United States
Environmental Protection
Agency

Air And Radiation
(EN-341)

EPA 340/1-89-007
October 1989

EPA

Inspection Manual For PM-10 Emissions From Paved/ Unpaved Roads And Storage Piles

Inspection Manual for PM-10 Emissions From Paved/ Unpaved Roads and Storage Piles

Final Report

U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Stationary Source Compliance Division (EN-341)
401 M Street, SW
Washington, D.C. 20460

Attn: Mr. Robert Marshall, Jr.

EPA Contract No. 68-02-4463
Work Assignment No. 17
MRI Project No. 8911-L(17)

October 27, 1989

PREFACE

This report was prepared for the U.S. Environmental Protection Agency's Stationary Source Compliance Division under Contract No. 68-02-4463, Work Assignment No. 17. Mr. Robert Marshall, Jr. was the EPA Work Assignment Manager. The work was performed in Midwest Research Institute's Environmental Systems Department (Dr. Chatten Cowherd, Director). The report was prepared by Mr. John Kinsey (Task Leader), Ms. Deann Hecht, and Mr. Frank Pendleton.

Approved for:

MIDWEST RESEARCH INSTITUTE

Chatten Cowherd, Director
Environmental Systems Department

October 27, 1989

CONTENTS

Page

Preface ii
Figures iv
Tables vii

1. Introduction 1-1
   1.1 General overview 1-1
   1.2 Scope and objectives of inspection manual 1-2
2. Inspection Overview 2-1
   2.1 Introduction 2-1
   2.2 Baseline inspections 2-6
   2.3 Typical permit conditions 2-9
   2.4 Record keeping 2-14
   2.5 Sampling and analysis techniques 2-15
   2.6 Equipment preparation 2-16
   2.7 Safety considerations 2-17
   2.8 References for Section 2 2-22
3. Paved Roads 3-1
   3.1 Public paved roads 3-8
   3.2 Industrial paved roads 3-13
   3.3 Regulatory formats and associated inspection procedures 3-17
   3.4 References for Section 3 3-26
4. Unpaved Roads 4-1
   4.1 Emissions estimation 4-1
   4.2 Emission control methods 4-7
   4.3 Regulatory formats and associated inspection procedures 4-9
   4.4 References for Section 4 4-35
5. Storage Piles 5-1
   5.1 Estimation of emissions 5-1
   5.2 Emissions control methods 5-9
   5.3 Regulatory formats and associated inspection procedures 5-14
   5.4 References for Section 5 5-26

Appendices
A. SIP requirements for the control of PM_{10} A-2
B. Overview of clean air act authority for inspectors B-1
C. Inspectors responsibilities, safety procedures, and preparation C-1
D. Summary of state methods for determining visible emissions from open dust sources D-1
E. EPA Reference Method 22 for visual determination of fugitive emissions E-1
F. Material sampling and analysis procedures F-1

FIGURES

Number		Page
3-1	Example facility map with roads divided into road segments.....	3-3
3-2	Sampling data form for paved roads.....	3-5
3-3	Example pneumatic traffic count log.....	3-6
3-4	Example manual traffic count log.....	3-7
3-5	Photo of a vacuum street sweeper.....	3-16
3-6	Example inspection form.....	3-18
3-7	Possible use of "action levels" to trigger paved road controls.....	3-20
3-8	Meteorological data log for example facility X.....	3-24
3-9	Operator's log for example facility X.....	3-25
4-1	Example facility map with roads divided into road segments.....	4-2
4-2	Example pneumatic traffic count log.....	4-5
4-3	Manual traffic count log.....	4-6
4-4	Mean annual number of days with at least 0.01 in of precipittion.....	4-8
4-5	Water truck treating a mine haul road.....	4-10
4-6	Example inspection form.....	4-13
4-7	Procedures for obtaining manual traffic mix and material samples.....	4-14
4-8	Annual evaporation data for the contiguous United States.....	4-17
4-9	Watering control effectiveness for unpaved travel surfaces.....	4-18

FIGURES (continued)

Number		Page
4-10	Example water application log	4-20
4-11	Meteorological data log for example facility X	4-22
4-12	Operator's log for example facility X	4-23
4-13	Watering control effectiveness for unpaved road D in example problem	4-26
4-14	Average PM_{10} control efficiency for chemical suppressants	4-28
4-15	Typical form for recording delivery of chemical dust suppressants	4-30
4-16	Typical form for recording chemical dust suppressant control parameters	4-31
4-17	Example chemical suppressant application log	4-32
4-18	Example completed log	4-33
5-1	Map of example facility X	5-3
5-2	Map of storage piles located within facility X	5-4
5-3	Typical storage pile emission sources	5-5
5-4	Mean wind speed	5-6
5-5	Fastest mile of wind	5-8
5-6	Sample inspection form	5-15
5-7	Operator's log for example facility X	5-18
5-8	Meteorological data for example facility X	5-20
5-9	Operator's log for example facility X	5-25
F-1	Location of incremental sampling sites on an unpaved road	F-2
F-2	Data form for unpaved road sampling	F-4
F-3	Unpaved road sampling	F-5

FIGURES (continued)

Number		Page
F-4	Location of incremental sampling sites on a paved road.....	F-6
F-5	Data form for paved road sampling.....	F-7
F-6	Paved road sampling procedures.....	F-8
F-7	Data form for storage pile sampling.....	F-10
F-8	Sample dividers (riffles).....	F-12
F-9	Coning and quartering.....	F-13
F-10	Example moisture analysis form.....	F-17
F-11	Example silt analysis form.....	F-18

TABLES

Number		Page
2-1	Generic categories of open dust sources	2-2
2-2	Correction parameters for AP-42 emission factor models	2-3
2-3	Fugitive dust reference documents	2-8
2-4	General checklist for conducting an inspection of fugitive sources	2-10
2-5	Recommended inspection and safety equipment	2-16
3-1	Selection of paved road emission factor	3-2
3-2	Summary of silt loadings (sL) for paved urban roadways	3-9
3-3	Paved urban roadway classification	3-9
3-4	Measured efficiency values for paved road controls	3-10
3-5	Estimated PM_{10} emission control efficiencies	3-10
3-6	Nonindustrial paved road dust sources and preventive controls	3-12
3-7	Industrial paved road silt loadings	3-14
4-1	Typical silt content values of surface material on industrial and rural unpaved roads	4-4
4-2	Control techniques for unpaved travel surfaces	4-7
4-3	Chemical stabilizers	4-11
5-1	Typical silt and moisture content values of materials at various industries	5-10
5-2	Threshold friction velocities--Arizona sites	5-11

TABLES (continued

Number		Page
5-3	Threshold friction velocities--industrial aggregates	5-12
5-4	Control techniques for emissions from storage piles	5-12
D-1	Summary of TVEE M1 requirements	D-3
D-2	Summary of Ohio Draft Rule 3745-17-(03)(B)	D-6
F-1	Moisture analysis procedure	F-15
F-2	Silt analysis procedures	F-16

SECTION 1

INTRODUCTION

1.1 GENERAL OVERVIEW

The Clean Air Act (CAA) of 1970 (and amended in 1977). was passed "to protect and enhance the quality of the Nation's air resource so as to promote the "public health and welfare and the productive capacity of its population." More specifically, the CAA provides the U.S. Environmental Protection Agency (EPA) with the broad responsibility and authority to implement a federal program to achieve these goals.

The interstate nature of air pollution caused Congress to charge the EPA with the responsibility of establishing uniform national ambient air quality standards (NAAQS) to assure consistency in protecting public health and welfare. These standards were set for those pollutants which the administrator identified as widespread (emitted by numerous or diverse mobile and stationary sources) and endangering public health and welfare. These so-called "criteria" pollutants come from the fact that the CAA (Section 108) requires the EPA to issue Air Quality Criteria Documents for each pollutant having an ambient air quality standard.

Through July of 1987 the EPA has identified seven criteria pollutants and promulgated national ambient air quality standards for: particulate matter, sulfur oxides, nitrogen oxides, carbon monoxide, hydrocarbons (revoked in January 1983), ozone, and lead. Of interest in this document is the NAAQS for PM_{10} promulgated on July 1, 1987. The NAAQS for PM_{10} specifies a 24 h primary and secondary standard of 150 $\mu g/m^3$ and an annual primary and secondary standard of 50 $\mu g/m^3$ (calculated as an annual arithmetic mean).

To attain and subsequently maintain the NAAQS for PM_{10}, each state is required to adopt and submit to EPA a plan providing for the implementation, maintenance, and enforcement of the standards over the entire state. Each SIP includes a major portion devoted to emission limitations and other regulations and programs to prohibit stationary sources from "emitting any air pollutant in amounts which will prevent attainment with the NAAQS or interfere with measures to prevent significant deterioration of air quality" (see Part C of Title 1 of CAA). Thus, each state directs its control regulations towards its unique set of sources and circumstances as long as the end result will be attainment of the NAAQS in the required time frame. An overview of SIP requirements for the control of PM_{10} is contained in Appendix A.

Collection of compliance-related information is used to determine compliance of sources with applicable regulations, to identify sources which may be in violation, and to provide evidence to support enforcement actions. The primary method of compliance monitoring is the on-site inspection. Under the CAA, authority has been granted to inspectors for the determination of compliance with applicable standards and regulations. This authority, under Section 114 of the CAA, is described briefly in Appendix B.

1.2 SCOPE AND OBJECTIVES OF INSPECTION MANUAL

This manual outlines the basic procedures necessary to complete an informative and accurate air compliance inspection for sources of fugitive PM_{10}. In addition, it addresses other topics relevant to the on-site inspection and compliance monitoring including the selection of sources for inspection, record keeping and reporting reviews, inspection safety, and technical inspection procedures. The role of opacity measurements is also briefly addressed. However, record keeping is primarily emphasized. An overview of the inspector's general responsibilities, safety, and preparations is provided in Appendix C with more detailed information on specific sources contained in subsequent sections.

The information in this inspection guide is based, in part, on a previous EPA document, "Control of Open Fugitive Dust Sources," EPA 450/3-88-008. Information useful to the inspector may also be found in that document. It provides examples for computing both controlled and uncontrolled PM_{10} emissions, potential regulatory formats, and additional information on various control techniques.

SECTION 2

INSPECTION OVERVIEW

2.1 INTRODUCTION

This section provides an overview of the key elements that together constitute a set of inspection procedures for fugitive sources. First, an introduction to fugitive dust sources, emissions, and controls is presented. The section then discusses baseline inspections, typical permit conditions for roads and storage piles, applicable record-keeping procedures, and sampling and analysis methods for aggregate materials. Finally, field equipment and on-site health and safety considerations are addressed.

2.1.1 Fugitive Dust Sources

Sources of fugitive particulate emissions may be separated into two broad categories--process sources and open dust sources. Process sources of fugitive emissions are those associated with industrial operations that alter the chemical or physical characteristics of a feed material. Open dust sources are those that entail generation of fugitive emissions of solid particles by the forces of wind or machinery acting on exposed materials. Only open dust sources are discussed in this document.

The partially enclosed storage and transfer of materials to or from a process operation do not fit well into either of the two categories of fugitive particulate emissions defined above. Examples are partially enclosed conveyor transfer stations and front-end loaders operating within buildings. Nonetheless, partially enclosed materials handling operations will be classified in this manual as open sources.

Open dust sources include both industrial sources of particulate emissions associated with the transport, storage, and transfer of raw, intermediate, and waste aggregate materials, as well as nonindustrial sources such as unpaved roads and parking lots, paved streets and highways, heavy construction activities, building demolition, and agricultural tilling. Generic categories of open dust sources are listed in Table 2-1.

There is a wide variety of industrial facilities that contain fugitive PM_{10} sources. Examples of industrial operations which could be evaluated by an inspector include asphalt plants, cement plants, mines and processing facilities, concrete ready-mix plants, power plants, quarries and rock products plants, slag processing plants, steel mills, transfer terminals, building demolition, and landfills.

TABLE 2-1. GENERIC CATEGORIES OF OPEN DUST SOURCES

1. Unpaved Travel Surfaces
   - Roads
   - Parking lots and staging areas
   - Storage piles

2. Paved Travel Surfaces
   - Streets and highways
   - Parking lots and staging areas

3. Exposed Areas (wind erosion)
   - Storage piles
   - Bare ground areas

4. Materials Handling and Storage
   - Batch drop (dumping)
   - Continuous drop (conveyor transfer, stacking)
   - Pushing (dozing, grading, scraping)

5. Building Demolition

6. Transfer Terminals
   - Ship loading and unloading
   - Rail facilities

Although the types of sources found in industrial and urban settings are generally similar (e.g., an unpaved road found in sand and gravel plant and an unpaved city street), the quantity of emissions generated and the type(s) of control applied may be quite different. Therefore, the inspector is cautioned to evaluate each source on an individual basis.

2.1.2 Particulate Emission Factor Models

In developing particulate control strategies for "traditional" pollutant concerns (i.e., to meet National Ambient Air Quality Standards [NAAQS]), particulate emissions from open sources are estimated using the predictive emission factors presented in Section 11.2 of EPA's "Compilation of Air Pollutant Emissions Factors" (AP-42).[1] Further details on these emission factors can be found in the EPA document entitled, "Control of Open Fugitive Dust Sources," EPA 450/3-88-008. These factors cover the generic source categories:

- Unpaved travel surfaces
- Paved travel surfaces

- Exposed areas (wind erosion)
- Materials handling

These emission factors share many common features. For example, the models are formulated as empirical expressions that relate variations in emission factor (e) to differences in the physical properties (p) of the material being disturbed and the mechanical energy (m) responsible for the generation of particulate according to the general form:

$$e = Kp^a m^b \tag{2-1}$$

As empirical models, open dust source factors have adjustable coefficients (K,a,b) that reflect relationships determined from actual open dust source testing. Table 2-2 provides the correction parameters used in the emission factor models published in AP-42 for the above open dust sources.

TABLE 2-2. CORRECTION PARAMETERS FOR AP-42 EMISSION FACTOR MODELS[a]

Source category	Model parameter	Units of measure
Unpaved roads	Silt content of a surface material	Weight %
	Mean vehicle speed	km/h (mph)
	Mean vehicle weight	Mg or 10^6 g (tons)
	Mean No. of wheels	Dimensionless
	No. of wet days per year	Dimensionless
Paved roads	Silt content of a surface material	Weight %
	Total surface dust loading	kg/km^2 (lb/mi^2)
Exposed areas	No. of disturbances per year	Dimensionless
	Erosion potential	g/m^2
Materials handling	Mean wind speed	m/s (mph)
	Material moisture content	Weight %

[a] From Reference 1.

2.1.3 Preventive and Mitigative Control Options

Typically, there are several options for control of fugitive particulate emissions from any given source. This is clear from the mathematical equation used to calculate the emissions rate:

$$R = A\ e\ (1 - c) \tag{2-2}$$

where: R = estimated mass emission rate
A = source extent (i.e., surface area for most open dust sources)
e = uncontrolled emission factor, i.e., mass of uncontrolled emissions per unit of source extent
c = fractional efficiency of control

To begin with, because the uncontrolled emission rate is the product of the source extent and uncontrolled emission factor, a reduction in either of these two variables produces a proportional reduction in the uncontrolled emission rate.

Although the reduction of source extent results in a highly predictable reduction in the uncontrolled emission rate, such an approach in effect usually requires a change in the process operation. Frequently, reduction in the extent of one source may necessitate the increase in the extent of another, as in the shifting of vehicle traffic from an unpaved road to a paved road.

In the case of open sources, the reduction in the uncontrolled emission factor may be achieved by adjusted work practices. The degree of the possible reduction of the uncontrolled emission factor can be estimated from the known dependence of the factor on source conditions that are subject to alteration. For open sources, this information is embodied in the predictive emission factor equations for fugitive dust sources as presented in Section 11.2 of EPA's "Compilation of Air Pollutant Emission Factors" (AP-42).[1]

Control techniques can be divided into two broad categories--preventive and mitigative. Although differences between the two are not always clear, in general, preventive measures involve techniques that reduce source extent or improve mechanical source operations relative to the generation of particulate emissions. By contrast, mitigative techniques typically focus on altering the surface/material conditions that constitute the source of particulate emissions.

The reduction of source extent and adjusted work practices which reduce the amount of exposed dust-producing material are preventive techniques for control of fugitive dust emissions. This would include, for example, the elimination of mud/dirt carryout onto paved roads at construction and demolition sites.

On the other hand, mitigative measures involve the periodic removal of dust-producing material. Examples of mitigative measures include cleanup of spillage on travel surfaces (paved and unpaved) and cleanup of material spillage at conveyor transfer points.

Most of the mitigative control measures for open sources involve periodic rather than continuous control application. Familiar examples are the watering of unpaved travel surfaces and the cleaning of paved travel surfaces. The resultant control efficiency follows a cyclic pattern, decaying in time from the highest value immediately after application. Because of the finite durability of these control techniques, ranging from hours to months, it is essential to relate an average efficiency value to a frequency of application. It must be emphasized that the rate of control efficiency decay is heavily dependent upon the source and control variables discussed in Sections 3, 4 and 5.

2.1.4 Compliance Determination

There are three general compliance formats that are potentially suited to open dust sources. These are:

a. opacity (visible emissions) readings;

b. evaluation of control program records--record keeping; and

c. "indirect" determination(s) of control performance.

These formats are described briefly below.

As a compliance tool, the determination of visible emissions (VE) has a long history of application to stationary sources. VE readings appear appealing as a compliance tool for open dust sources; in fact, two states (Tennessee and Ohio) as well as EPA have promulgated VE methods for open dust sources. A summary of the state methods is presented in Appendix D with EPA Reference Method 22 provided in Appendix E.

Record keeping offers another, easily used compliance tool for fugitive PM_{10} controls. As the name implies, record keeping involves the routine collection and recording of appropriate control application parameters (especially for periodically applied measures) by the source operator for the permitted sources at the facility. These application parameters are generally specified as part of a formal dust control plan and are critical to achieving a certain level of control performance. The level of detail needed for record keeping purposes varies with the control option employed. Record keeping, together with on-site inspections, as required, will allow the regulator to estimate performance of a dust control program.

While record keeping affords a convenient method of assessing long-term control performance, it is important that regulatory personnel have "spot-check" compliance tools at their disposal. For example, permit conditions could be written specifying a minimum surface moisture content (thus, corresponding to a minimum control efficiency) to be maintained on an unpaved

surface which is watered or treated with surfactants or salts. Inspection personnel would then collect grab samples for moisture analysis to determine compliance following the procedures discussed later in this section. This technique is referred to as an "indirect" performance standard which is enforced in lieu of actual source testing.

