Coffered Ventilating Ceilings	0.55mm - 1.1mm
Supply plenums	0.9mm - 1.2mm
Spigots	0.7mm

9.3 Fabrication

- 9.3.1 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.
- 9.3.2 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.
- 9.3.3 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.

9.4 Sealant

- 9.4.1 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.
- 9.4.2 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.
- 9.4.3 Conventional sealant should be used for spigot and ductwork joints.
- 9.4.4 All products shall be installed in accordance with the manufacturers' recommendations.

9.5 Polishing

- 9.5.1 All visible welds shall be ground to a smooth surface and reinstated to the finish of the base material by polishing.
- 9.5.2 The type of disc used for the grinding and polishing processes may vary according to the grade of material and joint being polished.
- 9.5.3 The polished areas should be covered with a low tack vinyl tape to replace the original laminated pvc protection removed for welding.
- 9.5.4 Abrasive discs that have been used on other materials shall not be used with stainless steel.

SECTION 10

Make-up Air

- 10.1 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.
- Kitchens with all electric equipment with air volumes below both $0.9\text{m}^3.\text{s}^{-1}$ and 40 air changes per hour do not need mechanical fresh air intake, natural unpowered fresh air ventilation via pre engineered grilles or ductwork is sufficient. For kitchens without access to an external wall seek professional advice. Care must be taken to ensure that the fresh air requirement of $10\text{ l.s}^{-1}/\text{person}$ is complied with.
- The supply air is best dealt with through a low velocity perforated diffuser such that the air flow does not entrain air captured from within the canopy into the occupied space.
- Where a natural ducted inlet for relief air is selected it should be as short as possible, and with filtration since the incoming air is likely to be contaminated. Figures 8a and 8b.
- 10.2 Where mechanical input is selected, the system shall provide a minimum of 75% and a maximum of 95% of the total extracted volume, with the remaining 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.
- 10.3 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 7a to 7d.
- 10.4 Where perforated plate diffusers are used, the free area should be a maximum of 50% and a minimum of 35%. The air velocity should be calculated at a minimum of 0.8ms^{-1} and a maximum of 1.25ms^{-1} , when taken across the complete face area of the diffuser.
- 10.5 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.

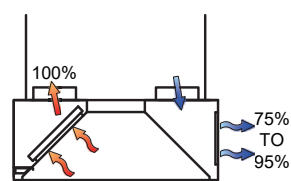


FIG 7a - FRONT FACE SUPPLY

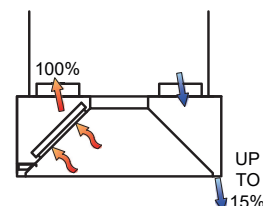


FIG 7b - AIR CURTAIN/SPOT COOLING SUPPLY

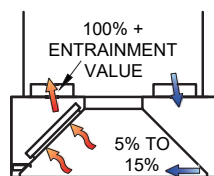


FIG 7c - ENTRAINMENT SUPPLY

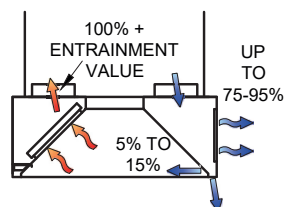


FIG 7d - COMBINATION SUPPLY

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.

- 10.6 Make Up air should be a minimum air entry temperature of 10°C for canopies and 16°C for ventilated ceilings. See Table 1.

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

- 10.7 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 ePM1 70% or 75% (see Appendix B). 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.
- 10.8 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.
- 10.9 Care shall be taken with infiltrated air to ensure that it is not taken from 'dirty' areas.
- 10.10 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.
- 10.11 Details of the various types of natural air transfer systems are shown in Figs. 8a and 8b below:
- 10.12 A significant factor behind a poorly performing kitchen ventilation system is often due to a badly designed / installed Make Up Air system. Avoid high velocity "throws", select perforated plate diffusers rather than proprietary grilles / diffusers and do not allow the incoming supply air to disrupt the rising extract plume.

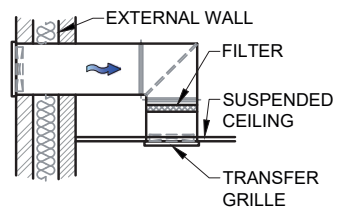


FIG 8a - OUTSIDE AIR TRANSFER

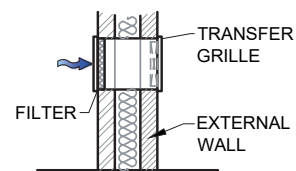


FIG 8b - LOW LEVEL WALL TRANSFER

SECTION 11

Grease Separation

11.1 Grease separators must be verifiably tested for Fire Protection Performance and separation efficiency

- Grease separators shall be manufactured in stainless steel.
- Separators are used primarily in commercial kitchen extract systems for the removal of flammable grease deposits.
- The grease extracted by the separators 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 separator shall also limit the penetration of flame downstream into the canopy plenum.
- The separator shall be constructed so that there are no sharp edges or projections and shall be easily removable for regular cleaning.
- Primary separators that retain grease within the filtration matrix until cleaned, shall not be used.

Further information for testing can be found from the following:

- UL 1046 Standard for Grease Separators for Exhaust Ducts.
- VDI 2052 Ventilation Equipment For Kitchens-Determination Of Capture Efficiency Of Aerosol Separators In Kitchen Exhaust.
- ASTM F2519 Standard Test Method For Grease Particle Capture Efficiency Of Commercial Kitchen Separators and Extraction.
- NFPA 96 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- UL710 Standard for Exhaust Hoods for Commercial Cooking Equipment.
- LPS 1263 Requirements for the LPCB approval and listing of the fire performance of grease separators used in commercial kitchen extract systems.

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

11.2.1 Grease separation fall into two main categories; primary (separators) and secondary (mesh).

Primary grease separators 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 separation process within the canopy.

Secondary mesh type impingement filters can be incorporated to the rear of the primary separators providing they do not affect the fire resistance.

11.2.2 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.

11.2.3 Disposable filter media must be fire resistant (see 11.1) and must be backed by a separator. Care must be exercised to ensure that grease and oil does not drip on to the cooking equipment or food products. Filter media can affect the system performance and clogged filter media will affect the resistance to air flow calculations.

11.3 Mesh Impingement Filters

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

11.4 Separators

- 11.4.1 Separators 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. Separators should be fabricated entirely from stainless steel.
- 11.4.2 The grease laden air passes through the separators 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.
- 11.4.3 The capacity of the collection drawer shall be a minimum of 500ml and should be sufficient to suit the type of cooking and frequency of cleaning. Grease is retained and care shall be taken to ensure that the grease collection drawer is isolated from the extract air stream as illustrated in Figure 9 to prevent re- entrainment.

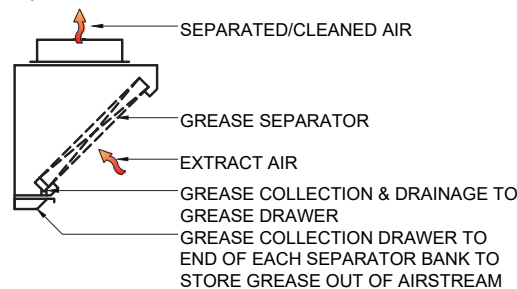


FIG 9 - TYPICAL AIRFLOW THROUGH SEPARATOR HOUSING

- 11.4.4 For plenums that contain more than one separator supports may be required to ensure that the housing remains stable. Separators shall be easily removable and installed so as to minimise air leakage around the perimeter.
- 11.4.5 Where installations are being refurbished, separators 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.
- 11.5 Separators shall be installed at an angle of not less than 45° from the horizontal.
- 11.6 Water Wash
- 11.6.1 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.
- 11.6.2 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.
- 11.6.3 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.
- 11.6.4 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.

11.7 Continuous Cold Water Mist

- 11.7.1 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.
- 11.7.2 The mist system has an additional advantage in that the continuous flow of cold water cools both the canopy and the exhaust air. This is particularly suitable for solid fuel appliances where the mist will also assist to extinguish hot embers that may be drawn up into the canopy.
- 11.7.3 One disadvantage is running cost of supply and waste water. Consider demand based water control.

11.8 Legionnaires Disease

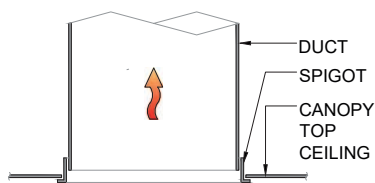
The bacterium legionella occurs naturally in water sources and, when in sufficient numbers, can cause 'legionnaires disease' by the inhalation of water laden air in an aerosol form by susceptible individuals. This is unlikely to occur with water wash and water mist systems due to the fact that the water 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:

- BSRIA document BG57 Legionnaires Disease Risk Assessment.
- HSE 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"

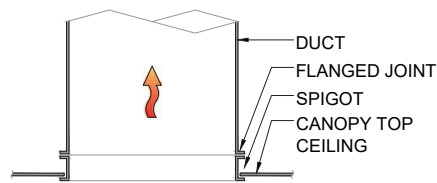
SECTION 12

Spigot Connections

- 12.1 The size of the spigots serving both the supply and extract plenums, should be determined by selecting a size appropriate for the air velocity.
- 12.2 The extract spigot area should be determined by dividing the total extract flow rate by a design velocity of $5\text{--}7\text{ ms}^{-1}$. and the supply air flow rate a velocity of $3\text{--}5\text{ ms}^{-1}$.
- 12.3 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.
- 12.4 The number of spigots shall be determined by the length of the canopy and any restrictions in the ductwork layout, there should be at least one spigot for every 3m of canopy to ensure an even air flow.
- 12.5 Consideration should be given to ensure that grease or moisture does not leak though the flange / connection.



**FIG 10a - SPIGOT CONNECTION
SLIP JOINT OPPOSING AIRFLOW**

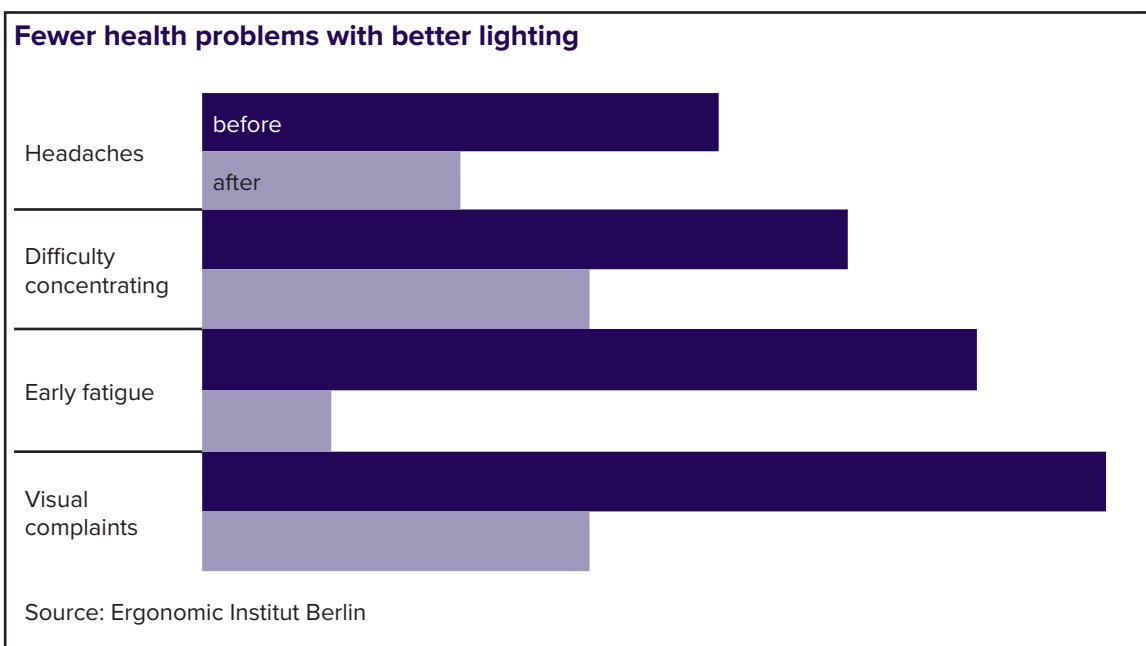


**FIG 10b - SPIGOT CONNECTION
FLANGED JOINT**

SECTION 13

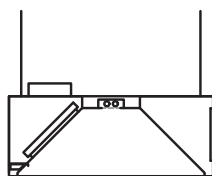
Lighting

- 13.1 The need for good quality, low-energy lighting in a potentially high risk area such as a commercial kitchen is of paramount importance. Not only does the quality of light in the workplace impact on the quality of work, studies show that poor lighting can have a detrimental effect on staff health and wellbeing. It is also fair to say that advances in lighting technology in recent times mean that efficient solutions that were not previously viable due to cost constraints can now be considered for use in canopy and ventilated ceiling lighting.

