1 AIR POLLUTION

A significant proportion of air pollutants in urban areas is generated by the motor vehicle. Air pollution from traffic is important mainly in the effects (possibly temporary) it can have on the well-being of road users and in particular in its possible effects on the health and behaviour of road users. It is also important in the consideration of the requirements for tunnel ventilation. The nature and concentration of the pollutants vary with the type of engine, the mode of operation, the fuel composition, atmospheric conditions and engine tuning. Nitrogen oxides cause respiratory problems and susceptibility to respiratory infections. Sulphur dioxide is the principal source of acid rain, damaging sensitive life forms and affecting visibility. Ozone by-products cause eye irritation, headaches and respiratory problems. Fumes are dirty, cause corrosion and, especially diesel, are potential carcinogens. Lead is toxic, affecting many parts of the body. In unfavourable meteorological and topographical conditions, photochemical smog may be formed, as in Los Angeles.

Petrol and diesel engines produce similar products although the proportions are very different. The exhaust gas of diesel engines contains significantly lower concentrations of pollutants than that of petrol engines, although diesel engines are liable to emit smoke and to make a nauseating smell if not correctly maintained.

In setting emission standards for any vehicle, the level of control which is possible and the level of control which is reasonable must be considered. Virtually all developed countries have passed legislation controlling vehicle emissions. The general trend is to introduce further legislation which is designed to reduce gradually the level of vehicle emissions which will be permitted.

Measures available to reduce the pollutants emitted by vehicles include

- modifying the engine;
- modifying the fuel composition;
- fitting catalytic converters; and
- developing new engines.

Urban development patterns determine total vehicular emissions because of the influence on the type and quantity of traffic. Land use and traffic measures can therefore significantly affect air pollution.

i) Land use controls should be used to ensure that susceptible activities (schools, hospitals, rest homes etc.) are not located in areas having high emission concentrations, e.g. near freeways, long gradients or where congestion occurs. Since tall buildings tend to trap pollutants, their height, shape and setbacks should be carefully controlled to minimise this problem.

ii) Transportation planning measures may have to be taken to limit traffic volumes on a particular facility to levels below congestion. In the analysis and evaluation of alternative transportation policies and proposals, the effect on emissions of diverting traffic to improve facilities or diverting trips to public transport should be considered.

iii) Facility traffic controls can effectively reduce emissions if a reasonably high level of service is provided. The greatest potential for improvement exists where smooth traffic flow (i.e. little heavy acceleration and deceleration) can be provided by coordination of signals, reversible lanes and freeway ramp controls. Emissions are lowest if a freeway operates at a uniform speed of about 65-80 kph.

iv) Local air quality can be improved by using a highway section that is elevated because this assists the dispersal of pollutants. If possible, facilities should be located so that the prevailing winds blow across them.

v) Artificial ventilation is required for all but the shortest of tunnels.

2 NOISE

Noise is usually defined as unwanted sound. Sound meters measure, in decibels (dB), the energy produced from all frequency ranges, weighted in proportion to the sensitivity of the human ear to frequencies in the middle of the range. One such internationally defined weighting scale is the "A" scale and sounds are then measured in dB(A). The scale is logarithmic so that an increase of 10 dB represents a doubling of loudness.

Noise affects the hearer by causing annoyance, by interfering with conversation, human performance, and sleep and by producing physiological and sociological effects.

Sources of vehicle noise include the engine, inlet, exhaust, fan and transmission - known collectively as the power train noise. Noise from all other sources such as road surface, tyres and brakes is known as rolling noise. Cars are the least noisy vehicles, trucks and motorbikes are the noisiest. Buses are somewhere in between. Generally, at low speeds, for all vehicles power train noise predominates. At high speeds, truck power train noise is still greater that rolling noise, while for light vehicles it is the rolling noise which predominates.

Traffic and road factors which influence traffic noise include, traffic flow, traffic composition, traffic speed, road intersections and pedestrian crossings, road gradient, road width and road surface. Stopping and starting creates more noise than travelling at steady speeds.

A hearer's experience of traffic noise varies as his environment varies. Generally, of course, noise reduces as the hearer's distance from the road increases. However, close to the road, individual vehicles can be clearly distinguished. At a distance, individual vehicle noise merges into the general traffic rumble. Traffic noise levels at a given distance from the road for any hearer environment can be calculated using the method given in the SABS Code of Practice for Calculating and Predicting Road Traffic Noise.

The two major problems in measuring traffic noise levels are first, to arrive at a unit that correlates well with annoyance. Traffic noise rises and falls throughout the day as does ambient, or background noise. While many methods have been proposed to take this variability into account, there is no international agreement as there is with the dB(A). Secondly, a decision has to be reached on the level of the unit to which it is worthwhile to reduce noise.

