

THE ECONOMIC ASPECTS OF REGULATION I OF THE
CLEAN AIR ACT OF TEXAS-1965 ON EIGHT
INDUSTRIAL FIRMS LOCATED
IN HARRIS COUNTY, TEXAS

Approved:

J. M. Stevenson

W. D. Hardisty

M. J. Erickson

Approved:

James F. Dawson
Dean of the Graduate School

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Ralph B. Rushing, B.B.A.

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A Masters Thesis involving the disclosure of information regarded as "authentic" provides a most provocative and challenging academic endeavor. Because of the authentic nature of this study, success has depended largely on the expert guidance and constructive criticism contributed by the thesis committee.

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CHAPTER I

INTRODUCTION

Air pollution--is it a natural or unnatural function of man? A question of this type creates an inexhaustible amount of controversial opinion. Regardless of its debatable nature, the fact that some air pollution exists today is unquestionable. Man's desire to upgrade his standard of living has created one of his major social problems: the pollution of the environment in which he lives. The problem continues to be reflected and amplified not only by the growing population and urbanization, but also by the increased utilization of automobiles, by the increased use of fuels in industry and in the home, and by the increased emission of particulates as a result of various types of manufacturing processes. The Public Health Service has estimated that over 7,000 communities have air-purity problems and over one-fourth of all Americans live in areas with major pollution problems.¹ Although precisely incalculable,

¹Emerging Industries (New York: Merrill, Lynch, Pierce, Fenner, and Smith, Inc., Securities Research Division, April, 1968), p. 38.

air pollution causes economic loss to property as well as accrued loss to health, happiness and aesthetic values. Can a social problem of such magnitude and with such public awareness continue to remain unrecognized and uncontrolled? Such a question is highly significant. As disclosed in the development of this report, the answer to such a perplexing question is "No."

When a social problem is recognized, actions are initiated to regulate and control the problem through legislative enactments. Suddenly, those (in this case, industry) who have not been restrained in their past operations from contributing to this problem are faced with either complying with the laws or ignoring them. If the latter choice is taken, federal or state prosecution may follow, with the order to meet and maintain predetermined standards or cease operations. Assuming prosecution occurs and the indicated firm's decision is to continue operations, the necessary actions must then be initiated to satisfy the prescribed limits of control, usually at a varied number of additional costs to the company. It is then desirable to determine the nature and range of such costs.

Objectives of the Investigation

Air pollution cost statistics released for publication in journals, newspapers, and magazines have

consistently concentrated on projections of expected costs or current expenditure trends representative of industry. To date, limited data is available concerning actual air pollution costs incurred as a result of legal action imposed by Texas air pollution laws and regulations. Such a presentation is an objective of this report.

In the interests of a comprehensive presentation of costs to industry, this thesis attempts first to investigate the published materials indigenous to the origin and development of the Clean Air Act of Texas - 1965. Because of the Act's regulatory nature, another objective of this presentation is to determine the financial impact that Regulation I has had on eight industrial firms indicted in Harris County, Texas. The final objective of this report will be to present a monetary breakdown which correlates with specific air pollution control costs.

Research of the Literature as a Basic Method

Since the conception of the Clean Air Act of Texas is dated 1965, sources of information concerning genesis and maturation are to date very limited or incomplete. Furthermore, due to the Act's relative newness, data relating to its effects in terms of economic

ramifications on indicted Texas manufacturers are unpublished or non-existent at this time.

The United States Bureau of Health, Education, and Welfare Public Health Services has published much material concerned with possible health damage and economic losses resulting from air pollution. The Texas Law Review, Texas Almanac, Science, A Manual for Citizen Action, air pollution court cases, and Texas Air Control Board publications and reports provide information which was extracted and synthesized as background material for this study. Information obtained through personal conferences with Texas Air Control Board staff members, Texas Legislators, an Assistant Attorney General of Texas, legal counsel for the Texas Health Department, representatives from the Texas Manufacturers Association, and selected general managers of local manufacturers proved to be of great assistance for this project.

Limitations of the Study

This investigation is limited to include only those companies who received air pollution indictments in Harris County, Texas between June, 1967 and April, 1970. It is further limited to include only the Harris County companies who sustained a court ordered monetary forfeiture or fine as a result of air pollution activities.

Today, air pollution is described as a major social issue. Industrial management is most sensitive to public attitude and to public reaction against firms which are openly admonished and restrained from emitting pollutants into the atmosphere. Consequently, air pollution control cost data supplied to the researcher by the indicted manufacturers may contain biased or padded cost figures. An explanation for this possible discrepancy may be due to the interviewed firm's fear of possible subjection to additional investigation or undue harassment by both the public and the state. Public relations may also be a factor because cost information may be structured to indicate to the general public and to interested state agencies that more funds are being allocated to the control of air pollution than actually are.

It is not the purpose of this report to suggest that air pollution control cost information obtained will be representative of all indicted manufacturers in Texas. For companies of similar size, process, and needs similar to those companies interviewed, cost data will be representative. Likewise, the purpose of this investigation is not to establish projected future air quality control expenditures, nor to predict expenditures representative of all industry in Texas. Furthermore,

this investigation does not intend to determine whether reported costs are adequate or inadequate or representative of all the manufacturers within the industry interviewed.

The results of this study will be presented from data received from the five companies which elected to participate of the eight companies contacted. Discontinued operations, as a direct or indirect result of the Clean Air Act, accounted for the non-participation of one of the companies. The remaining two companies which chose not to participate refused on the premise that meaningful cost information would require a significant amount of research which they desired not to undertake. The non-respondents contended that any disclosure of such guarded information would be detrimental to the well-being of the companies.

Organizational Plan of the Thesis

This thesis is divided into four chapters. The second chapter provides the historical background leading up to the passage of the Act and its development, including purpose, regulatory provisions, and the ultimate test of validity.

Chapter III deals with the methodology used in obtaining the air pollution control cost data. The results of the personal interviews are provided. The

results reveal the monetary allocation for each air pollution control cost variable as well as the total monetary allocation for each firm interviewed. The cost data collected provides for a financial impact statement.

Chapter IV draws together the three major air pollution control costs (immediate costs, equipment acquisition costs, and equipment operating costs) in an attempt to appraise the economic impact of Regulation I of the Clean Air Act of Texas on eight manufacturing firms indicted in Harris County, Texas.

CHAPTER II

A REVIEW OF THE HISTORICAL BACKGROUND AND DEVELOPMENT OF THE CLEAN AIR ACT OF TEXAS-1965 AND REGULATION I

Factors Contributing to the Adoption of the Clean Air Act of Texas-1965

An investigative study dealing with a specific element of legislation should concern itself with the factors which influenced the action instituted as well as a study of the legislation itself. The objective of this chapter is to report those specific elements which initiated and brought about the adoption of the Clean Air Act of Texas of 1965. These elements of influence are presented under six major classifications: the rapid growth of Texas cities, the increased expansion of Texas industry, the hazard of air pollution to public health, the burden of air pollution on the economy of Texas, the pressure applied by the federal government, and the major weaknesses surrounding Texas air pollution control prior to 1965. A detailed presentation of the Clean Air Act of Texas of 1965 will conclude this chapter.

Rapid Growth of Texas Cities

The advent of the industrial revolution sparked a virtually uninterrupted migration of people from the rural sectors to the urban sectors of Texas. Since this migration exists today, the growth of cities in Texas continues to be reflected by the large cities of today, such as Houston. The following demographic data of Houston and its surrounding area from the year 1900 to 1971 is useful. The population figure in 1900 was 44,633.² In correlation to this figure the population count in 1971 increased to 1,780,000.³ In seventy-one years Houston and its incorporated areas realized a population gain of 1,735,367. As the number of inhabitants increased, the need for manufactured goods and services flourished. This intensified demand was the stimulus or the inducement for industrial expansion which served to meet the growing public demands and needs.

Expansion of Industry in Texas

Characteristic of "the first ten years" of this century, Texas manufacturers increased almost two

²Texas Almanac and State Industrial Guide, (Texas: A. H. Belo Corporation, 1969), p. 173.

³Houston Chamber of Commerce, telephone interview, July 10, 1971.

hundred percent primarily because of the discovery of oil in 1901.⁴ Prior to this, Texas had shown little industrial development and was considered an agricultural state. Of significance also were the improvements in transportation and urban development and the development of the ports and harbors along the Texas Gulf Coast.⁵ These improvements aided industrial growth. Today, because of advanced technology and rapid industrialization, Texas is recognized as being "among the top eight manufacturing states" in the nation.⁶

Industrial expansion in Texas is easily seen in terms of the varieties and numbers of firms, the number of industrial employees, and the dollar value added by manufacturers from the early 1900's to the 1960's. The total number of manufacturing establishments in 1904 was 3,158. In 1963, the number increased to a total of 11,580.⁷ More current figures disclose the 1969 count to be 11,661.⁸ The second indicator typifying industrial

⁴Workers of Writers Program of the Worker Project, Texas-A Guide to the Lone Star State (New York: Hastings House, 1940), p. 58.

⁵Ibid., p. 59.

⁶Texas Almanac, op. cit., p. 436.

⁷Ibid., p. 435.

⁸Ibid., p. 438.

expansion in Texas is the employee increase. In 1904, the number of persons employed by industrial manufacturers totaled 54,819. In contrast to this, in 1965, the total number increased to 556,870.⁹ Following the 1968 survey, this figure increased to a new count of 709,000.¹⁰ The third and last factor is the added dollar value contributed by Texas manufacturers. The dollar figure in 1904 totaled \$58,924,759.00. In 1965, this figure increased to \$8,700,197,000.00.¹¹ The currently published figure indicates the 1969 figure to be \$12,600,000,000.00, a "30 percent increase" over the previous year.¹² Therefore, the recognized increased gain of 8,503 manufacturing establishments, 654,181 employment increase, and the \$12,541,075,241.00 dollar increase in value added all serve to document the increased industrial expansion in Texas.

Premised on the increases of the last decade, there is no indication to suggest that man intends to retard the advancement of technology. In direct contrast,

⁹Ibid., p. 435.

¹⁰Ibid., p. 438.

¹¹Ibid., p. 435.

¹²Ibid., p. 438.

the signs specifically denote an "ever-growing capacity to produce-by chance or by choice." As a result, urbanization continues, the great demands for more "products, services and energies" flourish, and the mechanization and automation of advanced technology continue to increase.¹³

The major contributors of air pollution in industry can be arbitrarily classified. National studies have indicated that the major air pollution violators are as follows:

1. Pulp and Paper mills
2. Iron and Steel mills
3. Petroleum refineries
4. Smelters
5. Inorganic chemical manufacturers, such as
Fertilizer manufacturers
6. Organic chemical manufacturers, such as
synthetic rubber manufacturers¹⁴

The studies also reveal that each year these industries discharge into the atmosphere the quantities and types of pollutants as follows:

¹³U. S. Department of Health, Education and Welfare, Public Health Service, Let's Clear the Air, No. 1238 (Washington, D.C.: Government Printing Office, 1964), p. 1.