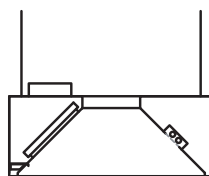


- 13.2 It is therefore appropriate to provide a lighting solution for a kitchen that incorporates excellent light properties with energy efficiency.
- 13.3 Historically, lighting for kitchen canopies and ventilated ceilings consisted of either surface-mounted tungsten bulkhead lights, surface-mounted fluorescent fittings or recessed fluorescent luminaires.
- 13.4 In order to minimise the health risks caused by the inability to properly clean surface-mounted light fittings, this type of fitting should no longer be used.
- 13.5 Low-energy LED luminaires are available as either tubes, strips or spotlights but care should be exercised in managing the heat that can be generated at the rear of the fitting. Although recessed fluorescent fittings can still be used, the preferred option is recessed, low-energy LED luminaires, given their proven energy-saving qualities.
- 13.6 Light quality should be the overriding factor when specifying a light source / fitting. Minimum average illumination levels of 500 lux on the main working areas of the cookline from a glare-free luminaire are required. Ideally, luminaires should be selected by using a readily-available software programme (Relux, or similar).
- 13.7 Colour temperatures of 3000K (warm white) or 4000K (neutral white) are acceptable for the primary light source, although certain specifications can call for levels between 2700K and 6500K.
- 13.8 The chosen light source shall have a minimum Colour Rendering Index (CRI) of 80.
- 13.9 Whilst advances in lighting technology have increased the life expectancy of most lighting sources, it is important that light levels are checked annually to ensure that the as-designed light levels are maintained.

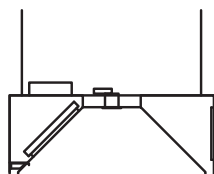
- 13.10 A lighting control system may be employed, where appropriate, that monitors natural light levels in the kitchen and adjusts the output of the canopy or ventilated ceiling lights whilst maintaining the required illumination at the work surface.
- 13.11 The luminaire housing shall be recessed and fit flush (maximum 10mm for lens allowed) with the internal surface of the canopy or ventilated ceiling, and shall be sealed against the ingress of grease and moisture. Surfaces facing the cooking area shall be designed to achieve a minimum rating of IP55, see Table 14 Appendix C.
- 13.12 The luminaire shall be easily accessible for maintenance and integrated into the design in such a way that ensures ease of replacement when required. The lens cover shall be either hinged or provided with restraining straps such that the lens cover does not need to be physically removed in order to gain access.
- 13.13 All sealing gaskets shall be of food quality material and be able to withstand temperatures up to 100°C.
- 13.14 The luminaire lens assembly shall be made from a temperature resistant material that is fit for application in a commercial kitchen canopy or ventilated ceiling. The surface of the lens shall have a smooth finish to help prevent grease build-up and facilitate ease of cleaning. Consideration should be given to the type of cooking taking place under the luminaire, and whether this will have a detrimental effect on the physical properties of the selected lens assembly over time.
- 13.15 Due consideration shall be given to the heat generated by the luminaires. Light technologies such as LEDs, whilst producing less heat than traditional alternatives, can generate heat to the rear of the light source which needs to dissipate effectively in order to maintain the fitting's expected life span.
- 13.16 Electrical wiring from the light fitting to any junction point on the canopy or ventilated ceiling shall be heat resistant and installed in a low smoke and fume (LSF) material. The power supply should be provided by the electrical contractor on site and switched elsewhere.
- 13.17 Emergency Lighting. 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. A commercial kitchen is classed as a high risk area and, therefore, in addition to the requirements for general emergency lighting specified in BS 5266-1 : 2016, provision must also be made to provide a minimum of 10% of operational illuminance under the canopy or ventilated ceiling. This is to ensure the safety of people involved in a potentially dangerous process or situation, and to enable proper shutdown procedures to be carried out on cooking equipment prior to evacuation, if safe to do so. Prior to designing the emergency lighting system it is recommended that advice is sought from a qualified lighting specialist to ensure legislative compliance. Care should be taken to ensure that Lithium battery packs are located away from high heat sources.



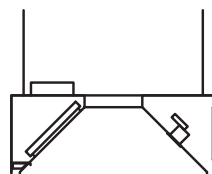
**FIG 11a - LED OR FLUORESCENT
LUMINAIRE IN ROOF**



**FIG 11b - LED OR FLUORESCENT
LUMINAIRE IN SUPPLY PLENUM**



**FIG 11c - SPOTLIGHTS
IN ROOF**



**FIG 11d - SPOTLIGHTS IN
SUPPLY PLENUM**

SECTION 14

Solid Fuel Appliances (this does not apply to natural or LP gas appliances):

- 14.1 Burning wood and other solid fuels for commercial cooking is becoming increasingly popular. Ventilation in these situations must go above and beyond standard grease duct ventilation requirements.
- 14.2 This section deals with the safe use and risks associated with the use of solid fuel appliances such as Tandoori ovens, Charcoal grills, and wood fired pizza ovens in commercial kitchens. This also applies when solid fuel is used as a secondary fuel and addresses exposure to Carbon Monoxide (CO) gas, the risk of fire and the need to provide adequate ventilation.
- 14.3 For details of Carbon Monoxide (CO) and Carbon Dioxide (CO₂) see Appendix F and G.
- 14.4 All employees must be aware of the risks associated with the use of solid fuel appliances and the need for adequate ventilation.
- 14.5 Both wood fired catering and charcoal fired catering equipment are classed as Solid Fuel Appliances but due to their separate and distinct properties should be considered separately when designing a safe and effective ventilation system.
- There is a fundamental difference between wood and charcoal burning appliances as unlike wood, charcoal does not produce large amounts of creosote and tar.
- 14.6 In view of the possible emission of sparks, avoid locating solid fuel burning equipment within 900mm of a fryer. Some fryers may have side screens which reduce the risk, it is recommended that you consult with the fryer manufacturer for their advice.

Wood Burning:

- When solid fuel in the form of wood and charcoal is burned, products of combustion including carbon monoxide gas are released.
 - Carbon monoxide is a highly poisonous gas with no taste, smell or colour. Moderate exposure can lead to serious permanent ill health effects or death.
 - Creosote is an oily liquid produced by the distillation of wood tar. In the ventilation system Creosote behaves like grease laden vapours and has a high flammability risk.
 - Wood will continue to produce fumes until the fuel is completely extinguished.
 - Only use wood burning appliances that are designed for indoor use.
 - Wood burning appliances used at an outdoor event but located inside a tent, garage or gazebo can expose people to the risk of carbon monoxide poisoning.
 - Sparks from the wood fire are the most common source of the heat and fire risk.
- 14.7 Ventilation Systems:
- Wood burning cooking equipment shall not be connected directly to a naturally vented flue to atmosphere. The reason for this is that in a kitchen with a powered ventilation system under negative pressure, fumes and gases will be drawn back down the naturally vented flue serving the wood fired appliance and into the kitchen space. The result of a direct connection is that the kitchen staff may suffer from the harmful effects of toxic products of combustion. The system should be tested to EN1366-1.

- 14.8 The only time that a natural flue system can be permitted is if there is no other form of mechanical extract ventilation in the kitchen in which the wood burning appliance is located.
- 14.9 Wood burning appliances shall be located beneath a stand-alone, suitably designed and equipped canopy and ventilation system. This will provide an air break between the appliance and the ventilation system unlike a directly connected flue, ensuring the proper balanced collection and removal of fumes. It will also dilute in-duct air temperature and reduce the risk of fire.
- 14.10 Extract Flow Rates:
Wood burning appliance coefficient and temperature schedules. Refer to Section 4 Table 2.

Manufacturers of solid fuel catering equipment shall test and provide ventilation requirements for new equipment. These tests should be to a recognised country standard where the equipment is used.
- 14.11 Exhaust System:

Exhaust ventilation systems serving wood burning cooking equipment shall be separate from all other exhaust systems. Wood burning appliances shall not be incorporated into the same exhaust system which serves gas and electrical equipment.
- 14.12 There are several reasons why the wood burning appliance and the exhaust ventilation system need to be separate:
- To prevent sparks from wood burning equipment entering duct systems serving other cooking equipment.
 - There will be less build-up of grease and creosote in the system and no cumulative effect of contamination between the ventilation systems.
 - Less risk of fire spreading through the duct system.
 - Easier to clean and maintain.
 - Ensure that the products of combustion can be safely removed.
- 14.13 Supply Air Ventilation:

When positioning the wood burning appliance, consideration must be given to the location of the fresh air entering into the room.

Ensure that the supply inlet is positioned well away from any solid fuel extract ventilation outlet.

Where mechanical input is selected, the system shall provide a minimum 75% and a maximum of 95% of the total extracted flow rate with the remainder infiltrating naturally into the kitchen from surrounding areas.
- 14.14 Addition of wood burning appliance to existing Exhaust Ventilation Systems:

Exhaust ventilation systems serving wood burning cooking equipment shall be separate from all other exhaust systems.

When purchasing a wood burning appliance it is essential that the existing ventilation system is checked to ensure that it is a dedicated system and separate from all other extract ventilation systems. Any new equipment added to the kitchen must have a ventilation system in accordance with the latest DW/172 specification.
- 14.15 Spark Arrestor:

Sparks from the wood fire are the most common source of the heat and fire risk.

Ventilation systems serving wood burning appliances shall be fitted with suitable spark arrestors.

No spark arrestor can guarantee that sparks will not enter the extract ventilation system. Regular maintenance and cleaning is necessary to minimise the risk of fire within the system.

Types available and how they work:

- Mesh screens must be manufactured in stainless steel.
- Separators positioned within the ventilation canopy extracting air from wood burning appliances shall be provided with permanent spark arrestors on the rear face of each separator.
- Cold water mist will act as a spark arrestor.

14.16 Fans:

All fans shall have the motors out of the airstream and impellers shall have metal blades.

The high temperatures commonly seen from wood burning appliances can reach 260/300 °C . This can lead to failure of the fan motor bearings and other components which cannot withstand the heat. By using a ventilation canopy to dilute the duct air temperatures these can reduce to between 90/120 °C. Using cold water mist canopies will provide further reduction in temperature.

14.17 Ductwork Materials and Construction:

Unless specified to the contrary, for wood burning appliances the complete duct system shall be manufactured from stainless steel, constructed to DW/144 specification. Ductwork must be site specific and have a minimum of 2 hour resistance unless otherwise specified and be tested and assessed to the latest version of BS476 part 24 or EN 1366-1. Surface temperatures can reach in excess of 250 °C. In these instances in accordance with Building Control the ductwork should be insulated to avoid heat transfer to adjacent combustible materials.

14.18 Fire Suppression:

Reference must be made to the Regulatory Reform (Fire Safety) Order 2005. Only fire suppression systems which have been tested and approved for use on wood burning equipment can be used. Almost every installation is different in terms of potential fire risk due to the type and positioning of equipment, therefore it is essential that a risk assessment is carried out by a qualified fire engineer to determine the most appropriate solution for fire suppression.

14.19 Controls:

The extract and supply ventilation systems shall continue to run until all burning wood has been extinguished, even if no person is on the premises. This will ensure that there is no risk to people in neighbouring property and that the building is safe for staff to enter for the next working shift.

The mechanical kitchen ventilation system must be interlocked with the carbon monoxide and carbon dioxide detectors.

14.20 Monitoring:

Carbon monoxide gas can build up very quickly and occupants can be overcome by poisonous gases without warning. See Appendix G and H for carbon monoxide and carbon dioxide details.

Audible and visual carbon monoxide and carbon dioxide alarms shall be fitted to provide 24 hour protection and to warn staff of dangerous levels of poisonous gases. This is also very important in the case of fan failure or power cuts. Alarms must comply with BS EN 50291 and evacuation procedures must be in place in the event of alarm activation.

Carbon monoxide and carbon dioxide detectors must be installed and positioned

in accordance with the manufacturer's instructions as laid down in IGEM/UP/19 See Figure 19 for typical locations.

The alarms shall be interlocked with the mechanical kitchen ventilation system to ensure that the system remains in operation until both sensors read acceptable safe levels of Carbon Monoxide and Carbon Dioxide.

14.21 Power Cuts:

In the event of a power cut, operation of wood burning appliances will continue to emit carbon monoxide gas and the risk to staff and others in the vicinity will be very high. Fuel will continue to burn but the mechanical ventilation system will be unable to remove the resultant poisonous fumes.

All staff and personnel must evacuate the kitchen in the event of a power cut. Once power has been reinstated, the kitchen ventilation system must run for 15 minutes before any staff can be allowed to re-enter the kitchen.

All employees must be made aware of the risks associated with the use of wood burning appliances and the need for adequate ventilation.

In-house risk assessments and safe working procedures must be in place in the event of power failure.

14.22 Cleaning and Maintenance:

Cleaning access doors and their locations shall be such that all internal surfaces of the ductwork system can be visually inspected and cleaned in accordance with BESA TR/19 and Fire Protection Association RC44. The system must be accessible for safe access for maintenance. The lack of cleaning and maintenance will significantly increase the risk of fire within the system which can quickly spread to other areas.

14.23 General Note:

There are fundamental differences between the burning of wood as a fuel and the burning of charcoal. Charcoal is wood that has already been burned and the impurities of creosote and tar have subsequently been removed.

Charcoal burning catering appliances still demand special conditions and the different characteristics for ventilating charcoal versus wood are outlined below. In all other respects charcoal burning equipment should be treated the same as wood burning.

14.24

Charcoal Burning:

All previous clauses in this section must be followed with the exception of the following:

- Wood must not be used on charcoal burning appliances.
- Only fuel as recommended by the equipment manufacturers should be used.
- Products of combustion from the burning of charcoal are akin to those emitted from gas fired appliances. Therefore there is no requirement for stainless steel extract ductwork. Galvanised steel ductwork manufactured in accordance with DW/144 is acceptable.
- As there will be no creosote or tar deposited in the kitchen extract ductwork system there is no requirement for the charcoal fired appliances to be served by a separate canopy and extract system.
- This will also apply when a charcoal burning appliance is added to an existing exhaust ventilation system. Care must be taken however to ensure that the extract air flowrate is correctly calculated.