2.2 BASELINE INSPECTIONS

The purpose of this section is to describe the Baseline Inspection Technique and illustrate how it should be applied to the common types of fugitive dust sources. The Baseline Technique is an approach which inspectors can use to obtain relevant data in an organized fashion. These procedures are organized into four categories that roughly correspond to increasing levels of effort. The inspection procedures have been developed to ensure that the data obtained are as accurate and complete as possible. The procedures outlined should be used by field personnel unless technical or safety considerations at a specific site demand modified approaches. In such a case the reasons for the deviation from the standard procedures should be briefly described in the inspection report.

2.2.1 Inspection Categories

It would be desirable to conduct detailed engineering-oriented inspections at all sources, however, this is obviously impractical due to the large number of sources inspected regularly by EPA, state, and local regulatory personnel. Therefore, inspection categories have been incorporated into the overall inspection program to give agencies the opportunity to properly allocate limited resources. The most complete and time-consuming evaluations are performed only when preliminary information indicates the potential for a significant emission problem.

Inspection categories are designated as Levels 1 through 4 with the intensity of the evaluation increasing from one to another. The types of activities normally associated with each level and the experience necessary to conduct the different types of inspections vary substantially. The four categories are:

- Level 1 inspection is a field surveillance tool intended to provide relatively frequent, but very incomplete indications of source performance. No entry to the plant grounds is usually necessary, and the inspection is never announced in advance. The inspector makes observations on all sources which are visible from the plant boundary and which can be properly observed, given prevailing meteorological conditions. To the extent possible, general plant operations are observed to determine whether they correspond to permit requirements.

- Level 2 inspection is a limited "walk-through" evaluation of the source and its control(s). Entry to the facility is necessary. Therefore, appropriate administrative inspection procedures (Appendix C) should be followed. The inspection can be performed

either in a concurrent (i.e., with the process flow) or countercurrent fashion depending on the anticipated types of problems. In either case the inspection data gathered is limited to that which can be provided by readily available existing information.

- Level 3 inspection includes a detailed evaluation of individual emission sources, types of control techniques employed, source operation, and identification of potential problem areas. Source material analyses may be reviewed and samples obtained for later evaluation. Control techniques and application parameters would also be identified for further engineering analysis. Sufficient data and documentation is also obtained on-site to ascertain if control procedures are being followed as specified by permit or regulatory requirements.

- Level 4 inspection involves the observation of a source test(s) or evaluation of an on-site air quality monitoring program specifically intended to measure control performance. This is a very specialized inspection and should be conducted with full knowledge of the source/control specifications being evaluated. This type of inspection is performed explicitly for the purpose of determining compliance with permit conditions, regulations, and/or site-specific dust control plans.

An important part of the level 3 inspection is the preparation of general material flow charts and site plans. It is recommended that these be prepared in accordance with the guidelines presented in Reference 2. As a starting point, the inspector should request a map of those portions of the plant of interest. Specific flow charts should be prepared so that all of the important information concerning material flow streams, traffic flow and volumes, and locations of all stationary equipment and material storage areas are clearly shown. These charts then are used to perform the on-site inspection.

2.2.2 Assembling Background Information

The inspector's knowledge of the source(s) and the associated controls at a facility plays an important part in the success of an inspection, particularly in the diagnosis of control problems. It is, therefore, highly recommended that the inspector build his or her own and/or an agency technical library of books, reports, guideline documents, and other publications related to the inspection process. This should include materials addressing specific dust-emitting sources, operation and maintenance of all types of controls, and specific inspection procedures for various types of controls and dust sources.

To assist in assembling background information, Table 2-3 provides a list of useful references involving the control of fugitive dust and PM_{10}. Although this list is not all-encompassing, these documents should definitely be available to regulatory personnel prior to making an inspection of an unfamiliar facility or source.

TABLE 2-3. FUGITIVE DUST REFERENCE DOCUMENTS

U.S. Environmental Protection Agency. 1988. Compilation of Air Pollutant Emission Factors, AP-42. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina.

Grelinger, M. A. 1988. Gap Filling PM_{10} Emission Factors for Selected Open Area Dust Sources. EPA-450/4-88-003, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina.

Cowherd, C., G. E. Muleski, and J. S. Kinsey. 1988. Control of Open Fugitive Dust Sources. EPA-450/3-88-008. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina. September.

Cowherd, C., Jr., and J. S. Kinsey. 1986. Identification, Assessment and Control of Fugitive Particulate Emissions. EPA-600/8-86-023, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina.

U.S. Environmental Protection Agency. 1982. Control Techniques for Particulate Emissions From Stationary Sources--Volumes 1 and 2. EPA-450/3-81-005a and b, Emission Standards and Engineering Division, Research Triangle Park, North Carolina. September.

Ohio Environmental Protection Agency. 1980. Reasonably Available Control Measures for Fugitive Dust Sources. Columbus, Ohio. September.

Guidelines for Development of Control Strategies in Areas With Fugitive Dust Problems. 1977. OAQPS No. 1.2-071. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina. October.

Climatic Atlas of the United States. 1968. U.S. Department of Commerce, Washington, D.C. June.

2.2.3 General Inspection Procedures

Although fugitive dust control measures are generally implicit in federal air quality regulations, the regulations generally do not explicitly include readily enforceable standards of performance. However, a number of states have (as part of their State Implementation Plans [SIPs] for PM_{10}) developed and adopted rules to control fugitive dust emissions. These rules are enforceable by either state, local, or federal air pollution control officials. Clearly, a portion of a general air compliance inspection should be devoted to identifying potential sources of fugitive dust emissions and the collection of data indicative of a source's compliance status with regard to applicable permit conditions and regulations.

As is the case for other types of emission sources, the inspector should be familiar with potential sources of fugitive PM_{10} at the plant and applicable state/local/federal regulations and permit requirements. Preentry evaluation from outside the plant (i.e., level 1 inspection) is particularly important in regard to fugitive sources. During this evaluation, the inspector should identify and note any visible fugitive emissions at or near plant boundaries and their source(s); conditions around feed, product, and/or waste storage piles; and any other obvious sources of fugitive emissions. Notations of any visible emissions and photographs should be taken at this time, as appropriate.

The portion of the fugitive emissions inspection which is conducted within the plant boundaries (level 2, 3, and 4 inspections) generally consist of four phases:

1. Visual inspection of the facility in order to observe fugitive sources and controls (including photographs to document).

2. Examination of the source's control equipment.

3. Observations of any spraying or other dust control operations undertaken by source during the inspector's visit.

4. Examination of the source's records relating to the controls used.

A general checklist similar to that shown in Table 2-4 should be used as a reminder of key information to be collected by the inspector during a level 2 evaluation. This list should be refined according to the specific goals of the inspection during subsequent visits and can be arranged in chart formats, if desired. Also, the compliance formats described below should be incorporated into the inspection, as applicable.

2.3 TYPICAL PERMIT CONDITIONS

Specific conditions placed on an air permit for open dust sources depend to a large extent on the type of source being permitted as well as the statute and regulations under which the permit is issued. Also, permit conditions will depend on whether the permit is included in revisions to a State Implementation Plan, which are subsequently enforceable by EPA personnel.

TABLE 2-4. GENERAL CHECKLIST FOR CONDUCTING AN INSPECTION OF FUGITIVE SOURCES

Name of facility: _____

Address: _____

Type of facility or SIC code: _____

VISUAL INSPECTION

1. Are all points listed in current permit/control plan still existent?

   _____

2. Are there additional points that are not noted in the files? If so, please note each new point. _____

   _____

   _____

3. For each source, note the type of control being applied (reference to map or plot plan and/or process diagram).

   Source ID: _____
   Type of material processed: _____
   Type of control: _____

   Source ID: _____
   Type of material processed: _____
   Type of control: _____

   Source ID: _____
   Type of material processed: _____
   Type of control: _____

(continued)

TABLE 2-4 (continued)

Source ID: _____

Type of material processed: _____

Type of control: _____

Source ID: _____

Type of material processed: _____

Type of control: _____

4. Does control equipment and/or control measure(s) match the information in the current permit file? If not, specify. _____

_____

5. Does control equipment appear to be well maintained? If not, note that equipment which does not. _____

_____

6. Is there evidence that the source can and does make repairs to control equipment? Specify. _____

_____

_____

INFORMATION FROM SOURCE FILES

1. Does the source have the current permit (and emissions control plan, if applicable) on file and available for inspection? _____

2. Is source operator aware of applicable regulations, permit conditions, and/or control plan specifications under which operation is permitted? _____

(continued)

TABLE 2-4 (continued)

3. Has a regular staff member been assigned to implementation of the control plan? _____

4. Does a budget exist for implementation of the control plan? _____

5. Are permanent facility records being kept in accordance with permit or control plan? _____ If not, what are the deficiencies? _____

_____

_____

6. Is ambient air monitoring being conducted near the facility? _____
How is the monitoring equipment cited relative to fugitive sources?

_____

7. The person to contact regarding fugitive emissions control at facility is: _____ Telephone No.: _____

INSPECTOR'S NAME: _____ DATE OF INSPECTION: _____
TIME OF INSPECTION: _____ REINSPECTION DATE: _____

Because of the wide diversity in permit systems, it is difficult to present "typical permit conditions which apply to all types of generic open dust sources. Therefore, in this section, example conditions will be presented as a guide to the inspector as they may appear on an air permit for a fugitive dust source.

In general, permits for open sources are issued either in response to ambient air quality violations (e.g., sources in nonattainment areas) or, where air quality meets applicable standards, are directed to aesthetic, nuisance, or similar considerations. Where ambient air violations are present, the dust control strategy implemented by the source operator must be very specific. Control application parameters must be rigorously adhered to in order to achieve overall reductions in PM_{10} emissions and thus expected improvements in ambient air quality in the area where the plant is located. A formal schedule and methods of application must be established for each source and control method applied; this is especially true for periodically applied controls used on sources such as paved and unpaved roads.

As mentioned in Section 2.1.4, compliance with a permit condition can be determined either by record keeping or some type of indirect performance standard based on sampling and analysis of the sources material. An example permit condition for sources in areas with air quality problems using record keeping as a measure of compliance might be:

> "Within 90 days of issuance of this permit, the plant operator will submit to the Department a fugitive dust control plan for the following sources . . . . This plan shall include sufficient information to determine the control technique to be used for each emission source, the application parameters for these controls, and the expected level of reduction achieved. Within thirty days after plan submittal, the Director will notify the permittee of plan acceptance of, if found unacceptable, any deficiencies to be corrected. Revisions to the dust control plan shall then be submitted to the Department within 30 days following plan rejection. Appropriate plant records will be kept and submitted to the Department on a monthly basis to verify compliance with the dust control plan."

For sources where indirect measures are used to determine compliance, a permit condition similar to the following might be appropriate:

> "Within 90 days of issuance of this permit, the plant operator will submit to the Department a dust control plan for the following sources . . . . This plan shall include sufficient information to determine the type of control used for each source, the applicable control application parameters, and specific performance goals for each source/control combination. Control performance goals shall be specified in the plan in terms of key source material characteristics (e.g., moisture content) which can be verified by on-site sampling and subsequent laboratory analysis . . . ."

For permits issued for aesthetic, nuisance, or similar considerations where air quality is not a problem, a dust control plan should also be submitted by the source operator. However, in this particular case, some amount of discretion is usually allowed to maintain the dust emissions leaving the site to within some allowable limit. This type of permit is much harder for the inspector to enforce but, if properly handled, can result in adequate dust control. Again, periodically applied controls should be formalized to the extent possible.

For areas where air quality is not an immediate concern, the following could appear on an operating permit for an open dust source:

> "Within 90 days of issuance of this permit, the plant operator will submit the to Department a dust control plan for the following sources . . . . The control measures included in this plan shall be sufficient to preclude dust emissions from leaving the site as determined visually by Department personnel. If, upon inspection, the dust control plan is determined to be inadequate, a revised control plan will be submitted to the Department within 30 days of the inspection . . . ."

Many variations of the above are also possible depending on the statute and regulations in force at the time the permit is issued.

2.4 RECORD KEEPING

As stated previously, record keeping is one alternative method to determine compliance in lieu of an actual performance standard. To implement this technique, records of site activity and control should be submitted to the regulatory agency on a monthly basis. These records must be certified by a responsible party as to their accuracy and completeness. All site records should be maintained by the agency on a permanent basis.

To enforce the permit conditions and/or dust control plan, field audits of key control parameters should be made by inspection personnel. The results of these audits would then be compared to site records submitted to the agency for that period to determine compliance. If differences are found between application of the control(s) observed on-site and those recorded by facility operating personnel, this would constitute a violation and would be grounds for enforcement action. To illustrate this process, an abbreviated example will be given as applied to a typical building demolition project.

Assume a large demolition project consisting of the demolishing of a block of buildings is to be conducted in a large metropolitan area. The site dust control plan calls for watering of all truck routes to and from the active demolition every 2 h as well as cleanup of mud/dirt carryout from the access point on a twice-daily basis. Also, watering of debris during demolition and loadout to haul trucks is to be conducted on days without measurable rainfall. An agency inspector observes the site activity from the public street (Level 1 inspection) for a period of 3 h. During this period no water truck is observed to be in operation, and debris are not watered prior to loading into trucks.

At the end of the month the inspector checks the submittal from the site operators and finds start and stop times for the water truck operator which indicates operation during the observation period. The inspector also notes that the water cannon used for debris control was broken down and was in a repair shop. It is clear from this analysis that the operator is in violation of the dust control plan for watering of unpaved surfaces. Because the truck operator did not follow required dust suppression measures (and/or failed to keep accurate records) an enforcement action could be taken against the site operator.

As noted by the above example, no quantitative data are required for enforcement of the dust control plan. This reduces the need for a set performance standard (e.g., opacity limits) against which the site operator is evaluated. This approach is, however, predicated on the fact that strict implementation of the dust control plan will achieve certain reductions in PM_{10} emissions associated with site operation.

In order to implement record keeping of site control activity, general guidelines are provided in Sections 3, 4, and 5 for paved roads, unpaved roads, and storage piles, respectively. These guidelines include only basic information and should be modified, as necessary, according to the source being monitored. Other information pertaining to control performance determination as related to record keeping is provided in Reference 3.

2.5 SAMPLING AND ANALYSIS TECHNIQUES

Sampling and analysis of source material (i.e., road surface and aggregate materials) can be useful for a number of purposes. First, material characteristics are generally required to calculate uncontrolled PM_{10} emissions for most open dust sources and, in some cases, are used to estimate or verify control effectiveness. For the inspector, material sampling can be used as an indirect measure of control performance as explained previously in Section 2.1.4.

In general sampling of road surface material involves the collection of a composite sample from each road segment being analyzed. For paved roads, this entails collection of samples across the width of the travel lane using a portable, stick-type vacuum cleaner equipped with tared collection bags. In the case of unpaved roads, a whisk broom and dust pan is used in a similar fashion. Details of these techniques are discussed in Appendix F.

For the sampling of aggregate materials, incremental samples are collected from the top, middle, and bottom of storage piles or from the process flow itself. A relatively large gross sample is collected in this manner which is subsequently reduced to laboratory sample which is analyzed. This technique is further described in Appendix F.

Finally, moisture content is determined in the laboratory by drying each sample in a laboratory oven with the silt content determined by dry sieving to obtain the fraction passing a 200 mesh (70 μmP) screen. Details of both techniques as well as special preparation procedures for paved road samples are provided in Appendix F.

2.6 EQUIPMENT PREPARATION

Part of the preinspection preparation involves obtaining and preparing inspection and safety equipment. The type of equipment may vary according to the inspection objectives; the level of inspection; and the process, control equipment, and safety requirements at the facility itself. A general list of recommended equipment is provided in Table 2-5.

All equipment should be checked, calibrated, and tested before use. The inspector is responsible for seeing that all equipment necessary to conduct an inspection is brought to the inspection site.

Safety equipment required for a facility is based on plant health and safety requirements. Safety requirements must be met, not only for safety reasons, but to ensure that the inspector is not denied entry to the facility or parts of it.

TABLE 2-5. RECOMMENDED INSPECTION AND SAFETY EQUIPMENT

Equipment necessary for most inspections	Equipment required for certain inspections
Hard hat	Respirator with appropriate cartridge(s)
Safety glasses or goggles	Air velocity meter
Gloves	Shovel or scoop
Coveralls	Broom-type vacuum sweeper
Safety shoes	Tared vacuum bags and premarked envelopes
Ear protectors	Dustpan and broom
Tape measure	Riffle
Flashlight	Bucket
Stopwatch	Sample containers (polyethylene trash bags and/or screw-top jars)
Duct tape	Self-contained breathing equipment
"NIOSH/OSHA Pocket Guide to Chemical Hazards"	Rope
Rain gear	

As previously stated, Table 2-5 shows a listing of standard inspection and safety equipment for air compliance inspections. It is recommended that those items necessary for the majority of inspections (level 2) be carried in a portable case or tool belt pouch from emission point to emission point. The appropriate items from the list of "Equipment Required for Certain Inspections" (levels 3 and 4 and certain safety equipment not normally required) should be added to the equipment carried or placed in a central location at the plant or in the inspector's car to be retrieved if needed.

Before or after equipment preparation, the inspector must also consider what written materials, forms, documents, etc., he/she will require during the inspection. These should also be gathered and organized before the inspection. These materials may include any or all of the following:

- Maps
- Flow charts
- Plant layout
- Applicable regulations
- Inspection checklists
- Field notebook
- Field observation data recording forms (e.g., Method 22 data sheets)
- Reference materials
- Inspection plan or agenda
- Credentials
- Facility information
- Baseline data
- Information requested by facility

2.7 SAFETY CONSIDERATIONS

The performance of any field inspection always involves a certain degree of risk. It is the objective of this section to describe means of minimizing this risk through adherence to safety procedures. Procedures are presented for most common health and safety problems encountered during the evaluation of fugitive sources and controls. The official EPA Health and Safety Policy can be found in Reference 2.

2.7.1 General Considerations

The inspection of any plant, industrial facility, mine, etc., inherently involves a large number of potential health and safety problems which occur frequently. Therefore, the inspector must be constantly alert so as to avoid potentially hazardous situations.

Inhalation hazards are often created by leaks of pollutant laden gases out of worn expansion joints, cracked welds, and corroded shells of process equipment. The sudden downdraft from nearby stacks and vents can also lead to acute exposures. The partially confined areas can allow high concentrations of toxic material to accumulate even when the leak rates are comparatively small. Most of the high pollutant concentrations occur by accident and without the knowledge of plant personnel. The highly variable conditions make any exposure monitoring data highly questionable. These problems complicate the selection of the proper respirator for these conditions.