¹⁴U. S. Department of Health, Education and Welfare, Public Health Service, Sources of Air Pollution and Their Control, No. 1548 (Washington, D.C.: Government Printing Office, 1966), p. 9.

1. 2 million tons of carbon monoxide
2. 9 million tons of sulfur oxides
3. 2 million tons of nitrogen oxides
4. 4 million tons of hydrocarbons
5. 6 million tons of particulate matter.¹⁵

In a short period of time the resources of this country have been so utilized as to form the "most advanced and prosperous Nation in the history of mankind." The criticism attached to the rapid industrial expansion focuses on man's obsession to reap the benefits of the "American Industrial Revolution" while displaying very little concern for the by-products of waste and pollution which were generated by success.¹⁶

The rapid growth of Texas cities and the increased industrial expansion aided in initiating Texas air pollution legislation in 1965. The external factors which influenced legislative action prior to 1965 are, therefore, important. However, the information is incomplete without a discussion of the side effects of air pollution on health.

The Hazard of Air Pollution to Public Health

The years prior to Texas air pollution legislation in 1965 produced a vast number of studies and

¹⁵Ibid.

¹⁶Ibid.

symposiums which revealed facts relevant to air pollution and health. Many federal agencies within the national structure directed efforts and energies to the production of large volumes of information, placing emphasis on the possible linking of health hazards to air pollution. In a different direction, but with similar ramifications, air pollution conferences were conducted to discuss the findings from specific air pollution cases and health research projects. Upon adjournment, conference reports containing research findings were published and made available to the general public. In addition to the federal and conference publications, various interested state departments in Texas continuously published information. Such observers as newspapers, magazines, and journals published articles pointing out the same possible connection or relationship. In substance, the collective combination of all of the above helped form and initiate an atmosphere conducive to air pollution hysteria among the general public.

As previously established, both the federal government and organized air pollution conferences were instrumental in the passage of the Clean Air Act of Texas. The succeeding discussion will present in essence the health/air pollution information previous to the Clean Air enactment.

The knowledge of health and air pollution has been both broadened and amplified considerably through three types of investigations, such as:

. . . statistical studies of past illness and death as correlated with geographic locations and other factors associated with air pollution; epidemiological studies of death and respiratory functions as related to variations in air pollution; and laboratory studies of response by animals, and in some cases by human beings to exposure to various pollutants or combinations of pollutants.¹⁷

Laboratory studies have been conducted where both animals and humans were exposed to "controlled concentrations of gaseous pollutants." The results of the laboratory studies coincide with the results of the epidemiological studies. One such study resulted in the "development of lung cancer." The animal was infected with an influenza virus and after being exposed to an "artificial smog consisting of ozonized gasoline," the animal showed signs of lung cancer. When exposed singly to either "influenza or ozonized gasoline," the animal did not incur lung cancer.¹⁸ The laboratory studies serve to support the reports which indicate the relationship of air pollution to "chronic disease, especially of the lung."¹⁹

¹⁷Let's Clear the Air, op. cit., p. 2.

¹⁸Ibid., p. 3.

¹⁹7th Annual Air Pollution Medical Research Conference, "Air Pollution and Health," Science, Vol. 145, (July 10, 1964), p. 184.

Studies have clearly shown that death from "cardio-respiratory causes correlates in general" with varying air pollution levels and that "asthmatic attacks among susceptible patients" have been definitely associated with varying levels of "sulfate air pollution" and air pollution in the form of "incomplete combustion of refuse."²⁰ Other studies have indicated that "employee absenteeism due to respiratory illness" has been directly related to varying levels of "sulfate air pollution." Another study revealed that people living in areas where air pollution is recognized show dramatic "differences in average respiratory resistance" when compared with people living in areas where the air pollution level is deemed lower. It has been established that "more than 200 deaths occurred in New York City in 1953" as a result of a long period of air stagnation.²¹

When combined with past studies related to this subject, a considerable body of evidence is formed which makes it clear that air pollution is associated with such important respiratory diseases as lung cancer, emphysema, chronic bronchitis, and asthma.²² The question has arisen

²⁰Let's Clear the Air, op. cit., p. 2.

²¹Ibid.

²²"Air Pollution and Health," op. cit., p. 184.

as to whether air pollution actually causes health disorders. In reply, the statement has been made that there is no single cause, but there is sufficient evidence that air pollution can and does contribute to the development of health disorders. Authorities indicate "that there is no longer any doubt that air pollution is a hazard to health." The point then is a matter of choosing it "as the single cause, one of several causes, or simply a contributing factor" of the health disorders.²³

In reviewing the effects of air pollution on human health, it is important to note that in no area of the world is the mean annual level of air pollution high enough to cause continuous acute health problems. It is equally as important to point out that while many of the air pollution/health studies have concentrated on short-term episodes of air pollution/health effects, the greatest concentration of effort has been in the long-term effects of living in a polluted atmosphere.²⁴ It was the long-term effects which were ultimately brought to the attention of state officials and the general public. Research studies of air pollution/health side effect relationships significantly influenced and accelerated air pollution legislation

²³Let's Clear the Air, op. cit., p. 4.

²⁴Lester B. Love and Eugene P. Siskin, "Air Pollution and Human Health," Science, Vol. 169, (August 21, 1970), p. 723.

in Texas. However, the economics of air pollution was also an evident and recognized element of both criticism and influence.

Economic Burden of Air Pollution on
the Economy of Texas

That an economic burden is created by air pollution is a fact supported by research. Research studies have indicated that air pollution does cause extensive damage through "effects on animal and plant life, through soil-ing and corrosion and deterioration of materials and structures," through the subsequent "depreciation of property values," through "interference with air and surface transportation," as a result of diminished visibility, and through "losses of unburnt fuels."²⁵ More specific studies relating air pollution and economic losses have indicated that it "rots and soils clothing, discolors house paints, rusts metals, corrodes stone as well as metal, and mars monuments and public buildings."²⁶ A recent study conducted estimated the dollar costs of air pollution nationwide as twenty billion a year.²⁷ One study based on

²⁵Let's Clear the Air, op. cit., p. 4.

²⁶The Conservation Foundation, "Your Right to Clean Air," A Manual for Citizen Action. (August, 1970), p. 13.

²⁷Ibid.

expenses such as "laundry bills, maintenance of walls and windows, and the cleaning of drapes, rugs and upholstery," indicated that the additional costs per person living in an area designated as heavily polluted, could be more than "\$200.00 a year, or about \$800.00 for a typical family."²⁸ In addition to the economic burden, federal pressure was a significant if not the paramount element which led to legislative action.²⁹

Federal Pressure

Subsequent to the Congressional enactment of the Federal Clean Air Act of 1963, interested individuals with the air pollution division of the Texas Health Department recognized the imperative need for a state air pollution law, not only to insure that pollution laws in Texas be effective, but to "prevent federal control over Texas' air resources."³⁰ The latter point was the major element which influenced Representative Don Cavness of Austin to sponsor the Bill in the House of Representatives.³¹ In

²⁸Ibid., p. 14.

²⁹Don Cavness, Texas Legislature, Personal Interview, March 2, 1971.

³⁰G. Todd Norvell and Alexander W. Bell, "Comments. Air Pollution Control in Texas," Texas Law Review, Vol. 47:1086 (1969), p. 1090.

³¹Ibid., p. 1091.

essence, it became a matter of deciding on the lesser of two evils: state control or federal control and regulation. After relenting to the fact that air pollution control was inevitable, the interests involved decided that power over air pollution regulation could be exercised more effectively at the state level than at the federal level. Therefore, the decision was necessary that the legislature at least place a clean air act on record with the intent to modify it at a later time.³² Federal pressure and its ramifications introduces the discussion of the final reason which produced air pollution legislation in Texas--the Nuisance Doctrine.

Nuisance Doctrine--Early Air Pollution Regulation

Prior to the enactment of the Clean Air Act in 1965, the instigation of a nuisance suit was the only legal "method of air pollution control in Texas."³³ The responsibility of conducting such nuisance investigations and controlling atmospheric pollution was "vested in the Texas Health Department."³⁴ The application of

³²Don Cavness, loc. cit., March 2, 1971.

³³Norvell and Bell, op. cit., p. 1087.

³⁴Texas State Department of Health, Texas Air Control Board Biennial Report, September 1, 1968-August 31, 1970, (Texas: State of Texas, 1970), p. 1.

the Nuisance Doctrine produced a dilemma for the courts, as they had to attempt a balancing of the "'enjoyment of life' with the 'progress of society'." ³⁵ In addition to the legal dilemma produced by the doctrine, eminent weaknesses were evident despite the successfulness of the State Health Department in the abatement and control of pollution emissions. ³⁶ First, if an individual desired to abate a nuisance, he had to "show a substantial injury." As a compounding effect, the courts favored industry by "requiring the individual to show a special injury"--different from simply to the general public. ³⁷ Second, the cost involved in litigation proved to discourage such nuisance suits. Third, and most serious, was the Nuisance Doctrine's inability to guide the conduct of business. ³⁸ The Nuisance Doctrine was not utilized effectively; and, more specifically, it did not serve as a remedy for the problem. Consequently, the major action in pollution control shifted from a condition of nuisance to regulation. ³⁹

³⁵Norvell and Bell, op. cit., p. 1088.

³⁶Air Control Board, op. cit., p. 1.

³⁷Norvell and Bell, op. cit., p. 1088.

³⁸Ibid., p. 1089.

³⁹Ibid.

In summary, the rapid growth of Texas cities, the expansion of industry and commerce, the established fact that polluted air endangers health, the economic burden created thereby, the usurped Federal pressure, and the weakness contained in the Nuisance Doctrine all contributed to the creation and adoption of the Clean Air Act of Texas in 1965, which was revised and strengthened in 1967 and again in 1969.

Clean Air Act of Texas - 1965

Basically, the act centered around the shifting of the power to control and abate air pollution from the "Texas Health Department to an Air Control Board," which coordinated and received assistance from the "Texas Health Department." The Act provided for the creation of a regulatory system administered by the "Air Control Board," with a "liberal provision for granting variances from the regulations."⁴⁰ A legislative condition to the establishment of the regulatory system was the instruction to establish a system which would curtail pollution activities while not jeopardizing "the maximum employment and full industrial development of the state."⁴¹

⁴⁰Ibid., p. 1092.

⁴¹Ibid.

Purpose

Taken from context, the Act's purpose reads as follows:

It is the purpose of this Act to safeguard the air resources of the State from pollution by controlling or abating air pollution consistent with the protection of normal health, general welfare, and physical property of the people, maximum employment and full industrial development of the State.⁴²

Section 3 (A)

To insure the maintenance of air purity and to insure the protection of health and physical property, Section 3 (A) of the Act created an Air Control Board which consisted of nine members appointed by the Governor for overlapping terms of six years. The Board established the following objectives as guidelines in its quest to create an air pollution control program.

1. The preservation of the health and welfare of man now and in the future;
2. The protection of animal and plant life;
3. The prevention of damage to physical property and interference with its normal use and enjoyment;
4. The provision for visibility required for safe air and ground transportation;
5. The maintenance of a program compatible with continuous economic growth and development;
6. The maintenance of an aesthetically acceptable environment;

⁴²Texas Civil Statutes Annotated, Article 4477-4, Sec. 1, (Supp. 1965).

