This description of the local environment was given in Shakespeare's Hamlet during the Renaissance Age. More recently in this Age of Aquarius, Ralph Nader said more simply in the forward of a new book entitled Vanishing Air: "Air pollution is a form of domestic biological and chemical warfare."

Apparently circumstances haven't changed much over the years, which leads one to raise certain questions (or charges depending on your vantage point): What is air pollution? Is anyone doing anything about it? If so, why do we see so-and-so's chimney belching smoke? How bad is the problem in Kentucky? What does air pollution have to do with highways?

Providing half an answer to all of those questions would be quite a challenge. Starting in reverse order, I would have to say that apparently highways have very little to do with air pollution. After reviewing seven current projects within the U.S. Department of Transportation and sixty projects sponsored by the National Air Pollution Control Administration aimed at reducing emissions from motor vehicles, I could find only one related to highway design. Entitled "Air Pollution Aspects of Various Roadway Configurations," the study dealt with the potential adverse effects of building a submerged expressway in Lower Manhattan (New York City). The results must have been interesting because NAPCA refused to release them.

There may be others which I have not been able to identify, but I don't believe I'd be too far wrong to say that very little effort has been focussed on the planning and design aspects of highway construction, a point where much good could undoubtedly be achieved, to prevent air pollution problems. Instead, attention has been devoted to more visible targets, incidental to the roadway itself, but which are direct sources of air pollution. These include ancillary activities such as rock quarry operations, concrete and hot-mix asphalt production necessary to provide materials for highway construction, the process of highway construction itself, and the motor vehicles that use the highway after completion. I would like to touch on each of these topics, materials production, highway construction, and motor vehicles, together with some background on the nature of air pollution and the State Commission in the discussion.

NATURE OF AIR POLLUTION

In Kentucky, statutory air pollution is: "presence in the outdoor atmosphere of one or more air contaminants in sufficient quantities and of such characteristics and duration as to threaten to be injurious to human, plant or animal life, or to property, or which unreasonably interferes with the comfortable enjoyment of life or property" (KRS 224.319(6)).

Shakespeare, Hamlet

Types of pollutants.

The kinds of pollutants present in the atmosphere are indeed many. One method of classification is by their physical properties. Gaseous pollutants produced by man's activities are, by greatest weight, carbon monoxide, sulfur oxides, nitrogen oxides and hydrocarbons. Solid and liquid airborne particles, such as fly ash, dust, fume, and mist are referred to as particulate matter. Other gaseous and particulate pollutants which have alarming effects, but may not be present in all communities include such substances as fluorides, lead, polynuclear compounds which have cancer-causing properties, asbestos, beryllium, pesticides and radioactive wastes.

Another method of classification is by primary and secondary pollutants. Primary pollutants are those substances directly released from a source to the atmosphere. Secondary pollutants may, by chemical reaction of the primary constituents, form new families of compounds and associated effects. One familiar example of this phenomenon is photochemical smog. Hydrocarbons and oxides of nitrogen spewed from automobile exhausts, react in the presence of sunlight to form a variety of substances including ozone and peroxycetil nitrate, commonly called PAN. Ozone is highly phytotoxic, causing widespread crop losses especially in broad leaf plants like corn, spinach and tobacco. PAN, also phytotoxic, is a strong eye irritant, and is principally responsible for the tearing effect of smog. To discuss pollutant concentrations, one must become familiar with terms such as ppm and ug/M$^3$, as these are the levels commonly encountered, with concentrations sometimes being of concern in the ppb range.

Sources of air pollution.

Sources of air pollution are as diverse as the wide variety of pollutants they emit. Four categories of sources are commonly considered in typifying a community's air pollution problem. These include (1) transportation, (2) fuel combustion in stationary sources, including power plants, industry, space heating, (3) industrial processes, and (4) solid waste disposal. Sources are also classified as "point sources" if the amount of pollutant emission is large enough to cause an impact on its nearby surroundings. Generally any source which emits as much as 1.0 tons per day of any kind of air pollutant is treated as a point source.

Meteorology and topography.