The elevated and isolated locations of many types of process equipment also increases the safety risk. It may be necessary to climb permanent or portable ladders to reach the equipment. In some cases, the equipment can only be reached by crossing roofs or elevated walkways. Since these portions of the plant are not regular work areas, even the plant personnel may not be aware of some of the potential problems involved with the ladders and roof areas. Frequently cables, hoses, and debris are found along the elevated

platforms and roofs since plant maintenance personnel do not remove this material. Injuries which occur in these portions of the plant can be very serious. Rescue of injured personnel is difficult and time consuming due again to the isolated and elevated locations of control equipment.

Due to the numerous potential hazards, it is very important that each inspector adhere to established safety policies and procedures. It is also necessary that the inspector recognize unusual and extreme conditions which warrant additional or extreme safety precautions.

To minimize the risk of potential hazards, each inspector should follow the general rules summarized below:

1. The work should be halted immediately when the inspector suffers any nonspecific symptoms of exposure. The area should be approached again only after the proper personal protective equipment has been obtained.

2. The work should be conducted at a controlled pace.

3. If the work cannot be accomplished safely, it should be postponed until the appropriate steps are taken to permit safe inspection.

4. Nothing should be done which risks the health and safety of the inspector, plant personnel, or which risks the conditions of plant equipment.

5. All agency and plant safety requirements must be satisfied at all times.

2.7.2 Specific Safety and Health Procedures

2.7.2.1 General Safety Procedures--

The following general procedures should be adhered to while conducting an inspection:

1. Personal Protective Equipment--Inspectors should bring personal protective equipment necessary to conduct the inspection of the facility. All personal protective equipment should be in good working order and the inspector using it should be trained in its use and limitations.

2. Unaccompanied Inspections--The inspector should request that a responsible plant representative accompany him at all times. The plant representative can identify areas known to be unsafe and can warn the inspector about intermittent plant operations which can result in health and safety risks.

3. Warning Codes and Sirens--The inspector should learn the warning codes and sirens used at the plant to indicate blasting or emergencies such as plant fires, etc. The inspector and plant representative should move to a safe location as rapidly as possible after hearing the warning sirens and report in to the appropriate authorities so that no attempt is made to "rescue" them from the affected area.

4. Personnel Rescue--If an inspector observes another individual who has suffered an accident, help must be summoned immediately. Attempting to rescue the person can jeopardize the rescuer unless the proper procedures are used. Rescue should be attempted only if the proper equipment is available to ensure the safety of the rescuer.

5. Inclement Weather Conditions--Except in the case of public health emergencies, field activities should be interrupted or postponed whenever severe weather conditions present a significant safety risk to the inspector. The specific criteria for interrupting or postponing the field activities should be determined by each office. As a general guideline, work should be delayed whenever: the ambient temperature is less than -20°F (wind chill); the ambient temperature is greater than 100°F; the wind speed is greater than 25 mph; and/or whenever there are sleet and freezing rain conditions.

2.7.2.2 Walking and Climbing Hazards--

Inspectors should wear hard hats at all facilities being inspected. These hats provide protection against collision with overhead beams and protruding obstacles and also provide limited protection against falling objects. Inspectors should also wear safety shoes approved for the specific type of facility being inspected and gloves whenever the inspection will involve climbing of ladders or handling of hot surfaces.

Portions of the facility with potentially slippery surfaces should be avoided to the extent possible. Inspectors should not use temporary "walkways" such as planks and horizontal ladders. Also, before walking on elevated catwalks, the inspector should confirm, to the extent possible, that the supports are intact and have not corroded or rotted.

Accumulations of solids and snow can easily exceed the rated load bearing capacity of roofs. Also, portions of the roof can be made of materials with only a limited load bearing capability. For the above reasons, all roofs and other elevated, horizontal surfaces should be approached cautiously. It is recommended that inspectors follow plant personnel in such areas and that they remain on defined walkways.

In climbing any ladder, the foot rungs should be grasped while climbing even when the rungs are wet or muddy. Under no circumstances should an inspector attempt to climb a ladder covered with ice or snow. Both hands must always be free for climbing ladders.

Portable and fixed ladders in good physical condition should be used. Portable ladders should be inclined on an angle to minimize the chances of slippage or toppling and must extent above the surface being reached by a minimum of 3 ft. The cage (if present) must have an opening ranging from 18 to 24 in at the top. The cage should not be severely distorted since this would prevent easy movement inside. The ladder must have at least 9-in clearance between it and where it is attached to allow secure placement of the feet on the rungs and should extent at least 3 ft above the platform or surface being reached. Finally, guard rails should never be used for climbing.

While walking through the plant, inspectors must be alert for protruding obstacles. Often these are difficult to spot in dimly lit portions of plants. Loose clothing should not be worn when conducting an inspection since this can result in entrapment in rotating equipment. Inspectors must be cautious when in the vicinity of all rotating equipment since it is often impossible to see the components moving at high speed. Equipment which operates intermittently, such as hoists, should never be touched since this equipment often starts automatically and without warning.

Inspectors should stay at least 75 ft from stationary rail cars at sidings since these are sometimes coupled to remote-controlled engines run by an operator without a complete view of the siding areas. Inspectors should also not stand on coal piles and other material stockpiles since it is possible to become entrapped in the conveying equipment which is often underneath these piles.

2.7.2.3 Eye and Hearing Protection--

Because of the possibility of hazardous chemicals or gases, contact lenses should not be used during the inspection. Instead, inspection personnel should use prescription safety glasses with side shields while performing field activities. Splash goggles should be used in addition to the safety glasses whenever there is potential exposure to acid mist and/or liquid chemicals.

Inspectors should use hearing protection whenever required by plant policies and whenever it is difficult to hear another person talking in a normal tone of voice at a distance of 2 ft. To the extent possible, time spent in areas of the plant with high noise levels should be minimized.

2.7.2.4 Electrical Hazards--

The inspector should not use line powered equipment or instrumentation not served by an approved ground fault interrupter. Prior to inspecting any facility, the inspector must ask responsible plant personnel to identify any high voltage cables in the area to be inspected. It is important to find any lines which could be inadvertently touched while walking through the plant.

2.7.2.5 Explosions--

Inspectors should never take battery-powered, portable equipment such as nonexplosion-proof flashlights, etc., into portions of the plant where there are potentially explosive dusts and/or vapors. The equipment can be a source of ignition. Also, smoking materials, including but not limited to matches and lighters, should never be taken into any facility. Many areas of plants visited by inspectors can have explosive dusts and vapors. Finally, the inspection should be terminated immediately whenever a severely vibrating fan is encountered. When a fan disintegrates, shrapnel can be sent over a large area resulting in very serious injuries. Plant personnel should be notified immediately if this problem is detected.

2.7.2.6 Burns--

The areas immediately around hot ducts should be avoided to the extent possible. Also, uninsulated hot roofs should be avoided to the extent possible. In cases where such is required, the proper foot wear must be

worn. When climbing up to potentially hot roofs, gloves should be worn and the roof should not be touched.

2.7.2.7 Inhalation Hazards--

To the extent possible, inspectors should avoid areas which allow the accumulation of airborne pollutants. The appropriate respirators should be selected in accordance with the procedures discussed during safety training provided by the regulatory agency. Furthermore, the respirator must not be worn whenever any condition would prevent a good seal. The most common reason for an improperly fitted respirator is facial hair. The protection factor limits of each respirator must be understood and used only for the specific contaminants listed and only for the concentration range listed. Since monitoring data is rarely available, the inspector must exercise some judgment when selecting the appropriate respirator. Selection of the type of respirator should never be done by smell or taste perception since some of the most toxic pollutants cannot be detected at high concentrations.

Inspectors should use only a self-contained breathing apparatus or an air line respirator when entering areas believed to be oxygen deficient. Each individual using respirator protection must be trained in its proper fitting, use, maintenance, and storage.

The respirator must be inspected before and after each use (disposable respirators excluded). Equipment used only for emergencies will be inspected at least monthly. A record should be kept by date with the results of all inspections. All respirators must be cleaned and disinfected after each use. All filters and cartridges must be replaced whenever necessary. Replacement of other than disposable parts and any repair should be done only by personnel with adequate training and test equipment to ensure the equipment will function properly after the work is accomplished. Only certified parts supplied by the manufacturer for the product being repaired shall be used. The respirators should be stored in atmospheres that will protect them from dust, sunlight, extreme heat or cold, and damaging chemicals.

Individualized eyeglasses mounted to the face piece of full face mask respirators should be used whenever such respirators are necessary for the field duties assigned. Also, contact lenses should not be worn while wearing respirators. Inspectors with perforated ear drums or who have not demonstrated, by means of regular physical examination, that they are capable of withstanding the additional physical stress imposed by respirators, should not wear respirators. Since respirators are necessary for field activities, such individuals should not perform field duties. Finally, inspectors should not chew gum or tobacco while wearing a respirator.

2.7.2.8 Heat Stress--

Each inspector working in moderate and hot climates should drink copious amounts of water and carry drinking water in the vehicle used. The inspection should be interrupted immediately whenever an inspector experiences the symptoms of heat exhaustion including but not limited to fatigue, nausea, vomiting, headache, dizziness, clammy skin, and rapid pulse. The affected individual should rest in a cool place which is not less than 75°F and seek medical care as soon as possible. Continuing the field activities during the onset of

heat exhaustion can lead to heat stroke, a very serious condition requiring immediate medical help. Also, the inspection should be interrupted immediately whenever an inspector experiences heat cramps. The affected individual should find a cool place to rest and drink water containing 0.1% by weight salt (1 teaspoon per 5 quarts of water).

2.7.2.9 Cold Stress--

Field inspectors should avoid portions of the plant exposed to high wind conditions or wet areas when the ambient temperature is low. Clothing for inspections conducted during cold weather must be selected to provide the appropriate degree of protection and to reduce the chances of excessive perspiration accumulation. Clothing should generally be layered to trap heat and to provide the flexibility to adjust to both outside and inside conditions while conducting the inspection. Steel-tipped shoes should not be worn whenever the ambient temperature is low. All shoes worn must be watertight.

2.7.2.10 Skin Absorbable Chemicals--

Inspection personnel should consult published reference materials concerning the selection and use of protective clothing (including gloves) whenever working with or near chemicals which are readily adsorbed by the skin. A partial list of such chemicals is provided in the OSHA Pocket Guide to Occupational Hazards. Inspectors should also exercise extreme caution when sampling liquids containing skin absorbable chemicals. Under no circumstances should the employee allow direct contact between such liquids and the skin (e.g., hands and arms) while acquiring a sample.

2.8 REFERENCES FOR SECTION 2

1. U.S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, AP-42, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1988.

2. Segall, R. R., et al. Air Compliance Inspection Manual. EPA-340/1-85-020. U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1985.

3. Cowherd, C., G. E. Muleski, and J. S. Kinsey. Control of Open Fugitive Dust Sources. EPA-450/3-88-008, U.S. Environmental Protection Agency, Research Triangle Park, NC. September 1988.

SECTION 3

PAVED ROADS

Particulate emissions occur whenever a vehicle travels over a paved surface, such as public and industrial roads and parking lots. These emissions may originate from material previously deposited on the travel surface, or resuspension of material from tires and undercarriages. In general, emissions arise primarily from the surface material loading (measured as mass of material per unit area), and that loading is in turn replenished by other sources (e.g., pavement wear, deposition of material from vehicles, deposition from other nearby sources, carryout from surrounding unpaved areas, and litter). EPA's *Compilation of Air Pollutant Emission Factors* (AP-42) indicates that the PM_{10} emission factors for paved roads may be written in the general form:

$$e = A \left(\frac{sL}{B}\right)^{C} \tag{3-1}$$

where A, B, and C are constants and

e = PM_{10} emission factor, mass/vehicle/length
s = fractional surface silt content, dimensionless
L = total surface loading, mass/area

The product sL represents the mass of material less than 200 mesh per unit area of the road travel surface and is usually termed the "silt loading."

Selection of the appropriate emission factor model (i.e., the constants A, B, and C) for a given road depends upon:

- The value of the silt loading (sL)
- The average weight of the vehicles traveling on the road

Table 3-1 describes the selection process for paved road emission factors. Note that, for purposes of preparing an emissions inventory, this equation would be applied to each road segment in a facility. A road segment is the distance between two intersections. Figure 3-1 shows an example facility with each road divided into road segments and assigned an arbitrary identification.

TABLE 3-1. SELECTION OF PAVED ROAD EMISSION FACTOR

Silt loading (sL)		Range weight (W)		Applicable PM_{10} emission factor	
g/m^2	oz/yd^2	Mg	Ton	g/VKT[a]	lb/VMT[a]
sL < 2	< 0.06	W > 4	> 4.4	$220\ (sL/12)^{0.3}$[b]	$0.78\ (sL/0.35)^{0.3}$[b]
sL < 2	< 0.06	W < 4	< 4.4	$2.28\ (sL/0.5)^{0.8}$[c]	$0.0081\ (sL/0.015)^{0.8}$[c]
sL > 2[d]	> 0.06	W > 6	> 6.6	$220\ (sL/12)^{0.3}$[b]	$0.78\ (sL/0.35)^{0.3}$[b]
2 < sL < 15	0.06 < sL < 0.44	W < 6	< 6.6	$220\ (sL/12)^{0.3}$[b]	$0.78\ (sL/0.35)^{0.3}$[b]
sL > 15[d]	> 0.44	W < 6	< 6.6	93	0.33

[a]VKT = Vehicle kilometers traveled, VMT = vehicle miles traveled.

[b]Commonly referred to as the "industrial" paved road model.[3]

[c]Commonly referred to as the "urban" paved road model.[3]

[d]For heavily loaded surfaces [i.e., sL > ~ 300 to 400 g/m^2 (9 to 12 oz/yd^2)], it is recommended that the resulting estimate be compared to that from the unpaved road models (Section 4.1.1 of this manual), and the smaller of the two values used.

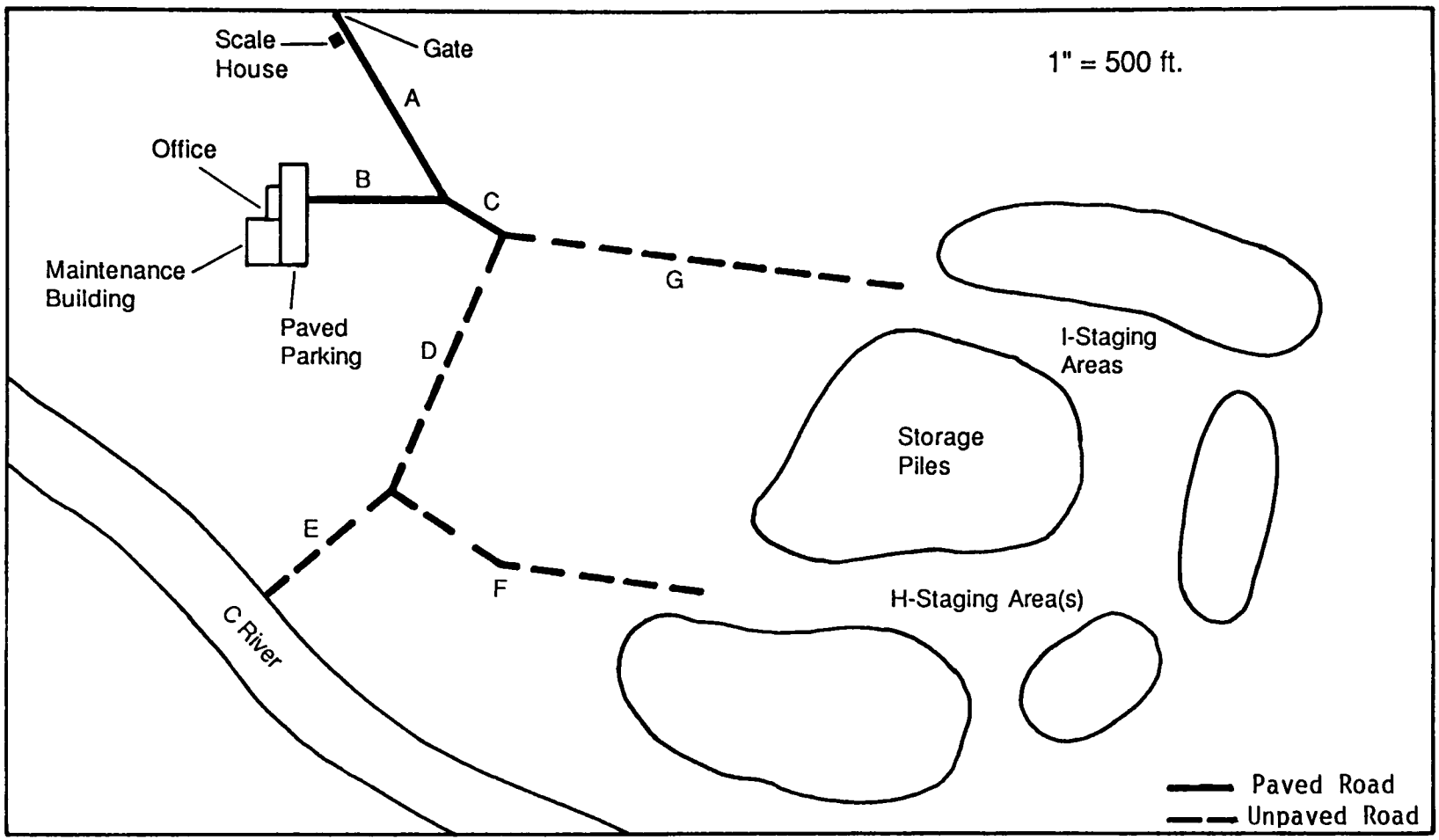


Figure 3-1. Example facility map with roads divided into road segments.

The emission rate is determined by multiplying the emission factor of each road segment by the total vehicle mileage on the segment over the averaging time of interest. Totaling the individual emission rates for each road segment will provide an uncontrolled emission rate for all unpaved roads in the facility.

Surface silt content (s) is the fraction of material smaller than 75 μm in diameter. L is the total dust loading and the product sL represents the mass of silt-size dust particles per unit area of the road surface. As is the case for all predictive models in AP-42, the use of site-specific values of sL is strongly recommended. The silt loading should be determined using the sampling techniques and laboratory analysis procedures described in Appendix F. Figure 3-2 is an example of a sampling data form for paved roads.

Vehicle-related parameters should be obtained using a combination of counting devices, manual or automated records, and information from plant personnel. Pneumatic tube axle counters can be used to obtain traffic volume data. Figure 3-3 shows an example pneumatic traffic log. However, because these counters only record the number of passing axles, it would also be necessary to obtain traffic mix information (e.g., number of axles per vehicle) to convert axle counts to the number of vehicle passes. Vehicle mixes may be observed either visually or by the use of videotape or time-lapse motion pictures. Figure 3-4 shows an example of a manual vehicle log. Comparison of the observed vehicle mix to the pneumatic counter totals allows the accuracy of the axle counter to be assessed.

