

ILLINOIS POLLUTION CONTROL BOARD  
July 10, 1975

IN THE MATTER OF )  
PROPOSED AIR QUALITY STANDARDS ) R72-7  
)  
)

OPINION OF THE BOARD (by Mr. Dumelle):

This Opinion supports the Air Quality Standards for particulates, sulfur oxides, carbon monoxide, nitrogen dioxide, non-methane hydrocarbons, and photochemical oxidants adopted by the Board May 3, 1973 and July 10, 1975. The standards were adopted following a review of the record in this proceeding which includes testimony at two public hearings, exhibits submitted at the hearings, and written comments submitted to the Board. The record also contains portions of the record in another proceeding, R74-2, concerning health effects of sulfur dioxide, ordered incorporated into this proceeding by Board Order on February 14, 1975.

The Proposed Air Quality Standards, drafted by the Board and published in Board Newsletter #47 (Exhibit 1), consisted of primary (i.e. health related) and, in some cases, secondary (i.e. welfare related) standards for particulates, sulfur oxides, non-methane hydrocarbons, carbon monoxide, nitrogen dioxide, and photochemical oxidants. Measurement methods for these pollutants were also proposed. Table I summarizes the Proposed Air Quality Standards.

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The Board acknowledges with appreciation the excellent work of Edward H. Hohman, Administrative Assistant to the Board, in this proceeding.

TABLE I PROPOSED AIR QUALITY STANDARDS

<u>POLLUTANT</u>		<u>PROPOSED STANDARD</u>	
1.	Particulates	Primary	75 $\mu\text{g}/\text{m}^3$ annual geometric mean 260 $\mu\text{g}/\text{m}^3$ maximum 24-hour, not to be exceeded more than once per year
		Secondary	60 $\mu\text{g}/\text{m}^3$ annual geometric mean 150 $\mu\text{g}/\text{m}^3$ maximum 24-hour, not to be exceeded more than once per year
2.	Sulfur Oxides (measured as sulfur dioxide) Alternate 1	Primary	80 $\mu\text{g}/\text{m}^3$ (0.03 ppm) annual arithmetic mean 365 $\mu\text{g}/\text{m}^3$ (0.14 ppm) maximum 24-hour, not to be exceeded more than once per year
		Secondary	60 $\mu\text{g}/\text{m}^3$ (0.02 ppm) annual arithmetic mean 260 $\mu\text{g}/\text{m}^3$ (0.09 ppm) maximum 24-hour, not to be exceeded more than once per year
			1300 $\mu\text{g}/\text{m}^3$ (0.45 ppm) maximum 3-hour, not to be exceeded more than once per year
			Alternate 2

TABLE I (Continued)

3. Non-methane Hydrocarbons (measured as methane)	160 $\mu\text{g}/\text{m}^3$ (0.24 ppm)	maximum 3-hour (6 to 9 am), not to be exceeded more than once per year
4. Carbon Monoxide	10 $\text{mg}/\text{m}^3$ (9 ppm)	maximum 8-hour, not to be exceeded more than once per year
	40 $\text{mg}/\text{m}^3$ (35 ppm)	maximum 1-hour, not to be exceeded more than once per year
5. Nitrogen Dioxide	100 $\mu\text{g}/\text{m}^3$ (0.05 ppm)	annual arithmetic mean
6. Photochemical Oxidants	160 $\mu\text{g}/\text{m}^3$ (0.08 ppm)	maximum 1-hour, not to be exceeded more than once per year.

NOTES:  $\mu\text{g}/\text{m}^3$  means concentration in terms of micrograms per cubic meter  
 $\text{mg}/\text{m}^3$  means concentration in terms of milligrams per cubic meter

The proposed standards and measurement methods, except for sulfur dioxide alternate 2, were consistent with the Federal Ambient Air Quality Standards published on April 30, 1971 (Exhibit 2).

In making this proposal, the Board discussed in some detail the need for statewide ambient air quality standards. The following excerpt from Exhibit 1 discusses this need.

"Air quality standards designating the maximum tolerable levels for various air contaminants have been the subject of several regulations adopted by the Air Pollution Control Board (Chapter V, APCB Rules) and of further hearings (R70-9, R70-10) by the Pollution Control Board. The regulations proposed at this time are those promulgated by the Federal EPA, April 30, 1971 (36 Fed. Reg. 8186-8201). The federal government further specified that these standards were to be attained at the latest, by July 3, 1975, although provision was made for limited extensions past this date (36 Fed. Reg. 15486-15506, August 14, 1971). As a result, the control strategy embodied in the Illinois Implementation Plan, as well as the emission levels specified in the recently promulgated stationary source air emission regulations (Parts I and II of the PCB Rules - Chapter 2), were developed based on achieving these levels of air quality.

We are expected by federal law to adopt and enforce implementation plans to achieve and maintain the new federal standards throughout the State. If we do not, the federal agency will -- the statute says--, and there will be no federal funds to support state or local air pollution control efforts. Given this state of affairs one course for us would be to adopt no air quality standards of our own. But it is useful to have a complete set of regulations at the state level, not only for ease of reference since these standards are importantly related to emission control limits, but also because federal standards are not immutable and because in some instances we may wish to adopt stricter standards. The federal standards are what we can tolerate in crowded areas; in national parks, for example, we might find stricter standards necessary. On the other hand, uniformity between state and federal

standards is obviously desirable unless there is solid ground for disagreement, especially since we have already devised a plan for achieving federal standards.

In light of the above considerations, the PCB is today proposing adoption of the federal standards. This action also repeals and supersedes the air quality standards of Chapter V of the APCB Rules and Regulations. An alternative sulfur dioxide standard has been included which applies the present Illinois standards for St. Louis and Chicago to the entire State (Alternate - 2)."

Public hearings on the proposal were held on June 15, 1972 in Chicago and on June 16, 1972 in Granite City. The record from these hearings includes 68 pages of testimony and 10 exhibits from 8 witnesses. The record incorporated from the R74-2 hearings consists of 358 pages of testimony and 16 exhibits from 5 witnesses. All of the submitted material, including the comments submitted prior to and subsequent to the hearings has been reviewed by the Board in reaching the findings of fact and conclusions of law contained in this Opinion.

Public comments concerning the proposed regulations were received from 13 parties; citizens, industry, citizen groups, and trade associations. The bulk of the comments were in reference to the sulfur dioxide proposal. The citizens and citizen groups supported the more stringent Alternate 2 proposal while industry supported, generally, the proposed standards with Alternate 1. There was, in addition, some opposition to the secondary standards for sulfur dioxide. Other public comments were that the oxidant standard was not too lax and that the particulate standard may not be attainable.

The following sections contain discussions of each individual pollutant for which an ambient air quality standard was proposed. It is important to distinguish between proposed primary standards and proposed secondary standards, if such distinctions are made for a given pollutant. According to Exhibit 2,

"National primary ambient air quality standards are those which, in the judgment of the Administrator (of the U.S. EPA), based on the air quality criteria and allowing an adequate margin of safety, are requisite to protect the public health.