Meteorology and topography play a large role in the nature and effects of air pollution. The atmosphere has certain dispersive and other characteristics which vary with time and location. You may have noticed that a given
city looked more polluted on some days than others. Assuming the amount of pollutants emitted remains constant, that difference was likely due to another variable – the weather.

Some weather conditions are more important than others. Wind speed and direction are obviously prime factors. Greater wind speeds produce greater natural dispersion. Persons who live downwind of a pulp mill are more likely to be reminded of its presence than those living upwind. Colder climates require more space heating and more fuel combustion leading to higher pollutant concentration levels during the heating season. This difference is becoming less noticeable, however, with the upsurge of air conditioning, which also requires more fuel combustion for electrical energy and tends to level out conditions throughout the year. Frequent rainfall has the positive effect of washing out pollutants from the atmosphere (from which point they become water pollutants).

The change in atmospheric temperature with altitude is of special importance. Ordinarily, air temperature is highest at the earth’s surface and decreases with altitude. Since warm air rises, a vertical turbulence is produced which helps move pollutants away from ground level. Sometimes this situation is reversed, and cold air is trapped on the surface with a layer of warm air aloft. This condition is called an inversion and is characterized by low wind speeds and little vertical or horizontal turbulence, thus producing pollutant emissions buildup and a rise in concentration levels. Fortunately, inversions are of short duration, commonly occur during the night, and dissipate the next morning as the sun heats the earth's surface.

A more serious condition, a stagnation period, is associated with large scale weather fronts - the highs and lows you see on nightly TV forecasts. These average about four days in length and may persist up to seven or more days. Complex plans, called high air pollution emergency episodes, are being laid in major metropolitan areas across the nation to cope with such events. Some refer to these as “death watches.” They consist of sequential steps to gradually turn-off a community as pollutant levels reach increasing plateaus of danger. We have just completed the preliminary design of such a plan, together with the States of Indiana and Ohio, for the Cincinnati region. Eastern Kentucky lies in a belt of high frequency of both inversions and stagnations.

Topography becomes important in the relationships of source to receptor location. Sources situated on a valley floor may have devastating effects on receptors on the surrounding high ground. Mountainous terrain and waterways tend to channelize wind flow along their respective valleys, and carry pollutants with them.

Effects of air pollution.

Air pollution constitutes a threat to human life and health, as well as to our property and well being. Disasters have occurred which have taken lives in such diverse locations as London, the Meuse Valley, Belgium, Costa Rica, New York City and Chicago - nor are these limited to large metropolitan areas. One occurred in the small western Pennsylvania mining town of Donora, in 1948, which shocked this nation into an awareness of the problem’s potential. These incidents were caused by high air pollution concentration levels which developed during stagnation periods. Also of concern are health effects associated with continued exposure to “low levels” of air pollution. Levels to which we have become so accustomed we barely notice them. Nobel Prize-winning geneticist, Dr. Joshua Lederberg, has pointed out the grotesque absurdity that even the Food and Drug Administration may consider many of the chemicals we inhale unfit for human consumption if contained in food.

The etiology of chemically or physically induced disease is not as clear cut as those caused biologically, thus it is seldom possible to state unequivocally that a certain dosage of pollutant “x” will cause disease “y”. More often it is the case of predisposing a subject to disease. Thus air pollution is believed to contribute to respiratory diseases such as emphysema and bronchitis. Carcinogenic materials in the air, such as benzo-a-pyrene and asbestos, are associated with increasing rates of lung cancer. Heart diseases, the single largest cause of death in the United States, has been linked to excessive levels of atmospheric carbon monoxide. Effects on animals, vegetation and property are also well documented.

The presence of two or more air pollutants at the same time has been observed to produce more serious effects than the same concentrations of each pollutant separately would produce. This peculiar characteristic - a way of adding one and one and getting four – is called the “synergistic effect.”

I will say more about specific effects caused by those pollutants related to highways later.

Costs of air pollution.

