Technical Bulletin 140

Developed in conjunction with the Institution of Gas Engineers and Managers (IGEM)

Title: Guidance on ventilation and extract requirements for commercial catering installations

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Note: *This Technical Bulletin 140 supersedes information that was previously contained in TB 093, originally published 15 April 2011, which is now withdrawn. This version incorporates up to date industry guidance to ensure that the information remains both current and relevant. A revised version of HSE Catering Information Sheet 23 (CAIS 23) will be made available separately for caterers by HSE.*

This Technical Bulletin has been developed in conjunction with the Institution of Gas Engineers and Managers (IGEM) and replaces HSE Guidance Note Catering Information Sheet 23 (CAIS23) for the catering sector, providing technical information for Gas Safe registered businesses/engineers and commercial kitchen designers.

Introduction

The aim of this bulletin is to clarify some of the requirements and options for new and existing commercial catering installations, large and small.

The primary standards for reference are BS 6172[(1)], BS 6173[(2)] and BS 5440-2[(3)].

The requirements for school teaching areas are covered in IGEM/UP/11[(4)].

All new appliances must be CE marked, refer to BS 6173[(2).]

Only relevantly qualified Gas Safe registered engineers are permitted, to install, commission, repair and maintain gas installations within catering establishments.

Overview

BS 6173[(2)] is targeted at commercial catering installations and is not intended to apply to dwellings or most domestic premises, such as those in Bed and Breakfast installations for which reference would normally need to be made to standards such as BS 6172[(1)] and BS 5440-2[(3)]. However, some installations may border on commercial activities due to their high cooking loads and this would need to be taken into consideration when deciding on the most appropriate Standard to apply.

What really matters is how often the kitchen is used and the cooking load. For example, the country pub with two domestic cookers might rely on a microwave for serving hot food with little use on the gas cooking. Equally it might use two or three domestic cookers in continual operation if for example it is in a holiday area and thus will require more ventilation than stated in BS 5440-2[(3).]

It is possible that natural purpose provided ventilation could achieve adequate safe levels of Carbon Dioxide (CO_2) in a kitchen environment. However for small spaces with a large cooker or large catering installations, the installation of mechanical ventilation would normally be required. This may or may not require mechanical extract canopies but special care will be needed to ensure good air movement within the space to ensure a safe working environment.

A risk assessment approach should be employed to assess the application of ventilation, canopies and interlocks of any type in use, to ensure the safety of staff and, where appropriate, any customers. This is to ensure what is provided is considered to be a sensible and safe solution. It is therefore important that all installations, other than those in dwellings, are required to be risk assessed, looking at the range of safety issues.

Definition of appliances

- **Type 'A' appliance. '**An appliance not intended to be connected to a flue or a device for evacuating the product of combustion to the outside of the room in which the appliance is installed' (from PR CEN/TR 1749[(6)]).
- **Type 'B' appliance.** 'An appliance intended to be connected to a flue that evacuates the product of combustion to the outside of the room containing the appliance. The combustion air is drawn direct from the room' (from PR CEN/TR 1749[(6)]).

  In some cases a Type 'B' appliance may be terminated internally under the extract canopy providing other provisions are made to safely remove the products of combustion.

Ventilation system design – general aspects

The current advice used in the industry is provided by the Building & Engineering Services Association (B&ES) [Formally the Heating and Ventilation Contractors Association (HVCA)] in their publication DW 172[(10)] Specification for kitchen ventilation systems.

This information has been developed to safely remove cooking products from a kitchen area but does not claim to guarantee that the combustion products will be diluted to figures required in BS 7967-5[(7)]. In reality in the great majority of cases it does however achieve the desired kitchen working conditions.

The information contains advice on materials selection and on canopy design. It recognises that what goes in must come out and thus kitchens will be fitted with either mechanical or natural ventilation (or a combination of both).

