CAR PARK VENTILATION

Richard Tully gives practical advice on ventilation requirements for underground car parks, emphasising the need to remove fumes quickly from exit ramps where vehicles emit up to half as much carbon monoxide again as on the level.

Experience has convinced me that it is wise to avoid the complication of mechanical ventilation in car parks if at all possible. Where site conditions preclude adequate natural ventilation great care must be exercised in designing a mechanical system.

The standards were set some 30 years ago in Post-War Building Study 28, *Precautions against fire and explosion in underground car parks*. This document describes precautions to avoid petrol leakage and to minimise risk of ignition of petrol vapour. It discusses the removal of petrol and petrol vapour and lists the sources of risk as evaporation from petrol tanks and carburettors; spillage from tanks damaged by collision in the car park; leakage from defective tanks, carburettors and feed pipes; leakage from petrol cans carried in cars; spillage from filling tanks from cans; leakage from adjacent underground petrol storage tanks; and spillage during filling at adjacent pumps. A further source of useful information is the *IHVE Guide* (now *CIBS Guide*) which gives figures for carbon monoxide emission by vehicles and exhaust gas analyses as well as statistics concerning the effect of carbon monoxide on the human body.

In the UK the regional and local authorities lay down the requirements with which the designer, and subsequently the operator, must comply. The Health & Safety Commission will no doubt lay down national standards in due course. In London, under the Petroleum (Consolidation) Act 1928, there is a Code of Practice, BG2, for underground garages. For larger garages the ventilation requirements are derived from Section 20 of the London & Building Amendment Act 1929, these being similar to those given in BG2. As this guide requires some interpretation the experience of the author's partnership is briefly set out later in this article. In other areas of the UK the Code of Practice has been found broadly acceptable, but discussion and agreement with the local authority is essential before design is undertaken.

No two car parks are alike. Some have staff in attendance at all times, while others have only occasional supervision. Some have ticket kiosks on a gradient, which will have considerable effect on the carbon monoxide (CO) emission of passing vehicles. Table 1 shows that up to 50% more CO is emitted on up-gradients normally met in tunnels, than on the level, and that on down-gradients the CO is reduced by 40%. This gives an indication of the problem which must be considered in multi-storey car parks.

It is best if the products of combustion can be removed at source, and it is important to have a fresh air supply to car park ticket kiosks, as the attendant is likely to remain there for some hours. It is suggested that not less than six fresh air changes per hour is desirable, and that there should be a face velocity over the ticket window of not less than 0.5 m/s. Care must be taken that this fresh air is not derived from a contaminated source, such as downstream of the main garage exhaust terminal.

While filters to remove CO can be installed in the fresh air inlet, these represent a complication which is best avoided as they increase both recurring servicing costs and initial cost.

Two thirds of the extract from car parks should be at low level if possible, the minimum figure being 50%. Where there is likely to be a build up of traffic at the exit a higher proportion should be extracted near the ramps. Even distribution of ventilation is essential as cases have been found where problems of excess CO concentration have arisen due, it is believed, to lack of proper distribution. A check should be made, using CO concentration as the criterion, to determine if any increased rate of extraction is necessary. The following is generally acceptable.

Internal underground car park — first basement level: 2½% of the floor area evenly distributed as low level natural air inlet plus mechanical extracts at the rate of three air changes per hour. Or, in the absence of natural inlet, five air changes mechanical supply and six air changes mechanical extract per hour, both supply and extract systems to have two fans each to give 50% duty and one supply and one extract fan to be driven by alternative means in case of mains electricity failure.

Internal underground car park — second basement level: The GLC assumes that at this level it is impractical to provide natural air inlets and require the first condition above to be met.

Covered car parks at ground level and above: 2½% of the floor area evenly distributed as low level ventilation (low level means the lower 4 ft of any floor height), or alternatively mechanical ventilation to provide three air changes supply and three air changes extract per hour.

Semi-underground car park, as cut into a hillside with one side fully exposed to external air: At least 5% of the floor area to be evenly distributed as low level on the exposed wall as natural air inlet, but further mechanical ventilation may be required depending on depth of car park, etc.

