MEDICAL BULLETIN
UNIVERSITY OF MINNESOTA

May - June, 1971

2 Ecology

THE UNIVERSITY OF MINNESOTA MEDICAL BULLETIN
WILLIAM R. FIFER, M.D., EDITOR / EIVIND O. HOFF, JR., EXECUTIVE EDITOR
TOM PATTERSON, MANAGING EDITOR
Published bi-monthly by the Minnesota Medical Foundation. Annual membership and subscription: $25.00. Second Class postage paid at Minneapolis, Minnesota. No advertising accepted. Editorial office: 5412 Powell Hall, University of Minnesota, Minneapolis, Minnesota 55455.
Postmaster: Send Form 35792 to Minnesota Medical Foundation, Box 193, University of Minnesota Hospitals, Minneapolis, Minnesota 55455.

About the cover:

Original cover photo courtesy of
Environmental Graphics, Wayzata, Minn.
Retouching and art by Virgil Buescher.

EDITORIAL COMMENT

It is of considerable importance that we look **out** at the world as we have done in the two ecology issues. The importance of ecology is difficult to overstate and certainly deserves the attention given it in the **Medical Bulletin,** but perhaps we should look **in** as well as out.

As I strolled through the campus in late April, the leaves were just beginning to show. It was overcast and humid with intermittent showers. The auto and bus exhaust fumes were caught under the lacy network of new leaves and seemed to be pressed downward by the humid air. The din of several thousand persons constantly on the move added to my discomfiture. Is this the setting in which my three sons will some day attempt to further their education?

Looking **in** would certainly seem in order. A befouled campus like a befouled stream is difficult to appreciate and use appropriately.

Central to the current environmental crisis is the problem of over population, a highly controversial issue. Is this not a subject worthy of our consideration? Perhaps reader comments will force the issue.

JOHN N. MORK, M.D.
Worthington (Minn.) Medical Center

Vol. 42 No. 5

May-June, 1971

Published by the Minnesota Medical Foundation in behalf of the University of Minnesota Medical School, Minnesota Medical Alumni Association, and the Minnesota Medical Foundation. Statements and opinions published herein are exclusively those of the authors themselves.

JET POLLUTION: THE WILD GRAY YONDER

BY NICHOLE VICK
Editorial Assistant
School of Public Health

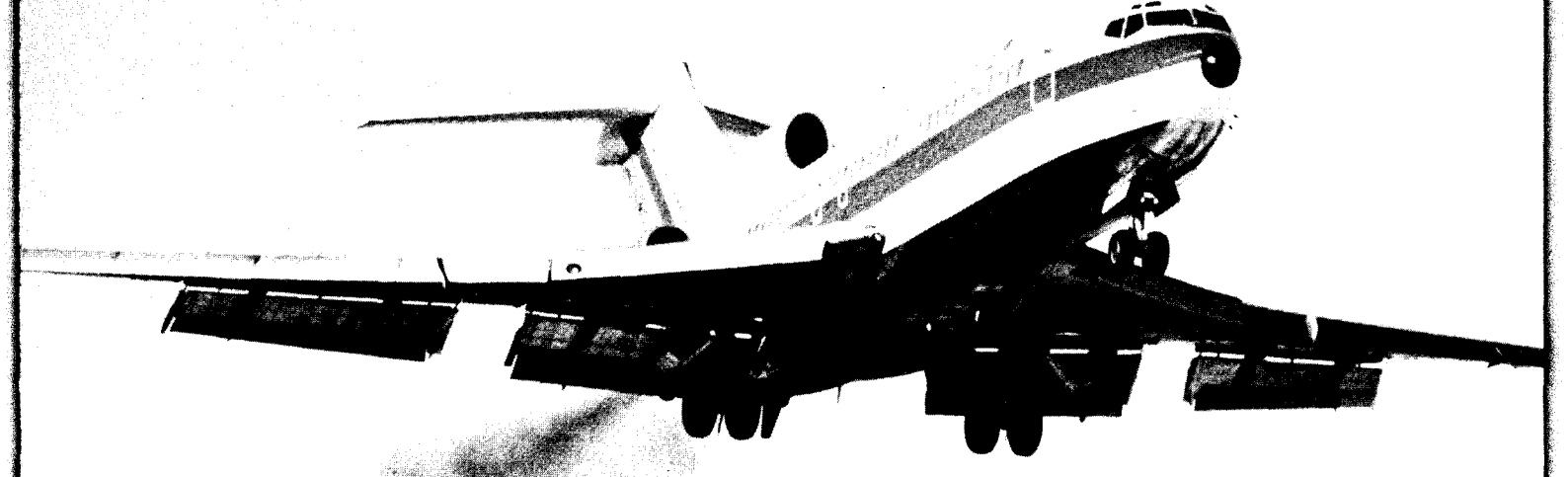
With tails submissively tucked between their wings, jet aircraft are conceding to the public admonition that jets should be neither seen nor heard — for the aircraft industry is making a surprisingly self-imposed effort to ameliorate the double-guilt of jets as sources of both noise and air pollution.

Why is the aircraft industry yielding without the usual self-exonerating battlecries of alleged polluters confronting the accusations of environmentalists?

Perhaps the exhaust plume and deafening thunder of the jet are just too flagrant for the industry to deny. Maybe the aircraft industry is altruistically motivated.

More likely is the air industry's realization that if it doesn't take more preventive action, irate citizens (especially neighbors to airports) and concerned legislators will retaliate against the noise and air pollution from jets — and such action already is clipping the industry's wings.

Already Federal law prohibits sonic booms by ci-

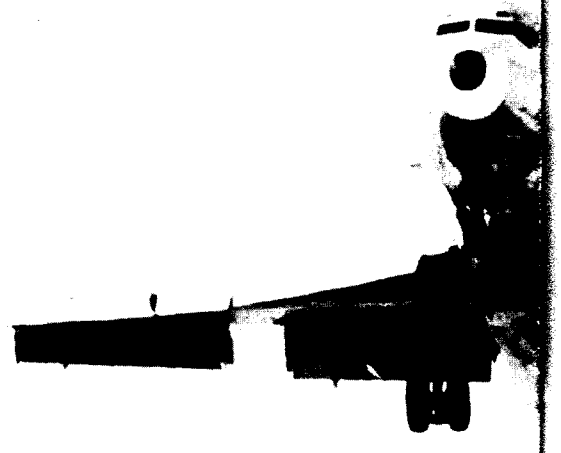


vilian flights over U.S. land areas. In 1970, Inglewood, California, tried (unsuccessfully) to restrict night flights, noisy planes, and runway use at Los Angeles International Airport. Noise complaints by residents of Frankfurt, West Germany, dropped after construction of an airport wall 50 feet high and one-half mile long to deflect landing, takeoff, and taxiing noises. Voters of Zurich, Switzerland, recently accepted a two-year plan to phase out night flights from Europe's eighth busiest airport.

A precedent-setting California law effective Jan. 1, 1971 limits the visible emissions from aircraft. Now the federal government is developing uniform national emission standards for aircraft, but impatient states might follow California's aggressive precedent.

This attention is no surprise to the aircraft industry. Air-conscious Los Angeles began studying jet pollution in the early 1960's. A 1964 Senate subcommittee hearing considered aircraft emissions. Congress passed the Air Quality Control Act of 1967, specifying that the Department of Health, Education and Welfare investigate plane pollution.

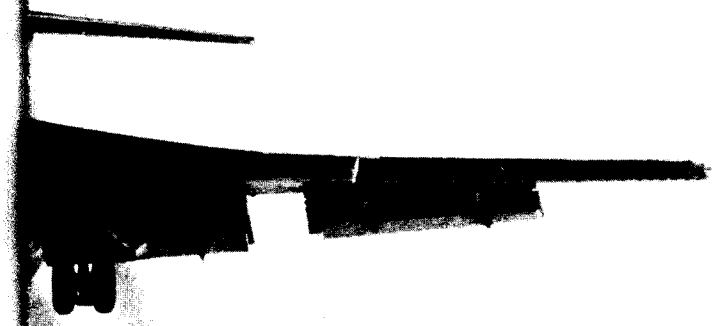
Consequently, in 1968 HEW announced, "The curtailment of ground operations and new airport design concepts aimed at emissions control . . . should reduce emissions, and should contribute to a reduction in noise."



CLOSE-TO-GROUND PROBLEM

Landing, takeoff, and ground operations produce most of the objectionable air pollutants and noise of jets. Consequently, jets become major contributiors to pollution around airports although the aircraft cause relatively little of the total atmospheric pollution. In addition, market values of property adjacent to airports generally decrease because of local noise and vibration from overhead jets.

