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ABSTRACT

This unit, designed for senior high school students, focuses on air pollution by examining its effect on man, plants and animals, the causes of air pollution, and possible solutions to the air pollution problems. It approaches each of these topics through both natural science and social science perspectives. The unit is divided into seven separate packets each containing a list of the major concepts to be studied, behavioral objectives, and the expected student criteria for evaluation, pretests and posttests, teacher background information, a suggested instructional sequence and a student booklet consisting of suggested activities and instructions, selected readings and data sheets. Each packet is complete within itself and could be utilized without any of the others. A bibliography of additional appropriate readings is attached. (MLB)

ENVIRONMENTAL ECOLOGICAL EDUCATION PROJECT

Parkway School District
Chesterfield, Missouri

DR. WAYNE FICK, Superintendent
VERLIN M. ABBOTT, Project Director

UNIT: AIR POLLUTION

Sr. High

The work presented or reported herein was performed pursuant to a Title III ESEA Grant administered by the Missouri State Department of Education.

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SETTING

Dr. Paul Erhlich, of Population Bomb fame, states that humanity has an inalienable right to breathe clean air. Clean air is a basic need for man and the life that surrounds man. Much has been spoken and written about man's desire for clean air.

The broad topic of air pollution has been divided into three sections. In the first section the student will study the problem air pollution presents for man, plants and animals. Secondly, the student will study the causes of air pollution. Finally, possible solutions to the problem will be discussed.

Two disciplines, science and social science, will be used in studying the air pollution problem. Using both of these disciplines, this unit of study will attempt to give an integrated perspective to the air pollution problem."

CONCEPTS: PACKET 1

I. Air pollution has resulted from technological and social needs.

II. Air pollution is economically harmful to man with regard to higher medical costs, increased maintenance costs and reduction of crop yields.

III. There is a positive correlation between air pollution and occurances of emphysema, bronchitis and lung cancer.

IV. Particulate matter can be transferred from the air to the soil and water.

V. Air pollution detracts from the appearance of the community.

BEHAVIORAL OBJECTIVES: PACKET 1

I. Upon completion of this packet the student will, in a paragraph of two hundred words or less, describe three ways that technological and social needs cause air pollution.

II. Given a list of seven items describing the economic results of air pollution the student will match each item with either higher medical costs, increased maintenance costs or reduced crop yields.

III. After studying a series of graphs that shows air pollution levels and cases of emphysema, bronchitis and lung cancer the student will write two one sentence interpretations of not more than twenty words each that shows the possible correlation between air pollution and these diseases.

IV. In two sentences of not more than twenty words each the student will state two effects of air pollution on lung tissue.

V. Given a diagram which shows how particulates are transferred from air to the soil and water the student will list one way that particulates are transferred from the air to the soil and one way that particulates are transferred from air to water.

VI. The student will list five ways that air pollution detracts from the appearance of the community.

At this time administer the pre-test.

PRE-POST TEST
PACKET 1

Behavioral Objective Number

1 — 1. In a paragraph of 200 words or less describe three ways that technological and social needs cause air pollution.

2 — 2. In the column on the right is a list of items caused by air pollution that you are to match with the correct category on the left.

a. Higher Medical Costs ___

b. Increased Maintenance Costs ___

c. Reduction In Crop Yields ___

A. Corn yields along major highways are lower than corn yields more removed from traffic

B. increase in respiratory disease

C. rotted clothing or upholstery

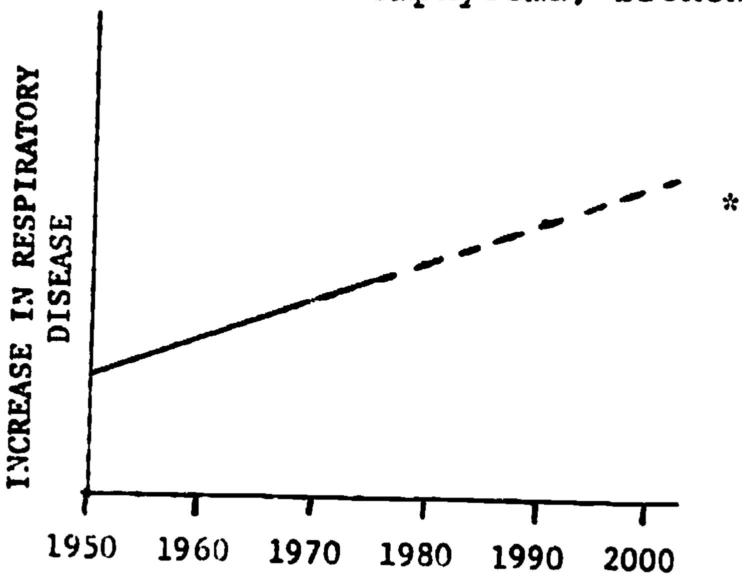
D. chipped and peeled paint from metal and non metal surfaces

E. replacement of masonry

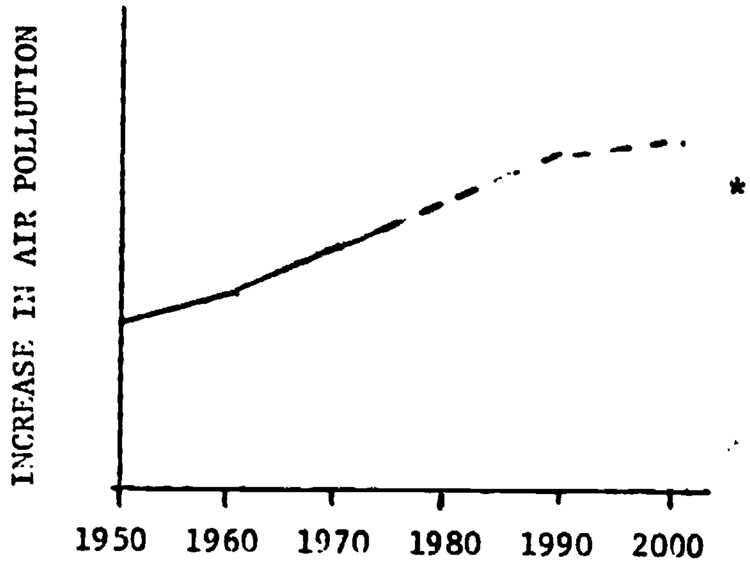
F. higher food bills

G. Fruit falls from plants before it is ripe

3 3. Study the following graphs and then write two one sentence interpretations of not more than 20 words each of the graphs that support a possible correlation between air pollution and emphysema, bronchitis and lung cancer.



* ----= prediction based on current trends



* ----= prediction based on current trends

1.

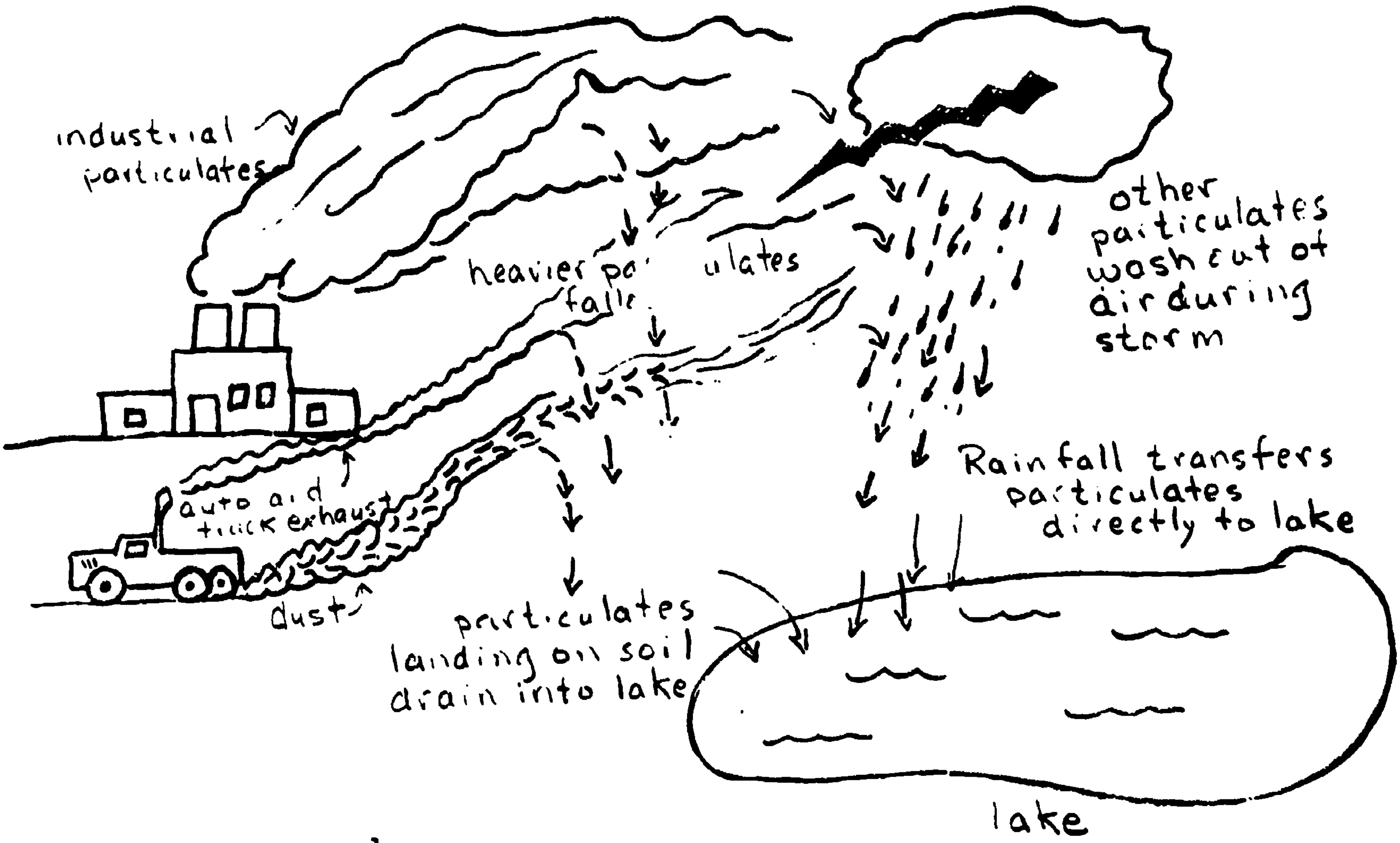
2.

4 4. In two sentences of not more than 20 words each state two effects of air pollution on lung tissue.

1.

2.

5 5. Study the diagram shown below and then list one way that particulates are transferred to the soil and one way that particulates are transferred to water.



1.

2.

6 6. List five ways air pollution detracts from the appearance of the community.

1.

2.

3.

4.

5.

PRE-POST TEST ANSWER KEY
PACKET 1

Behavioral Objective Number

1 — 1. In a paragraph of 200 words or less describe three ways that technological and social needs cause air pollution.
Man's needs and wants are responsible for air pollution, 1) Man must have transportation and automobiles, buses, trains and aircraft cause pollution. 2) Man must be warm in winter and cool in summer and systems powered by electricity require coal to be burned for electrical generation and, therefore, air pollution results. 3) The need or want for extra electrical appliances such as trash compactors hot combs, electric toothbrushes and blenders cause pollution to increase for the same reason stated in #2.

2 — 2. In the column on the right is a list of items caused by air pollution that you are to match with the correct category on the left.

a. Higher Medical Costs B

b. Increased Maintenance Costs CDE

c. Reduction in Crop Yields AFG

A. Corn yields along major highways are lower than corn yields more removed from traffic

B. increase in respiratory disease

C. rotted clothing or upholstery

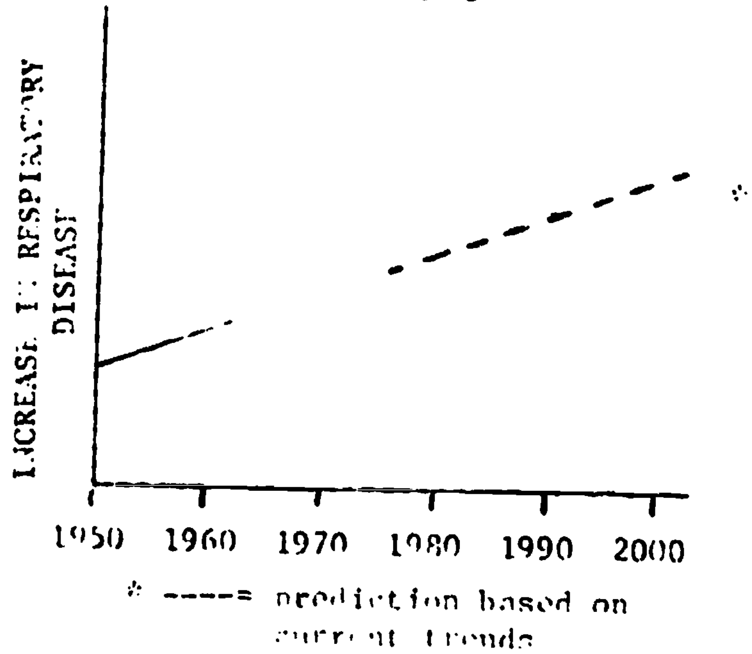
D. chipped and peeled paint from metal and non metal surfaces

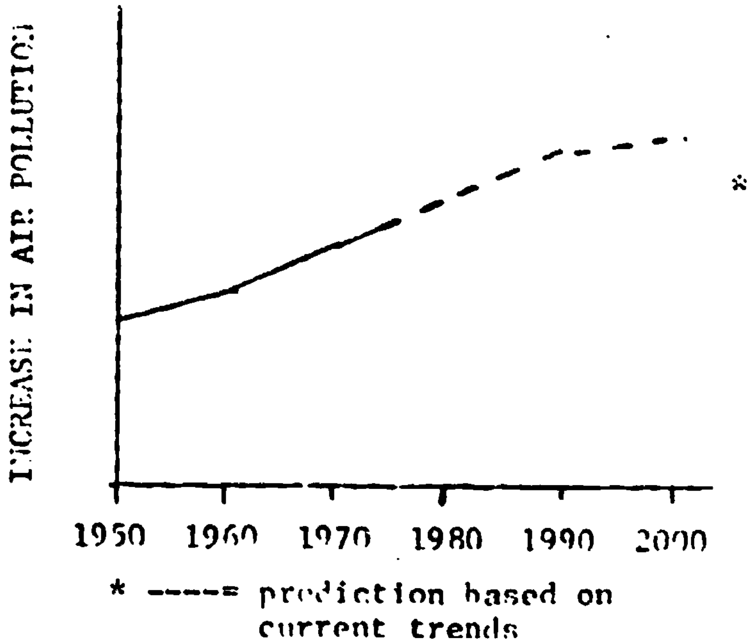
E. replacement of masonry

F. higher food bills

G. fruit falls from plants before it is ripe

3 3. Study the following graphs and then write two one sentence interpretations of not more than 20 words each of the graphs that support a possible correlation between air pollution and emphysema, bronchitis and lung cancer.





1. Between 1950 and 1970 the rate of increase in air pollutior is nearly the same as the rate of increase in respiratory disease.

2. Between 1980 and 2000 the predictions indicate a continual increase in respiratory disease along with steady increases in air pollution.

4 4. In two sentences of not more than 20 words each state two effects of air pollution on lung tissue.

1. Air pollution paralyzes and destroys the cilia that line the windpipe.

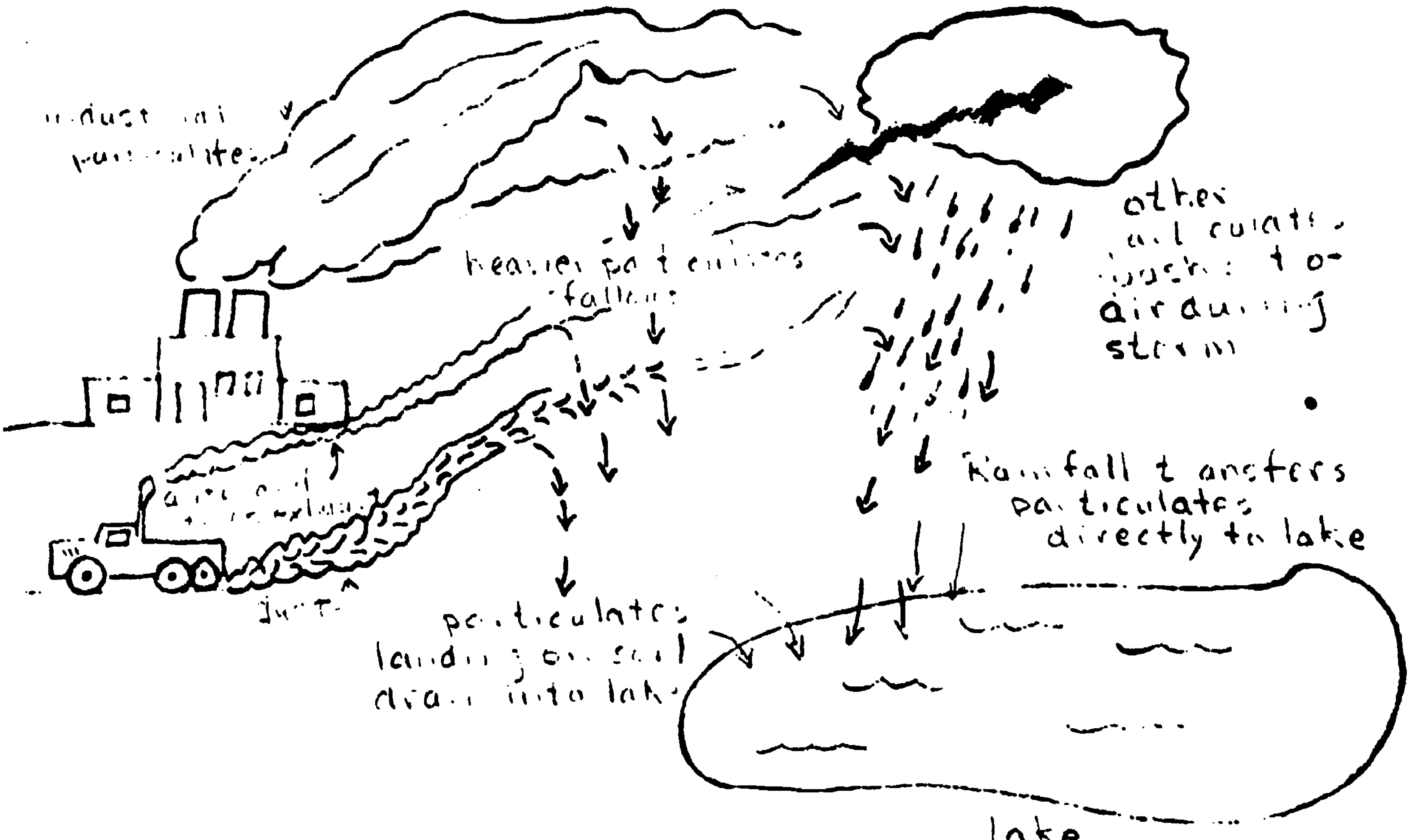
2. Air pollution sears lungs tissue

3. Air pollution reduces elasticity of lung tissue

4. Air pollution indirectly causes lungs to hold mucus and water which prevents an adquate exchange of carbon monoxide an oxygen.

5

5. Study the diagram shown below and then list one way that particulates are transferred to the soil and one way that particulates are transferred to water.



1. Heavy industrial particulates fall out on soil soon after leaving stack.
2. Particles and dust caused by automobiles, trucks, etc., settle on soil.
3. Less heavy particles may be washed out of the air to the soil by storms.
4. Less heavy particulates may be washed out of the air by storms and deposited directly into a body of water or particulates washed out of the air may drain into a body of water after hitting the soil.
5. Heavy particulates may be directly deposited in bodies of water.

6

6. List five ways air pollution detracts from the appearance of the community.
   1. Black soot on buildings
   2. Chemical corossion of statues and tombstones
   3. Dust on buildings and vegetation
   4. Peeled pain on buildings
   5. Acid corossion of car finish
   6. Discoloration and/or death of plants

BACKGROUND INFORMATION
PACKET 1

The activities in this packet show how air pollution problems are related, directly and indirectly, to man. The impact of air pollution on man is seen in a greater incidence of respiratory disease, increased maintenance cost for equipment, clothing and homes, and reduction in crop yields which cause higher food prices.

There is no direct link between polluted air and respiratory disease but statistics do indicate a relationship. Air pollution works insidiously on the respiratory tract by stripping the small hair-like projections (called cilia) from the windpipe. The destruction of this natural filter permits airborne particulates to penetrate deep into the air passages of the lung. Particulates often carry sulfur dioxide and other chemicals that, scientists believe, change the defense mechanisms of lung tissue. Once these natural defenses are lowered the respiratory tract becomes vulnerable to disease organisms and chemical agents that attack the lung tissue.

The exact relationship between air pollution and lung cancer is not known but current thought suggests that the relationship begins with a breakdown in natural defense mechanisms which makes it easier for cancer causing agents to invade the body.

Carbon monoxide is another air pollutant that affects man through the respiratory system. Carbon monoxide affects the entire body because it reduces the ability of the red blood cells to carry oxygen. Carbon monoxide and oxygen have a great affinity for the hemoglobin found in and on red blood cells. The problem is that when carbon monoxide combines with hemoglobin it clings to it with great force. Therefore, the red blood cells have little room to carry oxygen and without oxygen the body cells cannot release energy and death may result.

Air pollution costs every family about $300.00 a year. Two thirds of this amount is related to health problems and costs to residential property. The remaining third is spent on costs of repair and replacement or cleaning of clothing and upholstery. A small amount is attributed to costs for damaged vegetation.

The activities in this packet are arranged so that students may progress at their own rate or all together under greater guidance from the instructor. It is important to decide which activities can be managed in your particular teaching situation and then make sure that these materials are available for student use.

INSTRUCTIONAL SEQUENCE
PACKET 1

Before starting this unit on air pollution, you should give two groups of students the questionaire (Data Sheet 1).

Behavioral Objective Number	
	Concept I and II Required Activities:
1&2	A. The readings in the <u>Air Pollution Primer</u> and and <u>Progress and the Environment</u> help to develope the overall nature of the air pollution problem. Behavioral Objective 1 demands that students relate man's social and technological needs to air pollution. The relationship may not be clear to them so the instructor should read the readings himself in order to develop the relationships later in the class discussion designed to knit the behavioral objectives together. The paragraph they are supposed to write may be handed in, checked for thoroughness, unchecked, ets., depending the emphasis you choose to place on the activity. It is important that they do this preliminary reading to help set the stage for the other activities including class discussion.
3	Concept III Required Activities:

A. The graphs showing the comparison of emphysema in St. Louis and Winnipeg suggests the following interpretations: (hopefully you and your students will find others)

1. The total incidence of mild, moderate and and severe emphysema for all age groups is greater in St. Louis than Winnipeg.

2. In the 20-49 year old category there are no moderate to severe cases of emphysema found in Winnipeg while in St. Louis all three levels are found.

3. The total incidence of emphysema seems to increase with age.

4. Greater incidence of emphysema in St. Louis is probably related to the industrial nature of the city. (For your information: population of St. Louis 622,236; population of Winnipeg, Canada 243,208)

Experimental data that shows exact relationships between air pollution and disease is very difficult to obtain. However, data such as that from the St. Louis, Winnipeg comparison are important in making generalizations and outlining possible trends. You should try to emphasize this as students become involved in the activity.

The "Air Pollution Kills" graph showing bronchitis, emphysema, lung cancer and other respiratory ailments (tuberculosis, pneumonia, pulmonary obstruction, etc.,) should be compared to the "Automotive Atmospheric Improvements" graph. The comparison suggests the following interpretations:

1. The increase in respiratory disease between 1950 and 1965 appears to be directly related to the increase in automobile emissions.

2. The slowing in the rate of increase of respiratory disease appears to be related to the reduction of emissions (via the emission control devices).

These two graphs also raise some interesting questions:

1. Will the incidence of respiratory disease begin to decrease with the reduction of automobile emissions?

2. The "Automotive" graph shows that emissions will begin to increase again in the late 1980's. This will happen because, according to present trends, Americans are expected to buy more and more cars, therefore more emissions because of the increase in the number of cars. How will this affect the incidence of respiratory disease later on?

3. Does this data suggest that alternate, more effecient means of transportation will help to control deaths due to air pollution?

3 B. The article "I Am Joe's Lung"needs no special treatment. It is written in a style that explains the technical medical terms or reduces the technical term to a simple definition that most students can understand. You should encourage questions based on the article during class discussion.

4 C. This is an optional activity. The filmstrip "Air Pollution and Lung Tissue" was ordered without preview so it is impossible to cite any details regarding its use. It will be available for loan from the Science Department, Parkway North Senior High School, you may order it from:

Society for Visual Education, Inc.
1345 Diversay Parkway
Chicago, Illinois 60614

Order # 428-2, Air Pollution and Lung Tissue Sound filmstrip on the effects of polluted air on mice are analyzed to find effects of atmospheric pollution on humans. 53 frames, 12½ minutes, cost: $7.00 for the filmstrip, $6.00 for the casette tape.

5 Concept IV Required Activities:

A. The reading on pages 77-81 of the <u>Air Pollution Primer</u> gives a good example of how an airborne pollutant (flourides) may move from air to soil and into living systems. Although the possibility of Flourides contaminating drinking water is not shown it is implied and should be brought out in class discussion.

5 B. There are several optional activities that students may want to do. These experiments are outlined in the <u>Eduquip Air Pollution Study Program Manual.</u> A copy of this manual can be found in the Science Department, Parkway North Senior High School, 12860 Fee Fee Road, Creve Coeur, Mo. 63141. A copy of the manual and a catalogue of supplies and equipment may be obtained by writing to:

Eduquip, Inc.
1220 Adams Street
Boston, Mass. 02124

Eduquip equipment and supplies may also be found in the Central Scientific Supply Company catalogue. A copy of this catalogue may be obtained by writing:

Cenco
2600 Kostner Avenue
Chicago, Illinois

The experiments outlined in the student packet for Concept IV Activity B, really show how particulate matter is transferred throughout the environment. If you are not able to purchase the exact equipment it may be possible to construct alternate pieces of equipment using laboratory glassware and tubing. Give those students with a scientific "bent" a chance to put some of these experiments together. Some of the equipment needed for experiments 1-5 are located in the science department, Parkway North Senior High School.

6 Concept V Required Activities:

A. The purpose of this field trip is to help students see actual examples of the effects of particulates (and related pollutants) on the appearance of the community. You will need to provide each student with a copy of the data sheet. Here are some locations to consider as you plan the trip.

1. East side of the Mississippi

   a. Shell, Clark and Mobil refineries

   b. Olin Company

   c. Alton Box Board Company

All the above have very active smoke stacks. Evidence of particulate effects on the local community would be black, soot material on vegetation as well as on any homes in the immediate area.

2. West Side of the Mississippi

   a. Meramec Power Plant(Union Electric)

   b. Portage de Sioux Power Plant (Union Electric)

   c. National Lead(Titanium Plant), Carondelet Facility

   d. Great Lakes Carbon

   e. Monsanto

   f. Cupples Plant (July, 1973...Litigation: People of Overland vs. Cupples, suit brought for particulate discharge that caused eye irritation and unsightly appearance in the community)

All of the above sites are known for black particulate discharge as well as obnoxious odors. Evidence of particulate pollution detracting from the appearance of the community would be soot coatings on local residences and vegetation. It would be good to point out that particulate fallout may occur many miles from the actual source.

3. Sites that show effects of particulate discharge:

   a. Defense Mapping and Aerospace Center is a good place to go to see the corrossive effects of air pollution. Sulfur dioxide mist and particulates, thought to originate from National Lead Company, are thought to be responsible. Mr. Mike Galloway, facilities Engineer for the center is the person to contact regarding a field trip to this location. Telephone 268-4445. Address all inquiries to:

      Mr. Mike Galloway, Facilities Engineer
      Defense Mapping Agency and Aerospace Center
      Second and Arsenal
      St. Louis, Missouri 63118

   b. Mr. Jim Clark of the St. Louis County Air Pollution Control Commission will meet student groups outside local cement plants and quarries to discuss effects of particulate fallout from these industries. Mr. Clark may be able to arrange for students to talk with local residents to get their feelings on the particulate discharge. Contact Mr. Clark at 726-1100.

   c. When cement dust mixes with water vapor (or water droplets on a surface) it forms a basic substance with a ph of 10 or 11. The resulting product is caustic and comparable to a weak solution of Drano. The effects of this type of particulate pollution may be seen at Bethlehem Cemetery Located on Bellefontaine Road just North of Missouri Portland Cement Co. The cemetery custodian complains that he cannot keep tombstones clean. This is because the pollutants cause pits to develop in the stones and the cement and water "slurry" coats the stones. A trip to Bellefontaine Cemetery may be arranged by calling the cemetery office.

4. Mr. Bill Haggar of St. Louis Air Pollution Control Commission can recommend sites in in St. Louis that can be visited to see the effects of particulate pollution. Arrangements can also be made through him to visit Monitoring stations and laboratories. Telephone 453-3334

1-6 B. The class discussion should be held at the end of the packet when everyone has completed the activities. If the students are moving at different rates through the activities several smaller discussions will have to be held in lieu of one large group discussion. This is not to say that discussions should not be held at other times. Small groups or even the large group may need to be brought together to clarify or emphasize various concepts encountered in the activities. The purpose of the concluding class discussion is to help the students draw together all the concepts studied into a whole. This discussion will help them to prepare for the post-test as well. Particular attention should be given to the first concept during the discussion. Most of the activities provide inferences about the relationship of air pollution and man's technological and social needs. The readings in Progress and the Environment should be reviewed during discussion questions.

At this time administer the post-test.

ENVIRONMENTAL ECOLOGICAL EDUCATION PROJECT

Parkway School District
Checterfield, Missouri

DR. WAYNE FICK, Superintendent

VERLIN M. ABBOTT, Project Director

Unit: Air Pollution: Packet I

BY:
Robert Goode
Wayne Mosher
Tom Pollmann

The work presented or reported herein was preformed pursuant to a Title III ESEA Grant administered by the Missouri State Department of Education.

SETTING

Air pollution is a complicated problem that has created unrest among people. Apathy is not the answer and merely complaining about pollution will not make the problem disappear.

The purpose of the following packets will be to provide some experience with specific air pollution problems that affect plants and animals including man. Consideration will be given to the cost of pollution control and, more importantly, how much air pollution is costing each of us every day in terms of health, destruction of crops and maintenance of our homes and equipment. An understanding of the problem is the basis for formulating possible solutions which will be considered in later packets.

CONCEPTS: PACKET 1

I. Air pollution has resulted from technological and social needs.

II. Air pollution is economical harmful to man with regard to higher medical costs, increased maintenance costs and reduction of crop yields.

III. There is a positive correlation between air pollution and occurances of emphysema, bronchitis and lung cancer.

IV. Particulate matter can be transferred from the air to the soil and water.

V. Air pollution detracts from the appearance of the community.

BEHAVIORAL OBJECTIVES: PACKET 1

I. Upon completion of this packet the student will, in a paragraph of two hundred words or less, describe three ways that technological and social needs cause air pollution.

II. Given a list of seven items describing the economic results of air pollution match each item with either higher medical costs, increased maintenance costs or reduced crop yields.

III. After studying a series of graphs that show air pollution levels and cases of emphysema, bronchitis and lung cancer, the student will write two one sentence interpretations of not more than twenty words each that shows the possible correlation between air pollution and these diseases.

IV. In two sentences of not more than twenty words each the student will state two effects of air pollution on lung tissue.

V. Given a diagram which shows how particulates are transferred from air to the soil and water the student will list one way that particulates are transferred from the air to the soil and one way that particulates are transferred from air to water.

VI. The student will list five ways that air pollution detracts from the appearance of the community.

At this time take the pre-test.
Obtain a copy from your teacher.

ACTIVITIES

Behavioral Objective Number	
	Concepts I and II Required Activities:
1&2	A. The following readings will provide the background you need for objectives 1 and 2. These books may be obtained from your instructor.

Objective 1: Air Pollution Primer, National Tuberculosis and Respiratory Disease Association, page 7.

Progress And The Environment, by Shaver, Larkins and Anctil, Chapter 1.

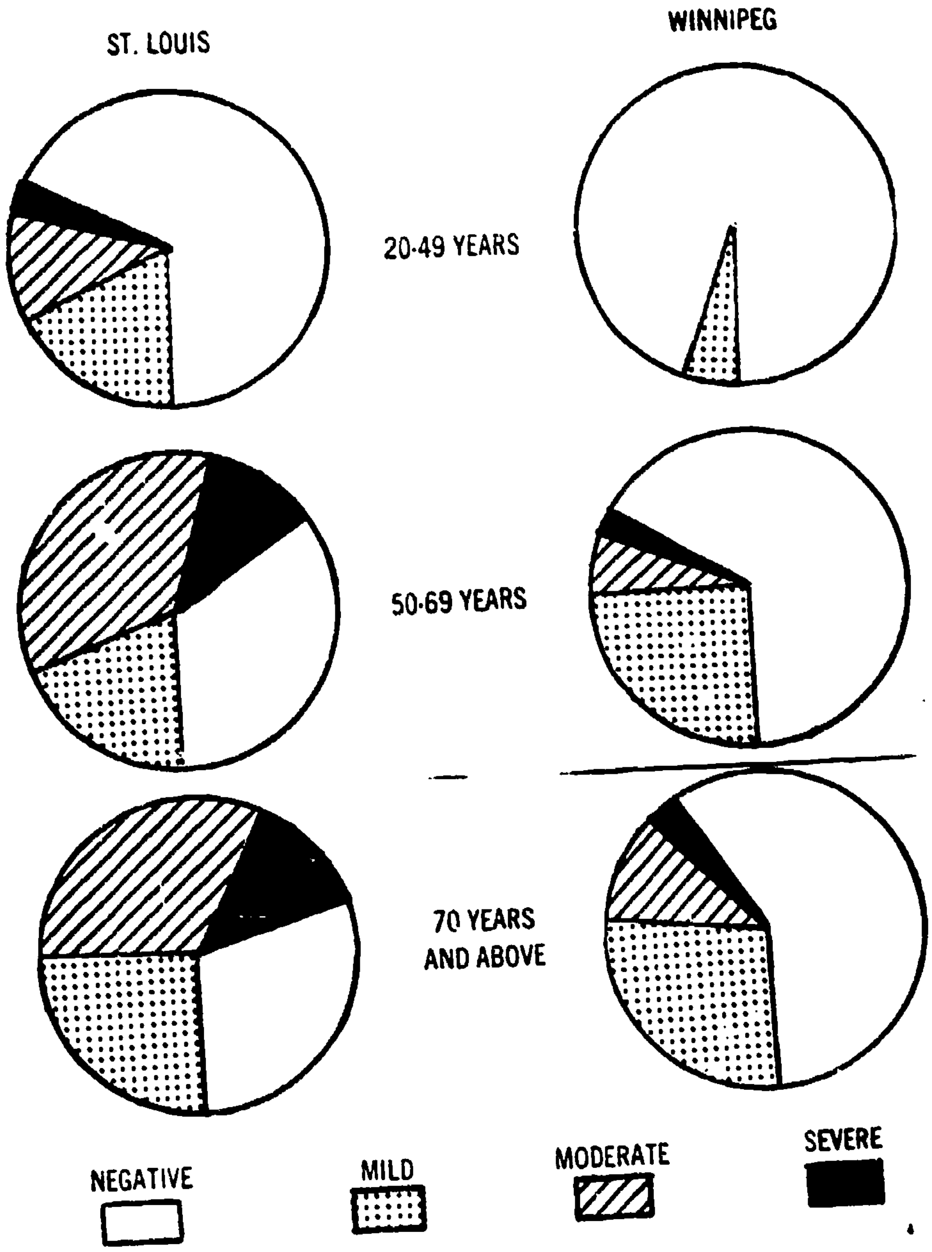
Objective 2: Air Pollution Primer, pp. 84-87.

Progress And The Environment, pp. 69-72.

When you complete the readings write a paragraph summary of the ways that man's technological and social needs cause pollution; and, describe some of the ways that air pollution results in higher medical costs and reduced crop yields and increased maintenance costs.

3 Concepts III Required Activities:

A. The following activity is related to objective 3. Study the following graphs on the following page and answer the study questions that follow.

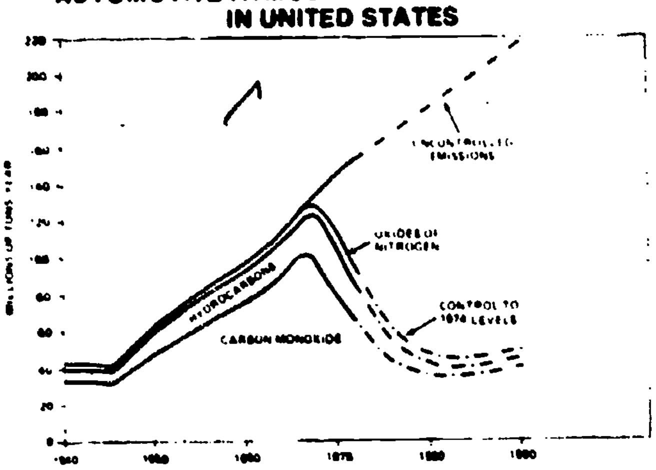


PREVALENCE OF EMPHYSEMA IN TWO CITIES WITH CONTRASTING LEVELS OF AIR POLLUTION

Prevalence of emphysema, as found in a 1960-66 post-mortem examination of the lungs of 300 residents of heavily industrialized St. Louis, Missouri and an equal number from relatively unpolluted Winnipeg, Canada. The subjects were well matched by sex, occupation, socio-economic status, length of residence, smoking habits, and age at death. The findings clearly suggest a link between air pollution and pulmonary emphysema.

These graphs were taken from the Air Pollution Primer, National Tuberculosis and Respiratory Disease Association.

AUTOMOTIVE ATMOSPHERIC IMPROVEMENTS IN UNITED STATES



This graph was furnished by Chrysler Corporation.

Air pollution kills

Death rates from diseases associated with air are climbing.

This graph taken from National Wildlife, 1971 Environmental Quality Index.

Study Question:

1. Write two interpretations of the emphysema graphs (St. Louis vs. Winnipeg, Canada) that show the possible relationship between air pollution and the prevalence of emphysema.

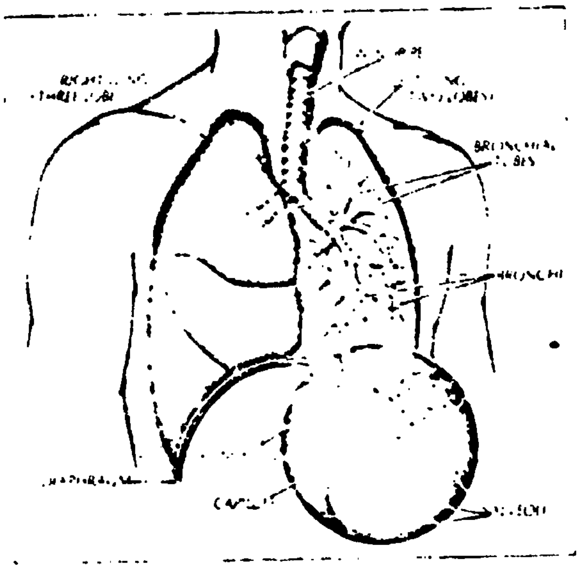
2. Using the "Air Pollution Kills" graph and the "Automotive Atmospheric Improvements In United States" graph, list two examples of the possible relationship between automobile emissions and lung cancer, emphysema and bronchitis.

3. What might happen to the incidence of lung cancer and emphysema in the United States by 1980? 1990?

B. The following article, I Am Joe's Lung, will provide backgroung for objective 3. As you read make a list of ways that air pollution can effect lung tissue.

A Reader's Digest

An inside glimpse of a vital and delicate organ—which deserves a lot better care than it generally gets



I Am Joe's Lung

By J. D. Ratcliff

You know dozens of people like Joe. He is 47, successful, happily married. Joe's heart and stomach have already told their stories in this magazine.* Now it's my turn.

I am Joe's right lung, and I claim the privilege of speaking since I am slightly larger than my partner in the left side of his chest. I have three lobes—sections—while the left has only two. Joe would be surprised if he could see me. He thinks of me as a kind of hollow, pink football bladder hanging in his chest. I'm not much like that at all. I am not hollow—if you cut through me, I would look something like a rubber bath sponge. And I am not pink. I was when Joe was a baby. Now, a quarter of a million cigarettes plus half a billion breaths of dirty city air later, I am an unattractive slate-gray with a mottling of black.

There are three separate, sealed compartments in Joe's chest: one for me, one for the left lung, one for his heart. I hang loosely in my compartment, filling it completely, and weigh a little over a pound.

I have no muscles and hence play

*See "I Am Joe's Heart," The Reader's Digest, April '67. "I Am Joe's Stomach," May '68 a passive role in breathing. There is a slight vacuum in my compartment—so when Joe's chest expands, I expand. When Joe exhales, I collapse. It is simply a recoil mechanism. Let Joe puncture his chest wall in an accident and my vacuum is broken. I'll hang loosely, doing no work, until healing takes place and the vacuum is re-established.

Take a closer look at my architecture. Joe's four-inch-long windpipe divides at its lower end into two main bronchial tubes—one for me, one for my partner. Then branching begins in me—like an upside-down tree. First the larger bronchi, then the bronchioles 1/100 of an inch in diameter. These are simply air passages. My real work is done in my alveoli—grape-like bunches of minute air sacs. I have some 250 million of these sacs. Flattened out, their tissue would probably cover half a tennis court.

Each alveolus is covered with a cobweb of capillaries. Blood is pumped by the heart into one end of a capillary. Red cells pass through single-file—passage taking about a second—and a remarkable thing takes place. Through the gossamer membrane of the capillary wall, the cells diffuse their cargo of carbon dioxide into my alveoli. At the same time, the cells pick up oxygen going the other way. It's a kind of gaseous swap shop—blue blood flowing in one end of the capillary, emerging refreshed and cherry-red at the other.

Joe's more important body organs—notably the heart—are under automatic control. Most of the time this is true of me, too, though I am under voluntary control as well. As a child, Joe had temper tantrums and would sometimes hold his breath until he turned a faint blue. His mother worried—unnecessarily. Long before he got into any real trouble, automatic respiration would take over. He would start breathing whether he wanted to or not.

My automatic breathing control is in the medulla oblongata—the bulge where the spinal cord taps into the brain. It's an amazingly sensitive chemical detector. Laboring muscles burn oxygen rapidly and pour out waste carbon dioxide. As it accumulates, the blood becomes slightly acid. The respiratory control center detects this instantly—and orders me to work faster. Let the levels rise high enough—as when Joe does heavy exercise—and it orders *deeper* breathing as well—one's "second wind."

Lying quietly in bed, Joe needs about eight quarts of air a minute. Sitting up requires 16; walking, 24; running, 50. Since Joe is a desk worker, he has no large oxygen demands. Normally, he breathes about 16 times a minute—a pint of air each time. (This only partially inflates me I can hold eight times as much.) Even so, not all of that one-pint breath reaches me; one third of it shuffles aimlessly in and out of the

This article is based largely on interviews with Drs. Alton Ochsner and Hurst B. Hatch, of the world-famed Ochsner Clinic in New Orleans, La.

windpipe and other air passages.