Traffic noise can be controlled by vehicle design and by legislation aimed at limiting noise production but methods and techniques available to the highway designer include, in general, the routing and location of roads, the reduction of traffic speed and density, the promotion of the smooth flow of traffic and by the use of traffic management techniques. More specifically, traffic noise can be influenced by the road gradient, the road elevation, placing the road in tunnel, by the erection of noise screens or noise barriers and by pavement design.

Land use planning can be used to locate particularly sensitive uses at a distance from the roadway, building lines should be established to avoid the "canyon" effect and achieve adequate distance between buildings, building orientation and layout should be designed to minimise noise impact.

3 INTRUSION

Highway development has an effect on land use, on communities, on the visual environment and on existing streets.

3.1 The Effect on Land Use

When land is allocated for highway use, the supply of land for other uses is reduced and accessibility is substantially improved, thus leading to higher land values. This generally benefits property owners, but people not displaced may find rents will increase and the utility of the area may be adversely affected. Uncertainty over the exact route or implementation date of a proposed highway may inhibit property from being maintained, thereby leading to general decay and a run-down appearance to the area. Land uses compatible with a highway, e.g. industry, offices, transport facilities, should be introduced along the

primary route corridors, if possible, to shield other, more sensitive, uses. Consideration should be given to replacing land taken up by a highway where possible.

3.2 The Effect on Communities

When a new highway cuts across existing roads, freedom of movement across the line of the new facility is sacrificed for the sake of a high level of flow along the highway. Journey lengths are increased and crossing points over the new road usually reduced. This impacts particularly on pedestrians who should be given more frequent crossings than typically given to vehicles.

A new highway alignment may confirm an existing feature or protect a high-quality area from one of lesser quality. However, the implications of increased journey lengths on the ability of the area to continue to function as a community need particularly careful assessment. The fundamental concept is accessibility and what is lacking is a method of assessing the impact on a community of changes in accessibility to various services. A highway changes accessibility by the changes it makes to the local street pattern, by its position within the neighbourhood and by the psychological effects of its presence.

3.3 The Effect on the Visual Environment

Visual problems include disturbing views of the highway itself and of the traffic moving along it. Visual dominance by the highway is evident at multi-level interchanges, also if the highway itself is elevated. A highway can break up important views and visual severance can cause psychological severance. Loss of privacy and the obstruction of daylight and sunlight can also occur.

The visual impact can be reduced in a number of ways. Highways should be aligned close to other large-scale elements. Depressed highways are most easily integrated into the urban scene, visually. Alignment can be used to screen an unpleasant view. The conflict in scale can be reduced by careful landscaping which should be an integral part of the design process and not a cosmetic afterthought. Visual dominance can be reduced by screening the highway with purpose designed buildings.

The visual intrusion of an object can be measured as the ratio of the solid angle subtended by the object at the viewer's eye to the total hemispherical field of view. The measure assumes that all objects are equally "intrusive" and takes no account of aesthetic quality, which has to be separately assessed.

3.4 The Effect on Existing Streets

Although most attention is paid to new highways, it should not be forgotten that increasing traffic volumes can have a considerable impact on conditions in existing streets, where traffic can affect at least as many people as traffic on new urban motorways.

At a strategic level, people living on heavily trafficked streets tend to withdraw from the street, living in the back rooms of their properties which tend to be apartment blocks rather than single family houses. Quiet streets tend to have a rich social climate.

At the tactical level, the presence of people and vehicles at the same place and at the same time has to be considered. Crossing many roads today is not easy even for the physically fit and mentally determined. It is often an ordeal for the young, the old and the infirm, especially at night or in bad weather. The provision of exclusive pedestrian areas should be considered. Modifications to existing situations are more difficult.

Consideration has been given to the concept of "environmental areas" which may have large volumes of local traffic but should not be subject to traffic that does not have business in the area. The basic criterion associated with the quality of the environment is the freedom with which pedestrians can walk about and cross the street. This is considered to be a useful guide to the civilised quality of an urban area. Consequently, there is a relationship between the ease of pedestrian movement and the traffic capacity, the "environmental capacity", of the road network serving the area.

All of these issues are addressed in the “National Guidelines for Road Access Management in South Africa.” That document recommends the majority of streets are retained as “Activity Streets” where mixed traffic and pedestrian uses are catered for.

4 VIBRATION

Vehicles produce vibrations in the road and in adjacent buildings by generating stress waves which are transmitted through the ground and through the air. Stress waves transmitted through the air are insignificant in terms of their effect on buildings. Waves transmitted through the ground consist of longitudinal and shear waves, collectively known as body waves. The ground surface introduces a further wave in which energy is transported along the surface by a wave motion confined to the region close to it. This is known as a Rayleigh wave. Body waves decay as the square of the distance from the source and are less important than Rayleigh waves which decay as the square root of the distance. Also, horizontal vibration is negligible compared with vertical vibration. The difference should be noted between the velocity of propagation of vibrations, i.e. the speed through the ground away from the source, and the peak value of the velocity at which the particles of soil vibrate locally. It is the local peak particle movement that is of prime importance to buildings and people.