Public complaints repeatedly single out the highly visible (and often fetid) trail from jet exhausts. Actually, jet exhaust "conveys a visual impression of smoke considerably out of proportion to the actual



particulate content," HEW reported in Congress in 1968. Turbine engines use excessive amounts of air in combustion — consequently, small emissions of minute (0.6 microns or less in diameter) carbon particulates disperse in the exhausted air to form misleadingly visible plumes.

Misled or not, the public complains. In response, engine manufacturers and airlines voluntarily pledged in the late 1960's to include a new engine combustor design on new engines and to adapt engines in use by the early 1970s to reduce smoke emissions. By late 1972, airlines will have installed about 3,000 smoke controlling combustors ("burner cans") on jet engines to cut smoke an estimated 70%.

'CANS' DON'T CONTAIN PROBLEM

Unfortunately, this emphasis on smoke and particulates overlooks the hazards posed by other jet emissions, including major gaseous pollutants such as carbon monoxide, unburned hydrocarbons, nitrogen oxides, and organic gases. These emissions (and pollutant effects) are similar to those from internal combustion engines, so determining the pollution contribution of jets is difficult.

However, a 1965 study by the plane- and car-choked Los Angeles County blamed all aircraft (both piston and turbine engines) for 1 to 2% of all organic gases, carbon monoxide, and nitrogen oxides, plus 10% of all particulates — and jets, as the major share of air traffic, contribute most of this pollution. By 1980, jets are expected to cause 3 to 5% of all carbon monoxide emissions in Los Angeles County.

In fact, jet emissions will be an increased, though still small, proportion of total air pollutants in 1980 because of new control devices for autos and other sources of air pollution. Even if control devices reduce individual jet emissions an anticipated 10%, annual increase in jet activity will yield net increases in overall pollutants from turbine engines.

Ironically, tests show that the higher temperature of the "burner cans" will increase turbine emissions of nitrogen oxides although reducing carbon monoxide and hydrocarbons. Robert Sawyer, associate professor of mechanical engineering at the University of California, Berkeley, says, "At a cost of $13-15 million by American Airlines' estimate, the new combustors may control smoke, but not necessarily pollution."

Uncontrolled jet pollution, especially nitrogen oxides, will aggravate the problems of auto pollution. These compounds of nitrogen and oxygen react in the atmosphere to form the toxic nitrogen dioxide — this combines with sunlight and other atmospheric pollutants to form photochemical smog. Smog reduces visibility, irritates mucous membranes, damages plants and textiles, and acts as condensation nuclei.

NOISY, TOO

Noise is another problem shared by autos and jets — in fact, the public antagonism aroused by jet noise may have stimulated a more critical public attitude toward previously tolerated noises, such as road traffic.

Most complaints about jet noise come from the densely populated communities often surrounding airports. Noisy turbine jets began replacing commercial piston aircraft in the mid 1950s — consequently, the fast-growing popularity of jets, paralleled by continued urban growth, put airplanes and man on a collision course.

Maximum engine power needed for takeoff produces the greatest amount of noise. As a result, new takeoff procedures of climbing, leveling, and climbing again aim at reducing noise. Yet these powerful planes demand longer runways for landing and takeoff in the noise sensitive lower atmosphere — jets even idle louder than other aircraft. However, vertical or short takeoff and landing aircraft are being designed to reduce noise from these operations.

Quantitative definition of "noise pollution" is difficult. The definition of noise itself is too subjective to allow determination of "excessive" noise. Dr. Aubrey C. McKennell of the University of Southampton, England, says, "One can expect to find whole communities reacting quite differently to noise even though subjected to much the same physical conditions of exposure." In fact, annoyance with noise is affected by psychological and social factors as well as physical variables, according to McKennell.

VARIABLES AFFECT PUBLIC OUTCRY

Although both aircraft and auto traffic exceed dangerous levels for the human ear, many physical variables, such as distance from the noise, pattern of the sound and geography of terrain, have an influence on aircraft noise levels — other variables include the season, humidity, and foliage. Because many communities set threshold limits for aircraft noise, jet noise is more of an individually determined irritant than a physical danger — interfering with sleep, conversation and relaxation, and causing windows to rattle.

One solution to jet noise is to move airports away from populated areas. However, population growth and the desirability of accessible airports make noise-reducing changes in engine design a more practical alternative. In addition to mechanical controls, noise complaints are reduced by rescheduling flight routes and landing patterns over less populated areas and reducing night flights.

"Noise reduction is accompanied by a reduction in efficiency with increased operating costs," according to William Burns, professor of physiology, University of London. Yet by 1960, the aircraft industry had spent more than $215 million on noise control of the 200 jets then in operation — and noise abatement efforts have continued with the rapid conversion to turbine engines during the past decade.

The aircraft industry faces a challenging double task because emission and noise control are not necessarily synonymous. Our health may depend on whether or not the aircraft industry can rise to the challenge. □

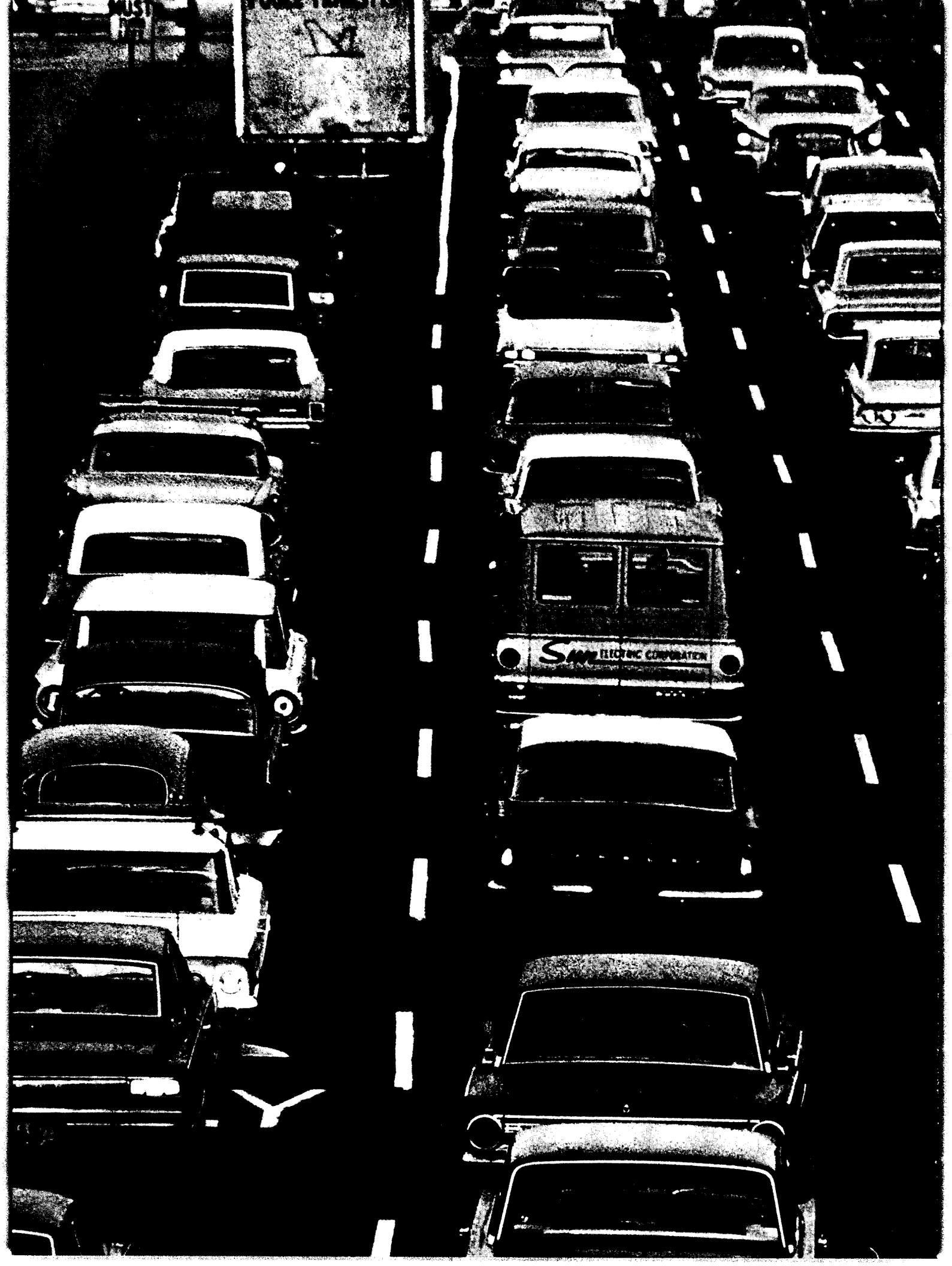
NO-LEAD GASOLINE: Placebo or Panacea?