National secondary ambient air quality standards are those which, in the judgment of the Administrator, based on the air quality criteria, are requisite to

protect the public welfare from any known or anticipated adverse effects associated with the presence of air pollutants in the ambient air."

#### Particulates

The major evidence regarding this pollutant is contained in Exhibit 3, entitled "Air Quality Criteria for Particulate Matter" (AP-49) published by the U. S. Department of Health, Education and Welfare. This document discusses the effects of atmospheric particulate matter on visibility, materials, the climate, economics (soiling, property values, etc.), vegetation; and the toxicological and epidemiological effects on animals, including humans.

Regarding health effects, the toxic effects of particulates are related to injury to the respiratory system of man. As discussed in Exhibit 3,

"Such injury may be permanent or temporary. It may be confined to the surface, or it may extend beyond, sometimes producing functional or other alterations. Particulate material in the respiratory tract may produce injury itself, or it may act in conjunction with gases, altering their sites or their modes of action. Laboratory studies of man and other animals show clearly that the deposition, clearance, and retention is a very complex process, ... Particles cleared from the respiratory tract by transfer to the lymph, blood, or gastrointestinal tract may exert effects elsewhere."  
(Exhibit 3, p. 182)

The epidemiological studies discussed in Exhibit 3 can be used to quantify levels of particulates at which health effects have been observed. The following is a summary of particulate levels and health effects contained in the Exhibit.

"Excess deaths and a considerable increase in illness have been observed in London at smoke levels above  $750 \mu\text{g}/\text{m}^3$  and in New York at a smokeshade index of 5-6 cohs. Sulfur oxides pollution levels were also high in both cases. These unusual short-term, massive exposures result in immediately apparent pathological effects, and they represent the upper limits of the observed dose-response relationship between particulates and adverse effects on health.

Daily averages of smoke above  $300 \mu\text{g}/\text{m}^3$  to  $400 \mu\text{g}/\text{m}^3$  have been associated with acute worsening of chronic bronchitis patients in England. No comparable data are available in this country. Studies of British workmen found that increased absences due to illness occurred when smoke levels exceeded  $200 \mu\text{g}/\text{m}^3$ .

Two recent British studies showed increases in selected respiratory illness in children to be associated with annual mean smoke levels above  $120 \mu\text{g}/\text{m}^3$ . Additional health changes were associated with higher levels. These effects may be of substantial significance in the natural history of chronic bronchitis. Changes beginning in young children may culminate in bronchitis several decades later.

The lowest particulate levels at which health effects appear to have occurred in this country are reported in studies of Buffalo and Nashville. The Buffalo study clearly shows increased death rates from selected causes in males and females 50 to 69 years old at annual geometric means of  $100 \mu\text{g}/\text{m}^3$  and over. The study suggests that increased mortality may have been associated with residence in areas with 2-year geometric means of  $80 \mu\text{g}/\text{m}^3$  to  $100 \mu\text{g}/\text{m}^3$ . The Nashville study suggests increased death rates for selected causes at levels above 1.1 cohs. Sulfur oxides pollution was also present during the periods studied. In neither study were the smoking habits of the decedents known.

Corroborating information is supplied from Fletcher's study of West London workers between the ages of 30 and 59. The data indicate that with a decrease of smoke pollution (yearly mean) from  $140 \mu\text{g}/\text{m}^3$  to  $60 \mu\text{g}/\text{m}^3$ , there was an associated decrease in mean sputum volume. Fletcher noted that there may have been changes in the tar composition of cigarettes during the period studied; such a change could affect the findings. This study provides one of the rare opportunities to examine the apparent improvement in health that followed an improvement in the quality of the air." (Exhibit 3, p. 183-184)

The Exhibit thus identifies particulate levels of 80 to  $100 \mu\text{g}/\text{m}^3$  (2 year geometric means) as the lowest levels at which health effects (increased mortality) have been observed in the United States, and daily averages of 300 to  $400 \mu\text{g}/\text{m}^3$  as causing a worsening of chronic bronchitis.

The effects of particulates on public welfare are likewise discussed in Exhibit 3. The effects include the following:

- a) At concentrations ranging from 100  $\mu\text{g}/\text{m}^3$  to 150  $\mu\text{g}/\text{m}^3$  for particulates, where large smoke turbidity factors persist, in middle and high latitudes direct sunlight is reduced up to one-third in summer and two-thirds in winter.
- b) At concentrations of about 150  $\mu\text{g}/\text{m}^3$  for particulates, where the predominant particle size ranges from 0.2 microns to 1.0 microns and relative humidity is less than 70 percent, visibility is reduced to as low as 5 miles.
- c) At concentrations ranging from 60  $\mu\text{g}/\text{m}^3$  (annual geometric mean), to 180  $\mu\text{g}/\text{m}^3$  for particulates (annual geometric mean), in the presence of sulfur dioxide and moisture, corrosion of steel and zinc panels occurs at an accelerated rate.
- d) At concentrations of approximately 70  $\mu\text{g}/\text{m}^3$  for particulates (annual geometric mean), in the presence of other pollutants, public awareness and/or concern for air pollution may become evident and increase proportionately up to and above concentrations of 200  $\mu\text{g}/\text{m}^3$  for particulates.

Exhibit 3 concludes that adverse effects on materials were observed at an annual mean particulate concentration exceeding 60  $\mu\text{g}/\text{m}^3$ .

The particulate standards were discussed by several witnesses at the hearings. Kirkwood (R. 49) and Sutton (R. 62) supported the particulate levels. Sutton testified concerning the particulate levels in Granite City (the levels for the first five months of 1972 averaged 200  $\mu\text{g}/\text{m}^3$  in one residential area) and urged the Board for a "speedy implementation of the State's air quality standards." (R. 62-63)

Fancher, of Commonwealth Edison, provided the only opposition to the levels, stating that in his opinion, the bases for these levels was "extremely weak". (R. 30) He suggests that particulates from large scale fossil-fuel combustion plumes have not been investigated in terms of toxicological research and that the evidence (the Buffalo study) regarding effects at the secondary standard level may be caused by some other pollutant. (R. 30-31) Fancher also provided information regarding particulate levels in Illinois (Exhibit 1 to Fancher statement) and concluded that isolated,



non-metropolitan communities have particulate levels the same as non-industrial suburbs, and only slightly less than metropolitan areas including parts of Chicago. (R. 32) He suggests that this indicates high "natural" background levels of particulates which could not be reasonably controlled.