I like my air just about as moist and warm as that in a tropical swamp. Producing this very special air in the space of a few inches is quite a trick. The same tear glands that bathe Joe's eyes, plus other moisture-secreting glands in his nose and throat, produce as much as a pint of fluid a day to humidify my air. Surface blood vessels along the same route—wide open on cold days, closed on warm days—take care of the heating job.

There is an almost endless list of things that can cause me trouble. Each day, Joe breathes in a variety of bacteria and viruses. Lysozyme in the nose and throat, a powerful microbe slayer, destroys most of these. And those that slip into my dark, warm, moist passages—a microbial happy hunting ground—I can usually handle. Phagocytes patrol my passages and simply wrap themselves around invaders and eat them.

Dirty air, of course, is my biggest challenge. Other organs lead sheltered, protected lives, but for all practical purposes I am *outside* Joe's body—exposed to environmental hazards and contaminants. I am really quite delicate, and it's a wonder I am able to survive at all, having to deal with such things as sulfur dioxide, benzopyrene, lead, nitrogen dioxide. Since some of them actually melt nylon stockings, you can guess what they do to me.

My air-cleaning process—such as it is—begins with hairs in the nose, which trap large dust particles. Sticky mucus in nose, throat and bronchial passages acts as flypaper to trap finer particles. But the real cleaning job falls to the cilia. These are microscopic hairs—tens of millions of them—along my air passages. They wave back and forth, like wheat in the wind, about 12 times a second. Their upward thrust sweeps mucus from lower passages to the throat, where it can be swallowed.

If Joe could watch my cilia under a microscope, he'd see that if cigarette smoke or badly contaminated air is blown on them, the wind-in-the-wheatfield action stops. A temporary paralysis sets in. Let this irritation continue long enough, and the cilia wither and die, never to be replaced.

After 30 years of smoking, Joe has lost most of his cilia, and mucus-secreting membranes in his air passages have thickened to three times normal size. Joe doesn't know it, but he is in actual danger of drowning. If enough mucus drops down into my air sacs, it halts breathing just as effectively as a lungful of water. One thing saves Joe from this: his noisy, inefficient smoker's cough, which has replaced the quiet efficiency of the cilia. Joe might remember that it's the only cleaning method left to me—and be cautious about taking cough-suppressing drugs.

A large part of the time, Joe is asking me to breathe real garbage. Some of the particles clog my smaller passages, and some actually sear my tissues. The fragile walls of my alveoli lose elasticity. They don't collapse the way they should when I exhale. (Thus it is possible to breathe *in* but not *out*.) Carbon dioxide is trapped in them, and they can no longer contribute oxygen to the blood or extract waste carbon dioxide. The result is emphysema—a fearsome trial in which each breath represents a fight for survival.

Although Joe doesn't know it, this has already happened to a few million of my alveoli. Since Joe has about eight times the lung capacity he needs for desk work, he still has plenty of reserve. But lately he has noticed that even a small amount of exertion brings on breathlessness. I'm warning him.

Joe should heed the old medical saying, "If you are aware that you have lungs, you are already in trouble," and take a little better care of me. In the main, this means giving me better air to breathe. The big thing, of course, would be to give up smoking. Short of this, there are other things he can do. There is a small, reasonably priced machine which circulates room air through a thin bed of activated carbon—the stuff used in gas masks—and cleanses this air of chemicals deadly to my tissues. One in Joe's bedroom would give me some eight hours of protection, and another in his office would provide eight more.

A little more exercise and more sensible eating would be in order. Any general body exercise—climbing stairs, walking, jogging, sports—forces me to breathe more deeply, which is all to the good. And there are exercises for me alone. Ordinarily, the best breathing is deep breathing—more air at a slower pace. Joe could practice abdominal breathing, the way babies and opera singers do it: not by inflating the manly chest, but by dropping the diaphragm down. Then air is sucked into even my deepest alveoli.

Joe could also give me a housecleaning a few times each day. He thinks that with a normal exhalation I'm empty. By no means. Let him blow out all the air he can via his mouth. Then if he will purse his lips, he can do quite a lot more blowing. If he does this while smoking, he will see something that should give him pause: smoke trailing out through his pursed lips that would normally be left in me to stagnate.

It all adds up to this: Most of my neighbor organs can absorb an enormous amount of abuse without complaint. I can't. Nature hasn't equipped me with all the defenses I really need in today's world. That's why a variety of lung diseases have reached epidemic proportions.

Boss Joe, take heed!

Reprints of this article are available. Prices, postpaid to one address: 10—50¢, 50—$2; 100—$3.50; 500—$12.50; 1000—$18. Address Reprint Editor, The Reader's Digest, Pleasantville, N.Y. 10570

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(This article was taken from a Reader's Digest reprint, March, 1969. The Reader's Digest association, Inc., Pleasantville, N. Y. 10570.)

B. The Following article, I Am Joe's Lung, will provide background for objective 3. As you read make a list of ways that air pollution can effect lung tissue.

C. The following activity is an OPTIONAL sound filmstrip on "Air Pollution And Lung Tissue". Your instructor will be able to tell you if the filmstrip is available.

Concepts IV Required Activities:

5 A. Read pages 77-81 in Air Pollution Primer and pages 132-133 in Environmental Pollution. These readings will provide the necessary background for this concept.

5 B. These experiments are OPTIONAL activities that permit an in depth study of the effects of particulates on the environment. Your instructor can tell you if the materials for these experiments are available. Details on how to set up the following investigations are outlined in Eduquip Air Pollution Study Program Manual.

1. Dust and Particulate Fallout
2. How Dirty Is The Air In Your Town?
3. High Volume Particulate Sampling Indoors
4. High Volume Particulate Sampling Indoors vs. Outdoors
5. Air Pollution Analysis

Concept V Required Activities:

6 A. There will be a field trip to provide background for this concept. The trip will visit various locations in St. Louis City and County that illustrate the effects of particulates (and the pollutants related to them) on the appearance of the community. Use Data Sheet 1 on this field trip. Your teacher will privide you with a copy upon which to write.

1-6 B. A class discussion will be held upon completion of the activities in this packet.

At this time take the post test.
Obtain a copy from your teacher.

DATA SHEET 1

AIR POLLUTION FIELDTRIP TO ST. LOUIS CITY AND COUNTY

This activity provides the necessary background for Concept V, Activity A.

Use the following chart to record your observations during the trip.

Kind of location visited (factory, quarry, refinery, etc.)	Kinds of particulates produced (black smoke, limestone dust, soil dust, etc.)	Effects of particulates on surrounding area (discoloration or or chemical corrosion of buildings, cars, local plants and animals).

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The Unclean Sky, Louis J. Battan, Double day and Company, Garden City, New York, 1966.

CONCEPTS: PACKET 2

I. Plant growth is affected by air pollution.

II. Clean air is a basic need for most living things.

III. Peppered moths are examples of the correlation that exists between an air pollutant and the survival of a species.

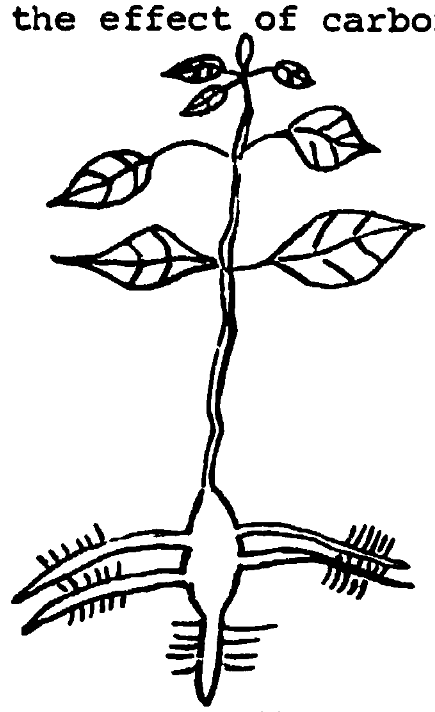
Concepts		BEHAVIORAL OBJECTIVES
I.	1.	Given a diagram of a plant the student will use arrows to identify the parts that are affected by carbon monoxide and list at least one effect of carbon monoxide on each of those parts.
I.	2.	After completing a laboratory report using the format recommended by your instructor the student will list two effects of ethylene gas on the growth of bean seedlings.
II.	3.	In a single written sentence the student will be able to state why clean air is needed by most living things.
III.	4.	In an essay of not more than 300 words describe the relationship between air pollution and the survival of peppered moths.

At this time administer the pre-test.

PRE-POST TEST
PACKET 2

Behavioral Objective Number

1 1. Use arrows to identify three parts of the plant (shown below) that are affected by carbon monoxide and list the effect of carbon monoxide on each part.



2 2. List two effects of ethylene gas on the growth of bean seedlings.

1.
2.

3 3. In one sentence state why clean air is needed by most living things.

1.

4 4. In a paragraph of not more than 200 words describe the relationship between air pollution and survival of peppered moths.

PRE-POST TEST ANSWER KEY
PACKET 2

Behavioral Objective Number

1 **1. Use arrows to identify three parts of the plant (shown below) that are affected by carbon monoxide and list the effect of carbon monoxide on each part.**

2 **2. List two effects of ethylene gas on the growth of bean seedlings.**

1. Roots do not penetrate soil
2. Stems do not elongate
3. Stems curl or twist
4. Leaf growth is slowed

3 **3. In one sentence state why clean air is needed by most living things.**

1. Clean air is needed to maintain the natural balance and cycle of oxygen and carbon dioxide between green plants and other living things.

4 **4. In a paragraph of not more than 200 words describe the relationship between air pollution and survival of peppered moths.**

The production of smoke as a result of burning coal to heat homes caused trees in the London area to blacken. Originally the tree trunks were lighter in color. The peppered moths, of which there is a range of color varieties from light to dark, frequently rest on the trunks of these trees. Before the trees were blackened the predatory birds would pick off the darker color moths. With the advent of blackened trees the birds began to eat the lighter variety. As a result, the darker variety predominates today.

BACKGROUND INFORMATION
PACKET 2

After students go through the packet they will probably have a tendency to say that all plant damage they see in the future is caused by air pollution. This is a dangerous generalization to make. While there is no doubt that air pollution damages plants, much of this damage is very similar to damage caused by mineral deficiencies. The possibility that plants along highways may be harmed in some way by carbon monoxide becomes a reality when an experiment is conducted under controlled conditions in the laboratory. These controlled experiments are necessary to remove the variable of mineral nutrition. The instructor should try to develop a questioning attitude among students with regard to the effects of air pollution on plants and avoid loose generalizations.

There is no doubt that man can influence his own existence through air pollution. The human machine (with special emphasis on the respiratory system) cannot exist optimally within a polluted environment. The possibility exists that increased levels of air pollution could cause the extinction of man. While this is not a pleasant topic it should be considered by students, not from the "doomsday" approach but, rather from the position that man has the ability to solve a problem once it is recognized.

The peppered moths are a very good small scale example of the effects of air pollution on the animal world. The instructor should make a great effort to show the broader implications contained within the peppered moth example. If man's pollution can influence the survival of a variety of peppered moths why would it not be possible for man to influence his own survival as a species?

INSTRUCTIONAL SEQUENCE
PACKET 2

Behavioral Objective Number	Concept I Required Activities:
1	A. The film loop clearly shows the effects of carbon monoxide on bean plants. Be sure to view it yourself and encourage questions during class discussion. If you have a student who would like to try this experiment here are some guidelines:

1. The experiment should be conducted under a fume hood or near an exhaust fan (open window would also do) away from large groups of students. Although, large quantities of carbon monoxide are not produced assuming that no more than 20 mls of formic acid are used each day. It is not a good idea to risk breathing even small amounts of this gas.

2. Plastic bags may be substituted for the aquaria covers shown in the film loop.

3. We used 18 molar sulfuric acid and 88% formic acid to produce the carbon monoxide. These materials should be available in the chemistry department of your school. Certainly, sulfuric acid would be available. Formic acid may be obtained from the Science Department of Parkway North Senior High School, 12860 Fee Fee Road, Creve Coeur, Mo. 63141, if it is not available in your school.

4. Beans work well for this investigation but encourage the use of other types of plants to see if the results in the film loop are consistent for a variety of plants.

The Data Sheet 1 should help the students to make a list of the important effects of carbon monoxide on bean plants. The film loop shows that most of the damage was localized on the leaves. This is typical of many plants affected by air pollution. We made no attempt to show the possible effect of carbon monoxide on root growth. Hopefully, some students would question this since it is not shown. The difference between the length of the control and experimental plants is slightly significant. Remember that these results were shown at the end of just two and one half weeks and, if continued, the effect of carbon monoxide on the plants would most likely be more generalized and severe.

2 B. The instructions for this activity are essentially the same as those for Activity A above. There is no danger to humans as a result of breathing ethylene gas although it has been observed to cause early abortion in mice. The primary source of ethylene gas as an air pollutant is the automobile. Additional sources include industry, especially those involved in the manufacture of paint and paint components. Encourage your students to set up their own experiments using different kinds of fruit other than apples. Bananas, peaches and avocados are also good sources of ethylene as they ripen. You might even encourage some students to determine the effect of ethylene gas on adult plants. This would provide a good contract to the film loop that focused on bean seedlings.

Data Sheet 2 should provide enough space for the students to record their observations. Be sure to discuss this activity at the end of the packet, especially from the standpoint of pollution effects on food sources for man and other animals.

This activity calls for the students to write a laboratory report. It is possible to write a laboratory report by observing a film loop if the students watch it carefully and write down their observations. The film loop "Effects of Ethylene Gas On Bean Seedlings" describes a problem, shows the procedures and outlines the results. In a science class the laboratory report would be quite detailed in covering the points listed below. A modified form of this report would be acceptable but it is very important that the students record and interpret the results of the experiment as shown. Students should see the film loop at least twice in order to appreciate the effects of ethylene gas.

PARTS OF A LABORATORY REPORT IN SCIENCE

1. Problem...stated as question. Example: What will polluted air do to the growth of bean seedlings?

2. Relevant Information...facts that are already known about the problem from previous experiments. This information may come from books, magazines, films and is used to make a workable hypothesis and interpret data which comes at the end of the report.

3. Hypothesis...a prediction about what might happen as a result of the experiments. Example: If bean seedlings are exposed to ethylene gas then the stems will not elongate.

4. Procedures...If the students were doing this experiment themselves they would list all the materials and methods they used. In this case, however, students may simply refer their reader to the film loop for a complete list of materials and procedures.

5. Results...Usually includes a chart or graph (or both) that presents a "picture' of the results.

6. Interpretations...The student reads the chart or graph and attempts to write all the possible meanings. Then using the relevant information they may attempt to isolate one or two of the best interpretations that are supported by present facts. Further, the student should discuss those findings that are not in agreement with known facts.

7. Conclusions...A response to the hypothesis. Example: Hypothesis is valid, Hypothesis invalid, Hypothesis inconclusive (not enough data to support either validity or invalidity).

2 C. The film strip and casette tape on "Smog and Plant Growth" was ordered without the benefit of preview. It can be borrowed from the Science Department, Parkway North Senior High School, 12860 Fee Fee Road, Creve Coeur, Mo. 63141.

2 D. This article provides a good overview of the biological effects of air pollution. The students are not told to take notes or write a summary of the article because it was intended as general background for class discussion. During class discussion try to develop the ideas presented about the effects of air pollution on man and upon the plants and animals in food chains leading to man.

3 Concept II Required Activities:

A. Both choices (1 and 2) provide underlying reasons why clean air is needed by most living things. Niether article lists exact reasons why clean air is necessary so you will probably have to give some help. Remember that animals and green plants (those that have chlorophyll and carry on photosynthesis) are involved in a life support exchange: green plants release oxygen (O_2) and animals release carbon dioxide (CO_2). This cycle is primary to the maintenance of life on earth. Air pollutants such as carbon monoxide (CO), ozone (O_3), and nitrous oxides (NO_2) also cycle through air to plants and cause a variety of ill effects such as leaf spot, slowed stem growth and leaf yellowing. There is a direct suffocating effect of carbon monoxide on animals while ozone and nitrous oxide are thought to be harmful to lung tissue. So, when we think about clean air we think of the normal percentages of carbon dioxide, oxygen and nitrogen with minimal levels of pollutants. It is when the air pollution levels rise and operate on the living systems via naturally occuring cycles that we see the need for clean air for most living things. Using the word "most" implies some exceptions. There are some organisms (mainly bacteria) that do not require air for life. They are called anerobic organisms and are excused from the generalization that most living things require clean air. However, when you consider that most of the anerobic bacteria are involved in the process of decomposition and that the things they decompose were once plants and animals that required clean air, you see that even these anerobic organisms depend indirectly on clean air.

4 Concept III Required Activities:

A. All three of these activities are excellent ways of showing how pollution can influence the survival of a species. The particular example of the peppered moths demonstrates an indirect effect of man's activity. The black smoke (produced by man's activity) lands on the tree trunks (where peppered moths rest), therefore camouflaging the black variety while exposing the light variety to stand out to predation by birds. The hypothesis is that if birds eat more and more of the light variety there is a danger that their numbers will fall below that level which is considered necessary for breeding potential which could result in the extinction of the light variety of peppered moths.

Many students will say "so what" to the extinction of peppered moths. You should help them to see the implications of this for man. If man influences the survival of insects through pollution activities could he not influence his own survival. A statistical comparison of air pollution and respiratory disease (Packet 1: Air pollution and Man, Activity III A) may indicate that man does have the capability of eliminating himself as a species. While most of us would assume that Homo sapiens have enough innate intellegence to avoid this, it is nevertheless, a possibility and students should be exposed to it for the sake of examination.

The instructor should get involved with all three versions of this activity so that a meaningful class discussion can be held.

The film loop mentioned in activity 2 is available on a loan basis from the Science Department, Parkway North Senior High, 12860 Fee Fee Road Creve Coeur, Missouri 63141.

The questions that follow 1 and 2 can be used to develop important ideas during class discussion.

At this time administer the post-test.

ENVIRONMENTAL ECOLOGICAL EDUCATION PROJECT

Parkway School District
Checterfield, Missouri

DR. WAYNE FICK, Superintendent

VERLIN M. ABBOTT, Project Director

Unit: Air Pollution: Packet II

BY:
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CONCEPTS: PACKET 2

I. Plant growth is affected by air pollution.

II. Clean air is a basic need for most living things.

III. Peppered moths are examples of the correlation that exists between an air pollutant and the survival of a species.

Concepts		BEHAVIORAL OBJECTIVES
I.	1.	Given a diagram of plant the student will use arrows to identify the parts that are affected by carbon monoxide and list at least one effect of carbon monoxide on each of those parts.
I.	2.	After completing a laboratory report using the format recommended by your instructor the student will list two effects of ethylene gas on the growth of bean seedlings.
II.	3.	In a single written sentence the student will be able to state why clean air is needed by most living things.
III.	4.	In an essay of not more than 300 words describe the relationship between air pollution and the survival of peppered moths.

At this time take the pre-test.
Obtain a copy from your teacher.

ACTIVITIES

Behavioral Objective Number	
	Concept I Required Activities:
1	A. The following activity will provide the necessary backgroung for objective one. See the film loop showing effects of carbon monoxide on the growth of bean plants. Use the Data Sheet 1 (supplied by your teacher) to record your observations.
2	B. This activity is related to objective two. See the film loop which demonstrates the effects of ethylene gas on the growth of bean seedlings and write a laboratory report on your findings. Use the Data Sheet 2 (supplied by your teacher) to record your observations on the effect of ethylene gas on bean plants.
2	C. The following activity is OPTIONAL and will provide additional background for objective two. See the sound filmstrip "Smog and Plant Growth". After viewing the filmstrip, write a short definition of smog and describe the ways in which smog effects plant growth.
2	D. Read "Biological Effects of Air Pollution", located in the student readings.
	Concept II Required Activities:
3	A. You should select activity one or activity two. Both of which provide information related to objective three.
	1. Read the following article on "The Atmosphere" and write a paragraph (of 100 words or less) that discusses severals reasons why most living things require clean air.

THE ATMOSPHERE

Man's atmospheric environment is both narrow and finite; comprehension of its limitations and normal conditions is necessary to understand how it became polluted. The density of the atmosphere decreases with altitude, and approximately half of the atmosphere by weight lies below 18,000 feet. It contains about 21 percent oxygen which animals, including man, require for life and, because the average person requires available oxygen at pressures approximating 3 pounds per square inch, man cannot survive for long if oxygen is not available in close to that proportion and at the pressure. Other constituents of air include variable amounts of water vapor, nitrogen (78 percent), and carbon dioxide, carbon monoxide, and certain other gases, all of which total less than 1 percent by weight. The proportions of the gases are about the same in all parts of the world. The water vapor (water in a gaseous form) amounts to 1 to 3 percent by volume throughout the world's atmosphere. For our considerations, the water vapor can be regarded as an independent gas mixed with air.

There are several atmospheric layers. The troposphere is the layer adjacent to the earth and varies in height from about 28,000 feet over the poles to 55,000 feet over the equator, the depths being subject to seasonal change. Normally, tropospheric temperature decreases with increasing altitude and we term this phenomenon the lapse rate. Where an abrupt change in the rate of temperature fall with altitude increase occurs, we reach a region called the tropopause. This atmospheric region separates the troposphere from the stratosphere (26 to 29 miles thick). our discussion will principally be concerned with the effects of man's activity on the troposphere and, to some degree, the stratosphere.

The atmosphere is influenced by many forces, both natural and man-made. Chief among these is heat energy from the sun. Heat is a form of energy as well as an expression of molecular activity. Since air is composed of atoms and molecules, air temperature is also a measurement of heat or molecular activity. Because different materials have different molecular structures, they will develop different temperatures (molecular activities) when the same amount of heat is applied. Accordingly, substances are said to have different specific heats or heat capacities. Land, for example, becomes hotter than water when indentical amounts of heat are applied and cools faster than water, as at night. Heat to the earth is largely supplied by the sun and this incoming radiation is offset roughly by outgoing or reflected radiation (terrestrialradiation). At night, cooling occurs by terrestrial radiation. Temperatures of land masses rise and fall more rapidly than water masses, and, therefore, the land is warmer by day and cooler by night than the sea. This results in breezes toward land in coastal regions during the day which often reverse at night.

Atmospheric pressure is the force exerted by the weight of the atmosphere on a unit measurement of area (example, per square inch). We measure this force with an instrument called a barometer, one form of which is an evacuated tube with its open end placed vertically in an open container of mercury. At sea level, the weight of the atmosphere acts as a force on the mercury causing some of it to rise as a column in the tube, on the average about 29.9 inches. Mercury is used rather than lighter substances such as water because the displacement of a heavier substance in terms of column rise is considerably less, thus requiring a shorter tube. Differences in atmospheric pressure between points on the globe account, among other forces, for movement of air from regions of high to low pressure. When this movement is parallel to the earth's surface, we refer to it as wind. Other factors responsible for air movement include the earth's rotation about its axis, its yearly revolution about the sun, the uneven heating of the earth's surface by the sun, and the tilt of the earth's axis, to mention a few. However, solar energy is the predominant force responsible for weather phenomena.

In discussing the tropopause earlier, we defined it as the altitude zone where an abrupt change in the lapse rate occurs. Actually, lesser changes occur quite frequently and even closer to the earth. For example, there may be a narrow layer within the troposphere in which temperature increases with altitude for several hundred feet; we call this an inversion (or temperature inversion) of the usual decrease of temperature with altitude. Inversions can, thus, impede the rise of the air below and if the latter air contains impurities (pollutants) the inversion acts as a lid to seal them below. If no significant lateral movement of air (wind) occurs, then the stage is set for an acute air pollution episode in the volume of air below.

If the earth did not rotate on its axis one might conceptualize air movement occurring by another means. We could conceive of warm air rising over the equator where it is more heated and less dense. It would rise high and flow laterally resulting in atmospheric pressure below lower than that in the surrounding adjacent area where the air is more dense because of its cooler temperature. Thus, cool air from the poles would move toward the low equatorial pressure where it in turn would be warmed, rise, and spread laterally toward the poles in a continuing cycle. For example, under these conditions, a lighter than air balloon turned loose over the equators would rise and drift toward either pole. It would then descend over the poles and simply skim the earth's surface toward the equator thence to rise again. However, the earth does rotate and this rotation results in a force which deflects the southern winds toward the east in the northern hemisphere and toward to west in southern hemisphere; we call this the Coriolis force. Other influences on local weather include differential cooling and heating between mountains and flat land, desert and cultivated land, green and pavement, etc. All contribute to weather phenomena.

Air Pollution, Scientist's Institute For Public Information, New York, 1970, pp 4-8

2. Read pages 92-95 of Environmental Pollution, paying particular attention to the diagram on page 93. After you complete the reading compile a list of reasons that might explain why clean air is needed by most living things.

Concept III Required Activities:

4 A. The following activities are related to objective 4. You must do at least one of the following activities.

1. See the film loop on peppered moths. It is strongly recommended that you see it at least twice in order to appreciate what is happening. When you are finished answer the following questions:

   a. Does man have a direct or an indirect relationship with peppered moths? Defend your selection.

   b. Why were the trees darkened?

   c. How did the change in the appearance of the tree trunk influence peppered moths?

   d. What happens when the white peppered moths are continually preyed upon by the birds?

   e. Can you think of any other ways that man influences the selection of organisms as a result of environmental pollution?

2. Read the following article on peppered moths and then answer the same questions that are found in Activity 6 a.

ACT ONE

Time: 1850. Place: England, in the neighborhood of Manchester, an industrial city. It has not been an industrial city very long, for there is still countryside around it - clean countryside, with woods and streams and fields. The curtain rises on a wood near the city.

Several biologists are seen plucking something from the bark of surrounding trees. Their talk tells us that they are collecting moths of the species Biston betularia. (bĭs'tən bĕt' ū lā' rĭə) These moths are active at night; in the daylight hours they rest on the trunks of trees. The biologists study their collection.

Among some hundreds of specimens, all are much alike. But the biologists also note a good many differences. A few moths have shorter antennae than most. A few have longer legs. One or two are distinctly darker than the others. There are many other noticeable differences, but each difference is represented by only one or a few of the moths. In other words, these moths vary as individuals - and at least some of these variations are probably hereditary, though our biologists of 1850 would know little of this.

ACT TWO

Time: 1950. Place: The same. The countryside has changed. The sunlight is less bright, for there is a smog of dirt and soot in the air. The trees are darker, their bark and leaves covered with a layer of soot. For years the factories of Manchester have been pouring out their smoke, dirtying the town and the countryside.

Again several biologists are collecting Biston betularia. They examine the specimens for similarities and differences. They also compare their notes with those recorded a century ago by their predecessors. The same variations are evident amid the general similarity. Most of the difference are still represented by only a few of the several hundred moths collected. But one of the differences that was rare in 1850 is now common. Most of the moths are now dark; only a small percentage are light in color. A change has taken place in the local population of Biston betularia.

ACT THREE

Time: A few months later. Place: The same.

A biologist is hidden in the bushes. He has a movie camera, with a telephoto lens and is pointing it at one of the darkened tree trunks. There are moths on the tree - half are the dark type, half the ligh type; they have been collected alive and put there by the biologist. Birds appear - birds that eat these moths.

Later we see the biologist's notes on his experiment. They indicate that the preying birds ate many more of the light moths on the tree than they did the dark ones. We also see from his notes that he conducted the same experiment in a clean grove of trees farther from the city. There he found the opposite to be the case: The dark moths were eaten more often than the light ones.

This article was taken from High School Biology (BSCS Green Version), Biological Sciences Curriculum Study, Boulder, Colordo., 1963.

3. This activity is related to the effects of air pollution on the survival of peppered moths. The materials and instructions for this activity can be obtained from your instructor.

At this time take the post test.
Obtain a copy from your teacher.

DATA SHEET 1

Effects of ethylene gas on the growth of bean seedlings.

Part of the seedling affected	Kind of effect lie, twisting, yellowing, etc.

DATA SHEET 2

Effects of carbon monoxide on the growth of bean plants.

Part of the plant affected	Kind of effect lie, spots, wrinkles, etc.

Biological Effects of Air Pollution

In any metropolitan area, acute air pollution episodes can occur whenever atmospheric conditions prevent rapid dispersal or dilution of the pollutants. Acute air pollution episodes resulting collectively in the deaths of thousands in Belgium's Meuse Valley (1930), Donora, Pa. (1948), London (1952, 1959, 1962), New York City (1953, 1962, 1966) have been well documented. All of these episodes shared certain characteristics:

A high population density with a correspondingly high concentration of combustion processes.

Seasonal influence--occurrence was in the winter when fuel consumption was increased and upper respiratory diseases were prevalent.

A stagnant air situation and temperature inversion for several days to a week with accumulation of pollutants in the air.

In general, the fatalities and severe illnesses resulted from acute, chemically irritative changes to the lining of the air tubes (bronchi) leading to the lungs. In London, the leading causes of hospital admissions during those episodes were respiratory disease, often with heart failure complicating the processes in the lung. The heart in a person with pre-existing heart-lung disease could not take the added burden of moving blood through the chemically irritated lungs.

No single smog component in either London or Donora was present in concentrations very much higher than usual. Thus, an increased duration of exposure is implicated, with the possibility of additive or synergistic factors. (The latter is a biologic effect produced by two or more agents together which is greater than the sum of the effects of the individual agents.) Other membranous body surfaces reflected the same irritative mechanisms, consequently, sore throat and burning of the eyes were frequent complaints, as were headache and nausea. While no specific offending agents have been indicted in the London and Donora disasters, oxides of sulfur, common to both, were probably acting in concert with particulates and possibly other pollutants. Infecting agents may also have been operative. In Donora, 5,910 people were affected and 17 died. In London, 4,000 to 6,000 more deaths occurred between December 5-9, 1952 during a dense smog; in December, 1962, 340 more deaths occurred than was normal, during a similar period of smog.

For a long time the medical profession has been preoccupied with infectious causes of disease to the neglect of the physical and chemical aspects. While this was justifiable in the early part of the twentieth century when people were dying from diseases such as pneumonia, influenza, meningitis and tuberculosis, it no longer seems valid at this time in the United States when most people are dying from non-infectious diseases. Indeed, the diseases which appear to be killing Americans today seem not only to be non-infectious in origin but to have other common characteristics, namely multiple rather than single causes, insidious onset and development over a 20 to 30 year period and extremely difficult to treat when full-blown. Included in this group are cardiovascular disease, stroke, cancer, particularly bronchogenic cancer, and chronic pulmonary disease (bronchitis and emphysema).

Although complicated by many variables, the evidence linking chronic lung disease with air pollution is impressive. Bronchitis, an inflamation of the bronchi. is characterized by excessive mucous secretion accompanied by chronic or recurrent cough productive of sputum. Bronchitis is not considered chronic unless these manifestations are present on most days for at least three months of the year and for two successive years. Using these criteria, a 20 percent incidence is estimated in urban men in Great Britain between the ages of 40 and 60 years.[1] In Great Britain, illness from chronic bronchitis is related to the population size of cities,[2] suggesting that air pollution, which also increases with the size of cities, may be implicated. Another study showed a correlation between the bronchitis mortality rate and the amount of fuel burned for domestic and industrial purposes.[3] In England and Wales, places with higher mean annual sulfur dioxide measurements had associated higher mortality rates due to chronic bronchitis.[4] Using decreased visibility as an index to pollution, British investigators showed an association between pollution and illness-absenteeism among postmen.[5] The postmen's counterparts working indoors suffered less work loss due to bronchitis, an association not attributed to weather alone. A number of observers have related aggravation of symptoms of bronchitis to air pollution increases.

Bronchial asthma, a disease in which the muscles of the bronchi constrict and impede outward movement of air, seems unquestionably to be influenced by air pollution. Thus, in Donora, 87 percent of asthmatics became ill, while illness struck 43 percent of the rest of the town's population.[6] Bronchial asthma generally responds well to certain medications which dilate the air tubes or combat allergy and infection. In contradistinction, another type of lung disease, indistinguishable from asthma by physical examination but distinguishable by negative response to these medications has been described among American military personnel in Yokohama. Evacuation seemed to be the only form of therapy for "Yokohama respiratory disease," pointing to some offending local environmental contaminant.[7] New Orleans has experienced epidemic outbreaks of asthma, typically in October.[8] Dr. Murray Dworetsky, in the presidential address to the American Academy of Allergy in 1969,[9] pointed out that "the literature strongly suggests that the frequency of death from asthma has recently been increasing," and said that although "inappropriate management" is probably one cause, "There is much reason to believe that in and of itself air pollution may be increasing the number of deaths from asthma."

Emphysema, another chronic respiratory disease, appears to be adversely affected by air pollution. In this disease, the small air sacs into which the air passages empty become distended, rupture and/or coalesce. The lining of these sacs is the site of gaseous exchange between air and blood. Thus, the larger sacs for the same volume present less surface area for exchange. Lung emptying is impeded, coughing is less effective, and victims become predisposed to infection. Heart failure is a common complication. Emphysema prevalence in the United States is increasing; this disease has doubled in incidence and mortality every five years for the past two decades.[10] Not only is emphysema aggravated by air pollution, especially in conjunction with smoking, but one California study showed that lung function could be improved simply by placing the patients in an air pollution-free room.[11]

While most authorities agree that cigarette smoking plays the dominant role in the development of lung cancer, there would appear to be some further agreement that an urban factor plays a much smaller although detectable role as well. Data suggest a higher incidence of lung cancer in urban than in rural areas among smokers. Thus the incidence of lung cancer among smokers who emigrated from Great Britain to South Africa was higher than among white native South Africans who were even heavier smokers.[12] Immigrants to Australia and New Zealand from Great Britain had higher lung cancer mortality than native New Zealanders and Australians in spite of similar smoking backgrounds.[13,14]

Air pollutants frequently have been concentrated and applied to the skin of mice. This has resulted in the

> ...induction of a kind of cancer called squamous cell carcinoma. Tumors under the skin have been induced in mice exposed to air pollutant tars collected from a number of American cities. The induction of lung cancer (adenocarcinoma) in mice has been achieved by exposure of mice in dust chambers to asphalt road sweepings and also by the same type of exposure to soot....On the other hand rats and mice are quite resistant to induction of lung cancer. Even when exposed to aerosols of pure carcinogens, the animals do not develop lung tumors but

do get skin tumors from this type of exposure although rats are normally resistant to skin tumor induction. Both species, however, develop lung cancers when the exposure is sufficiently intense. Thus, when the carcinogens are implanted in the lung in high dosages the animals develop lung cancer....[15]

It must be cautioned that such evidence is not definitive, although certainly suggestive. A one-pack-per-day smoker of cigarettes exposes himself to several hundred times more inhaled organic matter than an individual in a congested traffic area of New York. The major difference is that the smoker can stop smoking, while the pedestrian can hardly be expected to stop breathing.

New York City's 1953 episode was not really recognized until approximately nine years later when a comparative analysis of hospital records,[16] and air pollution data revealed an excessive number of deaths during a period of severe air pollution. It is, therefore, hardly unreasonable to assume that many deaths from pollution may take place without ever coming to the attention of Public Health officials because of the unavailability of the necessary measurements or the necessary data analysis, or because the numbers are so small as to fail to give significant results.

Only three parts per million of sulfur dioxide exposure to a healthy person can produce a slight increase in airway resistance, that is, the ease with which expired air passes through the airways. Yet, people with chronic bronchitis or similar conditions may be aggravated by levels as low as 0.25. Twice as many acute respiratory illnesses were found at exposures to 0.25 ppm for twenty-four hours as at 0.4 ppm among those aged 55 or over with chronic bronchitis.[17] Increased airway resistance can frequently occur even at extremely low levels of sulfur dioxide when it is combined with inhalation of particulate matter or sulfur trioxide, which combines with water to form sulfuric acid. Twelve-hour averages of sulfur dioxide (parts per million) in New York City have been known to exceed 0.8. The major source of sulfur dioxide in that city was the combustion of high sulfur content fuel oil and bituminous coal. The implication of these figures to New York's over one million estimated sufferers[18] of asthma and hay fever could well be profound. Fortunately, some steps have been undertaken to reduce the sulfur content of New York fuels.

Obviously, the respiratory system is most directly affected by breathing polluted air, and we have concentrated so far on cardio-respiratory diseases in terms of possible cause and/or aggravation. Not infrequently, however, certain pollutants can attack an organ system far removed from the portal of entry to the body. Lead, for example, can have diffuse and confusing effects, as experience with occupational exposure, and with exposure of children to lead paints has shown. Lead can enter the body via lungs, intestinal tract, or skin and by poisoning certain enzymes which are present in most organs can affect blood-forming, nervous, gastrointestinal and excretory (kidney) systems among others. Lead toxicity can occur after chronic as well as after acute exposure.

The biological effects of carbon monoxide are different than many other air pollutants. First, it cannot be tasted, smelled or otherwise sensed by the body and second, it does not directly affect the eyes, nasal passages or lungs. Instead, it passes unchanged through the walls of the lung into the blood, where much of it actively combines with hemoglobin, the substance in the red blood cells normally responsible for carrying oxygen to all the tissues of the body. (A very small amount of CO is produced by normal body metabolism; we are concerned here only with *additional* exposure to CO from the environment.) This combination forms a substance called carbomonoxyhemoglobin, and has the effect of decreasing the oxygen-carrying capacity of the blood. Since CO is about 200 times more strongly bound than oxygen to hemoglobin, a small amount of CO in the ambient air has a greatly magnified effect on the oxygen transport function of the blood. All tissues of the body may suffer from oxygen deprivation, but the two tissues most sensitive to lack of oxygen are the heart and the brain. Thus, at low levels, effects on these two

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Table 1. HEALTH EFFECTS OF CARBON MONOXIDE (CO)

Prepared by D.M. Snodderly, Jr., New York Scientists' Committee for Public Information

Concentration of CO in air	% Carbomonoxyhemoglobin in blood	Symptoms
Up to 300-400 ppm	30 - 40% and above	Severe headache, dim vision, nausea, collapse.[1]
100 ppm	Up to 20% depending on exposure and activity of subject	Headache at 20%. Impaired performance on simple psychological tests and arithmetic above 10% CO in blood.[1]
	20% in dogs exposed for only 5.75 hours per day, for 11 weeks	Brain and heart damage found at autopsy.[2]
50 ppm and below	2 - 4% and above Maximum of about 8% (calculated from [5])	Ability to detect a flashing light against dim background worsens with increasing amounts of CO. 4% was lowest point shown, but authors state that even the CO from a single cigarette could be shown to cause rise in visual threshold.[3] It is, therefore, obvious that smoking and exposure to CO from auto exhaust interact. Subjects presented with two tones and asked to judge which is longer. Judgment impaired at this level of CO in the air; lower levels of CO not studied.[4] Results interpreted as impairment of ability to judge time.[5] Not known whether this may influence people's ability to drive safely. Another author[1] concluded that 1 - 2% CO in the blood should cause a detectable number of errors on psychological tests if a sufficiently large-scale experiment were done.
15 ppm	Up to 2.4% (calculated from [5])	New York's air quality goal. Even this amount of CO could cause some of the effects on vision and loss of judgment of time that are mentioned above.

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tissues are well documented. (At higher levels, about 1,000 ppm and more, CO can be lethal.) As Table 1 indicates, such effects can range from changes in various psychological capabilities in humans, such as time discrimination, to permanent heart and brain damage in experimental animals. (Concerning this last point, many scientists feel the now well-documented correlation between smoking and heart disease may well be due in part to the CO in cigarette smoke.)

The effects determined in the laboratory and described in Table 1 should be compared with the actual measured levels of CO, culled from several sources, listed in Table 2. The overlap is clear; the only uncertainty concerns how long people in urban areas are exposed to these various levels.

Table 2. CARBON MONOXIDE LEVELS AT VARIOUS LOCATIONS

Location	CO Levels (in average ppm's)	
Los Angeles Freeways	37	
Los Angeles Freeways, slow, heavy traffic	54	
Los Angeles, severe inversion	30	for over 8 hours
Parking garage	59	
Cincinnati intersection	20	
Detroit, short peak	100	
Detroit, residential area	2	
Detroit, shopping area	10	
Manhattan intersection	15	all day long
Allowed industrial exposure for 8 hours (for comparison)	50	recently lowered from 100

One of the air pollutants resulting from the aniline dye and benzene industries has, by careful epidemiologic analysis, been shown to result in the increased occurrence of bladder cancers among workers in these industries.[19,20] In this instance, the target organ, the bladder, was certainly distant from the portal of entry, the lungs. Since bladder cancers are responsible for only a few percent of all deaths from malignancy, these pockets of disease could be expected to attract attention, and did. The disease was found to be heavily concentrated in workers within these industries *and in residents in the immediately surrounding vicinity*. Laboratory confirmation by the provocation of experimentally induced aniline dye tumors in dogs using beta-naphthylamine has been reported.[19] An increased frequency of tumors of the bladder paralleling the increased occurrence of lung cancers in smokers has been reported[21] and as one might expect, cigarette smoke contains these same contaminants. In the case of this pollutant, short term exposure revealed no ill effects; it was exposure for a long time to a relatively low level that resulted in disease.

Similarly, the results of airborne radioactive isotopes are slow in developing. In 1954, 53 Marshall Islanders were subjected to radiation fallout including iodine 131 from a nuclear bomb test. Iodine 131, although a short-lived isotope, concentrates in the thyroid and can damage the thyroid tissue as it emits its energy and decays. Eleven and twelve years later, 18 of these individuals were reported to have thyroid abnormalities. In 11 cases, surgery was performed, and one cancer of the thyroid was found.[22] Fallout was not blamed for the malignancy found in another patient, who was reported to have received less exposure from iodine 131. However, in a population of this size, one would not expect even a single case of thyroid cancer to be present in 15 years. It should be remembered that this represents also a rather brief period between exposure and disease. The mutagenic properties of radiation are well known, and would lead us to expect effects on later generations. Experience has taught us that it may be as many as five generations after exposure before the effects of a recessive mutation appear. These concerns are probably quite applicable to the long term effects of release of radioactive materials into the environment from whatever source.

There is much that we don't know about what pollutants are in the air. As Glenn Paulson shows on page 19, the term "particulate matter" is a general one that includes numerous pollutants, many as yet unidentified. There are also gaseous pollutants emitted by various industries or released in the burning of wastes that are not monitored. If we knew more about what is in the air, this would be only the first step toward studying the biological effects of single pollutants and pollutants in various combinations.

Early concern with the effects of air pollution was largely confined to effects on man which, while quite proper, was also somewhat misleading. By the time we started noticing damage in man, a devastating toll had been taken in plants and possibly in lower animals. Long before the health effects of air pollution became a matter of serious concern, enormous areas of formerly fertile ground surrounding ore processing mills in this country and others became bare as a result of fumes emanating from the mills. This occurred during the days prior to the development of high stacks which promoted more rapid dilution. Sulfur dioxide from stack gases tends to burn vegetation, particularly alfalfa and soft-leafed vegetables. Hydrofluoric acid has been described as being damaging to plants and fluorosis has been described in cattle. By the end of the late 1940's more and more complaints from farmers were heard concerning smog injury to crops. Virtually every crop in New Jersey has been adversely affected by air pollution.

The effect of smog on plants can be quite variable and consequences can include the reduction of crop yield, growth retardation or outright destruction of the plant. Visible damage is probably best known since it is the most easily observable, as when pine trees lose their needles, or when lawns become brown after an intense smog assault. Of continuing concern should be the fact that the more extensive the damage to plants, the greater the reduction in oxygen production by green things. For example, phytoplankton, microscopic marine plants which produce oxygen, can be destroyed by air or water pollution by DDT.