BY NICHOLE VICK

The numerical vocabulary of Minnesota's boom in freeway construction — 35, 94, 694, etc. — may be a form of Russian roulette for citizens. How much auto pollution can we stand? What will be the magic number?

The rush hour and weekend clogging of our growing network of "super-roads" is symptomatic of Minnesota's increasing motor vehicle population and increased air pollution from engine exhausts.

Despite the claims and counter-blames ignited by the volatile "Get the lead out" pollution controversy, the removal of lead additives from your car's gasoline is neither a placebo nor panacea for the automobile's contribution to air pollution. In fact, the alleged



aggravation of other exhaust emissions and reduction in engine performance, plus the cost of the refinery conversion — an estimated $3-$7 billion to the oil industry hitting the consumer as a 1¢-3¢ per gallon price increase — might tempt the bewildered consumer to champion lead as the lesser of the evils.

Yet, the anti-lead proponents are rallying wide support including environmentalists, legislators, the auto industry in Detroit, and previously reluctant oil companies now capitalizing on the antipollution appeal of their new unleaded and low-lead fuels.

The most vocal dissent sounds from Ethyl Corporation and E. I. dupont de Nemours and Company, the nation's largest producers of lead additives. In fact, Ethyl has suggested that lead is being used as a "scapegoat" for the problems of the automotive industry.

That charge is not unfounded, either. Atmospheric lead concentrations have sparked controversy periodically — yet this year's furor erupted when the auto industry demurred that lead-free fuel is necessary for new cars to comply with the stringent 1975 federal auto emission standards.

LEAD AND OCTANE RATINGS

Why is lead-free fuel so critical?

Lead alkyl additives — tetraethyl and tetramethyl lead — raise octane ratings so that fuel burns more evenly. This increases power and eliminates engine misfiring and "knock," in high-performance engines —sort of like vitamins to supplement a diet deficiency.

Yet the lead additives have drawbacks. Although lead is less than one-tenth per cent of the gasoline consumed, deposits build up on the engine's pistons and cylinders, reducing combustion and increasing the production of unburned hydrocarbons. Now the auto industry charges that this build-up not only increases the emission of pollutants but also causes deterioration of proposed emission control devices, especially catalytic converters for further combustion in the exhaust pipe.

Ford researchers claim that cars using leaded gas are 35% "dirtier" than comparable cars with unleaded fuel. Du Pont's tests show only a 7% difference while Ethyl finds almost identical results with leaded and unleaded fuels.

Environmentalists stress the harmful effects of the suspended atmospheric lead on man. They fear that the lead particulates, inhaled and absorbed in the lungs, will accumulate to toxic levels in human tissues.

About 75% of the lead additives enter the atmosphere as suspended particulates. Since the introduction of leaded gasoline over 45 years ago, more than 12×10^9 pounds of lead have been consumed as antiknock additives in the U.S. "Lead from motor vehicle exhausts enters the environment in amounts of two pounds per capita per year," says Dr. Henry A. Schroeder of Dartmouth Medical School and director of a metal-free research laboratory in Vermont.

LEAD IN THE HUMAN BODY

"Evidence of a biochemical abnormality in persons exposed to urban air concentrations of lead is beginning to appear. There is little doubt that, at the presen rate of pollution, diseases due to lead toxicity will emerge within a few years," Dr. Schroeder adds.

Long-term epidemiological studies of chronic exposure to low concentrations of toxic metals like lead are negligible although lead is well known as a poison. Consequently, lead proponents are able to argue that no case of lead poisoning is attributable to the suspended lead emissions from automobiles.

Yet, the blood of apparently healthy persons contains 100-300 p.p.b. of lead, a level two to five times greater than expected without artificial contamination of the environment. Although most people can tolerate lead concentrations of 500 p.p.b. safely, lead could accumulate to dangerous levels in the blood during a person's lifetime. Over 200 autopsies by Dr. Schroeder indicate that lead *does* accumulate in the body with age.

Acute lead poisoning occurs at concentrations of 1,000-5,000 p.p.b., yet experiments show that low level intake affects the red blood cells. So far residents of some traffic-choked cities have demonstrated tissue lead concentrations of 250 p.p.b.

Dr. Schroeder's experiments show that lead ingested orally by animals (simulating accumulation in persons living near heavy traffic) does shorten life span. His results published in *Science News* (June 6, 1970) suggest a tenuous relationship between lead and "some of the endemic nervousness, fatigue, and vague ill-health in the United States." Yet, the U.S. Surgeon General says excessive metal pollution of the air is not an immediate problem.

MAN LIVES NOT BY BREATH ALONE

The small quantities of atmospheric lead — dismissed by one Ethyl executive as the equivalent of "one BB shot of lead inhaled by one man over a period of 70 years" — are more threatening in conjunction with other sources of lead. Precipitation washes out atmosperic lead to raise concentrations in ground water. One study shows that the lead content in rainwater of several cities parallelled the areas' gasoline consumption. Some atmospheric lead may be incorporated into plants and animals — even the earth's crust naturally contains 100-150 p.p.b. of lead.

Challengers of the validity of lead's double hazard — both to man's health and to the efficiency of new auto emission control devices — are impotent against the snowballing opposition now actively forcing the lead out.

The proliferation of anti-lead efforts attests to the momentum of the campaign. New York City proposed a ban on the sale or use of leaded gases after 1974 — in the meantime, taxis and city-owned cars are switching to unleaded gasoline to help reduce lead levels.

In November, California set the stringent limit of

1.5 micrograms per cubic meter (compared to 10.0 micrograms advocated by industry) for 30-day average atmospheric lead concentrations. Earlier California defeated legislation that would have forced gasoline companies to lower the lead content of their products.

President Nixon proposed a $4.25 per pound tax on the lead in fuel additives. The bill was defeated. Congress has also considered proposals to ban lead additives.

In effect, the Federal Government has forced industry's hand by adopting emission standards so stringent that the auto and oil industries have no alternative but to "get the lead out."

AROMATICS REPLACE LEAD

Rather ironically, removing lead from gasoline, despite its good intentions and desirable effect, might actually increase other auto pollutants. In order to match the high octane level of the lead fuels, the oil industry adds larger quantities of a more combustible, yet relatively cheap, alternative — aromatics. Aromatics evaporate rapidly, and an Ethyl executive charges that burning these additives emits toxic benzene and other chemicals which react with sunlight to form smog.

More critical is the charge that aromatics increase emission of unburned hydrocarbons which are suspected carcinogens. Ethyl used this as a defense for lead before a Senate subcommittee in 1970, "In our opinion, the unknown health hazards of increasing aromaticity — the problems of carcinogens—outweigh the long-studied question of lead."

The solution to both de-leading fuel, yet keeping auto emissions below federal standards, will probably be a combination of both fuel change and new engine design. Organic chemist Fausto Remirez, of the State University of New York at Stony Brook, suggests lowering the engine's compression ratio to reduce octane requirements, yet keep emissions within limits using the aromatics. This lower compression ratio is being incorporated in 1971 cars, while the oil industry continues work on other fuel alternatives. Although getting the lead out is a valid and necessary step, unleaded fuel is only part of the answer to auto pollution.

As *The New Republic* (November 21, 1970) gloomily reported, "Because present high octane automobiles will not be scrapped until they wear out, auto pollution will continue long after the introduction of scheduled low octane cars and tack-on devices." So, when the manufacturers come up with effective mechanical solutions, we will still have generations of "clunkers" to contend with.

Let's hope we don't all get "out of breath" trying to find a workable solution to the lead problem. □

THE TV RADIATION PICTURE

BY ROBERT G. WISSINK
Senior Health Physicist
3M Company

Is there double jeopardy for the armchair quarterback who watches pro football on color television and prepares his half-time snack in a microwave oven? Both the color TV and the microwave oven have come under attack by the U.S. Public Health Service in the past few years, and, as a result, regulation concerning radiation emissions from them have been issued.