No advice is given in DW/172[(10)] on the sizing of natural ventilation grilles but standards such as IGE/UP/10[(8)] indicate that the free area of grilles can be designed using a grille face velocity of 2m/s. This means that to dilute the products of combustion to 2500ppm CO_2 requires approximately 48m^3 per hour of air per kW of heat input. This equates to approximately 70cm^2 for free grille open area per kW of heat input. In all cases, the ventilation needs to ensure a safe working environment by limiting the maximum CO_2 levels.

Advice is also given on the option of preheating the incoming air supplies which may, in certain circumstance, be required by the client in cold environments to overcome cold draughts in the work areas. The use of variable speed fan controls will also reduce such complaints, but where this method is employed, the minimum operational level of the ventilation systems must not fall below the required ventilation rates to ensure safe removal of products of combustion. Consideration shall be given to ensure that where supply air is provided through mechanical means, that the correct ratio to extracted air is maintained throughout the speed controlled process.

The supply air can be preheated where the client requires it, but most systems do not consider such a feature to be necessary.

Mechanical ventilation system interlock requirements

Interlocks need to be provided to ensure the safety of a system should a component fail that might then lead to a risk to persons.

A shutdown during the operation of a kitchen in a catering environment could lead to major financial losses. Some existing systems incorporate a manual over-ride. Such over-rides are

considered unsatisfactory since the system could operate in this mode without limit. This guidance introduces the concept of a secondary carbon dioxide controlling interlock that could be actuated upon a failure condition and this interlock would automatically shut-down after a pre-set period such as 24 hours.

***Important**: Secondary or additional interlocks must not override a primary interlock system.*

Manual over-rides of interlocks on existing systems are no longer considered acceptable When encountering an existing installation which incorporates a manual override, the registered gas engineer should use a Risk Assessment process to evaluate the classification to be adopted in accordance with the current Gas Industry Unsafe Situations Procedure (GIUSP) (TB 001[5]). Manual over-rides of interlocks on new systems are no longer acceptable (see additional information on this in BS 6173[2])

***Note 1:** The GIUSP can be viewed at: https://engineers.gassaferegister.co.uk – login and visit the Technical Information area.*

For traditional commercial catering installations, interlocks will be required between mechanical ventilation systems and the operation of appliances. These are described below in more detail.

Any mechanical extract, or air supply system, used in association with a Type 'B' appliance must incorporate an interlock system which prevents the operation of the appliance if the air supply or extract system fails such that the products of combustion are not being safely removed (see BS 6173[2] clause 11.2).

A small domestic type cooking installation e.g.in a village hall or B&B, which is used infrequently and only for short periods could be considered satisfactory, providing the room is a minimum of $10m^3$ has an opening window, door, adjustable grille or louvre or hinged panel that opens directly to outside air, or a domestic type wall extract fan. Where the volume is less than $10m^3$ additional purpose provided ventilation will need to be provided in accordance with BS 6172[1]. Interlocks would be unnecessary in the case of small domestic type cooking installation but safe systems of work need to be in place. This would include suitable signage identifying the ventilation and other requirements to be followed, for example, a notice stating "When cooking, ensure adequate ventilation by opening windows or operating extract fans".

For intermediate pseudo-domestic installations, e.g. not more than two domestic gas cookers, where for example a small guest house, providing a wider range of meals, there is greater need to ensure the safety of the environment at the design stage but the design of the installation may make it difficult to install interlocks. Power monitoring if an extract fan is fitted or CO_2 environmental monitoring could be applied, either providing an alarm as a minimum or shutdown if practicable. This also recognizes that valve proving systems may be too expensive for many such small operations.

Pressure/Flow (Primary interlock)
The simplest method of sensing the correct operation of fans is by the use of a pressure or differential pressure switch. The latter normally being fitted across the inlet and outlet of the fan. A paddle flow switch is rarely used as it can become fouled in the contaminated exhaust products from the cooking processes, it does, however, provide a true indication of flow which a pressure switch does not. Careful maintenance and cleaning of the extract canopy, filters and associated duct work will also ensure that the nozzle whereby the pressure is 'sensed' does not become blocked.