7. To insure that a significant reduction in the emissions of all harmful pollutants into the Texas atmosphere is realized, either through voluntary actions or by enforcement of the Clean Air Act of Texas and Board regulations; and
8. To predict air pollution loadings within major metropolitan areas based on urban and industrial growth so that measures may be taken to preserve air quality.⁴³

Section 4 (A)

The power with which the Board has been vested is described in Section 4 (A). The Board's primary concern is focused on the preparation and development of a plan to implement the proper control of air resources. To facilitate the achievement of these objectives, the Board adopted rules and regulations which "covered administrative details" and "scientific and engineering principles which it deemed to be necessary." The regulations provided explicit guidelines for "industries, municipalities, and the general public" for the planning of preventive or corrective measures. In addition, the regulations contained emission standards, which provided "definite limits on various emissions to the atmosphere" and were expressed in engineering terms.⁴⁴ The Board created five regulations. However, as the economic impact of

⁴³Air Control Board, op. cit., p. 4.

⁴⁴Ibid.

the selected Harris County industry is a direct result of Regulation I, the discussion to follow will omit Regulations II through V and concentrate on the first regulation.

Regulation I: Control of Smoke, Visible
Emissions, And Suspended
Particulate Matter

Bestowed with the responsibility to conserve the air resources of Texas the Air Control Board created Regulation I. The purpose of the Regulation is to deal directly with the control of air pollution from smoke, visible emissions and suspended particulate matter and directly affects those industries whose manufacturing process produces pollutants.

The remaining discussion concerning Regulation I will concentrate on an examination of the standards and limits of pollutant emissions. The terms which apply to this regulation and which are significant to its understanding must be defined.

1. "Particulate Matter." Discrete particles of liquid (except uncombined water) or solid matter or both which are often, but not always, suspended in air or in other gases at atmospheric temperature and pressure. The term "suspended particulate matter" is used to distinguish such liquid or solid matter from material which is not transported by air beyond the property boundaries.⁴⁵

⁴⁵Texas Air Control Board, Regulation I, "Control of Air Pollution From Smoke, Visible Emissions and Suspended Particulate Matter" (1968), sec. II (B).

2. "Ringelmann Smoke Chart." The Ringelmann Scale for Grading the Density of Smoke, published by the U. S. Bureau of Mines, or any chart, recorder, indicator or device for the measurement of smoke density which is approved by the Board as the equivalent of the Ringelmann Scale.⁴⁶
3. "Smoke." Small gas-borne particles resulting from incomplete combustion, consisting predominantly of carbon and other combustible material, and present in sufficient quantity to be observable.⁴⁷
4. "Equivalent Opacity." The degree to which an emission, other than gray or black smoke, obscures the view of an observer, expressed as an equivalent of the obscuration caused by a gray or black smoke emission of a given density as measured by a Ringelmann Smoke Chart.⁴⁸
5. "Visibility" or "Visual Range." The distance at which it is just possible to perceive a dark object against the horizon sky.⁴⁹
6. "Incinerator." An enclosed combustion apparatus designed to efficiently reduce solid, semi-solid, liquid, or gaseous waste at specified rates, and from which the residues contain little or no combustible material, and being equipped with a flue, stack, or chimney for conducting products of combustion to the atmosphere. An approved open trench type (with closed ends) combustion unit may be considered an incinerator.⁵⁰

Further discussion concerns prescribed standards and limits on the control of excessive pollutant emissions.

⁴⁶Ibid., sec. II (C).

⁴⁷Ibid., sec. II (D).

⁴⁸Ibid., sec. II (E).

⁴⁹Ibid., sec. II (F).

⁵⁰Ibid., sec. II (G).

Visible Emissions of Smoke and Suspended Particulate Matter

The Board concluded that in order to control and abate air pollution effectively, visible emissions, smoke and particulate matter must be limited. When such emissions are controlled, individuals are enabled to have normal use and pleasure of their property; and the prevention of undesirable levels of visibility "enhances safety in transportation," primarily air, and aids in insuring safety to humans and property. Experience indicates that adverse effects from visible emissions could be reduced considerably by limiting the individual smoke emissions and by reducing the "opacity of emissions other than black or gray smoke."⁵¹ As a first attempt to establish limits, the Board created air quality standards for atmospheric visibility.

Air Quality Standards for Atmospheric Visibility

As a means of determining what actually constituted an undesirable level of "smoke, aerosols, or suspended particulate matter," the Board adopted two measurements as basic criteria, as follows:

1. An atmospheric visibility of less than three miles during periods when atmospheric relative humidity is less than 70%.

⁵¹Ibid., sec. III (A).

2. An atmospheric visibility in areas downwind of a source or sources of visible emissions of less than one-half of the visibility in surrounding areas not downwind from the source of visible emissions, but subject to the same general meteorological conditions. This provision applies with any atmospheric humidity, but only when the visibility is restricted to less than ten miles.⁵²

To aid in achieving these air quality standards, the Board specified emission limits which applied under all meteorological conditions. Before establishing the limits on control, the Board attempted to clarify the relationship between atmospheric particulate matter and visibility and their unpredictability. It was pointed out by the Board that such relationships "may change in a manner which cannot always be predicted on the basis of humidity, air pollution measurement, and other pertinent factors." Therefore, "a single occurrence of visibility less than the level specified" does not necessarily indicate the need for air pollution control. However, if the occurrence of the lack of visibility is less than "specified on more than five days in a twelve-month period," this is a clear indication that air pollution does exist at an undesirable level.⁵³

⁵²Ibid., sec. III (B).

⁵³Ibid.

Limits on Control

The specific limits on control were segmented into two major sections which are classified as limits on the control of gray or black smoke emissions and the limits on the control of visible emissions other than gray or black smoke.

The limits on the control of gray or black smoke emissions

"The limits on the control of gray or black smoke emissions apply throughout the State." However, due to variations in types of combustion units, limits were designed to allow for these differences or variations. The limits according to combustion unit sources are as follows:

1. The emission of gray or black smoke from any combustion unit (other than a flare) . . . or from any type of burning in a combustion unit (other than a flare), including the burning in an incinerator of industrial, commercial and municipal wastes, shall be controlled so that the shade or appearance of the emission is not as dark as nor darker than No. 2 on the Ringelmann Smoke Chart . . . for a period or periods aggregating not more than five minutes in any sixty consecutive minutes, nor more than six hours in any 10 day period.⁵⁴
2. The emission of gray or black smoke from a flare or other similar device installed prior to February 1, 1967 . . . , shall be

⁵⁴Ibid., sec. III (C).

controlled so that the shade of appearance is not as dark as, nor darker than No. 2 on the Ringelmann Smoke Chart for more than five minutes in any consecutive sixty minutes, nor more than an aggregate time of six hours in a 10 day period. Emissions of gray or black smoke from such a flare or similar device installed or substantially modified in design after January 31, 1967, shall not be as dark nor darker than No. 1 on the Ringelmann Smoke Chart⁵⁵

3. The emission of gray or black smoke from continuous process units during periods of shut-down and start-up . . . of new units shall be controlled so that the shade of appearance of the emission is not as dark as nor darker than No. 2 on the Ringelmann Smoke Chart more than an aggregate time of six hours during any 24 consecutive hours, nor more than 12 hours during any 10 day period.⁵⁶

The Ringelmann Smoke Chart and the procedure for the determination of gray or black smoke are provided in Appendix A. Instrumental methods (alternative methods), which are shown to give comparable results, are likewise provided in Appendix A.

The limits on the control of visible emissions other than gray or black smoke

The limits on the control of visible emissions other than gray or black smoke are based on measurements taken on the basis of equivalent opacity. The limits are described as follows:

⁵⁵Ibid.

⁵⁶Ibid.

1. Sources which have visible emissions other than gray or black with an opacity equal to or greater than an equivalent opacity of No. 2 on the Ringelmann Smoke Chart are prohibited, except that visible plumes emitted during rapping or precipitators, removal of collected dust and equipment changes may be equal to or greater than an equivalent opacity of No. 2 on the Ringelmann Smoke Standard for a period or periods aggregating not more than five minutes in any sixty consecutive minutes, nor more than six hours in any 10-day period.⁵⁷
2. Sources which have visible emissions other than gray or black having an equivalent opacity of No. 1 or greater on the Ringelmann Smoke Standard more than one half of the time may, at its discretion, install an optical instrument capable of measuring visual characteristics of emissions as outlined in Appendix A If the light transmittance is shown to be 70% or less as determined by such instrumental determination, then the source shall be deemed to be in violation⁵⁸

Subsequent to establishing limits to control visible emission, the Board proceeded to establish prescribed limits on suspended particulate matter.

Suspended Particulate Matter

The Board created standards for suspended particulate matter on the basis of field surveys which concluded that in certain regions and areas throughout the State there was a need to prevent "an increase in the level of suspended particulate matter emitted into the atmosphere."

⁵⁷Ibid., sec. III (D).

⁵⁸Ibid.

In other regions of the State, it was found that a reduction in overall levels of suspended particulate matter was not only necessary, but also imperative.⁵⁹ In keeping with previous methodology to control visible emissions, the Board once again reviewed and established air quality standards for suspended particulate matter.

Air Quality Standards for Suspended
Particulate Matter

When concentrations of suspended particulate matter in the atmosphere are higher than the levels specified in Table 1 below for the various land use areas, undesirable levels prevail and a state of air pollution is said to exist. In addition, the "ambient air quality for an area" is determined on the basis of "not less than ten, 24-hour samples taken within a 30-day period of time." Based on the same 24-hour prerequisites, if the suspended particulate matter in the ambient atmosphere of the areas "exceed these levels more than 10% of the time," the ambient air quality has exceeded the prescribed standards.⁶⁰

⁵⁹Ibid., sec. IV (A)

⁶⁰Ibid., sec. IV (B).

TABLE 1
 LAND USE AND CORRELATING STANDARDS
 (Micrograms of Suspended Particulate Matter Per
 Cubic Meter of Air Sampled)

Type-Land Use	Description	Standard
A	residential & recreational	125
B	commercial & business	150
C	industrial	175
D	all other	200

Source: Texas Air Control Board Regulation I,
 "Control of Air Pollution from Smoke,
 Visible Emissions and Suspended Particu-
 late Matter," (1968), sec. IV (B).

To assist in meeting the ambient air quality standards,
 the Board established standards on the emission of
 suspended particulate matter which may be made from
 any property.⁶¹

Emission Limits for Suspended
 Particulate Matter

Emission limits for suspended particulate matter
 focuses on the "contribution of suspended particulate
 matter by a single property to an affected land use area."
 The contribution is measured by the "difference between
 the upwind and downwind level of air contaminants for

⁶¹Ibid., sec. IV (C).

the property" as outlined in Appendix B, or by "stack sampling calculated to a downwind concentration" as outlined in Appendix C.⁶² If after surveying in accordance with the procedures outlined in Appendix B and C the contribution from the property exceeds the emission set forth below in Table 2, the property is in violation of this regulation.⁶³

TABLE 2

EMISSION LIMITS FOR SUSPENDED PARTICULATE MATTER
(Micrograms of Suspended Particulate Matter Per
Cubic Meter of Air Sampled)

Land Use Area Affected	Property Emission Limit
Type A	100
Type B	125
Type C	150
Type D	175

Source: Texas Air Control Board Regulation I,
"Control of Air Pollution from Smoke,
Visible Emissions and Suspended Particu-
late Matter," (1968), sec. IV (C).