Although one cannot deny that X rays from color TV sets or microwaves from ovens should be limited because of potential hazards to a specific segment of the public, it is unfortunate that the home user has become overly concerned about the safety of these devices. There has never been any evidence of harm to a viewer from X rays being emitted by a color TV set! There has never been a case of a housewife cooking herself from stray radiation while cooking a roast in her microwave oven! Then why the concern by the U.S. Public Health Service? First, because Public Law 90-602 amended the Public Health Service Act to provide for the establishment of an electronic product radiation control program. Second, because the effects a low-level radiation on a public-wide scale requires a value judgment about what could happen when such units are in every home. Third, because there are occupational exposures involved.

NOT A FRONTAL ATTACK

The controversy over color TV sets started in 1966 when it was discovered that some sets were emitting X radiation in excess of 0.5 milliroentgens per hour (mR/hr) at a distance of 5 centimeters (cm) from

the cabinets. In particular, some General Electric sets were alleged to produce "hazardous" levels of radiation. In virtually all cases, the source of radiation was faulty high-voltage shunt regulator tubes, not the face of the picture tube. Since TV set components are used on an industry-wide basis, the U.S. Public Health Service and a number of state agencies subsequently conducted radiation surveys on many different brands and found that levels in excess of 0.5 mR/hr at 5 cm could be found on a few receivers regardless of the manufacturer.

Due to serviceman exposures, there is justification for insisting that manufacturers conform to recommendations of the National Council on Radiation Protection and Measurements which is the group that established the standard of 0.5 mR/hr at 5 cm. However, the implication that levels exceeding this value are a health hazard to homeviewers is misleading. For example, in a survey of 1,124 color TV sets conducted by the U.S. Public Health Service, only two sets showed radiation levels at or above 12.5 mR/hr, the full-scale reading of the instrument used to make the measurements. Assuming the radiation level to be exactly 12.5 mR/hr at 5 cm, the radiation level at the closest position a viewer would likely be positioned, six feet, would be less than 0.01 mR/hr. Normal background radiation exposure from natural sources has been reported as 100 mR/year in Minnesota. To receive this same quantity of exposure from the TV set used in this example would require viewing 8 hours a day for 3½ years! This, of course, assumes the direction of the X ray field is toward the front of the set. In all probability, this would not be the case since surveys have shown the fields to be at the sides, back, or bottom.

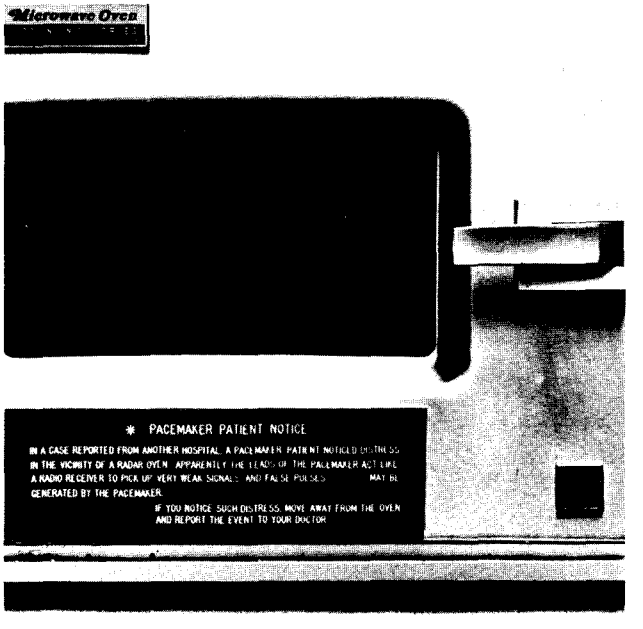
MICROWAVE OVENS

This past year the adverse publicity about color TV sets subsided and microwave ovens took the stage. Microwave radiation hazards are entirely different from X ray hazards. The difference begins with the nature of the radiation itself. Microwave radiation is nonionizing and X radiation is ionizing. Microwave hazard is primarily based on the thermal effects and X radiation on its ionizing capability. The energy content of a microwave photon ranges from one millionth to one thousandth of an electron volt, while X radiation from color TV is thousands of electron volts. Microwaves can be transmitted, refracted, absorbed, or any combination thereof; X rays are only absorbed. It is this last characteristic that presents the possible health hazard in both cases.

The principal health hazard of microwaves comes from the heating effects in body organs, such as the eyes, where there is no mechanism to adequatly dissipate heat. In the United States it is generally recognized that the heating effect is the only concern and standards of permissible exposure levels have been based on this premise. The U.S.S.R., Poland, and Czechoslovakia do not agree and have set much lower standards based on alleged nonthermal effects. These effects have not been demonstrated in the United States.

Unlike the X ray standard, one uniform standard for microwave exposure is not in use, but the differences between the various standards are primarily in the permissible period of exposure above power densities of 10 milliwatts per square centimeter (mW/cm^2). Exposures between 1 and 10 mW/cm^2 are considered safe for incidental, or casual exposure, and those below 1 mW/cm^2 are considered safe for indefinitely prolonged exposure. The standard established for microwave oven leakage is 1 mW/cm^2 when the unit is new, and no more than 5 mW/cm^2 during its useful life. These power density levels are applied at a distance of 5 cm from the oven.

A new microwave threat?

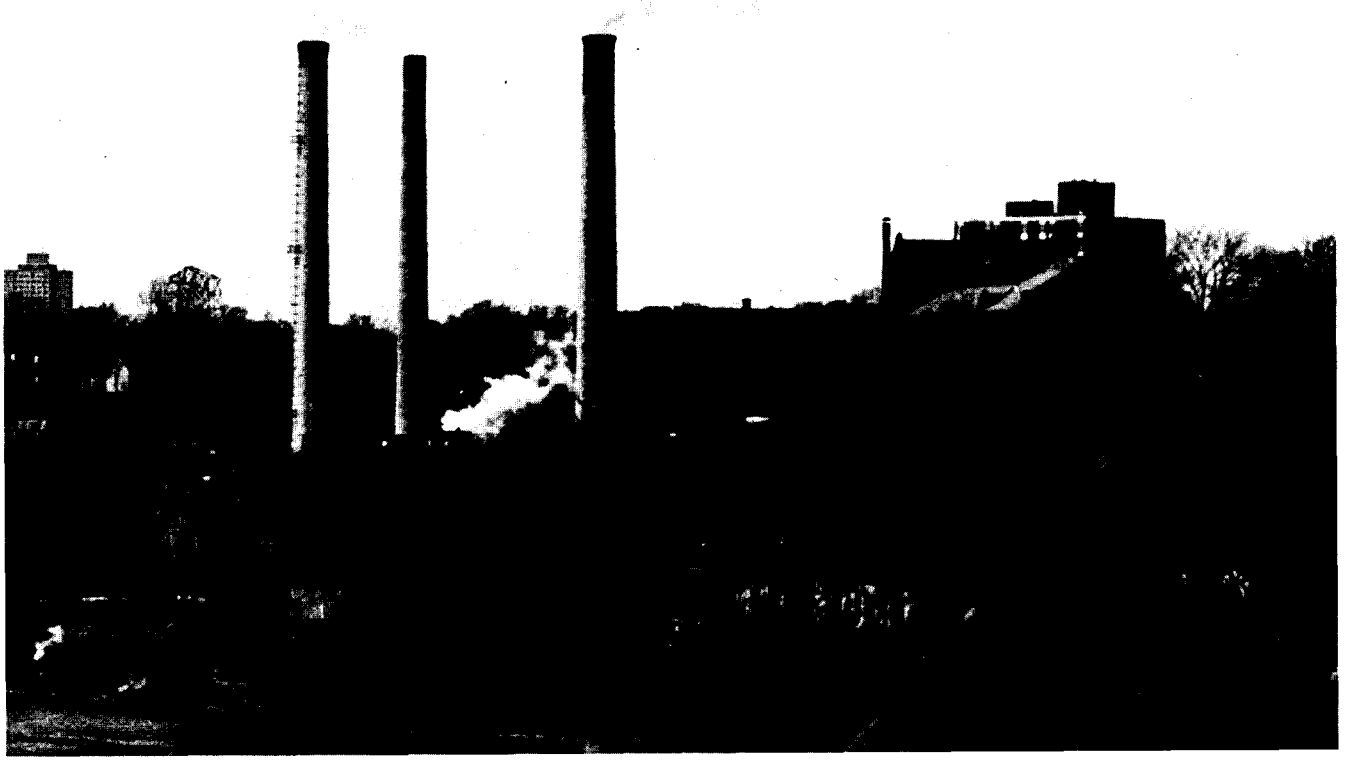


KEEP YOUR DISTANCE

As with color TV sets, a large number of microwave ovens were surveyed and a significant percentage were found with leakage exceeding 10 mW/cm^2. The reporting of various survey findings by the press implied that the home user was in jeopardy. This has been misleading for several reasons: (1) A home user is not located at a distance of 5 cm from the oven during the time the food is cooking; (2) the leak is in the form of a narrow beam, and the possibility of eye exposure is extremely remote; (3) the microwave intensity decreases as the square of the distance. For example, if a small gap in the door seal emits 100 mW/cm^2 at 5 cm, would this be a hazard? It would be 20 times the permissible standard, but the power density at two feet from the door would be only 0.7 mW/cm^2 which is well below the standard for occasional exposure.