In addition to the above requirements a maximum carbon monoxide concentration limit may be enforced and this may necessitate additional ventilation. The level of the CO should not exceed 100 parts in 10^6 where persons are present for short

Table 1. Carbon monoxide in exhaust gases of cars and lorries in motion

Speed mile/h	*Ascending %*	*Descending %*	*On level %*
Cars			
10	0.00[16	0.000[7*	0.00[12
15	0.00[16	0.000[7*	0.00[11
Lorries less than 2 ton load			
10	0.00[16	0.000[8	0.00[13
15	0.00[13	0.000[7*	0.00[11
Lorries 2-5 ton load			
10	0.00[32	0.00[16	0.00[24
15	0.00[22	0.00[12	0.00[15
Lorries 5 ton load and over			
10	0.00[45	0.00[16	0.00[29
15		0.00[16	0.00[15

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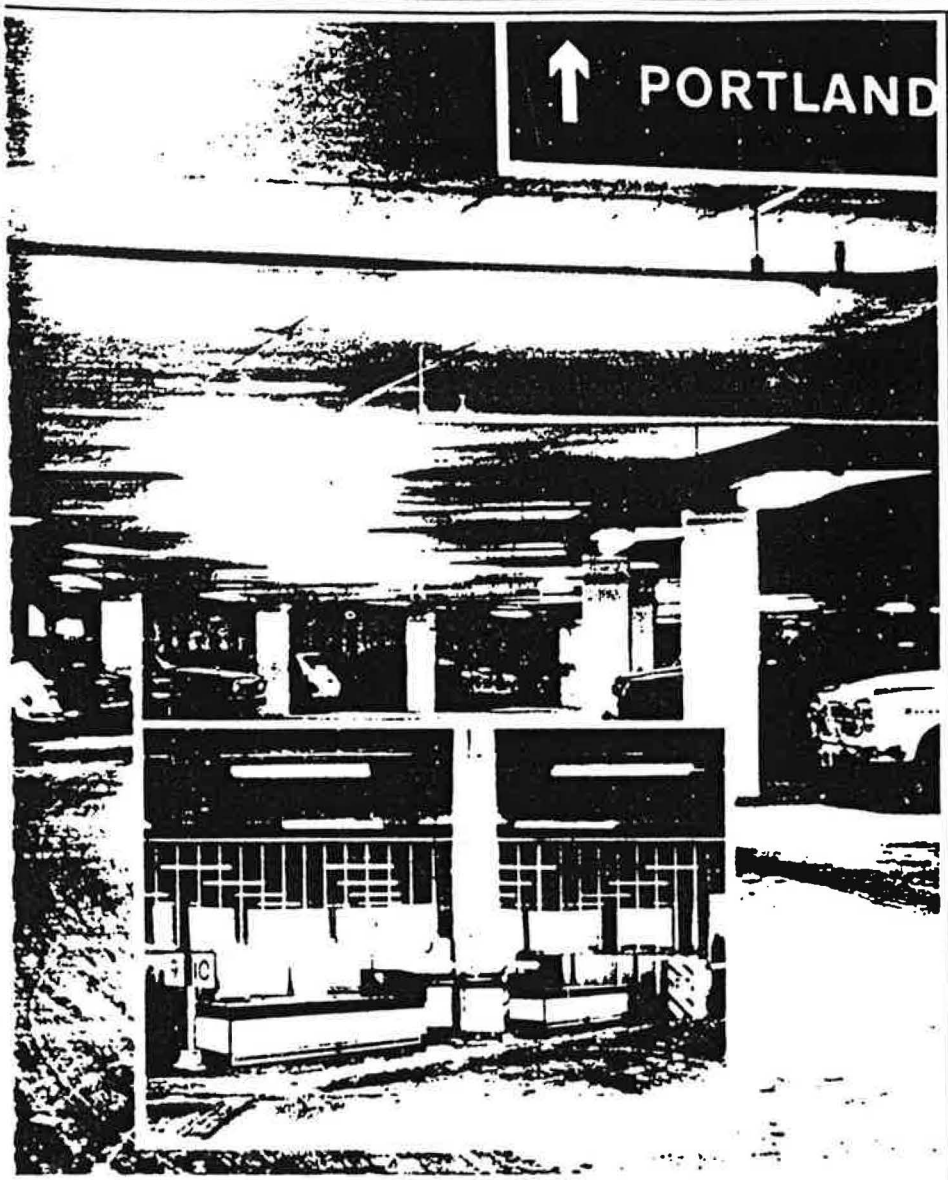