In typical American fashion, we have attempted to place a price tag on air pollution. In 1963, a staff report of the Senate Committee on Public Works ventured the estimate that air pollution costs averaged (or at least that part of it which could be translated into dollar costs) eleven billion dollars annually, or sixty-five dollars per American citizen. Other estimates have ranged upwards to thirty billion dollars annually. Whatever, the dollar cost is impressive, and what is more important, the cost of control is considerably less.

Kentucky Air Pollution Control Commission.

The Kentucky Air Pollution Control Commission, a relatively new state regulatory body, was created by legislative act in 1966. It is presently comprised of thirteen members - five ex officio due to their position in State government and eight appointed by the Governor. The technical staff employed by the Commission is housed in the State Health Department in Frankfort.

Pursuant to its authority under the Kentucky Air Pollution Control Law of 1966, the Commission has promulgated twelve regulations. These spell out performance criteria, or emission standards, for a wide range of air pollution sources, including: incinerators, wood waste burners, fuel combustion devices for generation of power and steam, and industrial process equipment. Open
burning of solid wastes, with some exceptions, is prohibited. All potential sources of air pollution are required to register with the Commission, and those of major significance must obtain a permit to construct, alter, and operate their equipment. This latter requirement, along with specific emission standards for manufacturing operations, will have a definite future impact on highway construction in Kentucky. One regulation is unique in its nature, and perhaps the most far-reaching in terms of working toward a clean air environment for Kentucky. This regulation sets minimum standards of air quality throughout the Commonwealth, designed first to protect human health, but also to prevent, insofar as possible, adverse effects on animals, vegetation, and property, and to preserve the natural beauty of the land. These air quality standards represent goals for future attainment and as such represent the cornerstone upon which our control efforts will be based. A corollary of the standards is the stated intent that where better air quality than that stipulated by these standards already exists, that no further significant and avoidable deterioration of air quality shall occur. Kentucky's air quality standards are tough and stand among the most stringent in the country.

The reason why they are, in my view, is that they determine the base level requirements of future performance for all sources of air pollution. For example, in a given area, say Louisville, a study would be undertaken in which the Commission would: (1) make an inventory of the kinds and amounts of pollutants emitted; (2) take measurements of existing air quality; and (3) analyze local meteorological conditions. A comparison of the existing air quality to that projected in the goal for a given pollutant will determine the emission reductions required for the area. These reductions are translated into performance standards imposed upon all sources contributing that pollutant to the area. This process is called "air resource management." The Commission has recently completed, again in conjunction with their regulatory counterparts in Indiana and Ohio and the Federal government, such a study for the Cincinnati metropolitan area. The analysis showed that previously adopted performance criteria, applicable statewide, were not sufficient for that region and had to be strengthened. Reduction of sulfur oxide levels was also determined necessary. Sulfur oxides are gaseous byproducts formed mainly from burning fuels that stipulated by these standards already exists, that no further significant and avoidable deterioration of air quality shall occur. Kentucky's air quality standards are tough and stand among the most stringent in the country.

Now having talked all around the subject on air pollution, let's look at specific problems with highways.

Air pollution from highway materials production.

Highway materials production primarily includes rock and gravel quarry operations, batch concrete and hot-mix asphalt plants. All of these mineral industries involve all or some of the same processes, such as crushing, conveying, screening, drying, mixing, and have a common air pollution problem, the emission of dust or particulate matter.

There are two kinds of particulate matter of concern. The first is so finely divided that it floats about indefinitely. These particles are 40 microns in diameter or less (200 mesh = 74 microns, one micron is 1/25,000 inch) and are called suspended particulates. The other consists of larger particles which fall by gravity to earth. These are referred to as settleable particulates and include everything greater than 40 microns in diameter on up to bricks and baseballs. Un desirable health effects are associated with suspended particulate concentration levels of 300 micrograms per cubic meter (ug/M^3) averaged each day over a period of 3-4 days, or 80 ug/M^3 averaged over a year. Other effects of this pollutant, including soiling, and visibility reduction, are observed at even lower concentrations. Kentucky's air quality standards for suspended particulates are set at a maximum value of 220 ug/M^3 averaged over twenty-four hours and 65 ug/M^3 as an annual average. One of the highest measurements our monitoring networks have ever recorded was taken at a private residence adjacent to a crushed dry aggregate establishment and registered 1380 ug/M^3. This operation was so dirty that the trees in a grove of white cedars bordering the property were all bent over from the encrustation of dust. Fortunately this situation is not the rule, but it is not altogether unique either.