City growth, increased miles of highways, and the spreading out of more and more people over the countryside reduce the area given to plants producing life-giving oxygen. Statistics on how fast land is being consumed are not available for many sections of the country. However, according to the U.S. Department of Agriculture, roughly 420,000 acres a year are being converted to urban use (which includes buildings and roads), and approximately the same amount is going underwater as new dams and reservoirs are built. In addition, approximately 160,000 acres are being converted each year in rural areas for highways and airports. It is estimated by the USDA that cropland furnishes roughly one-half of this million acres.[23] Thus man, with his exponentially increasing population and his soaring per capita energy use, at least in this country, may ultimately threaten one of his own basic life-sustaining systems, the oxygen cycle.

The measures taken so far to reduce air pollution are being offset by increases in the sources of pollution--more and larger power plants, more and larger industrial plants, more automobiles and trucks. So far, controls are being imposed on industry slowly, and principally to reduce sulfur dioxide and particulate matter. Knowledge of what comes out of

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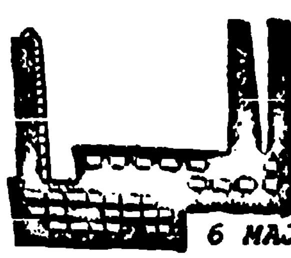
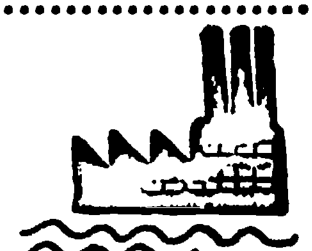
POLLUTION AND ITS SOURCES
Five major pollutants and their sources are shown below. The total for industry is obviously incomplete, since it includes only the six major industrial polluters. Putting all pollutants into the same units--millions of tons--is somewhat misleading. Some pollutants are harmful even in very small amounts. Some are more harmful than others, and some are more harmful together than separately. (From "The Sources of Air Pollution and Their Control," Public Health Service Publication No. 1548, Washington, D.C., 1966.)

ANNUAL EMISSIONS OF FIVE MAJOR POLLUTANTS IN MILLIONS OF TONS, AS OF 1966

Carbon monoxide..66
Hydrocarbons.....12
Nitrogen oxides.. 6
Sulfur oxides.... 1
Particulates..... 1
TOTAL AUTOMOBILE.......86



Sulfur oxides.... 9
Particulates..... 6
Hydrocarbons..... 4
Nitrogen oxides.. 2
Carbon monoxide.. 2
6 MAJOR INDUSTRIES.....23



TOTAL

industry's stacks is often limited, and authority to control it is even more limited. For example, the Committee for Environmental Information found that while industries reported to the city's Air Pollution Control officer what was coming out of their stacks, this was sometimes privileged information, not available to the public. The Air Pollution Commissioner could order reductions in industrial emissions only for sulfur dioxide, hydrogen sulfide, oxidants and particulates--the pollutants for which standards have been adopted by the city. He has authority to reduce emissions of other pollutants only if he can show that they present a danger to the health of the people in the vicinity or constitute a nuisance. Direct cause and effect on human health is extremely difficult to prove in connection with any environmental contaminant, and for new and untested chemicals would be impossible to prove until after the tragic fact. (The dye industry example described previously is a good case in point.)

At a recent conference on air pollution and the automobile at the University of Missouri[24] William H. Megonnell, Assistant Commissioner for Standards and Compliance, National Air Pollution Control Administration, said:

> In my judgment, the best we can expect from the Federal standards now in effect is that hydrocarbon and carbon monoxide emissions will in 1980 dip to approximately 60 percent of current emissions, or roughly what they were in 1953. And after 1980, when these standards have passed the saturation point of their effectiveness, as vehicle use continues to increase, the levels of pollution will resume their upward climb.

At the same conference, Dr. Robert Karsh, president of the St. Louis Committee for Environmental Information, said:

> The 1968 automotive emission standards reduced carbon monoxide emissions by 50 percent and hydrocarbons by 70 percent of uncontrolled levels in new cars only. The devices are not maintained because they do not have to be maintained in most areas. Because of increased numbers of cars and increased driving, under existing controls automotive pollution will double in the next 30 years.

Since that conference, new federal standards have been proposed which would reduce carbon monoxide emissions to half of present emissions, hydrocarbons to a fourth, particulates to a third and nitrogen oxides to a sixth. These stringent standards would not go into effect until the 1975 model year, and therefore would not reduce the total automotive pollution by those amounts, and then only if the control devices are maintained, and the number of cars does not increase.

According to the U.S. Bureau of Public Roads, the number of registered motor vehicles is increasing every year--in 1969 the increase was three million over 1968. But this tells only a small part of the story. The amount of air pollution from cars is more closely related to miles travelled, and particularly to *urban* miles travelled. In 1946, urban miles travelled were 170 billion. Twenty years later this had more than doubled, to 470 billion, and it is still rising.[25] What this indicates is that our control efforts continue to lag behind our capacity to pollute the air.

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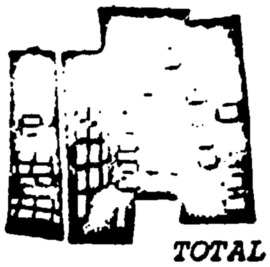
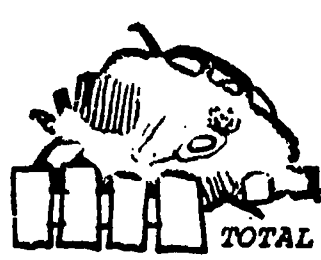
TOTAL: 142 MILLION TONS

lfur oxides....12
trogen oxides.. 3
rticulates..... 3
bon monoxide.. 1
drocarbons..... 1
CTRIC POWER...20



Sulfur oxides....3
Carbon monoxide..2
Nitrogen oxides..1
Hydrocarbons.....1
Particulates.....1
TOTAL SPACE HEATING....8



Carbon monoxide..1
Hydrocarbons.....1
Particulates.....1
Sulfur oxides....1
Nitrogen oxides..1
TOTAL REFUSE DISPOSAL..5

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CONCEPTS: PACKET 3

I. Man's increasing dependence upon the auto has produced an increase of carbon monoxide, nitrogen dioxide, and hydrocarbons in our atmosphere.

II. Incomplete combustion in the auto engine results in the production of carbon monoxide which effects the health of man.

III. Hydrocarbons emitted in auto exhaust affect the growth of plants.

IV. Nitrogen dioxide, emitted in auto exhaust, contributes to man's respiratory problems.

Concepts		BEHAVIORAL OBJECTIVES
I	1.	Upon completion of this packet the student will list and describe, in a few sentences, three ways that man's increasing dependence upon the auto has resulted in an increase in certain air pollutants.
II	2.	After completing the prescribed activity the student will state in a sentence how carbon monoxide results from incomplete combustion in the auto engine.
II	3.	Given a list of effects on man's health the student will choose the primary effect of carbon monoxide on man's health.
III	4.	The student will select the main effect of hydrocarbons, resulting from auto exhaust, on the growth of plants when given a list of effects on plant growth.
IV	5.	When presented with a list of man's health problems, the student will select the respiratory problems that are aggravated by the increase of nitrogen dioxide in the air we breathe.

At this time administer the pre-test.

PRE-POST TEST
PACKET 3

Behavioral Objective Number

1 1. In the space given, list and describe, in a few sentences three ways man's increasing dependence upon the auto has resulted in an increase in certain air pollutants.

A. ______________________________

____

____

B. ______________________________

____

____

C. ______________________________

____

____

2 2. State in a sentence how carbon monoxide is a resultant of combustion in the internal combustion engine.

____

____

____

____

3 3. Carbon monoxide primarily affects man's health. Circle the main effect of carbon monoxide on man's health.

A. irration of the soft lining of the trachia

B. complexation with the hemoglobin in man's blood

C. irration of the hair roots

D. complexation with oxygen in man's lungs

4 4. Hydrocarbons, resulting from auto exhaust, affect the growth of plants. Circle the main effect of hydrocarbons on the growth of plants.

A. keeps the roots from penetrating the soil

B. causes the stem of the plant to become thin

C. causes the stem to twist

D. causes leaf discoloration

5 5. Increasing amounts of nitrogen dioxide in the air we breathe causes an increase in man's health problems. Circle the respiratory problems that evidence indicates are increased by the increased amounts of nitrogen dioxide in the air.

A. bronchitis

B. damage to the air sac of the lung

C. ear infections

D. thyroid problems

PRE-POST TEST ANSWER KEY
PACKET 3

Behavioral Objective Number	
1	1. In the space given, list and describe, in a few sentences three ways man's increasing dependence upon the auto has resulted in an increase in certain air pollutants.

NOTE:
There are many answers to this question. Any use of the auto by the masses leads to increased amounts of air pollution.

A. Most facilities that our lives require, such as stores and doctors, require us to drive more. This in turn increases the amount of air pollution.

B. Man is a very independent animal, they all wish to go were they want when they want. This increases the number of autos and the amount of pollution.

C. Man lives in suburbs and works in the cities. This causes a great influx of traffic from the suburb to the city, this quantity of autos increases the amounts of air pollution.

2 2. State in a sentence how carbon monoxide is a resultant of combustion in the internal combustion engine.

Carbon monoxide is formed in the internal combustion engine as a result of having an insufficient quantity of oxygen to combust with the fuel in the cylinder.

3 3. Carbon monoxide primarily affects man's health. Circle the main effect of carbon monoxide on man's health.

A. irration of the soft lining of the trachia

B. complexation with the hemoglobin in man's blood

C. irration of the hair roots

D. complexation with oxygen in man's lungs

4 4. Hydrocarbons, resulting from auto exhaust, affect the growth of plants. Circle the main effect of hydrocarbons on the growth of plants.

A. keeps the roots from penetrating the soil

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C. causes the stem to twist

D. causes leaf discoloration

5 5. Increasing amounts of nitrogen dioxide in the air we breathe causes an increase in man's health problems. Circle the respiratory problems that evidence indicates are increased by the increased amounts of nitrogen dioxide in the air.

A. bronchitis

B. damage to the air sac of the lung

C. ear infections

D. thyroid problems

BACKGROUND INFORMATION
PACKET 3

This portion of the unit on air pollution deals with the causes of the problem. It is presented to the student in a cause-effect type situation. In other words, the student will be presented with the orgins of the four predominant air pollutants and their main effects on man and his surrounding community.

This packet deals with our main air pollutor, the automobile and its major pollutants, carbon monoxide, nitrogen dioxide, and hydrocarbons.

The following pages contain a short summary of facts on the topics discussed in the packet. It is by no means comprehensive.

Below is a chart and a list of readings. The chart, although its data was collected in 1968, shows where the air pollution problem lies. The readings are references in the recommended texts, it is advised that you read them at least in part.

Estimated Nationwide Emissions, 1968
(Millions of tons per year)

SOURCES	CARBON MONOXIDE	PARTICULATES	SULFUR DIOXIDE	HYDRO-CARBONS	NITROGEN OXIDES
Transportation	63.8	1.2	0.8	16.6	8.1
Fuel conbustion in stationary sources	1.9	8.9	24.4	0.7	10.0
Industrial processes	9.7	7.5	7.3	4.6	0.2
Solid waste disposal	7.8	1.1	0.1	1.6	0.6
Miscellaneous	16.9	9.6	0.6	8.5	1.7
Total	100.1	28.3	33.2	32.0	20.6

Readings

ENVIRONMENTAL POLLUTION pp 96-100 and pp 106-143

PROGRESS AND THE ENVIRONMENT pp 83-88

AIR POLLUTION PRIMER pp 23-29 and pp 35-44

A CITIZENS GUIDE TO CLEAN AIR pp 84-87

From the chart you can see that the automobile is the major source of most of our air pollution. It is not due simply to an inefficient combustion engine, but it has a great deal to do with the enormous quanity of automobiles and how much more frequently the auto is used today. Consider John Q. Public, in 1970 some 133,567,835 of drivable age, driving some 10,570,000 motor vehicles. A year later it was figured that for each 1000 of these automobiles, 64,000 lbs of carbon monoxide, 800,000 to 1,600,000 lbs of hydrocarbons and 200,000 lbs to 600,000 lbs of nitrogen oxides are spewed forth into the air we breathe. Even though pollution control devices will decrease these quantities per automobile the harrendous number of autos multiplies any and all contaminants produced. This idea is them compounded by the fact that Mr. Public, due to "URBAN SPRAWL" is using his auto more and more frequently, it takes him from here to there and back hundreds of times each day.

The major pollutant of the auto is carbon monoxide (CO). It is a colorless, odorless gas, that is quite poisonous at concentrations of 1 part in 100,000. It causes illness, dizziness, nausea, headaches and it can result in death within thiry minutes at a concentration of 1 part in 750. Carbon monoxide has a lesser effect on the growth of plants, causing yellowing and burning of the leaves.

Uncombusted hydrocarbons are another major pollutant from the auto. At low concentration, hydrocarbons have been shown to have no adverse effects to man; although some hydrocarbons are thought to be carcinogenic. The major problem with hydrocarbons is their effect on the growth of plants. Hydrocarbons such as ethylene, in a short time have a drastic effect on the growth of plants. The film-loop; "The Effect of Ethylene Gas on the Growth of Bean Seedlings" in the student packet shows these effects very vividly.

The final pollutant of the automobile we will discuss is nitric oxides. Nitrogen dioxide (NO_2) a reddish brown gas, makes up the major portion of the nitric oxide problem in our air. Nitrogen dioxide has been shown to have many adverse effects to man, from irritation of gums and a cause of teeth to break down to an increase in man's susceptibility to micro-organisms. In addition to causing man harm, nitrogen dioxide also effects the growth of plants and is a major source of the production of ozone photochemically.

The source of these three pollutants is the incomplete combustion in the auto engine. Incomplete combustion, which can be thought of at times as inefficient combustion is easily explained. The fuel of the auto is gasoline, long chain hydrocarbons, some containing nitrogen, this fuel is mixed and compressed with air and ignited. Ideally, if a sufficient quantity of oxygen is present all the hydrocarbons present will combust completely to produce water, carbon dioxide, and harmless nitric oxides. However, due to the nature of the auto engine, this quantity of oxygen is not present. When the mixture is ignited with an insufficient amount of oxygen, incomplete combustion results. The products produced are water, carbon dioxide, substantial quantities of carbon monoxide, nitrogen dioxide and uncombusted hydrocarbons.

INSTRUCTIONAL SEQUENCE
PACKET 3

These activities are directly correlated with both a concept and the behavioral objective (s). The activities are also suquentially arranged so the student will attain a good working knowledge of each concept. The arrangement hopefully leaves you some options, so that you may integrate your own teaching styles. A few general remarks about the activities and how we see them fitting into the instructional sequence are required before the individual background is presented. First, due to the nature of the teaching of this course, all the experiments are placed as optional activities. Second, because the experiments are set up as alternate activities, the student write-ups and required work is left up to the teacher's discretion. Finally, the background to these activities is viewed through the eye's of its authors, the perspective may be different through your eyes.

Behavioral Objective Number	
	Concept I

The students will complete activity A and B and either C, D or E.

1 A. This seminar may be presented as a whole class discussion or as several small group discussions. The idea here is to allow the student to verbalize his knowledge of how man depends upon his automobile and how this has in turn led to increasing amounts of air pollution. We see man's dependence on the auto as: his need to get to and from work, his need to drive to the ballgame or other recreation facilities, or his need to drive simply as an escape from his frustrations. We see the students bringing forth these ideas, and many more. He should relate these then to an increase in the amount of pollution in our air, this should be one of the main concerns of the summary written by the student.

B. This question is from ENVIRONMENTAL POLLUTION, it should hit at why man needs his auto from an economic point of view. Also, relating this need to an increase in the amount of air pollution, should be integrated into the answer.

C. If the student chooses this activity he may have trouble finding adeuqate answers, suggest to him to use as resources such texts as: The Almanac, the encyclopedia and books written durning the early 1940's. The answers to the

1970 portion of this question will be somewhat easier for the student to locate.

D. The questionaire will be prepared by the student. It is essential that his questions hit at how the auto is used and how frequently. You may wish to again relate this to increasing amounts of air pollution.

E. This question again hits at the fact that the automobile produces tremendous amounts of air pollution.

CONCEPT II

The students will complete A, B and C and either C, E or F.

2 A. A simple reading that covers a description of incomplete combustion and the effect of carbon monoxide on man's health. Questions 1 and 2 in <u>ENVIRONMENTAL POLLUTION,</u> serves as a review of the readings.

B. This study sheet, Data Sheet 1, will enable the student to view how much actual pollution his family car(s) put out into our air. Part four brings in the idea of man's health. Parts one, two and three will be different for different types of autos, this may serve as an interesting sidelight, whether the smaller autos produce as much pollution as larger autos. You will need to provide each student with a copy of Data Sheet 1.

C. This question is along the same vein as the preceding activity, although it applies on a national scale.

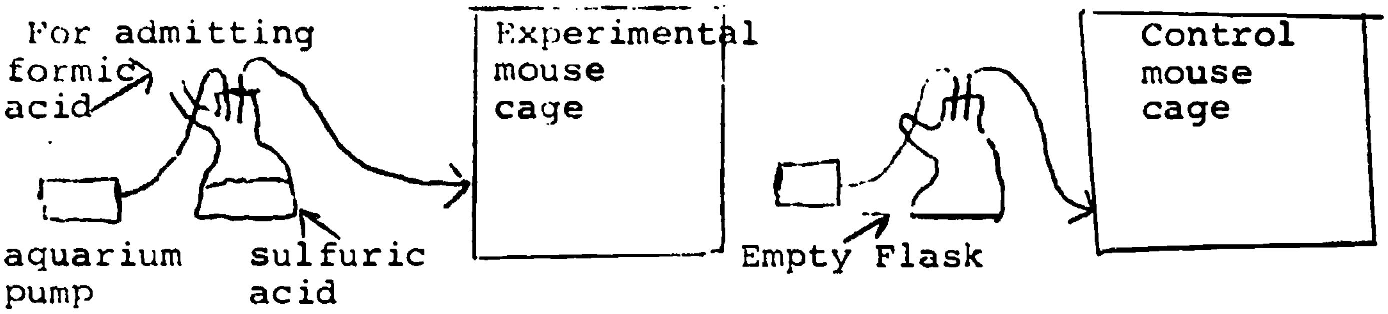
3 D. This experiment is not written in any text, below is how it might be set up and some of the possible conclusions that might be drawn.

THE EFFECT OF CARBON MONOXIDE ON THE ACTIVITY OF MICE

Equipment: four mice
two containers which will sustain a closed atmosphere
quantities of sulfuric acid concentrated
quantities of formic acid concentrated
two gas introduction apparatus as drawn on page 36

Procedures: The cages which must be air tight are to be set up as shown in the diagram. Two mice are to be placed into each cage, one cage serving as a control for the other, 5ml of formic acid should.

be introduced into the flask containing the sulfuric acid, the quantity is not important. When bubbling ceases, add another 5ml, and a 3rd 5ml may be needed to be added. In this way the amount of carbon monoxide produced can controlled. The student can then observe the activity of mice in the control chamber and those in the experimental chamber.



It was not the idea to hand the student a copy of a written experiment. This is to be a chance for the student to use his own thoughts in order that he might arrive at a workable experiment to show the effect of carbon monoxide on mice. You are to serve as a source of background and helpful hints.

E. The video-tape "Auto Air Smog Relationship" by Chrysler's Don Lofftus will be available along with this unit. The Data Sheet 2 accompanying the activity will enable the student to review specifically the carbon monoxide portion of the tape. You will need to provide each student with a copy of the Data Sheet.

F. This experiment shows the effects of carbon monoxide on various materials. It also allows the student the chance to measure actual amounts of carbon monoxide produced by different sources.

4 Concept III Required Activities:

A. Here again is a simple reading activity. It explains the production of hydrocarbons and their effects upon the growth of plants.

B. This is a continuation of Activity A. It covers basically the same questions except they are now related to the production of hydrocarbons and their effect on the growth of plants.

C. This Data Sheet deals with the readings. It is to provide the student with a review of the material he has read.

D. The film-loop is the same one used in Packet 2. The effects of air pollution on plants and animals. It also applies very directly to the concepts in this packet.

5 Concept IV Required Activities:

A. Another reading activity, this selection deals with the production of nitrogen dioxide and its effects upon the health of man. The students will complete activities A, B and C and either D, E or F. You will need to supply a copy of Data Sheet 4 for each student.

B. The final portion of Data Sheet 1. Here we are dealing with nitrogen dioxide production and questioning the effect of its increase in our atmosphere on the repiratory problems of man.

C. This question deals with the production of nitrogen dioxide. It is deficient in that it does not relate to the effects to man's health.

D. Data Sheet 4 is composed of fabricated data to allow the student to place himself in a position such that he must explain the problem of nitrogen to the public. His main point should be that if the air standards are not improved the number of respiratory problems will increase out of proportion.

E. This activity deals with the effect of nitrogen dioxide on many plants and flowers. It is more of an enlightenment type activity than an activity to teach the concept.

F. This experiment deals with the measuring of the amounts of nitrogen dioxide produced by certain sources. It is stright forward as are all the experiments taken from ENVIRONMENTAL POLLUTION.

At this time administer the post-test.

ENVIRONMENTAL ECOLOGICAL EDUCATION PROJECT

Parkway School District
Checterfield, Missouri

DR. WAYNE FICK, Superintendent

VERLIN M. ABBOTT, Project Director

Unit: Air Pollution: Packet III

BY:
Robert Goode
Wayne Mosher
Tom Pollmann

The work presented or reported herein was preformed pursuant to a Title III ESEA Grant administered by the Missouri State Department of Education.

SETTING

We hear much today about the "Air Pollution Problem" and almost everyone will admit we have serious problems concerning dirty air. These problems have solutions but before we can talk about possible solutions we must know the causes of air pollution. For any solution to be effective it must relate directly to the causes of the problem.

This set of packets (2,3,4) deal, with the cources and causes of our primary pollutants. You will be looking at two major sources of pollution, aumtomobiles and industry, along with other contributing factors, inorder that you will have a better understanding of what is causing our air pollution problem.

CONCEPTS: PACKET 3

I. Man's increasing dependence upon the auto has produced an increase of carbon monoxide, nitrogen dioxide, and hydrocarbons in our atmosphere.

II. Incomplete combustion in the auto engine results in the production of carbon monoxide which effects the health of man.

III. Hydrocarbons emitted in auto exhaust affect the growth of plants.

IV. Nitrogen dioxide, emitted in auto exhaust, contributes to man's respiratory problems.

Concepts	BEHAVIORAL OBJECTIVES
I	1. Upon completion of this packet the student will list and describe, in a few sentences, three ways that man's increasing dependence upon the auto has resulted in an increase in certain air pollutants.
II	2. After completing the prescribed activity the student will state in a sentence how carbon monoxide results from incomplete combustion in the auto engine.
II	3. Given a list of effects on man's health the student will choose the primary effect of carbon monoxide on man's health.
III	4. The student will select the main effect of hydrocarbons, resulting from auto exhaust, on the growth of plants when given a list of effects on plant growth.
IV	5. When presented with a list of man's health problems, the student will select the respiratory problems that are aggravated by the increase of nitrogen dioxide in the air we breath.

At this time take the pre-test.
Obtaine a copy from your teacher.

ACTIVITIES

Behavioral Objective Number	
	Concept I Required Activities:

1 A. You will complete A, B, and either C, D, or E.

a. A class seminar on how man's dependence upon the automobile has lead to an increase in air pollution. After the discussion you will write a summary of the main ideas brought forth in the seminar.

b. Answer the following question in a paragraph: "Are automobile an economic necessity in North America, knowing that the usage of the automobile increases Air Pollution."

c. Chart a comparison of the number of auto's/person and how they were used in the post-war 1940's versus the number of autos's/person and how they were used in the early 1970's.

d. Prepare a questionaire and graph the results for at least five families, indicating data on the type of use and the frequency of use different family members make of the automobile.

e. Question 1, Case Study 8.5 in Environmental Pollution.

Concept II Required Activities:

To obtain a greater understand of Concept II you will do A and B, and either C, D, or F.

2&3 A. A foundation for Concept II and be obtained by reading pp 23-27 in Air Pollution Primer, pp 96-100 and pp 113-115 in Environmental Pollution. Then complete questions one and two on pp 115-116 of Environmental Pollution. Related readings which are recommened are listed below.

Air Pollution Primer p 38
A Citizens Guide to Clean Air pp 83-84
Progress and the Environment pp 84-85

B. Part one of Data Sheet 1.

C. Question 3, Case study 8.6 in Environmental Pollution.

D. Set up an experiment to show the effect of varing amounts of carbon monoxide on the activity and respiration of mice. (The instructor's approval is required for this experiment.)

E. Complete Data Sheet two after viewing the video-tape; "Auto Air Smog Relationship" by Chrysler's Don Lofftus.

F. The carbon monoxide portion of Field Study 7.6 in Environmental Pollution.

Concept III Required Activities:

4 A. The following readings will provide you with the background for Concept III. In these readings you should look for the effects of hydrocarbons on plant growth.

Environmental Pollution pp 124-126
A Citizens Guide to Clean Air p 86
Air Pollution Primer pp 39-40 and p 82
"From Ethylene"

Completion of the following activities will provide an indepth look at Concept III.

B. Part two data sheet one

C. Data Sheet Three

D. A review of the film-loop; "The Effects of Ethylene Gas on the Growth of Bean Seedlings".

Concept IV Required Activities:

5 A. To obtain a working knowledge of Concept IV, read pp 119-122 in Environmental Pollution and p 41 and pp 55-74 in Air Pollution Primer. Keep in mind that nitrogen dioxides are accused of being a cause of respiratory health problems. Reading the prescribed selections provides only a basic background in to the air pollutant nitrogen dioxide. To further your knowledge of Concept IV you will complete B and C, and either D, E, or F.

B. Part three of Data Sheet One.

C. Question 4, Case Study 8.6 in Environmental Pollution.

D. Data Sheet Four

E. In Eduquip Air Pollution Study Program Manual: Experiment 1 B, Chapter 4; "The Effect of NO_2 on Various Plants and Flowers."

F. The nitrogen dioxide portion of Field Study 7.6 in Environmental Pollution.

At this time take the post test.
Obtain a copy from your teacher.

DATA SHEET 1

The automobile produces on the average 64 lbs. of carbon monoxide, 600 lbs. of hydrocarbons, and 400 lbs. as it combusts a gallon of gasoline. Use the above knowledge and your own resources to answer the following questions.

Part one:

1. How much carbon monoxide does your family car produce per mile?

2. Monitor your family car for four weeks. Graph the amounts of carbon monoxide per gallon produced each week. If you have more than one car in your family, monitor these also and compare the resulting graphs.

3. If we make the assumption that carbon monoxide molecules are cubic in shape. At room temperature and pressure we can assume that 64 lbs. of carbon monoxide will occupy 31.4 cubic inches. If your family car was idling at 20 mph, how long would it take to fill your living room with carbon monoxide?

4. How would increasing the amount of oxygen supplied to the carborator decrease the above amounts of carbon monoxide?

Part two:

1. How much hydrocarbons does your family car produce per mile?

2. Monitor your family car for four weeks. Graph the amounts of hydrocarbons per gallon produced each week. If you have more than one family car, monitor these also and compare the graphs.

3. Why might some auto's produce more hydrocarbons than others? How can you tell when an auto is producing hydrocarbons?

4. How do you think the plants and trees in your area would be effected if the number of autos kept increasing and there were fewer pollution control standards.

Part three:

1. How much nitrogen dioxide does your family car produce per mile?

2. Monitor your family car for four weeks. Graph the amounts of nitrogen dioxide produced each week. If

you have more than one family car, monitor these also and compare the graphs.

3. In the area you live do you see any effects of nitrogen dioxide on the respiratory problems of the people living around you? Why or why not?

DATA SHEET 2

Don Lofftus is a representative of Chrysler. After viewing his presentation write a summary on how carbon monoxide is produced by the auto engine and the effects on man's health by carbon monoxide.

DATA SHEET 3

The following questions, to be completed after your readings, will further clarify Concept IV.

1. What is the major source of hydrocarbons in the United States? ________________. Approximately how many tons/year come from this source? ______________.

2. What are the two major components of a hydrocarbon?

   A.____________________ B. ________________________

3. List three effects of ethylene on the growth of bean seedlings.

   A. ____

   B. ____

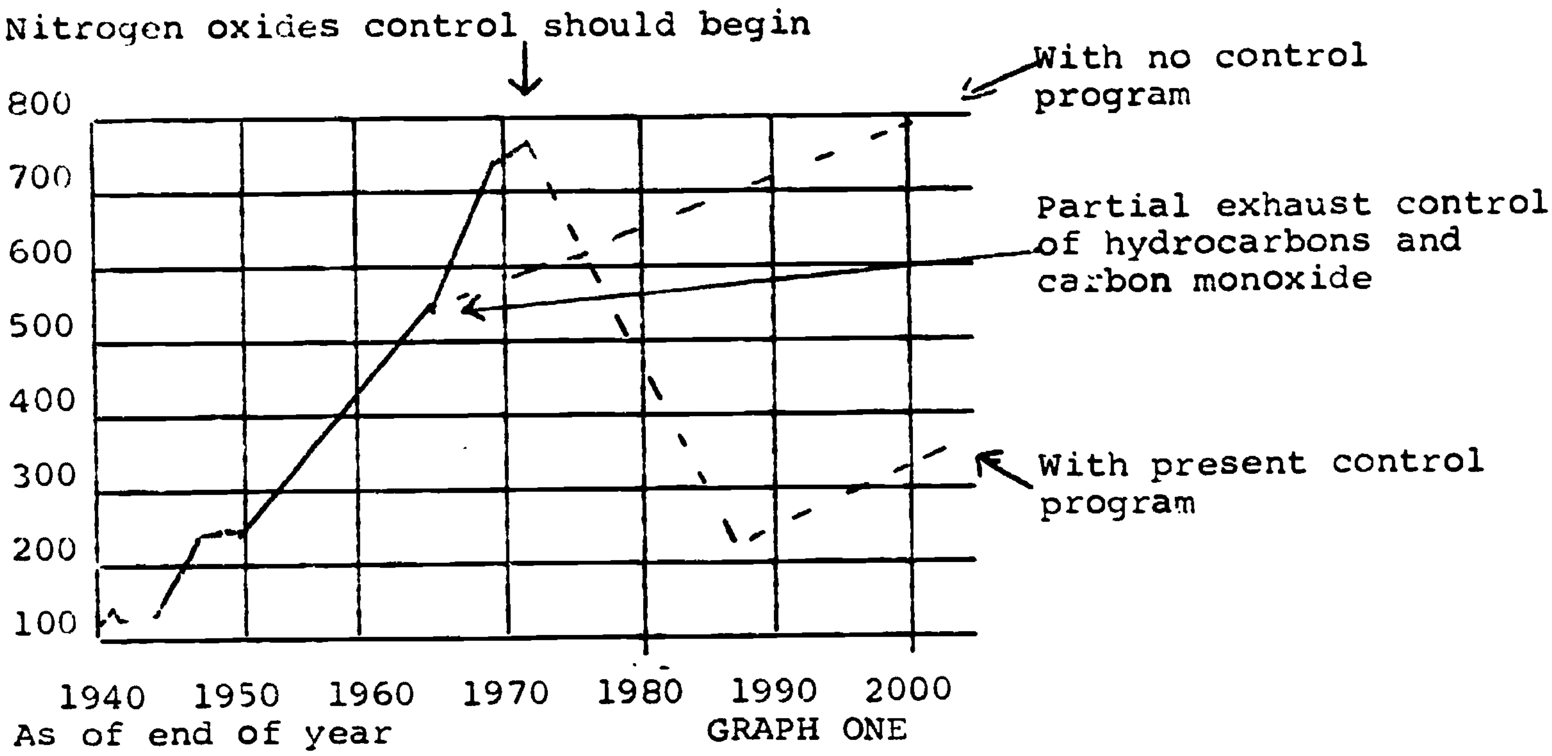
   C. ____

4. What is meant by CARCENOGENIC. ____________________

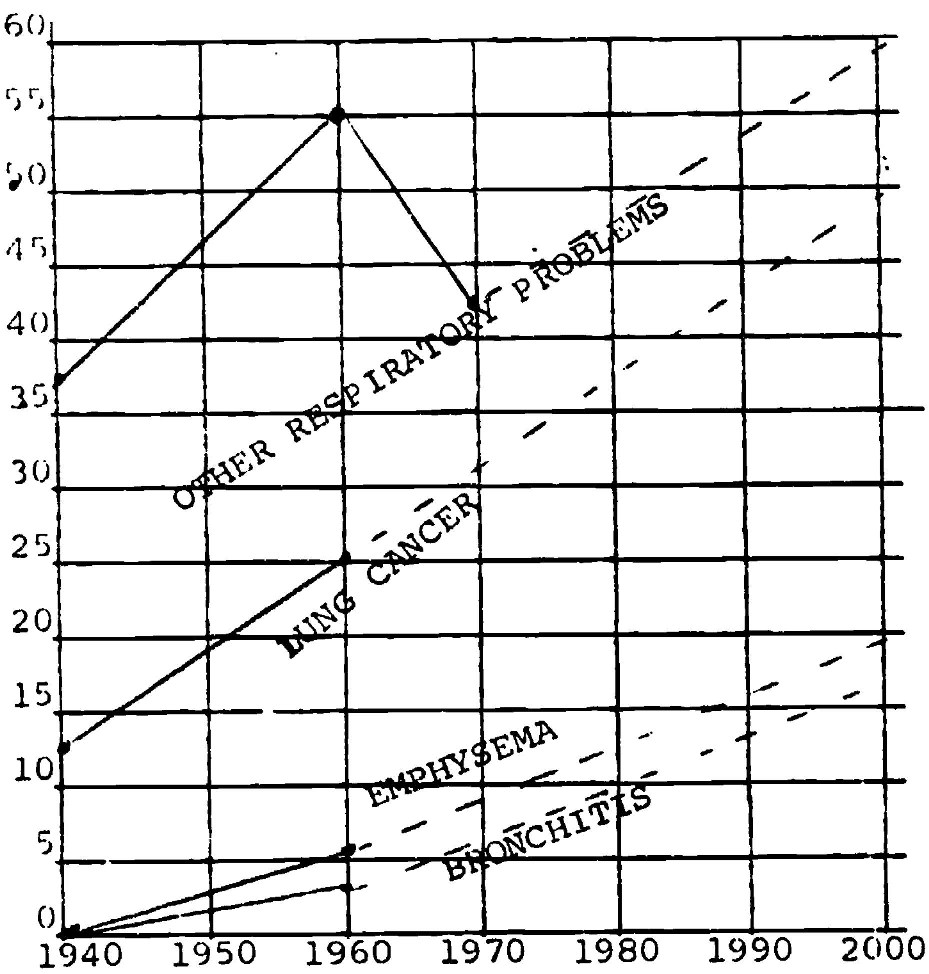
   ____

DATA SHEET 4

As health director of the Los Angeles area, you are often called upon to make press releases on the health of the people of this area. The EPA has recently requested that you, using the data from graph one, make known to the public the relationship between this data and any increase in the respiratory problems of the people in the Los Angeles area. In your files you find graph two, what whould you tell the people in this area about the relationship seen in these graphs about respiratory problems, and the effect of an increase of nitrogen dioxide in their air.



GRAPH ONE



As of the end of the year GRAPH TWO

Projections through 2000, are based on the idea that our Air will be cleaner and that general trends of smokers continue

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CONCEPTS: PACKET 4

I. Many industries, that use coal as a fuel, are major sources of the air pollutant, sulfur dioxide.

II. Sulfur dioxide leads to the formation of sulfuric acid, which is corrosive to objects in the surrounding community.

III. Thermal inversions along with topographical features, such as valleys and basins, contribute to air pollution episodes.

IV. The interaction of sunlight with certain air pollutants results in the formation of photochemical smog.

Concepts	BEHAVIORAL OBJECTIVES
I	1. After completing a map of the St. Louis area, upon which the major sources of sulfur dioxide and particulate matter are located, the student will correctly select from a list of industries, those that are major sources of sulfur dioxide.
II	2. Upon completion of the prescribed activities, the student will write a sentence describing how sulfur dioxide leads to the formation of sulfuric acid.
II	3. Given a list of corrosive effects on certain objects, the student will correctly select the corrosive effect of sulfuric acid, formed from sulfur dioxide, upon objects in the community.
III	4. Given a diagram of a valley, the student will draw and label those conditions which will result in an air pollution episode.
III	5. The student will correctly select factors that influence an air pollution episode, given a list of possible factors.
IV	6. After completing the assigned activities the student will complete a sentence describing how photochemical smog is formed.
IV	7. Given a list of air pollutants, the student will correctly identify two that are formed by a photochemical reaction.

At this time administer the pre-test.

PRE-POST TEST
PACKET 4

Behavioral Objective Number

1 1. Many industries are major sources of the air pollutant, sulfur dioxide. Correctly circle the industries below which are major sources of sulfur dioxide.

A. Concrete Plants

B. Power Plants

C. Sulfuric Acid Plants

D. Iron Foundries

2 2. In the space provided, describe in a sentence how sulfur dioxide leads to the formation of sulfuric acid.

____

____

____

3 3. Sulfuric acid is a corrosive agent. Correctly circle the following corrosive effects which are a result of the formation of sulfuric acid from sulfur dioxide in our air and which effect objects in the community.

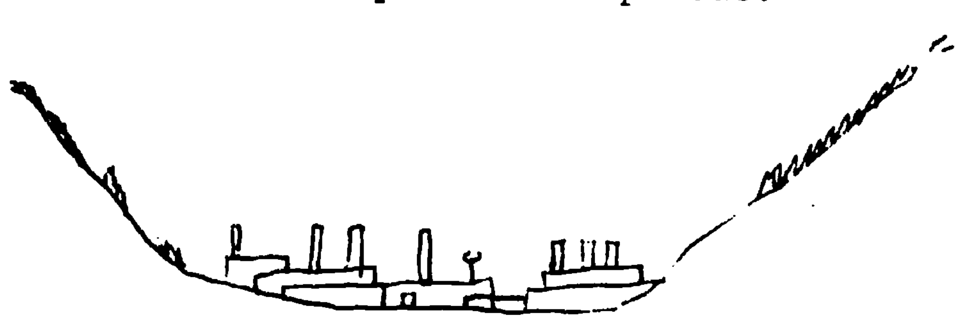
A. Discoloration of plants and other materials.

B. Etching of steel girders on bridges.

C. Dissolving of marble statues.

D. Eating away of paint on automobiles and houses.

4 4. Below is a diagram of a valley. Draw in and label those conditions which are necessary for an air pollution episode.



5 5. Many factors influence an air pollution episode. Correctly circle the following factors that contribute to an air pollution episode.

A. A warm air mass forming above a cold air mass

B. Steady accumulation of air contaminants

C. Normal air circulation

D. Moisture in the air

6 6. Photochemical smog results from the interaction of ________________ and ___________________________.

7 7. Correctly circle two of the following air pollutants that are formed photochemically.

A. Nitric oxides

B. Ozone

C. Pan (peroxyacetyl nitrate)

D. Sulfur dioxide

PRE-POST TEST ANSWER KEY
PACKET 4

Behavioral Objective Number		
1	1.	Many industries are major sources of the air pollutant, sulfur dioxide. Correctly circle the industries below which are major sources of sulfur dioxide.

A. Concrete Plants

B. Power Plants

C. Sulfuric Acid Plants

D. Iron Foundries

2	2.	In the space provided, describe in a sentence how sulfur dioxide leads to the formation of sulfuric acid.

Sulfuric acid is formed as a result of sulfur dioxide reacting with water vapor in the atmosphere.

3	3.	Sulfuric acid is a corrosive agent. Correctly circle the following corrosive effects which are a result of the formation of sulfuric acid from sulfur dioxide in our air and which effect objects in the community.

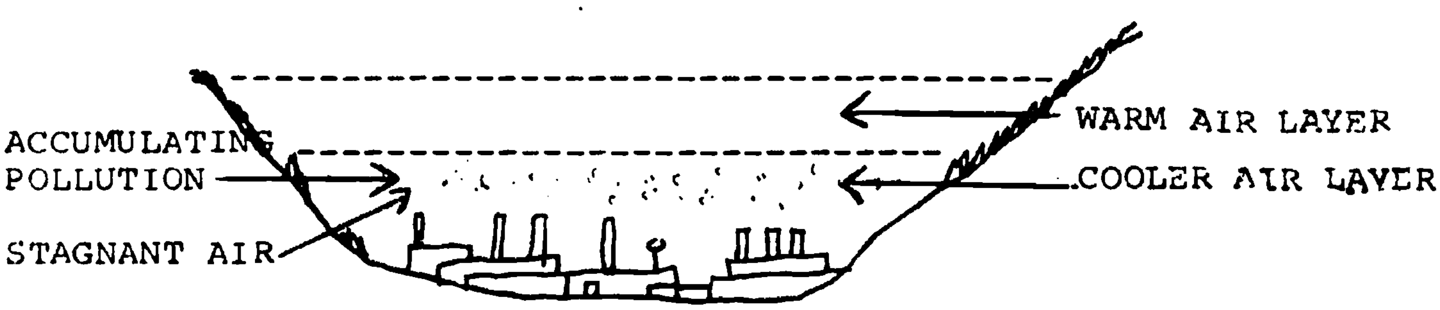
A. Discoloration of plants and other materials.

B. Etching of steel girders on bridges.

C. Dissolving of marble statues.

D. Eating away of paint on automobiles and houses.

4	4.	Below is a diagram of a valley. Draw in and label those conditions which are necessary for an air pollution episode.



5 5. Many factors influence an air pollution episode. Correctly circle the following factors that contribute to an air pollution episode.

A. A warm air mass forming above a cold air mass

B. Steady accumulation of air contaminants

C. Normal air circulation

D. Moisture in the air

6 6. Photochemical smog results from the interaction of sunlight and pollutants or nitrogen dioxide.

7 7. Correctly circle two of the following air pollutants that are formed photochemically.

A. Nitric oxides

B. Ozone

C. Pan (peroxyacetyl nitrate)

D. Sulfur dioxide

BACKGROUND INFORMATION
PACKET 4

"The Relationship of Weather and Air Pollution" may be misleading. The packet is a potpourri of the main industrial pollutant sulfur dioxide, and what is referred as contributing factors. The contributing factors being thermal inversion and photochemical smog.

Sulfur dioxide comes mainly from industries which use fossile fuels, such as coal, containing sulfur as an energy source. When combusted, the sulfur is converted to sulfur dioxide, a colorless gas, with a sharp choking odor. The odor is not to be confused with the odor of hydrogen sulfide, rotten eggs. Sulfur dioxide consitutes approximately 18% of the total accumulation of air pollutants. It is produced mainly by copper smelters, steel mills, oil refineries, paper mills, sulfuric acid plants, and non-nucleur power plants.

Sulfur dioxide by itself is irritating to the upper respiratory tract of man; however, the main problem with sulfur dioxide as an air pollutant stems from the reaction of sulfur dioxide with water vapor in the air to form sulfuric acid. The resultant sulfuric acid, the same acid used in auto batteries, is very corrosive to; metals, paints, skin and most other materials.

