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Department of Trade and Industry

THE EFFECT OF CEILING-MOUNTED RE-CIRCULATION FANS ON DOMESTIC OPEN-FLUE APPLIANCES

A report by Advantica Technologies Ltd
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1 INTRODUCTION

Instances have been reported, whereby ceiling-mounted fans were believed to be causing specific problems in domestic premises. The exact nature of the problems being encountered was not known, but was understood to affect open-flue gas appliances and open fires. It seemed likely that, under certain conditions, operation of the fan might have been exacerbating spillage of combustion products into the living space. These reports therefore needed to be investigated, and site visits arranged to ascertain the facts and confirm the causes.

In parallel, industry contacts needed to be explored, to gain any relevant information, and fan manufacturers contacted to verify fan performance. Any relevant incident data also needed to be studied, to determine whether a consistent pattern of behaviour was emerging.

2 CONTACTS

2.1 Initial Information

This programme of work was instigated by the Standards and Technical Regulations Directorate of the UK Government's Department of Trade and Industry (DTI) based on information that had been received from a number of sources. In particular, various local authorities had reported difficulties in dealing with instances raised during the annual servicing of gas appliances, carried out for council house tenants. The details of three such authorities were passed to Advantica, as the basis for establishing suitable locations for on-site testing, and these are described more fully in Section 3.

2.2 Industry Contacts

In addition to the contacts provided by DTI, attempts were made to obtain information from a wide range of other sources. Some of these were already known to Advantica, and some were purely speculative. A number of useful contributions were received, as follows,

- The Confederation of Registered Gas Installers (CORGI) referred to their technical bulletin no.79, reproduced as Appendix A.

- The Society for British Gas Industries (SBGI) circulated a message to all their members, and replies highlighted the following points:

    - Installation requirements for gas fires are detailed in BS 5440 (References 1 & 2) and BS 5871 (References 3 to 5) the latest versions of which specifically include testing with any re-circulation fans in operation.

    - Current practice is to fit spillage detectors to open flue boilers, intended to shut off the appliance under abnormal conditions, and so prevent high levels of combustion products entering the room.

    - Problems had been experienced with ceiling fans during routine servicing of domestic gas appliances in some areas of London, causing flame disturbance on gas fires and spillage of combustion products.

- Centrica (ie. British Gas Services) circulated the request to their senior supervisors, and a collated response confirmed instances of such fans causing flame disturbance on radiant gas fires, and spillage on combined fire and back boiler units. In addition, the potential was raised for even greater effects from portable air conditioning units, which were believed to be becoming popular.

- The Solid Fuel Association replied that they did not have any technical information, but passed on the enquiry to the main approvals agency for solid-fuel domestic heating appliances, fuels and services. HETAS responded that no measured data were available, but there was anecdotal evidence of slight effects on open fires, but not closed fires or boilers. However, any such effects were thought to be short-term and not serious, and it was considered that the problem was mainly due to low room heights.

- Incident data are recorded on special reporting (DIDR) forms, and these are currently collated by Advantica and analysed on behalf of the Health and Safety Executive (HSE). Examination of this information revealed two occasions since 1995 when ceiling-mounted fans were believed to have been materially involved:

    (i) One hospitalisation in July 1996 resulted from the effect of cooling fans on a commercial cooking range.

    (ii) Eleven hospitalisations in January 1998 were caused by spillage from a back boiler unit due to a ceiling fan.

- The Department of Transport, Local Government and the Regions (DTLR) referred to the changed requirements in paragraphs 1.20 to 1.23 of Approved Document “J” (Reference 6).

- HSE suggested that manufacturer’s instructions should advise against the installation of a ceiling fan in the same room as a non-room-sealed appliance, or any other location that might adversely affect safe removal of combustion products, unless it is demonstrated through appropriate tests that operation of the fan cannot prejudice safe operation of the appliance.

2.3 Further Information

Visits were made to local retail outlets, to ascertain the availability of the products under investigation, and the range of manufacturers selling such goods. The results are summarised in Appendix B, and it is immediately obvious that they can be bought readily and cheaply at most of the popular retailers. Note that the two referenced standards (EN 60335 and EN 60598) relate to electrical appliance and lighting equipment safety requirements, rather than operation of the fan itself.

The above exercise yielded a certain amount of information from the outside of the packaging, but it was decided to purchase one unit in order to find out what further information was given to the prospective installer. The unit chosen was typical of the more economical end of the market. It has a 36ins [92cm] diameter fan, with four reversible blades and a three-speed reversible motor, and incorporates a 60W screwed-thread light fitting.