Power monitoring (Primary interlock)
Systems are available that measure the absorbed power of the fan(s). They can discriminate between normal power conditions and a difference in power absorption if the flow is low due to high resistances say in the grease filters, or low power absorption if the impellor has broken, or the drive fan belt has broken. It is considered that they provide better indication of flow provision than a pressure switch, but there are cost implications.

Where the system also includes a variable speed drive controller, the lowest speed setting of the drive should be interlocked with a secondary interlock.

A secondary interlock could be actuated upon a failure condition which would automatically shut-down the gas supply after a pre-determined period such as 24 hours. Manual over-rides of interlocks on existing systems are no longer acceptable. When encountering an existing installation which incorporates a manual override, the registered gas engineer should use a Risk Assessment process to evaluate the classification to be adopted in accordance with the current Gas Industry Unsafe Situation Procedure (GIUSP).

Note 2: *The risk assessment may come to the conclusion that the manual over-ride should be disconnected or disabled. Where the client refuses to accept this option, it should be recommended that a CO_2 monitoring system be installed and incorporated as part of the manual over-ride.*

Manual over-rides of interlocks on new systems are no longer acceptable.

Gas Flow monitoring (Normally a Secondary interlock)
It is possible to measure the flow rate of gas to the cooking system and to calculate the required air flows for a safe environment. A speed controller can then operate a variable speed drive exhaust/supply system to meet demand. This type of system is considered to be a demand control system and could be used in conjunction with a Primary interlock. Where the control system incorporates sensors for CO_2 and temperature measurement it can be considered as a primary interlock.

Carbon Dioxide monitoring (Normally a Secondary interlock)
The intention of the various standards and guidance is to ensure a safe working environment. It can be argued that environmental monitoring is a true indication of the extract system performance and of the cooking load. For new installations, CO_2 monitoring alone is not normally acceptable as the primary interlock, but may be used as a secondary interlock in conjunction with e.g. pressure/flow interlocks as a back-up system, which may be actuated by a responsible person on site, should a major failure of the ventilation or extract system occur during a period of food service. This CO_2 monitoring back-up intervention should be limited to no more than 24 hours to enable remedial work to be completed.

Where the device also incorporates temperature monitoring sensors it can be treated as a primary interlock where only Type ‘A’ appliances are installed. However, fan failure shall cause an alarm to occur.

Carbon dioxide can be reliably sensed at concentrations well below harmful levels and therefore can give accurate assessment of ventilation/extract effectiveness. The current prescribed evaluation of extract and supply air efficacy, in this context, advocates measuring CO_2 levels with hand held devices. Fixed systems monitor CO_2 levels on a permanent basis. Calibration checks will still be required as specified by the manufacturer to maintain safe levels.

Such systems have been developed for arduous catering conditions and it is considered that they provide adequate reliability provided the systems are suitable for the environmental conditions in kitchens. The alarm conditions should be factory set to give first and second stage warnings. The second stage warning will normally shut down the gas supply, or turn off the gas appliances. The first stage warning allows the chef the opportunity to provide increased ventilation, or to reduce the cooking load whilst maintaining a safe working environment. Levels of 2800 and 5000ppm are now proposed for alarm and shutdown conditions respectively.

Detectors need to be mounted at not more than 2.5m from the floor and in the centre of the working area. Depending upon the layout of the kitchen, it might be necessary to install more than one detector to ensure representative conditions are monitored.

Fan power failure (Additional interlock)

Where 3-phase power supplies are used on fan motors, it is practicable to utilise the auxiliary power supply contact, which opens when the fan trips, or shuts down at overload conditions. This electrical contactor should normally be wired in series with the power supply to the automatic gas isolation valve -AIV control system. This interlock can only be applied in addition to those described above. It is not a primary or secondary interlock.

Application of Air flow proving

Where reasonably practical and cost acceptable, a Primary air proving interlock such as a pressure interlock system should be applied as a minimum, as it is probably the least expensive to apply. Where a Primary interlock is not practicable, that is where there are a number of wall mounted extract fans, a Secondary interlock should be applied. Where this is not practicable, such as on small domestic type installations, a simple 2-stage CO_2 audible alarm system might be seen as a minimum means of controlling the environment to safe levels.