In addition to the emission limits for suspended particulate matter, the regulation also contains a section which has provided for the control of emissions through stack sampling.

⁶²Ibid.

⁶³Ibid.

Control of Emissions by Stack Sampling

Stack sampling is the method preferred by the Board when feasible. The method of actual measurement is left to the discretion of professional engineers. Also, stack sampling devices may be of a temporary or permanent nature, depending on the judgment of the individuals responsible for their provision, and are bound to conform to all safety laws and practices. The results of the stack samples may be used as evidence to determine compliance or violation of the Regulation.⁶⁴

If the situation exists in which it would be unfeasible to stack sample, compliance is "determined by the difference between the upwind level and downwind level of air contaminants for the property" as outlined in Appendix B. There are two situations in which upwind-downwind sampling is preferred: first, when particulates are not emitted through a stack, but "rather through the side of a building or through roof vents"; second, when emissions are made through a great number of flares and stacks so that measurement of the flare and stack individually would not be practicable or feasible.⁶⁵

⁶⁴Ibid., sec.

⁶⁵Ibid.

Thus far, the discussion has concentrated on the control and regulation of visible emissions and particulate matter; however, the Regulation also provided for certain provisions which govern specific activities.

Provisions Governing Specific Activities

The specific activities have been classified so as to include the following:

1. Toxic Material
Smoke or suspended particulate matter which is by its nature toxic to human or animal life or vegetation shall be controlled to more restrictive levels than is required for smoke and suspended particulate matter generally, and it shall not be emitted in such quantities or concentrations as to injure human or animal life or vegetation.⁶⁶
2. Burning of Cotton Gin Wastes
Burning of burrs, trash, lint and other wastes from cotton ginning operations is prohibited, except with prior approval of the Board.⁶⁷
3. Hot-Mix Asphaltic Concrete Plants
A portable type hot-mix asphaltic concrete plant which is equipped with a cyclone or mechanical dust collector may be operated in a Type D land use area if it is at least one mile from any Type A, B or C land use area, other than a Type A, B or C land use area located on the property on which the plant is located. Section III and IV of this Regulation do not apply to such a plant operated in compliance with this provision. This paragraph D does not apply in Harris County. Any county which does not desire to have Paragraph D apply to its area

⁶⁶Control of Air Pollution from Smoke and Suspended Particulate Matter, sec. V (A).

⁶⁷Ibid., sec. V (B).

may petition the Board to be excluded. The petition shall be submitted by the governing body of the county. The Board, on its own motion, may also initiate such proceedings. The Board will cause an investigation to be made of the need for the deletion of this provision from the area and, after compliance with the applicable procedures, may at its discretion, adopt a special regulation to that effect.⁶⁸

4. Rock Crushers

A portable type rock-crusher equipped with a dust control system which applies a water spray to the process material used in the rock-crusher at those transfer points in the process which are open to the atmosphere may be operated in Type D land use area if it is at least one half mile from any Type A, B or C land use area, other than a Type A, B or C land use area located on the property on which the rock-crusher is located. The water sprays must be so operated and installed so as to maintain an emission level not to exceed the level in Section IVB of this Regulation at the boundary line of the Type D land use area. Sections III and IV of this Regulation do not apply to such a rock-crusher operated in compliance with this provision. This Paragraph E does not apply in Harris County.⁶⁹

Regulation I to this point has focused on air standards and their application to the various conditions; however, the Regulation also has encompassed a section which has provided for the exclusion of specific matters from application.

⁶⁸Ibid., sec. V (D).

⁶⁹Ibid., sec. V (E).

Exclusions from Application of
Regulation I

The conditions or circumstances which may be excluded from application under this regulation are as follows:

1. Emissions of smoke or suspended particulate matter pursuant to and in compliance with the terms of a variance granted by the Board.⁷⁰
2. Air conditions existing solely within the property boundaries of a commercial or industrial plant, works or shop when the source of the offending air contaminants is under the control of the person operating such plant, works or shop.⁷¹
3. Emissions of smoke or suspended particulate matter from an activity when all of the following conditions exist:
 - a. The source of the emissions is in a relatively unpopulated area of the State;
 - b. The source of the emissions was in operation prior to August 30, 1965, the effective date of the 1965 Clean Air Act of Texas (Chapter 687, Acts of the 59th Legislature, Regular Session, 1965), and has continued to be in operation from that date;
 - c. The quantity, characteristics and duration in the atmosphere of the air contaminants emitted are such that the air contaminants are not toxic to human or animal life and do not unreasonably interfere with the use of physical property of the people; and
 - d. It is not technically practicable nor economically reasonable to eliminate the emissions.⁷²

⁷⁰Ibid., sec. VI (A).

⁷¹Ibid., sec. VI (B).

⁷²Ibid., sec. VI (C).

The discussion of the exclusion provision completes the examination of Regulation I and precludes a most important phase of historical background. Characteristic of most legislative acts is that little is known concerning their true value and worth until the particular act's validity is tested. The following discussion will be concerned with the confirmation of both the Clean Air Act and Regulation I by the courts.

Confirmation of the Clean Air Act of
Texas and Regulation I

Despite the passage of the Clean Air Act of Texas, many industries which were polluting the Texas atmosphere refused to comply with the Board's regulations. Accordingly, legal action was initiated against the violators. For the most part, penalties were assessed in terms of temporary injunctions and small monetary fines. Although these cases aided in the confirmation of the Act and the legal acceptance of the Board's regulations, the true test of validity was brought about as a result of two significant lawsuits involving permanent injunctions and large monetary forfeitures. The basis of confirmation rested with the cases of Hooker Chemical Corporation and International Mineral and Chemical. Both companies, at the time of legal action, were located in Houston, Texas.⁷³

⁷³Texas Air Control Board Report, "Air Pollution Control in Texas," Texas State Department of Health, p. 6.

County of Harris vs. Hooker Chemical Corporation, et. al.
No. 760589, 55th District Court of Harris County, Texas

The first test of validity has been cited as County of Harris vs. Hooker Chemical Corporation, et. al., No. 760589. A brief history is provided so as to establish the situation which ultimately led to litigation.

Case Characteristics

Hooker Chemical Corporation was a corporation organized under New York statutes and conducted its business operations in Harris County, Texas. The company based its operations on the "Houston Ship Channel" near "the city of Galena Park," also located in Harris County. The Hooker Corporation is primarily engaged in "producing, manufacturing, packaging and distributing certain chemical and related chemical products." The products produced and manufactured by Hooker Chemical were agricultural chemicals which consisted of "sulfates, phosphates, sulfur and phosphorus compounds and mixtures" and other related products. The production process involved treating phosphate rock with sulfuric acid. As a result, the wastes, "sulfuric acid, sulfuric mist, acid mists, sulfur dioxides, sulfur trioxides, phosphate process fumes, and other related mists and gases, fumes and vapors, were released into the air and circulated through the atmosphere." In addition, the "milling,

grinding and packaging of the chemicals and agricultural chemical products" produced additional dust and particles which were released into the atmosphere compounding the already existing problem.⁷⁴

Alleged Violations

The original petition filed by Harris County, asserted that Hooker Chemical by its "character was industrial; and, furthermore, located in an area which according to Regulation I, would be classified as Type C, Industrial area." Therefore, according to Regulation I, Hooker was prevented from "contributing airborne particles" into the atmosphere in excess of "150 micrograms per cubic meter of air." The plaintiff further asserted that the corporation was located near areas classified as "Type A, Residential," and "Type B, Business or Commercial."⁷⁵

The basic accusations made by the plaintiff are listed as follows:

1. After December 31, 1967, Hooker Chemical had repeatedly caused the "emission of particulate matter into

⁷⁴County vs. Hooker Chemical Corporation, Civil No. 760,589, District Court of Harris County, 55th Judicial District of Texas, March 20, 1968, p. 2.

⁷⁵Ibid., p. 8.

the atmosphere in concentrations well in excess of 150 micrograms per cubic foot of air" and that particulate matter particles had crossed over properties classified as Types A and B;⁷⁶

2. Hooker Chemical was not in compliance with Regulation I, on December 31, 1967, in that it did not install the proper equipment to "control their emissions of particulate matter." At the time the petition was filed Hooker Chemical was still not in compliance with Regulation I. Also, Hooker Chemical failed to file for a variance with the Texas Air Control Board before September 30, 1967. Because of the failure of Hooker Chemical to apply, it was established that it had been in violation of Regulation I every day from "September 30, 1967, to January 23, 1968";⁷⁷ and

3. That because Hooker Chemical failed to install the necessary control devices to "control the emissions of sulfuric acid, acid mist, sulfuric dioxide, sulfur trioxide, phosphates," the processes were injurious and adversely affected human and "animal life, vegetation and property" and further affected the "normal use and

⁷⁶Ibid.

⁷⁷Ibid., p. 10.

enjoyment" of surrounding property by the people who owned and occupied the surrounding land.⁷⁸

Court Findings

After closely reviewing the facts and evidence of the case, the court reached a judgment in which an injunction would be initiated against Hooker with required outlined corrective action. Also, incorporated into the injunction was a variance granted by the Board. As a final consequence, the judgment also included a monetary penalty of \$10,000.00 for past violations of the Act's regulations.⁷⁹

A second case which served as a confirmation cornerstone has been cited as the City of Houston vs. International Mineral and Chemical Corporation.

City of Houston, et. al. vs. International Mineral and Chemical Corporation No. 767,407

This case has been distinguished as the most important single case which would prove to validate and establish a basis for constitutionality.⁸⁰

⁷⁸Ibid.

⁷⁹Texas Air Control Board Report, "Air Pollution Control in Texas," Texas State Department of Health, p. 6.

⁸⁰Texas Air Control Board staff, personal interview, February 19, 1971.

Case Characteristics

International Mineral and Chemical Corporation was legally organized in New York and like Hooker Chemical conducted business in Harris County, Texas. IMC at the time of indictment was located within the city limits of Houston in Harris County and was primarily engaged in the "processing, manufacturing, and handling of barite, an abrasive substance used in drilling mud."⁸¹

The processing and handling of the barite produced dust and particles which were released into the air and circulated around the surrounding land. The dust and particles were "carried in such concentrations" and duration to the surrounding area so "as to be injurious and harmful" to human health, "animal life, vegetation and property" and also to the aesthetic value of the property.⁸²

Alleged Violations

The City of Houston contended that the barite plant was partially "industrial and residential in character" and should be classified as "Type A, Residential, and

⁸¹Houston vs. International Mineral and Chemical Corporation, Civil No. 767.407, District Court of Harris County, 55th Judicial District of Texas, June 4, 1968, p. 1.

⁸²Ibid., p. 2.