- Systems designed for charcoal burning appliances cannot be retrospectively used for wood burning cooking equipment.
- All other risks associated with issues such as Carbon Monoxide and Carbon Dioxide emissions, high temperatures, spark arrestors etc are the same as for wood burning appliances therefore clauses 1 to 23 must be taken into account.
- In view of the possible emission of sparks, avoid locating solid fuel burning equipment within 900mm of a fryer. Some fryers may have side screens which reduce the risk, it is recommended that you consult with the fryer manufacturer for their advice.

14.25 Flavouring / Smoker Units:

Where an enclosed appliance uses wood pellets, shavings or wood chips solely for flavouring and not as a means for cooking they need not be treated as a solid fuel appliance. However ventilation and Carbon Monoxide, Carbon Dioxide controls as detailed in this section are still required.

SECTION 15

Fans & Accessories:

General:

The main design considerations for kitchen extract fans are air-flow rate, resistance, noise level, size and cost. The three main fan types generally found within kitchen extract systems are axial, mixed flow and centrifugal as described below.

Fan Blade Types:

15.1 Axial

The most commonly found fan type in existing and especially older kitchen extract systems. This type of fan consists of a propeller mounted in a cylindrical housing.

Axial fans are simple, cheap, easy to fit and come in a variety of formats such as plate mounted, duct mounted or circular flanged units with a straight through air flow pattern. They have an additional advantage over other fan types discussed here in that they can run in reverse to change the direction of flow, although only at approximately 60% volume.

The disadvantage with axial fans is that they are less efficient, especially where high system resistance is a factor, such as the resistance created by long or complex ductwork runs, canopy baffle separators, secondary filtration systems and odour control. Two-stage contra-rotating impellers configurations of axial fan can handle higher pressures. In practice however, this often means that a much larger axial fan is required in place of a more compact centrifugal or mixed flow unit. A larger axial fan will produce higher noise levels which can be a problem encountered in well ventilated kitchens. Axial fan blades have a tendency to load with grease/contaminants becoming unbalanced, which can in turn cause the fan to vibrate, create noise and lead to long-term damage.

15.2 Mixed Flow

The mixed flow design impeller is halfway between an axial and centrifugal blade pattern. The air flows in an axial direction but is then deflected 45° by the impeller. The resultant centrifugal force allows the fan to handle higher resistance when compared to an axial fan.

Mixed flow fans are usually mounted in straight duct sections with straight through air flow although plate mounted versions are available, but less common. When compared to an axial fan, a mixed flow fan is generally more efficient and will cope with a higher level of resistance.

Mixed flow fans cannot be electrically reversed to change the direction of airflow although this is not usually a requirement of kitchen extract systems.

15.3 Centrifugal

A centrifugal fan, often known as a radial fan, is similar in shape to a drum, where the end of the drum is solid and the sides consist of blades. The air is drawn into the rotating drum and thrown out through the blades. There are different formats of centrifugal fan based on the type of blades fitted. The two types generally used are as described below:-

- i. Forward curved (many tightly packed, small, forward curved blades).
- ii. Backward curved (fewer, larger backward curved blades).

Forward curved centrifugal fans are cheaper and smaller than backward curved centrifugal fans, but are not as well suited for kitchen extract when compared to backward curved fans for the following reasons:-

- Not as efficient.
- Blades collect grease and are difficult to clean.
- Sharper performance curve.
- Minimum amount of system resistance required or unit will over speed / over heat.

Centrifugal fans can be mounted as straight through duct fans but are more efficient when used to turn the airflow through 90°. Plate mounted centrifugal fans are also available. Backward curved centrifugal fans are of similar efficiency to mixed flow fans but at a far higher resistance level. This makes them ideal kitchen canopy fans.

Centrifugal fans cannot be electrically reversed to change the direction of airflow although this is not usually a requirement of kitchen extract systems.

15.4 Summary

Although axial fans have been the most popular fan type for small to medium kitchen extract systems in the past, mixed flow and centrifugal are now more commonplace as they are better suited to cope with the higher resistance levels caused by baffle filters and secondary filtration such as carbon or UV.

See Section 14 for information concerning fans which are suitable for Solid Fuel Systems.

Fan Enclosures:

15.5 Roof Fans:

Roof fans are designed to fit on to a timber or steelwork curb and either discharge vertically or downwards by means of a mushroom shaped cowl. No roof mounted ductwork is required so installation is straightforward. Ideally these fans should be mounted horizontally so if the roof is pitched the curb should be built up to provide a horizontal mount for the fan.

Vertical discharge fans are suitable for extract only but mushroom, side intake / discharge, cowls are often supplied with a fan that can be fitted either way to allow them to be installed for extract or supply use. Where supply and extract roof fans are located nearby, vertical discharge cowls should be used for extract and mushroom cowls for supply in order to reduce the risk of cross contamination.

'Acoustic' roof fans are available with integral attenuation material to reduce noise out-put.

15.6 Adaptable Box Fans:

Adaptable box fans typically consist of a centrifugal type fan mounted in a box shaped framework with removable panels. By re-arranging panels the fan can be used either as a straight through unit or alternatively to form a bend by turning the air through 90°. The performance of the fan is actually slightly better when used in the 90° arrangement due to the characteristics of the centrifugal impellor.

Many of these types of fan are available with an acoustic insulation lining within the double-skinned panelling which significantly helps the attenuation of break-out noise. Generally, these fans are the most useful for kitchen ventilation because of their positional adaptability, space saving attributes, high pressure capability against system resistance, reduced noise levels and efficiency. These fans are also available with motors out-of-airstream for extreme heat situations typically handling transported air temperatures of up to 120°C.

15.7 Plate Axial Fans:

Plate fans can be fitted to a wall opening and are useful for simple wall mounted

extract canopies with rear or end extract. They are usually limited to axial type fans although small centrifugal plate fans are available. The fan can be fitted either way round for extract or supply but cross contamination will occur if supply and extract fans are too close to each other. This type of fan may be suitable for smaller systems with low volumes, low resistances and low contamination levels such as dish-wash extract or very low output 'bar meal' type catering.

15.8 Duct (cased axial) Fans:

Duct mounted fans consist of a unit mounted within a section of ductwork which is normally flanged at each end to allow connection into the run. The fan can be used either way round for supply or extract and can often be fitted with the motor out of the airstream. These motor out of airstream models are known as bifurcated fans because the air passage is split and transported around either side of the motor. Generally, these types of fan are lower cost than others, they tend to be inefficient, noisy and have truncated performance curves operating at lower levels of resistance.

15.9 Custom Housings & Air Handling Units:

Where the extract or supply volume is too high for 'off the shelf' fans, an air handling unit may be required, this can be custom built to accommodate a larger motor and impeller than is found in standard fan ranges and may well utilise a belt drive arrangement or a centrifugal plug fan to achieve the required increase in performance. If speed control is required this type of fan will usually require the use of an inverter.

15.10 Temperature Ratings & Insulation:

Where a fan is likely to be subject to high temperatures and high levels of grease, such as for ventilating flame grilling or solid fuel equipment and other high output appliances, the motor should be mounted out of the airstream. In cooking situations such as those typically encountered in schools or care homes where the equipment duty-cycle and temperatures are usually lower, a standard configuration motor may be used providing the motor is suitably insulated. Class F insulation is recommended for temperatures up to 155°C and should be considered in most cases or Class B for up to 130°C may be suitable for a wash up or other low risk areas.

It should be noted that whilst fans fitted with motors out of the airstream are generally more expensive, they tend to require less maintenance and have a longer motor life – especially in kitchen extract.

Motor & Drive Types:

15.11 Squirrel Cage (IE2) Motors:

Most fan motors are traditional 'squirrel cage' type, these are the most common type of commercial AC motor available and generally consist of a casing which houses all the motor components, which is sealed to prevent the ingress of dust and moisture. The casing is usually cast with external heat-dissipating fins along the length and in some cases a small fan blows air along the fins to further cool the motor. This type of motor can be used on either belt driven or direct drive fans.

15.12 External Rotor Motor:

The 'external rotor' works on the same principal as the traditional 'squirrel cage' motor but the stator and the motor have swapped places, the rotor is on the outside and the stator on the inside. This means that the fan blades can be attached directly to the outside of the rotor and the whole motor is then an integral part of the fan. This more recent motor design has some distinct advantages, it is more compact than a traditional fan and motor combination and the motor is cooled by the transported air, making it more suitable for speed control. Due to the

nature of its integral construction, this type of motor is only suitable for direct drive fans.

15.13 EC Motor:

EC stands for Electronically Commutated which means it is a fan with a brushless DC or permanent magnet motor. They are synchronous motors powered by DC electricity via an inverter or switching power supply which produces an AC electric current to drive each phase of the motor. More succinctly, these motors are more efficient than the others mentioned above and are becoming more widely available which in turn is helping to reduce prices. Because they operate using an in-built inverter, they are available with a 0 to 10v signal terminal and can be controlled by a simple & low-cost remote mounted potentiometer. These types of motor can offer significantly reduced running costs on kitchen applications where typically high yearly operational usage is prevalent.

15.14 Direct Drive Fans:

Direct drive is where the motor is connected directly to the fan, either by the drive shaft on a conventional motor or integrated in the case of an external rotor motor. This type of fan is more compact and usually cheaper than a belt driven fan and is well suited to most small to medium sized kitchen ventilation systems.

15.15 Belt Drive Fans:

Belt drive fans consist of a separate motor and fan unit connected to each other by a fan belt and pulleys. This allows for a more powerful motor to be connected to a fan with blades of a steeper pitch. The advantages of this type of drive are that more air can be moved at a lower and quieter motor speed, the belt absorbs vibration from the motor and reduces noise levels and the pulleys can be adjusted to change the fan speed. This type of fan is generally used on larger kitchen ventilation systems and is often utilised in air handling units.

Fan Speed Controllers:

- 15.16 Speed control is essential to allow accurate commissioning of the system and adjustment of fan speed as secondary filters become dirty. Where fitted, controls should be mounted either in a lockable, ventilated control cabinet or in a supervisor's office. Alteration of the fan settings by the kitchen staff should be avoided because this could imbalance the extract to supply air ratio, or if turned down too low could reduce the extract to a point where it is not ventilating the combustion fumes properly. Too little or too great an air movement for the canopy design will result in a serious decrease in grease filtration efficiency as filter size and quantity are determined by a single air movement duty at the optimum efficiency of the filter. For these reasons, once a system is set up and commissioned, it should not be altered outside of predetermined parameters. Please refer to Section 16 Kitchen Ventilation Control Panels.

Small to medium sized kitchen ventilation fans may be controlled by a simple on/off switch, an electronic speed controller, a transformer or a frequency inverter. Larger fans usually require a frequency inverter.

15.17 On/Off Switch:

- The simplest method of fan control.
- Very easy to wire and cheap.
- No form of speed adjustment so system cannot be tuned when commissioning.
- No form of motor protection. (TP or TK).

15.18 Electronic Speed Controllers:

- The cheapest form of speed control.
- Easy to wire by a qualified electrician.

- Small and unobtrusive.
- Infinitely variable, step-less, speed control, although there is a minimum start speed. Control usually 60-100% of rated voltage.
- Tends to get hot and can produce an electrical humming noise.
- Can cause fan noise problems by creating harmonic vibration in the motor and should be avoided where noise is an issue.
- Life expectancy of motor bearings is reduced when operating at lower speeds.
- One controller should not be used for more than one fan unless the motor cases are shielded.
- An inefficient form of speed control.

15.19 Transformer Speed Controllers:

- Does not cause noise problems from the fan motor.
- Multiple fans can be connected to one transformer without special consideration.
- Motor protection available when one transformer used per fan.
- Easy to wire by a qualified electrician.
- More expensive than electronic controllers.
- Large and heavy compared with electronic controllers.
- Have steps, usually five, so not infinitely variable.
- Life expectancy of motor bearings is reduced when operating at lower speeds. (Usually speeds 1 and 2).
- Generally these controllers require good local ventilation to prevent overheating.

15.20 Frequency Inverter Speed Controllers:

- Controls speed by adjusting frequency.
- Can cause noise problems from the fan, harmonics, this may be reduced by changing set-up on the inverter.
- Motor protection available.
- Infinitely variable speed control. (Usually digitally from 1 to 100 %.)
- Most expensive type of control compared to the others listed here.
- More difficult to wire by qualified electrician.
- Complex controls, should not be adjusted by un-trained personnel.
- Requires an un-switched electrical supply.
- Generally these controllers require good local ventilation to prevent overheating.
- IE2 motors of 0.75kW or more must have an inverter control to comply with 2017 ErP requirements.

Wiring:

15.21 It is essential to ensure that any electrical connection to a fan or fan controller is carried out by a qualified electrician who has experience of this type of installation. Incorrect wiring can easily destroy the fan, the controller or both at great expense. Where an axial fan will reverse the airflow if wired the wrong way round, a mixed flow or centrifugal will not, so there is no obvious indication that the wiring is incorrect without a visual check of impellor rotation.

15.22 Motor Protection: (TP or TK)

Without motor protection a fan motor will cut out when it overheats and automatically start again when it cools down. If motor protection (TP or TK) is

utilised, then when the fan motor cuts out it sends a signal to the controller. The fan motor will not start again until it cools down and the controller is MANUALLY re-set. This is advantageous as it indicates to the operator that there is a problem with the motor overheating whereas without TP or TK protection the fan could be tripping out and re-starting for some time without the operator being aware, possibly leading to failure of the fan. Typically, not utilising the overload protection, invalidates fan warranties.

