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AND
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U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
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Research Triangle Park, North Carolina

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Introduction and Purpose

This paper has been prepared to define the differences between, and discuss pertinent facts concerning two separate, but in some cases, strikingly similar air pollution problems, i.e., fugitive emissions and fugitive dust emissions. Fugitive emissions include both gaseous and particulate emissions that result from industrial related operations and which escape to the atmosphere through windows, doors, vents, etc., but not through a primary exhaust system, such as a stack, flue or control system. Fugitive emissions may result from metallurgical furnace operations, materials handling, transfer and storage operations, and other industrial processes where emissions escape to the atmosphere. Fugitive dust emissions, on the other hand, are generally related to natural or man-associated dusts (particulate only) that become airborne due to the forces of wind, man's activity, or both. Fugitive dust emissions may include windblown particulate matter from unpaved dirt roads, tilled farm lands, exposed surface areas at construction sites, etc. Natural dusts that become airborne during dust storms are also included as fugitive dusts.

The above terms are defined as used in the context of this report. The reader is advised, however, that there are no universally accepted definitions to characterize and differentiate between the two separate "fugitive" emission categories. In fact, some use the terms interchangeably, and others include all fugitive sources in a single definition.

It should be noted that the EPA has recently identified a number of Air Quality Control Regions (AQCR's) that probably may not attain national primary particulate matter standards due to fugitive dust emissions. It has been found that windblown dusts from tilled farm lands, unpaved roads, and construction sites, as well as windblown natural particulate emissions from arid lands (desert) during dust storms and other meteorological conditions cause ambient concentrations above national particulate matter standards, particularly in the Western and Southwestern States. Fugitive emissions from industrial sources may also contribute to non-attainment of national standards in some industrial areas. At this time, however, fugitive industrial emissions have not been fully evaluated as a general cause of elevated levels of pollutants and especially of non-attainment of national ambient air quality standards.

Fugitive Emissions (Industrial)

Fugitive emissions are generated during various industrial, manufacturing and/or materials crushing, grinding, transfer or storage operations. Fugitive emissions generally escape to the atmosphere at various points, such as through windows, doors, roof ventilators, etc., but not through a primary exhaust system, such as a stack, flue, or a control device. In other cases, fugitive emissions are more directly emitted to the atmosphere from those industrial processes that operate out-of-doors, such as coke ovens and rock-crushing operations at quarries. Fugitive emissions also result from poor maintenance of process equipment and from environmentally careless process operations. For example, fugitive emissions can result in leakage from oven doors at coke ovens because such doors cannot be properly sealed due to excessive warpage. Further, some operators may begin process operations that will result in fugitive emissions without the proper placement of available moveable hoods and vents over the process area, because the time required to properly align such equipment may cause production schedules to lag.

Emissions which escape from the processes are termed "fugitive" because of the difficulties associated with their capture, which in many cases require innovative and unique equipment design. Once captured, fugitive emissions can be ducted to available emission control systems, such as baghouses for particulates and scrubbers for gaseous pollutants, where they can be effectively collected. Because fugitive emissions are relatively dilute (when compared to emissions ducted to the primary stack), more energy is generally required to process the larger volume of air that results from an effective capture system. In some cases, air from entire buildings which enclose metallurgical furnaces is exhausted to a particulate control device to prevent such materials from becoming airborne.

Crushed Stone

Fugitive emissions may include any pollutant that is emitted from the associated process. For example, particulates are primarily emitted from materials handling operations; particulate matter and carbon monoxide emissions may escape from blast furnaces, while fugitive sulfur dioxide and particulate emissions may be emitted from various process operations at non-ferrous smelters. Fugitive emissions often have a greater effect on air quality in the immediate vicinity of a source than do stack emissions. Stack emissions are released above ground level, often with a significant upward velocity and buoyancy that aids dispersion and dilution, thereby decreasing the impact of pollution on nearby residents. Fugitive emissions, by their very nature, occur at or near ground level and remain there, where the impact on people working and living in the area is greatest. For example, the fugitive particulate emissions from two non-ferrous smelters, which are comprised of very toxic components such as lead and arsenic, have been suspected of causing the noted concentration build-ups of these elements in the soils surrounding the smelters.