Thermal inversions and photochemical smog are not causes, they are more results or factors that contribute to the pollution of our air. Briefly, thermal inversions are episodes in which air pollutants accumulate in a layer of cold air near the surface of the earth, trapped by stagmant air circulation and a lid of warmer air. These episodes are explained in greater depth in the reading selections.

Photochemical smog can be thought of as an air pollutant; however, it is not spewed from any industrial smoke stack or expelled from any auto exhaust pipe. Rather, it is formed from the interaction of air pollutants already in our air, and sunlight to form a new type of air pollution. The reaction is complicated but can be explained easily via an example. Ozone is produced in a reaction of nitrogen dioxide and sunlight. Nitrogen dioxide produced by various sources is expelled into the atmosphere. Sunlight, radiant energy, reacts with the nitrogen dioxide to produce nitrous oxide and an energetic oxygen as shown in the following equation:

$$NO_2 + \text{sunlight} = NO + O^*$$

The oxygen with extra energy reacts with atmosphereic oxygen (O_2) to form ozone (O_3). Ozone is very reactive, having a very corrosive effect on many materials. In a similar manner other photochemical reactions occur producing very noxious air contaminants.

This is very elementary foundation upon which this packet is based. It is again urged that you take time to read further into the subject of the causation of air pollution.

INSTRUCTIONAL SEQUENCE
PACKET 4

Behavioral Objective Number	
	Concept I Required Activities:
1	A. This activity is integrated into all three portions of the unit on air polluters The map the student will complete will be of the St. Louis area. It will be facilitated by the field trip the students take in Packet 2 of the problems section. Once the pollutors are labeled, which is the heart of this activity, the student will use this map in the solution section to map air sampling sites. He will then be asked to make a correlation between where these sites are and where the polluters are located. You will need to provide each student with a copy of Data Sheet 1.
	B. Mr. Mullins from Monsanto in the presentation "Industrial Environmental Pollution", discusses some of the industrial pollutants and how they are dealt with. The student is asked to compile a list of these industries and their pollutants in order that he may better grasp where the pollutants originate from in the St. Louis Area.
	Concept II Required Activities:
2&3	A. A reading activity which will cover the producers of sulfur dioxide and how the formation of sulfuric acid from it are corrosive to the surrounding community.
2	B. A review of the readings is obtained by the student as he composes a paragraph on how sulfuric acid is formed by the reaction of sulfur dicxide and water vapor in the air.

The student will complete two of the following activities.

2&3	C. This experiment from the Eduquip text, enables the student to see the effects of sulfur dioxide upon plants and flowers. It is explained clearly in the text.
	D. This question will give the student a feel for how much sulfur dioxide is produced as compared to the total accumulation of air pollutants. It also shows the major source of sulfur dioxide and how we might change the quantity of this

pollutant expelled into our atmosphere.

E. The answers to the questions complete the objectives. The readings are the source of the answer, although they must transfer this to a community situtation.

F. This activity deals with the measuring of sulfur dioxide in our air and comparing several different samplings in the area.

G. This activity includes the quantitive measurement of sulfur dioxide in the air we breathe. Here again samples may be gathered from the surrounding area and the measurements compared.

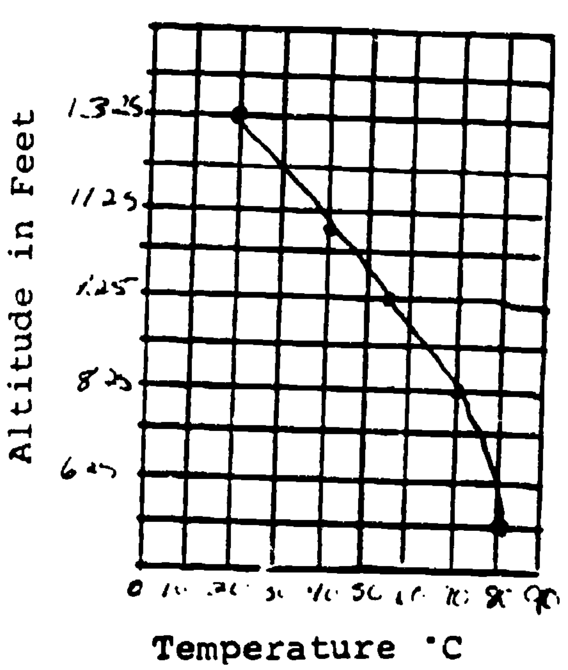
Concept III Required Activities:

4&5 A. A reading activity which will explain what a thermal inversion is and the factors that lead up to a thermal inversion episode.

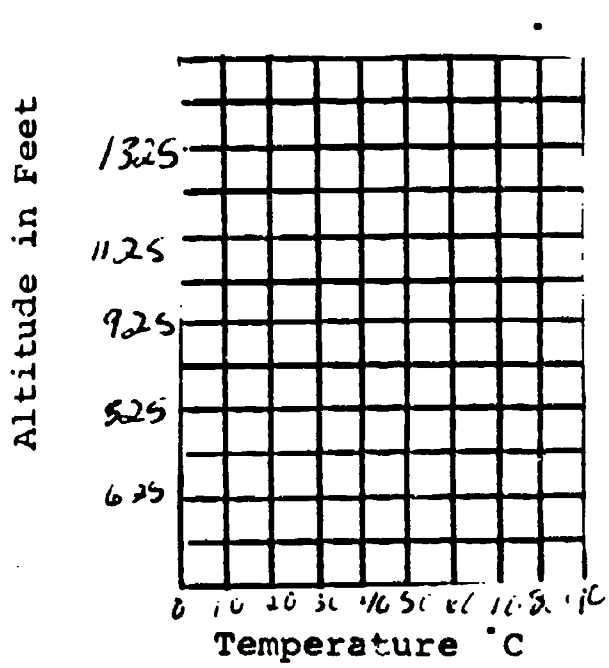
B. The film-loop "The Thermal Inversion" available with this unit shows how a thermal inversion occurs. The accompanying cassette explains the principles involved and how they lead to a thermal inversion.

C. The graphs of the data will look like the graphs below. The student should be able to choose Data B as that representative of a thermal inversion. His reasoning should be based on the fact that there is a warm air layer over a cooler air mass.

Data A



Data B



D. The demonstration of a thermal inversion as in this activity is very similar to the one on the film-loop. The only difference is the fact that this experiment is much easier to perform than the one in activity B.

E. This activity asks the student to pool his knowledge of the factors that cause a thermal inversion and correlate it with information about the St. Louis area; its topography, air currents, and the quantity of air pollutants produced.

F. Another experiment similar to Activicy D which enables the student to produce conditions necessary for a mock thermal inversion.

Concept IV Required Activities:

6&7 A. The readings here will give the student a good idea of how photochemical smog is produced and some examples of constitnent of it. You will need to give each student a copy of Data Sheet 2. Each student will complete activity A and B plus two of the following activities C, D, E, F and G.

B. This activity involves a data sheet which relates to the readings in activity A.

C,D,E. These activities are all experiments out of the Eduquip text. They deal with the generation of photochemical smog and its effect upon various materials.

F. This is a reading activity with a review in the form of a paragraph describing the production of photochemical smog.

G. The question deals with the fact that photochemical smog is formed in an interact of pollutants and sunlight. The diagram will help them grasp the whole picture of the factors involved in a thermal inversion.

At this time administer the post-test.

ENVIRONMENTAL ECOLOGICAL EDUCATION PROJECT

Parkway School District
Checterfield, Missouri

DR. WAYNE FICK, Superintendent

VERLIN M. ABBOTT, Project Director

Unit: Air Pollution: Packet IV

BY:
Robert Goode
Wayne Mosher
Tom Pollmann

The work presented or reported herein was preformed pursuant to a Title III ESEA Grant administered by the Missouri State Department of Education.

CONCEPTS: PACKET 4

I. Many industries, that use coal as a fuel, are major sources of the air pollutant, sulfur dioxide.

II. Sulfur dioxide leads to the formation of sulfuric acid, which is corrosvie to objects in the surrounding community.

III. Thermal inversions along with topographical features, such as valleys and basins, contribute to air pollution episodes.

IV. The interaction of sunlight with certain air pollutants results in the formation of photochemical smog.

Concepts		BEHAVIORAL OBJECTIVES
I	1.	After completing a map of the St. Louis area, upon which the major sources of sulfur dioxide and particulate matter are located, the student will correctly select from a list of industries, those that are major sources of sulfur dioxide.
II	2.	Upon completion of the prescribed activities, the student will write a sentence describing how sulfur dioxide leads to the formation of sulfuric acid.
II	3.	Given a list of corrosive effects on certain objects, the student will correctly select the corrosive effect of sulfuric acid, formed from sulfur dioxide, upon objects in the community.
III	4.	Given a diagram of a valley, the student will draw and label those conditions which will result in an air pollution episode.
III	5.	The student will correctly select factors that influence an air pollution episode, given a list of possible factors.
IV	6.	After completing the assigned activities the student will complete a sentence describing how photochemical smog is formed.
IV	7.	Given a list of air pollutants, the student will correctly identify two that are formed by a photochemical reaction.

At this time take the pre-test.
Obtain a copy from your teacher.

ACTIVITIES

Behavioral Objective Number	
	Concept I Required Activities:
1	A. Assume the EPA has recently employed you as director of clean air in the St. Louis area. You are an ardent employee and wish to strictly enforce the air standards for sulfur dioxide and particulate matter. What industries in the St.Louis Area would you suspect of emitting large quantaties of sulfur dioxide and particulate matter? Locate these areas on the copy of a map of St. Louis that is provided, Data Sheet 1. How might you prove that these industries are emitting sulfur dioxide? (Note: Data collected on the field trip in Packet One might help solve this question.)
1	B. After viewing the video-tape; "Industrial Environmental Pollution" by Mr. Mullins of Monsanto. Compile a list of the industries he mentioned and their pollutants.
	Concept II Required Activities:
2&3	A. Reading the following selections will provide a background for Concept II. Environmental Pollution pp 106-108 and 111-112 Air Pollution Primer pp 36-37 and p 80 Progress and the Environment pp 85-87
2	B. From the readings, compose a paragraph describing how sulfuric acid is formed from sulfur dioxide in the air.
2&3	You will complete two of the following:
	C. Experiment 1 A, chapter 4: "The Effect of SO_2 on Various Materials" in Eduquip Study Manual.
	D. Question number 2, Case Study 8.6 in Environmental Pollution.
	E. Answer the following questions in a paragraph: What type of fuel is used by the power plant which supplies your community? What is the average sulfur content of this fuel? What economic factors contribute to the choice of this fuel? What effects to the surroundings are apparent as a result of the production of sulfur dioxide?

F. The sulfur dioxide portion of Field Study 7.6 in Environmental Pollution.

G. Field Study 7.8, "Sulfur Dioxide in the Air" in Environmental Pollution.

Concept III Required Activities:

4&5 A. Relating to Concept III, you will read pp 134-138 in Environmental Pollution and pp 12-18 in Air Pollution Primer.

To provide you with a stronger foundation for Concept III, you will complete B and C, and D, E, or F.

B. After viewing the film-loop; "The Thermal Inversion", you will draw a diagram of a valley explaining the principles brought forth in the film-loop.

C. Graph Data A and Data B on two seperate graphs. Choose the graph that represents a thermal inversion and explain why it depicts a thermal inversion.

DATA A

Altitude	Temperature
625 Ft	80 C
825 Ft	70 C
925 Ft	55 C
1125 Ft	40 C
1325 Ft	30 C

DATA B

Altitude	Temperature
625 Ft	80 C
825 Ft	70 C
875 Ft	65 C
925 Ft	72 C
1125 Ft	40 C

D. Field study 7.10; "Demonstration of a Temperature Inversion" in Environmental Pollution.

E. Answer the following question in paragraph form. Could a thermal inversion episode ever threaten the citizens in the St. Louis Area? If so, what factors would contribute to such an episode?

F. Experiment number 1, chapter 3; "Temperature Inversion" in Eduquip Study Manual.

Concept IV Required Activities:

6&7 A. The following readings will provide you with the background for Concept IV. Read pp 127-128 and pp 139-143 in Environmental Pollution, and pp 28-29 and pp 42-44 in Air Pollution Primer.

B. Complete Data Sheet 2, which relates to the above readings and also complete two of the following:

1. Experiment 7, Chapter 2; "Ozone" in Eduquip Study Manual.

2. Experiment 1, Chapter 4; "The Generation of Photochemical Smog" in Eduquip Study Manual.

3. Experiment 1c, Chapter 4; "The effects of Ozone on Various Materials" in Eduquip Study Manual.

4. Read pp 85-86 in A Citizen Guide to Clean Air and pp 87-88 in Progress and Environment and write a paragraph describing how photochemical smog is formed and the main constitutent of photochemical smog.

5. Answer the following questions: Can you hypothesize why most photochemical smog problems occur in the afternoon? Explain the production of photochemical smog by constructing a diagram. Label the necessary items for smog production.

At this time take the post test.
Obtain a copy from your teacher.

Map of St. Louis and St. Louis County upon which may be located industries from activity one A.

DATA SHEET 2

Answer the following questions:

1. Is ozone naturally produced? If so what purpose does it serve?

____

____

____

____

____

____

2. Emission of ______________ from auto causes production of adnormal amounts of Ozone in our lower atmosphere.

3. The term photochemical smog refers to the interaction of __________________ and _________________ to produce __________________.

4. List in the space provided four photochemical constitutants of smog.

   A. ________________________________

   B. ________________________________

   C. ________________________________

   D. ________________________________

STUDENT BIBLIOGRAPHY

A Citizens Guide To Clean Air, The Conservation Foundation, Washington D. C., 1972.

Air Pollution Experiments For Junior And Senior High School Science Classes, Hunter and Wohler, Air Pollution Control Association, 1967.

AIR POLLUTION PRIMER, National Tuberculosis and Respiratory Disease Association, New York, 1969.

Environmental Pollution, Andrews, Moore, and LeRoy, Prentice-Hall Inc., New Jersey, 1972.

Eduquip Air Pollution Study Program Manual, Gordon, Francis Associates, Cambrige Mass., 1971.

Progress And The Environment, Shaver, Larkin, and Anctil, Houghton Mifflin Co., Boston, 1973.

CONCEPTS: PACKET 5

I. The 1970 Clean Air Act, which is sometimes referred to as the 1970 amendments to the 1967 Air Quality Act, has set limits for sulfur oxides, particulates, carbon monoxide, photochemical oxidants, hydrocarbons and nitrogen oxides.

II. The automobile industry is having technological and economic problems meeting the air pollution standards set in the 1970 law.

III. If the present laws prove inadequate, future legislation will be needed to reduce air pollution.

Concepts	BEHAVIORAL OBJECTIVES
I	1. After completing the assigned activities, the student will list the six major pollutants regulated by the 1970 Clean Air Act.
I	2. After completing the assigned readings the student will participate verbally at least three separate times in a group discussion of 40 to 50 minutes on the 1970 Clean Air Act. Then, after completing the group discussion, the student will correctly select from a list the major components of the 1970 Clean Air Act.
II	3. After completing the packet and listening to the video-tape speaker representing Chrysler, the student will correctly select from a list, two problems of the automotive industry in meeting the limits on emissions set by the 1970 law.
II	4. Given a list of proposals, the student will correctly select the proposal given by the automotive industry, specifically Chrysler Corporation, as an alternative to the present standards to be met by 1976.
III	5. After completing the packet, the student will list, in one sentence each, two reasons why future legislation might be needed to reduce air pollution.

At this time administer the pre-test.

PRE-POST TEST
PACKET 5

Behavioral Objective Number	
1	1. The 1970 Clean Air Act regulates the emissions of six major air pollutants. In the space provided below, please list the six pollutants.

1. ____________________

2. ____________________

3. ____________________

4. ____________________

5. ____________________

6. ____________________

2 2. Select from the list below, some major provisions of the 1970 Clean Air Act. Circle the appropriate letter.

A. The law will emphasize local rather than national ambient air quality standards

B. The law requires monitoring of pollution emissions and public access to the records.

C. The law has set deadlines for controlling major emissions for motor vehicles.

D. The nation has been divided into 25 air quality control regions.

E. All of the above

F. Both B and C

G. Both B, C and D

3 3. The automotive industry faces which of the following problems in meeting the limits on emissions set by the 1970 law. Circle the appropriate letter(s).

A. In meeting the emission standards the automobile companies are developing engine systems which consume greater quantities of gasoline; thereby contributing to the energy crisis.

B. The cost of the anti-pollution devices necessary to meet the standards, is in the opinion of the automobile industry, wasteful, unnecessary and unrealistic.

C. The industry lacks the technological ability to manufacture any of the emission control devices.

D. The standards established in 1970 requires a new engine instead of the internal combustion engine. However, the type of engine was left to the industry.

E. All of the above.

4 4. Chrysler Corporation has proposed an alternative to the 1970 standards. Circle the correct proposal from the list below.

A. Reduce the federal standards by 50 percent, a "more realistic level."

B. Suspend permanently the federal standards and allow the states to establish their own standards based on need.

C. Congress should suspend the 1975-76 standards, and allow the EPA to establish new standards based on need, cost and feasibility.

D. The Supreme Court should rule the 1970 Clean Air Act unconstitutional because the automobile industry was denied due process of law.

5 5. In the space provided below, list two reasons in one sentence each, why future legislation might be needed to reduce air pollution.

A. ____

____

B. ____

____

PRE-POST TEST ANSWER KEY
PACKET 5

Behavioral
Objective
Number

1 — 1. The 1970 Clean Air Act regulates the emissions of six major air pollutants. In the space provided below, please list the six pollutants.

1. Particulate
2. Sulfur Oxides
3. Carbon Monoxide
4. Photochemical Oxidants
5. Hydrocarbons
6. Nitrogen Oxides

2 — 2. Select from the list below, some major provisions of the 1970 Clean Air Act. Circle the appropriate letter.

A. The law will emphasize local rather than national ambient air quality standards

B. The law requires monitoring of pollution emissions and public access to the records.

C. The law has set deadlines for controlling major emissions for motor vehicles.

D. The nation has been divided into 25 air quality control regions.

E. All of the above

F. Both B and C

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3 — 3. The automotive industry faces which of the following problems in meeting the limits on emissions set by the 1970 law. Circle the appropriate letter(s).

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C. The industry lacks the technological ability to manufacture any of the emission control devices.

D. The standards established in 1970 requires a new engine instead of the internal combustion engine. However, the type of engine was left to the industry.

E. All of the above.

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A. Reduce the federal standards by 50 percent, a "more realistic level."

B. Suspend permanently the federal standards and allow the states to establish their own standards based on need.

C. Congress should suspend the 1975-76 standards, and allow the EPA to establish new standards based on need, cost and feasibility.

D. The Supreme Court should rule the 1970 Clean Air Act unconstitutional because the automobile industry was denied due process of law.

5 5. In the space provided below, list two reasons in one sentence each, why future legislation might be needed to reduce air pollution.

NOTE: The four most likely correct responses are:

A. An increasing reliance upon the automobile

B. An increasing number of automobiles

C. A greater concentration of auto traffic in urban areas

D. Present standards might prove to be inadequate

BACKGROUND INFORMATION
PACKET 5

Some two and a half years have passed since Congress enacted and the President signed the Clean Air Act of 1970, setting in motion a vigorous attack on air pollution in the U. S. The act has been called the single most important piece of environmental legislation ever passed by Congress. That statement is debatable. However, the law does have far reaching effects.

What follows is a condensation of the major components of the 1970 Clean Air Act. (Hereafter referred to as "the act."

1. The act established Air Quality Control Regions. These are the geographic units in which the control processes take place. The country has been divided into about 250 regions. Regional boundaries are based on such factors as urbanization, topography, climate and special factors affecting the air quality conditions for a given area.

2. The act established National Ambient Air Quality Standards. These standards are maximum levels permitted for air pollutants. The important item to understand with respect to air standards is the fact that there are two kinds of standards; primary and secondary. Primary standards are designed to protect public health while secondary standards are designed to protect public welfare.

3. One of the important aspects of the act was the Implementation Plans. By now, all of the regions have established an implementation plan.

4. The act has set deadlines for automobile emissions. The 1975 model year was the deadline date for emissions of carbon monoxide and hydrocarbons. However, in 1973 the EPA (Environmental Protection Agency) granted the automakers a one year extension. The automobile manufacturers still contend that these standards are too tough. Herein lies the controversy.

5. As with the nature of any law, the Act has a strong enforcement section. If a state fails to enforce the emission standards; then the EPA, representing the federal government, may step in and enforce the law.

6. In addition to the ambient air standards, the act requires the EPA to set Standards of Performance for new and "modified" stationary sources of pollution. This section of the law places direct limitations for all major pollutants form specified types of sources, such as Portland Cement Plants and municipal incinerators.

The EPA has set the national ambient air quality standards for six major classes of pollutants as listed in the table on the page.

NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	*Primary*	*Secondary*
Particulate Matter		
Annual geometric mean	75	60
Maximum 24 hour concentration*	260	150
Sulfur Oxides		
Annual arithmetic mean	80 (.03 ppm)	60 (.02 ppm)
Maximum 24 hour concentration	365 (.14 ppm)	260 (.1 ppm)
Maximum 3 hour concentration*		1,300 (.5 ppm)
Carbon Monoxide		
Maximum 8-hour concentration	10 (9 ppm)	
Maximum 1 hour concentration*	40 (35 ppm)	same as primary
Photochemical Oxidants		
Maximum 1 hour concentration*	160 (.08 ppm)	same as primary
Hydrocarbons		
Maximum 3 hour (6-9 am) concentration	160 (.24 ppm)	same as primary
Nitrogen Oxides		
Annual arithmetic mean	100 (.05 ppm)	same as primary

(All measurements are expressed in micrograms per cubic meter (μg/m³) except for those for carbon monoxide, which are expressed in milligrams per cubic meter (mg/m³). Equivalent measurements in parts per million (ppm) are given for the gaseous pollutants.)

* Not to be exceeded more than once a year

For a better understanding of the 1970 Clean Air Act, the instructor should read:

1. A Citizens' Guide to Clean Air, The Conservation Foundation, 1972, 1717 Massachusetts Ave., N. W., Washington, D. C. 20036.

2. "Enforcing the Clean Air Act of 1970," Scientific American, June, 1973, Volume 228, Number 6, pages 14-21. (An excellent article)

One of the important ramifications of the 1970 Clean Air Act is the criticisms the law has received from the automobile industry. The auto industry contends that the law is too rigid; therefore, the standards should be suspended and revised. Chrysler would like to meet some type of standards without the use of a catylst. However, the automobile industry also states that the technology is not available to meet all of the standards.

The second important contention by the automobile industry is the cost factor. Based on the literature provided to the EEE project by Chrysler Coroporation, the automakers find two specific drawbacks of the 1970 Clean Air Act.

1. Chrysler states that costs would be eight times greater than benefits. Notice, that the one million dollars in benefits, as a result of the law, is only to "material and vegetation" but not to health.

2. Chrysler states that the waste of resources as a result of the proposed emission control systems is too costly. It is generally recognized that present emission control systems result in an increase in fuel consumption and concurrently an increase in cost.

Therefore, the automobile industry feels that (using Chrysler's words) "the country is headed for an economic and technological confrontation." One of the tasks of the instructor of this air pollution unit is to help the student(s) understand the meaning and implications of this possible confrontation.

Concept III (if the present laws prove inadequate, then future legislation will be needed to reduce air pollution) becomes an important topic of discussion as a result of the possible impending confrontation between the auto industry with its powerful lobby, and the federal government. If the auto industry is effective, then the 1970 Clean Air Act will be amended.

On the other hand, if the American people continue their heavy reliance upon the automobile and the number of automobiles continues in its dramatic rise; then future legislation with stricter standards might be needed.

Some little tidbits of eco-trivia to the disbeliever of the need for tough emission standards.

1. Dateline-Tokyo: Residents of this huge metropolis can purchase oxygen from clean air machines in the downtown area.

2. Dateline-Los Angles: During smog alerts, traffic cops sometimes wear masks.

INSTRUCTIONAL SEQUENCE
PACKET 5

Behavioral Objective Number	Concept I Required Activities:
1&2	A. The first activity is a reading assignment. This reading assignment is designed to prepare the student for the group discussion of activity two. The Citizen's Guide to Clean Air has three sections of readings for the students. However, the teacher should familiarize himself with the entire pamphlet. There is an excellent appendix is a glossary which is not highly technical. Be sure to point out this glossary to the students. Students should look for pollutants which are regulated by the Clean Air Act of 1970. The second reading, from Progress and the Environment, pages 95-100, is important. Within this reading are contradictions to the Chrysler articles found in the student packet.
2	B. This activity is merely an extension of activity one. Having familiarized himself with readings, the instructor should strive to obtain the following goals for the group discussion:

1. Students should continue to develop and use good discussion skills.

2. Develop a clear understanding of the meaning of the 1970 Clean Air Act. There are some terms that might have caused the students some problems. The beginning of the discussion is a good time to have the students try to define terms, such as, ambient, parts per million, emission standards and variance.

3. It is very important that the student understands the emission standards for automobiles. Dates are very seldom mentioned in ecology; however, the students should be made aware of the deadline dates for automobile emissions. Some students might have difficulty with understanding what is meant by "90 percent from 1970's partially controlled level." Through group discussion, seek a clarification of the dates.

4. During the last part of the discussion, the instructor should set the framework for the possible confrontation between the federal government (EPA) and the automobile industry over the emission standards to be met.

1&2 C&D These activities are simple writing assignments designed to aid the student in understanding the 1970 Clean Air Act. The only area the instructor needs to be concerned with is the primary and secondary standards. Make sure the students emphasize that the primary standards are designed to protect public health.

Concept II Required Activities:

3&4 A, The reading assignment presents Chrysler Corporations views on both the air pollution problem and the 1970 Clean Air Act. Obviously, Chrysler presents a different set of statistics and data. The instructor might be confronted by a confused student at this time. After reading the Chrysler material and the readings in Concept I, Activity A, a student might, and hopefully will, question the accuracy of some of the data. This is good. Point out to the student(s) that one of the problems in studying air pollution is the accuracy of some of the data.

B. The video-tape used as this activity is available through the Administration Building, Mr. Verlin Abbott, Parkway School District. Because of three high schools in the district, it will be necessary to reserve the tape a few weeks in advance. The instructor should have copies of the Data Sheet 1 available for the students.

Concept III Required Activities:

5 A. This activity is a group discussion. Again, one of the purposes of the discussion is for the students to practice developing good discussion skills. This is an important discussion because the instructor has two functions to fullfill.

1. Two possible routes of legislation can develop. First of all, if the automobile industry has its way, the standards in the 1970 Clean Air Act will be suspended.

Ask the students their opinions of the need for lowering the emission standards. The second route of legislation is passage of stricter emission laws. Man's increasing dependence upon the automobile and increasing numbers of automobiles might require this action. During this discussion, try to limit the topic to legislation. Mass transit and changing life styles will be discussed in later packets.

2. If time allows, this is a good time to seek clarification of the variety (and sometimes contradictory) data presented. Student discussion can center around the data presented by Chrysler and the accuracy of the data. If some students are really interested, a research project could be the result of this discussion.

B. This is an inquiry activity. If a student is really interested in local standards and/or further information, this might be of interest. This is definitely an independent student activity with the teacher only providing assistance in the areas of where to seek information. One possible source of information is St. Louis Countys' Air Pollution Control Office, 801 S. Brentwood Blvd. Tel No. 726 1100

At this time administer the post-test.

SETTING

Since most environmental problems are man-made; the possible solutions should come from man. Air pollution is one of those environmental problems and man either has or is in the process of developing the know-how to solve certain aspects of the problem.

Possible solutions can develop in three areas. First, man can and has passed laws regulating the amount and type of pollutants that can be placed in the air. Secondly, man through scientific research can develop the technology necessary to keep automotive and industrial pollutants from ever being placed in the atmosphere. Finally, and perhaps the most important and most lasting of all possible solutions is for man to develop a value system which reflects a concern for preventing and eliminating air pollution.

ENVIRONMENTAL ECOLOGICAL EDUCATION PROJECT

Parkway School District
Checterfield, Missouri

DR. WAYNE FICK, Superintendent

VERLIN M. ABBOTT, Project Director

Unit: Air Pollution: Packet V

BY:
Robert Goode
Wayne Mosher
Tom Pollmann

The work presented or reported herein was preformed pursuant to a Title III ESEA Grant administered by the Missouri State Department of Education.

CONCEPTS: PACKET 5

I. The 1970 Clean Air Act, which is sometimes referred to as the 1970 amendments to the 1967 Air Quality Act, has set limits for sulfur oxides, particulates, carbon monoxide, photochemical oxidants, hydrocarbons and nitrogen oxides.

II. The automobile industry is having technological and economic problems meeting the air pollution standards set in the 1970 law.

III. If the present laws prove inadequate, future legislation will be needed to reduce air pollution.

Concepts		BEHAVIORAL OBJECTIVES
I	1.	After completing the assigned activities, the student will list the six major pollutants regulated by the 1970 Clean Air Act.
I	2.	After completing the assigned readings the student will participate verbally at least three separate times in a group discussion of 40 to 50 minutes on the 1970 Clean Air Act. Then, after completing the group discussion, the student will correctly select from a list the major components of the 1970 Clean Air Act.
II	3.	After completing the packet and listening to the video-tape speaker representing Chrysler, the student will correctly select from a list, two problems of the automotive industry in meeting the limits on emissions set by the 1970 law.
II	4.	Given a list of proposals, the student will correctly select the proposal given by the automotive industry, specifically Chrysler Corporation, as an alternative to the present standards to be met by 1976.
III	5.	After completing the packet, the student will list, in one sentence each, two reasons why future legislation might be needed to reduce air pollution.

At this time take the pre-test.
Obtain a copy from your teacher.

ACTIVITIES

Behavioral Objective Number	
	Concepts I Required Activities:
1&2	A. The following readings pertain to behav'oral objectives one and two. Other readings are available, and if interested one can refer to the student bibliography at the end of this packet. Look for pollutants regulated by Clean Air Act of 1970. A. A Citizens Guide to Clean Air, Required reading is pages 15 to 19; optional readings are pages 27-35 and pages 42-61. B. Progress And The Environment: Water And Air Pollution, Read pages 95-100.
2	B. After reading about the 1970 Clean Air Act you should participate in a group discussion to clarify the major components of the 1970 Clean Air Act. The second part of the discussion will explore the implications of this piece of legislation.
2	C. Prepare a paragraph summary or an outline of what steps are taken during an air pollution episode as described in the 1970 Clean Air Act. Limit your summary or outline to one page.
1	D. List the limits set in parts per million for the six major air pollutants controlled by the 1970 law. Then explain in one paragraph why there are primary and secondary national ambiant air quality standards.
	Concept II Required Activities:
3&4	A. The following readings, found in this packet, pertain to Concept II. A NOT TO THE READER: The automobile industry has reacted negatively to the 1970 Clean Air Act. The industry has disagreed with both the emission standards to be met and the deadline date by which they must meet these standards. In reading the following four articles by Chrysler Corporation, at all times keep the

source of information in mind. These four articles are included so as to present the reader with the automobile industry's point of view. Be alert to the fact that the data presented is from the automobile industry. Chrysler Corporation is one of the "big three" of the automobile industry. Chrysler's viewpoint generally represents and mirrors the attitude of the other two manufacturers; Ford and General Motors.

A. "Let's Have Clean Air - But Let's Not Throw Money Away."

B. "Position Statement by Chrysler Corporation on the Health Effects of Automotive Emissions."

C. "Thirty Handy Facts on Safety, Highways and Emissions."

D. "The Air Is Getting Cleaner (To Bad It's Still A Secret)"

3&4 B. A video-tape is available at this time. The speaker is Don Loftus representing Chrylser Corporation. Mr. Loftus presents the automobile industries views and attitudes relating to the 1970 Clen Air Act. When listening to the speaker, take notes of the main points of the presentation. Before viewing the video-tape, ask you instructor for a copy of the Data Sheet 1.

Concept III Required Activities:

5 A. You should participate in a discussion on the possible need for future legislation to reduce air pollution. Before the group discussion, review the position of the automobile industry and the provisions of the 1970 Clean Air Act for local standards.

B. An optional inquiry activity: Are local ambiant air quality standards different from the 1970 standards? If so, what pollutants have different standards? If possible, inquire as to why the local standards are different from the national standards. A possible source of information is St. Louis County's Air Pollution Control Office, 801 S. Brentwood Blvd. Tel. 726 - 1100.

At this time take the post test.
Obtain a copy from your teacher.

DATA SHEET 1

Video-tape presentation by Mr. Don Loftus representing Chrysler Corporation.

1. According to Mr. Loftus, how serious is the air pollution problem?

____

____

____

2. According to Mr. Loftus, what are two problems encountered by the automobile industry in trying to meet the 1970 emission standards?

   A. ____

   ____

   B. ____

   ____

3. What does Mr. Loftus propose as an alternative to the present standards as established in the 1970 Clean Air Act?

____

____

____

____

____

____

BEST COPY AVAILABLE

Let's Have Clean Air —But Let's Not Throw Money Away!

CHRYSLER CORPORATION

Over the past few years, the automobile industry has been subjected to a steady stream of regulations, restrictions, and standards which have affected the way we do business.

Some of them concern only Detroit. But others have some far-reaching implications to related industries and to the American consumer.

This booklet deals with one major problem—a problem that appears to affect just the automobile business but is going to have a very real and immediate effect on the entire nation. That is the question of increased controls on automotive emissions.

HISTORY OF EMISSION CONTROLS

The automobile industry is in total support of the drive for clean air. Over the years it has worked hard to protect the environment and improve air quality.

The industry became directly involved back in the 1950s, when the California Institute of Technology and Los Angeles County first began to identify the elements of photochemical smog, and the degree of responsibility that automobile emissions had for creating that smog. The automobile industry, working with government and university scientists, helped develop the instruments and test procedures needed to learn about the atmosphere. And as more accurate information became available, the industry's engineers set to work to eliminate the automobile as a major factor in the air pollution problem.

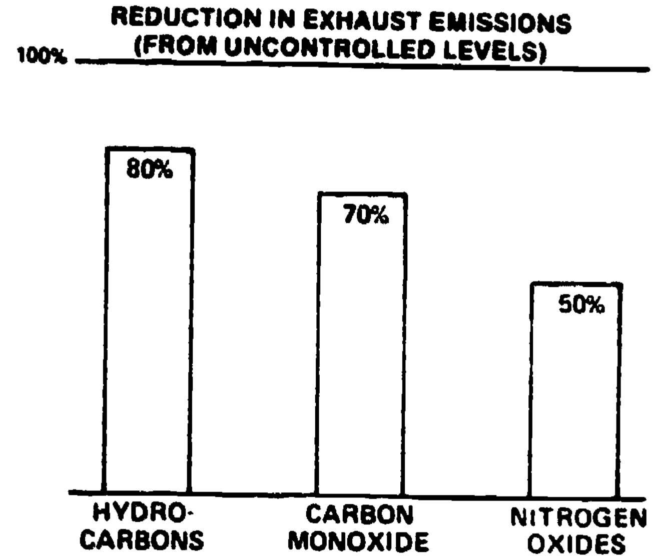

Fig. 1

There was very little public recognition of the industry's achievements over the years, but there was a great sense of urgency about cleaning up the atmosphere. The result was the passage of the Clean Air Act of 1970.

THE 1970 CLEAN AIR ACT

Among other things, that Act requires that by the 1975 model year, automotive emissions of carbon monoxide and hydrocarbons must be reduced 90 percent from 1970 levels. By 1976, emissions of oxides of nitrogen must be 90 percent below average levels of uncontrolled 1971 vehicles.

What is often overlooked is the fact that emissions of hydrocarbons are already 80 percent below those of uncontrolled vehicles. Carbon monoxide emissions have already been cut 70 percent, and oxides of nitrogen have been cut by 50 percent. (Fig. 1)

The fact is that the 1975-76 standards actually require a 97 percent reduction of hydrocarbons compared with uncontrolled vehicles, 96 percent on carbon monoxide, and 93 percent on oxides of nitrogen. (Fig. 2) sources, such as turbines, electricity, and steam were often suggested as logical approaches to meeting the new standards.

Given all these assumptions, it is a little easier to understand how men who were sincerely trying to solve what they believed to be a very real problem could devise the 1970 Act. The motivation was strong, and in the absence of fact, a stringent approach seemed to be the most appropriate.

MEETING THE STANDARDS

The initial industry response, after the shock wore off, was to determine how to meet those standards. Our engineers explored the suggested alternatives—turbines, electricity, and steam. But extensive testing and experimentation led to the conclusion that within the time limits imposed on the industry, there seems to be no power source other than the internal combustion engine that will meet the requirements for driveability, durability, fuel consumption, and cost.

Basically the same drawbacks apply to the second option, emission control devices added on outside the engine. These catalytic and reactor applications leave a lot to be desired in terms of cost, efficiency, and durability.

The third option is to continue improving the internal combustion engine. The industry has already made a great deal of progress with this approach, and at a reasonable cost to the consumer. That progress was adequately summed up by Dr. A. J. Haagen-Smit, head of California's Air Resources Board and the man who first discovered the automobile's role in photochemical smog, when he observed: "The problem is so far over the hump that I'm beginning to lose interest."

ASKING THE WRONG QUESTION

That conclusion points up what is wrong with the way many people in the automobile industry have been dealing with the issue. Certainly the automobile companies have an obligation to try to meet government standards. But they also

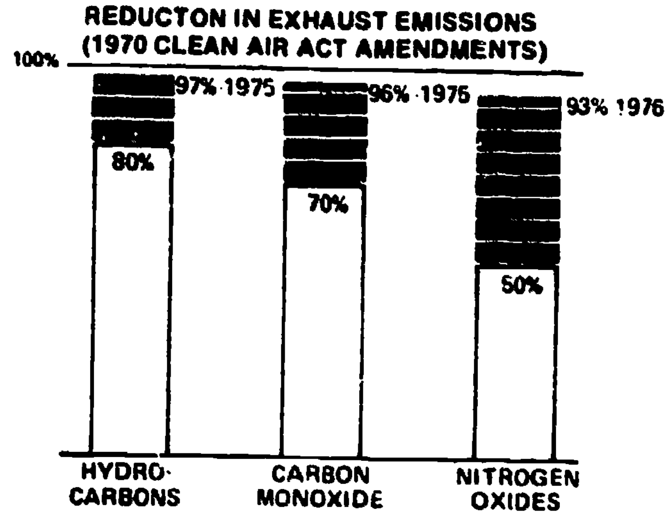

Fig. 2

WHY CONGRESS SET THE 1975-76 STANDARDS

The 1970 Clean Air Act was passed at a time when many people feared that the country was already at the point of national asphyxiation, and the automobile was presumed to be the major source. This assumption was based largely on a report prepared within HEW, before the formation of EPA, suggesting the reforms needed to protect the public health and welfare.

This report presumed the worst possible combination of all conditions. It used the lowest levels at which emissions had any effect in laboratory studies, the highest recorded atmospheric concentrations, and the largest projected increase in vehicle population.

When Congress drafted the 1970 Act, it relied on this HEW paper, and also made a number of other assumptions of its own. Reflecting attitudes then generally held, the Congress assumed that the nation's air was getting steadily worse, and that the automobile was the primary cause. It assumed that automobile emissions were the major source of pollutants that are harmful to health. It also assumed that the automobile industry, with its history of technological progress, could easily reach almost total emission reductions if it really wanted to, or had to. Alternative power have an obligation to express their opinion on bad law. Perhaps everyone has concentrated too much on the question of *how* these standards are to be met, instead of raising the far more relevant question: *why should they be met?*

NEW SCIENTIFIC INFORMATION

Ever since the Clean Air Act was passed there have been concerted efforts in the scientific and technological communities to gather the facts required for a reasoned, unemotional, informed approach to identifying and solving the air quality problem. But instead of seeing a growing number of debates and discussions over the validity of the standards, we are constantly barraged by headlines telling of some real or imagined breakthrough or failure in the struggle to meet them.

It seems that all of this is totally beside the point in view of the facts that have been gathered about the assumptions that were being made back in the late 60s by the public and by those pressing for cleaner air. Those facts all raise the question of why.

Here are a number of the key assumptions and the facts now available which refute them:

CITY AIR IS GETTING CLEANER

The first assumption was that America's air quality was getting steadily worse.

The fact is, according to a recent study for the Council on Environmental Quality, there has been a marked improvement in air quality in communities of all sizes.

These improvements, of course, are a result of the work that has been done by other industries in controlling emissions from stationary sources, and also the replacement of older cars by those equipped with effective control devices—controls which were being developed long before ecology became a household word.

AUTOMOTIVE ATMOSPHERIC IMPROVEMENTS IN UNITED STATES

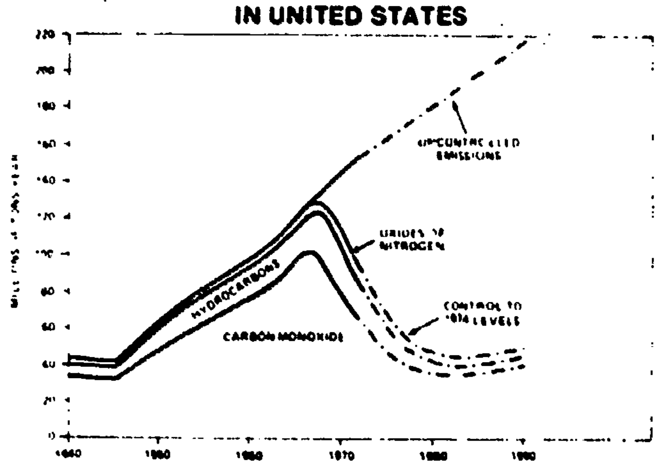

Fig. 3

As these improvements continue, there will be continued improvement in air quality. (Fig. 3)

NATURE OUT-POLLUTES MAN

The second assumption was that man—and especially his automobile—was the prime source of emissions.

The fact is that nature itself, and not man, is the major source of the three basic atmospheric gases emitted by the automobile. Perhaps the most surprising discovery in the past year is the fact that natural sources constantly produce about 15 times as many oxides of nitrogen as man, about 10 times as much carbon monoxide, and six times as many hydrocarbons. (Fig. 4)

EMISSIONS NATURAL VS. MAN-MADE SOURCES

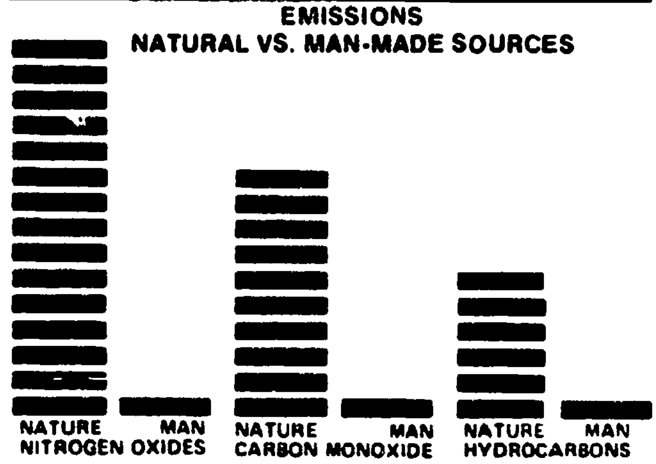

Fig. 4

NATURE CLEANS THE AIR

Moreover, it has been determined that nature is not only a source for these substances, but it also has effective ways of disposing of them. As just one example of these natural disposal systems, fungus in the soil in the United States alone has the capacity to consume more than double the total carbon monoxide produced by all the motor vehicles and factories in the world. This is not to say there should be no motor vehicle emission controls, but it does help show that automotive emissions are not the problem many once believed.