Underground car parks need ventilation which will remove fumes quickly. *Inset:* Customs Officer's inspection point at Dover Eastern Docks.

periods and 50 parts in 10^6 where attendants are in continual presence. Where cars pass through for short periods such as Beech Street in the City of London or the Hyde Park Underpass, 200 parts in 10^6 may be regarded as satisfactory with traffic control and CO detection.

The extent of the standby electric supply or alternative standby generator that will be required in the particular instance is set out in the Code of Practice.

The importance of a fresh air supply to the kiosk attendant has already been stressed. It is also advisable to take steps to extract at source the high concentration of CO around cars that may be waiting in a queue to pay for their parking time.

In addition to the basic mechanical ventilation system there may well be CO monitoring systems which will bring into operation additional fan plant as required to meet the licensing requirements.

As an illustration of some of the problems that have arisen in dealing with the products of combustion on car parks, at West London Air Terminal bus station although the buses are parked in semi-outside conditions there was a high risk of exhaust being swept into the bus station. This was minimised by installing extract points in the kerb near the vehicle exhaust. Similar methods have been adopted for other bus stations.

Another interesting installation was the Dover Harbour Board, Eastern Docks redevelopment, where there was the additional problem of the Customs Officer inspection points. This was dealt with by having high level and low level extract and in addition a separate fresh air supply was introduced at each of the customs examination points.

The importance of effective sealing of ductwork must be emphasised. Many normal building materials have a habit of shrinking and leaving cracks. Leakages give rise to uncontrolled ventilation which may well, if not promptly attended to, cause high points of CO concentration. Builders work ducts should be smooth-faced to keep resistance to a minimum, and should be capable of being cleaned. Below ground, pipe drains can be used quite effectively. Sheet metal ducts are satisfactory and should be constructed in accordance with *CIBS Guide* or the HVCA specification. Recent tests on duct work suggest there can be a high leakage factor in low velocity duct work, and an effective sealer should therefore be used.

Fans may be either centrifugal or axial flow type depending to a considerable extent on the space available. Centrifugal fans with good access doors for cleaning and ducted connections can avoid the need to provide flameproof motors as would be necessary for axial flow fans where the motor is in the air stream. Where multi-fan installations are provided the correct sequence of fan start up and motorised damper opening must be achieved if reversed rotation prior to start up is to be avoided. When two fans are installed, each at 50% total duty, ie, three air changes per hour extract per fan, one fan must be connected to an alternative electricity supply source. This condition can be satisfied by providing automatic change-over to an alternative supply, ie on-site generation or an automatically started diesel engine drive to the fan. The second method has advantages where an emergency generator is not required for other purposes and the author's practice has successfully engineered solutions on this basis.

Apart from normal checking procedures, it is important to rotate revolving plant such as fans and motors to avoid brinelling. Leakage tests may be necessary if there is any element of doubt on the effectiveness of sealing. A check should be made on the speed and rotation of fan motors. Many have been found to operate with reduced capacity with the wrong rotation. A check should be carried out on all standby equipment and change-over gear, even when a standby motor is on the same baseplate. CO equipment should be tested, together with the control equipment. Nothing should be left to chance, and clearly the greatest importance will be laid on this aspect of testing under the Health & Safety at Work Act.

Operating and maintenance instructions must be handed over to the owner or operator as part of the commissioning. The comprehensiveness or otherwise of literature from manufacturers varies wildly and it may be necessary to seek supplementary information to ensure that equipment can be maintained properly. In addition to manufacturers' literature there should be an overall background document properly indexed and tying up all aspects of the engineering services. The contract documents should preferably set out in some detail the scope of the operating and maintenance that will be required and it should not be left to the vagaries of goodwill of the installing contractor at the end of the contract. Clearly great importance should be laid on correct documentation.

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