Because fugitive emissions may be more "dilute" than stack emissions (i.e., their mass concentration is not as great as stack emissions) does not mean they have an insignificant impact on ambient air quality. While measurements of process and non-process fugitive emissions have proven arduous, a few such estimates have been made that indicate that fugitive emissions may comprise a large portion of nationwide emissions. For example, the Agency has estimated that total fugitive emissions of particulate from electric arc furnace charging can be from 5 to 50 times total emission during the normal operating period of the furnace when fitted with emission controls. Further, a recent technical paper reported that maximum ambient 24-hour particulate measurements observed around three fugitive emission sources in the Pittsburgh area (i.e., a wood products process, a new steel mill, and an old steel mill) were 655 ug/m^3, 447 ug/m^3, and 421 ug/m^3 respectively. Each of these concentrations is well above the 24-hour primary (health) standard for particulate matter (i.e., 260 ug/m^3) and is also above other observed concentrations at background sampling sites in the area of the sources, but which were not directly impacted by the fugitive emissions from such sources.

In addition to their impact on ambient air quality, fugitive emissions must in some cases be controlled to provide for effective regulatory control of total emissions from some sources. In some cases, source operators could circumvent the intent of a regulation designed to minimize the primary (stack) emissions from the source by allowing more than the normal amount of emissions to escape as fugitive emissions. In other words, without a total regulatory approach to minimize both primary and fugitive emissions, a loophole exists in the regulatory scheme that may allow unlimited fugitive emissions to be emitted.

Regulatory Approaches to Control of Fugitive Emission Sources

Generally, it is difficult to quantify emissions from fugitive emissions sources. Because fugitive emissions are not released at a common point, such as a stack, they cannot be easily measured to provide control officials with estimates of the relative magnitude of emissions from such sources. Because of this difficulty, the potential improvement in air quality that may result from control of such sources cannot be estimated. This deficiency has perhaps resulted in a lack of attention given to fugitive emissions sources in the past.

For example, under the air resources management concept of air pollution control, which is the conceptual basis of the State Implementation Planning (SIP) process for the control of existing sources, ambient air quality goals (standards) are established, existing source emissions are quantified and plans (regulations) adopted to reduce emissions from such sources to levels that will achieve ambient goals. During the development of SIP's, States quantified emissions from all sources using the best available information to determine such emissions. Primarily due to the magnitude of stack emissions from poorly controlled sources, (i.e., emissions from stacks of power plants and other industrial sources), but also because of the lack of available emission estimates for fugitive emission sources, few such sources were included in source emission inventories. Hence, the emission control regulations that were ultimately adopted by the State and local air pollution control agency under the SIP's primarily addressed control of non-fugitive emission sources. In other words, the mass emission limitations (i.e., those that limit emissions to "no more than X pounds per hour") adopted by States are not directly applicable to fugitive emission sources. This is because compliance with such regulations can only be determined by measuring the total emissions from the process, generally through a stack. As previously indicated, this is extremely difficult for process sources with fugitive emissions. In cases where fugitive emissions can be measured it is generally too expensive for source operators to rely upon the measurement technique to determine source compliance.

Some States did, however, adopt general regulations to address the fugitive emissions problem. Four general techniques have been used to minimize fugitive emissions, two of which are of limited value. The first involves the general nuisance provision which most pollution control agencies have included within their regulatory scheme. Under the nuisance provisions, emissions from a source are not allowed if they cause any person to suffer health or welfare effects. Nuisance regulations can be useful in some cases when the responsible sources can be specifically identified, and when such source is agreeable to minimize emissions. Generally, comprehensive source emission control programs do not result from action taken under nuisance regulations. The second regulatory approach which also has limited value requires source operations with fugitive emissions to take "reasonable precautions to prevent fugitive emissions from becoming airborne". These regulations are generally difficult to enforce since reasonable precautions are not specifically defined. The difficulties associated with use of this general requirement have lead to the development of the third and more successful regulatory approach for the control of fugitive emissions, i.e., the requirement for the source operator to install, operate and maintain specified equipment to capture and control fugitive emissions from becoming airborne. "Equipment standards", as they are termed, are enforceable and are believed to be effective for the control of fugitive emissions. The fourth regulatory technique used by control agencies is the visible emissions regulation. Such regulations generally do not permit the presence of visible emissions greater than a specified intensity in the atmosphere for more than a few minutes of each hour. In some cases, sources have probably installed fugitive emissions control systems to minimize violation of such visible emissions regulations. In general, the visible emissions approach is enforceable and relatively easy to implement. A regulatory approach which requires the use of specified equipment and which uses visible emissions as an enforcement tool is the recommended control strategy for control of fugitive emissions (particulate) at the present time.