The installation and operating instructions seemed to be quite comprehensive, and it is believed that DIY installation could be performed simply and easily. However, the recommended safe blade height of 2.3m would be difficult to achieve in most modern homes with a standard 8ft [2.5m] ceiling. Moreover, there is a contradiction, in that the installation instructions warn against usage of the fan in the same room and at the same time as a gas or fuel burning fire (unless the flue has been properly tested) whilst the packaging and operating instructions encourage cool weather usage to allow lower indoor heat settings.

The supplier was contacted by letter and by telephone to obtain definitive guidance on this contradiction, but suitable technical help was not available. Instead, the rather inappropriate advice was that "… an enclosed appliance should be alright, but if in doubt contact an electrician".

A search of relevant Internet sites was performed, and the following were found to be of particular interest,

- FantasyFans, with bases in Cheshire and Yorkshire, supply different makes and models of ceiling fans for commercial as well as domestic use. Their customer helpline agreed that the instructions were confusing. They advised that such fans should not be used at the same time as a gas fire, and that the energy saving was intended to cover central heating installations only.
- One high-profile brand name is that of Fantasia Fans, who responded to a request for information on the effect of ceiling fans on gas appliances. They said that there was no published data, but that the DTI had notified them of a single occurrence, so they have to make customers aware. Their advice was to consult a CORGI engineer to ensure that the gas appliance was operating correctly. However, their web site included further advice on installation, as follows:
    - Ceiling fans should not be installed in bathrooms, but can be mounted in all other rooms, including kitchens.
    - The minimum blade height (as specified by BSI) is 7.5ft [2.3m] although no standard was quoted as a reference.

- Recommended room sizes for different fan diameters are much smaller than those quoted elsewhere (Appendix B) and were given as,

Fan Diameter (ins) [cm]	Floor Area (sq.ft) [m^2]	Room Volume (cu.ft) [m^3]
36 [92]	144 [13.6]	1200 [34.8]
42 [108]	168 [15.9]	1400 [40.6]
52 [133]	225 [21.2]	1850 [53.6]

- Further information and advice is given on the American site “fanlocator.com” including a discussion on the use of ceiling fans during the winter, to equalise temperatures at floor and ceiling levels. Arguments are given for and against the use of fans in reverse mode, essentially to reduce draught effects. This site also includes an extensive listing of ceiling fan suppliers, some of whom trade over the Internet, see also “amazon.com”.

3 MEASUREMENTS AND DATA

As stated earlier (Section 2.1) contacts were provided to Advantica enabling field data to be gathered directly from practical situations. These were council housing managers, responsible for the routine servicing of all gas appliances in the homes of council tenants. They were each able to provide information, as follows,

- Problems had been identified in the Sunderland area at least three years earlier, mainly affecting back boiler units. It was stated that all instances of ceiling fans in the same room as open flue appliances were now dealt with by isolating the appliance, until the tenant disconnected the fan.

- Leicester City Council was in a very similar position, but staff were able to identify one location where the fan had not yet been disconnected, so that a site visit was possible. The address, in the Humberstone area of the city, proved an effective proving ground for pressure measurements within a real domestic location, using a Furness Controls Ltd FCO510 micro-manometer.

- The City of Salford housing services were able to provide some valuable data on households recently found to have ceiling fans installed. Over a seven month period in the summer of 2001, a total of 26 instances were found in the Eccles area alone, all having fans in lounges with gas fires, either separately or with a back boiler unit. More recently, ten addresses in the Worsley area still had fans that were operational, and arrangements were made to carry out site visits to six of these, to take practical measurements.

The visits described above enabled a sample of in-service fan installations to be assessed. The fans were of various makes, and ranged from 36 to 52ins [92 to 133cm] diameter, with either four or five blades. They were all mounted in lounges, with a blade clearance of 7 to 11ins [18 to 28cm] below the ceiling, and between 4.5

and 7.5ft [1.4 and 2.3m] from the gas appliance. Ceiling heights were 8.0 or 8.5ft [2.5 or 2.6m], floor areas varied from 140 to 190sq.ft [13.2 to 17.9m^2] and room volumes between 1100 and 1500cu.ft [31.8 and 43.5m^3]. Pressure measurements were taken at a height of approximately 4ft [1.2m] above the floor, both below the fan position and at the side of the room, with doors and windows closed and the fan running in all possible configurations.

There were no obvious patterns or trends in the results for the various parameters quoted above, except as summarised in the following table,

Fan Configuration	Air Movement At the Fan	Max. Observed Press. Drop (Pa)	
		Centre of Room	Side of Room
Normal	Downwards	1.5 to 3.0	0.5 to 1.0
Reverse	Upwards	0	0.5

4 DISCUSSION

Initial consideration of the parameters thought likely to have an effect on any interaction between ceiling fans and gas appliances, indicated two main categories,

(i) ***Fan Size and Design:*** Number of blades, overall diameter, motor power, rotational speed, blade angle and aspect ratio.