AUTOMOTIVE THREAT EXAGGERATED

The third assumption was that the automobile was a primary source of emissions that are harmful to health.

The fact is that while the automobile may be the source of 40 percent of this country's man-made emissions by weight, weight is not a valid measurement of harmfulness. Actually, concentration and toxicity are the important factors. In fact, looking across the entire spectrum of air pollutants, it is now estimated that motor vehicles account for only about 10 percent of the total problem of potentially harmful emissions produced by man. (Fig. 5)

EVALUATION OF TOTAL MAN-MADE U.S. EMISSIONS BY ENVIRONMENTAL EFFECTS (TOXICITY) (1969)

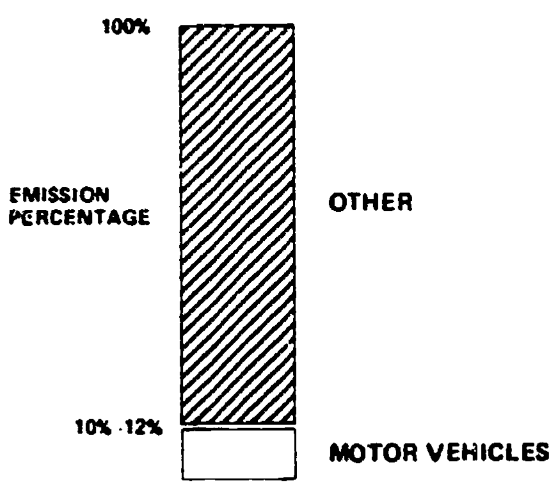

Fig. 5

EMISSIONS AT SAFE LEVELS

It is common knowledge that prolonged exposure to extremely high levels of any pollutants—including the automotive emissions—can have an adverse effect on health or behavior. However, the fact is that in heavily populated urban areas, there is no evidence that even prolonged exposure to average street level concentrations of automotive emissions is a threat to health.

For example, present studies show the carbon monoxide blood levels of non-smokers in the crowded cities across the country are already well below the two percent level that the EPA set as a goal for good health. (Fig. 6) That is also, incidentally, well below the CO blood level of smokers who are in the five to 12 percent range.

AVERAGE CARBON MONOXIDE BLOOD LEVELS

GROUPS	CO BLOOD LEVEL
SMOKERS	5% – 12%
NON-SMOKERS	
Chicago	1.88%
New York	1.43%
Washington, D.C.	1.39%
Denver	1.90%
San Francisco	1.65%
Seattle	1.56%

Fig. 6

Certainly where controls are needed, controls should be imposed. And certainly automobile emissions should be controlled to a degree that the scientific evidence shows is necessary to protect public health and welfare. But to go beyond the point of effective control of automotive emissions is to divert resources that should be used to attack our many other environmental and social problems. The nation has no shortage of problems to be solved, but its resources are limited. We ought to use those resources wisely, applying them only to scientifically established needs.

1975-76 STANDARDS HAVE LIMITED BENEFIT

Fourth—it was assumed that the 1975-76 standards were necessary to achieve a desirable air quality.

The facts indicate they are not. There were a number of inaccuracies in the assumptions used to establish the automotive emission levels. Accordingly, EPA is currently reviewing the calculations for the automotive standards. In addition, EPA has also said that the original ambient air quality standard for oxides of nitrogen may be too restrictive because of errors in the method used to measure atmospheric concentrations. As a result, the original standard for ambient oxides of nitrogen is also under review by EPA.

A MORE REALISTIC APPROACH

California, which is highly susceptible to air pollution problems, believes that the 1975-76 federal automotive emission standards are more restrictive than necessary. California has recommended 1975-76 standards which are very stringent, but more realistic than the federal standards, and which are tough enough to meet the requirements of the state with the worst automotive emission problem in the country. California is asking for a 94 percent reduction in hydrocarbons from uncontrolled levels, an 81 percent reduction in carbon monoxide, and a 75 percent reduction in oxides of nitrogen. (Fig. 7)

ENVIRONMENTAL OVERKILL

Fifth—it was assumed that the average citizen, simply by driving his car, contributes an inordinate amount of pollution to the air.

FEDERAL AND CALIFORNIA STANDARDS

	PERCENT REDUCTION (from uncontrolled levels)		
	HC	CO	NO_x
Federal	97	96	93
California	94	81	75

Fig. 7

The fact is that each vehicle with present controls contributes extremely small amounts. If we apply the even more stringent 1976 automotive standards to other activities of the average car owner, we find that the vegetation in his back yard, just in the process of growing and decaying, would give off as many hydrocarbons as his automobile.

If he burns one log in his fireplace, he'll have used up his daily allotment of carbon monoxide. If he's using oil heat, he's limited to three gallons of oil each day, which will last about eight hours, or he'll be over the limit in oxides of nitrogen. This is the degree of overkill represented by the 1976 standards.

ANNUAL BENEFITS BY SOURCE (EPA PROJECTIONS—1971) (MILLIONS)

SOURCE	HEALTH	RESIDENTIAL PROPERTY	MATERIAL AND VEGETATION	TOTAL BENEFIT	CONTROL COST
Mobile	$ *	$ *	$ 945	$ 945	$ 8,385
Solid Waste	172	145	119	436	224
Stationary Fuel Combustion	3 812	3,267	2,366	9,445	2,476
Industrial Processes Studied	1 413	1 302	734	3 350	1 213
Industries Not Studied	0	0	0	0	0
Miscellaneous	0	0	0	0	0
TOTAL BENEFIT	$5,397	$4,615	$4,164	$14,176	$12 298

*Despite intensive research, EPA says no data on effects are available

Fig. 8

COSTS 8 TIMES GREATER THAN BENEFITS

Sixth—it was assumed that the benefits of these standards would more than justify the cost.

The fact is that two different government studies show exactly the opposite. A 1972 EPA report to Congress estimates that in 1977, when all controls on motor vehicles are in effect, the annual cost of those controls will be more than $8 billion. The projected national annual benefit to "material and vegetation" will be less than $1 billion. The EPA report points out that health benefits were excluded from the estimate "because of an almost complete lack of data" establishing the health effects of carbon monoxide, hydrocarbons, and oxides of nitrogen at ambient levels. (Fig. 8)

Occasionally a small-scale isolated study does appear to show an adverse health effect from abnormally high concentrations, usually in combination with some other health or environmental factor. However, these same studies, when repeated under carefully controlled conditions representative of the normal city environment generally have not been validated. *The fact is that years of research, involving millions of people in hundreds of community studies, and in laboratory studies, have not developed any evidence showing any threat to health from average ambient levels of automotive emissions.*

ESTIMATED COST OF EMISSION CONTROL

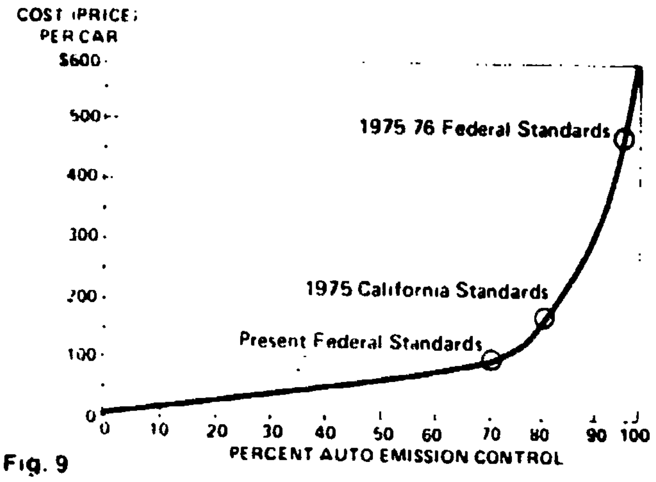

Fig. 9

WHY COSTS ARE SO HIGH

The cost estimate of these controls comes from a study by the Office of Science and Technology. (Fig. 9) According to this report, the 1975-76 federal standards could raise the price of a new car as much as $500. We estimate the cost of the California standards at about one-third of that.

The study committee concluded "that the nation is embarked on an air pollution program of enormous scope, complexity, and cost, with little measure of the relative harmfulness of the several pollutants being considered."

ENGINEERS CAN'T MEET THE STANDARDS

And seventh—the assumption was that the industry could meet the standards and with relatively inexpensive technology.

The fact is that we have no technology—expensive or inexpensive—that will meet all the requirements of the act. And as far as we know, no one —no manufacturer, no supplier, and no backyard inventor—has yet devised a control system that will meet the required emission levels for five years or 50,000 miles in customer service.

WASTE RESOURCES

The fuel cost penalty of as much as 30 percent associated with currently proposed emission control systems has to be included in any cost-benefit analysis. The additional cost to the nation's car owners could be as much as $10 billion a year. (Fig. 10)

ANNUAL COST OF FUEL ECONOMY PENALTIES

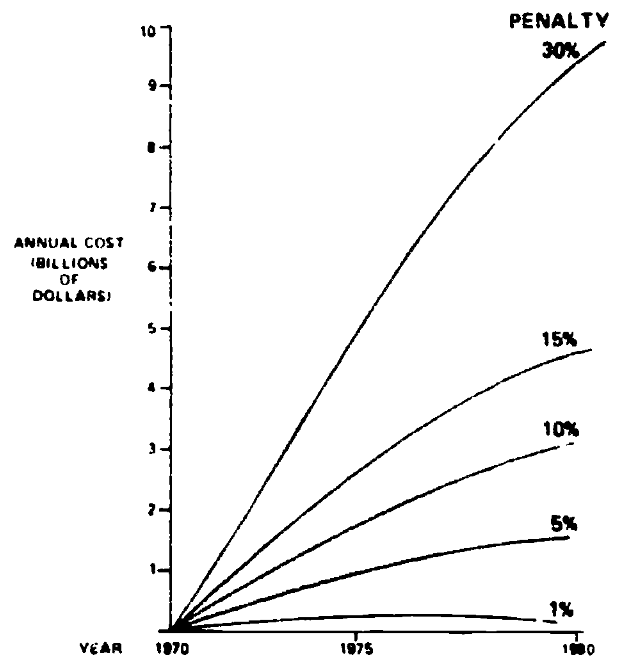

Fig. 10

The only emission control systems that we see with any hope of meeting the 1975-76 standards use catalysts which would require lead-free fuel. In 1975 about ten percent of the car population would require this new fuel, and a recent White House study estimates that it could cost the petroleum industry almost $5 billion for the new refinery equipment and the distribution system needed to get it from the well to the car.

A good share of that cost will go toward the development of an entirely new transportation system, separate from the leaded fuel system. Separate bulk storage tanks, tank cars and trucks, station pumps and storage tanks, and some sort of protection system to prevent accidental use of the wrong fuel in the wrong car. That's a big and expensive job, and we don't believe it's necessary.

Beyond this the current trend in the development of proposed catalysts involves the use of exotic and very expensive metals—platinum and palladium—which will add significantly to the cost of an automobile. These metals are sourced outside the United States, and the cost of importing about half the world's annual supply would have a negative effect on our country's balance of payments. The increase in fuel consumption would also add substantially to the nation's annual $4 billion outlay for oil imports with a further negative impact on our country's trade position.

These are the major facts that we believe have to be made known. There are others.

We invite anyone who is interested in all the basic scientific studies on which our position is based to examine our extensive bibliography or any other, and to read these reports.

NEEDLESS CONFRONTATION

In light of the facts presented here, we believe the country is headed for an economic and technological confrontation which nobody needs or wants, and which will do nothing for the cause of clean air.

There is no reason why this confrontation has to take place. We would like to suggest an alternative.

RECOMMENDATIONS

First, the Administrator of the EPA should defer the 1975 standard as the law allows him to do.

This decision needs to be made soon. Time is running out. We must commit huge capital investments in new tools and facilities, make long-term agreements with suppliers, and make binding decisions now if we are to meet our production schedules for 1975. The oil industry must also make commitments for the new refineries, separate fuel transport systems, and storage tanks it will need for the lead-free fuel that will be required by the fall of 1974.

Second, Congress should suspend the 1975-76 standards, and transfer to the EPA the authority for establishing new automotive emission standards based on need, cost, and feasibility.

EPA already has this authority for emissions from stationary sources, and should have it for mobile sources as well.

If the present standards are maintained, we could then devote our full attention to an economical emission control system which Chrysler Corporation believes in all likelihood could meet the proposed California standards, on cars sold in California, by the 1976 model year. And we believe we could meet them without catalysts.

CALIFORNIA STANDARDS

If necessary, we believe we can meet those same California standards nationwide by the 1977 model year.

Not only are these California standards tough enough to protect the state with the most severe automotive air quality problem in the nation, but they could save the car buyer several hundreds of dollars in original purchase cost and in operating costs. The buyer would not have to pay for catalytic systems on his new car. He would not have to buy expensive replacement catalysts. He would not have to pay extra for lead-free fuel, or suffer a severe mileage loss. And he would still be helping the cause of clean air, because his car would have controls which are even beyond the needs of the nation's environment.

Our nation, in turn, would conserve its limited resources, protect its balance of payments from further erosion, and serve the cause of clean air with responsibility. We urge your support in getting that job done.

IN SUMMARY . . .

Even if automotive engineers could meet the 1975-76 federal motor vehicle emission standards, Chrysler Corporation would oppose them because they are wasteful, unnecessary, and unrealistic. In place of these overly stringent standards, the company recommends the following actions to conserve the nation's limited resources while protecting the environment and the public health and welfare.

EPA should defer the 1975 standard as provided by law. This would avoid investing millions in the next few months for control systems the country does not need.

Congress should then carefully review its original legislation, revoke the 1975-76 standards, and transfer to EPA authority for setting any new mobile emission standards on the basis of current scientific information.

Chrysler believes it may be possible to meet the 1975 California standards nationwide by the 1977 model year without expensive catalysts. The stringent California standards which are adequate to protect the state with the most serious automotive air quality problem should be more than adequate for the rest of the nation.

POSITION STATEMENT BY CHRYSLER CORPORATION

On The

HEALTH EFFECTS OF AUTOMOTIVE EMISSIONS

INTRODUCTION

Chrysler Corporation has proposed a positive alternative to the 1975-76 federal automotive emissions standards. We believe the evidence shows the alternative to be more than adequate to protect the public health. It has the added advantage of removing the severe burden on natural and economic resources which will result from the standards as now written.

Chrysler Corporation believes it is in the nation's best interests for Congress to review the 1975-76 standards, and, if necessary, replace them with standards no more stringent than the proposed 1975-76 California standards. In all likelihood, these can be met with existing technology and without expensive devices added on to the engine. Most important, recent medical evidence shows that the reductions proposed by California are more than adequate to protect public health and welfare.

The Automotive Share of the Air Quality Problem

According to estimates made in 1969, motor vehicles account for more than 40 percent (by weight) of all man-made emissions in the United States more than any other single source. The 100 million cars and trucks on the road account for about two-thirds (by weight) of the country's man-made carbon monoxide (CO), about one-third of the oxides of nitrogen (NOx), and over 45 percent of the hydrocarbons (HC). With the vehicle population expected to grow to about 135 million within the next 15 years, cars and trucks could, unless controlled, be even more significant sources of man-made emissions in the future.

National Strategy

Clearly, any national environmental strategy must start with control of the source of the greatest amount of emissions. But three other factors need to be considered.

First, it should be recognized that nature itself, and not man, is the major source of the three basic atmospheric gases emitted by the automobile. Nature produces 15 times more oxides of nitrogen than man, 10 times more carbon monoxide, and six times more hydrocarbons. Moreover, nature recycles its own emissions, disposing of them through other natural processes. And nature has the capacity to recycle even more. That is why automotive emissions, for example, do not accumulate in the atmosphere.

These data on natural sources place the nationwide emissions of man and his automobile in a reasonable perspective. They also explain why, in some areas, natural sources produce levels of automotive-type emissions which can be nearly equal to the emissions levels allowed under the federal law.

Second, some man-made emissions are more harmful than others and should be more strictly controlled. As the Council on Environmental Quality once said, "It is somewhat misleading to consider air pollutants in terms of their aggregate weight. We worry about pollutants because of their effects." Oxides of nitrogen, sulfur oxides, and particulate matter are each considered more harmful than an equal amount of carbon monoxide. When the automotive emissions are weighted by their relative toxicity, *it is estimated that motor vehicles account for only 10 to 12 percent of the country's potential air quality problem.* While each emission should be held to a level that adequately safeguards the public, accurate data about relative harmfulness make it possible to determine which contaminants need to be controlled more stringently than others.

The third consideration is concentration. No one breathes the "average air" in the United States. About 75 percent of the population lives on only 1.5 percent of the available land. They breathe urban air containing concentrations of emissions from factories, automobiles, home furnaces and fireplaces.

Obviously the pollution mix will vary from one location to another. For example, the industrial north central and east coast areas of the country rely heavily on coal and low grade fuel oil. Emissions of sulfur oxides and particulate matter from this coal and oil will be far more important and serious a problem than in California where there is less use of these fuels. On the west coast other sources of emissions, including cars, will make up most of the air quality problem.

A national strategy needs to recognize that the air quality problem varies in different parts of the country. Accordingly, emission control standards, written as part of a coordinated national strategy, should be designed to protect the public health and welfare in the part of the country that clearly has the worst possible problem, and then extended as needed to the rest of the country.

In the case of motor vehicles, that means California, and the Los Angeles Basin in particular. While motor vehicles account for 40 percent of emissions by weight in the nation, it has been estimated they may contribute as much as 90 percent by weight of all emissions in the Los Angeles Basin. While motor vehicles account for only 10 to 12 percent of the potential national problem when emissions are measured by harmfulness, it is estimated they represent far more of the Basin's total potential problem.

Setting California Standards

California has, over the years, progressively tightened restrictions on the three primary automotive emissions: carbon monoxide, oxides of nitrogen, and hydrocarbons. Faced with the most severe automotive emissions problem in the nation, California officials have proposed both ambient and vehicle emission standards which are sufficient to eliminate any threat to health (ambient air is the air we breathe as we move about).* And those standards push the available technology to the limits. California officials have held extensive hearings and actively sought the expert advice of the researchers in the field. The Air Resources Board, its staff, and its Technical Advisory Committee thoroughly considered the medical evidence and the costs and benefits of various control strategies before formulating standards. The proposed 1975-76 California vehicle emission standards call for reductions of 94 percent in hydrocarbons (from uncontrolled levels), 81 percent in carbon monoxide, and 75 percent in oxides of nitrogen.

Setting National Standards

The Congress followed a different approach in setting automotive emissions standards. Its ultimate aim was to establish a national environmental strategy which would protect people everywhere from all the possible effects of all emissions.

Accordingly, Congress directed that HEW prepare a series of reports summarizing the medical, technical, and scientific evidence about the various air pollutants.

*Dr. A. J. Haagen-Smit, Chairman of the California Air Resources Board, wrote William D. Ruckelshaus on March 11, 1971, "The Board's Technical Advisory Committee has reviewed the Federal Criteria reports and the proposed [federal ambient] standards. They found no new information that warrants the establishment of standards more strict than those adopted by California." Since that time Dr. Haagen-Smit and other California officials have been critical of the federal standards. Dr. Haagen-Smit, for example, has said on different occasions that "It is difficult to follow the reasoning for these standards . . ." "Anyone who has to deal with the practical aspects of control has questioned the need for so many different air quality standards, motor vehicle emission standards and test procedures that exist . . . Both the citizen and the [automobile] industry are penalized for the entire cost in implementing the small differences without any real benefit to either one."

These Criteria documents, as they are known, although limited in scope, were an important first step in developing a national strategy. They were a compressed summary of the thousands of documents which could be used to determine desired air quality. Once the desired air quality was determined, it would then be possible to calculate the degree of reduction in automotive emissions needed to reach that level.

Dr. Delbert Barth, then Director of the Bureau of Criteria and Standards of the National Air Pollution Control Administration, explored one way in which these reductions could be calculated. Since his purpose was to explore a control strategy, he made a number of assumptions which were valid and justified *for his purpose.*

These assumptions included: 1) the summaries in the Criteria documents pertaining to the concentration and exposure time which cause or contribute to (or are likely to cause or contribute to) air pollution which endangers human health or welfare, 2) the largest projected increase in vehicle population, and 3) the highest recorded concentrations of each of the automotive emissions.

It was not particularly necessary to justify these assumptions by scientifically verifying them. For the purpose of Dr. Barth's exploratory paper, the approach was appropriate.

The country's sense of urgency about its environmental problems seemed to peak about the time Dr. Barth suggested this method of calculating emission reductions. Congress shared that urgency, and using Dr. Barth's exploratory paper as supporting evidence for its actions, passed the Clean Air Act of 1970. Since general air quality standards for the nation had not yet been established, the automotive standards written into the Act bore only a rough relationship to any national air quality goal. The 1970 Clean Air Act requires that by 1975, hydrocarbons must be cut 97 percent from uncontrolled levels, and carbon monoxide must be cut 96 percent. By 1976, oxides of nitrogen must be reduced 93 percent. Since these standards are more severe than California's proposed standards, the federal standards prevail.

The Fundamental Question

Many people believe the 1975-76 federal standards are automatically superior to the California standards because they require a more stringent control of the automotive emissions.

However, there is no benefit in going beyond a degree of control justified by the scientific and medical evidence. (And that is not to say that a level of a specific emission is "good" for people.)

Too great a degree of control can be counterproductive and wasteful of resources, particularly if its end result includes vast expenditures for expensive catalytic systems, conversion to more expensive fuel, and a loss of engine efficiency, as the federal law now does.

In light of all this, a number of people have raised serious questions about the standards. They have asked that Congress examine all the new evidence now available which was not available when the law was passed. And they have asked why the California standards, which are adequate to protect the state with the worst automotive emission problem in the country, are not more than adequate to protect the rest of the nation.

These are legitimate questions for which scientific answers are now available. We urge all interested persons to study the primary documents. (Some of the important references are listed at the end of this paper.) However, we offer here a small but representative selection of medical evidence which indicates that the degree of control required by the proposed California standards is strict enough to protect the health of not only the average person living in a crowded city, but even those persons who might be unusually susceptible to the effects of automotive emissions.

The Carbon Monoxide Standard

The summary of the Criteria document for carbon monoxide states that a carbon monoxide blood level (carboxyhemoglobin level) of 2.5 percent "has been associated with impairment of time-interval discrimination." As a result, EPA said in establishing the national air quality standard (setting maximum allowable atmospheric concentrations for emissions regardless of source) that the intent of the federal ambient CO standard is to prevent carboxyhemoglobin levels from rising above two percent.

The conclusion in the Criteria document is based on a study by Rodney Beard and George

Wertheim of Stanford University. The two scientists did not measure the carbon monoxide blood level - they estimated it. Dr. Richard Stewart and Dr. Peter Mikulka have since attempted to duplicate these test results, and have not been able to do so.

The experiments of Schulte, Stewart, Hanks, Mikulka, and others likewise indicate no significant effect on a person's actions until the carboxyhemoglobin level reaches about five percent.

Even granting that it is necessary to prevent carboxyhemoglobin levels from rising above two percent, the important question is what are the present levels of carbon monoxide in the blood of people who live and work in cities where 8 hour average atmospheric concentrations of carbon monoxide may be 20-30 ppm, and where peak concentrations may be even higher. Scientists have learned from laboratory experiments that exposure to 30 ppm for 8 hours will raise the carboxyhemoglobin level to more than 4 percent. It should follow that average carboxyhemoglobin levels of people in some cities should be in a range of four to five percent. But they are not. In the time since the Clean Air Act was passed, Dr. Richard Stewart has been surveying carboxyhemoglobin levels of about 30,000 persons in congested downtown areas of major cities across the country. His results so far indicate that in all but two cities, the average carboxyhemoglobin level of non-smokers in crowded cities is already at or below two percent. (The exceptions were Chicago at 2.04 percent and Denver at 2.09 percent.) In other words the actual carboxyhemoglobin levels are less than half those normally expected. (Figure 1.)

AVERAGE CARBON MONOXIDE BLOOD LEVELS

GROUPS	CO BLOOD LEVEL
SMOKERS	5% - 11.5%
NON-SMOKERS	
Chicago	2.04%
New York	1.42%
Washington, D.C.	1.41%
Denver	2.09%
San Francisco	1.70%
Seattle	1.67%
Los Angeles	2.00%

Figure 1.

A study by Dr. Richard Stewart of people in crowded downtown areas shows that in all but two cities the average carboxyhemoglobin level is already at or below two percent—the level EPA set for good health. Dr. Stewart found that even non-smokers who went above the average were still well below the five percent level at which there is a significant effect. Non-smokers were also well below the carboxyhemoglobin level of smokers.

There are two reasons for this finding which has upset conventional thinking about the effects of atmospheric carbon monoxide. First, atmospheric measurements are accurate only for the specific location where the recording equipment is placed. Studies show readings can vary by as much as 100 percent from one side of the street to the other. Second, as Dr. W. H. Forbes of Harvard and others have pointed out, people who go about their normal routines are not exposed to a constant amount of carbon monoxide. The exposure changes as they move from place to place. Dr. Stewart's study shows that because of the limitations of the recordings and the fact that people do not breathe the same concentration for extended periods, atmospheric readings (whether average or peak concentrations) cannot be accurately translated into carbon monoxide blood levels.

It is important to remember that the values reported by Dr. Stewart were obtained when only a fraction of motor vehicles had today's

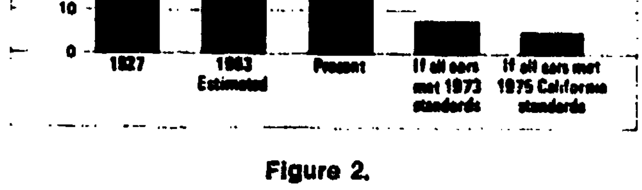

Figure 2.

Carbon monoxide levels in crowded cities have been decreasing steadily over the years. It is estimated that in 1927 the sidewalk concentration in some cities was more than 60 parts per million. As a result of improvements in engine efficiency, the level dropped to about 30 parts per million by 1963. Since that time, there has been a further reduction in atmospheric CO as a result of emission control systems. By the time all cars meet the 1973 standards, these levels should fall to less than 10 parts per million.

emission control systems. The proposed California standard, which calls for an absolute 81 percent reduction in CO, therefore provides a very large additional safety factor.

Several scientists have also tried to determine actual effects of atmospheric CO. A study in Los Angeles by Alfred Hexter and John Goldsmith showed a statistical relationship between atmospheric carbon monoxide levels and hospital admissions and deaths from heart attacks. However, a similar but very detailed study by Johns Hopkins University has not been able to establish this same relationship, or show an effect of atmospheric carbon monoxide on mortality.

Present concentrations are already a fraction of the atmospheric levels of the 1930s and 1940s. And while some people fear the downward trend

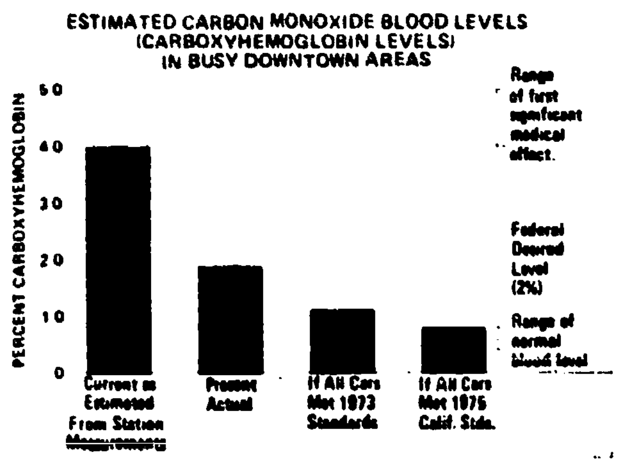

Figure 3.

According to information developed in laboratory studies, the average carboxyhemoglobin level of people in cities across the country should be at least 4 percent. Actual measurements by Dr. Richard Stewart of people in crowded downtown areas show the average level of the great majority of non-smokers is already under two percent the level EPA set for good health. If all cars meet the 1973 standards, the average carbon monoxide blood level would be about one percent. If all cars met the 1975 California standard, it is estimated that atmospheric CO would have practically no effect at all. CO in blood would come primarily from natural sources in the body.

may be reversed as the vehicle population increases, the fact is that all new cars will be equipped with controls that reduce CO emissions at least 70 percent from uncontrolled levels. As a result, the atmospheric CO levels in cities will continue to decrease steadily, and the already low carboxyhemoglobin levels will also continue to decrease. (Figures 2 and 3.)

As a result of facts such as these, Dr. A. J. Haagen-Smit, head of California's Air Resources Board, has said, "Even if we accept the federal air quality standard (9 ppm maximum eight hour concentration of carbon monoxide) as being the correct value, the motor vehicle emission standard goes beyond that needed to achieve the air quality goal."

The Oxides of Nitrogen Standard

The original ambient air quality standard for NOx was based largely on a study in the suburbs of Chattanooga, which was the only one then available. That study concluded that school children living in a high oxides of nitrogen area (defined as being in the range of 0.063 to 0.083 ppm) had a slightly impaired breathing ability compared with other children, and were more likely to suffer respiratory illness. Because EPA itself has serious questions about this study, it is currently being repeated.

At a conference on the health effects of air pollution sponsored by the American Medical Association in October 1972, papers presented by several researchers including William Nelson and George Comstock, indicated that NOx levels normally found in the atmosphere did not have adverse health effects. Research by Irving Tabershaw and the work of the Hazleton Laboratories, and William Busey also support these conclusions.

In originally promulgating the ambient oxides of nitrogen standard of 0.05 ppm, the Administrator of the Environmental Protection Agency, William Ruckelshaus, said, "No adverse effects on public health or welfare have been associated with short-term exposure to nitrogen dioxide at levels which have been observed to occur in the ambient air." There has been no new evidence to contradict this view.

The ambient air quality standard itself is under question. The measurement methods EPA used may have overestimated ambient air concentrations, and therefore overstated the degree of control needed to protect public health. (Two methods have been used by the government to measure atmospheric levels of NOx—with one producing values as low as one-third the other.) However, even accepting as valid those extreme values EPA originally used, the evidence shows that the 75 percent reduction proposed by California is more than adequate to protect public health.*

Photochemical Oxidants

A major reason for controlling both oxides of nitrogen and non-methane hydrocarbons (which are not considered harmful at present levels) is that they react in sunlight to form photochemical oxidants. The federal standard requires a 97 percent reduction in hydrocarbon emissions to prevent formation of oxidants. The federal ambient air quality standard is 0.08 ppm oxidants for a maximum one hour concentration.

Officials in California, which has the worst oxidant problem in the country, have called the federal standard unreasonable and beyond any need established by medical evidence. John Maga, executive officer of the California Air Resources Board explained. "The standard is so near background levels (levels of emissions produced by nature) that only small amounts of hydrocarbons and oxidants of nitrogen will produce enough ozone to go over the standard."

The original standard was based in part on a study which showed that performance of high school athletes was adversely affected by oxidant levels. However, the data show no significant decrease in athletic performance when the concentration went below 0.2 ppm. Other studies indicate there should be no eye irritation before the concentration reaches 0.1 ppm. Yet the standard remains at 0.08 ppm.

*Researchers from EPA, DuPont, and the Motor Vehicle Manufacturers Association have used Dr. Barth's method of calculating the amount of reduction in automotive emissions necessary to meet the ambient oxides of nitrogen air quality standard. The estimates are 82 percent, 77 percent, and 64 percent. In view of the apparent indication that the ambient standard will be modified as a result of more accurate data on atmospheric concentrations, a 75 percent reduction in emissions should provide a more than adequate safety factor.

The scientific consensus is that oxidants are not a threat to health at present ambient levels. Major epidemiological studies by Phillip Buell and E. Cuyler Hammond established no relationship between ambient oxidant levels and community health. Studies in Los Angeles of sickness among school children, of mortality rates in the community, and of the incidence of cancer, support these findings. California officials have pointed out that the oxidant problem in Los Angeles County is being diminished. The number of days when residents of Los Angeles County experienced eye irritation have been reduced nearly 50 percent since 1956. Days when ozone concentration equalled or exceeded 0.10 ppm for a one-hour average have been reduced about one-third in that time. Accordingly, California officials believe their proposed reductions of 94 percent in hydrocarbon emissions and 75 percent in oxides of nitrogen emissions are sufficiently stringent to assure continuing improvements in air quality and safeguards for public health.

The Scientific Consensus

In its report to Congress in March 1972, EPA reported on the costs and benefits of the Clean Air Act. After reviewing the extant evidence, EPA indicated there was not enough evidence to estimate any health damage from the atmospheric levels of carbon monoxide, hydrocarbons, oxides of nitrogen, or photochemical oxidants. That report was based in turn on a study by Barrett and Waddell, who stated in their report, "Until better evidence is forthcoming, it is assumed that the health costs of air pollution stem from particulates and sulfur oxides." (These emissions come from sources other than the automobile.)

As a result, EPA estimates that in 1977 when all automotive controls will be in effect, the annual cost of those controls will exceed $8 billion; the annual benefits will be less than $1 billion.

Even using Dr. Barth's method, which led to the original numbers in the Clean Air Act, a strong case can be made in support of a different set of numbers which are more in line with present information. Several researchers have used Barth's own technique to recalculate the reductions. And using his technique, which is valid, but making assumptions about present air quality and vehicle population which are more realistic, scientifically verifiable, and more representative of actual conditions than those Dr. Barth used, these researchers have concluded that smaller reductions than required by the Clean Air Act would be more than adequate to protect the public health.

Recommendations

In view of all the new evidence that has been developed about the health effects of automotive emissions, the more accurate information about atmospheric levels of various gases, and the degree of reduction actually needed to protect health, Chrysler Corporation believes the requirements of the 1970 Clean Air Act should be suspended and the law revised.

This proposal is all the more urgent in light of the additional new body of evidence detailing the extreme cost penalty of the federal standards, their drain on our natural resources, and their effect on the nation's trade position.

The high cost of the federal standards and the lack of incriminating evidence about automotive emissions should not, of course, be taken as an excuse for relaxing pollution control efforts. The question, therefore, is not one of control versus no control. It is what degree of reduction is necessary to safeguard the public health and welfare, and also to provide additional assurance that persons who might be particularly susceptible to air contaminants will not be endangered by concentrations of automotive emissions.

In this connection, the case for the California standards has been well stated. The scientific evidence shows these standards will eliminate the remaining problems automotive emissions are creating today. These standards can accomplish the same objective in other parts of the country where the automotive problems are less serious. And they will lead to cleaner air at far less economic and social cost than the federal standards as now written.

30 Facts on Safety, Highways and Emissions

CHRYSLER
MOTORS CORPORATION

1. Maximum carbon monoxide levels measured in ambient air in heavy traffic situations, such as a traffic policeman directing traffic in downtown Manhattan in an 8-hour period, have less effect on a human being than does the smoking of two cigarettes in one hour.

2. Total man-made pollution, especially the kind of pollutants coming from automobiles, is small compared to the amount of those same pollutants given off by natural sources, i.e. vegetation, ocean organisms, etc. Currently, it has been estimated that natural sources of hydrocarbon going into the air give off over fifteen times as much as do total man-made sources. In the case of carbon monoxide, recent researchers estimate that twenty-five times as much carbon monoxide goes into the air from natural sources as it does from man-made sources. As for oxides of nitrogen, over fifteen times as much is given off by natural sources as man-made sources and over one hundred times as much ammonia goes into the air from natural sources, which results in subsequent formation of oxides of nitrogen.

3. According to government figures, transportation sources, principally the automobile, account for 42% of total man-made air pollution on a weight basis. On the other hand, on a toxicity basis, transportation sources account for 5%–12% of total air pollution. This is because some pollutants, notably sulfur dioxide and particulates, are much more harmful than others on a weight basis, and the automobile is a very small contributor of these harmful pollutants.

4. The 1970 Clean Air Act Amendments (the Muskie Bill) actually requires reductions in unburned hydrocarbons of 97% compared to those from uncorrected cars. The carbon monoxide reduction required is 96% and the oxides of nitrogen reduction is 93%. Controlling pollutants gets increasingly expensive as the amount of reduction approaches 100%, so that the last 5% of control usually costs ten to twenty times as must as the first 20%. This is what we mean when we say that the required amount of control for automobile pollutants has gone far past the point of diminishing returns with the 1970 Clean Air Act Amendments.

5. Measured maximum concentrations of carbon monoxide in busy traffic situations, such as the Chicago Loop and downtown Manhattan, are less than a third of the concentrations measured in the same locations back in the early 1930's.

6. Air pollution from automobiles is decreasing at an increasing rate as new cars replace old cars and will continue to decrease until 1980, even if car pollution is never reduced beyond the amount required by the 1973 Federal Standards.

The degree of control required by unburned hydrocarbons for 1975 is such that if those levels are reached more unburned hydrocarbons will be given off into the air during the filling of the gas tank than will be given off through the car exhaust while that same gasoline is being burned in the engine.

We don't know how to meet the 1975 Standards yet over the five-year or 50,000 mile period. Nor do we know yet how to meet the 1976 Standards with individual, specially-adjusted laboratory cars. But the extra cost to the customer for the devices that we anticipate having to put on these cars in hope of meeting these standards will run from $300 to $500, excluding what we might have to charge for maintenance and warranty.

9. Questions concerning the advisability of our current vehicle emissions policy were raised by the RECAT Committee report prepared for the Office of Science and Technology. The report stated, "It appears, therefore, that the nation is embarked on an air-pollution-control program of enormous scope, complexity, and cost, with little measure of the relative harmfulness to health of the several pollutants being considered."

10. More unburned hydrocarbons are given off from the grass and bushes in a normal 100' x 100' backyard than would be given off by an automobile meeting the 1975 Standards running average mileage during a comparable period of time.

11. The RECAT report concluded, "The imposition by statute of arbitrary time deadlines may not only impose unnecessary short-term costs on the public, but it may also postpone or foreclose research into alternative means of providing more efficient long-term solutions to the public. The 1975-1976 motor vehicle emission requirements of the Clean Air Act may have just such an unfortunate effect."

12. The RECAT report states that the average retail price of an automobile by 1976 resulting from compliance with already planned regulations for safety damage-limiting design and emission controls is expected to increase by about $873. They estimate $350 of that amount would be for emissions and $523 for safety.

13. In comparing the costs versus benefits of the 1976 emission controls, the RECAT Committee estimated that the net excess costs over benefits for the ten-year period, 1976-1985, would be anywhere from $49 billion to $76 billion to the car buyer, with the difference being due primarily to problems assessing the dollar benefits from such controls.

14. All the air pollution man has produced doesn't equal the amount of particulates and gases from just three major volcanic eruptions (Krakatoa, Mt. Katmai, and Hekla).

15. The United States has the lowest fatality rate per 100 million miles of any country in the world, and the fatality rate continues to decrease. The fatality rate in West Germany is about twice as great and in Japan it's over three times as great as in the United States. The next best accident rate of any country is in Sweden, where it is still about 35% higher than the United States.

16. The 1974 bumper standards require that front and rear bumpers for all cars meet each other (be similar in height). They further require that the bumper systems be able to take 5 mph pendulum impacts at any point along the bumper face. These bumpers will be over three times as strong as the bumpers we used to have in the "good old days".

17. Accident statistics show that heavier cars are much safer than lighter cars. If a car is involved in an accident, the chances of a serious or fatal injury are 2-1/2 times as great if the car is a sub-compact car weighing less than 2,000 pounds as they are if the car is a full-size domestic car. The heavier the car, the less change of a serious or fatal injury.

If we exclude fatalities to pedestrians, motorcyclists, and bicyclists, the number of U.S. fatalities due to automobiles is reduced from 55,000 to less than 35,000.

19 Australia recently enacted mandatory use of lap and shoulder belts laws (first for the State of Victoria and now for all Australia). The latest reports from New South Wales (Sydney) indicate that serious injuries and fatalities have been reduced by about 24% since enactment of the mandatory belt usage law and less than 50% of the cars on their roads have belts installed. Thus, the outlook is that serious injuries and fatalities may be reduced by 48% when the entire car population is equipped with belts.

20 50% of the accidents which result in serious injuries or fatalities in the United States involve drivers who are legally intoxicated. Stiff penalties (including jail sentences) for driving while intoxicated in Sweden have resulted in a substantial decrease of serious injuries and fatalities.

21 In 1901, when 26 million horses traveled some 12 billion miles, some 3,850 people were killed in accidents involving horse-drawn vehicles. Then we had a death rate of over 30 per 100 million miles traveled. Our latest figures for the automobile show a death rate of 4.7 per 100 million miles traveled.

The following quotes from a speech by Francis Turner, Federal Highway Administrator, on May 31, 1972.

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22 Completely ban the automobile from the city, they say, or the city is dead. The *fact* is, if we ban the automobile from all of downtown, then downtown is going to be dead. We should, of course, experiment as we are doing with auto-free pedestrian malls or zones, accessible to close-by transportation, either by auto or mass transit. People and automobiles are synonymous, and people and life, economic or social, are synonymous. Without people, downtown would quickly lose its reason for being.

23. They say highways and the automobiles have caused "urban sprawl." The *fact* is that the automobile didn't *cause* people to move from the center city to low-density, single family residential developments in the suburbs–it enabled them to. And in so doing, it permits us to enjoy that life-style which the vast majority of Americans today prefer.

24. They say that we must stop building new freeways in our urban areas. The *fact* is that we must continue to provide our urban areas with the modern highway systems that are their very lifelines–because for the vast majority of American cities, due to economic, geographic and population reasons, highways will continue for as far as we can see into the future to serve as *the* principal or sole means of transportation, including bus mass transit, which is the major part of all mass transit.

25. They say our cities are continuously enmeshed in hopeless traffic jams. The *fact* is that, generally speaking, except for the morning and afternoon rush hour, there is no real problem–people can travel quite freely in their cars in all directions throughout the entire metropolitan areas. The problem is to reduce the rush hour congestion . . . Overall, our highway system works at only about 25 percent of its theoretical capacity. During many hours of the day and night, it has large amounts of capacity not being used. We need to recognize this fact and build a solution on it.

26. They say, too, that we are paving over our cities. The *fact* is that as much area was used in cities for horses and wagons and buggies in pre-automobile days as is being used today. Right here in Washington, D.C., for example, a higher percentage of the city was devoted to streets when L'Enfant planned it almost two centuries ago than is used for streets today.

27. They say that highway construction adversely affects land values. The *fact* is that owners of property adjacent to improved highways almost always benefit in terms of land value gains; and improved highways freeways in particular - exert a very favorable influence on urban and suburban property values in general.

28. They say that highway construction results in ratables being removed from the tax rolls. The *fact* is that long-range effects of highway construction on tax rolls is generally very favorable. Highway improvements almost always result in the development of vacant and other unproductive land. Thus, the loss of some property from the tax rolls is offset by increased assessments on property which benefits from highway improvement or construction, and thus there is in the big majority of cases a net gain rather than a loss.

29. They say new freeways bring more air pollution to a city. The *fact* is just the opposite. Freeways tend to reduce stop-and-go driving, and this, in turn, greatly reduces the emission of air pollutants and the production of undesirable noise.