Valve proving systems

The original weep by-pass proving systems were developed for multi-burner process plant such as ovens and furnaces. They have been widely applied in commercial catering and schools where a large number of individual appliances and burners operate without the provision of flame safeguard systems.

The intention was to prevent gas being restored to the downstream system until it has been proven that all the gas taps on the appliances were in the closed position. They relied on a simple pressure switch and originally they were all manually controlled without in-built timers.

With new technology, variants have been produced which require differentiation between the process and the catering/educational environments.

- **Pipework Integrity System**

  This is similar to the weep by-pass system but operates differently and has less reliance on the design of the orifice in the weep line. The downstream system is pressurised and then closed off by the weep solenoid valve. The system is then tightness tested for a time related to the pipe volume; very similar to the detailed in IGE/UP/1[(9)].

- **Pressure Test System**

  This is similar to the above system but operates differently and has no reliance on the design of the orifice in the weep line. It does however rely on accurate opening and closing time of the main AIV. The downstream system is pressurised, then closed off by the solenoid valve and the system is then tightness tested for a time related to the pipe volume. Some systems use pressure transducers and some measure pressure change across the AIV. There will be a short delay before restart after a failed test, in order to ventilate any gas that may have passed into closed combustion spaces such as ovens etc.

Application of Valve Proving

With regards to the application of valve proving systems, although preferable and proof against operator error, it may be acceptable to have manual operation of the isolating valve to an area, provided staff are trained in the procedures and recognise the dangers that may exist. Safety warning signage is essential. The responsibility for safe operation of the valve rests with the chef or site management. A valve proving system should normally be applied unless it is not reasonably practical to do so or unless all the burners are protected by a flame-safeguard system which prevents the flow of gas upon loss of flame.

Appliance Canopies

BS 6173[(2)] requires proper ventilation and where this is achieved with mechanical systems it is required that canopies and exhaust systems to be designed according to B&ES standard DW/172[(10)]. Such a system may not be practical or acceptable on cost grounds for existing

smaller domestic type cooking installations such as those with natural or mechanical ventilation complying with BS 5440-2[3]. It is however always preferred on new installations to apply extract canopies over cooking appliances. These need not be DW/172[10] type canopies for domestic appliances.

Whatever system is applied, during commissioning, a check needs to be made of the CO_2 levels at 2m above floor in the centre of the working area, and where fitted at the outside edge of any canopy, under full cooking load conditions. Where the levels of CO_2 exceed 2800ppm, additional ventilation will be required.

Assessing the effectiveness of existing ventilation provision/systems

Assessing the effectiveness of existing ventilation provision for a catering establishment has always been difficult, and guidance has previously been provided in the 2004 and 2007 editions of CAIS23 and currently in BS 6173[2] and BS 7967-5[7].

This advice is now replaced by a simpler test which measures the levels of CO_2 in the atmosphere at 2m above floor level in the centre of the cooking work areas and at the outside edge of any canopy.

Test equipment for measuring CO_2

To carry out environmental testing it is recommended that direct reading CO_2 analysers that meet the minimum requirements of the product standard BS 8494: 2007[11] are used.

Testing

Tests should be performed with appliances and burners operating under maximum cooking load conditions.

After the environment has settled (not less than about 10 minutes) the concentrations of CO_2 at the sample positions should not exceed 2800ppm.

Where it is found that the concentration of CO_2 exceeds that given above, the person performing the test should advise the responsible person for the installation that they shall consider improving ventilation or turning off /isolating non-essential gas cooking equipment. It may also be necessary to ventilate the affected area by opening windows and doors as necessary until the concentrations of CO_2 are reduced below 2800ppm.

Where an atmosphere sampling test identifies that continued use of the catering establishment would be considered unsafe, the current Gas Industry Unsafe Situations Procedure (GIUSP)[5] should be implemented **(see Figure 1** *Flowchart dealing with assessment protocol when dealing with gas-fired commercial catering appliances* **in Appendix 1**) and the necessary actions taken to make the installation safe. Again it must be stressed that this decision can only be made following close liaison with the responsible person for the catering establishment and may involve the isolation of some appliances to achieve acceptable environmental conditions rather than shutting down the kitchen.

