Natural Gas Safety			
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RESULTS OF A STUDY INTO NATURAL GAS/FLUE GAS BUILD-UP AND DISPERSAL IN A HOUSE

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Summary

This DIN summarises the main findings from two research projects which looked at the build-up and dispersal of both combustion products and natural gas in a house[1] [2]. The research was carried out to provide supporting evidence for use by Specialist Inspectors in legal action where the cause of the incident may not be evident. It can also aid accident prevention by determining the best location for gas detectors.

Q1. *What test equipment was used?*

A purpose-built two-storey house was supplied with natural gas at normal domestic pressure, through a typical arrangement of domestic gas installation pipework, to a range of appliances. Sample probes were used at various heights and locations throughout the house to obtain concentration profiles. Wind speed and direction data was also collected.

Q2. ***What experiments were conducted?***

In the first set of experiments several appliances were operated under fault conditions to produce carbon monoxide (CO). In the second set natural gas (gas) was allowed to leak in several locations and quantities to simulate different possible leak scenarios.

Q3. ***What were the main conclusions about carbon monoxide build up?***

1) In the release room the highest concentration of CO was present near the ceiling. In rooms open to the release room the concentration was more uniform with height.

2) The greatest concentration of CO at mid-height in a room containing a non radiant appliance e.g. a boiler, was found at the walls.

3) A wall-mounted appliance tended to produce a greater CO concentration above the height of the appliance than elsewhere within the release room. The concentration became uniform from floor to ceiling in the release room once the appliance was turned off.

4) Releases in one room lead to a CO-air mixture accumulating in other rooms, even with the interconnecting door closed.

5) A CO release above the top of a door tended to remain above the door, with or without the door open, and resulted in a high concentration of CO-air above the door.

6) The build up of CO from a given appliance with 100% flue blockage tended to proceed over a time scale which can be related to the release room volume.

7) The tendency for an appliance operating with a partially blocked flue to produce CO is related to the extent of the blockage and the appliance heat input rating.

8) Wind conditions affect the CO build up from an appliance with a fully blocked flue in a ventilated room, if the wind is parallel to the ventilator it will discourage flow out of the room but if the wind creates a reduced pressure outside the ventilator an out flow will be encouraged.

9) A ventilator in a room where an open flued appliance is operating with a blocked flue does not necessarily prevent a significant amount of CO building up within the room.

Q4. ***What were the main conclusions about natural gas build up?***

1) Gas releases at low levels in a room lead to a significant gas-air mixture accumulating in adjacent rooms, even with the interconnecting door closed (up to 17% at 2m high). When the door was open the accumulation was as if both rooms were one single volume. When the release was upstairs a small concentration of gas-air mixture accumulated downstairs.

2) Gas release above the top of a door tended to remain above the door, with or without the door open, and resulted in a high concentration of gas-air above the door. There could be a potential risk of ignition from ceiling-mounted light fittings.

3) The orientation/height of a gas release within a room gave different concentration profiles. Upward releases above mid-height were least likely to give a uniform mixture in a room and gave high concentrations near the ceiling. Downward releases gave good, uniform mixing.

4) Flueless appliances tended to produce gas-air mixtures which extended down to fill a greater proportion of a release room than the equivalent leak from a carcass pipe that is unaerated. A high proportion of gas released from flued appliances passed up the flue.

5) During gas build up phases with windows open the gas concentrations did not reach the lower flammability limit, even with only modest wind speeds.

Q5. What affects ventilation after a build up of natural gas or carbon monoxide?

1) The rate of ventilation is increased by opening windows on opposite sides of a room or house rather than on one side.

2) Efficient natural ventilation requires an air flow directly through as many rooms as possible. Opening all internal doors, external doors and windows would achieve this.

3) Air entering the room at velocities greater than $1ms^{-1}$ tend to reduce the concentration of gas in air from 15% to 5% in less than 2 minutes. At lower velocities the reduction can take considerably longer.

4) Gas-air mixtures which accumulate close to the ceiling tend to decay over a longer period of time compared to a concentration which extends lower down in the room.

References

1 'An experimental study of the build-up and dispersal of combustion products containing carbon monoxide in a house', Contract Research Report 141/1997, British Gas plc.

2 'An experimental study of the build-up and dispersal of natural gas in a house', Contract Research Report 169/1998, BG Technology.