Our review of the record finds that the points raised by Edison are not supported. The levels contained in the criteria document and summarized earlier in this Opinion are based on epidemiological studies from both Europe and North America where the particulate levels certainly contained contributions from fossil-fuel combustion sources, the combustion being used for heating as well as power generation. In addition, particulates both cause adverse effects and magnify the adverse effects of other pollutants as pointed out earlier in this Opinion. Regarding the Edison testimony concerning the Buffalo studies, we note that Exhibit 3 reports a positive correlation between total mortality including mortality from chronic respiratory disease, and particulate level; and increased mortality at particulate levels exceeding  $80 \mu\text{g}/\text{m}^3$ . (Exhibit 3, p. 159) Except for the unknown smoking habits, we conclude that Fancher's statement concerning the Buffalo study is mere speculation. Finally, our review of the Edison statement concerning particulate levels in Illinois shows 1970 levels ranging from  $50 \mu\text{g}/\text{m}^3$  for Crystal Lake to  $205 \mu\text{g}/\text{m}^3$  for Chicago Heights; and we question whether this is evidence as suggested by Edison of similar particulate levels existing statewide. Furthermore, Fancher estimates a "natural" background of  $45 \mu\text{g}/\text{m}^3$  and adds on estimated contributions due to man's activity. (Exhibit 3 of Fancher statement) We conclude from this "evidence" that if all particulate emissions due to man's activity were completely abated, a level of  $45 \mu\text{g}/\text{m}^3$  could be achieved. This, however, is not required since the primary and secondary standards we have adopted are  $75 \mu\text{g}/\text{m}^3$  and  $60 \mu\text{g}/\text{m}^3$  respectively.

We, therefore, have adopted the federal primary and secondary standards for particulates as state standards for Illinois.

#### Sulfur Oxides (Sulfur Dioxide)

The federal document, "Air Quality Criteria for Sulfur Oxides" (AP-50), published by the U.S. Department of Health, Education, and Welfare, was entered into the record as Exhibit 4. This document contains a discussion of the effects of sulfur oxides on materials, vegetation, animals and man, and at the time of the hearings, formed the major basis for setting standards.

Sulfur dioxide is a non-flammable, non-explosive, colorless gas. It is emitted to the atmosphere as a result of combustion processes.

The effects of sulfur dioxide on humans are related to irritation of the respiratory system, the injury can be either temporary or permanent. Broncho constriction, as evidenced by increased airway resistance, has been shown to occur in man following 30 minute exposures to sulfur dioxide at levels of 5 ppm. Sensitive individuals exposed to 1 ppm of sulfur dioxide have in some instances exhibited severe bronchospasms. (Exhibit 4, p. 155-156)

Epidemiological studies discussed in Exhibit 4 relate to both short term-high level and long term-low level exposures. The Exhibit concludes the following regarding the effects of sulfur dioxide on human health (Exhibit 4, p. 161-162):

- a) At concentrations of about  $1500 \mu\text{g}/\text{m}^3$  (0.52 ppm) of sulfur dioxide (24-hour average), and suspended particulate matter measured as a soiling index of 6 cohs or greater, increased mortality may occur.
- b) At concentrations of about  $715 \mu\text{g}/\text{m}^3$  (0.25 ppm) of sulfur dioxide and higher (24-hour mean), accompanied by smoke at a concentration of  $750 \mu\text{g}/\text{m}^3$ , increased daily death rates may occur.
- c) At concentrations of about  $500 \mu\text{g}/\text{m}^3$  (0.19 ppm) of sulfur dioxide (24-hour mean), with low particulate levels, increased mortality rates may occur.
- d) At concentrations ranging from  $300 \mu\text{g}/\text{m}^3$  to  $500 \mu\text{g}/\text{m}^3$  (0.11 ppm to 0.19 ppm) of sulfur dioxide (24-hour mean), with low particulate levels, increased hospital admissions of older persons for respiratory disease may occur; absenteeism from work, particularly with older persons, may also occur.
- e) At concentrations of about  $715 \mu\text{g}/\text{m}^3$  (0.25 ppm) of sulfur dioxide (24-hour mean), accompanied by particulate matter, a sharp rise in illness rates for patients over age 54 with severe bronchitis may occur.
- f) At concentrations of about  $600 \mu\text{g}/\text{m}^3$  (about 0.21 ppm) of sulfur dioxide (24-hour mean), with smoke concentrations of about  $300 \mu\text{g}/\text{m}^3$ , patients with chronic lung disease may experience accentuation of symptoms.
- g) At concentrations ranging from  $105 \mu\text{g}/\text{m}^3$  to  $265 \mu\text{g}/\text{m}^3$  (0.037 ppm to 0.092 ppm) of sulfur dioxide (annual mean), accompanied by smoke concentrations of

about  $185 \mu\text{g}/\text{m}^3$ , increased frequency of respiratory symptoms and lung disease may occur.

h) At concentrations of about  $120 \mu\text{g}/\text{m}^3$  (0.046 ppm) of sulfur dioxide (annual mean), accompanied by smoke concentrations of about  $100 \mu\text{g}/\text{m}^3$ , increased frequency and severity of respiratory diseases in school children may occur.

i) At concentrations of about  $115 \mu\text{g}/\text{m}^3$  (0.040 ppm) of sulfur dioxide (annual mean), accompanied by smoke concentrations of about  $160 \mu\text{g}/\text{m}^3$ , increase in mortality from bronchitis and from lung cancer may occur.

This information was buttressed by Dr. Carnow of the University of Illinois Medical Center. Dr. Carnow testified regarding his epidemiological studies. (Exhibit 9) By dividing the City of Chicago into different areas, he found that at each level of  $\text{SO}_2$  from 0.041 ppm to 5 ppm, the higher the level, the greater the number of people (male, 55 years old with advanced bronchitis) reporting acute chest disease. (R. 7) He also found increased instances of acute illness at  $\text{SO}_2$  levels greater than 0.09 ppm and further increases at  $\text{SO}_2$  levels greater than 0.19 ppm. (Exhibit 9) He concludes from these and other studies that there is no threshold for  $\text{SO}_2$ , that at every level someone is affected adversely. "...you cannot compare a 30-year old population, which is done frequently, and examine them and compare them with new-borns (sic) and people with emphysema and severe arteriosclerosis, ...we have to define levels that are achievable and those which will protect the maximum number of people." (R. 222)

Exhibit 4 also includes information relating to the public welfare aspects of sulfur dioxide. The following conclusions are drawn from this information: (Exhibit 4, p. 162)

a) At a concentration of  $285 \mu\text{g}/\text{m}^3$  (0.10 ppm) of sulfur dioxide, with a comparable concentration of particulate matter and a relative humidity of 50 percent, visibility may be reduced to about five miles.

b) At a mean sulfur dioxide level of  $345 \mu\text{g}/\text{m}^3$  (0.12 ppm), accompanied by high particulate levels, the corrosion rate for steel panels may be increased by 50 percent.

c) At a concentration of about  $85 \mu\text{g}/\text{m}^3$  (0.03 ppm) of sulfur dioxide (annual mean), chronic plant injury and excessive leaf drop may occur.