Existing Systems

Rarely do standards cover the retrospective issue of existing installations. They can, however, set a basis for consideration of performance upon which a risk assessment should be developed. Checks for CO_2 levels shall be performed as above.

It can be argued that any improvements in safety are better than none at all. It may be unreasonable to expect that an old installation should be brought right up-to-date in all respects. Where a major refurbishment of the installation takes place, then it would be reasonable to consider the installation as a New Installation as far as is reasonably practicable.

Application of Valve Proving

With regards to the application of valve proving systems, although preferable and proof against operator error, it may be acceptable to have manual operation of the isolating valve to an area, provided staff are trained in the procedures and recognise the dangers that may exist. Safety warning signage is essential. The responsibility for safe operation of the valve rests with the chef or site management.

A valve proving system should normally be applied unless it is not reasonably practical to do so or unless all the burners are protected by a flame-safeguard system which prevents the flow of gas upon loss of flame.

Maintenance and inspection

In GB – the Gas Safety (Installation and Use) Regulations (GS(I&U)R) Regulation 35 is the primary legislation concerning safe installation, maintenance and use of gas systems and appliances at places of work. Together with duties under the Health and Safety etc at Work Act, this requires employers and users to ensure that gas appliances, flues, pipework and safety devices are maintained in a safe condition to prevent the risk of injury to any person.

Note 3: *- **See Figure 1** Flowchart dealing with assessment protocol when dealing with gas-fired commercial catering appliances in **Appendix 1**. Carrying out a risk assessment following the guidance of the flowchart will assist in establishing the level of risk and determining the appropriate category to be applied in accordance with GIUSP.*

Particular attention will be required for the maintenance of controls systems and detection instrumentation to ensure the continued safety of the system.

A functional test of any interlock system present should form part of any programmed maintenance schedules. This functional test needs to ensure that should the extract fail (by means of isolation as an example) then the gas supply is isolated. Any safety device that is inoperative, failing to danger or has been disabled should be classified in accordance with the current GIUSP[(5)].

Note 4: *Similar requirements apply in other geographical areas covered by Gas Safe Register. For details of current gas safety legislation, building legislation and industry standards for the geographical areas covered by Gas Safe Register, see Technical Bulletin (TB) 999[(12)] at: https://engineers.gassaferegister.co.uk - login and visit the Technical Information area.*

Records

Information on all work undertaken on the gas and ventilation systems should to be retained on site by the site occupier.

This information should include details of all controls systems, maintenance records, risk assessments and faults/remedial work required. Where the GIUSP[(4)] has been applied, details of the faults found and recommendations provided should be retained in the records.

Note 5: *For details of current gas safety legislation, building legislation and industry standards for the geographical areas covered by Gas Safe Register, see TB 999[(12)]).*

Note 6: *For general information about the process behind the development of Gas Safe Register Technical Bulletins and the expectations for all Stakeholders, see TB 1000[(13)]).*

Bibliography

(1) ***BS 6172: 2010*** *(Specification for installation, servicing and maintenance of domestic gas cooking appliances (2nd and 3rd family gases)*

(2) ***BS 6173: 2009*** *– Specification for installation and maintenance of gas-fired catering appliances for use in all types of catering establishments (2nd and 3rd family gases)*

(3) ***BS 5440-2****: Flueing and ventilation for gas appliances of rated input not exceeding 70 kW net (1st, 2nd and 3rd family gases) – Part 2: Specification for the installation and maintenance of ventilation provision for gas appliances*

(4) ***IGEM/UP/11*** *Institution of Gas Engineers and Managers Standard, Gas installations for educational establishments*

(5) ***TB 001*** *– The Gas Industry Unsafe Situations Procedure*

(6) ***PR CEN/TR 1749*** *European scheme for the classification of gas appliances according to the method of evacuation of the combustion products (types)*