Most of these operations are point sources, ie. they emit more than one ton per day of pollutant. There are about 60 rock quarries in operation across the State, with a combined total production in 1969 exceeding 32,000,000 tons of crushed stone, gravel and other aggregates. It is estimated that about 20 pounds of particulate matter is emitted per ton of product, resulting in an industry-wide air pollution production of about 320,000 tons per year. Although production rates vary widely, a single quarry operating a primary crusher at a rate of 1,000 tons per hour could produce 80 tons of particulate matter in a single 8-hour day.

The Kentucky Department of Highways recognizes 121 hot-mix asphalt plants as being qualified for State construction work. These plants have an estimated annual production capacity of 15,500,000 tons. A typical plant may have a production capacity of 200 tons per hour. The estimated emission rate of particulate matter is about 5 lbs. per ton mix or about 1,000 lbs. per hour. This is after passing through cleaning equipment designed to recover materials for re-introduction into the process. We do not have statistics on the number and production of concrete batch plants, but it is known that their emission potential is generally not as great as the others.

Similar problems have similar solutions and in the case of all these operations control technology is well established and equipment available to collect dust emissions. Typical installations include spray systems, cyclone collectors, scrubbers, and more recently in the case of asphalt plants, fabric filters.

The required performance is prescribed by Regulation No. 11 of the Commission. This emission standard is based on the size of the operation, which in turn reflects the emission potential of the operation. A sliding scale is applied so that the larger the operation, the
greater is the degree of control required. For example, the 200 ton per hour asphalt plant would be allowed an emission rate of 57 lbs. per hour. In all cases high efficiency control systems on the order of 97 to 99 percent will be required.

AIR POLLUTION FROM HIGHWAY CONSTRUCTION

Kentuckians should be pleased, and are probably somewhat amazed at the tremendous growth in completed miles of limited access highways across the State during the 1960's. This construction could not have been accomplished without some impact on the environment. The physical process of building a road does not rank high among major sources of air pollution, but it does contribute to the overall problem, again largely by emission of particulate matter. Demolition of existing masonry buildings, grading of earth and movement of heavy road-building equipment on temporary roads all produce nuisance dust situations. Open burning of demolition and land clearing wastes is perhaps the worst contributor of air pollution from this activity.

An attractive solution to the problem of solid waste disposal was proposed in the September 1970 issue of American Road Builder. In an article by H. S. Lindberg, Chief, Construction and Maintenance Division, FHWA, methods were described to minimize water pollution from soil erosion during highway construction. These methods utilized brush and logs from land clearance to create wood chips for mulching, and siltation traps at the bottom edge of steep exposed slopes. Of course, such materials would no longer need to be burned in the open. Simple solutions like these to multiple environmental problems are rare indeed, and deserve implementation.

It is not possible to quantify the total amount of air pollution arising from these activities, but it is estimated that open burning produces about 17 pounds of pollutants per ton of refuse burned.

Air pollution from motor vehicles.

Los Angeles has been dubiously pegged as "the only place where you wake up in the morning and hear the birds coughing." Smog is no longer a joke. The haze that hangs over busy highways and city streets may look innocent, but it carries a lethal punch, and it can no longer be relegated to a peculiar aspect of west coast living. Since the early 1950's it has crept over other cities as far dispersed as Denver, Chicago, New York City, Louisville, and Cincinnati. The situation in California has become so bad, that last year the Senate Chamber of the State's legislature passed a bill banning the internal combustion engine from California by 1975. Although the bill failed to pass the House, it threw the fear of the Lord into Detroit. The message was stated loud and clear — clean up the automobile, or clear out!