Paved road emissions can only be controlled in two ways: (a) by reducing the silt loading in Eq. 3-1 and, therefore, reducing the emission factor, and (b) the emission rate may be reduced by limiting the number of vehicles traveling on each road segment. A combination of both techniques could be used. Because it is often impractical to reduce vehicular traffic on a road, most available control techniques either attempt to prevent material from being deposited on the surface or to remove (from the travel lanes) any material that has been deposited.

While the mechanisms of particle deposition and resuspension are largely the same for public and industrial roads, there can be major differences in surface loading characteristics, emission levels, traffic characteristics, and viable control options. For the purpose of estimating particulate emissions and determining control programs, the distinction between public and industrial roads is not a question of ownership but rather a question of surface loading and traffic characteristics.

Although public roads tend to have lower surface loadings than industrial roads, the fact that these roads have far greater traffic volumes may result in a substantial contribution to the measured air quality in certain areas. In addition, many public roads in industrial areas often are heavily loaded and traveled by heavy vehicles. In that instance, better emission estimates would be obtained by treating these roads as industrial roads. In an extreme case, a road or parking lot may have such a high surface loading that the paved surface is essentially covered and is easily mistaken for an unpaved road.

PAVED ROAD SURFACE SAMPLING

Date _____ By _____

Site of Sampling: _____

No. of Traffic Lanes: _____ Type of Pavement: Asphalt/Concrete

Surface Condition: _____

Sample No.	Vac. Bag No.	Time	Location*	Sample Area	Broom Swept? (y/n)

* Use code given on plant map for segment identification and indicate sample location on map.

Figure 3-2. Sampling data form for paved roads.

Pneumatic Traffic Count Log

Facility:_____ Recorded by: _____

Road Segment ID	Counter ID No.	Site Location	Start Count	Date/Time	Stop Count	Date/Time	Axles/Vehicle Mix Observation*	Total No. of Vehicle Passes

* Obtained from the manual traffic log

Figure 3-3. Example pneumatic traffic count log.

VEHICLE LOG

Date _____ Recorded by _____

Road Location: _____

Road Type: _____

Sampling Start Time: _____ Stop Time: _____

Vehicle Type	Axles/Wheels	1	2	3	4	5	6	7	8	9	10	Total
	/											
	/											
	/											
	/											
	/											
	/											
	/											
	/											
	/											
	/											
	/											

Figure 3-4. Example manual traffic count log.

In that event, use of a paved road emission factor may actually result in a higher estimate than that obtained from the unpaved factor, and the road is better characterized as unpaved in nature rather than paved.[2]

3.1 PUBLIC PAVED ROADS

As discussed above, the term "public" is used in this manual to denote not only ownership of the road but also its surface and traffic characteristics. Roads in this class generally are fairly lightly loaded, are used primarily by light-duty vehicles, and usually have curbs and gutters. Examples are streets in residential and commercial areas and major thoroughfares (including freeways and arterials).

3.1.1 Estimation of Emissions

The emission factor for public paved roads is determined by the decision rule discussed above. Tables 3-2 and 3-3 present a summary of silt loadings as a function of roadway classification and the scheme used to classify roadways, respectively.

In general, roads with a higher traffic volume tend to have lower surface silt loadings. This relationship is expressed in the empirical model presented in Reference 3:

$$sL = 21.3/(V^{0.41}) \qquad (3\text{-}2)$$

where: sL = surface silt loading (g/m^2)
V = average daily traffic volume (vehicles/d)

3.1.2 Demonstrated Control Techniques for Public Paved Roads

Available control methods for public roads are largely designed either to prevent deposition of material on the roadway surface or to remove material which has been deposited in the driving lanes. Measurement-based efficiency values for control methods are presented in Table 3-4. Note that all values in this table are for mitigative measures applied to industrial paved roads.

In terms of public paved road dust control, only very limited field measurement data are available. One reference was found that could be used to indirectly quantify emission reductions and this, too, is for mitigative measures. Estimated PM_{10} control efficiencies (Table 3-5) were developed by applying Eq. 3-1 to measurements before and after road cleaning.[4] Note that these estimates should be considered upper bounds on efficiencies obtained in practice because no redeposition after cleaning is considered. Note also that these estimated emission control efficiencies for urban roads compare fairly well with measurements at industrial roads. No airborne mass emission measurements quantifying control efficiency were found.

TABLE 3-2. SUMMARY OF SILT LOADINGS (sL) FOR PAVED URBAN ROADWAYS[a]

City	Local streets		Collector streets		Major streets/ highways		Freeways/ expressways	
	$\bar{X}_g$ (g/m²)	n	$\bar{X}_g$ (g/m²)	n	$\bar{X}_g$ (g/m²)	n	$\bar{X}_g$ (g/m²)	n
Baltimore	1.42	2	0.72	4	0.39	3	--	--
Buffalo	1.41	5	0.29	2	0.24	4	--	--
Granite City, Ill.	--	--	--	--	0.82	3	--	--
Kansas City	--	--	2.11	4	0.41	13	--	--
St. Louis	--	--	--	--	0.16	3	0.022	1
All	1.41	7	0.92	10	0.36	26	0.022	1

[a] Reference 1. $\bar{X}_g$ = geometric mean based on corresponding n sample size. Dash = not available. To convert g/m² to grains/ft² multiply g/m² by 1.4337.

TABLE 3-3. PAVED URBAN ROADWAY CLASSIFICATION[a]

Roadway category	Average daily traffic (vehicles)	Lanes
Freeways/expressways	> 50,000	≥ 4
Major streets/highways	> 10,000	≥ 4
Collector streets	500-10,000	2[b]
Local streets	< 500	2[c]

[a] Reference 1.

[b] Road width ≥ 32 ft.

[c] Road width ≤ 32 ft.

TABLE 3-4. MEASURED EFFICIENCY VALUES FOR PAVED ROAD CONTROLS[a]

Method	Cited efficiency	Comments
Vacuum sweeping	0-58%	Field emission measurement (PM-15) 12,000-cfm blower[b]
	46%	Reference 5, based on field measurement of 30 μm particulate emissions
Water flushing	69-0.231 V[c,d]	Field measurement of PM-15 emissions[b]
Water flushing followed by sweeping	96-0.263 V[c,d]	Field measurement of PM-15 emissions[b]

[a] Reference 6, except as noted. All results based on measurements of air emissions from industrial paved roads.

[b] PM_{10} control efficiency can be assumed to be the same as that tested.

[c] Water applied at 0.48 gal/yd^2.

[d] Equation yields efficiency in percent, V = number of vehicle passes since application.

TABLE 3-5. ESTIMATED PM_{10} EMISSION CONTROL EFFICIENCIES[a]

Method	Estimated PM_{10} efficiency, %
Vacuum sweeping	34
Improved vacuum sweeping	37

[a] Reference 4. Estimate based on measured initial and residual $\leq$ 63 μm loadings on urban paved roads and Eq. 3-1. Value reported represents the mean of 13 tests for each method.

In general terms, one would expect that demonstrated control techniques applied to industrial paved roads could also be applied to public roads. One important point to note, however, is that it is generally recognized that mitigative measures decrease in effectiveness as the surface loadings decrease. Because mitigative measures are less effective for public paved roads, the use of preventive measures should be stressed, especially in instances where no dominant or localized source of road loading can be identified. Example sources would include: (1) unpaved areas adjacent to the road; (2) erosion due to storm water runoff; and (3) spillage from passing trucks. Corresponding examples of preventive measures include: (1) installing curbs, paving shoulders, or painting lines near the edge of the pavement; (2) controlling storm water or using vegetation to stabilize surrounding areas; and (3) requiring trucks to be covered and to maintain freeboard (i.e., distance between top of the load and top of truck bed sides). In instances where the source of loading can be easily identified (e.g., salt or sand spread during snow or ice storms) or the effects are localized (e.g., near the entrance to construction sites or unpaved parking lots), either preventive or mitigative measures could be prescribed. Table 3-6 summarizes nonindustrial paved road preventive controls.

There are few efficiency values for any of the preventive measures presented in Table 3-6. Because these materials are designed to prevent deposition of additional material onto the paved surface, quantitative measurements before and after the control are generally not possible and interpretation of results are complicated. For example, based on ambient TSP monitoring results over a 3-month period, immediate and continuous manual cleaning of the access area to a construction site was estimated to result in ~ 30% control.[7] It is unclear, however, what effect seasonal variation in the monitoring data has on the estimate of 30%. Also, because this estimate is based on ambient air concentrations, use of the value may be inconsistent with the other efficiency estimates given in this chapter.

Inspection Procedures for Public Paved Roads. In many respects, public paved roads cannot be considered subject to "field inspections" in the traditional regulatory sense. Silt loadings on these roads are at least partially due to a wide range of ubiquitous sources (such as deposition of ambient dust, application of snow/ice controls, pavement wear, spills, tire/brake wear, litter). It is obvious that those types of sources of silt loadings cannot be routinely inspected. In addition, EPA policy emphasizes preventive rather than mitigative controls for public paved roads. In this way, general reductions in silt loadings in an area would be expected. However, the determination of the effective silt reduction due to a particular preventive control is complicated because of the spatial and temporal separation of the cause and the effect.

Thus, with the exception of "localized" preventive controls employed at industrial and construction sites (such as covering haul trucks or cleaning plant entrance areas), control measures taken to reduce silt loadings on public paved roads cannot be generally inspected.

TABLE 3-6. NONINDUSTRIAL PAVED ROAD DUST SOURCES AND PREVENTIVE CONTROLS

Source of deposit on road	Recommended controls
-- Sanding/salt	-- Make more effective use of abrasives through planning, limited, and uniform spreading, etc. -- Improve the abrasive material through specifications limiting the amount of fines and material hardness, etc. -- Rapid cleanup after streets become clear and dry
-- Spills from haul trucks	-- Require trucks to be covered -- Require freeboard between load and top of hopper -- Wet material being hauled
-- Construction carryout and entrainment	-- Clean vehicles before entering road -- Pave access road near site exit -- Semicontinuous cleanup of exit
-- Vehicle entrainment from unpaved adjacent areas	-- Pave/stabilize portion of unpaved areas nearest to paved road
-- Erosion from storm water washing onto streets	-- Storm water control -- Vegetative stabilization -- Rapid cleanup after event
-- Wind erosion from adjacent areas	-- Wind breaks -- Vegetative stabilization or chemical sealing of ground -- Pave/treat parking areas, driveways, shoulders -- Limit traffic or other use that disturbs soil surface
-- Other	-- Case-by-case determination

Implementation and enforcement of "area-wide" (i.e., not "localized" in the sense described above) preventive measures--such as changes in snow/ice control materials and practices or city ordinances requiring homeowners to remove biological debris from streets in their neighborhoods--will generally require a strong working relationship between the air regulatory agency and other administrative bodies. This relationship is often expressed in a Joint Memorandum of Understanding. Once again, competing demands (e.g., the importance of maintaining traffic safety during ice and snow storms) make "inspection" in the usual sense largely impossible.

Consequently, the inspection procedures for public paved roads will be restricted to the localized preventive controls. These procedures are discussed in connection with industrial road inspections in Section 3.2 of this manual.

3.2 INDUSTRIAL PAVED ROADS

As noted earlier, emission estimation for paved roads depends less upon its ownership and more upon its surface material and traffic characteristics. In this manual, the term "industrial" paved road is used to denote those roads with higher surface loadings and/or are traveled by heavier vehicles. Consequently, some publicly owned roads are better characterized as industrial in terms of emissions. Examples would include city streets in heavily industrialized areas or areas of construction as well as paved roads in industrial complexes.

3.2.1 Estimation of Emissions

When estimating emissions from industrial paved roads, Eq. 3-1 and Table 3-1 should be used. Table 3-7 provides measured silt loading values for a few industries.

3.2.2 Demonstrated Control Techniques for Industrial Paved Roads

As noted in Section 3.1.2, the vast majority of measured control efficiency values for paved roads are based on data from industrial roads. Consequently, the information presented earlier in Table 3-4 is more applicable to this class of road.

Mitigative measures may be more practical for industrial plant roads because (1) the responsible party is known; (2) the roads may be subject to considerable spillage and carryout from unpaved roads; and (3) all affected roads are in relatively close proximity, thus allowing a more efficient use of cleaning equipment. Preventive measures, of course, can be used in conjunction with plant cleaning programs and prevention is probably the preferred approach for city streets in industrialized areas with many potential sources of paved road dust.

TABLE 3-7. INDUSTRIAL PAVED ROAD SILT LOADINGS[a]

Industry	No. of sites	No. of samples	Silt, percent w/w		No. of travel lanes	Silt loading, g/m^2	
			Range	Mean		Range	Mean
Copper smelting	1	3	[15.4-21.7]	[19.0]	2	[188-400]	[292]
Iron and steel production	6	20	1.1-35.7	12.5	2	0.09-79	12
Asphalt batching	1	3	[2.6-4.6]	[3.3]	1	[79-193]	[120]
Concrete batching	1	3	[5.2-6.0]	[5.5]	2	[11-12]	[12]
Sand and gravel processing	1	3	[6.4-7.9]	[7.1]	1	[53-95]	[70]

[a] Reference 1. Brackets indicate values based on only one plant vist.

Preventive Measures. These types of control measures prevent the deposition of additional materials on a paved surface area. As a result, it is difficult to estimate their control effectiveness. For mitigative controls, before and after measurement (of surface loadings or of particulate emissions) is possible; clearly, this is not the case for preventive measures. Table 3-6 contains a list of preventive measures along with recommended controls.

Inspection Procedures for Preventive Measures. As mentioned in Section 3.3.1, it is difficult to estimate control effectiveness for preventive measures. Therefore, inspections for this type of control would require a visual inspection. For example, the control plan/operating permit or construction permit (hereafter referred to as plan/permit) may specify that all haul trucks be covered to prevent spills, and all vehicles be cleaned before entering a public paved road to limit carryout. In this instance, the inspector would determine compliance by visually inspecting the haul trucks and the rinsing of vehicles. The inspector should be familiar with all preventive measures specified in the plan/ permit to determine if facility is in compliance.

Mitigative Measures. While preventive measures are to be preferred under the EPA urban dust policy, some sources of road dust loadings may not be easily controlled by prevention. Consequently, some mitigative measures may be necessary to achieve desired goals. This section discusses demonstrated mitigative measures.

Broom Sweeping of Roads. Mechanical street cleaners employ rotary brooms to remove surface materials from roads and parking lots. Much of their effect is cosmetic, in the sense that, while the roadway appears much cleaner, a substantial fraction of the original loading is emitted during the process. Thus, there is some credence to claims that mechanical cleaning is as much a source as a control of particulate emissions.

Measurement-based control efficiency of broom sweeping for industrial roads and estimated efficiencies for urban roads both indicate a maximum (initial) instantaneous control of roughly 25 to 30%. Efficiency, of course, can be expected to decrease after cleanup.

Vacuum Sweeping of Roads. Vacuum sweepers remove material from paved surfaces by entraining particles in a moving air stream. A hopper is used to contain collected material and air exhausts through a filter system in an open loop. A regenerative sweeper functions in much the same way, although the air is continuously recycled. In addition to the vacuum pickup heads, a sweeper may also be equipped with gutter and other brooms to enhance collection. Figure 3-5 shows a vacuum sweeper truck in operation.

Instantaneous control efficiency values were given earlier in Table 3-4. Available data show considerable scatter, ranging from a field measurement showing no effectiveness (over baseline uncontrolled emissions) to another field measurement of 58%. An average of the field measurements would indicate an efficiency of 34%. In addition, the estimated upper limits for PM_{10} control of urban roads (Table 3-5) compare fairly well with that average.

Figure 3-5. Photo of a vacuum street sweeper.

Water Flushing of Roads. Street flushers remove surface materials from roads and parking lots using high pressure water sprays. Some systems supplement the cleaning with broom sweeping after flushing. Note that the purpose of the program is to remove material from the road surface; in some industries, water is regularly applied to roads to directly control emissions (i.e., as in unpaved roads). Unlike the two sweeping methods, flushing faces some obvious drawbacks in terms of water usage, potential water pollution, and the frequent need to return to the water source. However, flushing generally tends to be more effective in controlling particulate emissions.

Equations to estimate instantaneous control efficiency values are given in Table 3-4. Note that water flushing and flushing followed by broom sweeping represent the two most effective control methods (on the basis of field emission measurements) given in that table.

3.3 REGULATORY FORMATS AND ASSOCIATED INSPECTION PROCEDURES

Once a PM_{10} control strategy has been developed and implemented, it becomes necessary for the control agency to ensure that (a) the plan is being carried out as specified, and (b) the plan is achieving the desired level of control. This section discusses methods for determining compliance, along with inspection procedures for paved roads.

3.3.1 "In-plant" Inspection Procedures

Figure 3-6 is an example inspection form which may be completed at the start of the Level II and III inspections by interviewing plant personnel. After determining any changes from the last inspection, a more thorough plant inspection should be performed. "In-plant" inspections for paved roads may consist of one or more of the following items:

1. Observation of control equipment in use.

2. "Spot" checks of pertinent traffic patterns.

3. Surface material sampling.

Each of these items is discussed in more detail below.

The plant inspection of paved road control equipment should focus on the following items:

- Ensuring that operation of the equipment has not changed markedly since the time of the last inspection.

- Examining that the "on-board" pollution control devices (e.g., bags on vacuum street cleaners, water sprays on flushing devices) are performing in an adequate matter. (This evaluation will usually be made on the basis of visible emissions from vents, brooms, etc.)

- Verifying that maintenance items (e.g., replacement nozzles) shown in the facility's records have actually been installed on the control equipment.

Business License Name of Corporation, Company, or Individual Owner or Governmental Agency:

Mailing Address:	Plant Address:

Name and Title of Company Representative:

Telephone Number:

Name of Official Conducting Inspection:

General Questions for Plant Personnel

	Yes*	No	N/A	Comments
1. Have any roads been eliminated or blocked off since last inspection?				
2. Have any roads been paved since last inspection?				
3. Any new roads?				
4. Have traffic volumes or vehicle characteristics on roads changed because of process changes, shutdown, etc.?				
Controls				
5. Have any changes been made in control program since last inspection?				
6. Any new equipment?				
7. Any equipment downtime since last inspection?				

* If any answer is yes, complete comment section.

Figure 3-6. Example inspection form.

- Noting the qualitative performance of the device in removing material from lightly to heavily loaded portions of the roadway.