30. They say that automobiles have no redeeming social values. The *fact* is that the automobile has vastly expanded the horizons and the freedom of the working man, and has opened up to him wide new recreational vistas.

The Air Is Getting Cleaner (Too Bad It's Still a Secret)

CHRYSLER MOTORS CORPORATION

Remarks by Mr. C.M. Heinen, Executive Engineer-Materials Engineering, Chrysler Corporation, before the Society of Industrial Realtors of the National Association of Real Estate Boards, at the Deauville Hotel, Miami Beach, Florida, on Saturday, November 13, 1971.

"The Air Is Getting Cleaner" (Too Bad It's Still a Secret)

Cleaner air, cleaner water and a cleaner earth have become top national goals and rightfully so. It is essential that each of us make a contribution, big or little, to maintain or improve the quality of life on our earth. We owe this to ourselves, of course, but what is even more important, we owe it to future generations.

My own stake in future generations is quite a large one. I have seven daughters and their welfare is the most important factor in my life

Today, I am here to discuss automotive emissions and how they fit into the overall air pollution problem. It is a pleasure and a privilege to have been invited by you to do so.

What I will present may surprise you. It is, however, the most up-to-date information on air pollution as we know it. Much of it comes from government sources. Most of the information has been discussed before various government bodies. They have read and studied the facts you are about to hear. No one has challer [illegible] disputed them.

The facts are in serious disagreement with much that you may have been led to believe by some government officials, by highly vocal activist groups, and by other supposedly authoritative sources.

Private industry, and particularly the auto companies, have been accused of a credibility gap. We have felt the force of this public disbelief. Out statements too often are ignored or discounted.

The finger is almost always pointed at the automobile as the biggest, the most dangerous polluter. We are accused of doing nothing to reduce vehicle emissions. We have been told that the industry has dragged its feet on the problem Then, we have been pictured as the Detroit monsters who don't care about air pollution and what it does to human beings.

Worse yet, the doomsday prophecies have been believed--by our children and grandchildren, by our senior citizens, our neighbors, our teachers, and other members of our national community. Instead of being responsibly educated, our citizens have been needlessly frightened. We have enough normal worries in our daily lives without unnecessarily adding the air we breathe to the anxiety list.

Misinformation is the foundation of crippling programs that are premature, unrealistic, unnecessary and costly - but politically and popularly very convenient.

Frantic measures to over-control automotive emissions cannot be justified during most of this decade. The truth of the matter is that in many areas of pollution control, we are making good progress and specifically that automotive emissions are being, and will continue to be, drastically reduced without the necessity for crisis actions.

Let us look at the facts.

For example, the public is almost completely unaware that they have been buying and driving cars with anti-pollution equipment since the 1963 models. The latest model year cars incorporate more effective systems for greater reductions of pollutants.

Another fact is that *starting with the 1970 models, the auto industry began to build low-emission vehicles.*

CHART I: Automotive Atmospheric Improvements in the United States

1. Auto emissions climbed to their peak in the atmosphere about 1968 and have been going downhill since then.

2. Emissions will continue to go down each year, even though car population will rise and vehicle miles driven will go up. That means that the air is already cleaner today than last year or the year before. It will be cleaner year by year through the 1970's and the 1980's.

3. By the early 1980's, we will have air quality — from an automotive standpoint — nearly comparable to the 1940's. Normally, it takes between 10 to 15 years to replace the older, higher-emission cars in the vehicle population. Putting it another way, if there were no other vehicles on the road today, except the 1971 models,* we would, overnight, breathe the same clean air we had in the 40's as far as the automobile contribution is concerned.

   Even if we achieved the impossible by inventing and building zero-emission vehicles today, it still would take up to 15 years to replace the car population.

*The 1973 models are further improved.

4. After emissions hit the low point in the air somewhere in the 90's, they will start going up gradually as more cars keep being added to the population — assuming, of course, no further reductions in auto emissions beyond that already programmed through 1974.

Viewing this automotive air quality chart, it's hard — in fact, impossible — to see any automotive air pollution crises or a desperate need for immediate, radical, costly government action to clean up the automobile.

Needless to say, we are rather proud of our product and environmental achievements to date and of the technical projects we have in mind for the future. What particularly pleases us is that the engineering of low-emission levels, current and future, is being done at the most reasonable cost to the customer by using engine modification and other reasonably priced approaches.

There have been efforts to discredit this chart. One misconception that has been greatly publicized is that our emission control devices don't hold up in customer use and thus fail to meet government standards. These reports are wrong.

The effective performance of emission systems in use was confirmed by tests of the Environmental Protection Agency on rental cars and other field cars, by exhaust tests run in California on cars selected at random, by Chrysler exhaust tests of vehicles coming off its assembly lines, and by similar tests on Chrysler customer cars after usage.

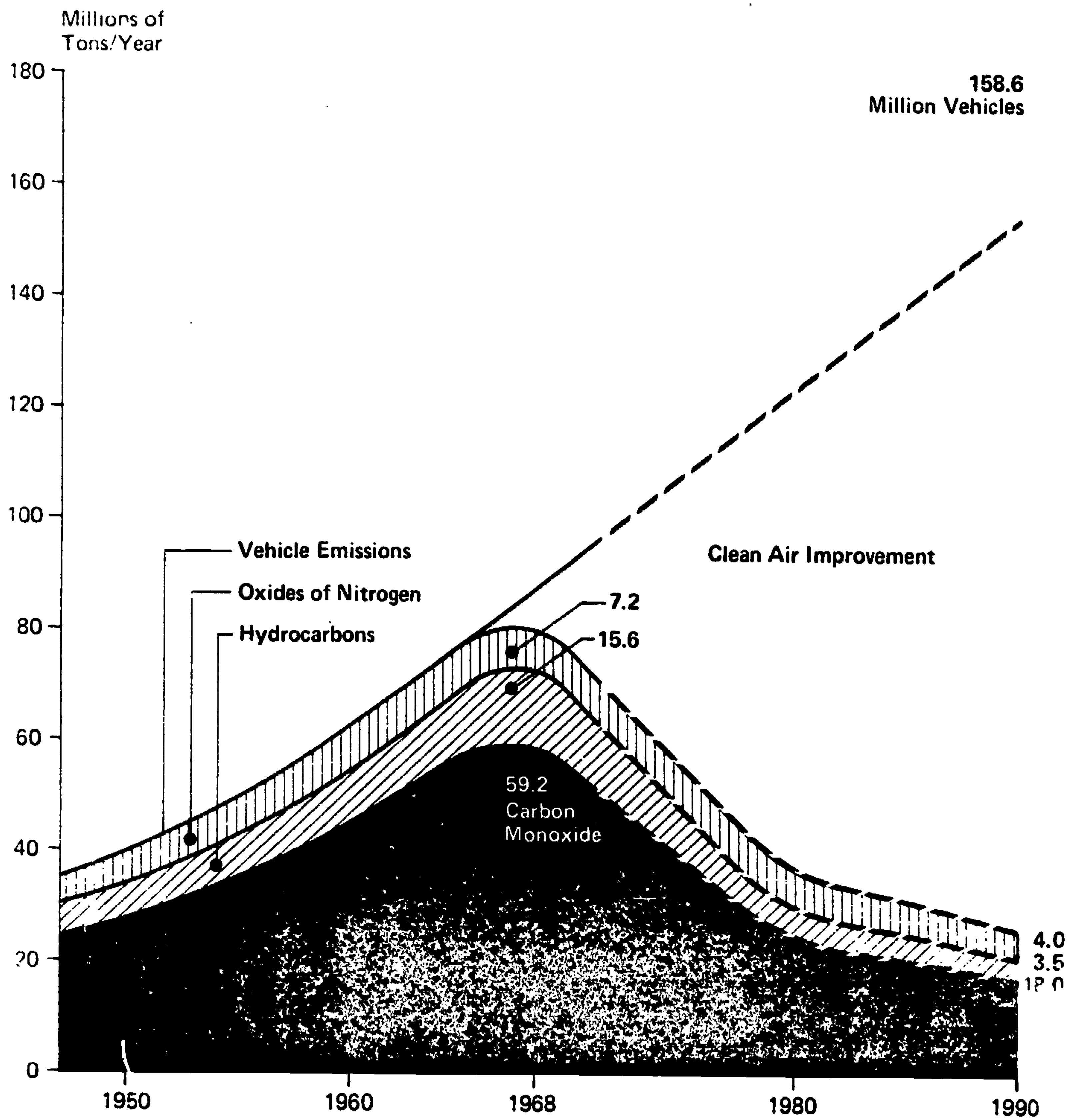
It is true, however, that we do expect about a 10 to 15 percent loss of effectiveness in our emission devices after many miles of use. Anticipating this, we design our systems to handle this loss after use, and still meet the emission standards on averages.

On the other hand, there is no getting around the mechanical and electrical facts of life, that every vehicle needs periodic maintenance to insure high standards of emission control performance. One dead spark plug can increase pollutant emissions by 10 to 15 times. One spark plug misfiring may double the output of hydrocarbons. A carburetor set for too rich an air-fuel mixture can increase carbon monoxide by 50 percent or more.

Every motorist can contribute to cleaner air by keeping his car in good service condition.

BEST COPY AVAILABLE

Automotive Atmospheric Improvements In United States*



*Chrysler estimate of emission reductions that could be achieved through further development engineering using the engine modification approach.

CHART 2 U.S.A. Air Pollution All Sources 1968 Estimate by Weight

The 1968 study by the Department of Health, Education and Welfare (now a part of the Environmental Protection Agency) revealed that the automobile contributed about 39 percent of the total pollutants into the atmosphere while other sources delivered 61 percent of the pollutants into the air.

U.S.A. Air Pollution—All Sources 1968 Estimate By Weight

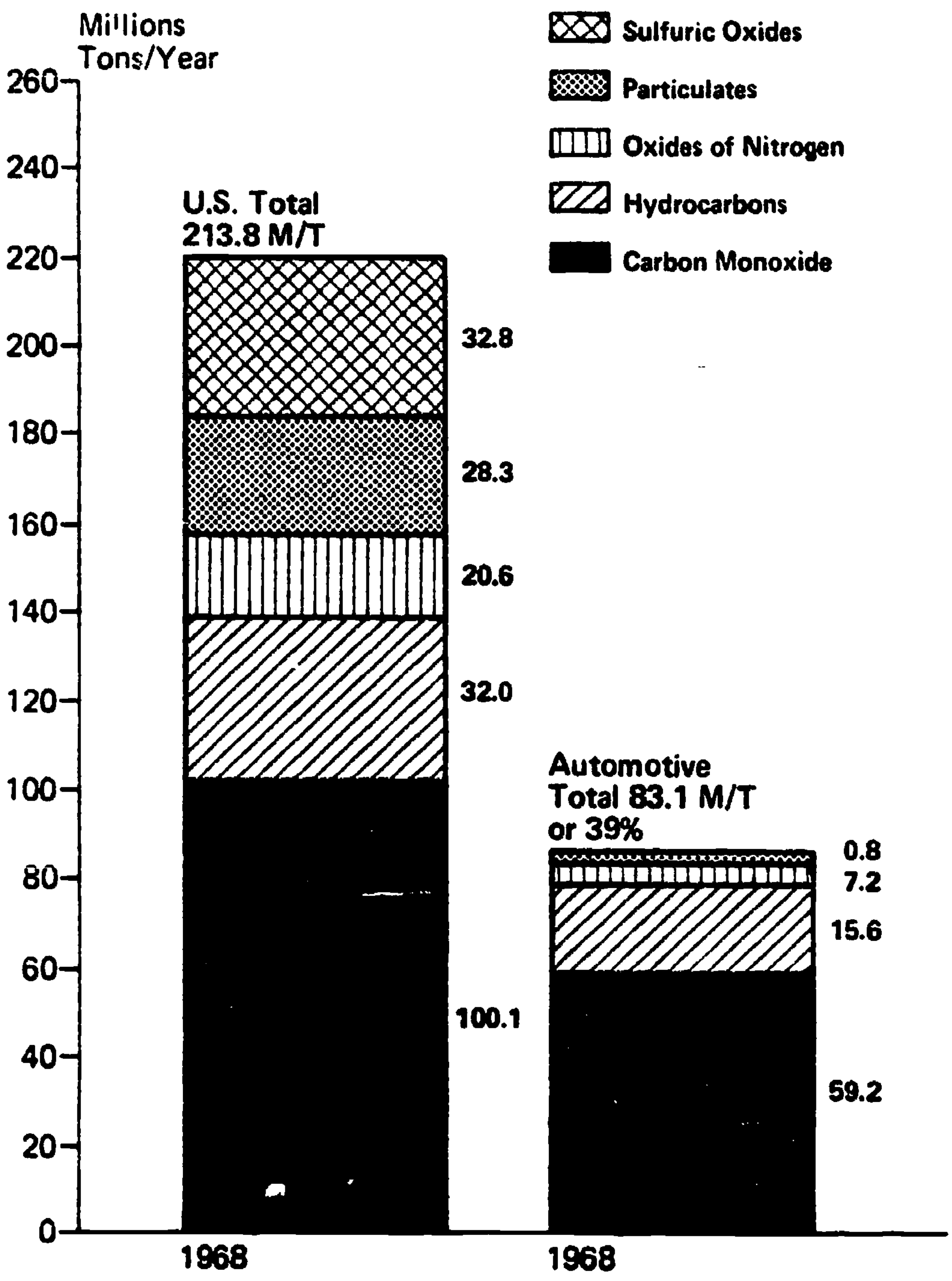


CHART 3 Evaluation of U.S. Air Pollution by Environmental Effects

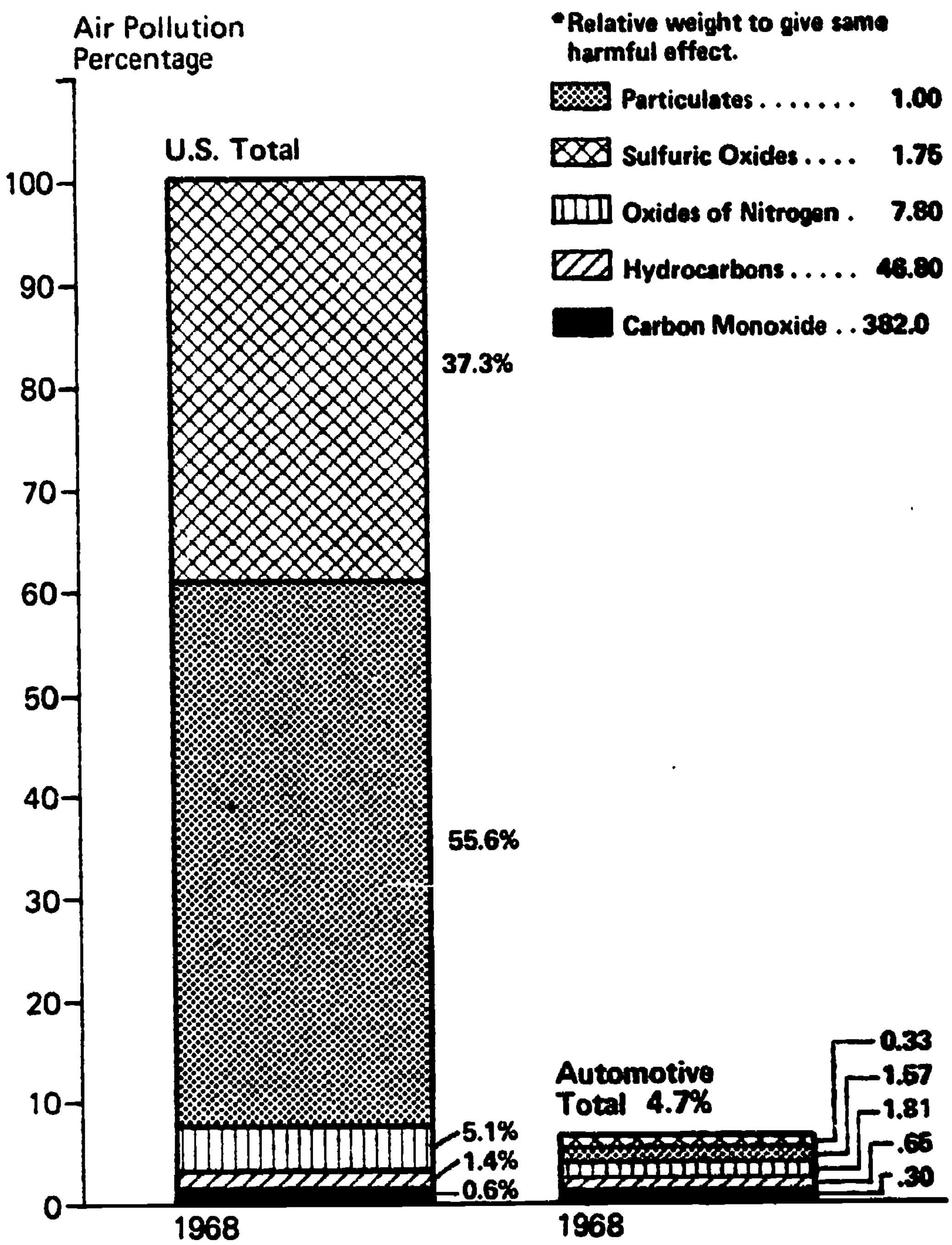
It is very common for reports on air pollution levels to be expressed in total tonnages of each pollutant as shown in the two previous charts. This chart, however, gives a more scientific evaluation in terms of the toxic properties of each pollutant.

All pollutants in the atmosphere do not have the same degree of importance. For instance, a given concentration of sulfur dioxide is [illegible] 200 times more harmful than an equal concentration of carbon monoxide. Comparing the two pollutants on a tonnage basis is about the same as saying that a bottle of beer is the equivalent of a bottle of whiskey.

This chart uses the 1968 estimates by the EPA and evaluates them in terms of the importance placed on each pollutant by the State of California authorities. In these terms, the automobile constitutes only about five percent of the problem. This will be true even with the increased vehicle population in the future.

The following three charts will demonstrate the emission reductions that have been and will be accomplished by using the [illegible] engine modification approach.

Evaluation Of U.S. Air Pollution By Environmental Effects*



*Using California determined air quality standards (Hydrocarbon determined by ratio to oxidant)

CHART 4: Vehicle Model Year Average Reduction of Carbon Monoxide in the United States

On the 1971 models, about 70 percent of the carbon monoxide has been eliminated from vehicle exhausts. Chrysler engineers believe that with normal further development of the engine modification system, carbon monoxide can be cut up to 76 percent by 1975.

CHART 5: Vehicle Model Year Average Reduction of Hydrocarbons in the United States

Hydrocarbons have been decreased about 83 percent on the 1971 model, and could go down by 88 percent by 1975, with engine modifications alone.

CHART 6: Vehicle Model Year Average Reduction of Oxides of Nitrogen in the United States

We took the first bite at reducing oxides of nitrogen with the 1971 California vehicles. These emissions, often referred to as NOX went down 33 percent in 1971, and will go down 50 percent in 1973, and 58 percent in 1975, according to our estimated projections.

Incidentally, the reason for governmental reluctance until recently to control NOX emissions was the uncertainty among involved scientists of its precise role in forming smog. There has to be a proper mix, or ratio, between hydrocarbons and NOX before a Los Angeles type of photochemical reaction occurs. One theory has it that if hydrocarbons were reduced and NOX levels were untouched, the ratio would change and smog could not take place.

This same theory holds that if total quantities of both emissions were reduced, the ratio between the two could remain about the same with the result that smog would not disappear and could perhaps increase. The disagreement still persists, but the decision to control NOX was finally taken and we in the industry were told to go ahead to start reducing it. Incidentally, I agree with the decision.

Chart No. 4 Vehicle Model Year Average Reduction Of Carbon Monoxide In The United States*

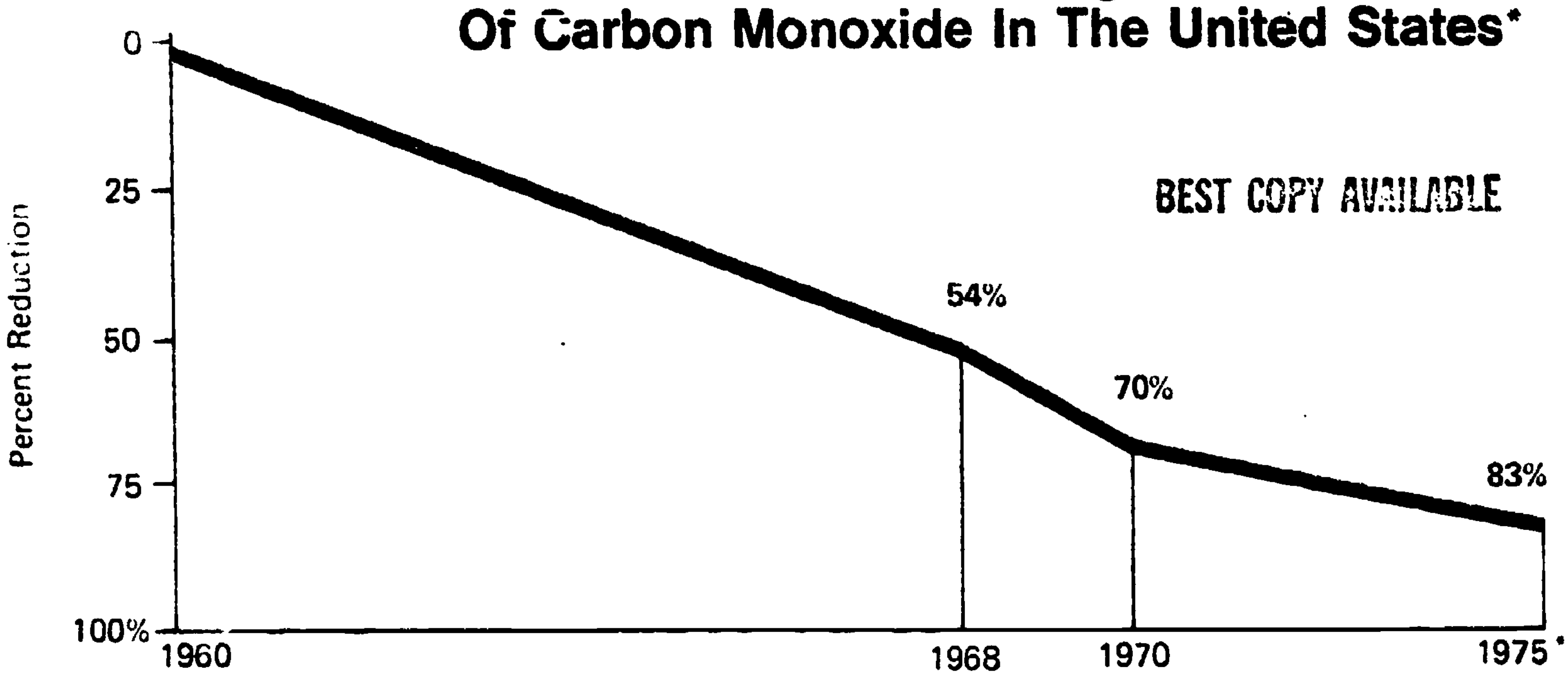


Chart No. 5 Vehicle Model Year Average Reduction Of Hydrocarbon In The United States*

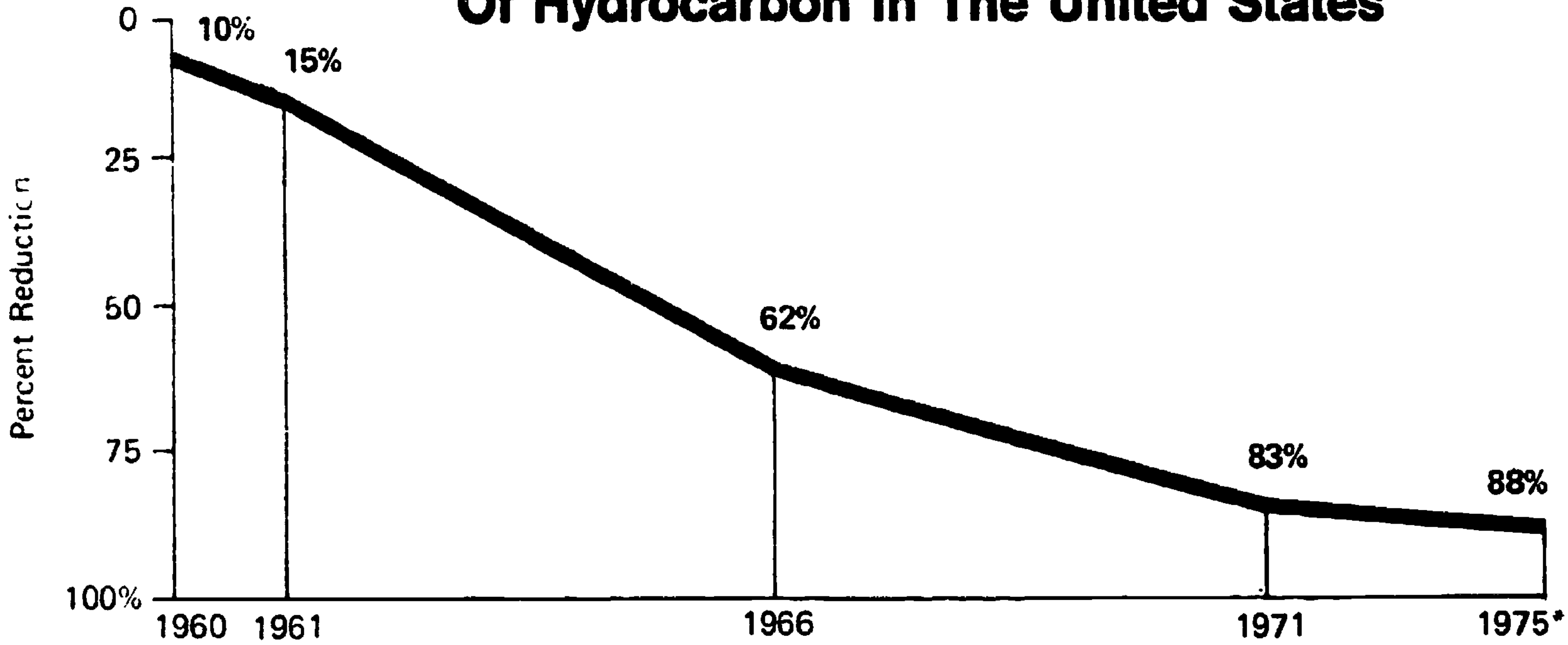
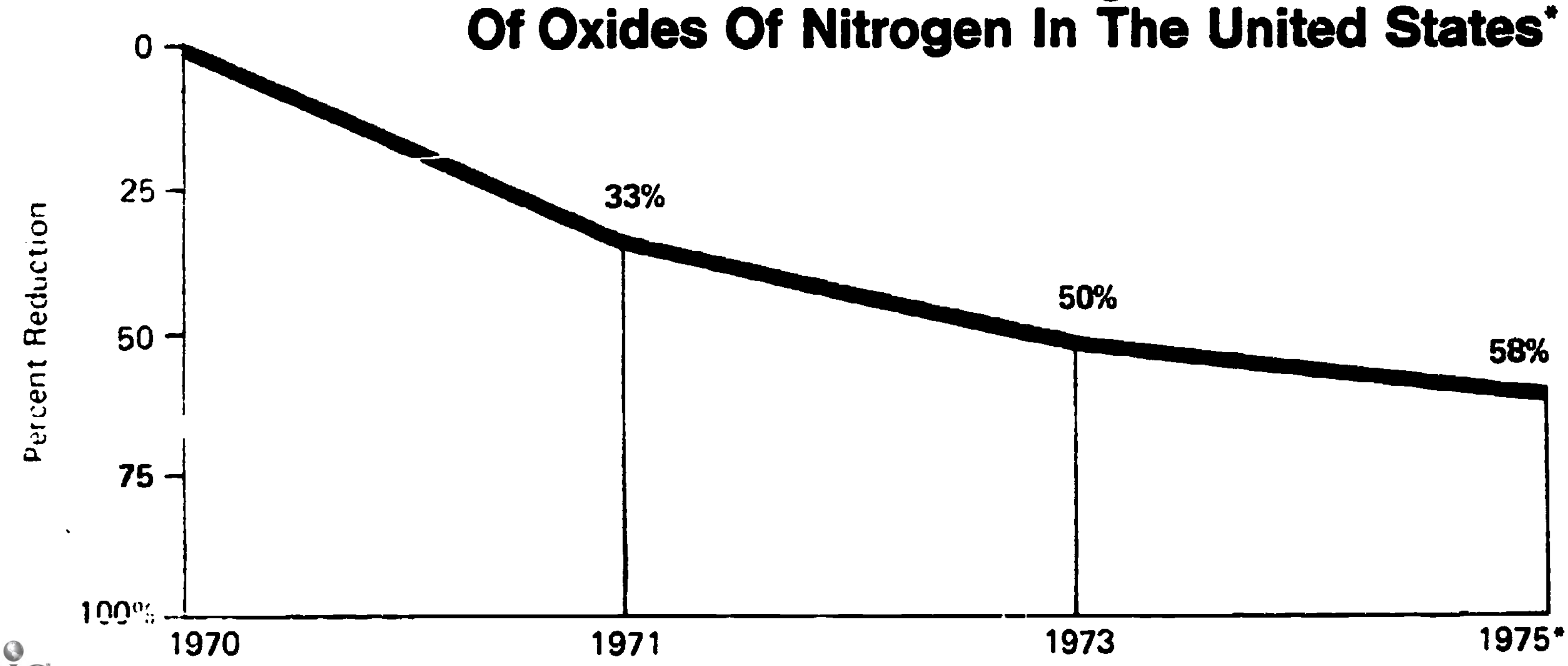


Chart No. 6 Vehicle Model Year Average Reduction Of Oxides Of Nitrogen In The United States*



*...emission reductions that could be achieved through further development engineering using the engine modification approach

CHART 7: All Sources - U.S.A. Atmosphere. Comparison of Various Vehicle Improvement Levels. Carbon Monoxide.

As you can see, these specified Federal levels in each chart are the lowest line shown. What has been labeled "Chrysler" is the lowest value attainable with engine modifications. In order to get proper perspective, the contribution of the other sources at the present level is shown.

Our current levels of carbon monoxide are slightly lower than those in Great Britain. Their doctors have decided that no lowering is required. This is understandable since our average level is such that after eight hours in downtown bumper-to-bumper traffic, the increase in blood content of CO is about the same as after smoking two cigarettes in one hour.

The Cleaner Air Act calls for standards so low that if they were achieved and there were no other source than the automobile, there would be less CO in the city than that which occurs naturally in the farmland country or the middle of the ocean.

CHART 8: All Sources - U.S.A. Atmosphere. Comparison of Various Vehicle Improvement Levels - Hydrocarbons

The present hydrocarbon standards are already very low and will result in levels which were generally agreed to be adequate through 1990; that was before the current crisis race for lower standards was started. Hydrocarbons, at atmospheric concentrations, have no known negative reactions but are the most important ingredient in the photochemical reaction known as Los Angeles smog.

The Cleaner Air Act asks that the hydrocarbon emissions from a vehicle in daily use would be about the same as the hydrocarbon fumes that are given off by an average homeowner's yard with a normal planting of grass, flowers or vegetables.

The fumes lost during the filling of a gallon of gas at a service station will be twice as much as is allowed during its use of the gasoline in driving the car.

CHART 9: All Sources - U.S.A. Atmosphere. Comparison of Various Vehicle Improvement Levels. Oxides of Nitrogen.

Oxides of nitrogen, the other ingredient of the photochemical reaction, show an interesting control picture. At atmospheric levels it is difficult to show any health effects, and measurements much below these levels are generally agreed to be inaccurate.

Considering that the automobile is not the major contributor of this pollutant, the 1973 levels specified by EPA very properly suggest a holding action until more is known.

The Chrysler value shown is our judgment of what could be achieved without major cost or performance penalty. The Cleaner Air Act will produce both.

Oxidants or Smog Compounds

One group of pollutants for which the automobile is largely responsible has never been measured in tons. These are oxidants–the chemical elements of smog. Oxidants or smog are created by a photochemical reaction between hydrocarbons and oxides of nitrogen. Fortunately, studies have not shown any major, long-term health effect. But just the short-range effects of real Los Angeles smog should convince anybody that this miserable, depressing, eye-irritating pollution mess has got to go. In my mind, it was, is, and will continue to be, the number one goal of our automotive emission program. Unfortunately, even today, we don't know quantitatively what will be required to reduce oxidants to acceptable levels.

Chart No. 7 All Sources—U.S.A. Atmosphere Comparison Of Various Vehicle Improvement Levels*

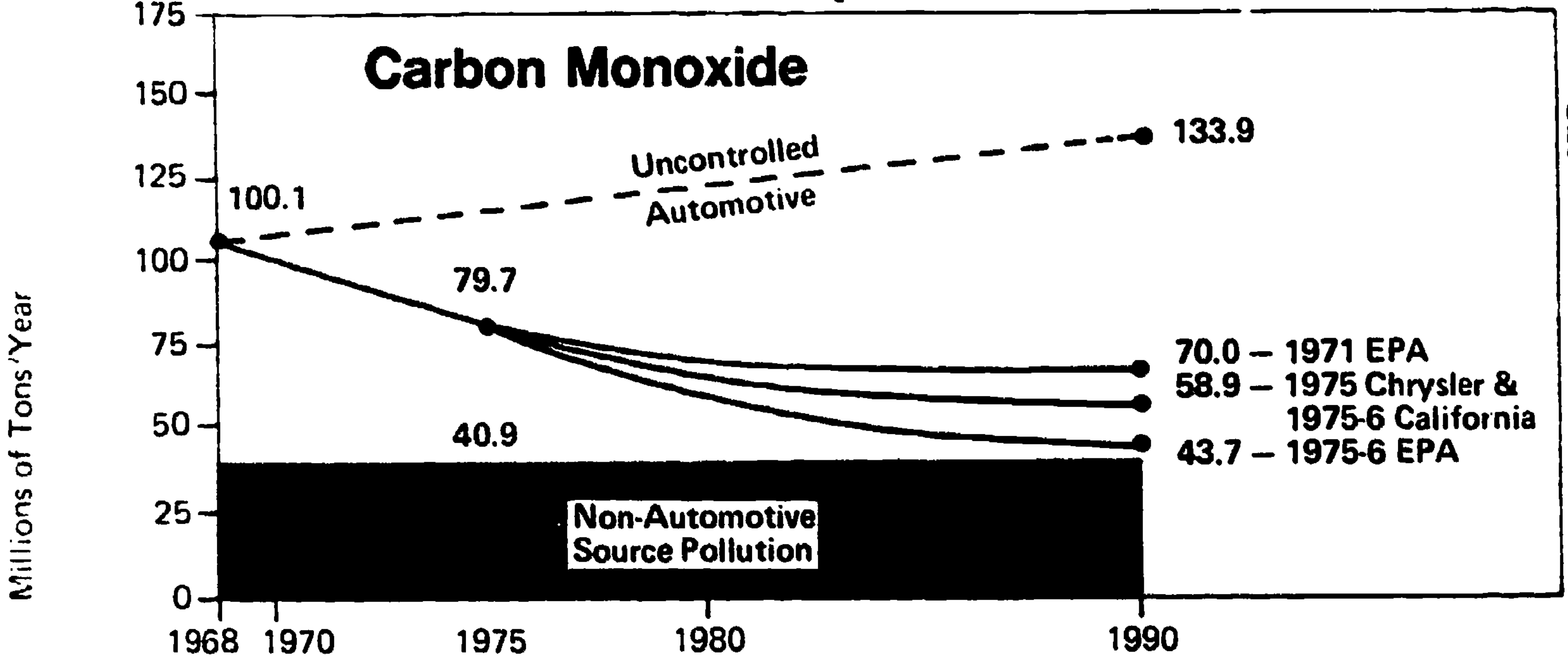


Chart No. 8

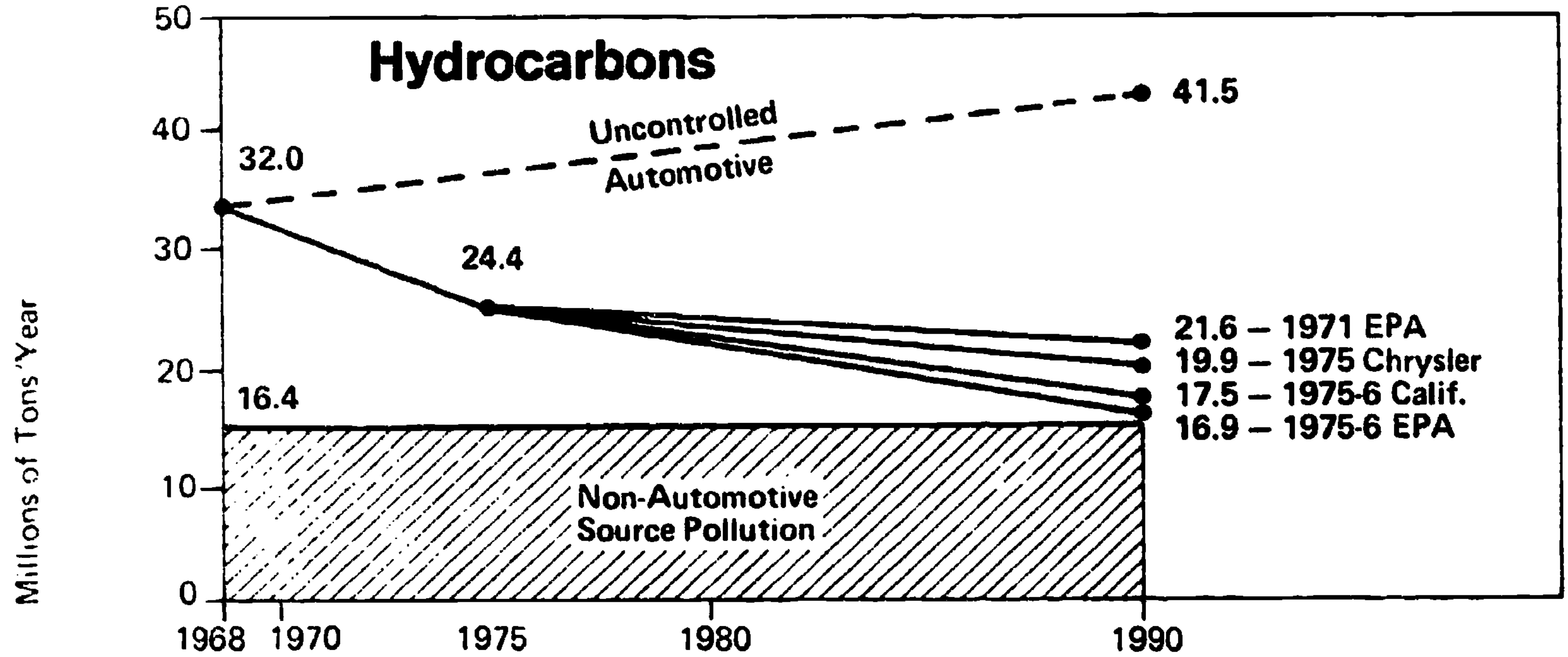
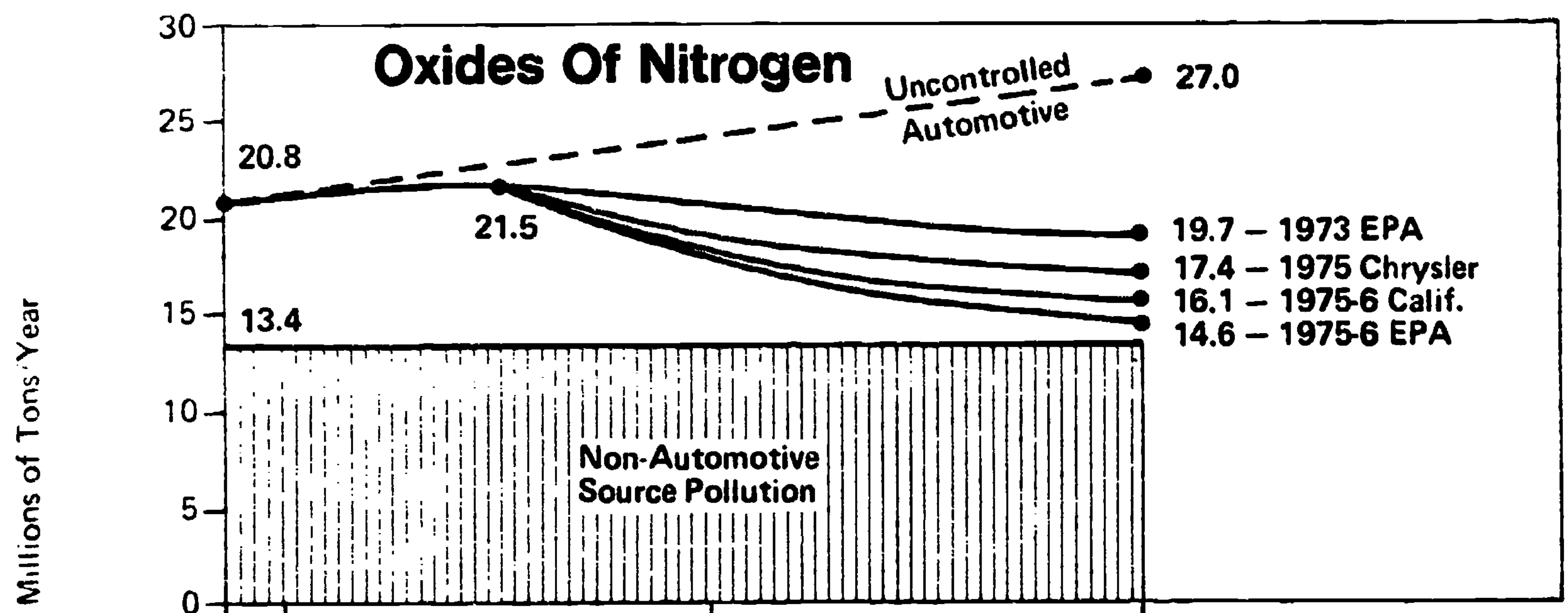


Chart No. 9



*Based on assumption that pollutants from non-automotive sources remain constant.

DISCUSS FROM THREE ECONOMIC CHARTS

The next charts show the economic effects of accomplishing the various pollution levels proposed. In each case, costs are for modification of the internal combustion engine as we know it today.

There are only two approaches which seem to have any possibility of being brought into production by 1975. These are the manifold reactor and various catalyst systems, either singly or in combination.

You will have noted that I have not mentioned alternate power sources as possibilities for 1975, such as electric cars, turbine, steam and others. Although we have worked energetically on all of them, major breakthroughs have to occur before they can become candidates for personal transportation on a mass production basis. Because of the technical obstacles in the development of alternate engines, we had no other choice except to further clean up the piston engine vehicle.

Three main points emerge:

1. Increasing oxides of nitrogen control has a strong effect on both fuel economy and cost of control equipment. This is primarily because all known usable oxides of nitrogen controls result in engine inefficiency and greater amounts of other pollutants to be handled in the exhaust.

2. Costs rise very dramatically for the last few degrees of control, so cost effectiveness decreases.

3. The magnitude of the costs is such as to make the proper determination of the emission level a major economic decision.

The point of all this is that vast sums of money may have to be spent to make relatively slight reductions in emissions. Clean air projections indicate there doesn't appear to be any justifiable hurry to obtain the clean air targets in the time frame that is proposed.