Type C, Industrial." According to Regulation I, airborne particles crossing over property Type A cannot exceed "125 micrograms of suspended particulate matter per cubic meter of air"; furthermore, they cannot exceed "175 micrograms of suspended particulate matter per cubic meter of air" crossing over property classified as property Type C.⁸³ The basic allegations made by the City of Houston are described as follows:

1. International Mineral and Chemical repeatedly, in its operation of its barite plant and facilities, "caused an unlawful emission of dust and particulate matter" which greatly exceeded "175 micrograms of suspended particulate matter per cubic meter of air" and that the dust was carried across surrounding property causing harm to persons, "animal life, vegetation and property," and caused interference with the enjoyment and normal use of property;⁸⁴

2. International Mineral and Chemical was not in compliance with Regulation I as promulgated and made "effective January 31, 1967," in that it did not install the proper equipment "to control the emissions of particulate matter" and that it was not in compliance from its

⁸³Ibid., p. 4.

⁸⁴Ibid., p. 5.

effective date.⁸⁵ In addition, it was alleged that International Mineral and Chemical failed to apply for a variance as required by the "original Regulation I" between "September 30, 1967 and January 23, 1968";⁸⁶ and

3. International Mineral and Chemical failed to initiate the adoption of the necessary control devices, it caused "dust and particulate matter to disseminate into the atmosphere" in such concentrations and duration so as to be injurious to and "adversely affect human and animal life, and vegetation and property."⁸⁷

Court Findings

Once again after close scrutiny of the case facts and evidence, the court reached the decision to issue an injunction against International Mineral and Chemical Company which would require certain corrective actions. In addition, a variance would be granted by the Air Control Board. The court's action also included a "monetary penalty of \$17,500.00" plus a mandatory shutdown of the "plant for five days pending action by the Air Control Board." Thus, the total monetary penalty to the company

⁸⁵Ibid., p. 6.

⁸⁶Ibid., p. 7.

⁸⁷Ibid., p. 8.

was estimated to be between fifty and sixty thousand dollars.⁸⁸

The second chapter has been devoted to a review of the historical background and development of the Clean Air Act of Texas-1965. The Act's adoption, basic purpose, regulatory provisions, and proof of court confirmation were reviewed. The foregoing information is essential before one can examine and understand the economic effect of Regulation I on eight industrial manufacturers in Harris County, Texas, as presented in Chapter III.

⁸⁸Texas Air Control Board Report, "Air Pollution Control in Texas," Texas State Department of Health, p. 6.

CHAPTER III

AIR EMISSION CONTROL EXPENDITURES FOR FIVE INDUSTRIAL MANUFACTURERS INDICTED IN HARRIS COUNTY, TEXAS

The effects of air pollution legislation are continuously being reflected through air pollution control cost studies. The most current studies have attempted to project "expected costs associated" with the control of excessive pollution emissions or to predict "current expenditure trends" representative of all industry concerned with air quality control.⁸⁹ Following an examination of such studies, it was concluded that a consensus of air quality control expenditures does not exist. This diversity is partially because of varying external forces affecting each industry, basic differences in the nature and size of operation, and the lack of an explicit definition and an accurate measurement of "cost" as related to air pollution control. In view of the external forces affecting air pollution control cost studies,

⁸⁹Carlton D. Stolle, "A Survey of Air Emission Control Expenditures in Texas Industry Since 1965," (Unpublished report, Texas A & M University, October, 1970), p. 1.

research presented in Chapter III intends to disclose the air quality control costs incurred by selected and indicted Harris County manufacturers as a direct or indirect result of Regulation I of the Clean Air Act of Texas-1965.

The Nature of Costs

The research is confined to five industrial manufacturers indicted in Harris County, Texas for contributing to the excessive emission of air contaminants into the Texas atmosphere. The names of the companies interviewed are withheld from this thesis as a courtesy to the companies and to safeguard against unwarranted criticism. As an added protective measure, the monetary penalty or court fine incurred by the indicted companies will also be withheld from this presentation to prevent any association between the names of the companies and the amount of the fine. This cost will be included in the total cost computation.

The selected firms included in this investigation were contacted by means of a personal interview. To aid the researcher in the interview, a checklist was devised which requested cost information for air pollution control. A sample cost checklist is presented as Appendix D of this report. As noted in Appendix D, the cost

checklist specifically requests low and high cost information. However, the difference between the low and high cost reported by the respondents proved to be insignificant. The author was advised that since the air pollution cost information supplied was primarily based on technical estimates, a mean or average cost figure could be used to achieve comparable results. The expenditure summary tables appearing later in this chapter have been adapted to report the mean or average incurred air pollution control cost.

It may appear that the cost checklist, Appendix D, and the tables devised and presented in this chapter are lacking in depth and detail. The cost checklist was prepared after initial visits with company officials who advised that this was about the extent they would go in furnishing this "vital and somewhat confidential" material.

The requested data were confined to include those costs which were representative of pre-purchase costs, cost incident to the purchase of air pollution equipment, and annual operating and maintenance costs. The costs acknowledged as those expended by the responding companies were costs which the organizations themselves considered to be expenditures made for the benefit of air emission control.

The expenditures reflected in the tables appearing later in this chapter are those which occurred as a result of purchasing the air pollution equipment. This report divides the incurred costs into three major categories:

1. immediate costs
2. equipment acquisition costs
3. equipment operating costs

Data supplied by the respondents, relative to immediate and equipment acquisition costs, is treated as non-repetitive. Therefore, the companies were asked to provide total cost figures rather than adjusted annual costs. In contrast to this request, equipment operating costs are treated as repetitive; therefore, the companies were asked to provide operating expenditures in terms of annual costs incurred.

Summary of Overall Air Pollution
Control Costs Incurred

Table 3 provides a summary of acknowledged overall costs by companies A through E. Each organization which responded to the personal interview and provided data relative to the acquisition of air pollution control equipment is included in the computation of Table 3. As indicated from the table, the total overall costs for the individual firms ranged from a total of \$26,000.00

TABLE 3

OVERALL EXPENDITURE SUMMARY PER INDICTED COMPANY
FOR AIR POLLUTION CONTROL

Company	Total Immediate Costs for Each Firm	Total Equipment Costs for Each Firm	*Total Operating Costs for Each Firm	Total Overall Costs for Each Firm
Company A	\$ 93,750	\$ 442,500	\$ 23,200	\$ 559,450
Company B	23,100	81,000	6,750	110,850
Company C	7,250	15,500	3,250	26,000
Company D	69,500	311,000	27,200	407,700
Company E	24,000	645,000	160,000	829,000
Total Expenditures	217,600	1,495,000	220,400	1,933,000

* Operating Costs
Computed Annually

to a total of \$829,000.00. The total outlay or total amount expended by the respondents for the three major cost areas was \$1,933,000.00.

Total Equipment Acquisition Costs

The total equipment acquisition costs for the individual firms range from \$15,500.00 to \$645,000.00. The respondents collectively expended \$1,495,000.00. This figure indicates that 77.34 percent of the total overall costs incurred were consumed by the acquisition of air pollution control equipment.

In reference to the large costs for air quality control, the respondents were asked to give their opinion concerning the pricing of the equipment. The responses were consistently the same. The respondents contended that the manufacturers of the air control equipment have and are unfairly pricing the equipment. There were two basic reasons given for the over-pricing. First, the number of firms engaged in the production of air quality control equipment at this time is relatively small and as a result there is minimum competition. Second, the air pollution law has created a seller's market. Following litigation, the companies charged with excessive pollution activities have but two primary courses of action to follow. As one possible alternative, the companies may choose to discontinue operations completely

after determining the modification or changeover costs. A second possible alternative involves the continuance of operations while maintaining compliance with state air pollution standards. The latter option necessitates the acquisition of control equipment. At this point the equipment manufacturer is in control. As one company executive phrased it, "We are over a barrel and they know it."

Total Operating Costs

The total operating costs range from \$6,750.00 to \$160,000.00. Again, collectively \$220,400.00 was expended for actual operation and maintenance of equipment following installation. This amount accounts for 11.40 percent of the overall total cost for air pollution control incurred by the respondents.

The wide range between the company operating costs is due to the variations in the nature and size of the operation. The operating costs reported by the respondents indicate the costs from the last accounting period. They do not reflect total operating costs beginning with the equipment acquisition date to the present accounting period. As many of the respondents' litigation date is as far removed as 1967, it is possible to conceive how the 11.40 percent could be a much greater percentage in relation to total overall costs.

The respondents were asked if such costs were fairly stable. They indicated that the operating costs were continuously increasing and that substantial increases are anticipated in the future.

Total Immediate Costs

The total immediate costs range from \$7,250.00 to \$93,750.00. The respondents collectively expended \$217,600.00 prior to and following litigation proceedings. This amount accounts for the remaining 11.26 percent of total overall costs. Figuratively speaking, the immediate costs in relation to each firm's overall air pollution costs are small, but are important in respect to overall costs incurred.

The immediate costs, as termed by the respondents, are unavoidable. They represent costs incurred as a result of the companies' determination to prove that they have and are complying with state air pollution standards. This cost does not include the fines received. The respondents conclusively indicated that the immediate costs are necessary as their absence would be viewed as an admission of guilt.

Summary of Immediate Costs

In order to comprehend fully the economic ramifications of Regulation I, investigation must begin at the

point where the first air pollution cost is incurred. Immediate costs reveal costs associated with litigation as well as planning and research costs that are associated with the acquisition of air control equipment. Although immediate costs are comparatively small, they serve as integral parts of the acquisition costs, and should not, therefore, be viewed too lightly.

Table 4 presents an expenditure summary per company for the immediate costs associated with air pollution control. The immediate expenditures range from \$13,100.00 to \$61,250.00. Attorney fees are the greatest expenditure as they account for 28.15 percent of the total immediate cost expenditure. However, the testing and consultant costs, with 26.54 percent and 25.04 percent respectively, follow the attorney fees very closely.

The cost indicating the smallest percentage of the total immediate expenditure is public relations with 6.02 percent. The respondents stated that to assign a value to public relations was a very difficult task as it is a continuous and arbitrary process. However, in view of this difficulty, the respondents concluded that it was a significant cost to the company.

TABLE 4

EXPENDITURE SUMMARY PER INDICTED COMPANY FOR
IMMEDIATE AIR POLLUTION CONTROL COSTS

Company	Attorney Fees	Public Relations	Testing Air-Sampling	Consultants (feasibility)	Total Immediate Costs for Each Industry
Company A	\$25,000	\$12,500	\$ 6,250	\$45,000	\$ 93,750
Company B	12,500	600	*NCI	7,500	23,100
Company C	7,500	NCI	1,500	NCI	7,250
Company D	5,000	NCI	45,000	2,000	69,500
Company E	18,000	NCI	5,000	NCI	24,000
Total Immediate Expenditures	61,250	13,100	57,750	54,500	**217,600

* NCI-No Cost Incurred

** Fines included

Summary of Equipment Acquisition Costs

Following litigation proceedings and the initiation of pre-equipment acquisition planning, actions are taken to acquire the necessary equipment to alleviate the company's excessive air pollution emissions.