Unlike color TV sets, leakage from microwave ovens is usually not from a defective component. The primary cause is from gaps in the door seals caused by food particles or misalignment of the door hinges and closure device. If the ovens are kept clean, thereby preventing buildup of grease and food particles, there should be no danger to the housewife.

Emission levels from color TV receivers and microwave ovens do not and have not presented a significant health hazard to home users. Occupational exposures have warranted the establishment of very low emission rates to protect servicemen who have repeated close contact with the units, but it is unfortunate that the general public has been led to believe that these two modern-day electronic wonders present a significant hazard to them. □



HEALTH AND AIR POLLUTION

BY WILLIAM R. FIFER, M.D.
Associate Director, Northlands RMP
Editor, Medical Bulletin

Air pollution is an unpleasant fact of life—or death. We are just beginning to document its effects on human health, and there are more questions than answers.

We have always been able to accept the fact that old people with heart and lung disease might be dealt a fatal blow by an acute air pollution episode, and this fact has been documented in New York (1953), London (1952), and Donora, Pennsylvania (1948), among other places. We have also accepted the industrial diseases such as silicosis and byssinosis in exposed workers as somehow inevitable. But now

we are faced with the real possibility that young, healthy city dwellers may be helplessly and relentlessly developing emphysema and lung cancer just because they have to breathe the air in polluted urban centers, and we begin to view the evidence with mounting concern.

We know a great deal about the pollutants in urban areas and the atmospheric circumstances which trap these substances like lethal halos around our cities. Monitoring stations can accurately measure ambient quantities of sulfur oxides, particulates, oxides of nitrogen, polycyclic hydrocarbons, ozone, lead, carbon monoxide, etc. We know that these poisons come from the combustion of fossil fuels, the action of sunlight on auto exhaust, etc. We can record the incidence of eye irritation, cough, chest tightness, and other symptoms, by survey questionnaire.

A SICKENING PROBLEM

But what evidence do we have that health — *our own health* — is being affected by the unseen gases we can't avoid inhaling with every breath? First, a wealth of experimental evidence exists: airway resistance increases as we increase the SO_2 concentration in inspired air, inhaled polycyclic hydrocarbons produce epithelial changes suggesting neoplasia in experimental animals, animals exposed to NO_2 develop a lesion very similar to human centrilobular emphysema. Second, we have acute toxicity experiences such as lead poisoning in children, or bronchiolitis obliterans in adults from NO_2 exposure (silo-filler's disease). Third, we have epidemiologic data demonstrating increased morbidity and mortality from lung cancer and chronic obstructive lung disease in city dwellers. These data are corrected for smoking, by the way. Smoking is *personal* air pollution, providing the smoker with carbon monoxide, carcinogenic hydrocarbons, and oxides of nitrogen. What really hurts is that even after one forswears the personal air pollution of smoking, he must continue his exposure to environmental air pollution with every breath.

Let's look at specific diseases related to air pollution: Lung cancer is twice as common in big cities as in rural areas. Chronic obstructive airways disease follows the same pattern. Asthma correlates with the level of sulfation in Nashville, Tenn. and Tokyo-Yokohama, Japan, and is produced by some unknown substance in the air in New Orleans in November. Both lung and pleural cancers (mesothelioma) are produced by asbestos inhalation, and more and more asbestos is appearing in random lungs at necropsy around the world. Coronary heart disease is probably related to inhaled carbon monoxide (Is that how cigarette smoking does it?) which produces typical coronary atherosclerosis in squirrel monkeys.

Finally, we are told there is lead in the air, that our "body burden" of lead is increasing with every car on every freeway, and we don't even know yet the subtle implications of having our bones full of lead. Yet we are told to buy lead-free gasoline — to "get the lead out."

This, then, summarizes some reasons for deep concern about the health consequences of our polluted air. We need much more information. But meanwhile we need much more action based on the common sense implications of what we already know. It seems likely that our polluted cities full of automobiles are killing us. We had better clear up the air soon and well. □

HEALTH AND WATER POLLUTION

BY JOHN B. CONWAY
Research Assistant
School of Public Health

Water pollution, like beauty, is often in the eye of the beholder. Some polluted water can make you sick, while the rest just looks that way.

Polluted water is difficult to define because the definition depends on who's talking. A power plant considers fish pollutants if they get into the water used for cooling. Microbiologists and sanitary engineers often define water pollution in terms of oxygen depletion.

The closest we can come to unpolluted water is distilled water, which doesn't exist in a natural state on this planet. Even rainwater which is condensed at high altitudes washes the air in its descent and is contaminated before it reaches the surface of the earth.

A good working definition is the presence of substances in water that interfere with man's health and well being. This includes those pollutants which man finds aesthetically unpleasant, even though they might not be a direct threat to his health.

WATERBORNE PATHOGENIC ORGANISMS

There are several different kinds of organisms that can survive in aquatic environments and will cause disease in man. These organisms are viruses, bacteria, protozoans and other parasites. This is the kind of water pollution that has traditionally most concerned man. Ironically, it is also man who has been the major contributor of these organisms to the water. Raw sewage contains, among other things, wastes from diseased persons. If this sewage reaches water used by others for drinking, cooking or recreation, it can infect them with disease.

Viruses of both poliomyelitis and infectious hepatitis have been isolated from sewage. Virulent and vaccine strains of poliovirus have been found viable for seven to 110 days in various water sources. Bacterial diseases of man commonly carried by sewage and water are cholera, typhoid fever, bacillary dysentery and leptospirosis. In 1965 there was an epidemic of waterborne salmonellosis in Riverside, Calif., involving 18,000 people.

Amebic dysentery (amebiasis) is transmitted by sewage contaminated with the cysts of the protozoan. Other parasitic diseases of man are the intestinal roundworm, hookworm, schistosomiasis, and the broadfish tapeworm. Schistosomiasis (snail fever) next to malaria is considered the world's most widespread disease; estimates of the number of infected persons range between 120 and 250 million. It is primarily a disease of tropical and subtropical areas, but New York City has an estimated 40,000 cases imported from Puerto Rico and Cuba. The eggs of this flatworm pass into the water in the feces or urine of infected individuals.

The broadfish tapeworm (diphyllobothriasis) enters man when he eats insufficiently cooked fish. Eggs of this parasite are passed to man's water in human wastes. Fish infected with this parasite are found in practically every watershed in Minnesota.

Proper sewage treatment, including chlorination, prevents the spread of the majority of these disease organisms.

CHEMICAL CONTAMINATION

Chemicals which have an adverse effect on the health of man constitute another kind of water pollution. Mercury and pesticides are two classes of chemicals that may be toxic to man which have received a great deal of attention. Insecticides, especially the chlorinated hydrocarbons such as DDT and Dieldrin, are common examples of such pesticides. Unfortu-

Some water fits everybody's definition of "polluted." ▶

nately, many of these chemicals persist in the environment for long periods of time and their levels build up in organisms as one proceeds up a food chain. Plants and animals living in water contaminated with an insecticide incorporate this insecticide into their bodies. Fish then feed on these organisms and concentrate the insecticide in their body fat. A bird or some other animal (man?) eating enough of these fish builds up his own body burden and might in time accumulate a lethal dose.

Levels of mercury build up in the same manner in aquatic food chains. Many pounds of Great Lakes fish have been destroyed because mercury levels were considered unsafe. In fact the Great Lakes fisheries are seriously threatened because so many fish exceed the 0.5 parts per million limit now set by most health authorities.