Noise Attenuation:

- 15.23 Attenuation in the form of conventional silencers is often used to reduce low to mid frequency noise created by ventilation fans. These silencers usually consist of a rectangular or circular length of flanged duct which is fitted with internal baffles. The duct and baffles are fitted with a perforated metal liner, the area between the liner and the outer skin is filled with a sound absorbing material such as inorganic glass fibre or mineral wool. Due to their construction the use of silencers should be avoided, when possible, on kitchen extract ducts. The sound absorbing material is also an excellent grease absorbing material, causing a fire and health hazard as the lining becomes saturated. Furthermore, the effectiveness of the material to absorb sound is reduced as it becomes saturated, to the point where it no longer effectively reduces noise. It is therefore necessary where possible, to ensure that the fan selection meets the specified noise criteria without the use of silencers.
- 15.24 Where in-line attenuators are used for kitchen extract, 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.
- 15.25 A further point to be aware of when considering duct silencers is that they restrict the airflow thereby increasing duct pressure. This may require a larger and possibly noisier fan to be selected.

See Section 17 Sound Attenuation.

Fan Mounting:

- 15.26 To minimise the likelihood of vibration and noise transference through the building structure, fans shall be mounted or suspended using suitable rubberised or spring-loaded anti-vibration mounts. Curb-mounted roof fans should sit upon closed cell neoprene strip measuring 50 x 10 mm in section, fitted to the full perimeter of the curb upstand.
- 15.27 To minimise the likelihood of vibration and noise transference through adjoining ductwork, in-line fans should have suitable flexible connections on both intake & discharge sides between fan and duct connection. Flexible connection materials should be selected to suit the air contaminants and air temperatures being transported. In extract systems, flexible connections should be suitable for use in a grease laden atmosphere and positively fixed by clamps or bonding to prevent leakage. Under fire conditions, the material must have a minimum integrity of at least 15 minutes and selected to suit the temperature of the fumes being exhausted.

See Section 17 Sound Attenuation.

Table 10: Flexible Connections		
Material	Temperature °C	Key Features
EPDM Coated Glass Cloth	to +130	Good resistance to weather, oils, solvents, acids and alkalis.
PVC Coated Polyester	to +60	Tough, flexible materials with good resistance to abrasion and weather.
Silicone Coated Glass Cloth	to +250	Flexible high temperature cloth with either a single or double sided coating.
Neoprene Coated Glass Cloth	to +100	General purpose grade with good resistance to ageing and weather
Aluminium Coated Glass Cloth	to +150	Good heat reflective properties and good resistance to solvents and corrosive liquids.
PEEK Fabric	to +260	Excellent chemical resistance and a high resistance to hydrolysis, food approved.

SECTION 16

Kitchen Ventilation Control Panels:

16.1 General

In their simplest form, system controls could take the form of one extract fan on/off switch and one supply-air fan on/off switch (or even a combined switch) mounted on the kitchen wall adjacent to the canopy. Speed control is essential to allow accurate commissioning of the system and adjustment of fan speed as secondary filters become dirty. These controls should be remotely mounted and easily accessible only by competent operatives who understand kitchen ventilation theory. Control wiring should be carried out by qualified engineers.

Alteration of the fan settings by the kitchen staff should be avoided because it could imbalance the extract to supply air ratio, or if turned down too low could reduce the extract to a point where it is not ventilating fumes properly and safely. Too little or too great an air movement for the canopy design will result in a serious decrease in grease separation efficiency because separator size and quantity are determined by a single air movement duty at the optimum efficiency of the separator. For these reasons, once a system is set up and commissioned, it should not be altered outside of its predetermined parameters.

However, as systems increase in complexity, they may serve multiple areas and have many additional functions such as heating, cooling, filtration, or interlocking and interfacing with other systems.

16.2 Control Panels or cabinets

The more complex a system becomes, the more there is a need to consolidate all of these functions in a single, automatic, control cabinet with a simple, user-friendly interface on the front. Pre-engineered cabinets can be factory tested before installation which reduces the risk of incorrect field wiring on site. They also reduce the amount of field wiring required.

Aesthetically, a single cabinet is usually considered preferable to multiple, non-matching items individually mounted with surface-mounted, inter-wiring between them. Stainless steel cabinets can be provided where required.

Control panels and their internal components, should be clearly, indelibly and correctly labelled to assist with commissioning, ongoing maintenance and future upgrades. Control panels should be supplied their own wiring diagram and component manuals as well as with a wiring diagram for the system. Control panel enclosures should be suitably IP rated for the environment in which they will be installed.

Considerations:

16.3 Speed Regulation

Where two or more fans are controlled by speed regulators, it is essential to have them running at a predetermined set point decided at the point of commissioning and to meet the system design intent. If the speed regulators are left in an accessible position on the kitchen wall, they can be altered by kitchen operatives who may not fully understand ventilation and subsequently the balance of the system can be upset.

Mounting speed regulators in a lockable and protected cabinet with a single start/stop function (possibly with audible alarm) on the front, reduces the risk of the system being used incorrectly. This can be enhanced by incorporating run & trip lamps to indicate fan condition and further simplified by adding a programmable time control to remove the need to turn the system on and off manually.

16.4 Interlocks

Consolidation of controllers and interlocks in the same cabinet, decreases site wiring requirements and tidies up an installation. Once pre-set, controls cannot be tampered with and so a safe working environment is maintained, whilst providing simple user interface on the front of the panel or cabinet. Please refer to Section 20 of this document regarding Gas Interlocking.

16.5 Electric Heater Battery

Electric heater batteries represent a significant risk of fire if they are not properly installed and controlled. Heater batteries shall be controlled such that they cannot be turned on until the correct airflow is verified and so that the fan cannot be turned off until all of the heat in the heating elements has dissipated to safe levels. Associated fans should run for at least 10 minutes after the heater battery has been turned off. This requirement should take account of room and or duct stats interfacing with the heater battery.

16.6 Low Pressure Hot Water Heater Coils

Low pressure hot water (LPHW) coils pose a much lower risk of fire but require specific control methods. They will usually require some form of frost protection which could be in the form of constant warm water flow or by electric pre-heater. Either of these methods needs to be interfaced with the ventilation system as well as having the water flow controlled via a three-port valve and duct or room stats.

16.7 Filtration Monitoring and constant flow

Many ventilation installations require filtration on both the extract and supply-air systems. Particulate filters will gradually clog, increasing resistance to air-flow with use. As this happens, the system performance will be affected and the filtration efficiency will reduce. Positioning sensors around the filters, enables the control panel to monitor the state of the filters and give warnings as to when filters should be replaced. In addition, the fan motor speeds can be automatically adjusted so as to maintain constant air flow through the system. This effect will prevent pre-set levels of interlocks being erroneously triggered and therefore the unnecessary shut-down of the gas supply for instance.

16.8 Air Quality Monitoring

Air quality monitoring is an effective method of controlling and maintaining a safe kitchen environment. Carbon Monoxide, Carbon Dioxide, temperature and humidity sensors can be interlinked with a control panel to adjust air-flow rates automatically. Please refer to Section 14 of this document regarding ventilation of solid fuel appliances.

16.9 Fire Alarm Interface

Under fire conditions, most local authorities require that the ventilation system operates in a predetermined way. By interfacing the kitchen ventilation system with the fire alarm & suppression systems, information from each system can be used to create a certain set of operating conditions appropriate to the situation.

The kitchen ventilation control panel should be capable of, or at least have the option of, shutting each fan down or running each to maximum. It is most common to shut down the supply fan and set the exhaust fan to maximum so that, in theory, feeding the fire with oxygen will be avoided whilst venting smoke away from the internal space to aid evacuation.

16.10 Building Management System (BMS) Interface

Where building management systems are in use, a kitchen ventilation control panel will allow an interface and an element of remote control where specified.

This may incorporate other interfaces with alarms, secondary ventilation systems, fire systems, occupancy timers and other inputs.

16.11 Demand Controlled Kitchen Ventilation (DCKV)

Kitchen ventilation can be costly in terms of energy usage and there are control methods available which minimise their cost within the parameters of this document. For more information on DCKV, please refer to Section 22 of this document.

SECTION 17

Sound Attenuation

17.1 Kitchen ventilation 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.

17.2 The average human cannot distinguish between two sound pressure levels up to 2dB apart. Above this level there is 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.

17.3 Tolerance of noise levels is subjective but within the conditional space levels should meet the requirements of BS 8233 “Guidance on sound insulation and noise reduction for buildings” which are summarized below.

- Kitchen 50dBA – 55dBA; where the lower value is considered as a good standard and the upper figure a reasonable standard.
- Restaurant 40dBA – 55dBA; where the lower is considered as a good standard and the upper figure is a reasonable standard.
- BB93 Acoustic design of schools-performance standards. Kitchens 50 dBA.

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, should be considered. Slower running fans and lower duct discharge velocities will assist with reducing overall noise but may be as commercial as a suitable online attenuator.

17.4 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.

17.5 Isolation of vibration using correctly specified resilient mountings or pads, together with heat resistant flexible connections to the ductwork will reduce transmission to the structure.

SECTION 18

Ductwork

For ductwork systems serving solid fuel appliances see also Section 14.

- 18.1 The correct standard of ductwork selected to complete the installation is as important as the selection of the canopies themselves.
- 18.2 Flexible ductwork must not be used on kitchen exhaust systems.
- 18.3 For the distribution of supply air to the canopy, the ductwork should be manufactured in accordance with DW/144, other than the requirement of thermal insulation where the supply air is tempered and the installation at a minimum ePM1 70% or 75% 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.
- 18.4 Under normal circumstances and providing it runs within the fire compartment of the kitchen itself, extract ductwork shall also have no special requirements.
- 18.5 All ductwork as described in 18.3 and 18.4 shall be low pressure Class A and be in accordance with BESA Specification number DW/144 with a minimum thickness of 0.8mm.
- 18.6 Where it is not possible to immediately discharge the captured air within the confines of the kitchen fire zone, fire resistant ductwork must be used to comply with BS EN1366-1/BS 9999. For further information see Appendix D.
- 18.7 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 mild steel 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.
- 18.8 Where a waterwash or watermist system is used, horizontal ductwork shall slope back to the canopy with a fall of 1:50.
- 18.9 Grease separators do not remove all the airborne grease produced therefore care should be taken against staining the fabric of the building at the discharge point.
- 18.10 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.
- 18.11 Extract ductwork. Internal thermal or acoustic lining should not be used, and turning vanes should be avoided wherever possible.

Exhaust ventilation system should have a straight vertical run with few or no

horizontal sections. Horizontal runs create more opportunity for the build up of heavier than air particles therefore creating a higher fire risk.

- 18.12 Where it is not possible to discharge the captured air directly from the kitchen fire compartment to atmosphere fire resisting ductwork shall be required from the fire break onwards. For further information see Appendix D.

Table 11 Duct Velocities		
	Supply	Extract
Main Runs	6-8 ms ⁻¹	6-9 ms ⁻¹
Branch Runs	4-6 ms ⁻¹	5-7 ms ⁻¹
Spigots	3-5 ms ⁻¹	5-7 ms ⁻¹

- 18.13 When designing kitchen supply and extract systems the duct velocities shown in Table 11 shall be followed.
- 18.14 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 2m centres and thereby enabling full cleaning of the system without manned entry. The access doors 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. If the access doors are part of a fire resisting duct, then it needs to be verified that any new access doors are also fire resisting and are compatible with the ductwork they are being fitted to. Refer to the ductwork manufacturer, or if that is unknown obtain an opinion from a fire test laboratory accredited by UKAS for fire resisting ducts or a suitably qualified fire consultant. For recommended cleaning procedures refer to Section 29 and the BESA publication TR/19 - "Guide to Good Practice - Cleanliness of Ventilation Systems".
- 18.15 Access panels should ideally be fitted at the side of the duct, a minimum of 10mm above the base to minimise the risk of grease leakage. On vertical ducts, cleaning doors shall be provided at each floor level.
- 18.16 Discharge points shall be positioned such that the extracted air cannot be entrained into a supply system. The ductwork shall discharge at a height described by the local authority.
- 18.17 High velocity terminal shall be designed to achieve an exhaust or efflux velocity of 12-15 ms⁻¹ or as required by the Local Authority from whom approval shall be sought. Consideration should be given to situations where the lack of a mesh/guard might be dangerous and allow hand access to operating fan blades.
- 18.18 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.
- 18.19 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 12c - 12g.
- 18.20 Drains shall be installed at the base of all risers (see Fig 12a and 12b).

