The Problem of Fugitive Dust in the Highway Construction Industry

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The passage of the Clean Air Act in December 1963 and the amendments to it in 1965 have provided the necessary impetus to focus public attention toward the matter of community air pollution. In light of this new awareness, the increased research efforts being expended, and the appearance of many new state and local codes and regulations, the problem of community air pollution is rapidly becoming both a legal and a public relations problem for the highway contractor and his materials suppliers. This paper highlights the current trends and developments in this field and abstracts the results of a 3-yr research program conducted by the National Crushed Stone Association relative to the development of an adequate dust monitoring system designed to provide the crushed stone producer with information concerning the dust pollution situation surrounding his operations. It is proposed that this system may be applicable to other segments of the highway construction industry as well.

•THE passage of the Clean Air Act in December 1963 and its amendments in 1965 served to focus public attention on the matter of air pollution. The bill also put "teeth" in the Federal Government's drive for clean air. By providing the funds to finance needed research and technical assistance through the Public Health Service to train competent personnel, the Clean Air Act is rapidly paving the way for the various states and municipalities to strengthen their air pollution control boards and to establish air quality standards.

As a result of increased newspaper, radio, and television presentations of the perils of polluted air, the general public is demanding remedial action. Many large urban areas now include in their daily weather reports an "air pollution index" which presumably is an integrated measure of the relative concentrations of selected contaminants. This increased publicity has aroused and created a public less willing to tolerate conditions previously accepted without complaint. The following excerpt from The Wall Street Journal (Nov. 10, 1965) is an example of such publicity:

> The annual damage air pollution does to crops, buildings, equipment, and other property is estimated at $11 billion—without even calculating the health hazards. Pollutants such as sulfur dioxide and suspended particles can aggravate asthma and other chronic respiratory diseases, and in large enough concentrations can even cause death.

Industry is the natural target of the initial efforts to purify the air. A plant stack emitting large quantities of dense smoke, obnoxious odors, or injurious fumes is the prime target. However, airborne dust is also an air pollutant, although not toxic,

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certainly nuisance enough to warrant control. This is where the highway construction industry, in all its phases from the quarrying of rock and manufacturing of the cement to the removal of the last truck from the construction site, is affected by air pollution control measures. Quarrying and processing stone, batching bituminous or portland cement paving mixtures, cutting and sculpturing the grade, scarifying the subgrade and in general the moving and hauling of equipment and supplies are dusty operations. There are many sources of escapable dust associated with a normal highway construction job. Unfortunately, one cannot put a hood over the tops of these operations and channel the dust to common-collector equipped outlets. Many plant-type operations have some form of dust collecting equipment functioning at the more troublesome points, and dust control, through the use of water or "dust laying" chemicals is becoming more prevalent at construction sites. Despite these efforts, complaints about dust have probably increased during the past two or three years.

Dust and dust pollution problems are not new items of concern in the highway construction industry. In the absence of specific codes or regulations, the tendency was to convince the public of the temporary nature of the situation and the impracticability of exercising adequate control over such transient operations. This course of action was often viewed as an alternative to meeting and dealing with the dust pollution problem directly. The air the average individual breathes is now viewed as an irreplaceable natural resource which must be protected from increasing pollution, whether permanent or temporary. Action is being taken to control emission into the atmosphere of all known pollutants. Airborne dust is considered a primary air contaminant and it may be well to examine some standards relative to its control recently imposed in certain areas of the country.

EXAMPLES OF CONTROL REGULATIONS

Before considering some existing dust control regulations, the general definitions applied to airborne dust should be thoroughly understood. Airborne dusts are generally separated into two broad categories: settled dusts and suspended dusts. Settled dusts are the coarser, heavier particles which settle rapidly and contribute to the dusting and soiling of property. Suspended dusts are the smaller, lighter particles which can be transported considerable distances by the air stream; they can be inhaled and affect atmospheric visibility. Air quality standards may be written about either or both types of dust. Settled dusts are generally measured in terms of tons per square mile per month or per year, simply by locating a suitable container to collect the settled material over a given period of time. Suspended dust concentrations are measured in terms of micrograms of dust per cubic meter ($\mu g/m^3$) of air sampled and require much more refined sampling equipment.

In October 1964, New Jersey added a new chapter to its Air Pollution Control Code designed to control the emissions of both coarse and fine solid particles from industrial processes (1). While it is true that the control limits imposed are related to particulate emissions from individual plant stacks, the values chosen may serve to indicate the control authorities' thinking with respect to pollutant concentrations.

The settled dust originating from any one given stack is limited to 200 tons per square mile per year when measured off the premises of the emitter. This value of 200 tons per square mile per year was derived from the examination of dustfall data which indicated that such a concentration represented a reasonably clean environment. The dustfall criteria are related to permissible stack emissions in the present code by considering such items as stack height, distance from the stack to the nearest property line, wind velocity, and particle free-fall velocity.