(7) ***BS 7967-5*** *– Carbon monoxide in dwellings and other premises and the combustion performance of gas-fired appliances Part 5: Guide for using electronic portable combustion gas analysers in non-domestic premises for the measurement of carbon monoxide and carbon dioxide levels and the determination of combustion performance*

(8) ***IGE/UP/10*** *Institution of Gas Engineers and Managers Standard, Installation of flued appliances on industrial and commercial premises*

(9) ***IGE/UP/1****- Institution of Gas Engineers and Managers Standard UP/1 Strength testing, tightness testing and direct purging of industrial and commercial gas installations*

(10) ***HVCA DW172*** *Heating & Ventilation Contractors Association standard DW 172 – Ventilation of kitchens in catering establishments*

(11) ***BS 8494: 2007*** *– Electronic portable and transportable apparatus designed to detect and measure carbon dioxide in indoor ambient air – Requirements and test methods*

(12) ***TB 999*** *Gas Safe Register Normative Document List*

(13) ***TB 1000*** *- An introduction to Gas Safe Register Technical Bulletins*

(14) ***EH40/2005*** *Health and Safety Executive (HSE) - Workplace exposure limits*

Note: *Gas Safe Register Technical Bulletins and the Registered Gas Engineer magazine can be viewed at http://engineers.gassaferegister.co.uk – login and visit the Technical Information area.*

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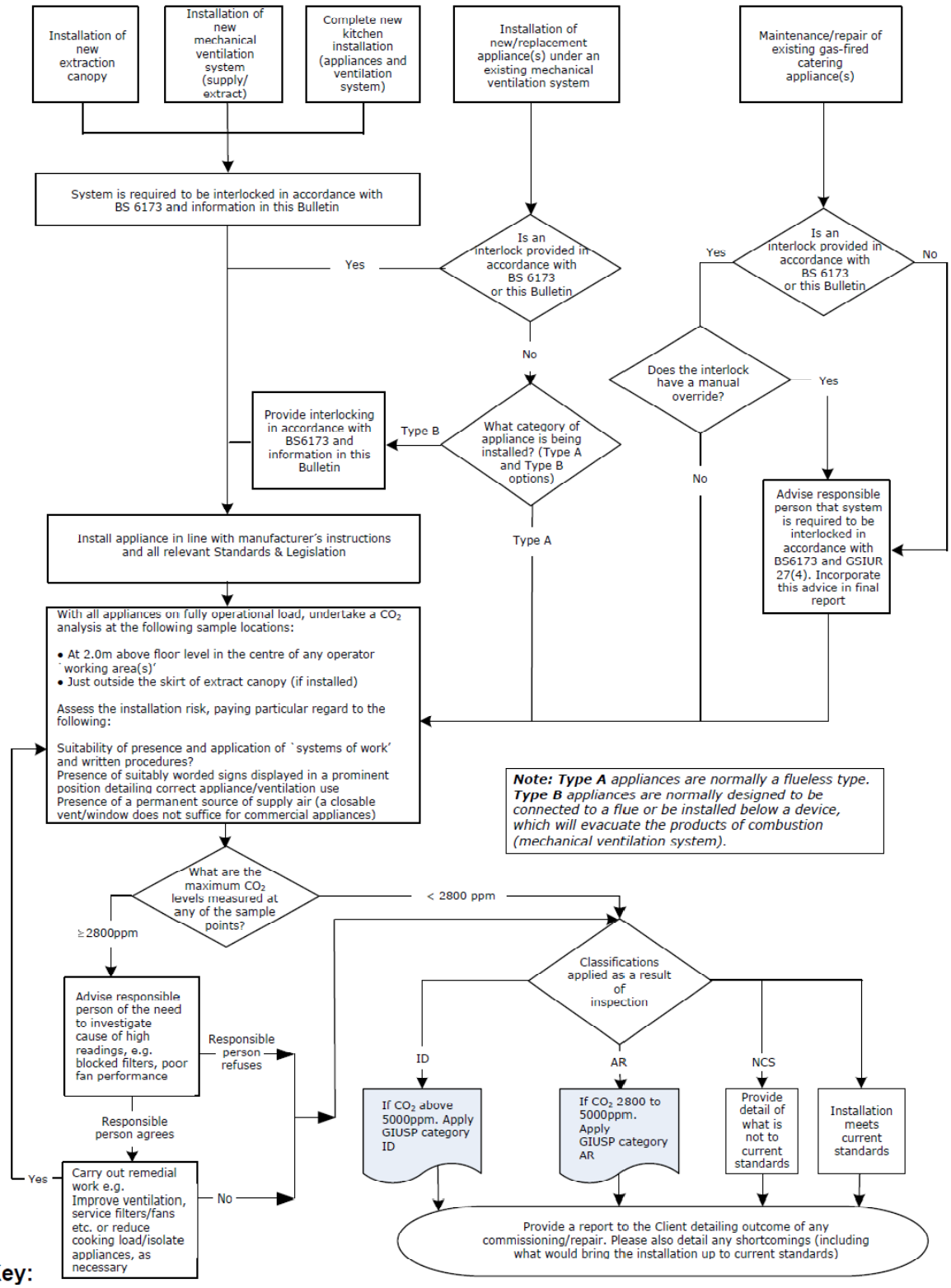
Appendix 1