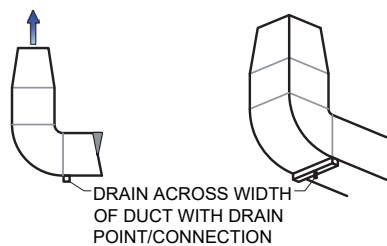


FIG 12a - HIGH VELOCITY VERTICAL DISCHARGE

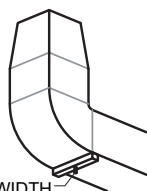


FIG 12b - DRAIN

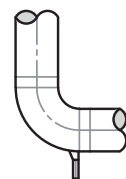


FIG 12c - ACCELERATOR

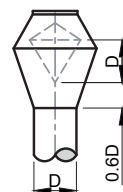
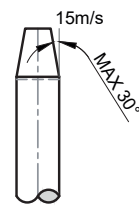


FIG 12d - SOLID TOP CONE

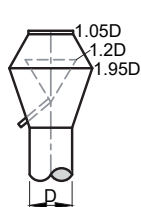


FIG 12e - OPEN TOP CONE AND DRAIN

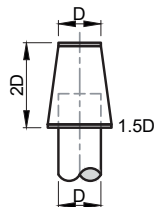


FIG 12f - INDUCTION TYPE

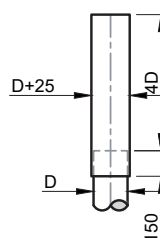


FIG 12g - SLEEVE TYPE

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 9999, 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

Gas Interlocking

- 20.1 BS6173 is entitled “Specification for Installation and maintenance of gas-fired catering appliances for use in all types of catering establishments (2nd and 3rd family gases)”
It covers a number of important issues but this section is only concerned with the interlocking of the gas supply with the mechanical ventilation system serving the kitchen.
- 20.2 This Specification is not intended to apply to domestic kitchens or to LPG appliances that are temporarily used outdoors.
- 20.3 In order to comply with BS6173 all new commercial kitchens, with one or more items of gas-fired cooking equipment, built or fitted-out since September 2001, must have a gas interlocking system on the ventilation system. Old gas equipment which is replaced will require gas interlocking even if replaced with like for like equipment.
- 20.4 This applies to both the mechanical extract and the supply air system.
- 20.5 Unlike some of the earlier versions of this Standard, BS6173 states that overrides, however short lived, are not permitted.
- 20.6 A gas interlock is a purpose-provided system which prevents the gas supply reaching the catering appliances when adequate ventilation is not in operation. This is to ensure that the kitchen staff, and in certain cases the customers, are not subjected to harmful levels of gases such as Carbon Monoxide, Nitrogen Dioxide and Carbon Dioxide. See Section 14 Solid Fuel Appliances. Where solid fuel cooking appliances are used, Carbon Monoxide (CO) and Carbon Dioxide (CO₂) detectors shall be installed and interlocked with the ventilation system to ensure it continues running until all burning fuel has been extinguished, and so that the system will restart automatically in the event that harmful gas levels increase, even if no person is on the premises. See Figure 17 for typical locations of monitoring devices. Where a demand controlled kitchen ventilation (DCKV) system is employed, CO and CO₂ sensors must override the settings of the system in the event of either a system malfunction or high levels being detected.
- 20.7 Various methods are used for gas interlocking. E.g. electrical current draw monitoring, electric current switches or by the use of pressure switches in both the supply and extract ductwork serving the kitchen. In the event of either air system dropping below a pre-set value, an electrical signal is sent via a small control panel to an electrical solenoid valve on the gas supply pipework serving the kitchen. The valve shuts off and the gas-fired catering equipment ceases to operate until an approved Gas Safe engineer attends site, rectifies the problem with the ventilation system and then resets the gas supply. If pressure switches are used care must be taken to correctly position the pitot tubes to ensure that they receive accurate readings and do not get blocked with contaminants that may be in the air stream i.e. on a linear run and not positioned on or near a grease catchment area such as a bend or tee section. See Section 28 Testing & Commissioning and 29 Cleaning & Maintenance.

SECTION 21

Fire Suppression

The Regulatory Reform Act loosely referred to as the Fire Reform Order is a statutory (Legally binding) regulation. Scotland and Northern Ireland have their own fire safety legislation.

This is intended to move the point of responsibility from the Local Fire Brigade to the operator (not necessarily the owner) of the restaurant, shop, etc., requiring him / her to produce a Fire Risk Assessment (FRA) for the premises.

This FRA will invariably require a fire suppression system if, for example, there is a deep fat fryer involved.

Heavy fines and, in some extreme cases, custodial sentences have already been served on operators who fail to observe and comply with this requirement.

- 21.1 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.
- 21.2 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.
- 21.3 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.
- 21.4 Where a surface fire suppression system is specified, selected manufacturers instructions shall be followed. See Fig 13 for a typical system layout.
- 21.5 Carbon dioxide CO₂ is not recommended due to its lack of cooling and high volumes needed to be successful. It can present a danger to people in the area and the fire may re-ignite. The correct term for Chemicals is Wet Chemical.
- 21.6 Chemical Systems
 - 21.6.1 Almost all fire suppression or extinguishing systems use special chemical agents which provide protection to the kitchen canopy and cooking appliances using grease and fats or producing residual grease and fats from the cooking process. Chemically based systems are in liquid form.
 - 21.6.2 These systems are activated either manually or automatically in the event of a fire. Thermal fusible links having different fuse temperatures are available and are chosen on a number of variables such as canopy height and cooking appliance layout.
 - 21.6.3 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.

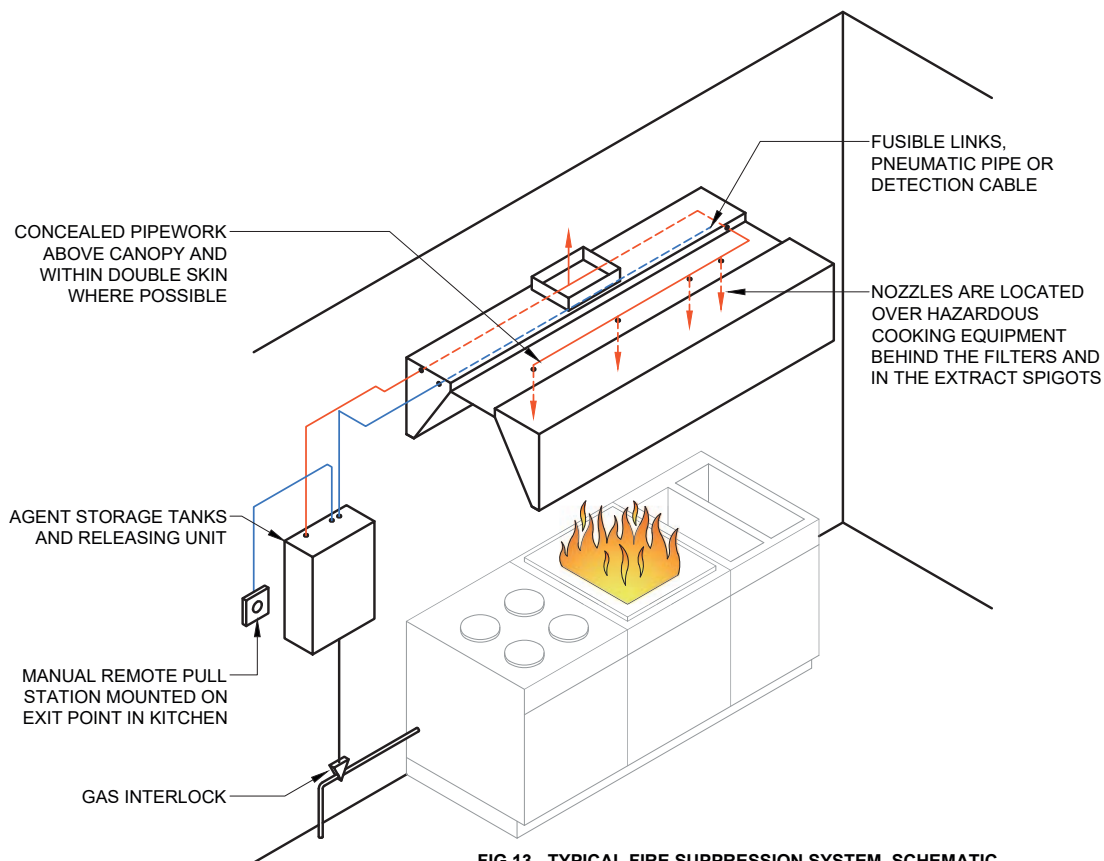


FIG 13 - TYPICAL FIRE SUPPRESSION SYSTEM SCHEMATIC

21.6.4 The chemical agent stored within the system is released along the distribution pipework. A gentle misting application is made at a rate that penetrates the heat pressure and gets to the seat of the fire. Wet Chemical systems use a chemical interaction to extinguish the flames. This is the primary function and that is the reaction termed saponification. As a result of the saponification a secondary foamy layer is produced and this creates a barrier to air enhancing the primary chemical reaction. It is not the element that prevents re-ignition. That is prevented with three elements

- 1) Saponification
- 2) Cooling as a result of the fine mist dropping the oil to below auto ignition temperature.
- 3) Foam layer to cut off air from the surface of the oil and fats.

21.6.5 All systems must have a manual actuation capability normally positioned adjacent to exit doors along escape routes.

21.7 Water Systems

21.7.1 The principle of this system has the same design philosophy, installation characteristics, mains shut off action and alarm status. A dedicated water supply can be used independent of a sprinkler system.

21.7.2 The water mist systems have pressure sensitive glass bulbs and as a fire is sensed the pumps are brought on line and all the pipework is pressurised. ALL heads in the system operate together not just the head affected by the heat. Water mist is sprayed throughout the canopy and over the appliances.

21.7.3 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.

21.8 Overlapping Systems

Appliance nozzles can be configured in an Overlapping pattern. This will invariably result in there being additional liquid suppressant tanks / cylinders in the system. The future benefits to the operator will potentially offset this. The capacity of the Overlapping nozzles are designed for any type and size of cooking appliance thereby facilitating trouble free future alterations to the type and layout of the cooking appliances.

21.9 System Design

21.9.1 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.

21.9.2 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
- Solid fuel
- Rotisserie
- Open Tandoori

21.10 Installation Considerations

21.10.1 Canopies and ventilated ceilings are required to have, by design, no snags, dirt traps and visible fixings so as to provide hygienic and cleanable surfaces as well as pleasing aesthetics. For this reason the use of visible fixings and surface-run pipework should be avoided.

21.10.2 Only vertical pipe droppers and nozzles should be used wherever possible within the canopy and under the ventilated ceiling.

21.10.3 Fire suppression pipework and detection runs should be installed such that they do not interfere with the operation and maintenance of grease separators, access doors, luminaires, UV-C cassettes, etc. To achieve this, it is essential that the fire suppression designer coordinates his work with the canopy or ventilated ceiling manufacturer.

21.10.4 The fire suppression pipework droppers and nozzles should not interfere with the operation of the cooking equipment. This is particularly important with the protection of salamander grills and equipment with opening lids such as bratt pans and boiling kettles.

21.10.5 Wherever possible, appliance nozzles (i.e. those serving cooking appliances under the canopy or ceiling) should be configured in an "overlapping/flood" type pattern. This may result in there being additional liquid suppressant tanks in the system, but the future benefits to the operator will, potentially, offset this. The use of the "overlapping" type nozzles is particularly important where mobile cooking equipment is

installed under the canopy/ceiling as the mobile equipment may not always be located correctly under “equipment specific” nozzle type installations. In addition, the “overlapping/flood” type installation will make it easier to accommodate any future alterations or additions to the cooking equipment installed under the canopy/ceiling.

- 21.10.6 “Overlapping” systems lend themselves to being factory fitted and thereby minimising costly site time.
- 21.10.7 A layout drawing of the proposed system shall be provided for co-ordination purposes and used during the installation works.
- 21.10.8 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.
- 21.10.9 For successful and correct operation, the liquid temperature in the containers shall not fall below 0°C or rise above 54°C.
- 21.10.10 Chemical fire suppressant is an alkaline solution, 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.
- 21.11 Testing and Commissioning
- 21.11.1 Once the system has been completely installed it shall be commissioned and tested in accordance with the manufacturer’s recommendations.
- 21.11.2 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.
- 21.11.3 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.
- 21.12 Maintenance
- 21.12.1 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. Maintenance should be carried out in line with the cleaning frequency and responsibility should be established for cleaning the external surface of the pipework and nozzles.
- 21.12.2 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 separators 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 and servicing.

- 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 22

Demand Controlled Kitchen Ventilation (DCKV)

DCKV systems are suitable for new systems and can be retrospectively fitted to most existing kitchen ventilation systems.

- 22.1 This is a system whereby the air flow rates to and from a canopy or ventilated ceiling in a commercial kitchen can be automatically adjusted according to the demands of the cooking activity. Maximum air flow rates should be assessed using Table 2 Appliance Coefficient and Temperature Schedule in Section 4. Consideration must be given to heat, room temperature and the risk associated with Carbon Monoxide (CO) and Carbon Dioxide (CO₂).
- 22.2 The primary benefit of this type of system is that the electrical energy consumed by carefully modulating extract and supply fans can be considerably reduced, as opposed to that consumed if both fans were running full speed continuously throughout the day. These savings will be further enhanced by the reduced cost of heating / cooling the make-up-air. Typical payback periods can be between 1 and 5 years, depending on operating hours.
- 22.3 Another beneficial side effect of controlling the speed of the fans throughout the day is that noise levels will be kept to an absolute minimum, thereby respecting the amenity of neighbouring premises.
- 22.4 Kitchen ventilation systems with total exhaust air flow rates exceeding 2.5m³.s⁻¹ should be considered for DCKV systems, with the following exceptions;
- At least 50% of all replacement air is transfer air that would otherwise be exhausted.
 - Heat recovery devices with sensible heat recovery effectiveness of not less than 40% are used on at least 50% of the total exhaust air flow.
- 22.5 DCKV systems shall be capable of at least 50% reduction in exhaust and supply air flow rates. The system shall include necessary controls to modulate air flow in response to appliance operation and to maintain full capture and containment of smoke, effluent and combustion products during cooking and idle modes.
- 22.6 When setting the algorithms for a DCKV system, it is essential that the minimum background ventilation of 20 air changes per hour is maintained at all times in the kitchen. A commercial kitchen where no cooking is taking place is classified as a Preparation Area, i.e. 20 air-changes per hour.
- 22.7 As the extract flow rate fluctuates in harmony with the cooking activity, it is crucial that the corresponding make-up-air flow rate alters proportionately in order to maintain the correct air balance.
- 22.8 Care must be exercised with any DCKV system to ensure that the correct air velocity through the grease-removal devices (separator) is not compromised thereby allowing excessive grease to enter the ductwork system.
- 22.9 Multiple sensors should be used to detect changes in temperature and the presence of smoke and steam. They should ensure that the optimum velocity through separators is maintained.
- Examples
- Air flow controlling device installed into each ductwork spigot.
 - Optical sensors under the canopy adjacent to the cooking equipment.
- 22.10 When there is no cooking activity, the temperature in the kitchen must be compared with that in each extract plenum. In the event of an increase in

temperature difference the fans must be increased accordingly to clear the residual heat from occupants, solar gains, refrigeration equipment etc.