It, therefore, seems reasonable and appropriate to allow more time for the automotive and nonautomotive industries to research and develop advanced experimental devices to a high state of reliability, durability and hopefully at much lower costs. I believe that by 1980, we will have learned a lot more about emissions technology in order to realize lower emission objectives through to the year 2000 and beyond.

Let me make it clear that Chrysler, the auto industry, and the government all agree on the goals of engineering low pollution vehicles. We also share the same ideals toward a better environment. The question of whether we control pollution is not the issue. Every decent human being would answer in the affirmative.

The question is not whether the auto industry is willing to produce emission-reduction devices if they are technically possible. We are a commercial enterprise. That's our business to engineer, build and sell transportation equipment. Whatever automotive parts we install on vehicles are bought and paid for by consumers.

The question really is to what extent, how fast, and how much money we as consumers and taxpayers have to spend to control each pollutant source. If we in this country had enough resources, we would agree to control all sources at the same time. Since we don't, are we then over-committing the nation's money to automobiles and not enough to other sources of air pollution? Could some of the money allocated to air pollution be diverted to solving the critical water pollution problem? How about solids' waste disposal and research?

Under no circumstances should there be a misunderstanding regarding the concern we all share concerning the health effects of environmental pollution. We urgently need more medical research on this subject. The automobile industry is sponsering this and other kinds of research to explore the unknowns.

Chart No. 10 Emission Control Vs Customer Cost 1960 Baseline

Millions of Tons/Year

	HC % Less	CO % Less	NO_x % Less	Fuel Penalty	Incremental Customer Cost*
– 1972 EPA Standards	83%	69%	0	0-2%	+$ 51.00
– 1973 California Std.	84%	69%	50%	3%	+ 128.00
– Lowest emissions without catalyst or reactor	88%	83%	58%	5-10%	+ 165.00
– 1975 Calif. standard requires catalyst or reactor	95%	80%	75%	5-10%	+ 245.00
– Current Chrysler 1975-76 program	95%	91%	75%	7-12%	+ 524.00
– 1976 EPA Standards	98%	97%	93%	25-30%	+ 675.00

*Includes standard warranty provision but not the 50,000 mile performance warranty.
Does not include assembly line testing.
Emission numbers are average values.

Chart No. 11 Estimated Costs 1975-1990 And Resulting 1990 Automotive Emissions

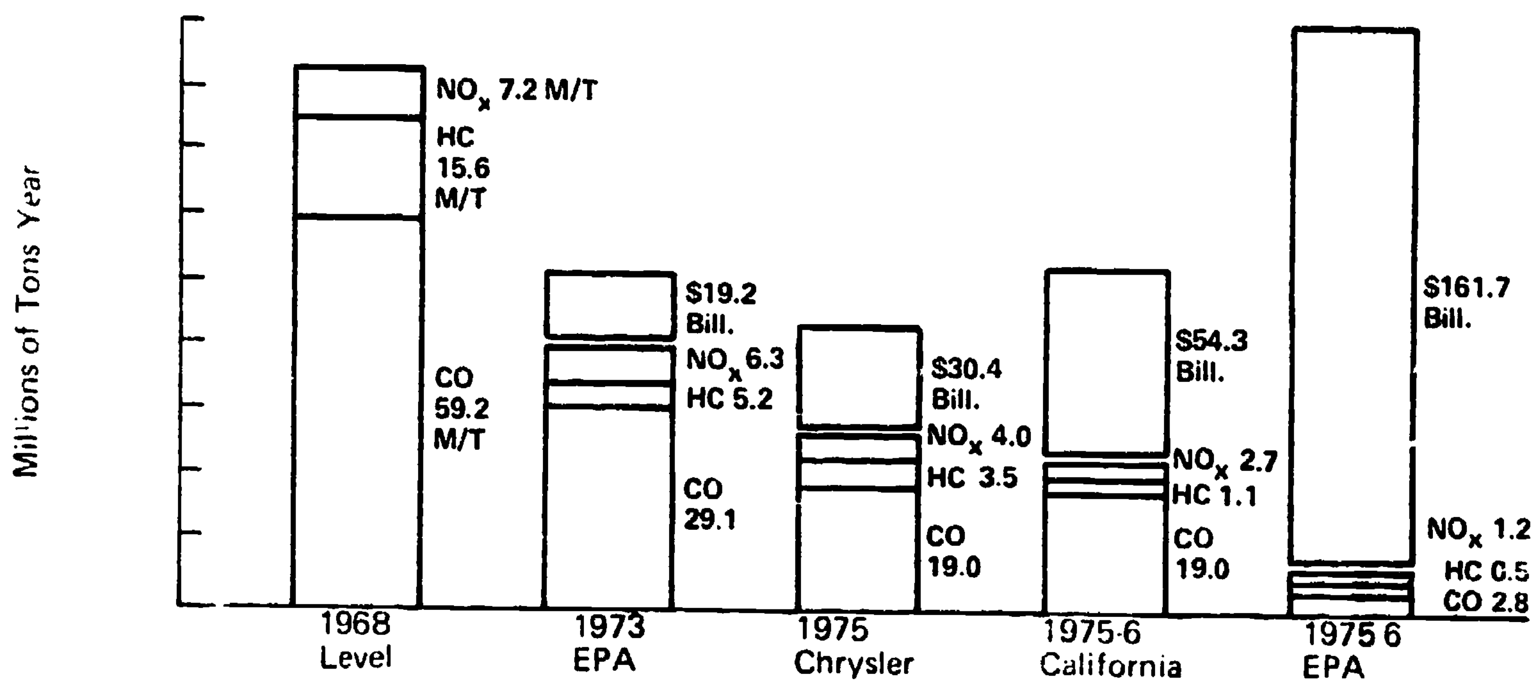
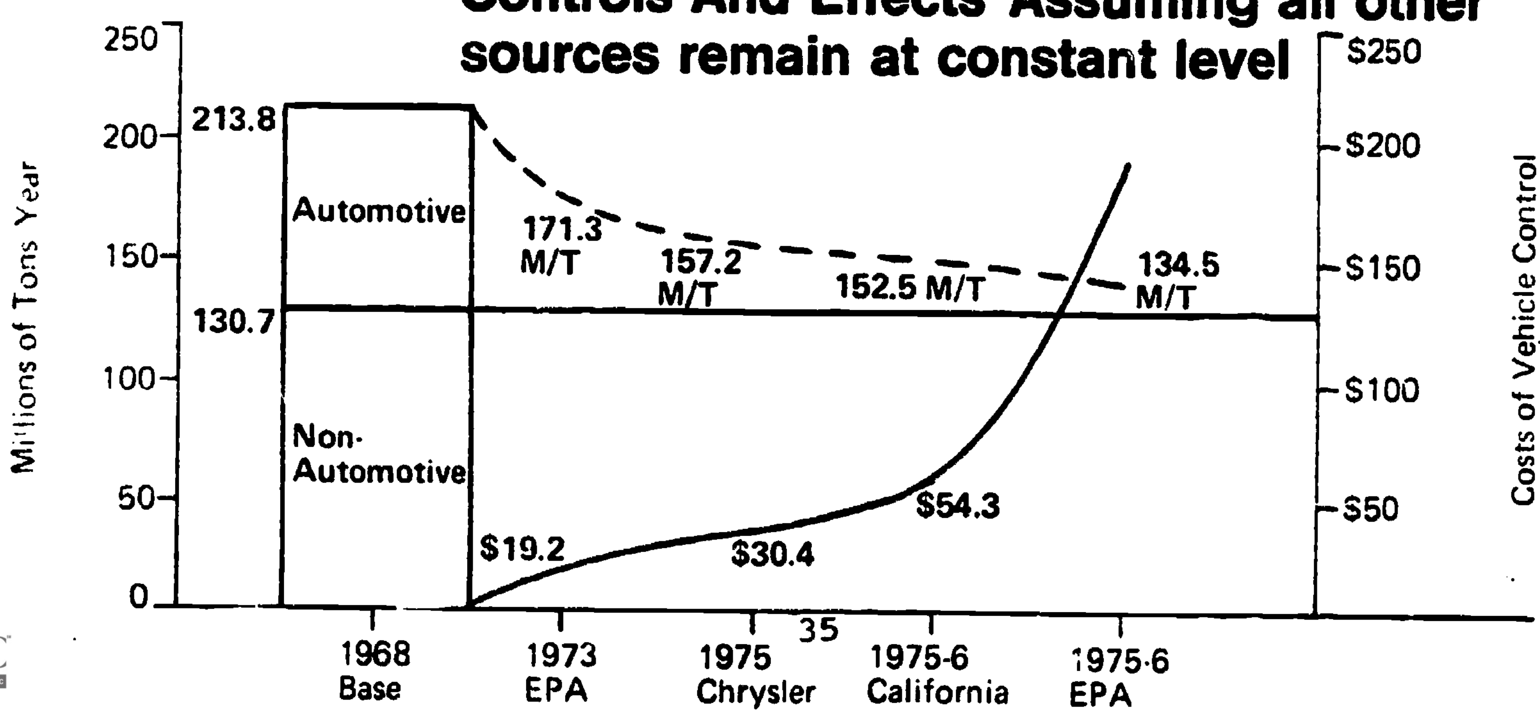


Chart No. 12 Estimated Costs 1975-90 Of Various Auto Controls And Effects Assuming all other sources remain at constant level



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Take Three Giant Steps to Clean Air, Environmental Protection Agency, Washington, D. C.

CONCEPTS: PACKET 6

I. Collecting and comparing air samples at certain sites with air quality standards will determine if air pollutants are below acceptable legal levels.

II. Technological modification of the present internal combustion engine could reduce the effect of the auto as a source of pollution.

III. An alternative to the present internal combustion engine will reduce auto emissions.

IV. The substitution of mass transit for automobiles is a possible solution to the reduction of air pollution.

V. Technological advances, including electrostatic filters used in industrial air purification systems are being developed.

Concepts	BEHAVIORAL OBJECTIVES
I	1. After touring the St. Louis City or County air testing site(s) the student will write a paragraph describing the manner by which air quality is measured.
I	2. After completing the assigned activities, the student will state in writing 200 words or less, the relationship of the emission levels in the St. Louis area to the air quality standards which have been established.
II	3. After completing the assigned readings the student will list three technological modifications of the internal combustion engine that might reduce auto emissions.
III	4. After completing the assigned readings, the student will participate verbally at least three separate times in a group discussion on the alternatives to the present internal combustion engine. Following this the student will list three alternatives to the present internal combustion engine.
IV	5. Given the various models for mass transit, the student will participate verbally at least three separate times in a group discussion on the benifits and problems of mass

transit systems as a possible solution to reducing air pollution. Then the student will select from a list the major benefits of mass transit systems as they relate to reducing air pollution.

V 6. After completing the assigned activities, the student will match the various technological advances in industrial air purification systems with the method by which each system operates.

At this time administer the pre-test.

PRE-POST TEST
PACKET 6

Behavioral Objective Number	
1	1. In the space provided below explain the manner in which air quality is measured in the St. Louis area.
2.	2. In 200 words or less, state the relationship between the emission levels in the St. Louis area and the air quality standards which have been established.

3 3. List three technological modifications of the internal combustion engine that might reduce auto emissions.

A. ______________________________

B. ______________________________

C. ______________________________

4 4. List three alternatives to the present internal engine.

A. ______________________________

B. ______________________________

C. ______________________________

5 5. Select from the list below the benefits of mass transit systems as relates to reducing air pollution. Circle the correct choice(s).

A. Mass transit systems will permit more people to live in metropolitian areas.

B. Mass transit systems should reduce the use of the automobile.

C. Mass transit systems will bring more tax money to the cities they serve.

D. Mass transit systems will eliminate the automobile as a means of transporation.

6 6. Match the name of the industrial air purification system with the method by which each system operates.

A. Electrostatic precipitators

B. Scrubbers

C. High smoke stacks

D. Cyclones

____ 1. takes the emission to higher elevations and disperses it over a wider area but does not purify the emission

____ 2. eliminates particulates by passing them between charged plates

____ 3. washes particulates out of the emission

____ 4. through centrifugal action, larger particles are forced to the outside and collect at the bottom in a large bag.

PRE-POST TEST ANSWER KEY
PACKET 6

Behavioral Objective Number	
1	1. In the space provided below explain the manner in which air quality is measured in the St. Louis area.
	There are two basic ways which ambient air is measured. St. Louis County has remote telemety stations and hi-volume samplers, which make use of filters and settling traps to capture particulates and other pollutants.
2.	2. In 200 words or less, state the relationship between the emission levels in the St. Louis area and the air quality standards which have been established.
	It is very doubtful that any student will answer the question when taking the pre-test. The data, which the students will gather during the packet will provide the answer to this question. The reason for this tentative answer is because the relationship asked for in the question is a variable depending upon the date this unit is studyed.

3 3. List three technological modification of the internal combustion engine that might reduce auto emissions.

A. blow-by devices D.different carburetors

B. catalyst E. after burners

C. PCV Valves F. crankcase scavenger

G. devices to prevent the gas evaporation

4 4. List three alternatives to the present internal engine.

A. electric cars

B. turbine engine

C. wankel engine

D. stratified charge engine and others could possibly be mentioned.

5 5. Select from the list below the benefits of mass transit systems as relates to reducing air pollution. Circle the correct choice(s).

A. Mass transit systems will permit more people to live in metropolitan areas.

B. Mass transit systems should reduce the use of the automobile.

C. Mass transit systems will bring more tax money to the cities they serve.

D. Mass transit systems will eliminate the automobile as a means of transporation.

6 6. Match the name of the industrial air purification system with the method by which each system operates.

A. Electrostatic precipitators

B. Scrubbers

C. High smoke stacks

D. Cyclones

__C__ 1. takes the emission to higher elevations and disperses it over a wider area but does not purify the emission

__A__ 2. eliminates particulates by passing them between charged plates

__B__ 3. washes particulates out of the emission

__D__ 4. through centrifugal action, larger particles are forced to the outside and collect at the bottom in a large bag.

BACKGROUND INFORMATION
PACKET 6

Science is developing or has developed some devices that can help keep the air we breathe clean. However, the first step in solving the problem is measuring the various pollutants in the ambient air. Both St. Louis City and St. Louis County have monitoring stations. The two main types of monitoring stations are remote telemetry stations and stations without telemetry. The telemetry stations are able to measure pollution levels at an appreciable distance while the stations without telemetry measure only local pollutants.

Air pollutants are measured two ways. Most of the time, filters are used. A second method employs settling to trap particles. Open containers or glass slides coated with a sticky material are placed in strategic locations for varying time intervals.

The map on page 69, enables the instructor to locate the monitoring stations. Both St. Louis City and St. Louis County provide tours to these monitoring stations. An explanation of how to go about obtaining the tours and services provided by the Air Pollution Control Boards can be found in the teacher instructions for this packet.

Mass transit systems are not new in their concept. The old street car lines were form of mass transit systems. Some students visualize mass transit systems as being some ultra-modern, superfast monorail. A good bus system should also be included in a discussion of mass transit systems.

The San Francisco Bay Area Rapid Transit (BART) is the mass transit system used by many as the model system for the future. Recently however, BART has developed mechanical problems. Run by computers, breakdowns have occurred. During the summer of 1973, the system was shut down by a labor strike. Rapid mass transit might be one possible cure for reducing air pollution, but like most systems of transportation, it is not without faults.

The automobile industry has two possible directions it can follow in reducing air pollution. The present internal combustion engine can be modified with various devices or a completely new engine can be developed. This new power system can be another internal combustion engine, such as the wankel or turbine, or some alternative to the internal combustion engine, such as the electric car. One possibility for the future, is an electric car for local driving and a car with some type of internal combustion engine for longer distance driving.

Unlike the automobile manufacturers, stationary industrial polluters have been developing satisfactory divices to reduce air pollution. Briefly, some of the devices are as follows:

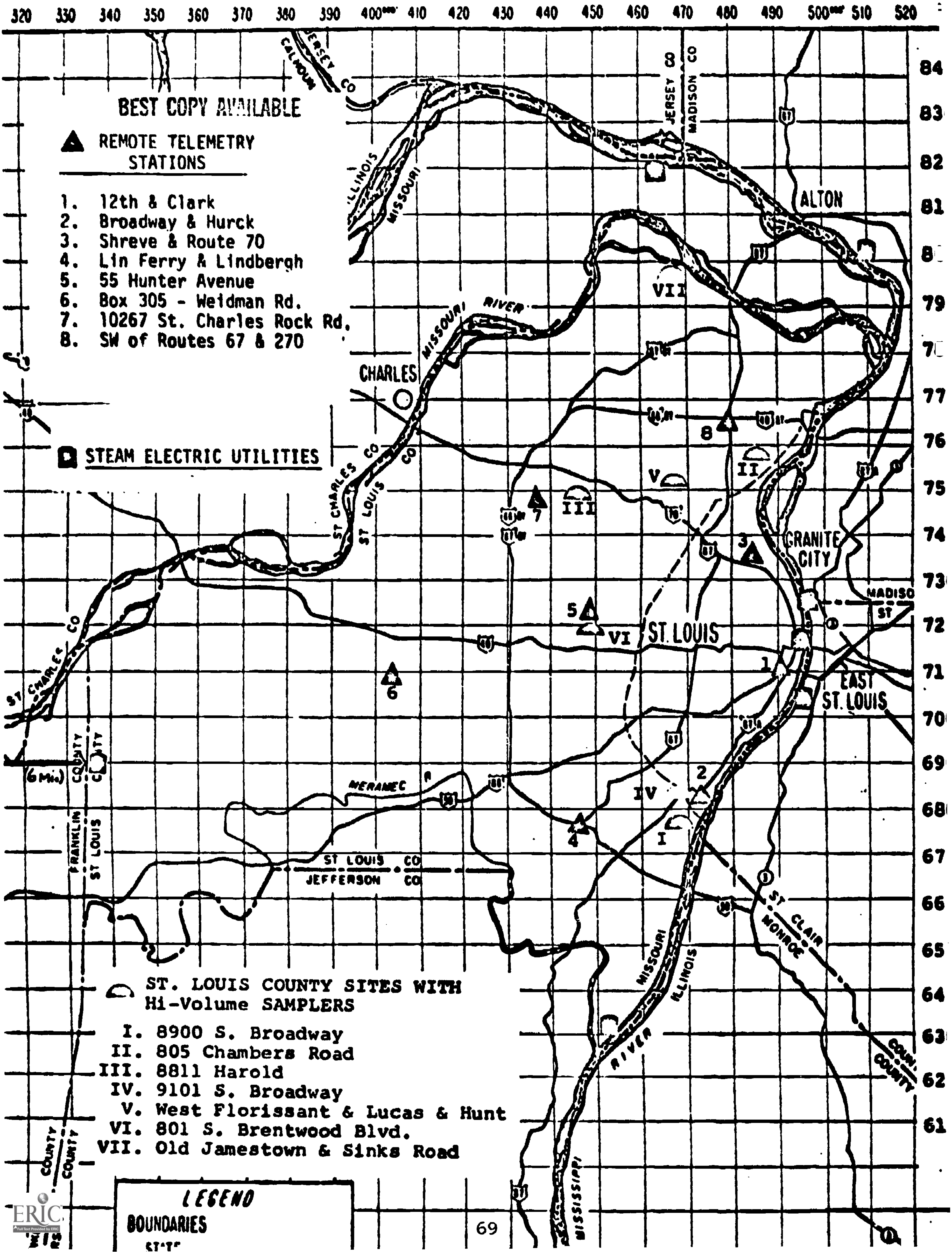
1. Scrubbers - These devices use water to eliminate pollutants from air emissions. The problem with scrubbers, is that pollutants are taken out of the air and put then into the water.

2. Electrostatic Precipitators - The emission is passed through electrically charged plates. These plates collect the pollutants. Then occasionally, the plates are vibrated to cause the collected particles to fall into collection bags at the bottom of the precipitators.

3. Cyclones - Through centrifugal action larger particles are forced to the outside of the device and fall into collection sacks at the bottom.

4. High Stacks - This is not a pollution control device. However, high stacks take the emission to a higher elevation and disperse it over a wider area. The reason why high stacks are included in this section is because sometimes industry places high stacks in the category of emission control devices.

There are other devices and some of the above mentioned devices are given different names. However, the first three items listed above, are some of the more commonly used devices.


BEST COPY AVAILABLE
REMOTE TELEMETRY STATIONS
1. 12th & Clark
2. Broadway & Hurck
3. Shreve & Route 70
4. Lin Ferry & Lindbergh
5. 55 Hunter Avenue
6. Box 305 - Weidman Rd.
7. 10267 St. Charles Rock Rd.
8. SW of Routes 67 & 270
STEAM ELECTRIC UTILITIES
ST. LOUIS COUNTY SITES WITH Hi-Volume SAMPLERS
I. 8900 S. Broadway
II. 805 Chambers Road
III. 8811 Harold
IV. 9101 S. Broadway
V. West Florissant & Lucas & Hunt
VI. 801 S. Brentwood Blvd.
VII. Old Jamestown & Sinks Road
LEGEND
BOUNDARIES
ALTON
CHARLES
GRANITE CITY
ST. LOUIS
EAST ST. LOUIS
MISSOURI RIVER
MERAMEC R
MISSISSIPPI RIVER
ILLINOIS
MISSOURI
JERSEY CO
MADISON CO
CALHOUN
ST CHARLES CO
ST LOUIS CO
ST LOUIS CO
JEFFERSON CO
FRANKLIN
ST LOUIS
ST CLAIR
MONROE
MADISON ST
(6 Mi.)
320 330 340 350 360 370 380 390 400 410 420 430 440 450 460 470 480 490 500 510 520
84 83 82 81 80 79 78 77 76 75 74 73 72 71 70 69 68 67 66 65 64 63 62 61

AIR QUALITY STANDARDS
St. Louis County

	Primary	Secondary
SO_2	.03 ppm - annual arithmetic mean .14 ppm - maximum 24 - hour average not to be exceeded more than once per year.	.02 ppm - annual arithmetic mean .10 ppm - maximum 24 - hour average not to be exceeded more than once per year. .50 ppm - maximum 3-hour concentration not to be exceeded more than once per year.
Particulate	75 ug/m^3 - annual geometric mean 260 ug/m^3 - maximum 24-hour concentration not to be exceeded more than once per year.	60 ug/m^3 - annual geometric mean 150 ug/m^3 - maximum 24-hour concentration not to be exceeded more than once per year.
CO	9 ppm - maximum 8-hour concentration not to be exceeded more than once per year. 35 ppm - maximum 1-hour concentration not to be exceeded more than once per year.	same
HC	.24 ppm - maximum 3-hour concentration (6 to 9 a.m.) not to be exceeded more than once per year.	same
NO_2	.05 ppm - annual arithmetic mean.	same
OX	.08 ppm - maximum 1-hour concentration not to be exceeded more than once per year.	same

INSTRUCTIONAL SEQUENCE
PACKET 6

Behavioral Objective Number	
	Concept I Required Activity:
1&2	A. The St. Louis Air pollution Control Laboratories offers a 60 minute tour for a maximum group of 15 students. Contact William L. Hager, Engineer, 453 3334. It is advisable to make reservations for this tour at least four weeks in advance.
	Mr. Jim Clark of the St. Louis County Air Pollution Control Commission, telephone 726 1000, will meet student groups at monitoring station(s) on the first Wednesday of each month.
	Available for the asking, are Air Quality Data Summary statistics. Both St. Louis City and County have these statistics in printed handouts. Ask both Bill Hagar and/or Jim Clark to bring some with them when the students take the field trips.
	The discussion (Activity A 3) is to be done after returning from the field trip.
	Concepts II, III, IV, V Required Activities:
3-6	A. Activity two is a reading assignment. However, the instructor should note that the readings provided in packet six are only superficial in their coverage of the various concepts and behavioral objectives. This is a good point in time to encourage or require additional reading. A plethora of data is available on these topics. Time and space limitations prevented more data from being included in the packet readings. Scientific American and Environment magazines are two excellent sources of information.
	Concepts II and III Required Activities:
. 3-4	A. The discussion in activity three might not require the typical 55 minute class period. Do not try to make this discussion longer than is necessary. The length of the

discussion will vary from group to group. If students are progressing at their own pace it might be necessary to hold two or more small group discussions.

Concept IV Required Activities:

5 A. The instructor has the option of combining discussions in activity three and four.

Concept V Required Activities:

6 A. The video-tape used in this activity is available through the Administration Building, Mr. Verlin Abbott, Parkway School District. It will be necessary to reserve the tape in advance. The instructor should have the Data Sheet 2 (page five in the student packet) available for the students.

6 B. This is an optional activity. The science department of most high schools should have the equipment necessary to perform this experiment.

ENVIRONMENTAL ECOLOGICAL EDUCATION PROJECT

Parkway School District
Checterfield, Missouri

DR. WAYNE FICK, Superintendent

VERLIN M. ABBOTT, Project Director

Unit: Air Pollution: Packet VI

BY:
Robert Goode
Wayne Mosher
Tom Pollmann

The work presented or reported herein was preformed pursuant to a Title III ESEA Grant administered by the Missouri State Department of Education.

CONCEPTS: PACKET 6

I. Collecting and comparing air samples at certain sites with air quality standards will determine if air pollutants are below acceptable.

II. Technological modification of the present internal combustion engine could reduce the effect of the auto as a source of pollution.

III. An alternative to the present internal combustion engine will reduce auto emissions.

IV. The substitution of mass transit for automobiles is a possible solution to the reduction of air pollution.

V. Technological advances, including electrostatic filters used in industrial air purification systems are being developed.

Concepts	BEHAVIORAL OBJECTIVES
I	1. After touring the St. Louis City or County air testing site(s) the student will write a paragraph describing the manner by which air quality is measured.
I	2. After completing the assigned activities, the student will state in writing 200 words or less, the relationship of the emission levels in the St. Louis area to the air quality standards which have been established.
II	3. After completing the assigned readings the student will list three technological modifications of the internal combustion engine that might reduce auto emissions.
III	4. After completing the assigned readings, the student will participate verbally at least three separate times in a group discussion on the alternatives to the present internal combustion engine. Following this student will list three alternatives to the present internal combustion engine.
IV	5. Given the various models for mass transit, the student will participate verbally at least three separate times in a group discussion on the benifits and problems of mass

At this time take the pre-test.
Obtain a copy from your teacher.

ACTIVITIES

Behavioral Objective Number

Concepts I Required Activities:

A. Your instructor has arranged a field trip. Approxiamately one-half the class will tour the City of St. Louis Air Pollution Control Laboratories. The remaining group will tour the sampling site(s) for the St. Louis County Air Pollution Control Agency. Listed below are some activities which relate to the field trip(s).

1 — 1. On the map used in Packet 4, Data Sheet 4, plot the location of the test sampling sites for the metropolitian St. Louis area.

NOTE: It will be necessary to share information. The group that toured the county site should swap information with those students who toured the city laboratories.

1 — 2. Complete the Data Sheet 1 supplied by your teacher.

2 — 3. Participate in a small group discussion on the relationship of the air sampling sites with respect to the location of air pollution sources. Discuss also, the relationship between the emission levels in the St. Louis area and the air quality standards.

Concepts II, III, IV and V Required Activities:

A. After each reading is the behaviorial objective to which the reading applies.

1. "Combustion to Install Devices, Cut Pollution by Gas Vehicles," from the Chattanooga Time, February 13, 1972 (B. O. #3)

2. "Clean Car Device Makers Oppose Delay on "75 Rules" from the Washington Post, April 11, 1972. (B. O. #3)

3. "Anti-pollution Engines Irksome, But Pure Air Worth Effort," from the Buffalo Evening News, February 8, 1972 (B. O. #3 and #4).

4. "Auto, Factory Anti-pollution Devices Successful," from the Chantanooga Times, June 18, 1972 (B.O. #3 and #6).

5. "Antipollution and the Electric Car," by Bruce C. Netschert from Protecting Our Environment, (B. O. #4).

6. "Inventor Calls Device Air Pollution Answer," fron the (Newark) Evening News, July 12, 1972. (B. O. #4)

7. "Big X for the Bay" from Time, September 18, 1972 (B. O. #5)

8. "Transportation...Sctratching the Surface" from Man: The Next Thirty Years, by Henry Still (B. O. #5)

9. "Kansas Invention Scrubs Air Blue" from the Wichita (Kan.) Eagle, February 7, 1972. (B. C. #5)

10. "NSP Find the Market Profitable For Its Generating Plants' Coal Waste," from the Minneapolis Tribune, July 6, 1972 (B. O. #6)

Concepts II and III Required Activities:

3&4 A. Participate in a groug discussion on the alternatives to the internal combustion engine on the various technological modifications of the internal combustion engine. Make sure that you have read the readings that apply to behavioral objectives three and four.

Concept IV Required Activities:

5 A. Participate in a group discussion on mass transit systems. Bring with you to the discussion, information on mass transit systems that you have gathered on your own research.

Concept V Required Activities:

6 A. At this time a video-tape is available for viewing. The speaker is Morton Mullins from Monsanto's Environmental Protection Group. In the last half of the video-tape, Mr. Mullins discusses industrial air purification systems. Before viewing the video-tape, obtain Data Sheet 2 from you instructor.

6. B. (Optional) Making an electrostatic precipitator instructions for the construction of this devise are given on pages 232-234 of Environmental Pollution.

DATA SHEET 1

Field trip to St. Louis County and/or St. Louis City Air Pollution Control Agency.

1. Either in the space provided below or on a separate sheet of paper describe the various types of test that are used in monitoring ambiant air.

2. Describe the manner by which ambiant air is measure in the St. Louis air.

DATA SHEET 2

Video- tape presentation by Mr. Morton Mullins representing Monsanto Chemical.

During the last half of the video-tape, Mr. Mullins discusses methods by which industrial emissions are purified by various control devices. In the space below, name the device and then describe briefly how it oporates.

1. ____________________ ____________________________________

2. ____________________ ____________________________________

3. ____________________ ____________________________________

4. ____________________ ____________________________________

COMBUSTION TO INSTALL DEVICES, CUT POLLUTION BY GAS VEHICLES

Combustion Engineering Inc., in its continuing effort to eliminate all types of air pollution at the Chattanooga works, is in the process of installing pollution masters on all of the company's gasoline-operated equipment.

The Chattanooga works of Combustion has been a pioneer in the field of eliminating air pollution, having demolised its stacks in 1968 after the plant switched to a cleaner fuel and completely climinated this part of air pollution.

A pollution master is composed of two units, and when installed will exceed existing standards for automotive emission control.

The system when completed, will be the first of its kind in Chattanooga and will be on a total of 65 pieces of equipment, including trucks, side loaders, fork lifts and gas weiding machines.

Figures from U. S. Department of Health, Education and Welfare show, more than half of the pollution in the United States comes from motor vehicles in the form of carbon monoxide and Combustion is now in the process of eliminating his health menace!

A pollution master's two units are crankcase savenger and exhaust scavenger.

Purpose of the crankcase scavenger is to trap any varnish, sludge or solids and separate them from the mixture of blow-by gases and air being drawn from the crankcase, before this mixture goes into the engine. The exhaust scavenger becomes an integral working part of the engine and automatically supplies air to the vehicles' cylinders to trap the exhaust gases left from the preceding power stroke, mixing them with oxygen and greatly improving the mixture in the engine for the next power stroke.

The addition of pollution master systems permits the cleaner burning of fuel, greater utilization of fuel, more power, economy and operation efficiency.

The installation of the system will be complete within the next two months.

Chattanooga (Tenn.) Times, February 13, 1972

CLEAN-CAR DEVICE MAKERS OPPOSE DELAY ON '75 RULES

By Victor Cohn Washington Post Staff Writer

Two leading makers of controls to clean up car exhaust yesterday urged the government to deny car makers a year's delay in meeting tough 1975 auto—emission rules set by Congress.

"It is our firm belief" that efforts to meet the standards will succeed "provided the development programs now in high gear throughout industry are not permitted to slacken," said Robert S. Leventhal, senior vice president of Engelhard Industries, Murray Hill, N. J.

If auto makers win a delay of the standards are significantly reduced, "we and others will have little incentive to continue those efforts," he told an Environmental Protection Agency panel.

The panel is considering five auto makers' requests for the delay, and hearing from most major U.S. and foreign manufacturers and suppliers.

Engelhard is in final stages of negotiating an agreement of supply Ford Motor Co. with catalytie converiers - devices to turn hydrocarbons and carbon monoxide into harmless carbon dioxied and water vapor - for its 1975, 1976 and 1977 models.

In interviews, both Laventhal and Joseph H. Povey of Mathey Bishop, Inc. (U.S. subsidiary of Britain's Johnson Mathey), said they think the auto industry can meet the 1970 Clean Air Act's requirement that hydrocarbon and carbon monoxide emissions be reduced by 90 per cent by the 1975 model year.

"We think we can do it, and I think the guys up there are beginning to get the feeling it can be done too," said Povey, referring to the EPA hearing panel headed by Deput Administrator Robert Fri.

V. W. Makin, Mathey Bishop president, is scheduled to testify today, AS EPA heads into the fourth of what could be 20 days of testimony. Detroit's Big Three-General Motors, Ford and Chrysler-are all scheduled for next week.

"A question which has not yet been answered completely is whether in the real world of customer use and abuse" controls will last without maintenance for the 50,000 mile goal set by Congress," Leventhal added.

But Mathey will report successful roadtesting of a catalyst-equipped Chrysler for 20,000 miles to date. EPA Administrator William Ruckelshaus has told auto firms he will permit controls even though they need some replacement or maintenance during a car's life.

The catalyst makers are also pressing for future "no-lead" gasoline with no more than .03 grams of lead a gallon, rather then .05 grams, the limit EPA has tentatively ordered starting in 1974. Lead ruins the catalyst materials needed to convert pollutants.

EPA yesterday completed hearings on its fuel propesals - including both no-lead and lower-lead general fuel-and is expected to announce its final decision next month.

Philip E. Robinson, executive vice president of the Lead Industries Association, yesterday requestioned the need for no-lead gas until auto makers have a proved emission-control system.

He also said no one has demonstrated that lead in the air is a health bazard. He was backed on the latter point by Dr. M. K. Williams, a London general practitioner and industrial doctor. Most health experts disagree.

Washington Post, April 11, 1972

ANTI-POLLUTION ENGINES IRKSOME, BUT PURE AIR AIM WORTH EFFORT

By Peter Weaver Buffalo Evening News

It's going to cost billions of dollars to drastically reduce engine exhaust pollution by 1975 as ordered by Congress.

Who's going to pay for it? You are.

Preliminary studies extimate that pollution-control devices on a new car in the fall of 1975 (1975 model) will hike the cost $275 to $300 above today's new car prices.

On top of this, the new owner will have to pay an estimated $125 to $150 a year in additional maintenance and fuel costs to keep the pollution-clean engine running properly. This is because pollution-control devices, to do their job, must devices, to do their job, must diminish the engine's performance.

Even with the 1972 cars that have just a few of the programmed pollution-control devices, owners are finding engines harder to start and performance on the sluggish side.

What's worse, surveys made in California show taht many of the new cars are polluting almost as much as some of the elder cars because pollution-control mechanisms aren't being properly maintained.

Sen. Philip A. Hart, chairman of the Senate Anti-Trust and Monopoly Subcommittee, feels the Environmental Protection Agency and other government agencies must keep the auto industry from artificially setting price of anti-pollution equipment too high. He fears there's not enough competition.

Also, to make sure we get our money's work in pollution control, Sen. Hart has asked EPA to get moving on the installation of a national emission-control inspection system to make sure anti-pollution devices on new cars are kept functioning properly.

So far, the news about the cost of anti-pollution controls has been rather gloomy. But there's a brighter side.

The new anti-pollution equipment on cars, even if it isn't running perfectly, will stave off disastrous air pollution conditions in a number of cities where automobiles are the major polluters.

The required periodic engine inspections, when they come, may be an inconvenience, but they will force owners to take better care of their cars. Owners will get more years' service out of their automobiles as a result.

General inspection programs in Pennsylvania and New Jersey show that their cars hold up much longer than those in states without inspection.

You may have to pay $300 or so for pollution-control equipment on a 1975 car but, when you think of it, many owners are willing to pay that price right now to condition and cool the air inside a car.

Why not spend the same amount to help condition and clean the air outside?

If we can get through the next five years or so without having to pay too much for emission-control devices, we might see entirely new engines evolving which will be clean runnings, reasonable prices and easy to maintain.

Here are some contenders: STRATIFIED CHARGE: This engine will have a new kind of cylinder head to give better combustion and less waste going out as pollutants. A four-cylinder, stratified-charge engine has been developed by the Army Tank Command for Jeeps. Hopefully, an eight-cylinder model will be ready by 1978. Ford is interested. WANKEL: The Germans developed this "rotary" engine and General Motors is experimenting with it. The engine packs a lot of power into a small space and will be less expensive to make clean. It can use less expensive fuels. TURBINE: The gas-turbine engine is supposed to give better over-all performance with far less pollution problems. Ford is putting this engine in some trucks, buses and boats - but, don't look for it in passenger cars until the 1980s.

<u>Buffalo Evening News,</u> February 8, 1972

AUTO, FACTORY ANTI-POLLUTION DEVICES SUCCESSFUL, CHATTANOOGA INVENTOR SAYS

By Jim Corbett Chattanooga (Tenn.) Times,

A Chattanoogan has invented a device which he says can eliminate 90 per cent of an automobile's pollution as well as increase the gas mileage.

The device costs less than $5 to build and is "fitted onto the carburetor to expand the gas," says inventor Joseph Gagliardi of 7641 Boriss Dr. But he won't describe the invention in greater detail because it isn't patented.

Gagliardi, a retired auto mechanic, steel millwright and minister, has been working on the pollution problem about three years.

He has also invented an apparatus which he says can contain flight-ash from industrial smokestacks, and a device which clamps onto the exaust system to reduce the emission readings.

"My device is far superior to what they have on the 1972 cars," he said.

Wesley Holder agrees. It was fitted onto his 1972 pickup which got about nine miles to the gallon in spite of several trips back to the dealer. With Gagliardi invention, Holder says, he gets about 17 miles to the gallon.

Holder also did the white hankerchief test for emission with success.

Gagliardi said the invention has been testied by the Chattanooga-Hamilton County Air Pollution Board and found it 90 per cent effective.

Her Parr, director of the bureau, said the test showed Gagliardi invention cleaned hydorcarbons and carbon monoxide but did not reduce the oxides of nitrogen and probably rasied that level.

Gagliardi has another apparatus which works like a rainy day" to reduce the oxides of nitrogen, he said. He claims to have cut them by one-half. He said the bureau did not have the machinery to test this.

"It eliminates 90 per cent of the three polluting gases," Gagliardi said.

Before he moved to Chattanooga about a year ago, he started writing letters attempting to gain support. Every major automobile and muffler company knows about his inventions, he said, but won't give him the aid unless he divulges his secrets.

The invention is not patented because of finances, he said. He said he has talked to representatives of several companies but hasn't been able to come to an agreement.

"They all wanted it on their own terms, and I'm not interested," he said.

The device which clamps onto the exhaust system has attracted some interest from the state of California, he said, but it isn't patented either.

He has consulted several public officials regarding a grant to continue his work without success, Gagliardi said.

He has applied for a patent on the smokestack apparatus, he said. Before the application, Gagilardi said, he tried to give it to three Chattanooga industries as well as Cleveland, Ohio plant for publicity, so he could gain support for his other inventions but they wouldn't talk to him until he obtained a patent.

"It costs thousands of dollars to control wastes from smokestacks," he said. "Many smaller factories have had to close down. They couldn't afford it.

"I can contain flight-ash. I can stop it."

Next the inventor is planning to concentrate on raising the gas mileage of cars.

"My ambition is to boost that gas milage on up to 20-40 miles to the gallon," he said, "Why shouldn't I ride in an American car that gets just as good milage as a Volkswagen."

Chattanooga (Tenn.) Times, June 18, 1972

B. O. #4 "ANTIPOLLUTION AND THE ELECTRIC CAR"

By Bruce C. Netschert

As you know, the electric automobile is looked on by many as a potential answer to the smog problem. I must confess I have a strong personal predilection for it. It makes sense to use a system that consumes energy only when it is in motion. It is quiet. It must, by its nature, be smaller that the palatial mobile palanquins we now drive, hence it would contribute mightily to easing the traffic problem. For the electric automobile to be commercial it is not sufficient that it have a battery that is economically feasible to manufacture and use: it must also recharge with electricity at a rate that is comparable with gasoline prices. Its fuel cost, in other words, must be competitive.

From the published information on the various proposals for electric automobiles it appears that, given the appropriate battery system, the electricity rates for charging would be competitive under present conditions. They might very well not be competitive, however, in 1990 or 2000, given the cumulative impact of environmental improvement measures on the power industry's costs in the coming decades. I don't know whether or not this is to be deplored. I certainly don't mean to imply that the electric automobile is the only or even the best solution to the smog problem. On the other hand, it would be deplorable if the fight for environmental improvement unintentionally and unknowingly foreclosed a potential development that could win one of the biggest battles.

What I suggest, therefore, is that those who are working to improve the environment should do their best to probe and appreciate the long-term implications of what they are doing, so that in their zeal they do not commit new mistakes in the name of remedying past ones.

In saying this I do not align myself with those who observe that there is no clear medical proof of the harmfulness of existing sulfur pollution levels in our urban centers; or with those who argue that there is no sense in equipping cars with devices to lessen exhaust emissions if the public is not going to maintain them; nor, especially, with those who protest that standards are being imposed too soon. I regard such objections as superficial.

I look, rather, at the more subtle aspects of the program to improve the environment, implications such as the long-term effect on electric rates I have just described-not so much the measures themselves as their direction. It is all too easy to set in motion economic forces which, once established are difficult or impossible to change or remove. It is all too possible to build new rigidities into our economic system, which depends for its well-being on a flexibility that should be as great as possible in order to withstand unforeseen shocks and disturbances, both internal and external.

There are, as we all know problems in environmental improvement that remain largely if not wholly, unsolved. We can as yet do nothing about the nitrogen oxides. High-level radioactive wastes from power reactors are still handled on a temporary basis in stainless steel tanks which must be periodically replaced. There is the nagging matter of carbon dioxide and the greenhouse effect: we cannot yet tell if we are raising the average temperature of the entire earth or, as has recently been suggested, wheather we are permanently depleting the oxygen content of the atmosphere, I am confident the solution to each of these problems will, in its turn, come along. In the meantime we cannot stand still, through reasons can always be found for doing nothing. I am tempted to say that we must move with caution, but caution implies timidity and delqy. Caution is also synonymous, however with discretion and vigilance, and it is these qualities I urge in our actions in combating pollution.

Protecting Our Environment, Bruce C. Netschert

Big X for the Bay

It all sounds like something thought up by Stanley Kubrick for the movie *2001*. The silent central control room houses giant twin computers that send dozens of sleek, 80-m.p.h. silvery aluminum passenger trains slicking sibilantly into stations at intervals as close as 90 seconds. Each train has only one blue-jumpsuit-clad attendant, and he allows computers to run the controls except in the event of an emergency. Even tickets are sold (in amounts up to $20) by machine. The buyer inserts coins or bills; after an electronic eye scans them, the machine gives forth a credit-card-sized ticket. Thereafter, the passenger merely enters whatever station he likes and sticks his ticket into automatic fare collectors that swiftly calculate fares (from 30¢ to $1.25, depending on the length of the journey) and electronically subtract the right amount from the ticket.