Nationally, over 90 percent of the total transportation emissions can be attributed to motor vehicles. These can be treated as two separate groups — automobiles and diesel powered vehicles, including trucks and buses.

I have often been asked, "Why don't you do something about those stinking trucks and buses?" Actually, nationwide, the greatest amount of attention has been devoted to abating automobile emissions, and for good reason. Statistics on vehicle population and fuel usage illustrate this point. For example, in 1960, 8,000,000 motor vehicles were registered in the State of California. Of these 2.6 percent were diesel-powered, 97.4 percent were gasoline-fired. The diesel engine accounted for 1.5 percent of the total fuel consumed, 98.5 percent was consumed by automobiles. The pollutants emitted follow the same pattern.

Carbon monoxide emissions from diesel engines are practically zero because of the large quantities of excess air provided for combustion in contrast to spark ignition engines, which operate on air insufficient to produce complete combustion. Smoke and odors are the primary problems. It is generally agreed that proper maintenance and fuel selection, operator training, derrating of engines, proper transmissions, and avoidance of overloading and prolonged idling will satisfactorily prevent smoke. Means of odor control are not so well defined. One consideration advanced is the use of lower-sulfur-content diesel fuels.

The automobile is really the prime contributor to today's air pollution problem. Nationally automotive emissions contribute about 42 percent of the total weight of pollutants emitted to the atmosphere from all identifiable sources, more than any other source category. In urban areas, the average is closer to 60 percent of total emissions, and in Los Angeles it amounts to 80 percent. Looking at the automobile as a unit, about 55 percent of its pollutant emissions come from the exhaust pipe, about 25 percent from the crankcase, and the remaining 20 percent from carburetor and tank evaporation losses.

Over 200 distinct chemical compounds have been identified in automobile exhaust, a half dozen of which are of special interest. The national tonnages produced by the present US population of about 90,000,000 motor vehicles is staggering. These include (on an annual basis):

66,000,000 tons of carbon monoxide
6,000,000 tons of nitrogen oxides
12,000,000 tons of hydrocarbons
190,000 tons of lead compounds
1,000,000 tons of sulfur oxides
1,000,000 tons of particulates

These pollutants are insidious because they are largely invisible.

For every 10 gallons of gasoline consumed by a car, 27 pounds of carbon monoxide (CO) are produced. Carbon monoxide has an affinity for hemoglobin in the blood more than 200 times greater than oxygen. It reacts to form carboxyhemoglobin (COHb) which reduces the blood's ability to carry oxygen. Persons breathing air contaminated with CO experience a decreased oxygen blood supply, which in turn places additional strain on the heart. A report by the National Academy of Science and the National Academy of Engineering indicates that "daily average (carbon monoxide) levels in excess of about 10ppm may be associated with an
increase in mortality of hospitalized patients with (heart disease).” This concentration level is found commonly in large cities and has been measured in Kentucky.

Normal background levels of COHb in the blood of nonsmokers is about 0.5 percent. Exposure to CO concentrations of 50ppm for as short a period as 90 minutes can raise this level to 3 percent. At that level impairment of time-interval discrimination, visual acuity, and brightness threshold can occur. Short term concentrations as high as 120-150ppm have been measured on urban thoroughfares, and there is strong presumptive evidence that this pollutant is partially responsible for increased traffic accidents and fatalities.

Hydrocarbons and nitrogen oxides are of less concern to human health at concentrations commonly measured, but both are essential ingredients of photochemical smog, whose products cause eye irritation, decrease visibility, and attack rubber, textiles, and vegetation.

Lead is added to gasoline in the form of antiknock fluids to raise the gasoline octane rating and is emitted from the tailpipe as a solid particulate. Any sizable accumulation of this poisonous substance in the body can cause impaired functioning of blood, liver, kidneys, and nervous system. The effect of minute accumulations due to constant exposure of urban lead contaminated atmosphere is largely unknown.

Other particulate emissions of concern from automobiles include asbestos fibers from abraded brake linings and clutch facings and rubber particles from tires. Inhalation of asbestos can cause the development of asbestosis, a lung disease.