- d) After exposure to about  $860 \mu\text{g}/\text{m}^3$  (0.3 ppm) of sulfur dioxide for 8 hours, some species of trees and shrubs show injury.
- e) At concentrations of about  $145 \mu\text{g}/\text{m}^3$  to  $715 \mu\text{g}/\text{m}^3$  (0.05 ppm to 0.25 ppm), sulfur dioxide may react synergistically with either ozone or nitrogen dioxide in short-term exposures (e.g., 4 hours) to produce moderate to severe injury to sensitive plants.

Since there were two alternative proposals for  $\text{SO}_2$  standards under consideration at the hearings, the issue was not only whether there should be a  $\text{SO}_2$  standard, but which proposal it should be. Rissman stated that Alternate 2, which included a 0.015 ppm annual standard, should be adopted, citing evidence of plant injury from  $\text{SO}_2$  at levels of 0.025 ppm to 0.017 ppm on a seasonal average. (R. 4) Carnow suggested that to protect the greatest number of people, 0.015 ppm was an achievable standard that should be adopted. (R. 12) Fancher testified that there was no toxicological or epidemiological evidence to support the Alternate 2 standards. He estimated that the additional cost to Edison's customers of complying with Alternate 2 would be \$400 million. (R. 29) He concluded that an 0.015 ppm annual average cannot be achieved even though in 1970 the annual average for Chicago was 0.017 ppm, since at only 3 locations within the city was 0.015 ppm reached. (R. 38-39) Kirkwood supported the Alternate 2 standards but suggested that the 0.17 ppm 24-hour standard be decreased to 0.14 ppm, citing evidence from Exhibit 4. (R. 49-50)

Following the hearings, the Board published for comment a proposed final draft for sulfur oxides air quality standards on May 17, 1973 in Newsletter #65. The proposed final draft contained the Alternate 1 standards, the federal standards, for most of the state with the Alternate 2 standards to apply to the Chicago and East St. Louis major metropolitan areas. Comments regarding the proposal were received from many parties, primarily in opposition to the more stringent Chicago and East St. Louis provisions.

On September 14, 1973 (38 FR 25678) the U.S. EPA Administrator revoked the annual and 24-hour secondary standards for  $\text{SO}_2$ , and retained the 3-hour secondary standard of  $1300 \mu\text{g}/\text{m}^3$  (0.5 ppm), not to be exceeded more than once per year. While not a part of this record, the Board takes official notice of this event in formulating its decision regarding sulfur dioxide air quality standards.

As mentioned previously, by Board Order on February 14, 1975 the portion of the record in R74-2, SO<sub>2</sub> Inquiry Hearings, pertaining to health affects was incorporated into the R72-7 proceedings. Five witnesses testified at some length regarding health effects, a summary of which follows.

Dr. Finklea of the U.S. EPA presented recent information regarding the effects of sulfur oxides, including sulfur dioxide and sulfates. He concluded the following regarding the justification of the SO<sub>2</sub> federal air quality standard:

"I think the discussion of our additional information has been toward saying that there is less of a safety margin in the primary air quality standard, and if anything the degree of control envisioned should be better supported so that the direction of our information is to say that we have more support for the existing standard and we have less of a safety margin that we thought in the present ambient air quality standard." (R. 74-2, p. 80)

Mr. Ross, from Great Britian, stated that concentrations of sulfur dioxide in the order of 1 to 2 ppm are practically harmless in the absence of particulates, and that if SO<sub>2</sub> concentrations remain below 500 µg/m<sup>3</sup>, there is no health danger. (R. 74-2, p. 1783-1784) He felt, however, that the primary and secondary standards for SO<sub>2</sub> were reasonable and adequate (R. 74-2, p. 1835)

Dr. Mueller, from ERT, supported Finklea's conclusion that the SO<sub>2</sub> primary and secondary standards are at an appropriate level to protect public health. (R. 1858) In addition, he felt that secondary pollutants from SO<sub>2</sub>, such as acid and particulate sulfates, are likely to exacerbate or increase adverse health effects. (R. 1864)

Dr. Carnow's testimony expanded on his presentation two years earlier. He cited the National Academy of Science's report that current data on SO<sub>2</sub> shows no justification for relaxing the air quality standards. (R. 74-2, p. 2063) He described an 18 month study that showed a direct correlation between SO<sub>2</sub> levels in Chicago and admissions to the emergency rooms of Cook County Hospital for acute respiratory illness (R. 74-2, p. 2066) He also rebutted Ross' testimony. (R. 74-2, p. 2069)

Mr. Patzlaff of the Illinois Environmental Protection Agency presented a literature survey on the health effects of sulfur. He concluded that there is no basis for a relaxation of the standards for sulfur oxides. (R. 74-2, p. 130)

The testimony from these recent hearings seems to be that the federal SO<sub>2</sub> air quality standards, especially the primary standards, are still adequate and are consistent with recent data. We find, based on the R74-2 information, additional justification for adopting SO<sub>2</sub> standards that are identical to the federal standards.

Based on the record established, including the comments relating to the proposed final draft, the Board published on February 18, 1975 in Environmental Register #98 a second proposal with request for comments. This proposal was identical to the federal air quality standard and differed from the previously published proposal in that the stricter standards for Chicago and East St. Louis were deleted, and the deleted federal secondary standards were also deleted from the proposal.

One economic benefit of this proposal is that the \$400 million additional compliance cost to achieve Alternate 2 estimated by Edison (R. 29) is now moot. Another is that the problem of modifying compliance plans on the part of all emitters to meet the stricter Alternate 2 limits is now eliminated.

Comments regarding the latest proposed final draft were received from the Illinois Manufacturers Association and Olin Brass Company. These comments urged the adoption of the proposed sulfur oxides standards as contained in Environmental Register #98. It was also pointed out by the Agency that a typographical error exists in Environmental Register #98, in that Rule 308(c) should be headed Measurement Method rather than Measurement Period. We have corrected this error in the final regulation.

We, therefore, adopt today the sulfur oxide air quality standards as published in Register #98 as corrected.

#### Non-methane Hydrocarbons

The primary evidence supporting the adoption of this air quality standard is contained in Exhibit 5, entitled "Air Quality Criteria for Hydrocarbons" (AP-50) and published by the U.S. Department of Health, Education and Welfare. This exhibit contains a description of the sources, nature, and principles of control of atmospheric hydrocarbons, atmospheric

levels of hydrocarbons and their products, the relationship of atmospheric hydrocarbons to photochemical air pollution levels, the effects of hydrocarbons on vegetation, and a toxicological appraisal of hydrocarbons.

The effects of atmospheric hydrocarbons on health and welfare are summarized in Exhibit 5 as they occur in three areas: the effects of hydrocarbons directly on human health, the effects of hydrocarbons in forming photochemical oxidants, and the effects of hydrocarbons on vegetation.