- Recording the vehicle's odometer (or elapsed usage clock) reading for comparison against last reading and facility records.

In addition to the above items, in-plant inspections of the paved road control equipment may also entail field measurements of silt loadings before and after control. This is discussed in greater detail below.

If the facility personnel indicate marked changes in traffic patterns, traffic volume, etc., or if the control plan calls for vehicle volume reduction (see Section 4.2), the inspector may wish to spot-check traffic parameters at selected roads in the facility. This is accomplished by taking manual traffic mix data. General procedures for manual mix observations are outlined below.

Procedures for Obtaining Manual Traffic Mix Data

Required equipment. Stopwatch, traffic count log (see Figure 3-3)

Procedure:

1. Select unobstructed observation point.

2. Determine distance between two easily defined points (A,B) on the road segment in question.

3. Indicate mix start time.

4. For each passing vehicle, record vehicle type (if known), the number of axles/wheels, and the time in seconds required to travel between points A and B. Alternately, an accumulating stopwatch may be used to determine the average time required to travel between A and B.

5. Record mix stop time.

Finally, the inspector can spot check paved roads by taking material grab samples and comparing either "before and after" silt loadings or comparing the silt loading against some "action level." The latter is useful in assessing prevention of material carryout into public paved roads. As an example, if the silt loading on a public road (with an average traffic volume of 2,000 vehicles per day) adjacent to an industrial or construction site ever exceeds 2.9 g/m^2 (the "action level"), the regulatory agency may require the responsible party to reduce the silt loading to a level less than the action level. The action level is an agency-supplied multiple (3 in this example) of either baseline measurements or the surface silt loading predicted by Eq. 3-1 and should correspond to a minimally acceptable level of control. Figure 3-7 presents a possible format for use with public paved road sources.

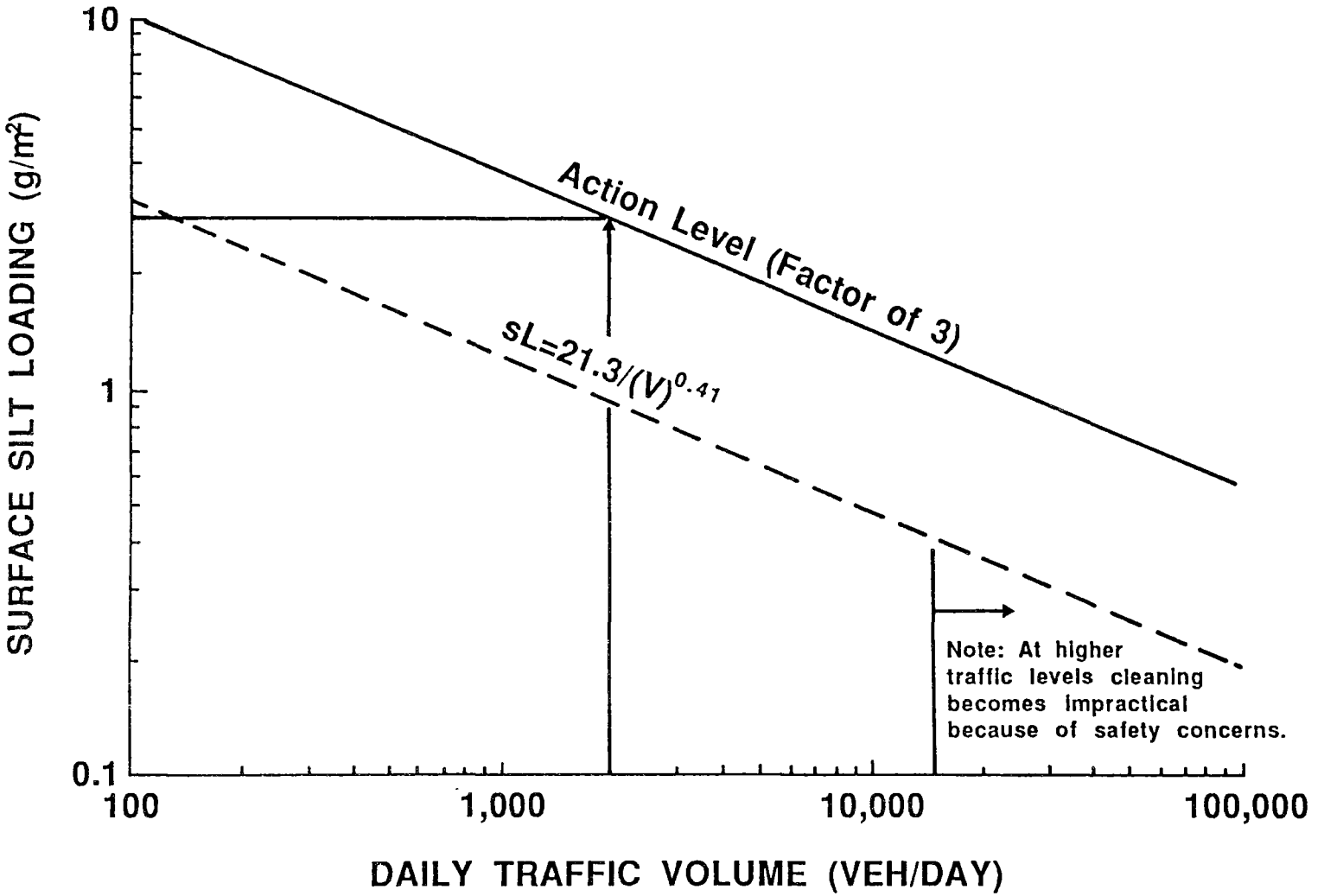


Figure 3-7. Possible use of "action levels" to trigger paved road controls.

The sampling method used to determine silt loading for compliance inspection should conform to the technique used to develop the AP-42 urban paved road equation. That technique is specified in Appendix F and briefly described below.

Procedures for Obtaining Surface Material Samples

Required equipment. Stick-type vacuum, hand broom, dust pan (Figure 3-2)

Procedure (See Appendix F):

1. Arrangements must be made to account for spatial variation of surface silt loading. Possible suggestions include (a) visually determining the heaviest loading on the road and selecting that spot for sampling, (b) sampling the midpoint of the road length segment of interest, and (c) sampling preselected (possibly on the basis of safety considerations) strips on the road surface (note that the samples may be aggregated).

2. After sampling site has been selected, hand sweep with a hand broom and dust pan if there are any large particles in the sampling area. Place sample in jar and label.

3. Vacuum the test site, using preweighed bags. Remove vacuum bag, check for leaks, and label.

4. Analyze for silt content as described in Appendix F.

3.3.2 Plant Record Keeping Requirements

Records must be kept to document the frequency a paved road is vacuumed, flushed, or swept. Pertinent parameters that should be specified in a control plan and regularly recorded include:

General Information to be Specified in the Plan

1. All road segments and parking locations referenced on a map available to both the responsible party and the regulatory agency.

2. Length of each road and area of each parking lot.

3. Type of control applied to each road/area and planned frequency of application

4. Provisions for weather (e.g., program suspended for periods of freezing temperatures; for broom and vacuum sweeping, a predetermined amount of rainfall will be substituted for one treatment).

Specific Records for Each Road Segment/Parking Area Treatment

1. Date of treatment

2. Operator's initials (note that the operator may keep a separate log whose information is transferred to the environmental staff's data sheets)

3. Start and stop times on a particular segment/parking lot, average speed, number of passes

4. Start and stop times for refilling tanks (for water flushing only)

5. Qualitative description of loading before and after treatment

6. Any areas of unusually high loadings, from spills, pavement deterioration, etc.

General Records to be Kept

1. Equipment maintenance records

2. Meteorological log (to the extent that weather influences the control program)

3. Any equipment malfunctions or downtime

Example Compliance Determination--Record Keeping for Flushing of Paved Roads. This example considers the hypothetical facility X with paved roads shown in Figure 3-1. Facility X is located in a PM_{10} nonattainment area and has an approved dust control plan that specifies the following control strategy for paved roads:

1. Flushing at intensities $\geq$ 0.50 gal/yd^2 (2.3 L/m^2)

2. To achieve an average control of 34% by water flushing, no more than 300 vehicle passes can occur between treatments (c.f. Table 3-4). Therefore, the frequency of flushing was determined by traffic volume in the control plan. Because roads A, B, and C have 50, 10, and 40 vehicle passes per working hour, respectively, the roads should be flushed every 6, 30, and 7.5 h of operation. For practical considerations, the permit requires that road B be flushed daily and road C be flushed every 6 h with road A. In addition, paved parking areas should be flushed at the close of each business day.

3. Flushing is to be performed from April 1 through October 31.

4. Each 1/2 in of rainfall (in the previous 24 h) will be substituted for one treatment, and the program will be suspended for days where the morning temperature (8 a.m.) does not exceed 32°F.

Note that the permit also specifies flushing between 11:00 a.m. and 3:00 p.m. when the ambient temperature at 11:00 a.m. is ≥ 40°F for the period from November 1 to March 31.

The source extent parameters for paved surfaces at facility X are given below:

Segment/area	Vehicle passes per hour	Length (ft)	Width (ft)	Approx. area (yd^2)
A	50	650	32	2,300
B	10	350	32	1,250
C	40	200	32	700
Parking	-	300	80	2,700

(Note that the vehicle passes are those used in the equation for determining uncontrolled emissions.) The facility operates a 5,000-gal water truck equipped with auxiliary spray "shoes" for flushing paved surfaces.

Example records kept by facility X to document its flushing program are shown in Figure 3-8 (meteorological data log) and in Figure 3-9 (operator's log). Because the control plan specifies the time interval between each application, the use of the operator's log is the best way to determine compliance. The operator's log should show at least one treatment for every 6 h for roads A and C and one treatment a day for road B. If it does not, the facility should be required to submit a written explanation for the apparent discrepancy. Note that this evaluation may require accumulating scale records over more than one business day, and that it should consider periods of minimal rainfall so as not to confound the check.

Facility X Meteorological Data Log

Month/Year: 06/89 Observer JPM

Day	Obs. Time	Precipitation (in)	Temperature (°F)	Comments
01	8:05	-	64	
02	8:05	-	64	
03				
04				
05	8:10	0.10	78	Rained on Sunday
06	8:10	-	72	
07	8:10	-	73	
08	8:10	0.08	72	
09	8:10	-	77	
10				
11				
12	8:05	3.12	56	No Flushing
13	8:05	-	67	
14	8:05	-	71	
15	8:05	-	74	
16	8:05	-	77	
17				
18				
19	8:05	0.66	64	No Flushing
20	8:05	-	70	
21	8:05	-	74	
22	8:05	0.27	79	
23	8:05	-	79	
24				
25				
26	8:05	T	74	
27	8:05	-	76	
28	8:05	-	76	
29	8:05	-	78	
30	8:05	-	75	
31				

T = Trace

Figure 3-8. Meteorological data log for example facility X.

Facility X Flushing Program--Operator's Log

Date	Segment I.D./Time Treated			
	A	B	C	Parking
6/1	7:30	7:40	7:45	
6/1	1:30	–	1:40	5:30
6/2	7:30	7:40	7:45	
6/2	1:30	–	1:40	5:30
•	•	•	•	•
•	•	•	•	•
•	•	•	•	•
6/12	— NO FLUSHING – JPM			
6/13	7:40	7:50	7:55	
6/13	1.40	–	1:55	5:30
•	•	•	•	•
•	•	•	•	•
•	•	•	•	•
6/19	— NO FLUSHING — JPM			
6/20	7:30	7:40	7:45	
6/20	1:30	—	1:40	5:30

Figure 3-9. Operator's log for example facility X.

3.4 REFERENCES FOR SECTION 3

1. U.S. Environmental Protection Agency. 1985. Compilation of Air Pollution Emission Factors, AP-42. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina.

2. Muleski, G. E. 1987. Update of Fugitive Dust Emission Factors in AP-42 Section 11.2. Final Report, U.S. Environmental Protection Agency, Contract No. 68-02-3891, Work Assignment No. 19.

3. Cowherd, C., Jr., and P. J. Englehart. 1984. Paved Road Particulate Emissions. EPA-600/7-84-077. U.S. Environmental Protection Agency. Washington, D.C.

4. Duncan, M., et al. 1984. Performance Evaluation of an Improved Street Sweeper. EPA Contract No. 68-09-3902.

5. Eckle, T. F., and D. L. Trozzo. 1984. Verification of the Efficiency of a Road-Dust Emission-Reduction Program by Exposure Profile Measurement. Presented at an EPA/AISI Symposium on Iron and Steel Pollution Abatement, Cleveland, Ohio. October 1984.

6. Cowherd, C., Jr., and J. S. Kinsey. 1986. Identification, Assessment and Control of Fugitive Particulate Emissions. EPA-600/8-86-023, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina.

7. Axetell, K., and J. Zeller. 1977. Control of Reentrained Dust from Paved Streets. U.S. Environmental Protection Agency. EPA-907/9-77-007.

SECTION 4

UNPAVED ROADS

As is the case for paved roads, particulate emissions occur whenever a vehicle travels over an unpaved surface. Unlike paved roads, however, the road itself is the source of the emissions rather than any "surface loading." Within the various categories of open dust sources (i.e., paved roads, storage piles, and wind erosion), unpaved travel surfaces have historically accounted for the greatest share of particulate emissions in industrial settings.

Unpaved travel surfaces are found in rural regions throughout the country and in industrial settings. Rural roads may be unpaved because they experience only sporadic traffic and involve considerable road length, making paving generally impractical. Some industrial roads are, by their nature, not suitable for paving. These roads may be used by very heavy vehicles or may be subject to considerable spillage from haul trucks. Other roads may have poorly constructed bases which make paving impractical. Because of the additional maintenance costs associated with a paved road under these service environments, emissions from these roads are usually controlled by regular applications of water and/or chemical dust suppressants.

In addition to roadways, many industries often contain important unpaved travel areas. These areas include travel around stockpiles, staging and reclaim activities. These areas may often account for a substantial fraction of traffic-generated emissions from individual facilities. In addition, these areas tend to be much more difficult to control than stretches of roadway.

4.1 EMISSIONS ESTIMATION

4.1.1 Emission Factor Equation

When considering emissions and their control from unpaved roads, each road must first be divided into road segments. A road segment is the distance between two intersections. Figure 4-1 is a map of an example facility with each road divided into road segments and assigned an arbitrary identification. After identifying each road segment, an emission factor may be determined by applying the following AP-42[1] equation to each road segment:

$$E = 0.61 \left(\frac{s}{12}\right) \left(\frac{S}{48}\right) \left(\frac{W}{2.7}\right)^{0.7} \left(\frac{w}{4}\right)^{0.5} \frac{(365-p)}{365} \text{ (kg/VKT)} \qquad (4\text{-}1)$$

$$E = 2.1 \left(\frac{s}{12}\right) \left(\frac{S}{30}\right) \left(\frac{W}{3}\right)^{0.7} \left(\frac{w}{4}\right)^{0.5} \frac{(365-p)}{365} \text{ (lb/VMT)}$$

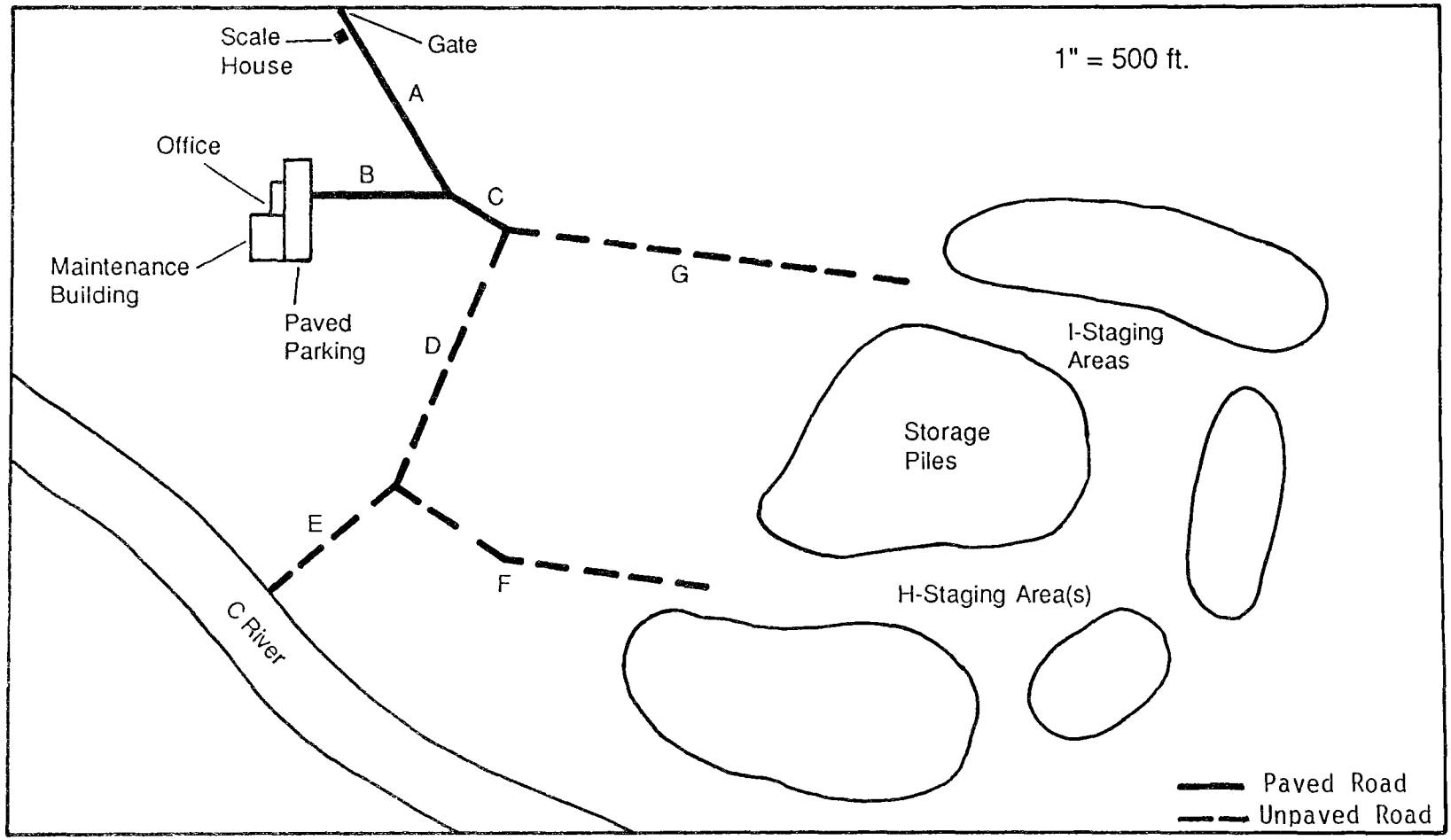


Figure 4-1. Example facility map with roads divided into road segments.

where: E = PM_{10} emission factor in units stated
s = silt content of road surface material, %
S = mean vehicle speed, km/h (mi/h)
W = mean vehicle weight, Mg (ton)
w = mean number of wheels (dimensionless)
p = number of days with $\geq$ 0.254 mm (0.01 in) of precipitation per year

The emission rate is determined by multiplying the emission factor by the length of the road segment and the vehicle passes per day. Adding the emission rate from each segment will provide a total unpaved road emission rate for the facility.