We have not observed routine excessive concentration of these pollutants yet in Kentucky. However, it is only a matter of time, urbanization, and increase in number of cars before we are confronted with it. I should also point out that our measurements are very sparse, and high concentrations may exist where we have not placed instruments to date.

What kinds of solutions have been or could be applied to reduce automotive emissions? Can the revolt against the internal combustion engine initiated in 1969 by California be brought to pass? Several points should be made that underscore special difficulties of the automobile emissions problem. So far, reduction programs have been aimed at new cars coming off the production line. The average life of automobiles in the United States is presently about ten years. Therefore any change or additions to new models take considerable time in showing an effect, due to the long time required to turn over the existing car population. Secondly, the number of cars, like people, continues to increase and emission reductions, therefore, must become continuously greater or any gain accomplished is cancelled by placing more cars on the road. Finally, since automobiles are mobile rather than stationary sources, and since wide and scenic roads are being built to encourage their transport from one end of the country to the other, the matter of control is legally impossible for a single state or local authority. Because of this Congress has pre-empted regulatory authority for automotive emissions at the federal level. That is to say, Congress sets the standards for required performance. They have generously left the enforcement of those standards to State agencies which are largely incapable of such an undertaking.

Control efforts so far have been limited to reducing emissions of carbon monoxide and hydrocarbons. This was initiated in California in the early 1960’s where the goal was to “roll back pollution by 1970 to the levels that existed in 1940.” Potential means of accomplishing this goal included development of “tack-on” devices, fuel modifications, and production of altogether new types of propulsion systems. Uncontrolled automobile exhaust contains on the average, 900ppm HC, 1500ppm NOx, and 3.5 percent CO. To achieve California standards it was necessary to reduce that composition by 1968 to 275ppm HC and 1.5 percent CO, and by 1970 to 180ppm HC and 1.0 percent CO. In 1961, California required installation of crankcase control devices on cars sold in that State, the so-called PCV valve. By 1963, they became standard factory equipment nationwide. The auto industry “volunteered” this feature, after the Secretary of Health, Education, and Welfare (at that time Abraham Ribicoff) threatened federal regulations. Previously, in 1961, California had required new automobiles sold in that State to be equipped with exhaust controls two years after the State had certified the effectiveness of at least two workable control devices. The auto industry solemnly announced that such devices could be developed no sooner than by 1967. Private developers, visualizing tremendous market potential, were not entirely convinced that was the case however, and by 1964 California certified four such mechanisms developed outside the auto industry. By the established timetable this would have required factory installed devices on the 1966 model cars. Just three months prior to June 1964 when this certification occurred, the industry’s trade association (Automobile Manufacturers Association) reiterated its position that compliance before 1967 was impossible, but in June the situation changed dramatically. Faced with the prospect of having to purchase devices from outside the automotive establishment, Detroit decided it had an answer after all, and that a system actually developed by Chrysler in 1962 would be installed on the 1966 model cars. This indiscretion eventually led to an anti-trust suit filed against the industry by the Justice Department on January 10, 1969. In 1968 these systems were, by Federal regulations, installed on all cars sold in the United States.

Just what do these systems involve? The Chrysler “Clean Air Package” consists primarily of engine modifications including a cleaner air-fuel mixture and modified spark advance to make the engine run hotter. This causes more of the undesirable combustibles to burn off inside the engine. General Motors developed an “air injection system” which forces air into the exhaust port near the exhaust valve, thus adding oxygen which improves combustion. How are these devices working? Results so far have been disappointing. Federal regulations require that cars continue to meet standards for 50,000 miles, with one major tune-up at 25,000 miles. Studies conducted both by the National Air Pollution Control Administration and the California Air Resources Board indicate that the average car is at the threshold of failure at 11,000 miles!
The automobile industry has grudgingly admitted that all is not well. As G.M. Vice President Paul F. Chenea explained to Florida Congressman Paul Rogers' Subcommittee on Public Health and Welfare: "It isn't a matter of durability of parts, it is a matter of getting out of adjustment that is plaguing us." In other words, the problem lies not with the automobile but with the driver who fails to have his car adequately serviced. This, of course, is reminiscent of the industry's argument that auto safety had nothing to do with the car, but with the driver. In the new rhetoric of air pollution control, the nut behind the wheel has been replaced by the nut under the hood.