EUTROPHICATION

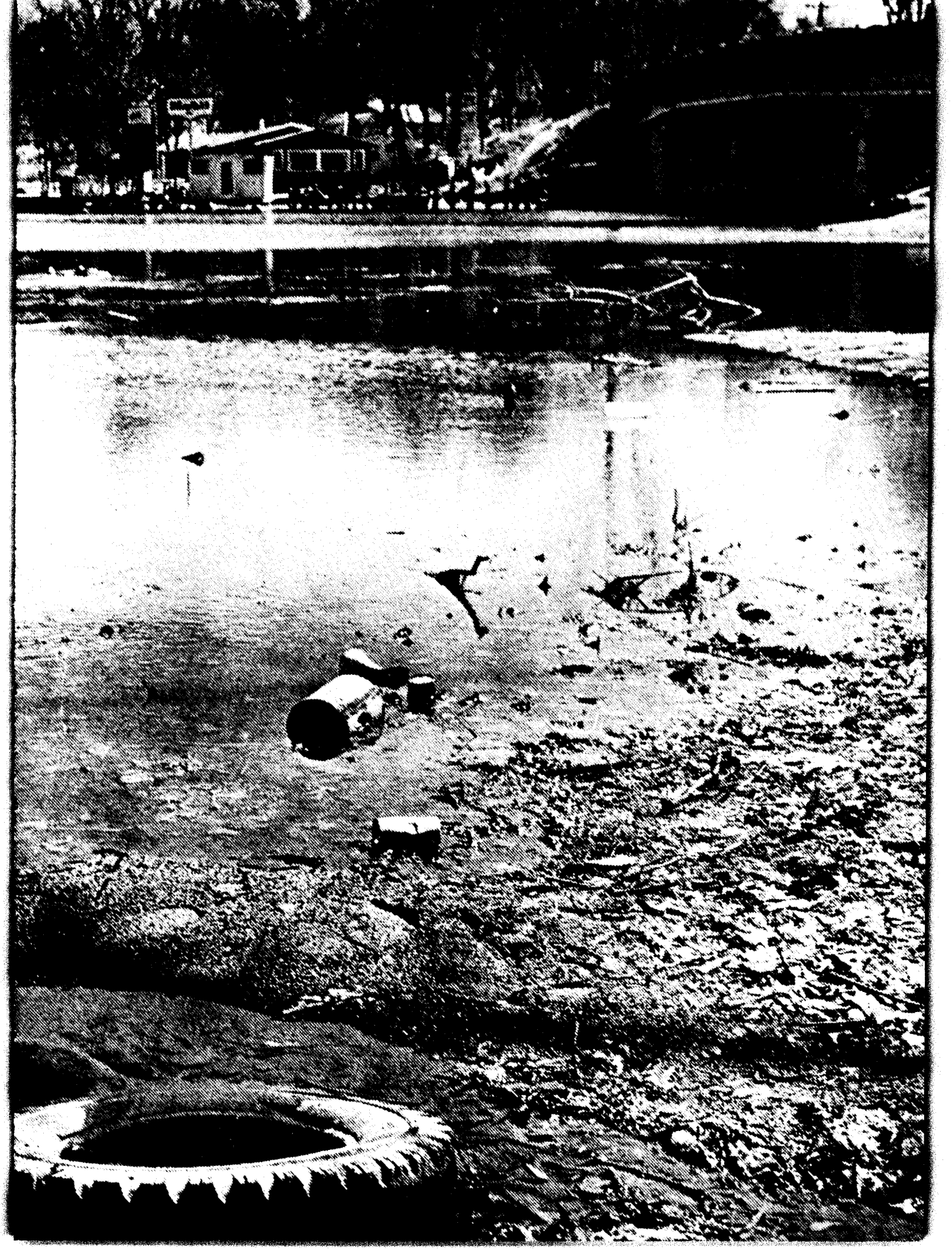
There is another type of water pollution which causes no direct threat to man's health, but does interfere with the "quality of life in Minnesota." Waters enriched with nutrients such as nitrogen and phosphorus produce excessive growths of aquatic plants and algae. Waters containing such excessive growths are undesirable for recreational use and if they are to be used as a water supply, they must be given complete treatment. This would include screening, coagulation, settling, filtration and chlorination. In some cases water softening would be necessary.

Unfortunately, chlorinating and treating sewage does little to the chemicals or nutrients contained in the water. The processes which kill the majority of the disease causing organisms do little to remove insecticides, mercury or nutrients. Methods have been developed to remove these materials, but they are very expensive and are considered impractical by some.

We can list other water pollutants not yet covered in this article: radioactive contamination, thermal pollution, gross air pollution, oil spills and acid mine wastes.

As new technology and manufacturing processes are developed, new pollutants will find their way into our waters. Medical science may discover new disease organisms that can be transmitted by sewage and water.

Water treatment and purification methods must be constantly improved and updated if man's health is to be preserved. □



CONTROLLING AIR QUALITY

BY HAROLD J. PAULUS
Professor, School of Public Health

Conservation of air resources is one of the major concerns in the environmental picture of today. The amount of pollution in the atmosphere has been increasing over the past several decades since it is directly related to the growth in population, industrial expansion and our continuing improvement in the standard of living. There is no doubt but that better control of air quality is absolutely necessary in Minnesota, in our country and throughout the world.

EAST SIDE, WEST SIDE

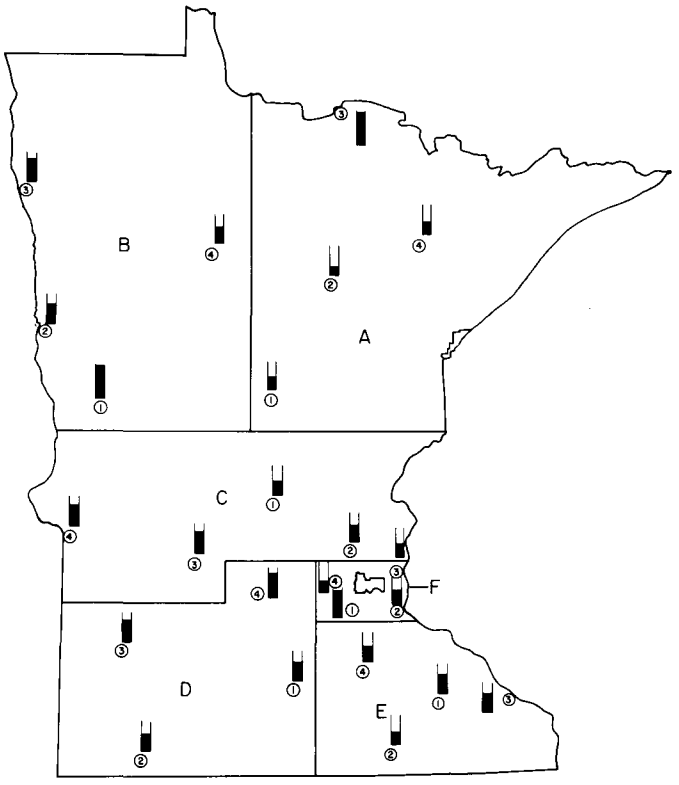
Over the past few decades, the air pollution situation has been worsening in several areas of the United States. Since the early 1940's, control of Los Angeles smog has been attempted by the alarmed public officials and citizenry. Generally the problem has not been solved and the situation today is quite similar to what it was about 30 years ago even though many proper steps have been taken to bring about adequate control.

The air pollution problem on the East Coast is acute at the present time with a good probability of a threatening disaster. Bounded by the Appalachian Range and the Atlantic Ocean and extending from the New England States to the Carolinas, the East Coast area has all the ingredients for a disaster with a very large population, heavy industrial density and frequent short periods of stable weather. About all that is needed to precipitate the calamity is an extended period of about a week to 10 days of stagnant weather conditions over this large area. The disasters of the past in Belgium, London, Donora, Pa., were the result of less favorable conditions than could be put together on the East Coast. There are several other areas in our country that may be considered today as serious air pollution problems including Metropolitan Chicago, Buffalo-Niagara Falls, Seattle-Puget Sound, and Denver.

FEDERAL ACTION

The federal government has shown an increasing concern about the air pollution problem in our country after a slow and half-hearted start. Even though the Donora disaster in 1948 awakened many people, including public health officials, to the fatal nature of too much pollution, it was not until 1955 that Congress saw fit to do something about it. Public Law 159 set up the Community Air Pollution Control Program in the U.S. Public Health Service and appropriated $5 million per year for training and research on the various aspects of the problem. From this beginning the federal body, pressured by the obviously worsening condition of the atmosphere of the country, has continued to improve the legislation for control and increase the amount of money appropriated for this cause.

In 1963 the Clean Air Act gave authority to the Public Health Service to settle air pollution problems involving two or more states and to grant money to communities and individual states for setting up



Minnesota's six air testing regions and 24 sampling locations.

or improving their air pollution control programs.

In 1967 the Air Quality Act urged all interested parties to solve the vehicle exhaust problem.