The generation and propagation of vibrations in a layered road pavement is extremely complicated. Rayleigh waves are set up at each interface between the road layers. The shock produced at the road surface depends on the shape of the irregularity, the axle load, the vehicle suspension, the inertial properties of the vehicle and its speed. Also, different materials react differently under stress.

In the case of bridges, previous designs have resulted in relatively massive, stiff bridges, with adequate structural damping to reduce any vibrations to insignificant levels very quickly. The current trend towards more slender structures will result in more "lively" bridges thus accentuating vibration as a design problem. No work is known on the transmission of vibrations from highway bridges to adjacent structures.

There is little published literature describing vibrations generated by vehicles. However, the information which is available, suggests that traffic vibrations, particularly from a well maintained road surface, are too low to cause structural damage and are of a similar order of magnitude to those caused by normal use of the building. Vibrations create unpleasant and worrying sensations in people due to the fact that the human body is an extremely sensitive detector, capable of sensing very small levels of vibration. People usually become concerned about vibrations at levels well below those that are likely to cause problems.

A certain amount of work has been done in trying to define levels of vibration which people find tolerable. Unfortunately, tolerance levels alone are not adequate to define criteria for the acceptability of the vibrations caused by traffic. Intrusion and understanding of the situation must also be considered.

5 ENVIRONMENTAL IMPACT STUDIES

5.1 Integrated Environmental Management (IEM)

IEM is a systematic approach for ensuring the structured inclusion of environmental considerations in decision-making at all stages of the development process, from the time that a need is first identified through to the implementation of a proposed course of action. The purpose of IEM is to ensure that the maximum benefit accrues to the community by seeking a balance between meeting development needs and conserving the environment. IEM requires that environmental factors, in addition to the normal political, economic and technological factors, are incorporated into the planning process within the framework of a multi-disciplinary approach.

The planning in respect of any project generally follows four stages from initial concept to implementation:

- Generation stage - the definition of all the feasible and desirable proposals
- Assessment stage - The degree to which the objectives are met by the preliminary proposals and the potential consequences of the proposed action are assessed and measures for mitigating the negative impacts are devised
- Selection stage - the identification and selection of the preferred scheme
- Implementation stage - devising a management plan for implementing the selected proposal

It is important for public participation to be undertaken at all stages of a project.

The Environmental Conservation Act has recently become law and enables the adoption of IEM as an enforceable system in South Africa. Regulations published in terms of the Act will define the procedures to be followed in some detail.

5.2 Environmental Impact Assessment (EIA)

The various techniques which have been used for EIA include, ad hoc methods, use of overlays, check lists and matrices. The matrix technique has been recommended for use in South Africa. Essentially the method involves tabulating specific actions of the proposed development, which might cause environmental impacts, against specific elements of the environment in which the proposed development is to take place. The actions are then scored based on their magnitude and their significance. This allows specific actions and elements to be ranked. Attention can then be given to those actions having the greatest potential for causing environmental damage and to those elements that are most vulnerable.

5.3 Environmental Surveys

Environmental surveys attempt to establish how people will react to a given situation. Physical measurement is important to quantify the situation, but it is meaningless unless it is related to the human reaction. It is necessary therefore to be able to predict the effects which alternative schemes will have on people and to be able to set acceptable standards for environmental factors based on the effects of these factors on people.

Surveys can be divided into those designed to obtain predictive information on the relationship between physical factors (noise, traffic flow) and some measure of subjective reaction (annoyance, money values), those aimed at describing the extent of a particular nuisance and those which attempt to predict the response to a new situation.

One of the uses of the data obtained is in determining acceptable standards for environmental variables. This is a difficult exercise since the decision as to what is an acceptable degree of annoyance is somewhat arbitrary.

The data can also be used during the assessment of road proposals, either by considering one factor at a time or by attempting to allow all environmental factors to be expressed on the same scale, e.g. by using money values, so that their impacts may be combined to form an overall environmental index. All of the methods involve considerable difficulty and are unsatisfactory for a variety of reasons.

People react differently to the same stimuli, in fact the same people can react differently to the same stimuli depending on the role they adopt, and no-one is in a position to say what is good or bad for the community. A solution to a transport problem will always involve a compromise and therefore a meaningful method of involving the public in planning decisions must be used. It should be remembered:

- that transport exists for people and not the other way around;
- that the road and its traffic play a prominent part in determining the quality of our environment;
- that environmental impact must therefore be a principal consideration in road and traffic planning; and
- that due attention must therefore be given to the public's reactions and the public's wishes.