The first effect, human health, is not as significant as the other effects. Exhibit 5 summarizes direct health effects as follows: (Exhibit 5, p. 8-3, 4)

"1. The aliphatic and alicyclic hydrocarbons are generally biochemically inert, though not biologically inert, and are only reactive at concentrations of  $10^2$  to  $10^3$  higher than those levels found in the ambient atmosphere. No effects have been reported at levels below 500 ppm.

2. The aromatic hydrocarbons are biochemically and biologically active. The vapors are more irritating to the mucous membranes than equivalent concentrations of the aliphatic or alicyclic groups. Systemic injury can result from the inhalation of vapors of the aromatic compounds; no effects, however, have been reported at levels below 25 ppm."

The second effect, formation of photochemical oxidants, is the most important in terms of an air quality standard; since photochemical oxidants, as will be discussed later in the Opinion, cause adverse effects such as respiratory irritation, eye irritation, cracking of rubber and damage to vegetation. The conclusion that we reach regarding oxidants is an air quality standard of 0.08 ppm as a maximum 1-hour concentration. It then becomes necessary to determine the maximum atmospheric level of hydrocarbons allowed to insure that the air quality standard for oxidants is not exceeded. Exhibit 5 discusses the data relating to the tie-in between hydrocarbons and oxidant levels, and contains the following summary: (Exhibit 5, p. 5-11, 12)

"The development of a model to relate emission rates of hydrocarbons to ambient air quality and then to the secondary products of photochemical reactions has proved to be an elusive problem. Because of this lack of an appropriate model, the relationship between hydrocarbon emissions and subsequent maximum daily

oxidant levels must be approached empirically. The empirical approach adopted is a comparison of 6:00 to 9:00 a.m. average hydrocarbon values with hourly maximum oxidant values attained later in the day. This approach has validity only because of the dominating influence of the macro-meteorological variables on both the concentrations of precursors and photochemical products. Furthermore, this approach can yield useful information only when a large number of days are considered; this guarantees the inclusion of all possible combinations of emission rates, meteorological dilution and dispersion variables, sunlight intensity, and ratios of precursor emissions. When maximum daily oxidant values from such an unrestricted data base are plotted as a function of the early morning hydrocarbons, a complete range of oxidant values -- starting near zero and ranging up to finite and limiting values -- is observed. Given data for a sufficient number of days, it becomes apparent that the maximum values of attainable oxidant are a direct function of the early morning hydrocarbon concentration. This upper limit of the maximum daily oxidant concentration is dependent on the metropolitan geographical area only to the extent that differences in meteorological variables exist between these areas. Thus, the data from all cities can be plotted on one graph when defining the oxidant upper limit as a function of early morning hydrocarbon.

In defining this oxidant upper limit, all available data relating directly measured non-methane hydrocarbon values to maximum daily oxidant concentrations have been used. Direct observation of this limit in the vicinity of  $200 \mu\text{g}/\text{m}^3$  (0.1 ppm) daily maximum 1-hour average oxidant concentrations shows that in order to keep the oxidant below this value, the 6:00 to 9:00 a.m. average non-methane hydrocarbon concentration must be less than  $200 \mu\text{g}/\text{m}^3$  (0.3 ppm C). This maximum oxidant concentration potential may be expected to occur on about 1 percent of the days."

It should be noted that the emphasis here is on the majority of the hydrocarbons that are photochemically reactive. For this reason, methane, a non-reactive hydrocarbon, is not included in the measurements or the air quality standards.

The effect on vegetation has been investigated since the 1900's, and the particular hydrocarbon ethylene has been shown to be the major hazard at ambient concentrations. The effects of ethylene are summarized in Exhibit 5 as follows: (Exhibit 5, p. 6-7)



"Hydrocarbons were first recognized as phytotoxic air pollutants about the turn of the century as a result of complaints of injury to greenhouse plants from illuminating gas. Ethylene was shown to be the injurious component. Renewed interest in hydrocarbons, and ethylene in particular, occurred in the mid-1950's when ethylene was found to be one of the primary pollutants in the photochemical smog complex. Research on several unsaturated and saturated hydrocarbons proved that only ethylene had adverse effects at known ambient concentrations. Acetylene and propylene more nearly approach the activity of ethylene than do other similar gases, but 60 to 500 times the concentration is needed for comparable effects.

In the absence of any other symptom, the principal effect of ethylene is to inhibit growth of plants. Unfortunately, this effect does not characterize ethylene because other pollutants at sublethal dosages, as well as some disease and environmental factors, will also inhibit growth.

Epinasty of leaves and abscission of leaves, flower buds, and flowers are somewhat more typical of the effects of ethylene, but the same effects may be associated with nutritional imbalance, disease, or early senescence. Perhaps the most characteristic ethylene effects are the dry sepal wilt of orchids and the closing of carnation flowers. Injury to sensitive plants has been reported at ethylene concentrations of 1.15 to 575  $\mu\text{g}/\text{m}^3$  (0.001 to 0.5 ppm) during time periods of 8 to 24 hours."

Ethylene is a major petrochemical product and is a major component of automobile exhausts. There is not, however, evidence available on the atmospheric concentrations of ethylene or vegetation affected in Illinois. Thus we cannot base an air quality standard for hydrocarbons on the effect of ethylene on vegetation.

There was no evidence presented during the hearings opposing the hydrocarbon proposal. Based on the record developed in this proceeding, we have adopted the non-methane hydrocarbon standard as proposed.

#### Carbon Monoxide

The major evidence presented regarding this proposal is contained in Exhibit 6 which is entitled "Air Quality Criteria for Carbon Monoxide" (AP-62) and is published by the U.S. Department of Health, Education, and Welfare. This document

discusses, in part, the occurrence, properties, and fate of atmospheric carbon monoxide, principles of formation and control of carbon monoxide, effects on plants and microorganisms, toxicological effects, and an epidemiological appraisal.

Carbon monoxide (CO) is a colorless, odorless, tasteless gas. It occurs in the atmosphere because of the incomplete oxidation of carbonaceous material, including the incomplete combustion of organic materials. The major emission source of CO, particularly in urban areas, is the internal combustion engine used in vehicles; major industrial sources include steel mills, petroleum refineries and foundries.

The effects of CO on plants and microorganisms occur at higher levels than the effects on animals. Detrimental effects on certain "higher order plants" have occurred, according to Exhibit 6, at levels greater than 100 ppm after exposures of 1 to 3 weeks. Nitrogen fixation by certain bacteria in clover roots was inhibited by 100 ppm CO for an exposure of 1 month. (Exhibit 6, p. 7-2) These effects are, however, not controlling in terms of establishing an air quality standard.