SETTING STANDARDS

The Air Quality Act directed the Public Health Service to divide the country into atmospheric areas and to set up air pollution control regions encompassing metropolitan areas either inter or intrastate. The Public Health Service also was assigned the task of working out criteria for the many air pollutants. Based on these criteria, air quality standards could then be adopted and air pollution regulations for control of the multiplicity of sources could be set on a sensible and reasonable basis. In 1970 Congress amended the previous acts to adopt air quality standards on a national scale and to set restrictive regulations on vehicle emissions to be accomplished within a specified timetable. These regulations on the major sources of air pollutants in all communities will materially aid in controlling air pollution across the country.

MINNESOTA

The air pollution problem in the State of Minnesota is not as severe as in many other areas of the country. With reasonably flat terrain and favorable meteorological conditions, the potential for a serious air pollution situation is much less than in other areas. Good ventilation brought by the frequent change in weather conditions and only short periods of stable air provide somewhat of a safeguard against a disaster. However, the air quality in Minnesota does leave a lot to be desired and should be improved for better enjoyment of life.

Even though the Minnesota Legislature passed enabling legislation in 1957 providing for rules and regulations to be adopted to control air pollution, nothing was achieved along this line until 10 years later. The 1967 Biennial Legislature worked out the means of controlling pollution by setting up the Minnesota Pollution Control Agency (MPCA) with responsibility for air pollution, water pollution and solid waste. The Air Quality Division of the MPCA has made several positive moves to control air pollution since May 1968 when the first staff member was hired. Air quality standards have been set and air pollution regulations have been adopted for the State of Minnesota. With assistance from the National Air Pollution Control Administration, the MPCA has set up four air pollution control regions in the state: Metropolitan Twin City, Duluth-Superior, Fargo-Moorhead and Southeastern Minnesota - LaCrosse, Wis. Currently these regions are in various stages of being formed and much further work is necessary to make them successful. Considering these accomplishments one can say that Minnesota has made a good start on the control of air pollution in the State. Future success will depend in great part on adequate appropriations from the State Legislature to properly budget the control program of the MPCA.

In July 1969, the current air quality standards and air pollution regulations were adopted by the MPCA. The air quality standards consist of airborne concentration values for different pollutants. They are based on the criteria developed by the Public Health Service. Recognition was given to the effects of exposure to the specific air pollutant on human and animal health, on vegetation, on visibility, on real property and even on aesthetic values. Generally, in selecting an air quality standard a safety factor of one magnitude is included. However, the air quality standard is in reality a goal that should eventually be achieved. The atmosphere normally has a greater concentration of the particular pollutant than the standard and our future efforts will be devoted to reduce that concentration.

Minnesota now bans this kind of open burning.

MEASURING AIR QUALITY

The six regions of Minnesota include 24 sampling locations (see photo). Data is presented on suspended solids for the six-month period from July-December, 1968. A jar 60% filled represents the air quality standard.

Air quality standards have been set on the visible pollutants by way of settleable solids, suspended solids and soiling index. By means of a dust fall jar the settleable materials in the air may be determined. The smaller particles which remain suspended are drawn through a filter at a designated rate of flow. The soiling quality of the air is measured by collecting the particles on a filter strip and determining the loss of light transmission due to the collected material. Air quality standards have also been set on various gases such as sulfur dioxide and the oxidants. The sulfur gases may cause a corrosive atmosphere in the presence of moisture while the oxidants such as ozone are an important ingredient in the Los Angeles smog.

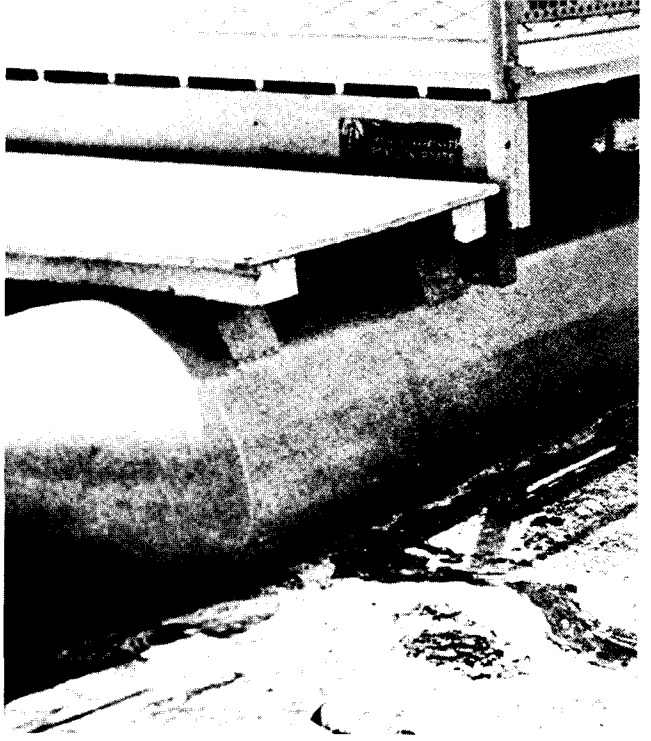
OPEN BURNING BAN

In order to achieve the air quality standards in a reasonable time period, the MPCA adopted some tough air pollution regulations. The regulations involve all segments of business and the population in Minnesota. Leaving the control of vehicle emissions to the federal government, all of the sources of appreciable pollution come under control of the Minnesota air pollution regulations. One of the regulations serves to ban "open burning." This concerns the homeowner as well as industry and local government as it puts a stop to the backyard burning of trash, burning leaves in the street, operation of a burning dump, disposal of dead trees and waste lumber in open fires, reclaiming of metal from scrap and old car bodies by prior burning of the nonmetal materials and use of fires to clear fields and forests of unwanted debris. Incinerators may be used by apartment houses and commercial establishments providing they have a multiple chamber design and do not emit more than a stated amount of pollution.

The air pollution regulations of Minnesota are very restrictive on power plants and other industry. The amount of pollutant emission allowed will require a reduction of 99% or greater in that amount normally emitted from the uncontrolled source. A further regulation on visible pollution might determine a source in violation even though the 99% reduction was achieved.

Since the standards and regulations were adopted in July 1969, many people wonder why all of the pollution sources are not now in compliance. The answer is that in most cases a considerable amount of time will be necessary to complete the necessary tasks. Take for example an industrial plant with an obvious pollution source— the emission stack. The first task involves an evaluation of what is going out the stack — concentration, particle size, nature, volume of waste air, etc. — in other words, stack sampling to determine the scope of the problem which should be done by an expert in the business. Then the proper control device can be selected and ordered and the control system designed, again a task requiring an expert. Once the collector and fans are received they must be installed and tested. This program will require a considerable amount of time. The outdoor burning ban caught cities unprepared to offer citizens an alternative method of disposing of their trash. Since there are several hundred such examples in Minnesota and thousands in our country, additional time will be necessary.

Control of air pollution in Minnesota has come a long way in the short time period since positive measures have been taken. There is a lot more to be done. With the air pollution regulations now being enforced, the amount of pollution emitted to the atmosphere will be materially reduced. There is a definite time requirement for full compliance with the regulations in many cases but in five years the change in the atmosphere will be noticeable. Each individual can do his part by complying with those regulations that pertain to him. Every citizen can also help by urging the state legislators to provide the necessary budget for the control officials. □



Pontoon boat test lab can move around lake for quick sample testing.

CONTROLLING WATER QUALITY

BY DAVID B. GRAHAM
Pollution Profiles, Inc.
Cokato, Minn.

Much of what we define as "water pollution" is excessive algae growth due to an overabundance of nutrients in our lakes, rivers and streams.

Many Minnesota lakes now have some type of weed or algae control program in effect. Weeds and algae grew so thickly, that boating on these lakes became difficult and swimming unpleasant at best. Some lakes had such heavy blooms of toxic blue-green algae that swimmers developed allergic reactions. During the summer months eye infections and swimmers itch are common.

To correct these problems many cutting techniques for weeds appeared and some are still used in limited areas. Copper sulfate was the only effective algicide, and it still sees extensive use in some areas.

FIND NUTRIENT SOURCE AND PLUG

These efforts fail to take into consideration the fact that the weeds and algae are not the problem in themselves, but are manifestations of the real problem — the lakes are receiving too much nutrition and continue to receive additional nutrient load every day.

In most cases there are logical, workable solutions to our environmental problems. Defining the problem is the first step. In working with polluted lakes, we must find the source of excess nutrients. Then we can determine the steps necessary to improve the quality of the lake and its biota.

Up until now, determining exactly where the nutrients come from has been a major hurdle. Ecologists still use chemical analysis techniques which were devloped in the 1930s. These methods are slow, include operator error, and incorporate further error introduced by the time lag between moment of sample collection and time of sample analysis. In some cases this lag may be several days.