Note that the above emission factor equation represents uncontrolled conditions. (Roads that are controlled will be discussed later in Section 4.3.) Emissions may be controlled by either "add-on" methods (such as watering, etc.) or by reducing the values of parameters in Equation 4-1 (e.g., halving the vehicle speed halves the emission rate). In addition, some compliance tools also make use of the parameters in this equation. Consequently, each parameter in the equation is discussed in more detail below.

4.1.2 Parameters Affecting Emissions

Silt content is the percent of mass which passes a 200 mesh screen (< 75 μmP). Table 4-1 gives a range of measured silt values for unpaved roads in certain industries. As for all AP-42 emission factors, the use of site-specific data is strongly encouraged. The silt content of the road surface material should be determined using the sampling techniques and laboratory analysis procedures described in Appendix F.

Vehicle-related parameters should be obtained using a combination of counting devices, manual or automated records, and information from plant personnel. Pneumatic tube axle counters can be used to obtain traffic volume data. (Note that traffic volume is also necessary to obtain emission rates from Equation 4-1.) Figure 4-2 shows an example pneumatic traffic log. However, because these counters only record the number of passing axles, it would also be necessary to obtain traffic mix information (e.g., number of axles per vehicle) to convert axle counts to the number of vehicle passes. Vehicle mixes may be observed either visually or by the use of videotape or time-lapse motion pictures. Figure 4-3 shows an example of a manual vehicle log.

Additional information obtained from traffic mix observations include fractions of different vehicle types, vehicle speed, and number of wheels per vehicle. A posted plant speed limit may also be used to represent average speed. Finally, comparison of the observed vehicle mix to the pneumatic counter totals allows the accuracy of the axle counter to be assessed.

TABLE 4-1. TYPICAL SILT CONTENT VALUES OF SURFACE MATERIAL ON INDUSTRIAL AND RURAL UNPAVED ROADS[a]

Industry	Road use or surface material	Plant sites	Test samples	Silt, weight percent Range	Mean
Copper smelting	Plant road	1	3	15.9-19.1	17.0
Iron and steel production	Plant road	9	20	4.0-16.0	8.0
Sand and gravel processing	Plant road	1	3	4.1-6.0	4.8
Stone quarrying and processing	Plant road	1	5	10.5-15.6	14.1
Taconite mining and processing	Haul road	1	12	3.7-9.7	5.8
	Service road	1	8	2.4-7.1	4.3
Western surface coal mining	Access road	2	2	4.9-5.3	5.1
	Haul road	3	21	2.8-18	8.4
	Scraper road	3	10	7.2-25	17
	Haul road (freshly graded)	2	5	18-29	24
Rural roads	Gravel	1	1	NA	5.0
	Dirt	2	5	5.8-68	28.5
	Crushed limestone	2	8	7.7-13	9.6

Note: NA - Not applicable.

[a] Reference 1 (AP-42).

Pneumatic Traffic Count Log

Facility:_____ Recorded by: _____

Road Segment ID	Counter ID No.	Site Location	Start Count	Date/Time	Stop Count	Date/Time	Axles/Vehicle Mix Observation*	Total No. of Vehicle Passes

* Obtained from the manual traffic log

Figure 4-2. Example pneumatic traffic count log.

VEHICLE LOG

Date _____ Recorded by _____

Road Location: _____

Road Type: _____

Sampling Start Time: _____ Stop Time: _____

Vehicle Type	Axles/Wheels	1	2	3	4	5	6	7	8	9	10	Total
	/											
	/											
	/											
	/											
	/											
	/											
	/											
	/											
	/											
	/											
	/											

Figure 4-3. Manual traffic count log.

The number of wet days (i.e., precipitation ≥ 0.01 in) per year (p) for the geographical area of interest should be determined from local climatic data. Figure 4-4 gives the geographical distribution of the mean annual number of wet days per year in the United States. Maps giving similar data on a monthly basis are available from the U.S. Department of Commerce.[2]

4.2 EMISSION CONTROL METHODS

As shown in Table 4-2, there are a variety of control options for unpaved travel surfaces. Note that the controls fall into three general categories of: source extent reductions; surface improvements; and surface treatments. Each of these is discussed in greater detail below.

TABLE 4-2. CONTROL TECHNIQUES FOR UNPAVED TRAVEL SURFACES

Source extent reductions:	Speed reduction Traffic reduction
Source improvements:	Paving Gravel surface
Surface treatments:	Watering Chemical stabilization - Asphalt emulsions - Petroleum resins - Acrylic cements - Other

4.2.1 Source Extent Reductions

These controls either limit the amount of traffic on a road to reduce the PM_{10} emission rate, or lower speeds to reduce the emission factor value given by Equation 4-1. Examples could include industrial plant bussing programs for employees, restriction of roads to only certain vehicle types, or strict enforcement of speed limits. In any instance, the control afforded by these measures is readily obtained by the application of the emission factor equation.

4.2.2 Surface Improvements

These controls alter the road surface. Unlike the surface treatments (discussed below), these improvements do not require periodic reapplication.

The most obvious surface improvement is, of course, paving an unpaved road. This option is expensive and is probably most applicable to high volume (i.e., more than a few hundred passes per day) public roads and industrial plant roads that are not subject to very heavy vehicles (e.g., slag pot carriers, haul trucks, etc.) or spillage of material in transport.

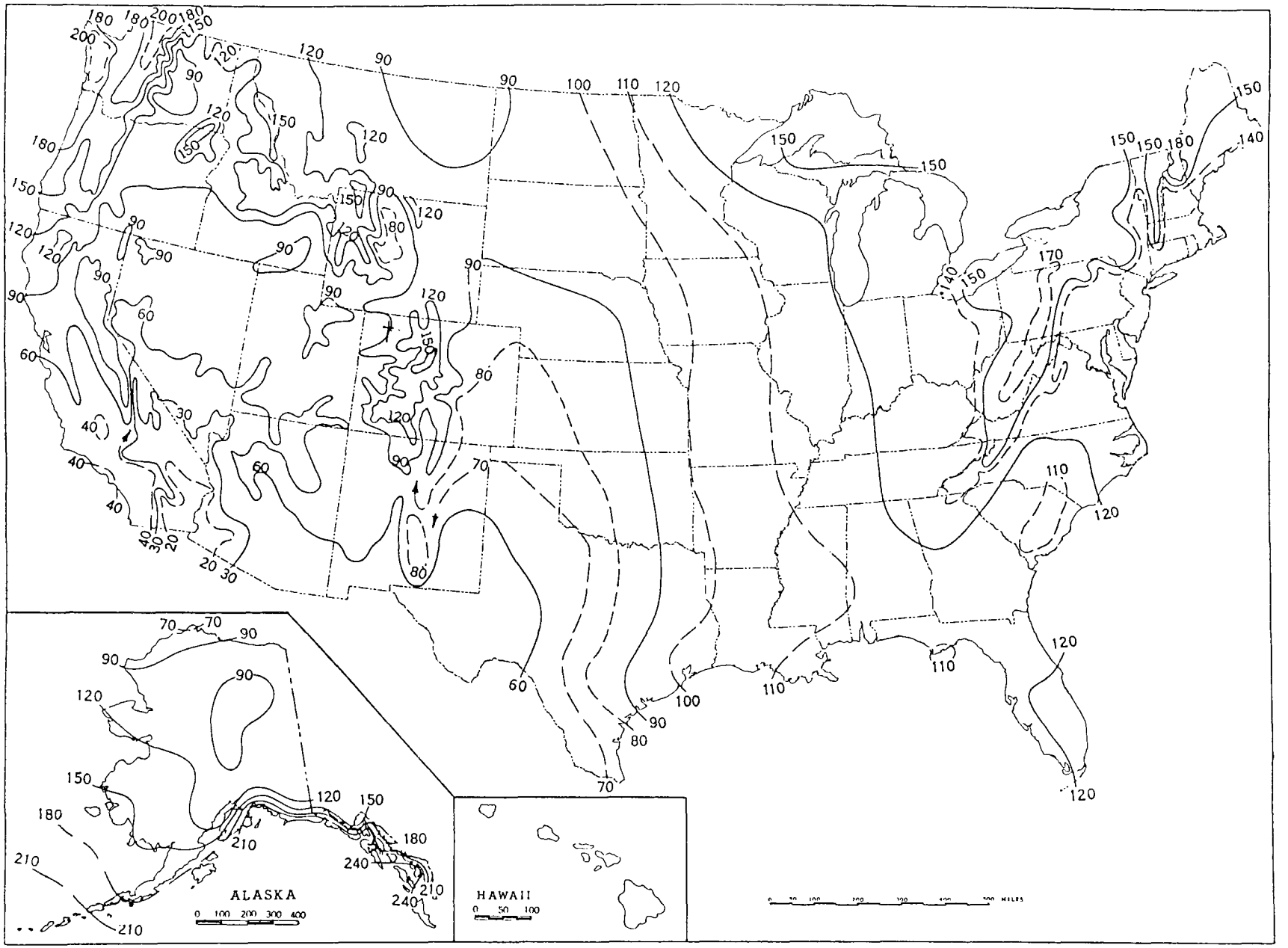


Figure 4-4. Mean annual number of days with at least 0.01 in of precipitation. As noted in Reference 2, patterns are too complex in Hawaii for inclusion on this map. (Means for Hilo, Honolulu, and Lihue are 148,204, and 90 days/yr, respectively.)

Other improvement methods cover the road surface material with another material of lower silt content (e.g., covering a dirt road with gravel or slag, or using a "road carpet" under ballast).[5] Because Equation 4-1 shows a linear relationship between the emission factor and the silt content of the road surface, any reduction in the silt value is accompanied by an equivalent reduction in emissions. This type of improvement is initially much less expensive than paving; however, maintenance (such as grading and spot reapplication of the cover material) may be required.

4.2.3 Surface Treatment

Surface treatment refers to those control techniques which require periodic reapplications. Treatments fall into the two main categories of: (1) wet suppression (i.e., watering, possibly with surfactants or other additives), which keeps the surface wet to control emissions; and (2) chemical stabilization, which attempts to change the physical (and, hence, the emissions) characteristics of the roadway. Necessary reapplication frequencies may range from several minutes for plain water under hot, summer time conditions to several weeks (or months) for chemicals.

Water is usually applied to unpaved roads using a truck with a gravity or pressure feed system. This is only a temporary measure, and periodic reapplications are necessary to achieve any substantial level of control efficiency. Some increase in overall control efficiency is afforded by wetting agents which reduce surface tension. Figure 4-5 shows a typical water truck used to treat unpaved haul roads in a mining operation.

Chemical dust suppressants (Table 4-3). on the other hand, have much less frequent reapplication requirements. These suppressants are designed to alter the roadway surface, such as cementing loose material into a fairly impervious surface (thus simulating a paved surface) or forming a surface which attracts and retains moisture (thus simulating wet suppression).

Chemical dust suppressants are generally applied to the road surface as a water solution of the agent. The degree of control achieved is a direct function of the application intensity (volume of solution per unit area), dilution ratio, and frequency (number of applications per unit time) of the chemical applied to the surface and also depends on the type and number of vehicles using the road.[5] Chemical suppressants have also been proven to be effective as crusting agents for inactive storage piles and for the stabilization of exposed open areas and agricultural fields.[5]

4.3 REGULATORY FORMATS AND ASSOCIATED INSPECTION PROCEDURES

Once a specific PM_{10} control strategy has been developed and implemented, it becomes necessary for the control agency to assure that it is being carried out as specified and is achieving the desired level of control. The control efficiency actually attained by a particular technique depends on the application parameters involved in its implementation. This section will discuss methods for determining compliance, along with inspection procedures, for various surface treatments of unpaved roads.

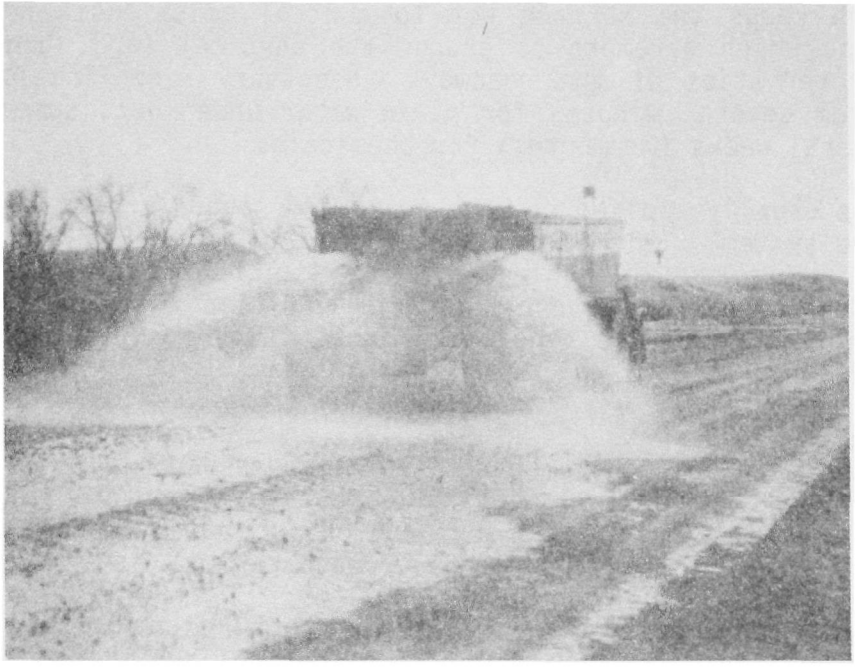


Figure 4-5. Water truck treating a mine haul road.

TABLE 4-3. CHEMICAL STABILIZERS[a]

A. Type: Bitumens

Product	Manufacturer
AMS 2200, 2300	Arco Mine Sciences
Coherex	Witco Chemical
Docal 1002	Douglas Oil Company
Peneprime	Utah Emulsions
Petro Tac P	Syntech Products Corporation
Resinex	Neyra Industries, Inc.
Retain	Dubois Chemical Company

B. Type: Salts

Product	Manufacturer
Calcium chloride	Allied Chemical Corporation
Dowflake, Liquid Dow	Dow Chemical
DP-10	Wen-Don Corporation
Dust Ban 8806	Nalco Chemical Company
Dustgard	G.S.L. Minerals and Chemicals Corporation
Sodium silicate	The PQ Corporation

C.

Product	Manufacturer
Acrylic DLR-MS	Rohm and Haas Company
Bio Cat 300-1	Applied Natural Systems, Inc.
CPB-12	Wen-Don Corporation
Curasol AK	American Hoechst Corporation
DCL-40A, 1801, 1803	Calgon Corporation
DC-859, 875	Betz Laboratories, Inc.
Dust Ban	Nalco Chemical Company
Flambinder	Flambeau Paper Company
Lignosite	Georgia Pacific Corporation
Norlig A, 12	Reed Lignin, Inc.
Orzan Series	Crown Zellerbach Corporation
Soil Gard	Walsh Chemical

[a] Reference 3, as cited by Reference 4.

4.3.1 General Inspection Procedures and Compliance Information

4.3.1.1 General Inspection Procedures--

Figure 4-6 is an example inspection form which may be completed at the start of the Level II or III inspection by interviewing plant personnel. After determining any changes from the last inspection, a more thorough plant inspection should be performed. "In-plant" inspections for a watering/chemical suppression program may consist of one or more of the following items:

1. Qualitative assessment of the water/chemical truck spray pattern.

2. "Spot" checks of pertinent traffic patterns.

3. Surface material sampling.

Each of these items is discussed in more detail below.

The qualitative evaluation of the water/chemical truck spray pattern should verify that:

1. The spray pattern is roughly uniform over the treated area.

2. The observed application pattern (i.e., one or more passes by the truck), effectively treats the entire travel surface.

If the spray pattern is not uniform, it often produces "ponding" of water/chemical in small areas with little or no water/chemical over other areas of the surface. The practical result is that although the average application intensity (e.g., gal/yd^2) based on calculations appears to provide acceptable levels of control, an erratic spray pattern in reality results in lower control efficiencies. Also, the inspector may want to record the vehicles' odometer reading to compare against the last reading and facility records.

If the facility personnel indicate marked changes in traffic patterns, traffic volume, etc., or if the control plan calls for vehicle volume reduction (see Section 4.2), the inspector may wish to spot-check traffic parameters at selected roads in the facility. This is accomplished by taking manual traffic mix data. General procedures for manual mix observations are outlined in Figure 4-7.

Finally, the inspector can spot-check controlled roads by taking material grab samples and comparing the moisture or silt content with a minimum acceptable value specified in the control plan/operating permit, as applicable. This represents an "indirect" measure of compliance determination as discussed in Section 2. An illustration of this technique to spot-check control efficiency of water and chemical suppressants is presented later in Sections 4.3.2.3 and 4.3.3.3, respectively. Figure 4-7 describes briefly the procedures for collecting material samples. A more complete description can be found in Appendix F.

Business License Name of Corporation, Company, or Individual Owner or Governmental Agency:

Mailing Address:

Plant Address:

Name and Title of Company Representative:

Telephone Number:

Name of Official Conducting Inspection:

General Questions for Plant Personnel

	Yes*	No	N/A	Comments
1. Have any roads been eliminated/blocked off since last inspection?				
2. Have any roads been paved since last inspection?				
3. Any new roads?				
4. Have traffic volumes or vehicle characteristics on roads changed because of process changes, shutdown, etc.?				
Controls				
5. Have any changes been made in control program since last inspection?				
Watering				
6. Any new equipment?				
7. Any equipment downtime since last inspection?				
Chemicals				
8. Any receipts since last inspection?				
9. Any new equipment?				
10. Any equipment downtime?				
11. Have any treated roads been repaired (e.g., bladed, filled in, etc.)?				
12. Any supplemental cleaning (e.g., flushing) since last inspection?				

* If any answer is yes, complete comment section.

Figure 4-6. Example inspection form.