Table 5 provides an expenditure summary for air pollution control equipment made by each company. As indicated by the table, the total equipment acquisition costs range from \$36,000.00 to \$997,000.00. The cost of the air pollution control equipment is the single greatest cost in relation to the other costs associated with equipment acquisition. The equipment cost accounts for 66.69 percent of the total equipment acquisition costs.

Several respondents reported that their equipment installation costs and consultant costs are included in the equipment cost. Therefore, an I.C. (incorporated cost) is placed in the chart for those companies whose costs were incorporated. The in-house planning or man-hour cost of planning accounts for 4.05 percent of the total cost of equipment. The man-hour cost of planning involves the selection of possible alternative courses of action, the selection of consultants or air pollution control equipment manufacturers, and any other selection or decision process associated with a system change.

TABLE 5

EXPENDITURE SUMMARY PER INDICTED COMPANY FOR
EQUIPMENT ACQUISITION COSTS

Company	Equipment Cost	Equipment In- stallation Cost	Man-hour cost of Planning	Consultant Cost (equipment)	Total Equipment Acquisition Costs for Individual Industry
Company A	\$375,000	* IC	\$42,500	\$25,000	\$ 442,500
Company B	75,000	IC	6,000	IC	81,000
Company C	7,000	\$ 6,500	2,000	IC	15,500
Company D	175,000	125,000	10,000	1,000	311,000
Company E	365,000	270,000	--	10,000	645,000
Total Equipment Acquisition Expenditures	997,000	401,500	60,500	36,000	1,495,000

* IC- Incorporated Cost

Summary Equipment Operating Costs

Most studies of industrial air pollution control costs overlook certain operating costs: power, parts and replacements, maintenance labor, disposal of collected wastes and the clean-up of approaches and access roads leading to the plant. An air pollution control cost investigation would not provide a comprehensive report if the operation and maintenance of equipment were not included. Equipment operation and maintenance costs reveal the funds expended for continual operation and maintenance of the equipment following the acquisition and installation of the air control equipment.

Most respondents reported that if the equipment operating expenditures were computed from the equipment acquisition period to the present period, the operating costs in some instances would surpass the costs of the control equipment and its installation. This cost could be obtained by multiplying the latest annual operating costs by the number of accounting periods since the beginning acquisition and installation period. Of course, annual price-level changes should be included in the computation to obtain the most accurate results.

Table 6 provides an expenditure summary for equipment and operating costs made by each company. (For the purpose of this report, only the last ending period of

TABLE 6

EXPENDITURE SUMMARY PER INDICTED COMPANY FOR
EQUIPMENT OPERATING COSTS

Company	Power, Fuel & Water Cost	Replacement Parts and Materials	Maintenance Labor	Disposal of Wastes	Clean-up Costs	Total Operating Costs for Indi- vidual Industry
Company A	\$ 6,000	\$ 9,000	\$ 4,000	*NCI	\$4,200	**\$ 23,200
Company E	3,000	750	1,750	NCI	1,250	6,750
Company C	NCI	1,250	1,000	NCI	1,000	3,250
Company D	8,000	10,000	8,700	NCI	500	27,200
Company E	9,600	70,400	80,000	NCI	NCI	160,000
Total Operating Expenditures	26,600	91,400	95,450	NCI	6,950	220,400

* NIC-No Cost Incurred

** Annual Operating Cost

annual operating costs will be provided.) The table indicates that the total operating costs range from no costs incurred to \$95,450.00. The labor for equipment maintenance and the replacement of parts and materials share the heading as the greatest amount expended. Maintenance labor accounts for 43.31 percent of the total operating expenditure and the replacement of parts and materials accounts for 41.47 percent. The table reveals that the respondents did not incur any costs associated with the disposal of collected wastes. They reported that due to a collection and recycling process, the product wastes were recovered which eliminated the need for disposal.

The results of this survey should provide the reader with a means to view the total air pollution control costs for the five responding firms indicted in Harris County and a means of analyzing the cost factors which are most significant to the total overall air pollution control costs.

Summary Statement of Air Pollution
Control Costs Incurred

In Chapter II it was pointed out that prior to 1965 the State of Texas air quality standards consisted primarily of a nuisance doctrine. The nuisance doctrine was not employed effectively and more specifically, it

did not serve as a remedy for the increasing air pollution problem. Consequently, the major action in pollution control shifted from a condition of nuisance to regulation. Regulation of the air pollution activities of Texas' industries was established by the adoption of the Clean Air Act of Texas-1965. The Act provided for the creation of an Air Control Board. The Board's primary responsibility focused on the creation of air quality standards to serve as guidelines for Texas industry. Prior to this time, Texas industry was under no pressure to conform to any air quality standards except those created by the company itself.

The period following the creation of the Texas Air Control Board was characterized by many investigations of potential and suspected air pollution violators. The investigations resulted in legal action taken against many Texas industries. The Air Control Board concluded that Harris County accounted for the heaviest concentration of air pollution activity. Therefore, Harris County industry accounts for the majority of the legal actions concerning the Texas Air Control Board.

The Harris County companies included in this study were investigated and charged with violation of the air quality standards set in Regulation I as presented in Chapter II. Consequently, the indicted Harris County

manufacturers who had not been restrained in past operations from contributing to air pollution, were faced with the choice of complying with State air quality laws or continuing to operate as always. The Harris County companies which chose the first alternative, either voluntarily or involuntarily, incurred additional costs. An account of the costs incurred by the Harris County manufacturers to maintain compliance with State quality standards is the focal point of Chapter III and the impetus of this report.

Between November, 1967 and April, 1970, eight Harris County, Texas manufacturers were involved in air pollution litigation proceedings. The eight Texas firms were charged with the violation of Regulation I of the Clean Air Act of Texas-1965. The petition requesting legal action by the Texas Air Control Board was filed by Harris County and joined by the State of Texas. In one case the petition for legal action was filed by the City of Houston and the State of Texas. The city, county and state alleged that the eight Harris County firms were in violation of the air pollution emission standards as prescribed by Regulation I of the Clean Air Act of Texas-1965. Court hearings were conducted for the companies charged and in each case, (except one) the company

received a permanent injunction to prevent excessive pollution activities and a fine.

The court actions resulted in each company incurring costs associated with the acquisition of the necessary air quality control equipment to meet and maintain state air pollution standards. As previously discussed in Chapter III, the air pollution costs for the five companies surveyed ranged from \$26,000.00 to \$829,000.00 with a collective total for the five companies of \$1,933,000.00.

CHAPTER IV

SUMMARY, FINDINGS AND CONCLUSIONS

Summary

The attempts to control air pollution activities in Texas are relatively recent. It has been only during the last decade that attempts have been made to control excessive emissions of pollutants on a nationwide basis. The attempts to control Texas air pollution are reflected in the adoption of the Clean Air Act of Texas in 1965. The effects of the Act on industry in Texas were minimal compared to its impact in 1967 and in 1969 when the Act was strengthened and revised. The impact of the Act on industry, beginning in 1967, can be viewed from many directions; however, the effects which are least arbitrary and possibly meaningful are the additional costs incurred as a direct or indirect result of the Act.

For five companies in Texas the effects of the Act have been felt in terms of additional costs to company operations. In an attempt to disclose the incurred costs and as a point of departure, a review of the historical background and development of the Act is

necessary. The historical background and development of the Act enhances the reader's understanding of why the Act was adopted, its basic purpose, its regulatory provisions and finally, its proof of validity.

There are many reasons which explain the adoption of the Clean Air Act; however, most authorities will agree that adoption came as a result of the rapid growth of Texas cities, the expansion of industry and commerce, the established fact that polluted air endangers health, the economic burden created, the pressure of the federal government, and weaknesses contained in the nuisance doctrine.

In 1965, the Clean Air Act of Texas was placed among the many Texas statutes with its basic purpose of safeguarding the air resources of Texas from pollution. To aid in accomplishing the purpose of the Act, Section 3 (A) and Section 4 (A) were included. Section 3 (A) provides for the creation of an Air Control Board with the Board's primary responsibility of insuring the maintenance of purity of air and to insure the protection of health and physical property. Section 4 (A) describes the power with which the Board has been vested. Essentially, the Board's responsibility is to adopt rules and regulations which it deems necessary to control air pollution in Texas.

Regulation I is included in the five regulations created by the Board. Regulation I deals directly with the control of air pollution from smoke, visible emissions and suspended particulate matter. As a control technique, Regulation I establishes standards and limits beyond which pollutant emissions for designated land uses cannot exceed.

Following the adoption of the Clean Air Act and the creation of Regulation I, the Act's validity was tested. The basis of court confirmation rested with the cases of Hooker Chemical Corporation and International Mineral and Chemical Corporation of Harris County, Texas. In both cases, the courts charged the corporations with violating Regulation I of the Clean Air Act. The court's judgments included a permanent injunction with outlined corrective actions and a monetary penalty for past violations of the Act's regulations. The court's decision, handed down in the two air pollution landmark cases, aided in the confirmation of the Act and the legal acceptance of the Board's Regulation I. Thus, an era of legal action concerning violation of the Clean Air Act's regulations had commenced. During this time, eight companies in Harris County, Texas were indicted for the violation of Regulation I of the Act. Consequently, the indictment of the companies posed the question as to

the Clean Air Act's effects on the indicted companies. An inquiry into the proposed question became the focal point of this report.

Findings

The selected firms included in this inquiry were contacted by means of personal interview. A checklist was devised which requested information concerning the costs which the companies had incurred for all pollution control. The incurred costs were classified into three basic categories:

1. immediate costs
2. equipment acquisition costs
3. equipment operating costs

The survey indicates the total overall costs for the individual firms range from a total of \$26,000.00 to \$829,000.00. The total cost incurred collectively by the respondents for the three major cost areas is \$1,933,000.00.

The total equipment acquisition costs for the individual companies range from \$15,500.00 to \$645,000.00 with a combined cost of \$1,495,000.00 for all companies surveyed. The total operating costs range from \$6,750.00 to \$160,000.00 with the five-company expended total being \$220,400.00. Lastly, the total immediate costs range

from \$7,250.00 to \$93,750.00 with \$217,600.00 expended collectively.

A summary of the three major cost areas indicates that attorney fees, testing, and consultant fees account for the majority of immediate costs incurred. As indicated by the summary of equipment acquisition costs, the cost of the equipment is the single greatest expense. For equipment operating costs, the labor for equipment maintenance and the replacement of parts and materials require the greatest amount to be expended.

Conclusions

The purpose of this report has been to determine objectively the financial impact sustained by eight companies as a direct or indirect result of Regulation I of the Clean Air Act of Texas-1965. Based on the findings provided in Chapter III, general conclusions may be drawn concerning the Act's effects on the indicted companies in Harris County, Texas.

The respondents reported pre-purchase costs, costs incident to the purchase of air pollution equipment, and annual operating and maintenance costs. The air pollution costs were incurred following the companies' court hearings for the violation of Regulation I of the Act. Therefore, it is concluded that the respondents incurred the air pollution costs as a direct result of being indicted

for the violation of Regulation I of the Clean Air Act of Texas-1965.