In 1973, modest federal standards on auto exhaust go into effect to control oxides of nitrogen. This creates a whole new set of problems because all methods heretofore employed to reduce hydrocarbons and carbon monoxide cause an increase in the amount of oxides of nitrogen being emitted. This technological quirk threatens another industrial giant - the petroleum industry. The reason is that the only control of NOx from internal combustion engines appears to be the application of a catalytic afterburner on the tailpipe. Catalysts are poisoned and rendered ineffective by the lead added to gasoline. Therefore lead apparently must go if the internal combustion engine pollution problem is to be conquered.

The elimination of lead presents a complex series of associated problems which can be described in an oversimplified fashion as follows. Present high-compression ratio engines depend on high octane fuels for smooth performance. A typical premium grade fuel has an unleaded octane rating of about 94. This is increased to the desired level of 100 by adding 2.7 grams of lead per gallon to the gasoline, the cheapest way to achieve the last few octane numbers. If lead is eliminated, the higher octane rating can only be achieved by additional refining and blending of more expensive gasoline components. The oil industry is not presently equipped to produce these components. It is estimated that it would take 2-3 years and about 4.5 billion dollars to convert refineries to leadless gasolines - a change the industry is understandably not too happy to make. The solution to this dilemma is not impossible, however, and appears to be taking the following form. The automobile manufacturers are reducing engine compression ratios and thereby fuel octane requirement on the 1971 model cars. These can satisfactorily burn 81 octane rated fuels. The oil industry, in stepwise fashion, going from present fuel formulations to "low-lead" fuels containing about one-half gram of lead per gallon and will eventually go to a no-lead fuel, while gaining time to achieve enough process conversion to produce high octane fuels routinely. As long as the temptation to engage in another automotive horsepower race can be avoided, this approach will probably work for the next few years.

You will note that all of these crash approaches to this serious problem are based on a single premise - that the old gasoline-fired internal combustion engine is here to stay. Many competent engineers (mostly outside the auto industry) and air pollution control officials question whether it can ever be cleaned up sufficiently, which leads to the real zinger - a totally new propulsion system. That idea generally brings on apoplexy in many corporate executive meeting rooms. Leading alternative candidates include the Stirling engine, the stratified-charge engine, gas turbines, the Wankel engine, and the electrically-powered cars. I would like to dwell for a moment on the Wankel engine - or the steam car if you will. Nine years ago a steam car was developed by the Williams' brothers in Ambler, Pennsylvania, with characteristics the present machine could never hope to achieve: HC emissions were 50ppm; NOx: 40ppm; CO 0.5 percent. Moreover, it has no clutch, no transmission, no carburetor, no starter motor, no muffler, no engine-block-cooling system, no distributor and only one spark plug. How would you consumers like to enjoy the maintenance costs of that machine? You bet we would!

It is unlikely that such a vehicle will ever be commercially introduced and for a very good economic reason: the profit margin in the "aftermarket," the sale of replacement parts, is greater than it is in the sale of new cars. The relinquishing of that abundant source of corporate profit would probably have to occur over the auto industries dead body.

I said such a probability was unlikely, but the industry may soon have to roll over. Last month the U.S. Senate passed, by a 73 to 0 vote, a new law which will require 1970 automotive emission standards to be reduced 90 percent by 1975. This bill is presently in a Senate House Conference Committee, but is expected to be passed unchanged. Detroit has once again screamed loudly that such accomplishment is impossible in the allotted time. This time they may be right.

A LOOK TOWARD THE FUTURE

Having looked at the nature and extent of the air pollution problem, that part of it attributed to highway-oriented activities, and some available remedies, let's consider what is currently being done about it in Kentucky, and what may be around the corner.