The effects of CO on humans is discussed in detail in Exhibit 6. The following excerpts summarize the toxicological and epidemiological effects of CO. (Exhibit 6, p. 10-3)

"CO is absorbed by the lung and reacts primarily with hemoproteins and most notably with the hemoglobin of the circulating blood. The absorption of CO is associated with a reduction in the oxygen-carrying capacity of blood and in the readiness with which the blood gives up its available oxygen to the tissues. The affinity of hemoglobin for CO is over 200 times that for oxygen, indicating that carboxyhemoglobin (COHb) is a more stable compound than oxyhemoglobin (O<sub>2</sub>Hb). About 20 percent of an absorbed dose of CO is found outside of the vascular system, presumably in combination with myoglobin and heme-containing enzymes. The magnitude of absorption of CO increases with the concentration, the duration of exposure, and the ventilatory rate. With fixed concentrations and with exposures of sufficient duration, an equilibrium is reached; the equilibrium is reasonably predictable from partial-pressure ratios of oxygen to CO.

Long-term exposures of animals to sufficiently high CO concentrations can produce structural changes in the heart and brain. It has not been shown that ordinary ambient exposures will produce this. The lowest exposure producing any such changes has been 58 mg/m<sup>3</sup> (50 ppm) continuously for 6 weeks.

The normal or "background" concentration of COHb in nonsmokers is about 0.5 percent and is attributed to endogenous sources such as heme catabolism. The body's uptake of exogenous CO increases blood COHb according to the concentration and length of exposure to CO as well as the respiratory rate of the individual."

The results of the toxicological appraisal according to Exhibit 6 are the following summary statements. (Exhibit 6, p. 10-4)

"(1) no human health effects have been demonstrated for COHb levels below 1 percent, since endogenous CO production makes this a physiological range; (2) the following effects on the central nervous system occur above 2 percent COHb: (a) at about 2.5 percent COHb in nonsmokers (from exposure to 58 mg/m<sup>3</sup> for 90 minutes), an impairment in time-interval discrimination has been documented, (b) at about 3 percent COHb in nonsmokers (from exposure to 58 mg/m<sup>3</sup> for 50 minutes), an impairment in visual acuity and relative brightness threshold has been observed, (c) at about 5 percent COHb there is an impairment in performance of certain other psychomotor tests; (3) cardiovascular changes have been shown to occur at exposure sufficient to produce over 5 percent COHb; they include increased cardiac output, increased arterial-venous oxygen difference, increased coronary blood flow in patients without coronary disease, decreased coronary sinus blood Po<sub>2</sub> in patients with coronary heart disease, impaired oxidative metabolism of the myocardium, and other related effects; these changes have been demonstrated to produce an exceptional burden on some patients with heart disease; and (4) adaptation to CO may occur through increasing blood volume, among other mechanisms."

Proceeding one step further, i.e. relating exposures to CO with effects on humans, the following results are shown. (Exhibit 6, p. 10-5, 6)

1. Experimental exposure of nonsmokers to a concentration of  $35 \text{ mg/m}^3$  (30 ppm) for 8 to 12 hours has shown that an equilibrium value of 5 percent COHb is approached in this time; about 80 percent of this equilibrium value, i.e., 4 percent COHb, is present after only 4 hours of exposure. These experimental data verify formulas used for estimating the equilibrium values of COHb after exposure to low concentrations of CO. These formulas indicate that continuous exposure of nonsmoking sedentary individuals to  $23 \text{ mg/m}^3$  (20 ppm) will result in a blood COHb level of about 3.7 percent, and an exposure to  $12 \text{ mg/m}^3$  (10 ppm) will result in a blood level of about 2 percent.

2. Experimental exposure of nonsmokers to  $58 \text{ mg/m}^3$  (50 ppm) for 90 minutes has been associated with impairment in time-interval discrimination. This exposure will produce an increase of about 2 percent COHb in the blood. This same increase in blood COHb will occur with continuous exposure to 12 to  $17 \text{ mg/m}^3$  (10 to 15 ppm) for 8 or more hours.

3. Experimental exposure to CO concentrations sufficient to produce blood COHb levels of about 5 percent (a level producible by exposure to about  $35 \text{ mg/m}^3$  for 8 or more hours) has provided, in some instances, evidence of impaired performance on certain other psychomotor tests, and an impairment in visual discrimination.

4. Experimental exposure to CO concentrations sufficient to produce blood COHb levels above 5 percent (a level producible by exposure to  $35 \text{ mg/m}^3$  or more for 8 or more hours) has provided evidence of physiologic stress in patients with heart disease.

Thus, a CO level of 10 to 15 ppm, if it exists for an 8-hour period or more, will result in a COHb level of 2 to 2.5 percent, which is associated with adverse health effects. In addition, a CO level of 35 ppm, if it exists for a one hour period, would result in approximately the same 2 percent COHb level (See Exhibit 6, p. 8-9). Furthermore, the U.S. EPA Administrator, in promulgating the federal air quality standards, stated that the CO standards are "intended to protect against the occurrence of carboxyhemoglobin levels above 2 percent." (Exhibit 2)

Once again the record does not contain any opposition to the CO levels proposed by the Board. Additional support for the levels was provided, in general terms, by Kirkwood.

Based on the record, the Board adopted the carbon monoxide air quality standards as proposed.

#### Nitrogen Dioxide

The record for nitrogen dioxide (NO<sub>2</sub>) is contained mainly in Exhibit 7, "Air Quality Criteria for Nitrogen Oxides" (AP-84), published by the U.S. EPA. This document discusses the properties and occurrences of nitrogen oxides (NO<sub>x</sub>), nitrogen dioxide (NO<sub>2</sub>) is of concern here, and the effects of NO<sub>x</sub> on materials, vegetation, and health.

Nitric oxide (NO) and nitrogen dioxide (NO<sub>2</sub>) are the two oxides of nitrogen considered to be significant pollutants in the atmosphere. They are emitted primarily from combustion processes, with the bulk of the NO<sub>x</sub> emissions being in the form of NO. The NO is then converted, in the atmosphere, by photochemical reactions and oxidation with oxygen to NO<sub>2</sub>. Typical peak atmospheric levels of these oxides of nitrogen are 0.05 ppm for NO<sub>2</sub> and 0.10 ppm for NO. (Exhibit 7, p. 6-10 to 6-13)

The effects of NO<sub>2</sub> on materials are most severe on textile dyes and additives. Exhibit 7 reports that fading of sensitive disperse dyes used on cellulose acetate fibers has been attributed to NO<sub>2</sub> levels below 100 ppm, and that other effects on dyes and textile fibers has been attributed to NO<sub>x</sub>. (Exhibit 7, p. 11-3)

The effects of NO<sub>2</sub> on vegetation have not been demonstrated at atmospheric concentrations according to Exhibit 7. Concentrations of 0.5 ppm to 25 ppm have resulted in visible injury such as leaf drop and chlorosis. There is also evidence that exposure for 8 months to NO<sub>2</sub> concentrations of 0.25 ppm or less caused leaf drop and reduced yield in naval oranges. (Exhibit 7, p. 11-4)

While NO is not considered a threat to human health at ambient concentrations, studies have shown definite human health effects for exposures to NO<sub>2</sub> at ambient levels. The primary toxic effect of NO<sub>2</sub> is on the lungs. The following summary of direct health effects is taken from Exhibit 7.