The difficulties States have had in developing fugitive emission control regulations under the SIP process are shared by EPA in developing a control program for some fugitive emission sources affected by New Source Performance Standards (i.e., sources affected by Section 111 of the Clean Air Act). This section of the Act requires the Agency to set forth "a standard of performance" which is defined as a standard for emissions of air pollutants which reflects the degree of emission limitation achievable through the application of the best system (considering cost) of emission reduction. This has been interpreted to mean that the Agency must develop mass emission standards, and does not have the latitude of adopting regulations that solely specify the use of equipment (e.g., ducts, hoods, vents). EPA believes that flexibility is needed to allow the Agency to establish emissions standards and/or equipment requirements depending upon the nature of emissions at the source. For that reason, the Agency has recommended an amendment to the Clean Air Act which, if adopted by the Congress, will provide the necessary legal base for EPA to manage a flexible emission control regulatory program.

An example of the current lack of regulatory flexibility for fugitive emission control is illustrated in relation to the Agency's current investigations of the grain handling industry under the NSPS regulatory process. For this particular industry, dust becomes airborne at various transfer points throughout the terminal as grain is transferred from point of delivery, usually along conveyor belts, to hoppers for cleaning, then to silos for storage where it is kept until shipment. There are no primary stack emissions at a grain terminal, only the dusts that become airborne at the various transfer points. The most reasonable regulatory approach identified by the Agency to minimize emissions for the sources is to require the installation of equipment such as hoods to capture the dusts that become airborne and ducts to channel the captive emissions to emission removal equipment. The regulatory alternative of specifying equipment standards, however, is currently not consistent with the present language of Section 111 of the Act.

Despite the present limitations of the Act, it should be noted that the Agency has implemented a fugitive emission control program for some sources affected by NSPS and has proposed or is developing such controls for other sources. For example, at aluminum plants where it is possible to measure total flouride emissions from the plant, [i.e., both fugitive and primary (stack) emissions], an allowable emission standard for total plant emissions has been proposed. In order to achieve compliance with the emission standard, the source operator must control not only the primary emissions but also the fugitive emissions. In a similar manner, the Agency has effectively regulated fugitive emissions from cement plants, asphalt plants and basic oxygen furnaces. In these cases, the Agency has established an opacity regulation in addition to the emissions standard. While not directly limiting fugitive emissions, the regulatory combination of an emission standard and an opacity regulation indirectly requires these sources to capture and control some fugitive emissions in order to comply with the opacity requirements. In each of these cases, the Agency has developed specific test techniques to assure the enforceability of the promulgated regulations. Similar opacity provisions have been proposed for electric arc furnaces.

In addition, the Agency has set forth fugitive emission controls for sources regulated under Section 112 of the Act, i.e., sources affected by hazardous emission standards. For example, requirements on sources which emit hazardous pollutants, such as mercury and asbestos have been promulgated which generally require the installation of prescribed emission limiting equipment and/or the implementation of certain operating and maintenance practices. Fugitive asbestos emissions are controlled by specifying allowable operating practices, such as the controlled ventilation (filtration) of air within buildings in which the material is used, such as in textile mills. Also, asbestos has now been prohibited from use in building construction as a fire preventative measure, to prevent fugitive asbestos from becoming airborne when buildings are demolished. Fugitive mercury emissions which can be emitted in cell rooms at chlor-alkali plants have been regulated by specifying good housekeeping measures (e.g., daily inspection to detect leaks, etc.). These measures effectively minimize emissions of mercury vapor to the atmosphere.