The same chapter of the New Jersey Code limits the concentration, during normal weather conditions, of suspended dusts to 615 $\mu g/m^3$ when measured off the premises of the emitter. This value compared with values obtained from outdoor air samples ranging from 50 $\mu g/m^3$ in rural areas to 1000 $\mu g/m^3$ in cities and up to 5000 $\mu g/m^3$ in heavy industrial areas. Like the settled dust criteria, the suspended dust concentrations measured off the premises of the emitter are related back to the permissible stack emissions through the use of such factors as the average wind speed, stack height, and the ratio of the vertical and horizontal diffusion (taken as 0.63).

Of somewhat more specific interest to the highway construction industry is part of the Florida Air Pollution Code. The Florida State Board of Health conducted a suspended dust survey (2) relative to portable asphalt plant operations and developed guides currently incorporated in the State Sanitary Code defining the permissible concentrations of fine particulate matter in areas adjacent to the operation. The results indicated that a buffer zone with a one-mile radius would provide adequate protection from unduly high concentrations of suspended dust. A concentration of 100 $\mu g/m^3$ was chosen as the limiting value, as this was the usual concentration found in Florida urban areas and any value greater than this is considered by the State Board of Health indicative of a "dirty atmosphere." Permanent asphalt batching plants are exempt from the buffer zone and suspended dust concept but are required to control their discharge to 0.3 grains of particulate emission per cubic foot of dry gas (68 F, 1 atm). The limiting of the weight of particulate emission per cubic foot of stack gas (or per hour of operation, etc.) is a third way in which control standards have been written. It is the oldest method and the most empirical from the standpoint of community air quality.

Of even greater interest and somewhat more direct concern to the heavy construction industry in general is the recent addition to the Pennsylvania Air Pollution Control Act (3) designed to control the emission of "fugitive dust." This document, Regulation IV (To Control Local Air Pollution From Sources of Particulate or Gaseous Matter Emissions) released in March 1966 defines fugitive dust as "solid air-borne particulate matter emitted at or near ground level from any source other than a flue." Regulation IV in its Section 1.3 on Limits for Particulate Matter Emissions sets forth the criteria applicable to fugitive dusts. These criteria are reproduced here as they are the first, to our knowledge, establishing quantitative limits applicable to fugitive dusts. Under the Pennsylvania Code, a local air pollution problem shall be deemed to exist "if any person causes, suffers, allows or permits fugitive dust to be emitted into the outdoor atmosphere from any air contamination source in such a manner that the ground level concentration of fugitive dust from the air contamination source at any point outside the person's property exceeds a concentration of 2.0 milligrams per cubic meter of air above background concentration, for any 10 minute period." Compliance is judged by taking companion samples, one upwind (taken as the background level) and one downwind of the alleged source, with a portable electrostatic precipitator. A control code such as this might readily be applied to a highway construction site, the prime contractor being deemed the responsible party and the limits of the right-of-way the point of compliance.

The foregoing descriptions are illustrative of the forms dust pollution control standards and codes may take. Most standards in current use generally apply to specific pollution sources and not to the control of dust emanating from such multiple source areas as crushed stone quarries or highway construction sites. Pennsylvania's Regulation IV represents the first real effort to control the emission of fugitive dust. In other areas, fugitive dusts are viewed simply as nuisances; however, legal definitions of a nuisance do exist. Even in the absence of specific codes or regulations, simple complaints about fugitive dust, if left unanswered, may be resolved in the courts. The funds are available and the research is being conducted in some areas to develop ambient air quality standards. The day of the controlled quality atmosphere is in the making and the problem of community air pollution, fugitive dust pollution in particular, is rapidly becoming both a legal and a public relations problem to those industries either directly or indirectly involved in highway construction.

AMBIENT AIR QUALITY STANDARDS

The terms "ambient air quality standard" and "ambient air quality objective" have been introduced. It might be advisable to examine the meaning of these expressions and to cite an example of how ambient air quality standards or objectives might be employed.

The New York State Air Pollution Control Board (4, 5) has issued ambient air quality objectives which find their statutory authority in New York Public Health Law #1271 and #1276. Quoting the New York Control Board, ambient air quality objectives are

defined as describing "a level of air quality designed to protect people from the adverse effects of air pollution; and they are intended further to promote maximum comfort, and enjoyment and use of property consistent with the economic and social well-being of the community." Ambient air quality standards, then, would be the specific regulations imposed to accomplish the desired objective.