Procedures for Obtaining Manual Traffic Mix Data

Required equipment: Stopwatch, traffic count log (see Figure 4-3)

Procedure:

1. Select unobstructed observation point.

2. Determine distance between two easily defined points (A,B) on the road segment in question.

3. Indicate mix start time.

4. For each passing vehicle, record vehicle type (if known), the number of axles/wheels, and the time in seconds required to travel between points A and B. Alternately, an accumulating stopwatch may be used to determine the average time required to travel between A and B.

5. Record mix stop time.

Procedures for Obtaining Surface Material Samples

Required equipment: Hand (whisk) broom, dustpan

Procedure:

1. Measure the width of the traveled portion of the roadway.

2. Remove the loose surface material from the hard road base with the hand broom and dustpan. The sample should be taken across the entire traveled portion of the road using an 8-in wide sample strip.

3. Place sample in a container and analyze for moisture or silt content as described in Appendix F.

Figure 4-7. Procedures for obtaining manual traffic mix and material samples.

4.3.1.2 Plant Record Keeping Requirements--

Records must be kept that document the date, time, and amount of water/chemical applied to unpaved surfaces. Pertinent parameters that should be specified in a control plan include:

- All road segments and parking locations referenced on a map available to both the responsible party and the regulatory agency (see Figure 4-1 for an example).

- Length of each road and area of each parking lot.

Watering

- Amount of water applied to each road/area and planned frequency of application. (Alternatively, a minimum moisture level could be specified. This is discussed in greater detail later in this section.)

- Any provisions for weather (e.g., 1/4 in of rainfall will be substituted for one treatment; program suspended during freezing periods; watering frequency as a function of temperature, cloud cover, etc.).

- Source of water and tank capacity.

Chemical treatment

- Type of chemical applied to each road/area, dilution ratio, application intensity, and frequency of application.

- Any provisions for weather (e.g., application of chemical dust suppressants during cooler periods of the year may be inadvisable for traffic safety reasons).

4.3.2 Watering

4.3.2.1 Control Efficiency Determination--

The control efficiency of unpaved road watering depends upon: (a) the amount of water applied per unit area of road surface; (b) the time between reapplications; (c) traffic volume during that period; and (d) prevailing meteorological conditions during the period. While several investigations have estimated or studied watering efficiencies, few have specified all the factors listed above.

An empirical model for the performance of watering as a control technique has been developed.[5] The supporting data base consists of 14 tests performed in four states during five different summer and fall months. The model is:

$$C = 100 - \frac{0.8\ p\ d\ t}{i} \qquad (4\text{-}2)$$

where C = average control efficiency, %
p = potential average hourly daytime evaporation rate, mm/h
d = average hourly daytime traffic rate, h^{-1}
i = application intensity, L/m^2
t = time between applications, h

Estimates of the potential average hourly daytime evaporation rate may be obtained from:

$$p = \begin{cases} 0.0049 \times \text{(value in Figure 4-8) for annual conditions} \\ 0.0065 \times \text{(value in Figure 4-8) for summer conditions} \end{cases}$$

Note that Figure 4-8 does not present data for Alaska and Hawaii. Readers responsible for those portions of the country should consult local meteorological data from local weather stations, state universities, etc.

An alternative approach is presented as Figure 4-9 which shows that between the average uncontrolled moisture content and a value of twice that, a small increase in moisture content results in a large increase in control efficiency. Beyond this point, control efficiency grows slowly with increased moisture content according to the relationship:

$$C = \begin{cases} 75(M-1) & 1 \le M \le 2 \\ 62 + 6.7M & 2 \le M \le 5 \end{cases}$$

where C = instantaneous control efficiency, %
M = ratio of controlled to uncontrolled surface moisture contents

An example using this procedure is illustrated in Section 4.3.2.3.

4.3.2.2 Record Keeping Review--
To determine compliance using record keeping, the facility must maintain records for each road segment/parking area including:

1. Date of treatment.

2. Operator's initials (note that the operator may keep a separate log from which information is transferred to the environmental staff's data sheets).

3. Start and stop times on a particular segment/parking lot, average speed, number of passes.

4. Start and stop times for tank filling.

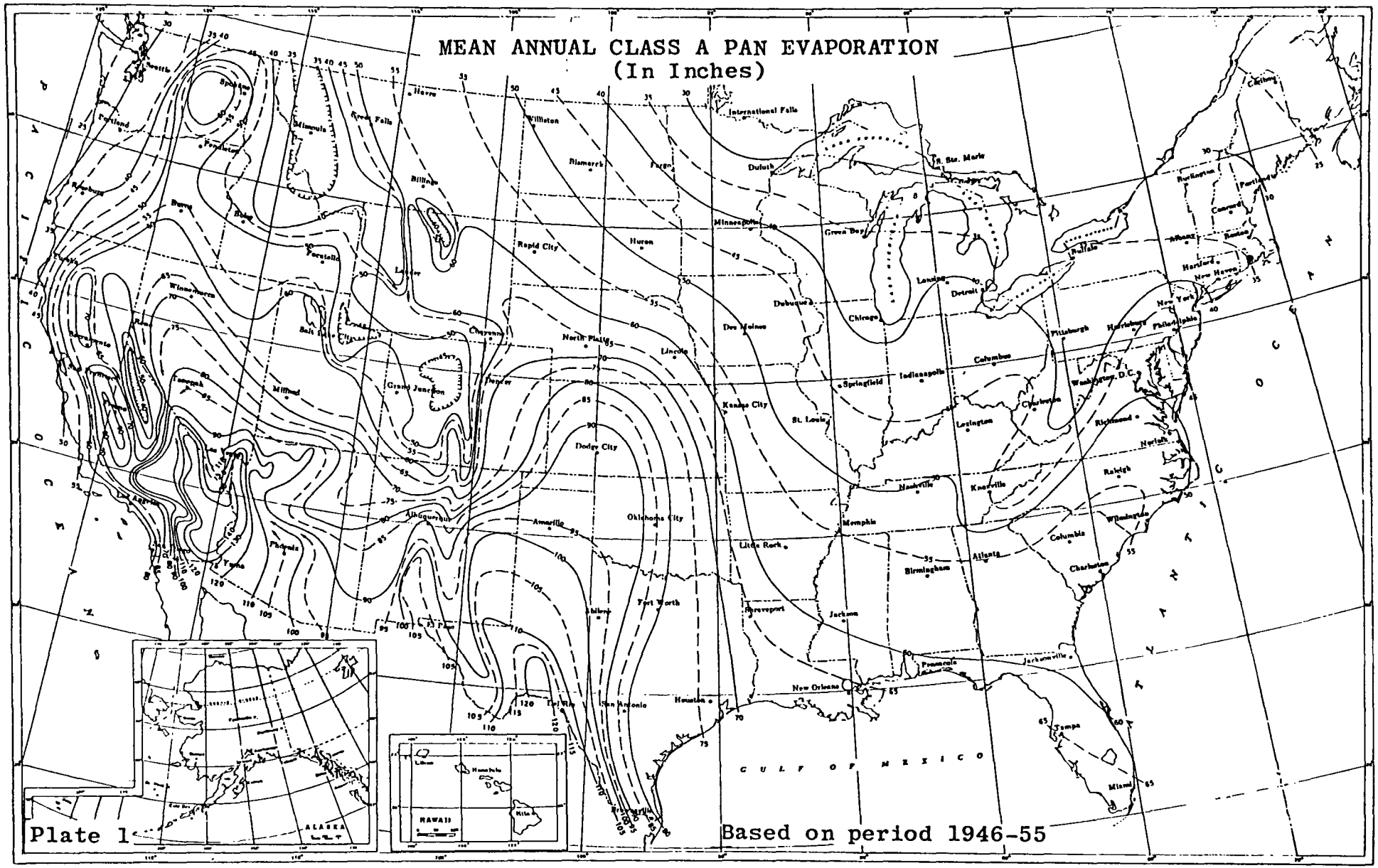


Figure 4-8. Annual evaporation data for the contiguous United States (as diagrammed in the "Climate Atlas of the United States," June 1968).

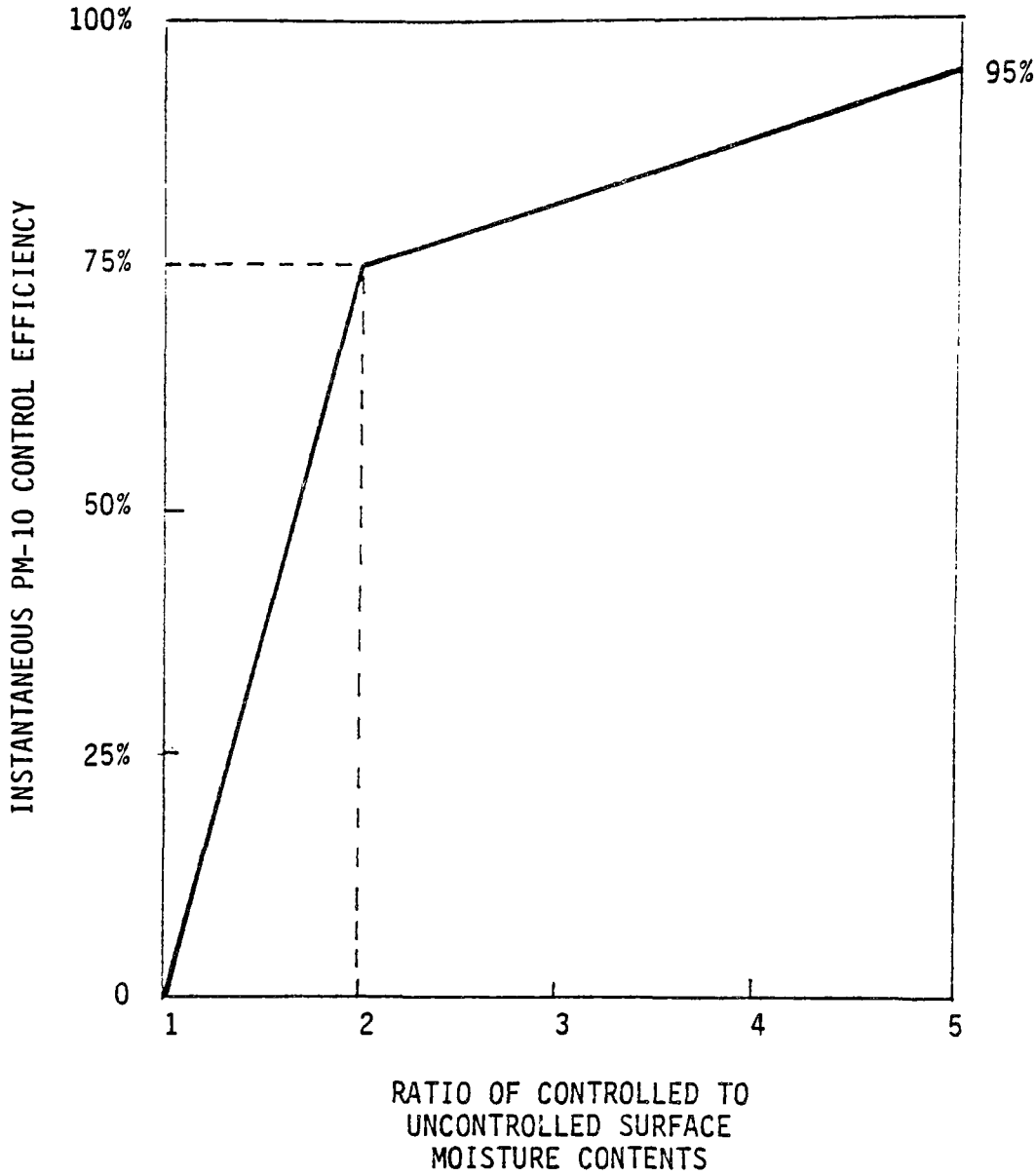


Figure 4-9. Watering control effectiveness for unpaved travel surfaces.

Figure 4-10 is an example form which plant personnel can complete when applying water to unpaved roads. In addition, plant-wide records must be kept including:

1. Equipment maintenance records.

2. Meteorological log (to the extent that weather influences the control program).

3. Any equipment malfunctions or downtime.

The procedures described above allow an inspector to review historical data to determine compliance. A procedure is described below which provides an independent assessment of dust control while the inspector is on-site.

Example Compliance Determination--Record Keeping for a Watering Program. This example considers the hypothetical facility X with unpaved roads and staging areas shown in Figure 4-1. Facility X is located in a PM_{10} nonattainment area and has an approved dust control plan that specifies the following conditions:

1. Application intensity ≥ 0.20 gal/yd² (0.91 L/m²).

2. Application frequency of twice/10-h workday.

3. Watering according to the application parameters is to be performed from April 1 through October 31.

4. Each ¼ in of rainfall (in the previous 24 h) will be substituted for one treatment, and the program will be suspended for days where the morning temperature (8 a.m.) does not exceed 32°F.

Note that the permit also specifies watering between 11:00 a.m. and 3:00 p.m. when the ambient temperature at 11:00 a.m. is ≥ 40°F for the period from November 1 to March 31.

The source extent parameters for unpaved surfaces at facility X are given below:

Segment/area	Length (ft)	Width (ft)	Approx. area (yd²)	Vehicle passes per hour	Vehicle speed (mph)
D	800	40	3,600	40	10
E	500	25	1,400	1	5
F	1,000	40	4,500	40	10
G	1,200	40	5,300	40	10
H (staging area)	-	--	10,000	40	5
I (staging area)	-	--	17,000	40	5

WATER APPLICATION LOG

Date	Time	Application intensity (gal/yd^2)	Area(s) treated	Climatic parameters		Equipment used	Operator initials	Comments
				Amb. temp. (°F)	Date/amt. of last rainfall			

Figure 4-10. Example water application log.

The facility operates a 5,000-gal water truck equipped with a 10-ft spray bar. Visual observation indicates that two water truck passes (i.e., one in each direction) effectively treats the travel surface of the unpaved roads. Five to six passes are required to cover the travel portions of the staging areas (H and I).

Example records kept by facility X to document its watering program are shown in Figure 4-11 (meteorological data log), and in Figure 4-12 (operator's log). The inspector responsible for the facility would, in practice, compare these two records for compliance with permit conditions. The check is intended to verify that all the unpaved roads and staging areas have been treated twice daily (except after significant rainfall or under freezing conditions). Note in Figure 4-12 that only one treatment is logged for 6/22 as 0.27 in of rainfall was recorded for the previous 24-h period.

If it is suspected that the documentation is inaccurate, for example, treatments are logged for periods where no water was applied, the operator's log can be cross-checked against any facility records kept for maintenance/service of the water truck. These records are typically more complete than those for the watering program. If the two sets of records do not match, the facility should be required to submit a written explanation for the apparent discrepancy.

Information compiled in the operator's log represents critical data against which operations observed during Level II and III inspections should be evaluated. For example, Figure 4-12 provides a basis for estimating the typical length of time for a typical "cycle"--the time required to complete a single application to all facility unpaved surfaces. For facility X, this cycle length is on the order of 2 h. In practice, if cycles observed during an inspection deviated considerably from those indicated in the operator's log, the inspector should require the facility to explain the reasons for the deviation.

In a similar fashion, while the operator's log does not allow the inspector to directly determine application intensity--the amount of water applied per unit surface area--a check of filling times during inspection does provide a qualitative indicator of whether or not the facility is, in fact, complying with its permit requirements. In the case of facility X, a typical filling time is on the order of 10 to 15 min. In practice, if the inspector can approximate the filling rate (from a knowledge of pump specifications), it is fairly easy to determine whether application intensities suggested by the log information meet permit requirements.

This procedure can be illustrated for facility X as follows:

1. The pattern of applications indicated in the operator's log--

   E (1 pass)/F (2 passes)/and complete application to staging area I--corresponds to 22,200 yd^2.

Facility X Meteorological Data Log

Month/Year: 06/89 Observer JPM

Day	Obs. Time	Precipitation (in)	Temperature (°F)	Comments
01	8:05	–	64	
02	8:05	–	64	
03				
04				
05	8:10	0.10	78	Rained on Sunday
06	8:10	–	72	
07	8:10	–	73	
08	8:10	0.08	72	
09	8:10	–	77	
10				
11				
12	8:05	3.12	56	Rained Sat & Sun, Roads Muddy
13	8:05	–	67	Roads still visibly wet (puddles)
14	8:05	–	71	Roads dry enough to water
15	8:05	–	74	
16	8:05	–	77	
17				
18				
19	8:05	0.66	64	Roads wet -- No watering
20	8:05	–	70	
21	8:05	–	74	
22	8:05	0.27	79	Skip morning application
23	8:05	–	79	
24				
25				
26	8:05	T	74	
27	8:05	–	76	
28	8:05	–	76	
29	8:05	–	78	
30	8:05	–	75	
31				

T = Trace

Figure 4-11. Meteorological data log for example facility X.

Facility X Water Control Program--Operator's Log

Date	Tank Fill Time Start	Tank Fill Time Stop	Road Segments/Areas Treated Start	Road Segments/Areas Treated	Road Segments/Areas Treated Stop	Comments	Op. Initials
6/01	8:45	8:55	9:00	E(1 pass)/F(2)/I(complete)	9:35		JPM
6/01	9:45	10:00	10:00	D(2)/G(2)/H(complete)/E(1)	10:45		JPM
6/01	1:05	1:20	1:20	D(2)/G(2)/H(complete)/E(1)	2:00		JPM
6/01	2:05	2:15	2:15	E(1)/F(2)/I(complete)	3:00		JPM
				•			
				•			
				•			
				•			
6/05	8:15	8:30	8:30	E(1)/F(2)/I complete	9:10		JPM
6/05	9:20	9:30	9:30	D(2)/G(2)/H complete/E(1)	10:15		JPM
6/05	1:00	1:15	1:20	D(2)/G(2)/H complete/E(1)	2:00		JPM
6/05	2:05	2:20	2:20	E(1)/F(2)/I complete	3:00		JPM
				•			
				•			
				•			
				•			
6/22	1:00	1:15	1:20	E(1)/F(2)/I(complete)	2:00		JPM
6/22	2:05	2:15	2:15	D(2)/G(2)/H(complete)/E(1)	3:00		JPM
				•			
				•			
				•			

Figure 4-12. Operator's log for example facility X.

2. Thus the minimum application intensity of 0.20 gal/yd² requires 4,440 gal (22,200 yd² x 0.20 gal/yd² = 4,440 gal).

3. Given a 10-min filling time, this corresponds to a fill rate of about 400 gal/min.

During an inspection, the inspector for facility X would verify the length of time required to completely fill the tank from an initial near-empty state. Because the application cycle cited above (one-half of the total cycle) requires nearly the entire tank capacity, it follows that if the tank is not at least 90% full after a typical fill time, then it is likely that facility X is not watering at the required application intensities.