Figure 1 - *Flowchart dealing with assessment protocol when dealing with gas-fired commercial catering appliances*



Key:

BS 6173 = Specification for installation and maintenance of gas-fired catering appliances for use in all types of catering establishments

GIUSP = Gas Industry Unsafe Situations Procedure

GSIUR = Gas Safety (Installation & Use) Regulations

AR = At Risk

ID = Immediately Dangerous

NCS = Not to Current Standards

Appendix 1

Notes to Appendix 1

Note A1
Some establishments may have a manager responsible for health and safety. A discussion with the responsible person might include the following questions:

(a) Does the problem only happen when appliances, including mobile/portable appliances, are or have been in use? Are there any safety warning notices/labels attached to the installation/appliances?

(b) Do workers feel unwell in the premises and recover when outside or away from the workplace? What are their symptoms?

(c) Is there a pattern to the occurrences, e.g. observed once, more than once or many times? Does it occur during particular weather conditions or certain activities, or from the use of a chemical or substance, or in a particular area?

Note A2
If other fuel burning appliances are present and in operation, where practical check them for production of CO and spillage. If these appliances are thought to be the cause of the problem, recommend the responsible person to seek expert advice.

For oil appliances, contact the Oil Firing Technical Association Tel: 0845 658 5080 Web site: www.oftec.co.uk

For solid fuel appliances, contact the Solid Fuel Association Tel: 0845 601 4406 Web site: www.solidfuel.co.uk .

Note A3
Other issues you could ask about include any possible damage, e.g. heat stress/corrosion, maintenance history, potential for misuse and any operating difficulties.

Note A4
Measure concentrations of CO_2 as follows:

(a) At 2m above floor level in the centre of any operator(s) working area.

(b) Just outside the skirt of extract canopy (if installed).

Concentrations should not exceed 2800ppm (no allowance is made for the outdoor level)

Occupational exposure limits (see EH40/2005)[(14)] for CO_2 are 0.5% (5000ppm) 8-hour time-weighted average and a short-term exposure limit of 1.5% (15 000ppm) 15-min time-weighted average.

Where concentrations exceed 2800ppm consider the need to turn off appliances or isolate non-essential appliances and the possibility of evacuation. Immediately ventilate the affected area by opening windows and doors as necessary until CO_2 level is reduced below 2800ppm so that the investigation can continue.

Where the concentration exceeds 5000ppm, recommend that appliances are turned off, non-essential staff leave the area and that ventilation is immediately improved by opening windows and doors until CO_2 level is reduced below 2800ppm so that the investigation can continue.

Note A5
Check that electrical power is being supplied to MEV fan, the fan is securely attached to drive motor shaft, the fan blades are present and undamaged, the fan rotes in the correct direction, air filters are not blocked, and any trip system is working correctly.