The ride itself is quiet, gentle—no lurching starts or jerking halts—and, above all, comfortable. Wool carpet covers the car floors, and there are no commuter straps above the cantilevered seats—the system hopes to provide each rider with a seat. Electronic equipment maintains a running check on each train's mechanical health. There are automatic doors, air conditioning and stations glowing in a dazzling, multicolored array of huge graphics enamel murals, mosaic columns and Fiberglas reliefs.

This would be an impressive package by any standard. For residents of the San Francisco region, who will see the $1.4 billion Bay Area Rapid Transit (BART) begin operation this week, it represents not only a considerable achievement—it is the first new rail transit system to be built in the U.S. in 65 years—but something of a challenge as well. BART was built as an attempt to entice San Francisco commuters out of their cars and onto a fast, smooth rail transport system that serves the entire Bay Area. Says Lawrence Dahms, BART's assistant general manager for planning and public service: "The basic reason behind BART was not just to keep people from building more freeways but to change development policy. Since 1946, America has put its money in Detroit and highways. The result was sprawling suburbs. Can we turn the corner on that old, auto-oriented policy?"

Fund Failure. Apparently the voters of three Bay Area counties—San Francisco, Alameda and Contra Costa—thought so in 1962, when they approved a $792 million bond issue to fund construction. BART was intended to order growth more rationally than new highways on the theory that development follows a rail system's route while highways are usually built wherever anyone develops the land. Beyond that, the planners argued that BART would allow poor citydwellers to get to new industrial jobs in the booming suburbs. But what really explained the vote, cynics say, was that most motorists simply hoped that the rail system would keep other cars off the congested roads: the individual driver had no intention of riding the rails himself.

In any case, the new system was a long time in coming. It was delayed by technical problems, political squabbles and, most of all, by inflation. In the late 1960s, the money ran out. Only aid from the state, a locally imposed sales tax and federal funds kept the ambitious project alive. The long years of

Time, September 18, 1972.

construction were marked by lawsuits, as well as by a succession of knotty technical problems and press charges of waste and incompetence. There were times when it seemed that BART might be abandoned.

On opening day, in fact, only 28 miles of what eventually will be a 75-mile network will be ready. By next year, however, the entire system is expected to be operative. The first stretch links Oakland, in the East Bay area, with Fremont in the south. The next will reach north to Richmond. Other arms will extend east to Concord and west under the Bay into San Francisco and down the peninsula to Daly City. The X-shaped system will touch every urban population concentration in the three counties, linking up an estimated 2.5 million people.

If BART works as expected, it will cut travel times by anywhere from 30% to 80%. For example, the trip from Oakland to San Francisco will take nine minutes, compared with 35 to 45 minutes by car in rush-hour traffic via the Bay Bridge.

Side Benefits. BART's promise has sparked a $1 billion office-building boom in downtown San Francisco, plus a major beautification program the length of Market Street. In the suburbs, new homes and apartments are sprouting near the system's stations, and land values have been rising steadily along its route. Whether BART will in fact realize its planners' original far-reaching goals is still moot, mainly because the system is so much shorter than first planned. "We would like to think we've been a catalyst for good things," says Dahms, "but it's too early to tell." Environmental organizations like the Sierra Club's Bay Chapter, however, have wasted no time in praising BART as a "reasonable alternative to freeways and the sprawl and smog they inevitably bring."

Another side benefit is aesthetic. BART's 34 stations are designed to be bright and appealing—quite a change from the usual dreary transit stop. The main station at Lake Merritt even has a pool and a plaza. About a third of its extra-wide tracks will be underground and out of sight. Another third will use freeway medians, and the rest will be elevated on graceful concrete columns. BART has spent $7.5 million on landscaping alone.

The crucial issue, of course, is whether enough people will ride the lines. BART is expected to pay its own way. (One reason for all the space-age automation was to minimize the labor costs that account for about 80% of the costs of the East Coast's deficit-ridden transit systems.) Projections for 1975 predict 200,000 riders on weekdays, or 60 million a year. This would account for 11% of the present commuting traffic. But a telephone survey indicated that only 7% of those questioned intend to use the system once it goes into operation.

Can BART corral more? Dahms is optimistic, and many another U.S. city is waiting anxiously for the results, since most urban planners agree that new highways exacerbate rather than solve traffic-congestion problems. For the future shape of U.S. cities, a lot depends on BART.

<u>Time,</u> September 18, 1972.

B. O. #4 ENVIRONMENT AIR POLLUTION

INVENTOR CALLS DEVICE AIR POLLUTION ANSWER

By Guy Savino Evening News N. Y. Reporter

New York - The termogenerator, hailed as the answer to the pollution problem caused by combustion power systems, was introduced here yesterday by its inventor, J. Lyle Ginter.

According to Ginter, the device he has patented after 30 years of research and at a cost of $3 million will permit the use of turbine engines in cars and trucks that will meet the 1976 standards set down by the Environmental Protection Agency.

While the automotive and aircraft industries should find the thermogenerator of special interest. Ginter said, it is electric power companies that should find it of most immediate value.

At a press conference at the Overseas Press Club yesterday, Ginter said: "We are not talking theory. We tell you we have develop running hardware. It is in Glendale, Calif., and is open for inspection."

Ginter said that his company, Ginter Corp., is ready to license other companies to produce and use the thermogenerator. Or his own corporation will produce it.

"The thermogenerator," said Ginter, "requires no cataiytic coverter or afterburner. It can be added at virtually no additional cost in comparison with other devices that are presently being worked on."

Ginter said the device is a combustion chamber in which controlled burning of hydrocarbon fuels occurs. Fuel, air and water - in liquid or steam form - is injected into the thermogenerator. The fuel - air ratio, flame temperature and exhaust gas temperatures are controlled independently.

Unburned hydrocarbons produce most of the pollution from combustion engines, Ginter said, and it is control of that factor which makes the thermogenerator successful.

"Water as an invert dilutent is used to control the flame temperature," said ginter. "The lowered flame temperature thus effectively limits the formation of the oxides of nitrogen."

In one application, water is added both prior to and following combustion, Ginter said. Experiments have proved that the gas horsepower of a unit can be increased 300 to 400 per cent in that in that way, he said.

HIGH SULFUR FUELS: One of the best features of his development, Ginter said, is that it makes the use of high sulfur content fuels possible. When coal is gassified and oil shale is made usable, the thermogenerator will help man tap a resource with a known world reserve for the next 300 years. He said this makes his invention of extreme importance to the power companies which have become increasingly alarmed over fuel supples of the future.

Ginter said the thermogenerator also is a satisfacory alternative to nuclear power and its pollution.

According to the Ginter organization, Advanced Automotive Power Systems Division, Ann Arbor, Mich., and the Combustion Research Section of the Electric Power Generation Division, Durham, N. C., both Environmental Protection Agency units, have requested an early testing date for the thermogenerator.

Newark Evening News, July 12, 1972

TRANSPORTATION

SCRATCHING THE SURFACE: At five minutes to eight on a cold morning in February 2000, a commuter hurries into the ground entrance of the Washington, D. C., subway station. His haste is not a matter of time but to escape the snow which mantles his coat collar. He has an hour to reach his desk in Manhattan, little more than two hundred miles away.

The junior executive shucks off his coat and rides down the escalator to train level. The lobby is busy with people, but it is clean, sound-conditioned, and as comfortably warm as the lobby of any large building. The commuter fumbles for his plastic credit tab and presents it to the turnstile scanner. The computer, to which the scanner is attached, instaneously identifies him, notes his destination, admits his through the gate, and blinks on a light directing him to his car. As he approaches, the doors slide open and just as smoothly close behind him. "Handy gadget," he muses as he has every weekday morning during the few months the new subway system has been in operation. "Ride anywhere anytime on the Boston-Washington system, then pay a monthly bill of only 150 dollars."

Mr. Commuter settles into his comfortable seat beside the curving wall of the car. There are no windows because this train will never travel above ground. He idly watches the 3-D taped newscast which will be repeated every fifteen minutes during the brief run to New York. He glances at his watch. The other nineteen seats in the car fill quickly, and at exactly 8 a.m., there is a slight sense of motion as the train pulls away from the station. He could have waited until the 8:10, but he preferred the express, which made only one stop - at Philadelphia - before reaching New York. Also the short express run gave him time for the leisurely six-block walk to his office from the midtown terminal.

After that first breath of acceleration, there is no sense of motion at all, no awareness that the train is picking up speed at a fantastic rate as it arcs downward in its tunnel, reaching a maximum depth of thrity-five hundred feet. The train is propelled entirely by the downward pull of gravity augmented by air pressure pumped in behind the train.

This view of ground travel three decades from now is not a sciencefiction dream. It is one of many imaginative but highly feasible schemes for major advancement in surface transportation. Under a new federal law, which established the Department of Transportation at cabinet level, government and industry researchers and engineers in the past three years have poured out new ideas and hardware that promise tremendous improvements in commuter travel, within and between metropolitan centers. Change was overdue in an industry which essentially had not improved in a third of a century.

Man is land-based creature, and thus for all of his centuries, most of his travel has been on the ground. But man is also an animal that accepts no limits to the scope of his hunting ground and has searched persistently for faster, more convenient, and comfortable ways to travel greater distances. Although his motion has been phenomenal, man so far has only scratched the surface in transportation. Moreover, some of his scratches, while providing great freedom of mobility, are also creating conditions which threaten general health and life, such as air pollution from the automobile.

Most of this generation has passed beyond memory of the horse-and-buggy days, but those days extended backward to antiquity and did not end until the automobile and electric streetcar gained popularity in the first two decades of this century. It was really the horse and buggy which created Small Town, American, because a farmer and his family with only this method of transportation could not travel more than ten miles for the Saturday trip to town. In the growing industrial centers of the East and Northeast, a young man climbing the executive ladder in the textile industry lived near enough to his factory that he could walk to work. It as the streetcar which firs impelled cities toward the urban sprawl so pronounced today.

Although not the inventor of the motor car, Henry Ford introduced mass production methods which made the Model-T the symbol of an era. Ford also aimed us along a half-century trajectory which very nearly has enslaved us in worship of the automobile. The Model-T went into production in 1908 at a cost of 850 dollars each. With improvements, production reacher 1,000 cars a day. Although finer automobiles were built in those early days, it was Ford who reached the common man. Fifteen million Model-T's were sold under the slogan "gits ya there and gits ya back," and the price eventually came down to 200 dollars. From that point on there was no stopping the horseless buggy.

As the decades - and two World Wars - passed, the auto pushed the electric streetcar into oblivion. Thousands of miles of railroad track were left to rust, deserted by passengers and freight that now moved by truck. The automobile sired the rubber-tired motor bus for mass transit in urban centers, then proceeded to clog the streets so buses could not move. Transit companies dwindled and died. Only large metropolitan centers, such as New York, Philadelphia, and Chicago, which could support mass transit tied to rails and subway systems, would boast of adequate means for getting the working masses (and shoppers) to and from their jobs each day. Even there, however, a constipation of humanity began to grow amid and unplanned jumble of trains, subways, buses, delivery trucks, and private cars. Anyone curious to see this mess in action (or inaction) needs only to ride a taxicab across midtown Manhattan at four o'clock any Friday afternoon.

The expressway, or freeway, when it emerged from the drawing boards of traffic engineers in the 1930's seemed to be the answer to all prayers. Indeed, the freeway, with its broad avenues of asphalt and concrete sweeping over, under and around the grid of streets and avenues of the "old" city, has served for more than twenty-five years as a tremendous step forward in the movement of mass millions of people. The limited-access speedway was not the panacea for all transportation ills, but for many years it blinded us to our growing enslavement to the automobile as the only way to move. As a consequence, suburbia spread farther and farther into the country from urban centers. Rail and bus lines lost customers because they failed to keep pace. As customers dwindled, mass transit systems failed to keep their tracks and rolling stock up to date, service grew progressively worse, and finally mass transit was threatened with extinction in most major cities at precisely the time in history when it was needed most. What the majority had failed to realize is that there must be a balance of several transportation modes to prevent any one system from progressing to the extreme of self-extinction.

The extremes to which we already have gone in our auto-idolatry is illustrated by the more than 90 million cars, trucks, and buses on United States road today. Although 1967 was a bad year, and only about 7.5 million cars were produced in the country,1968 was expected to approach the 10 million mark before its. close. Under a deliberate program of planned obsolescence, the auto industry spends 500 million dollars a year in advertising alone to ensure that 5 to 6 million cars each year are assigned to the junk heap, where they're now worth about 12 dollars per carcass for scrap. Aside from the simple pleasures of driving a car and its utility as a handy way to get from one place to another, this vehicle intensifies the natural aggressiveness of the human male and serves as an outlet for rivalry. How many time have we heard roaring motors and car horns used as a substitute for brains? The chrome-lated monster equipped with broad- traction slicks is especially useful to enhance the doubtful virility of young men. A national survey recently showed that 75 percent of high school juniors and seniors in the nation now have drivers' licenses. Forty-four percent own their own vehicles, chosen from the more than 300 different models available each year from Detroit.

In 1904, there were about 2 million miles of roads in the United States, all dirt. From then until well after 1909, when the first mile of concrete highway was laid down, a heavy rain or spring thaw was enough to bring all automobile travel to a halt, even the high-wheeled Model-T which was built to cope with the average roads available in those days. Today, after spending nearly 90 billion dollars on roads, the miles of concrete ribbon have increased to 4 million. We're now spending more than 12 billon dollars a year for the single purpose of handling the 2 billion miles we drive each day. In 1975, when the 41,000 mile

(50 billion dollars) grid of the National Interstate Highway System is completed, it is estimated American will drive 1,165 billion miles per year. If the automobile were allowed to grow in proportion to present trends and population predictions, by 2000 the national interstate highway system could well be reduced to a 41,000 mile parking lot. When we consider road building, automobile purchases, repairs, maintenance, a system of 30,000 drive-in restaurants and motels, parking lots, damage suits, and lawyer fees resulting from million of accidents, and support of most of the oil industry, the automobile accounts for about one dollar out of every seven dollars in total production of the United States annually. That means the automobile costs us more than 100 billion dollars a year. It seems something is drastically out of balance when one-seventh of the entire human effort in our nation is devoted to this single facet of transportation.

The automobile's mastery of our present civilization is expressed in the massive traffic jams of cars, delivery trucks, and buses on city streets and more recently the freeway, where road construction costing two million dollars to 23 million dollars per mile is unable to keep pace with the mushrooming numbers of vehicles. One answer to this disease is the suburban business center, but that leads to decay and abandonment of central cities, and does not ease the problem, now growing critical, of regional air pollution. Sixty percent of America's air pollution is blamed upon the gasoline-powered automobile. This growing threat to the health of 200 million people, quite aside from the 50,000 and more persons killed in accidents each year, may be the lever which will force us into new modes of mass transit; as Boyd comments, a balanced system which will give more people a free choice of the best way to move themselves and their freight where they need to go.

In a democracy major problems are often foreseen with adequate lead time for solution, but economic factors and lack of consensus delay action until an emergency situation arises. Then, unfortunately, the problems are solved under conditions of panic and crash programs which lead to waste of resources and money. Although it may not yet have reached the crisis point, such a situation now exists in the traffic congestion of our major cities.

One obvious answer to the problem, and one which probably will see the greatest advancement in the next thirty years, is the revitalization of municipal mass transit systems. One reason mass transit has declined so seriously in the past three decades is that a commuter in most cities can drive downtown faster and more conveniently than on a train or bus. At the same time, such major metropolitan centers as New York, Philadelphis, Boston, and Chicago have continued to expand principally because the venerable subway and companion bustrain systems offered greater ease and convenience of travel than the automobile.

One fact is clear: if a transit system is to serve any useful purpose by the turn of the century and beyond, it must be faster, cheaper, and more convenient than using a car. For example, a typical Los Angeles commuter wedded to the freeway system may drive 50 miles to and from work each day, spending a total of two hours or more in the process. That's 100 miles at minimum of 10 cents a mile plus one dollar or two dollar per day to park his vehicle. If a train or similar system can cut his cost and time in half, he will ride it. If not, the new transit system will simply languish without passengers.

The first completely new municipal transportation system in the United States in the past half-century is now under construction in the San Francisco Bay Area. Using new lightweight cars and computerized train control, it combines surface rail lines, elevated track, and submerged tube under the San Francisco Bay to link Oakland, Alameda, Berkeley, and dozens of other communities with San Francisco. When it is finished, at a cost of well over one billion dollars, the new system promises commuters an average speed of 50 miles an hour and frequent service. Considering that a new transit system should solve problems for at least half a century, the Bay Area complex will be to some degree obsolete when it goes into operation in the early 1970's. For the immediate future, however, the new train system is expected to bring about a 30 percent reduction in auto travel in the Bay Area.

While San Franciso builds one. Los Angeles is just now planning a new rapid transit system. This city, as it grew, sprawled all over the landscape, thanks mainly to the freeway system swallowing up new suburbs as fast as they could be born. As a result, population density is so low in any specific area that it is difficult to design a new high-speed system which will attract sufficient customers to keep it alive. Such a system, however, is mandatory both to reduce the strangling congestion of cars and the severe smog which they create in the Los Angeles basin.

Nationally, the lethargic transportation pendulum is just beginning to swing away from the auto and its expensive highways. In 1967, the nation spent 13 billion dollars for roads, but the federal government allocated only 11 million dollars for the Northeast Corridor Transportation Project, which hopefully will move millions faster in the megalpolitan area stretching from Washington, D. C., to Boston. As part of this plan, the Pennsylvania Railroad is now running new trains over improved roadbed at an average of 100mph. New York City itself, with 4 million commuters in and out every weekday, has funded plans for a new subway under the Manhattan core and extension of other subway lines. Electric trains from Long Island, Connecticut and upper New York state are expected to cut commuting times for many almost in half. But transport plans there are still heavily wighted with cost for extending freeway systems. Most of these improvements are helpful but only marginal in solving problems of the future. The technology exists for more imaginative approaches and future developments will depend primarily upon how soon the public is willing to buy really effective systems.

One experimental approach by Westinghouse Electric Company for suburban use consists of rubber-tired lightweight cars riding on overhead rails with automatic computer control of speed and spacing between cars. This type of system would offer about 50 mph average speed for riders within a city like Cleveland or Chicago. But if we are thinking 30 years into the future, we think of 100 million more people crowding into the major metropolitan centers. Commuting will stretch from 30 to 50 miles at present up to more than 100 miles in thirty years.

To tackle this problem, we need a train or similar conveyance which will average much more than 100 miles an hour. When we attempt very high speed in surface travel-say to 200 or 300 mph- it becomes advisable to stop thinking of steel wheels running on steel rails.

One alternative is the hovercraft, and the United States at the moment is lagging behind Great Britain and France in research and development of this concept. The hovercraft works on the principle of a cushion of air maintained beneth the properly shaped vehicle to keep it suspended a few inches, or even a fraction of an inch, above the surface on which it travels. Thus no wheels are involved at all. The French are experimenting with the Aerotrain, which as already achieved 210 mph in tests. The cars, powered by jet aircraft engines, follow a guide rail in the center of a smooth concrete roadway, and speed along only part of an inch above the surface. England has already invested more than $6 million in an 18 mile test track and equipment where the hovercraft principle is being tested. Speeds to 300 mph are under study. Although the French use the jet engine for propulsion, tests indicate this may be noisy and subject to train to buffeting. The English are experimenting with the linear-induction electric motor, which imparts power from the roadbed to counterpart electric elements in the moving cars as the train moves silently along suspended a tenth of an inch above the "track."

Although it would be pleasant to contemplate the end of the automobile by the turn of the century, this vehicle is likely to be much with us just as it is today. If is likely, however, that gasoline and disesl power-systems, at least for city and suburban driving, will have been replaced by quieter and cleaner methods of propulsion.

Although it may be ten years before practical models are perfected and marketed, the electric car has already started a major resurgence, principally under the goad of state and federal laws aimed at reducing air pollution. Models are already available which will carry four passengers as much as 100 miles at speeds from 30 to 50 mph. This kind of vehicle is foreseen as the ideal "second" or "third" car for the average suburban family of the future. Statistics show that a great majority of auto travel is done in trips of 10 miles or less with one or two persons driving on residential and commercial streets. Later, as improved batteries and electric storage systems become available, the electric auto will become attractive for long distance, higher-speed driving as well.

The electric car is seen as an ideal companion to the 200-to-300-mph rapid transit systems of the future. Bus and train lines are open to the complaint that they cannot deliver a person exactly where he wishes to go. Therefore, many engineers see the twenty-first-century salesman, who has several downtown calls to make, riding the train 100 miles in from the country, a journey of 30 minutes or perhaps less. At this terminal he will be able to check out a small electric car, make his calls during the day, and then when he returns the car, drop change into the automatic turnstile which measures the amount of power he used and charges accordingly.

Another high-speed combination using the electric car would not involve a train as such, but a continuously moving conveyor cable. The traveler would drive to the station, hook onto the cable, and then ride in his own vehicle to a downtown destination at speeds of 100 mph or better. At the end of the main run, he would disconnect from the cable and drive to his precise destination.

While many alluring plans for auto-transit combinations loom for the future, other engineers are seeking ways to improve untility of the freeways and increase their safety. Dr. Homer H. Grant, Jr., professor of industrial engineering at the University of Southern California, says that electronic devices coupled with freeways of the future will make "peak hour travel pleasant, relaxing and much safer." He believes computer control will be used for lane direction controls as well as for speed and safety. The day is coming, Professor Grant is certain, when only tiny automobiles will be permitted on commuter freeways. Both cars and drivers will be required to pass special examinations before they are permitted to use the road. Combining the electric car and the freeway, 200 may see freeway lanes which transmit power directly to the automobile passing overhead, and thus control its speed and position. According to a transportation study completed by North American Aviation for the State of California in 1965 such a freeway lane could handle forty cars (traveling at 150 mph) in the space now occupied by single moving vehicle. Obviously such a computerized freeway could effectively multiply the amount of vehicular traffic traveling our roads and bring marked safety improvements as well. Another technological development which may lead to an interface with the electric car is the experiment transmission of electric power by airwave, without use of wires. When this potential becomes reality, electric cars will travel freely without dependence up batteries, fuel cells, or other internal motive power. Such a development would be welcomed in high-smog areas such as California, where Frank

Stead, former chief of the state's anti-pollution efforts, has proposed that the legislature ban all gasoline-powered vehicles from state roads by 1975. Commenting upon the declining condition of our air, Stead said that a single car uses more oxygen in a 45-minute drive than all the millions of people in Los Angeles breathe during the same period of time.

In 1967, Max L. Feldman, a member of the American Institute of Planners, predicted that by the turn of the century there will be "at least one east-west and two north-south automatic highways, guiding and controlling individual passenger vehicles speeding from coast to coast and border to border. The ability of people to go where they want, when they want, in their own vehicles by the route of their own choosing will eventually have to be limited in order to prevent the complete collapse of urban circulation systems and save the cities themselves."

With surprise an inherent ingredient in a rapidly developing technology, none of the systems we have considered may be the favorite thirty years from now. However, the most promising future transport method, as discussed fancifully at the beginning of this chapter, is the underground tube, where gravity, air pressure, and vacuum may be used as cheap, high-speed propulsion sources. Aside from speed and convenience, the deep underground tube would serve the laudible purpose of removing transportation clutter from the surface. Moving people is a primary consideration, but most of our metropolitan freight of the future also should move by underground tube. Operating from terminals outside a metropolitan area, these tubes could transmit any commodity in containers to destinations within a city, just as the old vacuum-tube change systems used to work in department stores. Thus the large metropolis of the future could move its people and freight underground, and as an added step, empty containers could be filled with trash and garbage and removed by the same route.

In the 1965 study by North American, Jack Jones, an assistant to the company president, predicted transportation requirements will increase five to seven times between now and the end of the century. The study predicted that devices which will be commonplace by then include automatic freeways, underground trains traveling at six hundred miles an hour, ocean liners as fast as airliners, and floating ocean piplines to deliver produce from automated farms to city markets all over the world. Several of the predictions were echoed by Max Feldman of the Institute of Planners. "By the year 2000," he said, "the larger U. S. cities may have converted completely to electric transportation and several new cities should have been built to incorporate the most recently developed transport systems and offering maximum convenience."

"And," Feldman added, "with gasoline and other taxes paying the fare, public transportation might even be free."

<u>Man: The Next Thirty Years,</u> by: Henry Still

KANSAS INVENTION SCRUBS AIR BLUE

By Darrell Morrow, of The Eagle's State Staff

Burrton, Kan. - A rural machine shop operator has constructed and patented what he believes may be the solution to climinating pollution from industrial smokestacks. The equipment,designed and built by Leo Bassett, operator of LB Mfg. Inc., is called a Blue Sky Air Scrubber.

Bassett said his machine is a modification of one designed to remove particulate matter from exhaust systems of alfalfa mills. With the modifications. Bassett said, the machine will extricate fly ash, tars and sulphur dioxide from exhausts of furnaces burning fassil fuels, such as coal and oil. "In experimenting, I ran the thick, black smoke from burning rubber tires through it and no sign of smoke came out of it," said Bassett.

Bassett's experimental machine, which he estimates is capable of cleaning an exhaust of 50,000 cubic feet per minute, passes the exhaust through three stages before returning it to the atmosphere. First, the exhaust is forced through an after-burner to achieve more complete combustion, then it is sprayed with an ammonia water solution and finally filtered through a layer of crushed limestone rock, Bassett said.

No complicated chemical compounds are being used in the air pollution control unit, he stressed. "I think that if we use natural stuff that the good Lord put here on this earth to take care of this pollution, it will work longer and do a better job than anything else you can come up with," Bassett said.

Ultimate removal of the deadly sulphur dioxide is achieved through a chemical reaction with the limestone filter, he said.

The experimental air scrubber covers almost the entire bed of semi-trailer. The final stage is a large rotating drum with a steel mesh outer surface layer containing 10 tons of high grade crushed limestone rock. Bassett said he has determined it will take about 14 tons of crushed limestone to double its capacity to clean 100,000 cubic feet per minute of exhaust air.

The secret to removing the harmful sulphur dioxide lies in having the limestone hot when the gases pass through, said bassett. He said correct combination was discovered accidentally during experimentation with the machine when his assistant misunderstood his instructions and turned the gas burner used to heat the stone to its maximum output level.

"When the rock got to 300 degrees everything coming out of it (the exhaust) just disappeared," he said. "At 300 degrees, it take out sulphur and fly ash."

To assure complete removal of pollutants from the exhaust air, the limestone is fired to between 350 and 400 degrees, he said. The tars, ammonia and sulphur pollutants are cleaned automatically from the limestone as it wears away while tumbling inside the steel mesh drum, he added.

Some fossil-fuel power generaging plants under construction may utilize one-fifth of their potential generating capacity controlling pollution by using other control processes, Bassett said, "They could hook up this machine and do away with the smokestacks," he said. "There wouldn't be any need for them."

He doesn't anticipate being able to produce any standard models of the machine. "Each one of these is going to have to be designed for the job," he said. "We're not going to be able to go to work like with a Ford assembly line."

One of his machines is in use removing the dust from a ready-mix plant operation in Ogden, Utah, he said. His alfalfa mill scrubber was a wet model, using river gravel inside the drum to knock down the dried alfalfa particulate matter, he added.

Bassett estimates cost of his machine would be about $1.60 to $1.80 per 1,000 cubic feet emission capacity.

Wichita (Kan.) Eagle, February 7, 1972

NSP FINDS THE MARKET PROFITABLE FOR ITS GENERATING PLANTS' COAL WASTE

By Dick Youngblood Staff Writer Minneaspolis Tribune

In its pursuit of a brighter life for us all, Northern States Power Co. (NSP) has stumbled on a way to add a little radiance to its own financial reports about $170,000 a year worth.

This is the estimated 1972 payoff from NSP's recent success in developing markets for much of the furnace by products produced by its four coal-fired generating plants in the Twin Cities area.

Each year at these plants, devices called electrostatic prescipitators collect literally tons of fine-powdered fly ash from the burning process.

Before the first precipitators were installed in the early 1940s, dense black smoke pouring out of the plant stacks made life a little dimmer for all of us.

Since then, however, the problem has been what to do with the cocoa like stuff and with the larger, more granular particles of slag that collect in the bottoms of the furnaces.

Until last year, the compnay paid somebody to haul it away at a cost, in recent years, of about 50 cents a ton, according to Vic Wood, NSP's manager of fuel procurement.

Finally, after "working like Trojans" for 15 years to sell the material, Wood said, there were several break throughs in 1971, including:

Approval by city, county, and state governments of the use of fly ash as a low-cost partial replacement for cement in ready-mix concrete, as well as a compactable construction fill.

Growing acceptance of the slag for use as a granular construction fill and as a winter time ice control material.

"Fly ash can be used to displace up to about 20 percent of the cement in a mix," Wood explained. Government specifications now allow its use in curbs, gutters, foundations and a variety of cement products (but not yet on roadways).

NSP contends that not only is the cost of fly ash to the cost of fly ash to the ready-mix plant about $12 a ton less than cement, but it acts as a lubricant that makes the concrete easier to work with and to finish.

As a result of the recent breakthroughs in the market place, NSP is looking for these kinds of payoffs from the sale of furnace byproducts in 1972:

About 20,000 tons of fly ash will be sold as cement replacement. Figuring the 50 cent a ton saving on previous costs of trucking it away, plus a net price of about $2 a ton for the material, the total benefit would be approximately $50,000.

Sale of another 140,000 tons of fly ash as construction fill would return about a nickel a ton over hauling charges. Net benefit would be $77,000.

About 75,000 tons of slag will be sold for fill and ice control, returning about 10 cents a ton over hauling costs. This would add another $45,000 to the total benefit.

And if current experiments with the use of slag pay off. Wood said, this $172,000 combination of savings on hauling costs and sales of byproducts could go much higher.

"If these experiments prove out," Wood predicted, "we're looking at a potential annual benefit of $300,000 here in the Twin Cities."

Figuring about 19 million shares of NSP stock outsanding, that would amount to little more than a penny and a half a share.

"We'll take a penny and a half anywhere we can get it these days," an NSP official observed.

Minneapolis Tribune, July 6, 1972

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PERIODICALS:

Newsbank, a micro-film reader (available at North Senior)

Periodical Micro-film Reader - check your periodicals at your library for articles. Ther are many articles available.

Provided below is a list of articles as they appear in this tacket:

A. "Combustion to install Devices, Cut Pollution by Gas Vehicles," from the Chattanooga Time, February 13, 1972.

B. "Clean Car Device Makers Oppose Delay on '75 Rules" from the Washington Post, April 11, 19[illegible].

C. "Anti-pollution Engines Irksome, but Pure Air Aim Worth Effort," from the Buffalo Evening News, February 8, 1972.

D. "Auto, Factory Anti-pollution Devices Successful," from the Chantanooga Times, June 18, 1972.

E. "Antipollution and the Electric Car," by Bruce C. Netschert from Protecting Our Environment,

F. "Inventor Calls Device Air Pollution Answer," From the (Newark) Evening News, July 12, 1972.

G. "Big X kor the Bay" from Time, September 18, 1972.

H. "Transportation...Sctratching the Surface" from Man: The Next Thiry Years, by Henry Still.

I. "Kansas Invention Scrubs Air Blue" from the Wichita (Kan.) Eagle, February 7, 1972.

J. "NSP finds the market Profitable For Its Generating Plants' Coal Waste," from the Minneaspolis Tribune, July 6, 1972.

CONCEPTS: PACKET 7

I. In seeking solutions to air pollution, we must accept tolerance levels.

II. Changes in life style through car pools, bicycling, and walking are effective ways of reducing air pollution.

III. Profit making can be in conflict with the desire for clean air.

Concepts	BEHAVIORAL OBJECTIVES:
I	1. After completing the unit the student will define, in a single sentence of 25 words or less, the term, tolerance levels.
I	2. After completing the packet, the student will correctly select from a list two reasons why certain tolerance levels of air pollution might be accepted by society.
II	3. The student, after completing the assigned reading, will participate verbally at least three separate times in a seminar of 40 to 50 minutes on the topic of the reduction of air pollution as a result of a change in life styles through car pools, bicycling, and walking. Then the student will explain in one paragraph of less than 50 words the manner in which air pollution is reduced effectively as a result of car pools, bicycling and walking.
III	4. After completing the assigned readings, the student will participate verbally at least three separate times in a seminar on the possible conflict between profit-making and the desire for clean air. Then, the student will select from a list, two aspects of the confict that exists between the desire for profits and the desire for clean air.

At this time administer the pre-test.

PRE-POST TEST
PACKET 7

Behavioral Objective Number	
1	1. Define, in a single sentence of 25 words or less, the term tolerance levels.
2	2. Select from the following list two reasons why certain tolerance levels of air pollution might be accepted by society. Circle the correct choices.
3	3. Explain in one paragraph, of no more than 50 words the way in which air pollution is reduced effectively as a result of car pools, bicycling and walking.

1 1. Define, in a single sentence of 25 words or less, the term tolerance levels.

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2 2. Select from the following list two reasons why certain tolerance levels of air pollution might be accepted by society. Circle the correct choices.

A. The nature of industrialization causes air pollution. Without certain levels of pollution, some industries could not function.

B. The value of making money may be worth the inconvenience of some pollution.

C. The automotive industry is not too concerned with air pollution, therefore, why should the government?

D. Extensive use of the automobile means that urban areas in the future will have to accept smoggy days as being inevitable.

E. Science has not developed the technology necessary to appreciably clean the air.

3 3. Explain in one paragraph, of no more than 50 words the way in which air pollution is reduced effectively as a result of car pools, bicycling and walking.

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4. Correctly select from the following list, two aspects of the conflict that exists between the desire for profits and the desire for clean air. Circle the correct responses.

   A. The conflict between profits and clean air is an either/or situation. Very seldom can industr`'s make profits and not emit air pollut s.

   B. Usually the cost of emission control devices hits the small businessmen hardest, therefore, this cost could drive them out of business and eliminate competition in some industries.

   C. Most companies simply pass the cost of pollution control devices on to the consumer in the form of higher prices for goods.

   D. Changes in industrial production as a result of pollution control devices results in higher unemployment.

PRE-POST TEST ANSWER KEY
PACKET 7

Behavioral
Objective
Number

1 1. Define, in a single sentence of 25 words or less, the term tolerance levels.

Tolerance levels, when applied to air pollution, are levels of pollution which will not interfere with the health or welfare of mankind.

2 2. Select from the following list two reasons why certain tolerance levels of air pollution might be accepted by society. Circle the correct choices.

A. The nature of industrialization causes air pollution. Without certain levels of pollution, some industries could not function.

B. The value of making money may be worth the inconvenience of some pollution.

C. The automotive industry is not too concerned with air pollution, therefore, why should the government?

D. Extensive use of the automobile means that urban areas in the future will have to accept smoggy days as being inevitable.

E. Science has not developed the technology necessary to appreciably clean the air.

3 3. Explain in one paragraph, of no more than 50 words the way in which air pollution is reduced effectively as a result of car pools, bicycling and walking.

All three of the above mentioned activities are alternatives to individual use of the automobile. The automobile has become more than a mode of transportation. Today, automobile is a status symbol, recreation device, a hobby for many, and a means of instant convient transportation. Any-time individual use of the automobile is reduced or eliminated then air pollution is similarly reduced.

4 4. Correctly select from the following list, two aspects of the conflict that exists between the desire for profits and the desire for clean air. Circle the correct responses.

A. The conflict between profits and clean air is an either/or situation. Very seldom can industries make profits and not emit air pollutants.

B. Usually the cost of emission control devices hits the small businessmen hardest, therefore, this cost could drive them out of business and eliminate competition in some industries.

C. Most companies simply pass the cost of pollution control devices on to the consumer in the form of higher prices for goods.

D. Changes in industrial production as a result of pollution control devices results in higher unemployment.

BACKGROUND INFORMATION
PACKET 7

The most important aspect of this packet is for the instructor to clearly understand the conflict that exists between the desire for clean air and the desire for profits. Most of the time, this conflict is not a black and white situation. Profits and clean air can both be obtained simultaneously. However, too often industry appears to be concerned with only profits.

The automobile industry is a good example of the conflict that can occur between profit making and the desire for clean air. As much as the automobile industry would like you to believe, they did not start controlling emissions until laws were passed requiring them to do so. General Motors as late as 1970, spent fifteen to twenty times more on advertising than on research for pollution control devices.

Not only can profits and clean air be simultaneously obtained, but some companies are capturing some emissions and turning them into profits. The petroleum industry has taken the sulfur out of oil and is estimated to sell forty million dollars worth of sulfur a year.

The second important aspect of this packet concerns life styles and how modern, urban life styles contribute to air pollution. Two car families are commonplace in our society. We are very convenience oriented. If we forget something at the supermarket, then the housewife hops into the car and drives to the store to obtain the forgotten item. Also, despite efforts to get people to form car pools, the commuter prefers the convience of not having to bother with car pools.

For further reading, Progress and the Environment provides not only some more information but there are several good questions which can be used in the discussions.

INSTRUCTIONAL SEQUENCE
PACKET 7

Behavioral Objective Number	
	Concept I Required Activities:
1	A. This reading assignment (Progress and the Environment pages 92-92 and 100-109) is especially good for the groups discussions of activity II - B and III - A. There are many good questions in the reading that should help stimulate some discussion.
1&2	B. This is an open ended activity. The answers the student arrives at, especially part two, might not necessarily agree with the views of the instructor. The important thing for the instructor to remember when evaluating the answer is whether or not the answer is scientifically accurate and sociologically reasonable. This assignment has no standard textbook answer. Therefore, one problem that might confront the instructor is students constantly asking where they will find the answer. The instructor should encourage the student to hypothesize what might be the reasons tolerance levels must be accepted. Perhaps the most obvious answer to part two is the fact that it is economically unfeasible to obtain zero air pollution. The second answer students might give is that society might be unwilling to change its life style to reduce air pollution.
	Concept II Required Activites:
3	A. For this activity, use Data Sheet, 1. The Data Sheet 1, is to be used as a pre and post test. It is to be administered prior to beginning this unit on pollution and at this point in packet seven. This purpose of this data sheet is to develop a set of statistics, to be used for determining whether or not a change in life style has occurred with respect to transportation. The results can be used in the discussion of Activity B.
	Since this packet concerns itself with modern man's value system in respect to the use of the automobile, it is hoped the data sheet experiment will aid the student in developing an awareness of their own system of values.

B. Try to establish, through questioning whether car pools, walking and bicycling are going to be the primary way man can reduce air pollution. Again through questioning the students should verbalize some of the values they hold which are in conflict with the use of non polluting models of transportation. Some of the values that the students might discuss are as follows; convenience status of driving a car and social pressure to conform to norms as they relate to the use of the automobile.

Concept III Required Activites:

4 A. The following points that need to be discussed during this activity.

1. The possible conflict between profit making and the desire for clean air is just that, a possible conflict. It is not the purpose of this discussion to make industry appear as the big, nasty polluter.

2. The students on the other hand should realize that industry has very seldom taken the initiative to clean up their emissions. Government, through legislating emission standards, has required industry to stop polluting.

B. The video-tape used in this activity is available through the Administration Building, Mr. Verlin Abbott, Parkway School District. It will be necessary to reserve the tape a few weeks in advance. The instructor should have Data Sheet 2 available for the students.

ENVIRONMENTAL ECOLOGICAL EDUCATION PROJECT

Parkway School District
Checterfield, Missouri

DR. WAYNE FICK, Superintendent

VERLIN M. ABBOTT, Project Director

Unit: Air Pollution: PacketVII

BY:
Robert Goode
Wayne Mosher
Tom Pollmann

The work presented or reported herein was preformed pursuant to a Title III ESEA Grant administered by the Missouri State Department of Education.

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III	4. After completing the assigned readings, the student will participate verbally at least three separate times in a seminar on the possible conflict between profit-making and the desire for clean air. Then, the student will select from a list, two aspects of the conflict that exists between the desire for profits and the desire for clean air.

At this time take the pre-test.
Obtain a copy from your teacher.

ACTIVITIES

Behavioral Objective Number

Concept I Required Activities:

1 A. Read pages 92-95 and 100-109 in <u>Progress and the Environment.</u> This reading assignment will aid you in understanding all four behavioral objectives.

1&2 B. As a result of all the activities in the air pollution packets, you should now realize that zero air pollution is highly impractical. Air quality standards, either local or national, as in the 1970 Clean Air Act, are levels for tolerating air pollution. Write a one page essay, including the following:

1. A definition of the term tolerance levels in air pollution.

2. At least two reasons why tolerance levels must be accepted in our effort for clean air.

This assignment is asking you to draw certain conclusions as to why man should accept some levels of air pollution.

Concept II Required Activities:

3 A. Participate in a group experiment to determine if modern man is willing to change his life style to help reduce air pollution. Your instructor will provide the Data Sheet 1 and further instructions for this experiment.

3 B. Participate in a group discussion on the topic of reduction of air pollution as a result of a change in life style through car pools, bicycling, and walking. The results of the group experiment (activity II A) will be discussed at this time.

Concept III Required Activities:

4 A. Participate in a group discussion on the possible conflict between profit making and the desire for clean air. The reading of activity I A will help you prepare for this seminar.

3&4 B. A video-tap is available at this time. The speaker is Dr. Robert Karsach from the Committee for Environmental Information. Unlike the other speakers, who represented industry, Dr. Karsch is a member of an environmental group active in trying to present the environmental aspects of air pollution. Before viewing the video-tape, see you instructor so as to obtain the Data Sheet 2 for this activity.

At this time take the post test.
Obtain a copy from your teacher.

DATA SHEET 1

Group experiment on the use of the automobile.

1. Do you consider your use of the family automobile to be a contributing factor to air pollution?

   Yes __________ No __________

2. Do you drive an automobile to school?

   Yes __________ No __________

3. What do you consider to be a reasonable number of automobiles for a family in today's society?

   One ____ Two ____ Three ____ Four ____ Five ____

4. What do you consider to be a reasonable distance to walk before it is necessary to drive a car?

   One Block _____ Four Blocks _____ One-Half Mile ____

   One Mile _____ Five Miles ______ Ten Miles ________

5. How many times have you walked or ridden bicycle (instead of a car) within the past three weeks? ________________

DATA SHEET 2

Video-tape presentation by Dr. Robert Karsch from the Committee for Environmental Information.

List the main points Dr. Karsch emphasizes in his speech with respect to:

1. Air monitoring sites ____________________

2. Obtaining facts ____________________

3. Fluorides and the way two communities handled the sitution ____

What aspects of air pollution does Dr. Karsch discuss that were not emphasized by the two previous speakers, which represented industry? You will have to refer back to the data sheets for the two speakers.

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1. Newsbank, a micro-fiche reader (available at North Senior)

2. Periodical Micro-film Reader - check your periodicals at your library for articles. There are many articles available.

3. Provided below is a list of articles as they appear in Packet VI.

   A. "Combustion to Install Devices, Cut Pollution by Gas Vehicles," from the Chattanooga Time, February 13, 1972.

   B. "Clean Car Device Makers Oppose Delay on 75 Rules" from the Washington Post, April 11, 1972.

   C. "Anti-pollution Engines Irksome, But Pure Air Aim Work Effort," from the Buffalo Evening News, February 8, 1972.

   D. "Auto, Factory Anti-pollution Devices Successful," from the Chantanooga Times, June 18, 1972.

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