The Agency has under consideration the control of other fugitive pollutant emissions. For example, the Agency is presently considering fugitive emissions control of vinyl chloride emissions. These can be minimized by requiring the use of "leak-free" pumps, valves and seals at numerous potential emission sources. Control measures under consideration would also require the maintenance of these devices in a leak-free condition and further require periodic monitoring of the premises with leak detectors.

In addition to the development of regulations, the Agency has various investigations underway to identify and quantify the importance of fugitive emissions from numerous sources. For example, studies are in process that will document the impact of fugitive emissions for the iron and steel industry and for copper and lead smelters. Preliminary results from one such investigation indicate that fugitive lead emissions from a lead smelter may be two to three times the process (stack) emissions. As information becomes available, NSPS for such fugitive emissions sources will be considered. It should be noted that existing sources in source categories for which NSPS are promulgated shall be controlled by use of Section 111(d) of the Act. For example, if the Agency promulgates a fugitive lead emission standard for new smelters under NSPS, the existing smelters with fugitive lead emissions shall be controlled according to the provisions of Section 111(d).

While effective action to minimize fugitive emissions has been taken for some sources (and work is underway on others), the Agency believes that the additional flexibility requested by the Administration is needed to allow the Agency to specify equipment standards under the NSPS regulatory process, when needed.

Fugitive Dust (Windblown dust)

For the most part, fugitive dust emissions are found in the Western half of the nation, generally in the more arid areas such as the Southwest, but also where farming operations and unpaved roads are prevalent. Emissions from fugitive dust sources have been known to exist for some time, however no quantifiable estimates of the impact of such sources on air quality were available at the time of State Implementation Plan (SIP) development. Hence many States did not adopt regulations to minimize emissions from such sources. Because some of the SIP's were inadequate to attain national particulate matter standards, EPA conducted an investigation of fugitive dust sources in five AQCR's in the Southwest in the 1972-1973 time period. The results of the study (and additional studies subsequently conducted in other areas of the West) indicated that windblown dust (both natural dust and soil exposed by man, e.g., farms, roads), and dust generated directly by man's activity (e.g., driving on unpaved roads), created high ambient concentrations of particulate matter. For example, approximately 90% of the particulate emissions in the Phoenix AQCR are estimated to result from fugitive dust sources. Measured annual average particulate matter concentrations at some locations in the Phoenix AQCR exceed 200 ug/m^3 compared to a primary standard of 75 ug/m^3.

Control of fugitive dust sources was also explored in the 1972 study. The control strategies determined necessary to attain national standards in each of the five AQCR's generally indicated that unconventional air pollution control techniques were required. Specifically the study indicated that each of the following controls is probably necessary to attain primary standards in these AQCR's.

1. Chemical stabilization (i.e., the addition to the soil of a cohesive chemical compound to bind loose particles from becoming airborne) of a total of 1,160,000 acres of selected farm lands in the San Joaquin Valley, California, Phoenix-Tucson, Arizona, and Dona Ana County, New Mexico, at an approximate cost of $50/acre/application (total yearly cost of $50 million). The cost of this control (which may also cause water pollution and other environmental problems) may equal or exceed that of the cash value of the crop and, therefore, if imposed, would essentially result in the cessation of farming operations in some areas.

2. Implementation of soil management control programs, including such measures as continuous cropping, mulch cover, windbreaks, strip cropping and other soil erosion prevention techniques.

3. Paving of a total of 600 miles at a cost of $15.6 million of more heavily traveled unpaved roads in generally urbanized portions of the 5 AQCR's.

4. Speed control, generally 25 mph on all unpaved roads outside the city limits and 20 mph inside city limits for those areas with high measured particulate matter concentrations. If this control measure proved to be ineffective due to problems of enforceability, additional miles of road paving would be needed.