- 22.11 The systems require efficient controls in order to accurately monitor / regulate the air flow rates appropriate to the ever-changing cooking activity. Systems can be provided with electronic data logging and remote access for analysis and adjustment.
- 22.12 Carbon Monoxide (CO) and Carbon Dioxide (CO₂) detectors must be installed and positioned in accordance with the manufacturers instructions. See Figure 17 for typical locations. Detectors must override the settings of the DCKV system.
- 22.13 It must be borne in mind that, if ultraviolet lamps (UV-C) are incorporated within the system, then there will be an increased production of ozone (O₃) at times of lower extract flow rate.
- 22.14 It is of vital importance that in the event of DCKV system malfunction, then the DCKV system must automatically default to full air flow until such times as the malfunction is rectified.
- 22.15 For Gas Interlocking see Section 20.

SECTION 23

Services Distribution Units

- 23.1 Services 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 14) 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 separators.
- 23.2 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.
- 23.3 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.
- 23.4 For columns containing gas services a ventilation grille is required at high and low level.
- 23.5 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.
- 23.6 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.
- 23.7 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.
- 23.8 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.
- 23.9 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.
- 23.10 When the integral services are factory fitted, then the supplier shall be responsible for testing and certification and for the provision of earth bonding.
- 23.11 Services 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.

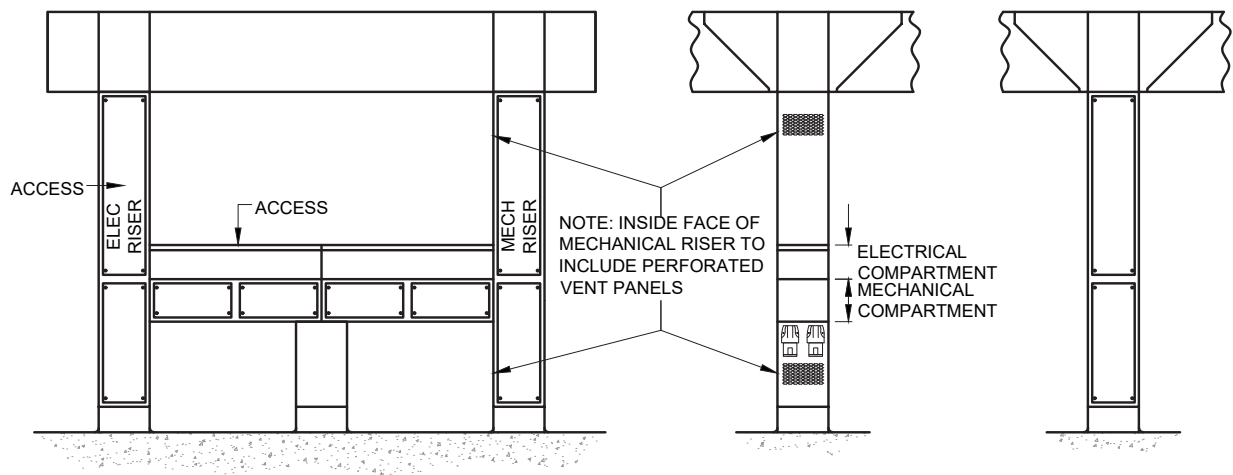


FIG 14 - TYPICAL SERVICES DISTRIBUTION UNIT

SECTION 24

Pollution Control

- 24.1 Most codes and regulations call for the exhaust air from commercial kitchen ventilation systems to discharge at least 1 metre above ridge level. However, with an effective pollution control system installed, and subject to Local Authority approval, it should be possible for the discharge to be made at low level.
- 24.2 It must be appreciated that no pollution control system for commercial kitchen ventilation is 100% effective. If properly designed and installed, it can drastically reduce the level of pollution, but never totally.
- 24.3 A pre-cursor for considering pollution control for any commercial kitchen ventilation system is the crucial importance of incorporating the most efficient type of canopy / ventilated ceiling complete with high-efficiency primary filtration.
- 24.4 Key considerations for low-level discharge are;
- Whether the discharge is into a confined area such as a courtyard.
 - Whether it is positioned too close to air intake systems.
 - Whether the unit can be effectively and safely maintained.
 - All necessary approvals are granted.

- 24.5 In the context of commercial kitchen ventilation, Pollution Control relates to the following pollutants;

- Particulate matter (smoke and grease)
- Cooking odours
- Surplus Ozone (only applicable if UV-C is involved)
- Heat
- Noise

Control of any, or all, of these pollutants is project-specific and each should be judged on its own requirements / local regulations.

- 24.6 Reduction of Particulate Matter (smoke and grease)

Not all cooking operations create smoke and grease in the exhaust air system, but those that do require a level of treatment.

The particle size of the airborne smoke and grease, at the point of discharge, should be reduced to 0.3 microns, or smaller, as this is then invisible to the human eye.

Electrostatic Precipitators (ESPs) can be incorporated into the system for this purpose or, alternatively, 3 stages of disposable filters. See Appendix B Table 13a, 13b and 13c.

Care must be exercised when selecting ESPs for particulate removal as, at higher velocities, small particles can pass through untreated.

- 24.7 Reduction of Cooking Odours

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

These odour molecules, or volatile organic compounds (VOCs), are too small to be removed by filtration alone, the solution being provided by selecting a combination of equipment from the following options, the extent of which will vary according to the expected level of pollution.

Activated Carbon Filters

- Widely used in the past as the only means of odour control.
- Require high level of upstream protection otherwise the useful lifetime of the cells can be very short.
- Increasingly not accepted by Local Authorities as the primary means of odour control due to their regular need for replacement and the associated “policing” issues.

Ultraviolet Lamps (UV-C)

- Can be mounted in the exhaust plenum of the canopy or ventilated ceiling, or even in a remote Ecology unit.
- Breaks down the longchain hydrocarbon molecules in the exhaust airstream by means of photolysis.
- At the same time, at 185 nm wavelength, ozone (O₃) is released thereby oxidising the molecules by ozonolysis, leaving typical by-products of carbon dioxide and water.
- Works best at an air temperature of 42°C and in humid air.
- End result is the reduction of airborne grease into the ductwork system and, with careful selection of the number of lamps, a drastic reduction in the cooking odours at the point of discharge.
- Imperative that safety devices are in place to ensure that the lamps turn off in the event of loss of airflow and that the kitchen staff cannot see the lamps in operation when routinely removing separators. An interlock shall be fitted between the fan and UV-C system.
- A local electrical isolator must be provided adjacent to the UV-C lamps in the canopy / ventilated ceiling.
- These lamps require regular maintenance to ensure that the safety devices are in full working order.

Electrostatic Precipitators (ESPs)

- Should not be considered as a primary form of odour control, albeit that they are very successful at removing grease from the airstream thereby extending the life of any downstream disposable filters by up to 80%.

24.8 Reduction of Surplus Ozone

If UV-C lamps are employed as the means of odour control, there will be times during the daily cooking operation when there will be insufficient contaminants in the exhaust airstream to consume the ozone being produced. Therefore, it is necessary to incorporate a form of filtration to adsorb this surplus ozone prior to discharge to atmosphere. The recommended means for achieving this is to incorporate a bank of activated carbon filters selected to adsorb (acts as a surface onto which ozone reacts and reverts back to oxygen) the ozone molecules. These must be capable of reducing the airborne ozone down to 10ppm which is a World Health Organization (WHO) recommendation.

24.9 Reduction of Heat

This is seldom a problem unless the increase in air temperature adjacent to the point of discharge to atmosphere is likely to have an adverse effect on supply air intakes or the operation of air-cooled condensers that might be in the vicinity. A heat recovery device could be included in the system which would have the side effect of reducing the temperature of the discharge air.

24.10 Reduction of Noise

Noise pollution can be a very subjective issue. What is acceptably quiet to one person, can be unacceptably noisy to somebody else. Many specifications

stipulate the maximum noise level that must be achieved at the point of discharge. Specific advice should be sought from an acoustic specialist where specified noise levels are required to be low. See Section 17 Sound Attenuation.

- 24.11 Whatever type of pollution control is implemented, the increase in system resistance shall be included when selecting the fan
- 24.12 As levels of expectancy become increasingly higher with respect to pollution control, particularly in dense urban areas, many Planning Authorities are calling for high-performance odour control systems to be incorporated from the outset. This can even apply to kitchen exhaust systems with high-level discharge where it is perceived that neighbours with roof gardens / patios, mansard structures with openable windows, etc might suffer a loss of amenity.
- 24.13 The UK Building Regulations require that all fan-powered ventilation systems, in both new and existing premises, are energy efficient, the Specific Fan Power (SFP), measured in Js^{-1} , must be provided.

However, given the nature of Pollution Control Units for commercial kitchens, often including numerous levels of fine filtration and heat recovery, it is recommended that these units are treated as “Process Plant” and, therefore, exempt.

SECTION 25

Recirculation Systems

25.1 This section deals with those commercial kitchen ventilation systems that do not discharge the ventilated air to atmosphere, but recirculate the treated air back into the space.

25.2 In December 2016, Westminster City Council issued “Guidelines for the control of odour from commercial kitchen extract ventilation systems”. In these guidelines it states;

New planning applications for commercial kitchens must be accompanied by either of the following:

- A scheme for full height kitchen extract discharge where the operation involves a full range of cooking, utilising any fuel types such as gas, electricity or solid fuel.

OR

- An approved recirculation scheme where all food operations are undertaken utilising electricity only.

25.3 Approval of a recirculation scheme shall require compliance with the following:

- No external discharge to atmosphere of any cooking effluent fumes.
- All food / cooking equipment to operate by ELECTRICITY only.
- The recirculated air must comply with the Workplace (Health, Safety and Welfare) Regulations 1992. These Regulations require that employers provide a safe and comfortable environment including effective ventilation in every enclosed workplace including kitchens.

25.4 Any proposal must therefore show that the design of the system has been tested to achieve the following standards for the quality of the recirculated air.

- Humidity (target 40-60%)
- Temperature (target 25°C ambient)
- Comply with occupational exposure limits as stated in HSE publication “EH40 Workplace Exposure” particularly for;
 - Airborne dusts (Aerosols)
 - Gases (CO, CO₂, NO_x)
 - Hydrocarbons

25.5 The recirculation system this must have the following design features;

- The recirculation system must not incorporate Ultra Violet / Ozone as part of the filtration process—this would exclude the installation of Electrostatic Precipitators (ESPs)
- The recirculation system must be interlocked with the electric cooking equipment such that cooking is only enabled when airflow is established and proved.
- The status of filters within the Recirculation Unit must be monitored to maintain system performance, recirculating air quality and kitchen staff wellbeing.
- The removal of any filters from the system must render the system inoperable by default.
- System must display clear signage stating that no gas or solid fuel equipment can be deployed at the premises.

- 25.6 The design of the system must utilise components that enable operators, if they so wish, to engage third parties to carry out maintenance of the system particularly after any guarantee period.

Care must be taken to ensure that the fresh air requirement of 10 l.s⁻¹/person is complied with.

- 25.7 Operating and maintenance instructions must be issued to the operator.

SECTION 26

Heat Recovery

- 26.1 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
- 26.2 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.
- 26.3 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 (minimum 73%).
 - 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 (minimum 68% efficiency). A circulating pump and pressurisation provisions are required for the pipework system. A further benefit of this form of heat recovery is that the recovered heat can be used to pre-heat the incoming fresh air during the winter months. When the outside ambient does not call for heating the recovered heat can be used to pre-heat the domestic hot water service.
 - 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. (Minimum 73% efficiency)
 - 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.
- 26.4 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 27

Installation

- 27.1 To ensure the smooth running of an installation, the following items shall be established at an early stage of the contract.
- 27.2 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.
- 27.3 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.
- 27.4 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.
- 27.5 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.
- 27.6 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.
- 27.7 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 airtight integrity of the ventilated ceiling system.
- 27.8 Canopies are fabricated to specific geometric shapes and dimensions. During the installation, inaccuracies in the building structure may be highlighted.
- 27.9 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.
- 27.10 For canopies, the provision of ceiling trims will normally be undertaken by the false ceiling contractor. Care should be 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.
- 27.11 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.
- 27.12 The supplier shall ensure that the canopy/ventilated ceiling performance rating plate has been fitted.