Another problem has been that, in most cases, pollution analysis for a particular lake has been done with a single water sample collected from the middle of the lake. This type of sampling gives an average chemical content for the lake as a whole, but tells you only what you knew all along — the lake is polluted. This method of sampling can give no information on the exact source of nutrient input.

ON-THE-SPOT TESTING

A new testing method which overcomes both deficiencies is the "profiling" technique. This method utilizes new, rapid, automated analysis equipment which "rides" right along with the tester on a barge which circles the lake. With analysis results available immediately, the operator can correlate nutrient peaks with geographic location, so that sources of pollution may be pinpointed.

This new technique is being tried this summer on selected Minnesota lakes as part of an experimental program which combines the sciences of biology, chemistry, ecology, and engineering to provide definite data on the lake, so that the prime *sources* of pollution may be cleaned up before beginning any chemical treatment program for the lake.

A YEAR IN LIFE OF LAKE

A lake is surveyed over the course of a full year in order to determine if there are any seasonal variations in nutrient addition.

There are five steps in the basic lake survey.

1. Production of a base map of the area, to provide orientation and to establish and define sampling profiles.

2. Aerial survey of the lake during the winter to determine the location of any springs, raw sewage inlets from commercial and private buildings, and any flowing streams or creeks which may empty into the lake.

3. Testing of water samples collected through the ice in the winter, and from a testing barge which operates on open water. Samples are taken around the lake in addition to the profiling for biological analysis, and when applicable, bottom samples are obtained for biological, chemical and geological analysis.

4. An engineering study is made of the lake and its surrounding watershed. Lake levels are taken, existing water level control examined, and a complete lands survey of the surrounding watershed is performed. The lake and its watershed are then examined as a whole to determine if the watershed has enough area to provide sufficient run-off water to maintain the lake at relatively constant levels. The area is surveyed to determine the most effective location for any additional water level control structures which may be needed.

5. Correlation of the data gathered from the lake and surrounding lands. This step involves the preparation of an action plan for the improvement of the lake. The plan contains inputs from all of the environmental specialists, and is designed to rely on a combination of engineering, fish and game management, and the ability of nature to heal some of her own wounds.

The three primary differences in this program are [1] thorough testing of the lake to determine the location of any nutrient beds prior to implementation of any treatment program; [2] the combining of the talents of ecologists, chemists, geologists, and engineers to provide multi-discipline analysis of the lake and its problems; and [3] the *automated* "profiling" technique of sampling and testing, providing more data bits, enabling the researcher to pinpoint the sources of pollution with greater speed and accuracy.

SCHEDULED POST-GRADUATE SEMINARS IN MEDICINE, 1971-72: UNIVERSITY OF MINNESOTA

For more information about any of the seminars listed, contact:

James M. Schless, M.D.
Director, Post-Graduate Medical Education
University of Minnesota
Box 193 — University Hospitals
Minneapolis, Minn. 55455

Subject	Dates
Clinical Dermatology for Family Physicians	Sept. 15-17, 1971
Clinical Problems in Obstetrics and Gynecology	Sept. 15-17, 1971
Conference on the Management of Cerebral Palsy	Sept. 20-25, 1971
Introduction of the Techniques and Clinical Applications of Hypnosis in Everyday Practice	Sept. 30-Oct. 2, 1971
Psychotherapeutic Applications of Hypnosis	Sept. 30-Oct. 2, 1971
Clinical Neurologic Syndromes	Oct. 7-9, 1971
Hypertension Symposium	Oct. 15-16, 1971
Pediatric Radiology	Oct. 18-22, 1971
Second Annual Kidney Foundation Symposium	Nov. 12-14, 1971
Refraction	Nov. 11-13, 1971
Application of the Health Science Computers in the Community Hospital	Nov. 18-20, 1971
Clinic Management for Doctors	Dec. 2-4, 1971
Ophthalmic Manifestations of General Disease	Dec. 6-7, 1971
Clinical Hypersensitivity Problems in the Upper Midwest	Jan. 13-15, 1972
Practical E.N.T.	Feb. 21-22, 1972
Elective Clinical Program in E.N.T.	Feb. 23-24, 1972
Clinical Therapeutics: A Rational Approach to Drug Utilization	Mar. 9-11, 1972
Cardiology	Mar. 20-22, 1972
Practical Urology	Apr. 13-15, 1972
Ophthalmology for Specialists	May 1-2, 1972
International Symposium on Laboratory Medicine	May 10-12, 1972
Anesthesiology	May 22-24, 1972
Surgery (topic to be announced)	May 22-24, 1972
Interrelationships Between Immunopathology, Virology, and Membrane Structure	June 5-7, 1972

SIGMA XI SERVICE AWARD

Dr. Richard Varco, professor of surgery (right) received a Distinguished Service Award from Sigma Xi at the 75th anniversary meeting of the Minnesota Chapter on May 20. Dr. Henry Buchwald, left, friend and associate of Dr. Varco, presented the award.

DISTINGUISHED TEACHING AWARDS

Richard E. Poppele, Ph.D., associate professor of physiology, and Robert W. ten Bensel, associate professor of pediatrics, received the 1971 Distinguished Teaching Awards of the Minnesota Medical Foundation.

The awards were presented by Dr. John W. Frost, president of the Minnesota Medical Foundation, and Dr. Robert T. Kelly, president of the Minnesota State Medical Association, joint sponsors. Winners were selected by student poll. Each received a certicate and a $1,000 cash prize.

Richard E. Poppele (left) and Robert W. ten Bensel.

BARNUM TEACHING AWARD

William E. Brown, 26, received the 1971 Cyrus P. Barnum Jr. Memorial Teaching Award of the Minnesota Medical Foundation at the Fifth Annual Barnum Society Colloquim held May 4.

The Barnum Award is given annually to the junior faculty member in biochemistry who best exemplifies the teaching dedication of the late Cyrus P. Barnum Jr., formerly of the faculty of the biochemistry department.

Bill Brown receives his Barnum Award check for $400 from Dr. Wallace Armstrong, professor and head of the department of biochemistry.

OBITUARIES

Donald G. Bohn—1945

Died May 17, 1971, at the age of 50. Dr. Bohn retired in 1969 as medical director for North American Life and Casualty Co. He was previously chief of staff at St. Barnabas Hospital, Minneapolis.

Ruben C. Fjellman—1919

Died Dec. 15, 1970, in Hennepin County General Hospital of pulmonary embolus.

Will W. Lee—1951

Died Jan. 1, 1971, at the age of 55, of periarteritis nodosa. Dr. Lee was on the staff of Seattle General Hospital.

C. Louis Lick—1919

Died March 27, 1971. Dr. Lick was a physician and surgeon in St. Paul, Minn., for more than 50 years.

Henry Lysne — 1910

Died May 13, 1971, at his home in Minneapolis. A charter member of the Fairview Hospital medical staff.

Leonard N. Sloan—1926

Died Nov. 12, 1970, in Sherman Oaks, Calif., of rheumatic heart disease.

Walter George L. Tanglin—1932

Died in St. Joseph Hospital, Polson, Mont., at the age of 72, of cerebral embolism and valvular heart disease.

Dr. Phillip Kernan Dies

Dr. Phillip D. Kernan, 60, assistant director of the University of Minnesota Health Service and longtime Gopher varsity physician, died April 28, 1971, of cancer in University Hospital. Dr. Kernan was graduated from The University of Wisconsin Medical School in 1933. He joined the medical staff of the University of Minnesota Health Service in 1937. For many years he was one of the physicians for Minnesota's varsity athletic teams.

THANK YOU

The Centurion (Sustaining) members' seal.

Membership dues reached an all time high for the Minnesota Medical Foundation this year, thanks to the extraordinary support among our growing ranks of Centurion (Sustaining) members and the continued support of our regular members.

Our sustaining members are called "Centurions" because they give at least $100 per year toward their membership in the Foundation. At this writing, they are 315 strong.

The Foundation now has 1050 regular members — or, a total of 1365 members in both groups.

We thank all of our members for their support.

Eivind Hoff

Eivind O. Hoff
Executive Director

Another form of Air Pollution . . . Personal

100,000 Doctors Have Already Quit!

PHOTO: ALDO TUTINO

Cigarette smoking is a major cause of lung cancer. Studies show it. Doctors know it. (At least 140 people die from lung cancer every day.) So if you want to live a little, play it cool and pass up the weeds.

A message from our friends, the **American Cancer Society**®