The New York Board has recognized that it would be impossible and impractical to demand uniform standards for all areas of the state. They have, therefore, devised a scheme composed of four different "regional objectives," each one subdivided into subregions based on normal land uses (agricultural, single and two family residences, commercial, industrial, etc.). Each subregion under each regional objective will have separate and distinct ambient air quality standards or regulations. The regulations governing each subregion, theoretically, will attempt to balance the cost of obtaining the desired level of air quality with the benefits attained from a health as well as an economic and aesthetic standpoint. Supposedly, as technology improves and the cost of providing cleaner air is reduced, the regional objective and hence the ambient air quality standards governing a given subregion will be tightened. The community air pollution problem and the control requirements necessary are being viewed in New York as a series of progressive and continuing efforts. The present ambient air quality objectives, now being put into effect, will limit both the concentrations of suspended and settleable particulate matter or dust. Under such a system it is conceivable that a highway contractor might be subjected to varying control standards, depending on the subregional and regional objectives relative to the construction site.

What Can the Contractor and Materials Supplier Do?

With the enforcement of air quality regulations, regardless of which form they take, highway contractors and materials suppliers must be familiar with the contribution their operations make to the overall local air pollution problem. From both a legal and a community relations standpoint the producer of pollutants must be aware of and ready to act on causes of complaint. With more knowledge of the situation surrounding their operations, the operators will be able to assess the impact of proposed regulations and effectively participate in the development of fair and adequate control standards.

The National Crushed Stone Association, anticipating the current trends and developments in the field of community air pollution and recognizing the crushed stone industry as a potential polluter of local atmospheres, began working in this area about four years ago. The engineering staff has developed an automatic monitoring system which, when properly designed and located, is capable of providing a permanent and continuous record of particulate concentration about a given plant area. The system is intended to function as a means to provide the records necessary to investigate and validate any complaints, and also to serve as a means for policing the operation to insure compliance with any existing or proposed codes or regulations. Development work was conducted during the period August 1964 to September 1965 with the aid of an NCSA member company. Admittedly, the present system will probably be refined and improved with time; however, in its present state it does function and does provide the desired information.

NCSA's Airborne Dust Monitoring System

The airborne dust monitoring system involves measuring both settled and suspended dusts in areas immediately surrounding a crushed stone operation. Basically, it is designed to determine compliance with dust regulations similar to those mentioned previously. Before initiating such a system it is necessary to develop reliable information as to local wind speeds and direction. Member companies faced with a potential dust pollution problem have been encouraged to install a suitable windscope and to keep records of measurements taken during operating hours. Information of this type is the first step toward a thorough understanding of local dust movements and is often in itself a powerful tool in combatting specific complaints.

Monitoring is accomplished by locating throughout the area surrounding the operations a series of "dustfall buckets" which collect dust settlement during 30-day periods. The results are usually recorded and reported in terms of tons per square mile per

Figure 1. Typical dustfall bucket.

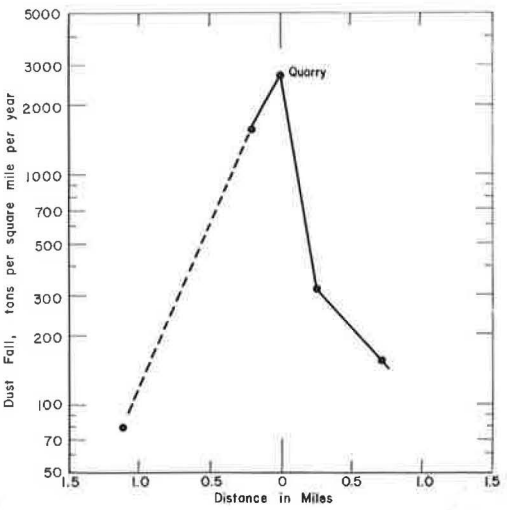

Figure 2. Northwest-southeast dustfall profile across study area.

month. Figure 1 shows one of these dustfall buckets; it is nothing more than an ordinary plastic waste basket. Figure 2 shows typical dustfall data taken across a line traversing the quarry property and indicates how rapidly the heavier settleable dusts deposit themselves. In the case illustrated, over 90 percent was dropped within a half mile of the source.

The high-volume and the papertape methods for measuring suspended particulates also have a place in the NCSA monitoring system.

The high-volume technique which gives results directly in micrograms of dust per cubic meter of air sampled is the method usually cited in control codes. It has the disadvantage, however, of requiring an individual's attention to change filters and recycle the unit, making it unsuitable as an automatic monitoring tool. The device (Fig. 3) is basically a vacuum cleaner with an indicating dial to record the air flow rate and a filter paper to trap the dust. The determination of dust content is a simple gravimetric measurement.

The tape sampler (Fig. 4) is essentially a small vacuum pump which draws air through a filter paper tape. The tape effectively removes the suspended dust from the

Figure 3. High-volume sampler.