SECTION 28

Testing and Commissioning

- 28.1 This section covers the requirements for testing the completed installation. The responsibility for this will depend upon the particular contract provisions.
- 28.2 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 separators 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.
 - Air flow rate through the canopy itself must be verified and not just at the fan as this does not take into account leakage throughout the system.
 - 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.
 - CO and CO₂ levels adjacent to the canopies and in the centre of the room when gas fired appliances are used. See Section 14 Solid Fuel Appliances.
- 28.3 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 separator size used.
 - Recommended velocity passing through the separator.
 - The pressure drop across the separator.
 - Whilst the grease extraction rate may be stated, this is not relevant to testing.
- 28.4 The air velocity passing through the separator or grille shall be first determined by using an anemometer. This figure is then multiplied by the face area of the separator or grille to arrive at the extract flow rate. The flow rate through each separator 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.
- 28.5 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.
- 28.6 Noise levels shall be checked to ensure that a maximum internal noise level of 50-55dBA 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 2dBA on completion of the installation. The use of vertical discharge, slow running fans and low duct velocities should help to achieve these levels.
- 28.7 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.

- 28.8 Further advice on commissioning may be obtained from TR/19, CIBSE and BSRIA application manuals (see Appendix J).

SECTION 29

Cleaning and Maintenance

Table 12 Kitchen grease extract systems

Perceived level of grease production	Typical example	Cleaning intervals (months) Daily usage			
		up to 6 hours	6-12 hours	12-16 hours	16+ hours
Low	No significant production of grease laden aerosols during normal daily food production operations	12	12	6	6
Medium	Moderate production of grease laden aerosols during normal daily food production operations	12	6	4	3
High	Heavy, significant or continual production of grease laden aerosols during normal daily food production operations	6	3	3	2

Notes to Table 12

- 1 Commercial liability/property insurance policies invariably contain conditions and warranties that stipulate a minimum cleaning frequency for grease extract ductwork systems under the insurance contract which can be a higher frequency of cleaning than TR/19 recommendations. Failure to comply with such requirements will invalidate the property insurance policy.
 - 2 The canopy and canopy/extract plenum is an area of higher fire risk and consideration should be given to more frequent cleaning in accordance with insurers' requirements.
 - 3 Periodic specialist cleaning should be accompanied by daily or weekly cleaning of canopies, filters and associated drains and traps in accordance with manufacturers' recommendations, typically carried out by the kitchen operator, in compliance with the property insurers' requirements.
- 29.1 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 2m centres, thereby enabling full cleaning of the system without manned entry. 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 BESA publication TR/19 - "Guide to Good Practice - Cleanliness of Ventilation Systems", (Appendix J) and Fire Protection Association RC44. For fire resistant ductwork refer to Appendix D.
- 29.2 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.
- 29.3 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.
- 29.4 Typically the minimum cleaning period for baffle type self draining separators 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.
- 29.5 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.

- 29.6 Compliance with the appropriate COSHH Regulations must be ensured with all cleaning materials and for thorough examination and testing of ventilation systems serving solid fuel appliances.
- 29.7 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.
- 29.8 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.
- 29.9 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.
- 29.10 In addition to daily cleaning and a weekly maintenance programme a specialist ventilation hygiene contractor should be appointed to clean and maintain the grease extraction systems and make up air systems (if required) as TR/19.
- 29.11 Manufacturers shall be consulted for maintenance procedures for proprietary plant and fire suppression systems where fitted.
- 29.12 Where grilles are fitted, they shall have easily removable cores to facilitate cleaning.
- 29.13 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.

APPENDIX A

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 ⁻¹	0.0004719
m ³ .s ⁻¹	cfm	2119
cfm	l.s ⁻¹	0.4719
l.s ⁻¹	cfm	2.119
cfm/ft	m ³ .s ⁻¹ .m ⁻²	0.001548
m ³ .s ⁻¹ .m ²	cfm / ft	646
fpm	m.s ⁻¹	0.00508
m.s ⁻¹	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 °C to °F: $x 1.8 + 32$ To Convert °F to °C: $-32 x 0.556$

APPENDIX B

Filter Classifications

- B1 The information contained in this section is based on ISO 16890-1 : “Air Filters for General Ventilation”.
- B2 It is an efficiency classification system of air filters for general ventilation based upon particulate matter (PM). It also provides an overview of the test procedures, and specifies general requirements for assessing and marking the filters, as well as for documenting the test results. It is intended for use in conjunction with ISO 16890 2, ISO 16890 3 and ISO 16890 4.
- B3 According to this ISO standard, filters are divided into four groups (refer to Table 13a). A prerequisite for each group is that a filter captures more than 50% of the appropriate particle size range. If a filter, for example, captures in excess of 50% of PM1 particles, it will be grouped as an ISO 16890 ePM1 filter.

Table 13a	
ISO 16890	Group Classification
ISO ePM1	ePM1, min > 50%
ISO ePM2.5	ePM2.5, min > 50%
ISO ePM10	ePM10, > 50%
ISO coarse	ePM10 > 50%

- B4 Table 13b indicates how actual filter testing can vary when trying to compare the original specification, EN779, with ISO 16890.

For example, F7 class filters can vary from ePM1 50% to ePM1 75%. This is a 25% filter efficiency variation in one popular classification, thus demonstrating that ISO 16890 is a much more accurate and descriptive classification to show filter efficiency than EN779.

- B5 ePM1 is the best filter performance going down through ePM2.5 to ePM10. Coarse class filters have a gravimetric test and not the efficiency tests of the ePM classes.
- B6 It is intended that supply air systems serving commercial kitchens should incorporate high efficiency filters such as ePM1 70% or 75%.

Table 13b		
16890	ISO 16890	EN779
High End	Low End	–
none	none	G1
Coarse 40%	Coarse 30%	G2
Coarse 50%	Coarse 40%	G3
Coarse 70%	Coarse 60%	G4
ePM10 60%	Coarse 85%	M5
ePM2.5 50%	ePM10 70%	M6
ePM1 75%	ePM1 50%	F7
ePM1 80%	ePM1 70%	F8
ePM1 85%	ePM1 80%	F9

B7 EN1822 : filter test standard for Epa and Hepa standards, E10 to H13. See Table 13c.

Table 13c		
EN 1822	EN 1822	EN 1822
Global	Local	
MPPS	MPPS	
85%		E10
95%		E11
99.5%		E12
99.95%	99.75%	

APPENDIX C

Indices of Protection (IP)

An index of protection known as an IP rating, 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.

Table 14			
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 15° from the vertical.
3	Protection against solid bodies larger than 2.5mm.	3	Protection against drops of rain water at 60° from the vertical.
4	Protection against solid bodies larger than 1mm.	4	Protection against solid bodies larger than 1mm.
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.
<i>These indices are provided in accordance with IEC529, BS5490 and DIN400 50.</i>			

APPENDIX D

Fire Resistant and Smoke Control 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 resistant 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°C. Flammable vapours are given off at 200 - 230°C and spontaneous ignition occurs at 310 - 360°C. 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, see Section 21.
- 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 9999 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 EN 1366-1. Fire inside (Type B) is rated for Integrity (E) and Insulation (I) 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 adjacent compartment shall also meet the insulation criteria.
 - Clause 32.5.4 of BS 9999:2017 states that "for non-domestic kitchens, extract ductwork should be entirely independent of each other and of any ventilation ductwork serving other parts of the building".

This is interpreted to mean that;

- a. Kitchen canopies or ventilated ceilings on different floor levels cannot be interconnected with the same “common” extract ductwork.
- b. Kitchen canopies or ventilated ceilings in different fire compartments on the same floor cannot be interconnected with the same “common” extract ductwork.

- D7 There are four ways of protecting ductwork recommended in BS 9999 where compartmentation is breached.

Method 1 covers the provision of thermally activated 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 resistant 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 resistant 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 resistant boards, as the boarding itself may absorb grease and be incapable of being cleaned.

Method 4 covers the provision of automatically actuated fire and smoke dampers triggered by smoke detectors located where the duct penetrates fire resisting compartments such as walls and 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.

- D8 In all cases where fire resistant 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. Any reduction in the performance of the insulation criteria needs to form part of a fire risk assessment and should be agreed with the local authority and a written record retained.

- D9 For both fire resistant and smoke control ductwork, the periods of 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 resistant ductwork, which shall comply with BS EN 1366-1 for fire rated ducts or BS EN 1366-8 for Smoke control ductwork, 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 resistant system unless the materials and construction of the whole system is in accordance with the requirements of British Standards.

- D10 The fire resistance 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 (duct A scenario). The insulation shall ensure that temperatures on the inside of the duct shall not exceed 140°C average above ambient and 180°C 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 resistant 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 90% 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 resistant compartments and motors must be rated to a minimum of 300°C 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 Access doors fitted must be the same construction and must not compromise the fire protection integrity of the system. Safety Notice:- some older fibrous boarded products may contain asbestos. Always treat with caution and if suspected as possibly containing asbestos, then consult a specialist before disturbing.
- D15 While this document has been updated to suit the latest specifications it must be acknowledged that until such time the product standard for fire resisting ductwork BS EN 15871 is published it is acceptable to use fire resisting ductwork tested to BS476-24 instead of BS EN1366-1. It is for the specifier/designer to decide which product standard to use.
- D16 Further information on fire resistant and smoke extract ductwork can be found in BESA DW/146 Guidance Document for Fire Resisting and Smoke Control Ductwork in Buildings and the Association of Specialist Fire Protection's publication "Fire Resisting Ductwork - An Industry Guide to Design and Installation" (aka the Blue Book).

APPENDIX E

Air Conditioned Kitchens

- E1 Section 4 showed that the two main sources of heat into a kitchen space comprised:
Radiant - 35% (Q_{rad}) and Convective - 65% (Q_{conv})
- 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 - (Q_{gen}).
- E3 The amount of Q_{rad} and Q_{conv} 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 Q_{conv} and the associated impurities are captured by the canopy (see fig 15).
- 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 (Q_{esc}), together with the radiant heat (Q_{rad}) and general gains (Q_{gen}), can be treated by means of an air conditioning system (see fig 16).
- 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:

$$Q_{esc} = (1 - Heff) \times Q_{conv}$$

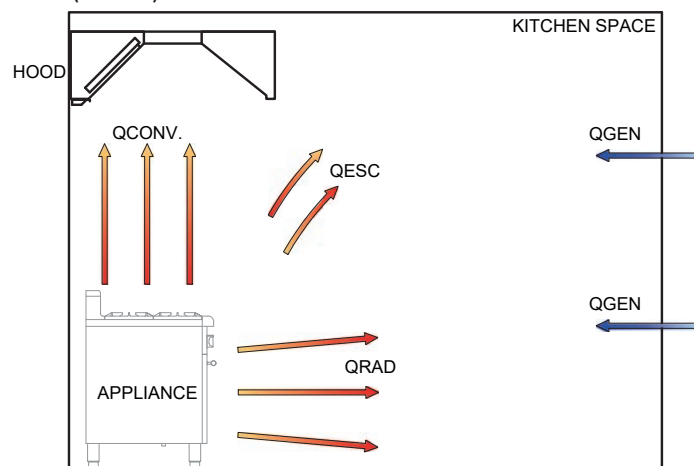


FIG 15 - PATTERN OF HEAT GAIN IN KITCHEN

- E6 In order to combat the extremely high heat loads in most commercial kitchens, calculations could indicate that the incoming supply air would have to be as low as minus 8°C.

Therefore it is often totally impractical to try and maintain a temperature controlled environment within the kitchen.

Once these variables are established, the total heat load (Q_{tot}) can be calculated by using the following energy balance equation:

$$Q_{tot} = \text{Sensible Heat } (Q_{sens}) + \text{Latent Heat } (Q_{lat})$$

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 Table 15.

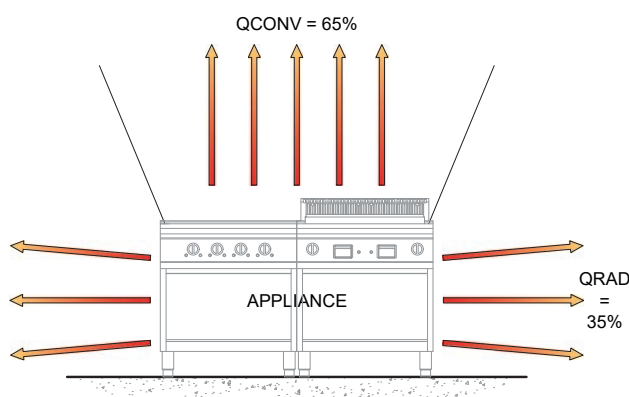


FIG 16 - PROPORTION OF APPLIANCE HEAT EMISSION

- 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)

Table 15 Heat Gain Calculation	
Sensible Heat $Q_{sens} = P \times cpm \times \Delta t \times q_s$ (kW)	
Latent Heat $Q_{lat} = P \times Hfg \times \Delta g \times q_s$ (kW)	
(specific latent heat of evaporating heating from tables for properties of water and steam)	
where:	
Q_{sens}	= $Q_{rad} + Q_{esc} + Q_{gen}$. (kW) (where $Q_{esc} = (1-H_{eff}) \times Q_{conv}$)
Q_{lat}	= latent heat given off by occupants etc. (kW)
P	= density of air. (kg.m ³)
C_p	= specific heat capacity of air. (kJ.kg ⁻¹ °C)
Δ	= temperature difference between supply air
	T_s and room condition (T_r) (°C) (normally 8 - 10°C)
Δg	= moisture content difference between supply
	air (G_s) and room condition (G_r) (kg.kg ⁻¹)
q_s	= supply air flow rate (m ³ .s ⁻¹)
Hfg	= latent heat energy of moisture at room conditions (kJ.kg ⁻¹)
	(latent heat of vaporisation from steam tables)

APPENDIX F

Carbon Monoxide

- F1 Carbon Monoxide (CO), by definition, is a colourless, odourless, tasteless, toxic, flammable gas formed by incomplete combustion of any material containing carbon. It is the result of oxygen-starved combustion.
- F2 It is slightly less dense (lighter) than air and doesn't occur naturally in the atmosphere.
- F3 It is an Indirect Greenhouse Gas.
- F4 Moderate exposure can lead to serious permanent health issues or death.
- F5 In the context of commercial kitchen ventilation, it is widely accepted that old, poorly maintained gas-fired catering equipment can produce unhealthy quantities of Carbon Monoxide. It is now also accepted that solid fuel appliances continue to produce Carbon Monoxide until all the fuel is extinguished. In reality, this means that when a chef at the end of the working day turns off all his gas and electric cooking equipment, and the ventilation system, any unburnt solid fuel continues to emit this poisonous gas into the kitchen.
- F6 A Carbon Monoxide detector should be wired into the ventilation system to provide 24 hour protection for adjacent premises and for kitchen staff returning the next day.