- (1) Short-Term Exposure. Limited studies show that exposure to NO<sub>2</sub> for less than 24 hours continuously can have several concentration-dependent effects.

1. The olfactory threshold value of  $\text{NO}_2$  is about  $225 \mu\text{g}/\text{m}^3$  (0.12 ppm).
2. Exposure to  $9.4 \text{ mg}/\text{m}^3$  (5 ppm) for 10 minutes has produced transient increase in airway resistance.
3. Occupational exposure to  $162.2 \text{ mg}/\text{m}^3$  (90 ppm) for 30 minutes has produced pulmonary edema 18 hours later, accompanied by an observed vital capacity that was 50 percent of the value predicted for the normal pulmonary function.

(2) Long-Term Exposure. An increased incidence of acute respiratory disease was observed in family groups when the mean range of 24-hour  $\text{NO}_2$  concentrations, measured over a 6-month period, was between 117 and  $205 \mu\text{g}/\text{m}^3$  (0.062 and 0.109 ppm) and the mean suspended nitrate level during the same period was  $3.8 \mu\text{g}/\text{m}^3$  or greater.

The frequency of acute bronchitis increased among infants and school children when the range of mean 24-hour  $\text{NO}_2$  concentrations, measured over a 6-month period, was between 118 and  $156 \mu\text{g}/\text{m}^3$  (0.063 and 0.083 ppm) and the mean suspended nitrate level during the same period was  $2.6 \mu\text{g}/\text{m}^3$  or greater.

Exhibit 7 summarizes the nationwide implications of the above long-term results, referred to as the Chattanooga studies. Yearly average  $\text{NO}_2$  concentrations exceed the Chattanooga health-effect-related value of  $113 \mu\text{g}/\text{m}^3$  (0.06 ppm) in 10 percent of cities in the United States with populations of less than 50,000, 54 percent of cities with populations between 50,000 and 500,000, and 85 percent of cities with populations over 500,000.

In addition to the direct health effect,  $\text{NO}_x$ , along with reactive hydrocarbons, are precursor compounds that participate in the formation of photochemical oxidants. Specifically, the following photolytic reaction involving  $\text{NO}_2$ ,  $\text{NO}_2 \xrightarrow{\text{NO}+\text{O}}$ , frees an oxygen for the subsequent formation of ozone ( $\text{O}_3$ ) and other oxidants using the reactive hydrocarbons that are present. One possible way, therefore, of insuring that an oxidant air quality standard is not exceeded is to limit the concentration of  $\text{NO}_x$  available to participate in the photochemical reactions.

Exhibit 7 relates oxidant levels to NO<sub>x</sub> (and hydrocarbon) levels. The relationship found is as follows: (Exhibit 7, p. 11-11).

"An analysis of 3 years of data collected in three American cities shows that on those several days a year when meteorological conditions are most conducive to the formation of photochemical oxidant, and the 6-to-9 a.m. nonmethane hydrocarbon concentration is 200  $\mu\text{g}/\text{m}^3$  (0.3 ppm C), a 6-to 9 a.m. NO<sub>x</sub> concentration (measured by the continuous Saltzman Method and expressed as NO<sub>2</sub>) that ranged between 80 and 320  $\mu\text{g}/\text{m}^3$  (0.04 and 0.16 ppm) would be expected to produce a 1-hour photochemical oxidant level of 200  $\mu\text{g}/\text{m}^3$  (0.1 ppm) 2 to 4 hours later. If this same functional relationship exists at the lowest levels at which photochemical oxidant has been observed to adversely affect human health, the corresponding nonmethane hydrocarbon concentration would be approximately 130  $\mu\text{g}/\text{m}^3$  (0.2 ppm C) and the 6-to 9 a.m. NO<sub>x</sub> level would be as high as 214  $\mu\text{g}/\text{m}^3$  (0.11 ppm)."

The only objection to the proposed NO<sub>2</sub> level was by Edison. Their comment was that they didn't know how much of the control strategy for nitrogen oxides was feasible. (R. 43) As with the other pollutants Kirkwood supported the proposal for NO<sub>2</sub>. (R. 49)

Based on the record, the Board has adopted the nitrogen dioxide air quality standard as proposed.

#### Photochemical Oxidants

The major evidence concerning this pollutant is contained in Exhibit 8, entitled "Air Quality Criteria for Photochemical Oxidants" (AP-63) and published by the U.S. Department of Health, Education, and Welfare. This document discusses the characteristics of oxidants, atmospheric concentrations, sources of ozone, measurement techniques, effect of oxidants on vegetation and microorganisms, effect on materials, and a toxicological and an epidemiological appraisal of oxidants on animals including humans.

Photochemical oxidants are a class of chemical compounds formed by a series of atmospheric reactions involving nitrogen oxides and certain organic compounds. The energy for the reactions is provided by the ultraviolet component of sunlight. The products of these reactions are photochemical oxidants, ozone being the major constituent in terms of concentration.

Other individual oxidants that have been identified include nitrogen dioxide, peroxyacyl nitrates (PAN), formaldehyde, acrolein, and organic peroxides. The complex nature of the reactions is indicated by the fact that nitrogen dioxide is both a photochemical oxidant and a precursor compound, due to the photolytic reaction, described previously, in the photochemical formation process.

The control of oxidant levels is not as straightforward as other pollutants, since one does not control oxidant emissions directly, but rather controls the precursor compounds, nitrogen oxides and photochemically reactive organics. The resulting oxidant level will also depend on the incident solar radiation intensity and the time for the chemical reactions to occur in an area, parameters not able to be controlled.

The effects of oxidants, in particular ozone, on materials has been known for some time. Many organic polymers are altered by ozone at levels found in the atmosphere. Rubber is extremely sensitive to ozone, especially when under tension. According to Exhibit 8, cracking of rubber can occur from exposure to ozone levels of 0.01 to 0.02 ppm. This can be prevented by the addition of expensive, and not totally effective anti-oxidant chemicals. Other effects caused by ozone exposures include fading of some dyes and deterioration of some fabrics, although no quantitative evidence is available.