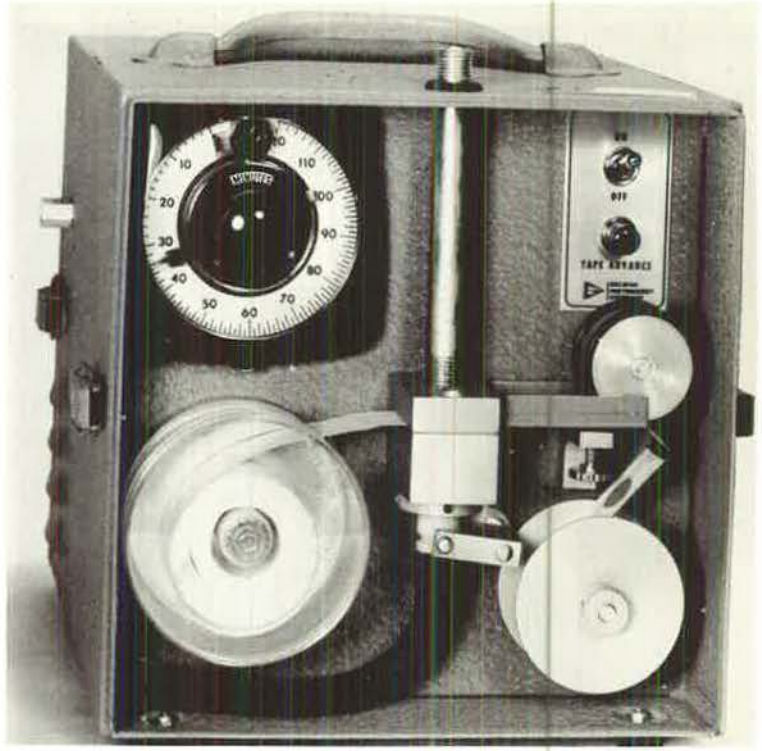

Figure 4. Automatic tape sampler.

Figure 5. Papertape analyzing unit (densitometer).

air stream leaving a spot on the paper. The sampler can be preset to sample for a given period and then recycle itself automatically. This feature is unique to the tape sampler and is the feature around which the suspended dust portion of the NCSA monitoring system is developed. The paper tape spots are analyzed photoelectrically and reported in semiquantitative units based on the principle of light reflectance. The device used for this determination is called a densitometer (Fig. 5).

The assumption made and the principle proved by the NCSA studies were that the semiquantitative results obtained using the automatic tape sampler could be satisfactorily correlated with the standard quantitative measurements made using the high-volume technique. This correlation enables the crushed stone producer to monitor his operations automatically with a minimum of human attention. The records produced may be used to (a) police the dust emissions from the quarry area, either as a matter of record or for compliance with a specific code or regulation; (b) establish the validity of any complaints received; and (c) form the basis for a sound defense in the event of litigation. Technical details concerning the monitoring system and its development were previously presented (6). However, it should be emphasized that it is still necessary to correlate the high-volume and papertape techniques at each sample site.

Such a monitoring system would be equally applicable for other permanent-type installations. Modifications of the basic concepts might be made to accommodate other situations in the highway construction industry. The approach is felt to be sound and the investment involved amply justified by the knowledge developed and the protection afforded.

From a practical standpoint it might be well to consider the cost of initiating a similar program. The capital outlay is relatively small; the required equipment and its approximate cost (about $750) is given in Table 1. There are more elaborate automatic tape samplers which incorporate the sampler and analyzer into one unit.

TABLE 1

APPROXIMATE INITIAL COST OF MONITORING SYSTEM

Item	No.	Cost
Automatic tape sampler	1	$345.00
Tape analyzing unit	1	175.00
Windscope with desk indicator	1	90.00
Dustfall buckets (6 at $1.00)	6	6.00
Metal frames for buckets	6	30.00[a]
Papertape filters	–[b]	12.50
Construction of enclosure[c]	–	50.00[a]
Filtering equipment	–	30.00
Filter papers	–[d]	6.00
Total		$744.50

[a]Estimated cost.
[b]Supply for operating 3 to 4 months.
[c]Includes electricity to tape sampler.
[d]Supply for 16 months.

Results are recorded on a strip chart. Samplers can also be equipped with a built-in alarm circuit which functions whenever contamination exceeds the established operating level. These units cost from $1100 to $1200, approximately, and increase the total cost by about $600. Continuing operating expenses are limited to the cost of filter paper and filter tape, with approximately 30 man-hours of time per month for tending the equipment and keeping records.

SUMMARY

It is necessary for industries producing contaminants to become familiar with the circumstances surrounding their operations. Airborne dust is viewed as a primary air contaminant and building highways, from production of the raw materials to grading of the finished road, is a dusty operation. This paper has attempted to summarize some of the current codes and regulations and to emphasize the need for awareness on the part of industry. The NCSA's airborne dust monitoring system was reviewed as an example of what has been accomplished by one segment of the highway-oriented industry. This monitoring system may be directly applicable to other situations in the construction industry.

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