APPENDIX G

Carbon Dioxide

- G1 Carbon Dioxide (CO₂), by definition, is a colourless, odourless gas produced by burning carbon and organic compounds, and by respiration.
- G2 It is approximately 1.7 times heavier than air and is a naturally occurring chemical compound
- G3 It is a significant Greenhouse Gas and the average level of CO₂ in the Earth's atmosphere is 400ppm.
- G4 In the context of commercial kitchen ventilation, since April 2012, it has been a requirement (IGEM/UP/19) that any commercial kitchen, with at least one item of gas-fired cooking equipment, shall demonstrate that prior to handover the levels of CO₂ in the kitchen do not exceed 2800ppm.

The reasoning behind this is that it has been proved that internal CO₂ levels of 2800ppm and above adversely affect the concentration levels of the occupants of the room.

- G5 The consequence of this threshold being reached prior to handover is that the Gas Safe engineer is instructed to lock off the gas supply to the kitchen until such times as the CO₂ level has been reduced. Typically, the only 2 options available are to either arrange for item(s) of gas-fired equipment to be exchanged for electrically powered models, or to ramp up the ventilation system, assuming that there is sufficient spare capacity in the fans, ductwork, etc.
- G6 A Carbon Dioxide detector should be wired into the ventilation system to ensure that this threshold is never exceeded during operating times.

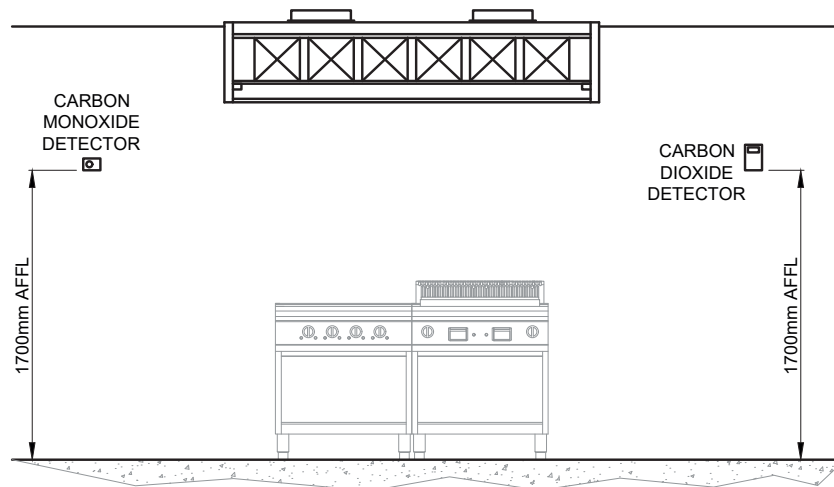


FIG 17 - TYPICAL CARBON DIOXIDE/CARBON MONOXIDE DETECTION

APPENDIX H

Ozone

- H1 Ozone (O₃), by definition, is a gas composed of 3 atoms of Oxygen. It is heavier than air, blue in colour and has a strong pungent odour. It can be damaging to health if inhaled in anything other than small concentrations.
- H2 Environmental scientists have classified Ozone into 2 categories; Good Ozone and Bad Ozone.
- Good Ozone is also called Stratospheric Ozone and occurs naturally in the upper atmosphere. In simple terms, it protects life on Earth from the Sun's harmful ultraviolet (UV) rays. The Stratosphere is the layer of space 6 to 30 miles above the Earth's surface.
- Bad Ozone, also known as Tropospheric Ozone or Ground Level Ozone, is not naturally occurring and is found in the Troposphere, the layer that forms our immediate atmosphere. Ground Level Ozone, although not naturally produced, can be harnessed and used in various processes such as commercial kitchen ventilation. Extreme care, however, must be exercised when considering the levels of O₃ that are released into the atmosphere.
- H3 The World Health Organization (WHO) states that O₃ must not be discharged to atmosphere at levels higher than 10ppm. Where air is being extracted at low level into a sensitive area (near windows, air intake louvre, or where people are present), the use of an ozone destruct system is recommended.
- H4 Surplus Ozone produced by the incorporation of, say, 185nm UV-C lamps into the kitchen exhaust system, can be reduced by either subjecting the exhaust air to very high temperatures, bright radiated light or by adsorption (activated carbon filters).

APPENDIX J

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CAIS 23 Gas safety in catering and hospitality.

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EH40 Workplace exposure limits.

COSHH Control of Substances Hazardous to Health

CESA Catering Equipment Suppliers Association

www.cesa.org.uk tel 020 7793 3030

CEDA Catering Equipment Distributors Association Ltd.

www.ceda.co.uk tel 01386 793911

FCSI Foodservice Consultants Society International

www.fcsi.org

Building Engineering Services Association Tel: 020 7313 4900

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Office of the Deputy Prime Minister

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

Notes

Example of a well designed kitchen appliance ventilation system for a single canopy installation

1. Supply air intake
2. Supply air filter module (section 10.7 & Appendix B)
3. Heater battery module (electric/lphw/gas fired) (section 10.6)
4. Supply fan - A.V. mounted, low noise centrifugal type (section 15)
5. Access panels for cleaning - sized & positioned with consideration for future maintenance (section 29 & BESA DOCUMENT TR/19)
6. Ductwork - properly sized extract & supply ductwork to minimise air noise & resistance to airflow with balanced spigot connections to distribute air along length of canopy (section 18)
7. Weathering cravat for roof penetration with suitable builder's curb detail (see BESA DW/144)
8. Duct/plant support system - non penetrative when external - to preserve waterproofing
9. Carbon filtration module with suitable pre-filter - where required - to be sited under negative pressure (pre fan) (section 24)
10. Flexible connections to isolate fan noise & transmission through duct (section 15)
11. Extract fan - av mounted, low noise centrifugal - positioned so as to keep all internal ductwork under negative pressure (pre fan). also consider fan position for future maintenance access. for high temperature output equipment consider 'motor out of airstream' (section 15)
12. High velocity discharge cowl positioned as high as 1m above roof ridge complete with suitable drain point (integrated or at bottom of stack). (section 18, see also DEFRA guidance)
13. Ductwork fixing brackets - suitable for application (section 18)

Example calculations:

Duct size: (for velocities see section 17 table 14)

	Supply	Extract
Main runs	500x450 @ 7m.s ⁻¹ (6-8m.s ⁻¹ recommended)	500x500 @ 7m.s ⁻¹ (6-9m.s ⁻¹ recommended)
Branch runs	550x550 @ 5m.s ⁻¹ (4-6m.s ⁻¹ recommended)	550x550 @ 6m.s ⁻¹ (5-7m.s ⁻¹ recommended)
Spigots (3x)	350x350 @ 4m.s ⁻¹ (3-5m.s ⁻¹ recommended)	350x4300 @ 6m.s ⁻¹ (5-7m.s ⁻¹ recommended)

Extract flow rate:

Item	Plan size	Power	Qty	Area	Coefficient	Flow rate
1. Salamander	600x450	Gas	2	0.27	0.75	0.405
2. Bench	1400x650	-	1	0.91	0.03	0.027
3. Open top range	900x800	Gas	1	0.72	0.40	0.288
4. Fryer	700x800	Elec	2	0.56	0.45	0.504
5. Bench	300x800	-	1	0.24	0.03	0.007

Total

1.231

Canopy factor overhead wall open one end +20%

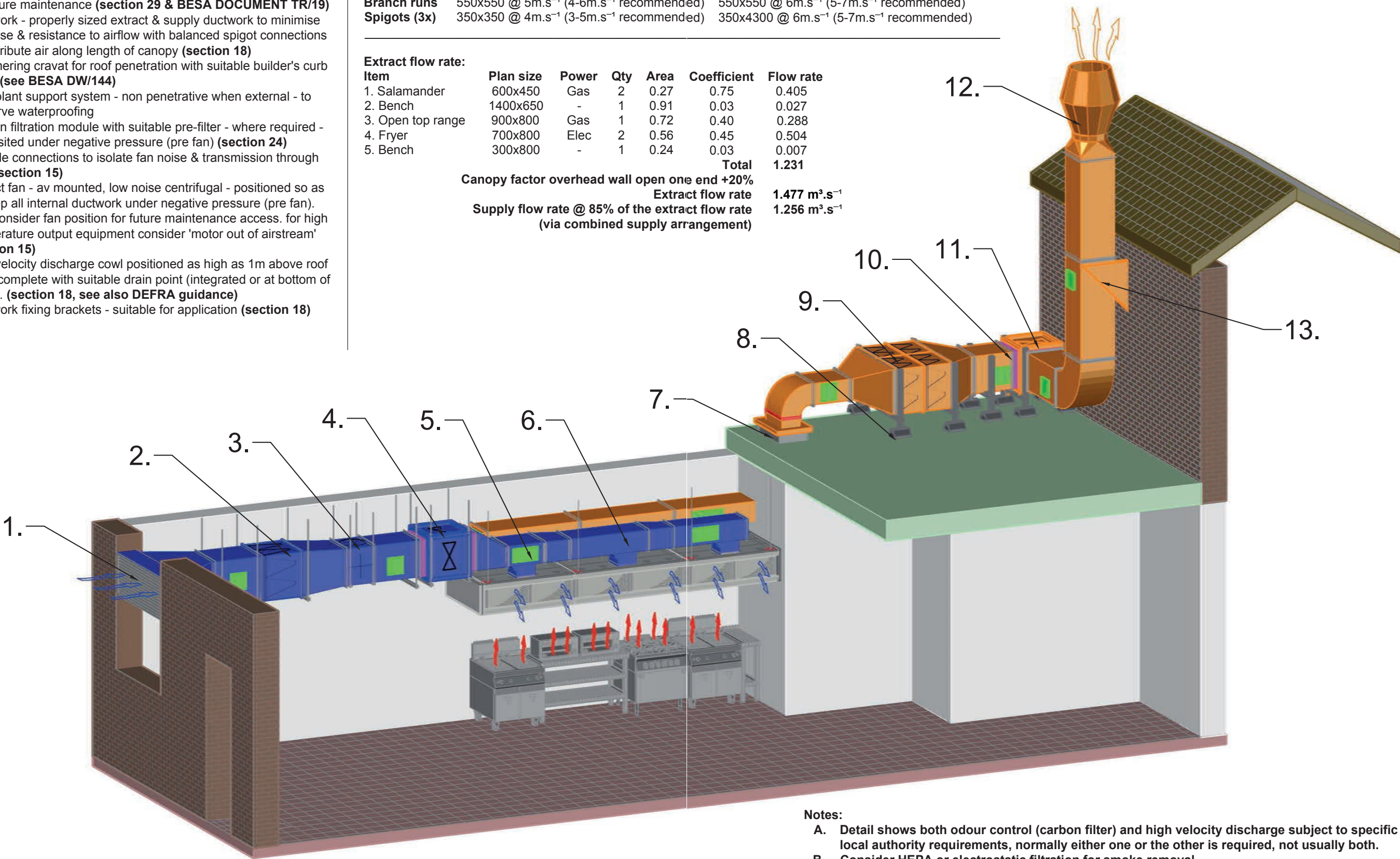
Extract flow rate

1.477 m³.s⁻¹

Supply flow rate @ 85% of the extract flow rate

1.256 m³.s⁻¹

(via combined supply arrangement)



Notes:

- A. Detail shows both odour control (carbon filter) and high velocity discharge subject to specific local authority requirements, normally either one or the other is required, not usually both.
- B. Consider HEPA or electrostatic filtration for smoke removal
- C. Consider in-canopy u.v. filtration to reduce odour & minimise downstream grease build up.
- D. NOTE: This detail only shows the ventilation of cooking appliances. Other general ventilation of adjacent kitchen areas is not shown (See section 3)



BESA Publications
Old Mansion House, Eamont Bridge, Penrith, Cumbria, CA10 2BX
Tel: 01768 860405, Fax: 01768 860401
Email: publications.info@theBESA.com
Web: www.BESApublications.com