(ii) ***Installation Features:*** Clearance between fan blades and the ceiling, height above the floor, distance between the fan and the appliance, total floor area and room volume.

In addition, thought was given to possible flow patterns, depending on the direction of air movement at the fan. It seemed likely that significant differences would be generated between the two conditions, as follows,

- In normal operation (ie. air downwards) a large air movement could be expected in the centre of the room, which would become more diffuse near to the floor, and hardly be noticeable by the time it reached the walls.
- In reverse operation (ie. air upwards) much less air movement was thought likely to be discernable in the centre of the room, but the ceiling and walls might act as constraints, and channel the flow close to these surfaces, and possibly across the front of a gas appliance.

Actual site measurements allowed this model to be modified and better defined. In particular, diffusion of the air movement appeared to occur much more readily, both with distance and with fan speed. It was also found that room size was of secondary importance, at least for the relatively small rooms in which these measurements were taken. A simplified summary of the pressure drop characteristics was therefore possible, as tabulated in Section 3 above.

Assessing the effect of these pressure drops on any particular appliance must take into account the actual flue conditions, since the possibility of combustion product spillage will depend upon the resultant flue pull, ie. after deducting the backpressure caused by the fan. Typical solid fuel appliance flue conditions are not known, but previous laboratory work on typical (6kW heat input) gas fires has shown flue differential pressures of 3 to 4Pa. On this basis, the measured maximum pressure drops could represent a reduction in flue pull of roughly 10 to 30%, although the consequent effect in practice will depend upon a number of other factors, such as internal condition of the appliance and efficiency of the flue system. The situation for back boiler units may also be different, because the higher heat inputs involved are likely to create different flue combustion product conditions.

One aspect that was very obvious from the site visits was the variation in the standard of installation of the ceiling fans. Some had distinct wobble characteristics, and clearance heights were usually less than the recommended 2.3m. Lateral distance from the gas appliance was also variable, and not necessarily related to room dimensions. However, the tenant stated in each case that the fan was never used in conjunction with the gas fire.

Unfortunately, it must be assumed that a proportion of ceiling fan installations will, in fact, be used at the same time as an open flue appliance. This is reinforced by the sales material and Internet information encouraging their use during the winter, even though this is apparently only intended to apply to centrally heated homes. In this light, it is perhaps surprising that so few actual incidents involving ceiling fans have been recorded so far. It may be that most installations are in rooms considerably larger and/or with higher ceilings than those visited, with a consequent reduction in pressure effects.

It is evident that UK building regulations and gas fire installation standards (References 1 to 6) are already starting to cover the effect of ceiling fans in practice, although North American standards (Reference 7) do not yet address the issue, even though numbers of installations are likely to be very much greater. It is also relevant that, for the sample unit procured, only the English version of the instructions included a warning on gas appliance usage.

From the information received and detailed in this report, it seems that there may be large numbers of ceiling fans already installed within the UK. They are readily available, reasonably cheap and easy to install, and Appendix A indicates that reports of their effect on open flue appliances can be traced back over a number of years. Furthermore, it is generally accepted that home comfort is assuming a higher priority than used to be the case, and consumer expectations are correspondingly greater. It is therefore suggested that numbers are likely to further increase, so more research work should be undertaken, to investigate the precise conditions under which problems are likely to arise in practice.

5 CONCLUSIONS

a) Ceiling-mounted re-circulation fans are readily available, reasonably cheap and easy to install. There are probably large numbers already in domestic premises within the UK, and numbers are likely to increase.

b) Problems have been reported in service for some years, whereby ceiling fans have caused flame disturbance and combustion product spillage on open flue fuel burning appliances, even resulting in incidents of hospitalisation. Pressure measurements in the homes of council tenants have now enabled derivation of a working model, showing that there is greater diffusion of air movement than had been originally predicted.

c) The consequent effect on open-flue gas fires will depend upon various factors, including the actual flue conditions, but it is estimated that there may be a reduction in flue pull of perhaps 10 to 30%.

d) The effect on solid fuel appliances and open flue back boiler units is not known, but note that modern open flue boilers often incorporate spillage detection devices, to protect against the abnormal delivery of high levels of combustion products into the room.

e) Advice provided by manufacturers on the correct installation and operation of ceiling fans seems to be confusing in terms of fan blade height, minimum room sizes, room suitability and cool weather usage, especially in relation to open flue appliances.

f) Appropriate legislation within the UK is already being revised in order to address the reported problems, although this does not appear to be the case in North America, despite the larger market size, or elsewhere.

g) A potential problem has been highlighted with the use of portable air conditioning units in domestic premises, although these are less likely to be used during cooler weather.