The Commission is working toward industry-wide control programs in dealing with establishments making roadbuilding materials. Through the cooperation of appropriate trade groups, including the Hot-mix Asphalt Industry of Kentucky, Inc., and the Kentucky Crushed Stone Association programs are being arranged to inform individual plant operators about regulatory requirements, alternative control measures, and the proper application for operational permits. The first of these meetings will take place in Lexington in December. We hope to take advantage of the seasonal shutdown period to install proper control devices where needed. It is anticipated because of the large number of plants involved, and lead time necessary for engineering design, purchase and delivery, that this program may take one to two years to complete. We expect good cooperation from the plant owners in obtaining compliance. However, for those few who need encouragement, the State law provides criminal and civil penalties of up to $1,000 per day in fines and one year in jail, with each day constituting a separate offense.

The Commission has not undertaken any specific programs with the Kentucky Department of Highways relative to highway construction, but we would welcome closer liaison and joint efforts.
In January, 1967, the Department of Highways adopted Special Provision 46-A relative to water pollution controls in connection with highway construction. I would like to see an effort made in proposing and adopting similar provisions related to controlling air pollution caused by highway construction, and that such provisions be considered and made part of bids received and reviewed on projects. Care in design of roadways to reduce travel distances and permit sustained moderate speeds induces automotive emissions in urban areas. Carbon monoxide and hydrocarbons emission decreases as route speed increases. Highway planners must incorporate knowledge of air and other environmental pollution factors into their decisions. Not that these matters need become controlling factors, but so that the planner is aware of his interrelation with them and can avoid or overcome undesirable problems. This might include an assessment of toxic pollutant concentration levels in tunnels, submerged roadways, elevated roadways that pass by occupied buildings, and in buildings constructed using air-rights over public roadways.

Controlling automotive emissions will not depend entirely on the ability of the auto industry to clean up the internal combustion engine. In July of this year, the National Air Pollution Control Administration launched a 5-year, 45 million dollar program to develop "two unconventional power sources by 1975 that will meet or exceed the 1975 emission goals and be mass produced by the auto industry." These funds are earmarked for research and incentives to produce prototypes, limited production test models, and finally full production models.

Controlling emissions from older cars produced before the 1968 model year by retrofitting of devices now being factory-installed remains a problem. General Motors conducted a test marketing program in Phoenix, Arizona, earlier this year. The company offered an air pollution control kit at a retail price of $9.95, or installed at about $20.00. In an eligible market population of 334,000 pre-1968 cars only 528 units were sold. Cost to GM was about $100 per unit due to an expensive promotion campaign. A company spokesman said: "There must be some inducement other than an individuals desire to clean up the air to motivate car owners into having the kits installed." That's corporate bureaucratese for: "They ain't gonna buy it if they don't have to!"

Earlier, I mentioned that the Federal government preempted automotive regulatory authority but delegated enforcement responsibility to the States. The enforcement options available to State agencies for this purpose are limited, and at present range from a simple visual inspection to see that factory-installed equipment has not been removed, to full scale testing, of actual emissions under load conditions, accompanied by diagnosis of the reason for failure when it occurs. Such programs are underway or being studied in California and New Jersey. I expect that if conventional cars remain the primary mode of individual travel, Kentucky will within the next two to four years develop some kind of mandatory inspection program for automotive and diesel truck emissions. This should properly be grafted onto a safety inspection program, assuming Kentucky develops a meaningful one. A bill to do just that was entered in this past legislative session, but died.

No final solution to all the problems associated with vehicular traffic; including noise, air pollution; traffic jams and the like, will ever occur without adequate attention and development of urban mass transit systems. It is ironic that this session of Congress has appropriated more funds for the development of two prototype SST jet airplanes, which have been widely criticized as posing a variety of grim threats to the environment, than it has for the advancement nationwide of urban mass transit systems.

In conclusion, I hope you are more aware of what air pollution is, what is being done about it, and how you, the highway builders and motorists of Kentucky, contribute to it. I am honored to have had this opportunity to address your meeting. In the succeeding months, we will look forward to your help and cooperation in working toward a clean air environment for Kentucky.