5. Stabilization or watering of construction sites, material storage piles, tailing piles (smelter) and animal feedlots.

Table 1 lists the specific controls and costs of implementing these controls for each of the individual AQCR's. The costs associated with chemical stabilization only reflect the cost of application of the material, and not the costs associated with possible termination of active farm lands due to the excessive costs of chemical stabilization.

The Agency has not implemented these fugitive dust control strategies for the five AQCR's because they include controls that are considered to be socially disruptive and unreasonable. Further, even with the application of these controls, national standards would probably be violated due to the existence of natural wind-blown dust from dust storms. Also the Act does not allow the Agency to adopt a control strategy that is not adequate to attain national standards (such as a strategy to implement only "reasonable" controls). For these reasons, the Agency has sought an Amendment from the Congress that would provide the Agency with flexibility in dealing with AQCR's with fugitive dust problems. Specifically, the recommended Act amendment seeks additional time (generally 5 years but in some cases up to 10 years) for attainment of the national standards for particulate matter in these areas and would require only the application of reasonable and achievable controls on an as-expeditious-as-practicable basis. Such an amendment would eliminate the requirement of applying unreasonable controls, such as chemical stabilization of farm lands. It is anticipated that reasonable and achievable controls would be determined on an area-by-area basis, depending upon the degree of the problem and the reasonableness of the controls needed to attain national standards.

TABLE 1

Special Study Cost Estimates of Attaining

Particulate Matter Standard in Southwest

State/Region	Measures Necessary to Achieve Primary Standards	Cost
California/ San Joaquin	a. Speed control	$ NEG.
	b. Pave 281 miles road	7,306,000
	c. Soil management[1]	
	d. Chemical stabilization[3,4] (820,400 acres)	32,830,000
	e. Construction control[2]	1,914,000
	f. Materials storage control	65,800
	g. Feedlots control[3]	834,000
Arizona/ Phoenix-Tucson	a. Speed control	$ NEG.
	b. Pave 138 miles road	3,588,000
	c. Soil management	
	d. Chemical stabilization[3,4] (301,700 acres)	15,085,000
	e. Construction control[2]	4,489,000
	f. Tailings control	866,000
New Mexico El Paso	a. Speed control	$ NEG.
	b. Pave 98 miles road	2,548,000
	c. Soil management	
	d. Construction control[2]	130,000
	e. Chemical stabilization[3,4] (40,185 acres)	2,009,250
Northwest Nevada	a. Speed control	$ NEG.
	b. Pave 84 miles road	2,184,000
	c. Tailings control	192,000
Nevada/Nevada	a. Speed control	$ NEG.
	b. Tailings control	375,000

[1]May actually realize some profit if the cover crop can be sold.
[2]Cost would depend upon the amount of current construction per year.
[3]Cost per year.
[4]Does not include cost of possible termination of farming operations due to cost of chemical stabilization.

Summary

This paper has pointed out the various aspects of two similar but indeed different air pollution problems. Both fugitive emissions (industrial) and fugitive dust emissions represent problems affecting attainment of national standards. Both are difficult to quantify so as to determine the relative magnitude of the problem. Both have been generally overlooked in the past in relation to developing an effective and widespread air pollution control program. Both problems will generally require the use of non-conventional air pollution control measures. Both are also becoming the subject of more intensive investigation as more knowledge is being gathered to implicate such emissions as significant air pollution problems.

More specifically, the Agency's Control Systems Laboratory has numerous studies underway to investigate various fugitive emissions and fugitive dust sources. For example, a $1,000,000 four-year investigation of numerous "fugitive" type sources is presently under contract. Such diffuse fugitive sources that will be investigated include combustion sources, organic and inorganic process operations, materials storage, rock crushing, strip mining, grain harvesting and loading, etc. Also, other contract investigations such as those examining the fugitive emissions at the iron and steel industry, iron foundries, copper and lead smelters, are currently being negotiated.

The information collected from these studies will assist this Agency, as well as the State and local agencies in controlling "fugitive" sources of air pollution. The recommended amendments to the Clean Air Act which EPA seeks from the Congress will provide the flexibility to establish an effective control program for fugitive dust and fugitive emission sources.