6 RECOMMENDATIONS

a) Further work should be undertaken, to fully define the effects of the observed pressure reductions on domestic open flue gas fires, under controlled conditions.

b) Further work should also be carried out to include other appliances, such as solid fuel fires and open flue back boiler units.

c) Relevant legislation should continue to be reviewed, and possibly further revised to incorporate the effects of portable air conditioning units.

d) Fan manufacturers and suppliers should be encouraged to provide consistent and sound advice on ceiling fan installation and operation.

References

1. Installation and maintenance of flues and ventilation for gas appliances of rated input not exceeding 70 kW net (1st, 2nd and 3rd family gases. Specification for installation and maintenance of flues. British standard BS 5440-1:2000.

2. Installation and maintenance of flues and ventilation for gas appliances of rated input not exceeding 70 kW net (1st, 2nd and 3rd family gases. Specification for installation and maintenance of ventilation for gas appliances. British standard BS 5440-2:2000.

3. Specification for installation of gas fires, convector heaters, fire/back boilers and decorative fuel effect gas appliances. Gas fires, convector heaters and fire/back boilers (1st, 2nd and 3rd family gases). British standard BS 5871-1:2001.

4. Specification for installation of gas fires, convector heaters, fire/back boilers and decorative fuel effect gas appliances. Inset live fuel-effect gas fires of heat input not exceeding 15 kW, and fire/back boilers (2nd and 3rd family gases). British standard BS 5871-2:2001.

5. Specification for installation of gas fires, convector heaters, fire/back boilers and decorative fuel effect gas appliances. Decorative fuel effect gas appliances of heat input not exceeding 20 kW (2nd and 3rd family gases). British standard BS 5871-3:2001.

6. The Building Regulations 2000. Combustion appliances and fuel storage systems. DTLR Approved Document J. Effective April 2002.

7. National Fuel Gas Code. American national standard ANSI Z223.1, 1996 Edition.

Acknowledgements

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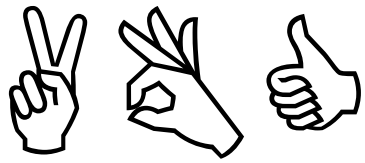
Appendix A. CORGI Technical Bulletin No.79

TECHNICAL BULLETIN
FOR GENERAL CIRCULATION



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Decorative Re-Circulatory Fans

Problems have been encountered throughout the industry where an open flue appliance is installed in the same room as decorative re-circulatory ceiling fans. When working on or inspecting open flue appliances (particularly DFE and ILFE gas fires) and there is a re-circulatory ceiling fan fitted in the same room, spillage tests should be carried out with the fan both on and off, at all speeds and where appropriate in both directions.

Where spillage is identified (due to the operation of the ceiling fan) the CORGI "unsafe situations procedure" should be applied and the installation classified as (ID) Immediately Dangerous.

Note*: this supersedes previous Technical Bulletin issued on 17.7.97*

Appendix B. Ceiling fan availability in local stores (October 2001)

Prices start at £18 for 36" diameter fan (complete with a light fitting) having a 3-speed reversible motor, and rated from about 70 watts. Besides summertime down-draught use, wintertime energy savings are claimed for all models found, using up-draught to disturb air close to the ceiling, giving a uniform temperature distribution.

- Most information is given on the Wickes own-brand box. Recommended sizes are 36" for 200 ft^2 and 42" for 360 ft^2 rooms. Reference is made to EN 60598-1 and 60335-1/2 (see below) plus a warning of use with open-flue gas appliances (reference to CORGI). 4" drop-rods are supplied, but 8" are also available.
- B&Q sell "New Living" and "Classic" brands, both of which show a warning on the box. "If you plan to install a fan in a room that contains an open-flue appliance which burns gas, oil or solid fuel, get expert advice from your fuel supplier first. Operating the fan could cause dangerous combustion gases to be drawn back into the room."
- Homebase and Focus/Do-it-All both sell the "Encon" brand, with no warning on the box. A warning is given in the installation instructions, but this appears to contradict the operating instructions. Compliance claimed with EN 60598 and EN 60335.
- Argos and Index catalogues both also feature the “Encon” brand, and include the warning that “ceiling fans and open gas heating should not be used at the same time, in the same room”.

Note. BS EN 60598-1:1997 Luminaires. General requirements and tests.

BS EN 60335-1:1995 Specification for safety of household and similar electrical appliances. General requirements.