The effects of oxidants on vegetation is discussed next. As summarized by Exhibit 8: (Exhibit 8, p. 10-3)

"Injury to vegetation is one of the earliest manifestations of photochemical air pollution, and sensitive plants are useful biological indicators of this type of pollution. The visible symptoms of photochemical oxidant produced injury to plants may be classified as: (1) acute injury, identified by cell collapse with subsequent development of necrotic patterns; (2) chronic injury, identified by necrotic patterns with or without chlorotic or other pigmented patterns; and, (3) physiological (sic) effects, identified by growth alterations, reduced yields, and changes in the quality of plant products. The acute symptoms are generally characteristic of a specific pollutant; though highly characteristic, chronic injury patterns are not. Ozone injury to leaves is identified as a stippling or flecking. Such injury has occurred experimentally in the most sensitive species after exposure to  $60 \mu\text{g}/\text{m}^3$  (0.03 ppm) ozone for 8 hours. Injury will occur in shorter time periods



when low levels of sulfur dioxide are present. PAN-produced injury is characterized by an under-surface glazing or bronzing of the leaf. Such injury has occurred experimentally in the most sensitive species after exposure to  $50 \mu\text{g}/\text{m}^3$  (0.01 ppm) PAN for 5 hours. Leaf injury has occurred in certain sensitive species after a 4-hour exposure to  $100 \mu\text{g}/\text{m}^3$  (0.05 ppm) total oxidant. Ozone appears to be the most important phytotoxicant in the photochemical complex."

The effect of oxidants on humans include eye irritation, and adverse effects on the respiratory system. This in turn may affect motor performance, and morbidity in persons with respiratory problems. As summarized by Exhibit 8: (Exhibit 8, p. 10-9, 10-10)

a. Ozone

- (1) Long-term exposure of human subjects.
  - (a) Exposure to a concentration of up to  $390 \mu\text{g}/\text{m}^3$  (0.2 ppm) for 3 hours a day, 6 days a week, for 12 weeks, has not produced any apparent effects.
  - (b) Exposure to a concentration of  $980 \mu\text{g}/\text{m}^3$  (0.5 ppm) for 3 hours a day, 6 days a week, has caused a decrease in the 1-second forced expiratory volume (FEV<sub>1.0</sub>) after 8 weeks.
- (2) Short-term exposure of human subjects.
  - (a) Exposure to a concentration of  $40 \mu\text{g}/\text{m}^3$  (0.02 ppm) was detected immediately by 9 of 10 subjects. After an average of 5 minutes exposure, subjects could no longer detect ozone.
  - (b) Exposure to a concentration of  $590 \mu\text{g}/\text{m}^3$  (0.3 ppm) for 8 hours appears to be the threshold for nasal and throat irritation.
  - (c) Exposure to concentrations of from 1,180 to  $1,960 \mu\text{g}/\text{m}^3$  (0.6 to 1.0 ppm) for 1 to 2 hours may impair pulmonary function by causing increased airway resistance, decreased carbon monoxide diffusing capacity, decreased total capacity, and decreased forced expiratory volume.

- (d) Exposure to concentrations of from 1,960 to 5,900  $\mu\text{g}/\text{m}^3$  (1.0 to 3.0 ppm) for 10 to 30 minutes is intolerable to some people.
- (e) Exposure to a concentration of 17,600  $\mu\text{g}/\text{m}^3$  (9.0 ppm) produces severe illness.

b. Oxidants

(1) Long-term exposure of human subjects.

Exposure to ambient air containing an oxidant concentration of about 250  $\mu\text{g}/\text{m}^3$  (0.13 ppm) (maximum daily value) has caused an increase in the number of asthmatic attacks in about 5 percent of a group of asthmatic patients. Such a peak value would be expected to be associated with a maximum hourly average concentration of 100 to 120  $\mu\text{g}/\text{m}^3$  (0.05 to 0.06 ppm).

(2) Short-term exposure of human subjects.

- (a) Exposure to an atmosphere with peak oxidant concentrations of 200  $\mu\text{g}/\text{m}^3$  (0.1 ppm) and above has been associated with eye irritation. Such a peak concentration would be expected to be associated with a maximum hourly average concentration of 50 to 100  $\mu\text{g}/\text{m}^3$  (0.025 to 0.05 ppm).
- (b) Exposure to an atmosphere with average hourly oxidant concentrations ranging from 60 to 590  $\mu\text{g}/\text{m}^3$  (0.03 to 0.30 ppm) has been associated with impairment of performance of student athletes.

The measurement technique proposed is specific for ozone, the major but not the only oxidant present in the atmosphere. Therefore, the air quality standard of 0.08 ppm for photochemical oxidants is really an ozone standard, since only ozone is measured, which allows ambient levels of total oxidants to exceed 0.08 ppm.

No opposition to the proposed standard was presented at the hearings. Upon a review of the record, we concluded that the air quality standard for photochemical oxidants should be adopted in the form proposed.

Technical Feasibility and Economic Reasonableness

The record does not contain much new information regarding technical feasibility and economic reasonableness, since these issues have already been addressed in conjunction with the R71-23 proceeding concerning Emission Standards.

It should be understood that one does not clean up the ambient air directly, but rather establishes limits on the emissions of pollutants in order to not exceed the air quality standards for these pollutants. For example, limits on the emissions of particulates are designed to achieve compliance with the federal air quality standards for particulates. In the prior Board proceeding, R71-23, which concerned emission standards, limits on the emissions of particulates, sulfur oxides, nitrogen oxides, hydrocarbons, and carbon monoxide were established as part of the State Implementation Plan for achieving compliance with the Federal Air Quality Standards. These emission limitations were ordered by the Board following a thorough review of the economic reasonableness and technical feasibility of the limits, as discussed in the R71-23 Opinion of the Board. It follows that since the air quality standards we adopted on May 3, 1973 and the SO<sub>2</sub> Standard we have adopted today are identical to the federal standards, upon which our emissions standards are based, the considerations of technical feasibility and economic reasonableness have already been taken into consideration in the prior proceeding.

In fact, the only new economic issue raised at the hearings was by Edison and it concerned the Alternate 2 sulfur oxides proposal. We have not adopted Alternate 2 so this issue is now moot.

Legally Enforceable Standards

Shell Oil suggested that the Board delete the portion of proposed Rule 301 that made the air quality standards "legally enforceable". (R. 57-58) The problem, as they see it, is that they may be in an area that violates an air quality standard and thus liable even though they are in compliance with the emission standards. Our response is that the air quality standards are the ultimate issue. Emission standards and implementation plans have as their goal the achievement of certain air quality standards. By the adoption of standards for Illinois, we are responding to

our mandate to provide people with a healthful environment in Illinois.

Measurement Methods

Measurement methods for particulates, sulfur dioxide, non-methane hydrocarbons, carbon monoxide, nitrogen dioxide, and photochemical oxidants adopted by the Board on May 3, 1973 and July 10, 1975 are identical to the federal procedures. This was done for the purposes of uniformity and in the absence of opposition at the hearings to these procedures. Furthermore, the Agency may approve alternate measurement methods in order to allow the use of equivalent procedures developed subsequent to the federal promulgation of standards.

This Opinion constitutes the Board's findings of fact and conclusions of law.

I, Christan L. Moffett, Clerk of the Illinois Pollution Control Board, hereby certify the above Opinion was adopted on the 10<sup>th</sup> day of July, 1975 by a vote of 5-0.

  
Christan L. Moffett, Clerk  
Illinois Pollution Control Board