In viewing the expense incurred by the respondents for the purchase of the necessary equipment to reduce their output of pollutant emissions, the primary question becomes one of social and moral responsibility: Would the indicted industrial companies have undertaken such added expenses without the requirements of Regulation I and the pressure placed upon them by the courts of the State of Texas?

In that the Clean Air Act of Texas is a recent statute, the future betterment of its overall purposes is probable. Hand in hand with these forthcoming revisions, the author concludes that Texas industry must be ever aware of the future financial allocations which will be necessary to update its equipment and processes to maintain complete compliance with the continuous revisions of Texas air pollution standards and regulations.

APPENDIXES

APPENDIX A

I. Determinations of Smoke Based on Principle of Ringelmann Smoke Chart

INTRODUCTION

The Ringelmann Smoke Chart was developed for use in evaluating black or gray emissions. The principle of equivalent opacity has since been developed which makes possible the application of the Ringelmann principle to density determinations of all colors of emissions, including gray and black emissions. A qualified, trained observer is capable of making accurate determinations of the density of emissions of all colors without having to refer to a density guide.

USE OF CHART

Support the chart on a level with the eye, at such a distance from the observer that the lines on the chart merge into shades of gray, and as nearly as possible in line with the stack. Glance from the smoke, as it issues from the stack, to the chart and note the number on the chart most nearly corresponding with the shade of the smoke, then record this number with the time of observation. A clear stack is recorded as No. 0, and 100 percent black smoke as No. 5.

To determine average smoke emission, observations are repeated at one-fourth minute intervals for a period of 6 consecutive minutes. The readings are then reduced to the total equivalent of No. 1 smoke as a standard. No. 1 smoke being considered as 20 percent dense, the percentage "density" of the smoke for the entire period of observation is obtained by the formula:

$$\frac{\text{Equivalent units of No.1 smoke} \times 20}{\text{Number of observations}} = \text{percentage smoke density.}$$

Further information on the Ringelmann Smoke Chart and its use may be found in the United States Department of Interior, Bureau of Mines Information Circular 7718 of August 1955. A modified Ringelmann Chart for hand use has been prepared by the Texas Air Control Board staff and may be used to determine smoke density. The chart may be obtained by writing the Executive Secretary.

Use of Modified Ringelmann Chart:

1. Hold chart at arm's length and view smoke above the grid on chart.
2. Be sure that light shining on chart is the same light that is shining on smoke being examined; for best results, sun should be behind observer.
3. Match smoke as closely as possible with corresponding grid on chart and record.
4. Proceed as outlined above.

II. Reading Equivalent Opacity of Visible Emissions

Below is the relationship between Ringelmann number and equivalent opacity:

<u>Ringelmann No.</u>	<u>Opacity %</u>
1	20
2	40
3	60
4	80
5	100

The general rules in making estimates of equivalent opacity are as follows:

- (1) Visible emissions other than gray or black are read in opacities and are recorded in percentages. These percentages may then be directly related to a Ringelmann number, as noted in the table above. Gray or black smoke is recorded in Ringelmann numbers.

- (2) During periods of bright sunshine, the sun should be directly behind the observer or within 45° either side of that direction. In cloudy weather, the position of the sun is relatively unimportant.
- (3) Readings shall be taken at right angles to the wind direction and from a distance necessary to obtain a clear view of the stack and background.
- (4) Readings shall be made through the densest part of the plume and where the plume is approximately the diameter of the stack. On plumes containing steam, opacity readings should be taken immediately beyond the point where the steam dissipates.
- (5) An observer should not study the plume as this will soon produce fatigue and cause erroneous readings. Instead, he should glance at the plume and record his observation immediately, looking away from the plume between readings.
- (6) Readings shall be taken at 15 second intervals for a period of six consecutive minutes and recorded on an appropriate form (See Figures 1 and 2).
- (7) The observer shall have successfully completed a training program at a training facility approved by the Texas Air Control Board and certified within the previous six (6) months.
- (8) An observer trained as provided in paragraph (7) may make readings directly without the necessity of referring to a density guide for visible emissions.

III. INSTRUMENTAL METHOD FOR MEASUREMENT OF TRANSMITTANCE

This Appendix provides guidelines for the measurement of transmittance through a visible plume prior to emission, for the purpose of determining compliance with the emission standard specified in Paragraph D of Section III of Regulation I.

- A. General Method. This method is intended to accomplish the same objective as the visual estimation of equivalent opacity; i.e., to measure the optical properties of a plume and thereby determine whether or not the emission will contribute to the degradation of atmospheric visibility in the area downwind of the source in question. Instruments are available from commercial suppliers which can meet the requirements of this Appendix, or persons skilled in instrumentation can assemble a satisfactory instrument from various components.
- B. Principle of Operation. The instrument shall include a light source which produces a collimated (approximately parallel) beam of light, and an adequate device capable of measuring the intensity of the light beam at the temperature and environmental conditions existing. The light source and measuring device shall be mounted in the stack or in a duct leading to the stack in such a way that the emissions to the atmosphere pass between the light source and measuring device and cause a reduction in the measured light intensity. The transmittance, or light intensity of the beam passed through the dust and particulate matter, shall be greater than 70% of the transmittance measured with the same instrument installation when no dust is present, when calibrated as described below.¹
- C. Light Source. The light source used shall emit spectral energy approximately equivalent to normal daylight. To prevent erroneously high readings for transmittance, no more than 10% of the total energy emitted shall be of longer wave length than two microns.
- D. Location. The instrument shall be located in the system at a point which provides transmittance readings representative of the optical properties of the particulate matter emitted to the atmosphere. Measurement of light scattering due to condensed water vapor may indicate a

¹Consideration is being given to making this 80%.

violation when, in fact, a violation does not exist; thus, for effluents containing water vapor, measurements should be made at some point in the system where gas temperature is above the dew point, thus preventing condensation.

- E. Installation and Calibration. The permissible optical properties of the emission depend, in part, on the total volume emitted. The instrument response will vary depending on the light path across which the measurement is made. These two factors must be considered in installing and calibrating the instrument. Also, the light path should not extend the full width of the stack or duct in which the instrument is installed, since disturbances in the flow pattern next to the wall of a stack or duct may cause erroneous readings; the usual practice is to provide a light path of approximately 90% of the stack diameter, leaving approximately five percent of the diameter near each wall which is not included in the light path.

The following steps are required in calibration:

1. Determine total volume of gases emitted, including air, combustion gases, gaseous impurities, and all gaseous matter combined, but excluding water or water vapor. Calculate volume at the pressure and temperature existing at the point of measurement. Multiple units substantially the same in design and operation shall be considered as a single process and the total combined flow from all such units shall be used. Process units which are different in design and/or operation will be evaluated and measured individually.
2. From Figure 1, determine the length of light path across which a minimum of 70% transmittance is required.

3. If possible, install instrument so that measurements are obtained over an actual light path close to that determined from Figure 1. Where this is not possible due to the geometry of the system, the allowable transmittance for a light path other than that indicated by Figure 1 can be estimated by using the following equation:

$$- \log T = k l$$

where T = Transmittance
 l = length of light path
 k = constant

(Use 0.70 transmittance and light path indicated by Figure 1 to evaluate k; then use this value of k to determine transmittance for actual light path of the particular installation.)

This determination can be made with the aid of Figure 2. This curve should not be extrapolated beyond the limits shown since the equation may not be applicable with extreme variations in light path. The value obtained is the permissible transmittance with the installation used, which is equivalent to a transmittance of 70% with the length of light path indicated by Figure 1.

Note: Some commercial instruments utilize a five-foot light path for installation in any stack five feet or more in diameter, even for very large stacks. To aid those contemplating such an installation, Figure 3 shows the minimum transmittance required with a light path of five feet. This should be used with caution with emission rates in excess of 250,000 cfm.

4. The instrument shall be calibrated for clear stack conditions (100% transmittance) and opaque conditions (0% transmittance). In addition, a 70% transmittance calibration reading should be made using a light obscuration grid. Calibration shall be per-

formed at such intervals as are necessary to maintain accuracy of 5%.

5. Lens surfaces should be cleaned when necessary to allow continued efficient operation of the instrument. Optical alignment of the light source and detector should also be checked periodically, especially if transmittance readings appear to be lower than anticipated.
 6. An automatic recorder is recommended to obtain a continuous record; otherwise, readings must be recorded at least four times per hour, plus additional readings if processing conditions change.
- F. Exceptions. Certain situations may arise in which this method is not applicable, such as the following:
1. Emissions change in character after emission to become more visible (so-called "detached plume"), so that an emission which is invisible in the stack may, in fact, cause deterioration of visibility in the community.
 2. Different emissions may mix and react in atmosphere to form aerosols which restrict visibility although each emission by itself may have no effect on visibility.
 3. Location at a point where temperature is above the dew point is not possible, and therefore errors due to water condensate cannot be avoided.

Where these or other conditions make it impossible to use the method outlined in Appendix A, Section III and achieve the intent of this Regulation, the Executive Secretary will investigate such situations on an individual basis. The Board may issue an order which will control this emission; and in such order, alternate methods of measurement and/or controls which are appropriate to control this emission will be considered.

- G. Alternate Methods of Measurement. The Executive Secretary may accept alternate methods of measurement which can be shown to achieve the intent of this Regulation.

APPENDIX B

High Volume Air Sampling

A. Determination of Ambient Air Quality

The sampling for ambient air quality shall be by high volume air samples of twenty-four hours duration. A minimum of ten air samples within a thirty-day period in the affected area shall be collected. The ambient air quality for the area is considered as having exceeded the standards outlined in Paragraph IV.B., if the 24-hour samples exceed those levels more than 10% of the time.

B. Determination of Compliance with Emission Limits

1. High volume air samplers shall be used to take upwind level samples and downwind level samples so as to determine the contribution of the property in question. Samples shall be taken away from areas of local air quality disturbances, such as dusty roads. The concentration of particulate matter in the "downwind sample" less the concentration in the "upwind sample" shall be used in determining whether the emissions from the property comply with the requirements in Section IV of this Regulation.

2. To provide adequate data to constitute proof of compliance or violation, the following minimum sampling requirements shall be met:

a. Duration of Sampling:

- (1) If the measured value exceeds the emission limit by not more than 100 ug/M^3 , a minimum 5-hour

sample shall be collected in a 24-hour period

- (2) If the measured value exceeds the emission limit by more than 100 but less than 300 $\mu\text{g}/\text{M}^3$, a minimum 3-hour sample shall be collected in a 24-hour period
 - (3) If the measured value exceeds the emission limit by 300 $\mu\text{g}/\text{M}^3$ or more, a minimum 1-hour sample shall be collected in a 24-hour period
- b. Individual samples shall be collected for a minimum of one hour each, unless the flow rate is reduced excessively in less than one hour due to plugging of the filter. The number of samples required to provide adequate sampling time can be collected continuously or intermittently.
 - c. To provide adequate samples, each filter used for downwind sampling should contain at least 20 mg. of sample so that accurate weight measurements may be obtained.

Variations in method and procedure which will give equivalent results may be utilized if approved by the Executive Secretary.

C. Standard Procedure and Equipment for High Volume Air Sampling

- 1. Filter Media - Collection media shall be a fiber glass mat (filter) or other suitable media capable of trapping all suspended particulate matter 0.3 micron or larger in size, such as MSA 1106B Flash Fired, Gelman Type A, or equivalent.
- 2. Vacuum Pump- Air shall be drawn through this filter at a rate not to exceed 70 cubic feet per minute (cfm), nor less than 10 cfm. This unit shall have a flow meter or measuring device capable of reading true air flow.¹

¹True air flow-If the flow meter device does not measure true air flow, it must be calibrated against known flows and a correction curve made for these findings.

3. Records

Sampling Data shall include the following:

- a. Starting and ending time and date of sample
- b. Initial flow rate and final flow rate
- c. Location of sampler
- d. Wind direction and velocity
- e. Signature and remarks of person collecting sample
- f. Temperature and atmospheric pressure during sampling period as obtainable from the nearest U. S. Weather Bureau Station

4. Weighing of Filter

Particulate weight collected shall be determined as the final weight of the filter, less the initial weight of filter.

- a. Initial and final weight of the filter shall be determined to the nearest one thousandth of a gram as determined by a standard analytical balance.
- b. Initial and final weight of the filter shall be determined after the filter has been exposed to standard laboratory conditions for a period of not less than 24 hours. (This is necessary to prevent the loss or gain of water vapor entering into the net particulate weight determination.)

5. Volume of Air Sampled

Total volume of air sampled shall be determined as average rate of flow times the period of sampling. (The average rate of flow shall be determined by obtaining the arithmetic average of the initial and ending rates of flow, provided the flow does not decrease by more than one-half during the sampling period; otherwise intermittent flow readings must be taken during the sampling period to compute the arithmetic average.) This shall be expressed as total cubic meters of air sampled.

6. Calculation of Pollutant Concentration

Particulate weight collected (grams) divided by volume of air sampled in cubic meters (M^3) shall be expressed as micrograms per cubic meter ($\mu g/M^3$) of air sampled.

7. Sample Criteria

- a. Samples mutilated or damaged during collection or analysis to an extent that would affect the air flow or determination of particulate matter weight shall be discarded as unuseable.
- b. Samples shall be collected at a height of not less than 3 feet nor greater than 10 feet from ground level.
- c. Sampling surface shall be so placed or shielded so as to collect only suspended particulate matter.
- d. Insects impinged upon the filter shall not be considered suspended particulate matter and shall be removed from the determination of net particulate collected. (If this is impractical, sample shall be discarded.)
- e. Barometric pressure and temperature correction to standard conditions may be made when such is indicated. When such correction is employed, average of hourly barometric pressure and temperatures must be used to determine the necessary corrections. Standard conditions are 14.7 lbs/square inch (29.92 inches or 760 mm of mercury) pressure and air having a density of 0.07495 lbs/cubic foot, temperature 20°C or 68°F.
- f. A constant voltage transformer of adequate capacity in the power system of the air sampler is recommended to prevent voltage fluctuations which may cause variable motor speeds and resultant variable air flow. To insure accurate elapsed time measurement, a timer switch clock may be incorporated

in the circuit.

8. Calculation of total suspended particulate matter

Example:

Air Flow:

- (1) Initial flow meter reading (True) 60 cfm*
- (2) Final flow meter reading (True) 58 cfm
- (3) Arithmetic average $\frac{(1)+(2)}{2} =$

$$\frac{60\text{cfm} + 58\text{cfm}}{2} =$$

59 cfm

- (4) Hour began 1/16/66 0001 hrs*
- (5) Hour complete 1/17/66 0001 hrs

- (6) Elapse time minutes=hrsX60'/hr=
24 hrs X 60'/hr= 1440 '**

- (7) Total ft³ of air sampled =
 (3) X (6)
 = 59 cfm X 1440' = 84960 ft³*

- (8) Total M³ of air sampled = (7)
 $\div 35.314 \text{ ft}^3/\text{M}^3 = 84960 \text{ ft}^3$

$$\therefore 35.314 \text{ M}^3 = 2406 \text{ M}^3 \text{#}$$

Suspended Particulate Matter:

- (9) Filter weight after sampling in gms 4.1090 gms*

- (10) Filter weight before sampling
in gms 4.0090 gms

- (11) TSPM* collected (9) - (10) =
4.1090 gms - 4.0090 gms = 0.1000 gms

- (12) $\mu\text{gms of TSPM (11)} = (11) \times$
 $106 \mu\text{gms/gm} = 0.1000 \text{ gms} \times$
 $106 \mu\text{gms/gm} = 100,000 \mu\text{gm}$

- (13) μgms^* of TSPM per M^3 of air
sampled equal (12) \div (8) =
 $100,000 \mu\text{gms} \div 2406 \cdot \text{M}^3 = 42 \mu\text{gm}/\text{M}^3$

*Explanation of symbols and abbreviations:

cfm - cubic feet/minute

hr or hrs - hour or hours respectively

' - minute or minutes

ft³ - cubic feet

M³ - cubic meters
gm or gms - gram or grams respectively
µgm - micrograms (0.000001 gm)
TSPM - total suspended particulate matter

APPENDIX C

A. Stack Sampling

The amount of particulate matter emitted from a stack shall be measured according to the American Society of Mechanical Engineers "Power Test Codes - PTC - 27" dated 1957 and entitled, "Determining Dust Concentration in a Gas Stream." This publication is hereby made a part of the Regulation by reference. Compliance shall be determined on the basis of not less than two complete determinations within any 24-hour period. Any other method approved by the Executive Secretary may be used in accordance with good professional practice.

B. Calculations of Particulate Matter Concentrations from Stack Samples and Measurements

Maximum allowable stack emission rates or ground level concentrations of suspended particulate matter from measured stack emission rates shall be calculated by Sutton's equation as set forth below. This equation has been modified to provide results comparable to one-hour ambient air samples:

$$Q_a = Z \pi \bar{u} C^2 X^{2-n} 10^{-6} \exp \left[\frac{H_e^2}{C^2 X^{2-n}} \right]$$

where,

Q_a = emission rate, grams per second

Z = ground level concentration, micrograms per cubic meter

π = 3.14

\bar{u} = mean wind speed set at 3.8 meters per second

C^2 = isotropic diffusion coefficient, set at 0.010 for neutral conditions, with dimensions m^n

X = downwind distance from source, meters

n = stability parameter, nondimensional, set at 0.25 for neutral conditions

exp= exponential function, e = 2.72

H_e = effective stack height, meters

If the stack emission contains a significant portion of large particles which fall out within the property, a correction may be made to exclude such portions from the sample weight, with the approval of the Executive Secretary.

Computation of Effective Stack Height

The effective stack height is the physical stack height plus the height that the effluent plume initially rises above the stack owing to the stack draft velocity and/or the buoyancy of the effluent. For a flue gas temperature equal to, or less, than 65° F., the effective stack height is calculated by the following equation:

$$H_e = H = d \left[\frac{V_s}{u} \right] 1.4 \left[1 + \frac{DT}{T_s} \right]$$

where,

H_e = effective stack height, meters

H = height of stack, meters

V_s = stack gas ejection velocity, meters per second

d = internal diameter of stack top, meters

u = wind speed, meters per second (Assume 3.8 meters per second.)

DT = stack gas temperature minus ambient air temperature, °K. (Assume ambient air temperature is 293 °K.)

T_s = stack gas temperature, °K

For a flue gas greater than 65° F, the effective stack height is calculated by the following equation:

$$H_e = H + \frac{(1.5 V_s d + 4.09 \times 10^{-5} Q_h)}{u}$$

where,

H_e = effective stack height, meters

H = stack height, meters

V_s = stack gas ejection velocity, meters per second

u = wind speed, meters per second (Assume 3.8 meters per second unless other acceptable meteorological data are available for the stack locality.)

d = internal diameter of stack top, meters

Q_h = heat emission rate of stack gas relative to ambient atmosphere, calories per second

$$Q_h = Q_m C_{ps} DT$$

where,

Q_m = mass emission rate of stack gas, grams per second

C_{ps} = specific heat of stack gas at constant pressure, calories per gram per °K.

$DT = T_s - T$

T_s = temperature of stack gas at stack top, °K

T = temperature of ambient atmosphere, °K
(Assume ambient atmospheric temperature is 293 °K.)

The attached graphs have been plotted from Sutton's equation, as modified above, using the following data:

$u = 3.8$ meters per second mean wind speed

$C^2 = 0.010 \text{ Mn}$

$n = 0.25$

$Z = 100$ micrograms per cubic meter for Type A Land Use

$Z = 125$ micrograms per cubic meter for Type B Land Use

$Z = 150$ micrograms per cubic meter for Type C Land Use

$Z = 175$ micrograms per cubic meter for Type D Land Use

$H_e = 33, 66, 131, 197, 262, 328, 394, 459, 525$ and 591 feet

$X = 1000$ to 70,000 feet

This graph shows the solution only for the region where Q_a increases with X . The region where Q_a decreases with X has been replaced by a vertical line.

The allowable emission rate for particulate matter shall be determined as follows:

1. Determine effective stack height for the source in question and select the proper curve on the graph.
2. Determine the distance from the property line or the affected area to the stack, and locate on the left-hand vertical scale. Read across at this point on the scale to the previously selected curve for effective stack height.
3. Then read down to the corresponding point on the horizontal scale to determine the allowable emission rate for the land use type of the affected area.

C. Multiple Stacks

For a property containing more than one stack, calculations shall be made from the modified Sutton's Equation for each stack and the addi-

tive effect for the stack emissions on the affected area determined. The owner of a multi-stack property may elect to use a computer program to calculate the additive effect of his multiple stack sources on adjacent properties, provided he provides the Executive Secretary a duplicate of the computer program and obtains the approval of Executive Secretary of the program.

APPENDIX D

COST CHECKLIST

Please complete the following by listing both the low and high dollar cost incurred as correlated to the cost variables listed below. If accurate cost figures are unavailable, please show estimated dollar cost figures for each.

IMMEDIATE COSTS

	<u>Low</u>	<u>High</u>
Attorney fees (prior to and following litigation)	\$ _____	\$ _____
Monetary Penalty (fines).	\$ _____	\$ _____
Public Relations Costs.	\$ _____	\$ _____
Testing Costs (air samples).	\$ _____	\$ _____
Consultants Costs (determine feasibility).	\$ _____	\$ _____

*Note--Variables 4 and 5 can in some cases be combined; please segment if possible.

EQUIPMENT ACQUISITION COSTS

Equipment Costs.	\$ _____	\$ _____
Equipment Installation Costs.	\$ _____	\$ _____
Man-hour Planning Costs.	\$ _____	\$ _____
Consultant Costs (equipment).	\$ _____	\$ _____

EQUIPMENT OPERATING COSTS

Power, Fuel, & Water Costs.	\$ _____	\$ _____
Replacement Parts & Materials Costs.	\$ _____	\$ _____
Maintenance Costs (labor).	\$ _____	\$ _____
Disposal of Collected Wastes Costs.	\$ _____	\$ _____
Clean-up Costs (approaches & access roads)	\$ _____	\$ _____

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