4.3.2.3 "In-Plant" Inspection Procedures

An "in-plant" inspection to determine compliance with fugitive dust rules or permit conditions for unpaved roads involves focusing on several items including:

- A visual inspection of the facility in order to observe that all unpaved roads listed in the state permit/control plan still exist and whether additional roads have been developed.

- An examination of the source's records (as described above) documenting frequency of water application, amount applied, area(s) watered, etc.

- Observations of any spraying operations undertaken by the source during the inspector's visit.

After becoming familiar with the plant facilities and the control plan, the inspector should request that plant personnel provide the information that will allow the inspector to complete the example work sheet shown in Figure 4-6. The inspector would conduct a full inspection of the facility in order to obtain and verify actual operating conditions.

The inspector should spot-check the controlled roads by taking either traffic counts or material grab samples from the road(s). The moisture or silt content of the traveled portion of the roadway may be compared against a minimum acceptable value specified in the control plan/operating permit to determine compliance. This is considered to be an indirect method of compliance determination as discussed in Section 2. For example, the control plan/operating permit may specify that the control efficiency can never be below 75% or the average instantaneous control efficiency must not be below 85%. If the latter is specified, more samples would be required because the instantaneous efficiency must be tracked over time.

To illustrate, assume that a facility waters unpaved road D (Figure 4-1) every 3 h to control fugitive emissions. A field estimate of the control efficiency can be determined by the following steps:

1. Determine the uncontrolled moisture content by sampling prior to the first control of the day and having the facility not water a small portion of the road. Then collect a sample and determine moisture content using the procedures found in Appendix F. The uncontrolled moisture content needs only to be collected once. In this example, the uncontrolled moisture is assumed equal to 1.5%.

2. Assume the facility waters road D (Figure 4-1) at noon and again at 3 p.m. A moisture sample should be taken right after water was applied, at 1 p.m., 2 p.m., and again right before reapplication at 3 p.m.

3. Each sample should be analyzed for moisture content as quickly as practical, again following the procedures found in Appendix F.

4. Next, the control efficiency can be determined by calculating the controlled to uncontrolled ratio and using Figure 4-9. Assume the following moistures from the four samples were:

Sample no.	Time	Moisture content (%)
1D	Noon	6.75
2D	1 p.m.	6.00
3D	2 p.m.	5.25
4D	3 p.m.	3.75

Therefore, the moisture content ratios and associated control efficiency values are:

Sample No.	Ratio	Control (%)
1D	6.75/1.5=4.5	92
2D	4.0	89
3D	3.5	85
4D	2.5	79
	Average	86

The instantaneous control efficiencies for this example are shown on Figure 4-13. Note that for this example, this facility would be in compliance with both a minimum of the 75% instantaneous or 85% average control limits.

4.3.3 Chemical Treatments

4.3.3.1 Determination of Control Efficiency--

As noted in Section 4.2, some chemicals (most notably salts) simulate wet suppression by attracting and retaining moisture on the road surface. These methods are often supplemented by some watering. In these cases it is

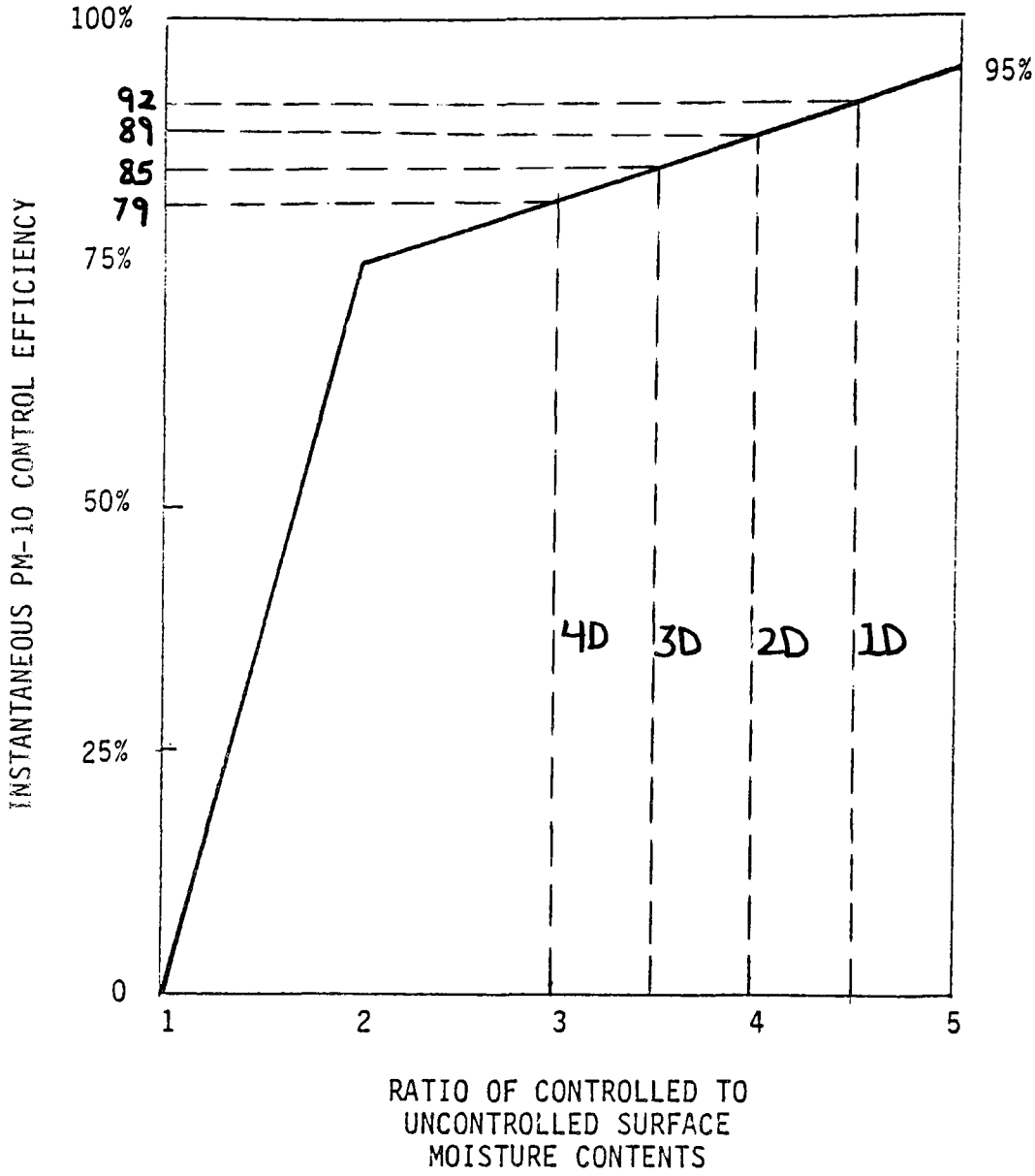


Figure 4-13. Watering control effectiveness for unpaved road D in example problem.

recommended that control efficiency estimates be obtained using Figure 4-9 and enforcement be based on the grab sample moisture content technique described above in Section 4.3.2.3.

The more commonly used chemical dust suppressants form a hard cemented surface. It is this type of suppressant that is considered below.

Besides water, petroleum resins (such as Coherex) have historically been the products most widely used and evaluated. However, considerable interest has been shown in alternative chemical dust suppressants. These have included asphalt emulsions, acrylics, and adhesives. In addition, "generic" petroleum resin formulations (designed to be produced on-site) have gained considerable attention. On-site production of this type of suppressant in quantities commonly used at iron and steel plants has been estimated to reduce chemical costs by approximately 50%.[6]

In an earlier test report, average performance curves were generated for four chemical dust suppressants commonly used in the iron and steel industry: (a) a commercially available petroleum resin; (b) a generic petroleum resin for on-site production at an industrial facility; (c) an acrylic cement; and (d) an asphalt emulsion.[7] The results of this program were combined with other test results to develop a model to estimate time-averaged PM_{10} control performance. This model is illustrated as Figure 4-14. Several items are to be noted:

- The term "ground inventory" is a measure of residual effects from previous applications. Ground inventory is found by adding together the total volume (per unit area) of concentrate (not solution) since the start of the dust control season. An example is provided below.

- Note that no credit for control is assigned until the ground inventory exceeds 0.05 gal/yd^2.

- Because suppressants must be periodically reapplied to unpaved roads, use of the time-averaged values given in the figure are appropriate. Recommended minimum reapplication frequencies (as well as alternatives) are discussed later in this section.

- Figure 4-14 represents an average of the four suppressants given above. The basis of the methodology lies in a similar model for petroleum resins only.[7] However, agreement between the control efficiency estimates given by Figure 4-14 and available field measurements is reasonably good.

4.3.3.2 Record Keeping Review--

After becoming familiar with the plant facilities and the control plan, the inspector should request that plant personnel provide the information that will allow the inspector to complete the example inspection form shown in Figure 4-6. The inspector would conduct a full inspection of the facility in order to obtain and verify actual operating conditions. Specific records for each road segment/parking area should include:

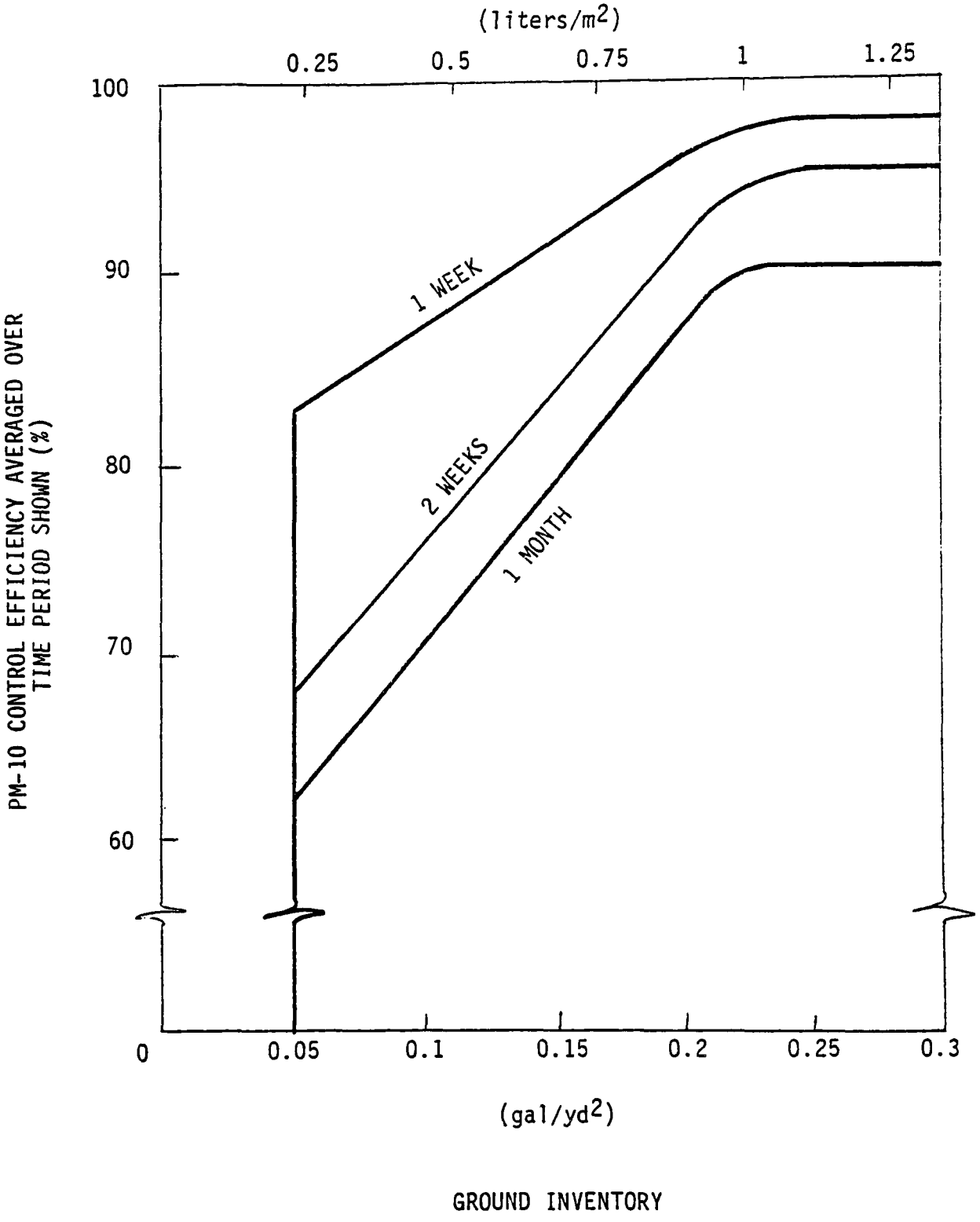


Figure 4-14. Average PM_{10} control efficiency for chemical suppressants.

1. Date of treatment.

2. Operator's initials (note that the operator may keep a separate log of whose information is transferred to the environmental staff's data sheets).

3. Start and stop times on a particular segment/parking lot, average speed, number of passes, amount of solution applied, and dilution. Figure 4-15 is a typical form which plant personnel can complete when applying chemical dust suppressants to unpaved roads.

4. Qualitative description of road surface condition.

In addition, plant-wide records must be kept including:

1. Equipment maintenance records.

2. Suppressant delivery record. Figure 4-16 is an example.

3. Meteorological log (to the extent that weather influences the control program).

4. Any equipment malfunctions or downtime.

These plant-wide records provide the inspector with the information necessary to cross-check the records kept for individual road segments. For example, the start/stop inventories and suppressant delivery record should be compared to the final ground inventory values over all roads at the facility. Also, application records should be checked against the meteorological and equipment maintenance/downtime records. The inspector should request plant personnel to explain any discrepancies.

Another form which can be used as part of record keeping review of chemical control programs is presented in Figure 4-17. A completed form containing typical data is shown in Figure 4-18. The following is an example using the information in Figure 4-16 as applied to the determination of monthly average control efficiency using Figure 4-14 above.

Suppose that Equation 4-1 has been used to estimate a PM_{10} emission factor of 2.0 kg/VKT. Further, suppose that starting on May 1, the road is treated with 0.25 gal/yd^2 of a (1 part chemical to 5 parts water) solution on the first of each month until October. In this instance, the following average controlled emission factors are found:

Date	Time	delivered	delivered	agent	Facility destination[a]	Comments

[a] Denote whether suppressant will be applied immediately upon receipt or placed in storage.

Figure 4-15. Typical form for recording delivery of chemical dust suppressants.

Date	Time	Type of chemical	Dilution ratio	Application intensity, gal/yd^2	Area(s) treated	Equipment used	Operator initials	Comments

Figure 4-16. Typical form for recording chemical dust suppressant control parameters.

CHEMICAL SUPPRESSANT APPLICATION LOG AND WORKSHEET

Site Description _____

Treatment No.	Date	Application Intensity (gal/yd^2)	Dillution Ratio (water:chem)	Ground Inventory (gal/yd^2)	Period (days)	Average PM-10 Control (%)

Figure 4-17. Example chemical suppressant application log.

CHEMICAL SUPPRESSANT APPLICATION LOG AND WORKSHEET

Site Description _____

Treatment No.	Date	Application Intensity (gal/yd^2)	Dillution Ratio (water:chem)	Ground Inventory (gal/yd^2)	Period (days)	Average PM-10 Control (%)
1	5/1	0.25	5:1	0.042	31	0
2	6/1	0.25	5:1	0.083	30	68
3	7/1	0.25	5:1	0.125	31	75
4	8/1	0.25	5:1	0.167	31	82
5	9/1	0.25	5:1	0.208	30	88

Figure 4-18. Example completed log.

Period	Ground inventory (gal/yd²)	Average control efficiency (%)[a]	Average controlled emission factor (kg/VKT)
May	0.042[b]	0	2.0
June	0.083	68	0.64
July	0.12	75	0.50
August	0.17	82	0.36
September	0.21	88	0.24

[a] From Figure 4-14; zero efficiency assigned if ground inventory is less than 0.05 gal/yd².

[b] 0.25 gal/yd² x 1/6 = 0.042.

Additional topics must also be considered when inspecting roads controlled by chemical dust suppressants. These are briefly discussed below.

* Use of paved road controls on chemically treated unpaved roads. Repeated use of certain chemical dust suppressants tend, over time, to form fairly impervious surfaces on unpaved roads. The resulting surface may allow the use of paved road cleaning techniques (such as flushing, sweeping, etc.) to reduce aggregate loading due to spillage and track-on. A field program conducted tests on surfaces that had been flushed and vacuumed 3 d earlier.[7] (The surfaces themselves had last been chemically treated 70 d before.) Control efficiency values of 90% or more (based on the uncontrolled emission factor of the unpaved roads) were found for each particulate size fraction considered.

The use of paved road techniques for "housekeeping" purposes would appear to have the benefits of both high control (referenced to an uncontrolled unpaved road) and potentially relatively low cost (compared to follow-up chemical applications). Generally, it is recommended that these methods not be employed until the ground inventory exceeds approximately 0.2 gal/yd² (0.9 L/m²) and the paved controls be tested on a small portion of the chemically treated road prior to full-scale implementation.

* Minimum reapplication frequency. Because unpaved roads in industry are often used for the movement of materials and are often surrounded by additional unpaved travel areas, spillage and carryout onto the chemically treated road require periodic "housekeeping" activities. In addition, gradual abrasion of the treated surface by traffic will result in loose material on the surface which should be controlled.

It is recommended that at least dilute reapplications be employed every month to control loose surface material unless paved road control techniques are used (as described above). More frequent reapplications would be required if spillage and track-on pose particular problems for a road.

* Weather considerations. Roads generally have higher moisture contents during cooler periods due to decreased evaporation. Small increases in surface moisture may result in large increases in control efficiency (as referenced to the dry summertime conditions inherent in the AP-42 unpaved road predictive equation).[8] In addition, application of chemical dust suppressants during cooler periods of the year may be inadvisable for traffic safety reasons.

4.3.3.3 "In-Plant" Inspection Procedures for Chemical Treatment--

While record keeping affords a convenient method of assessing long-term control performance, it is important that regulatory personnel have "spot-check" compliance tools at their disposal (i.e., a hand broom and dustpan). The inspector should broom sweep a portion of the road and determine silt loading as described in Appendix F. The industrial paved road equation (Equation 3-1) will conservatively overestimate controlled emissions:

$$\text{Control efficiency (\%)} \geq \left\{ \frac{[\text{Result from Equation 4-1 for } p=0] - [\text{Result from Equation 3-1}]}{\text{Result from Equation 4-1 for } p=0} \right\} \times 100\%$$

Note that this compliance tool (unlike others in this section) requires the inspector to obtain the all-information necessary to estimate the two emission factors (i.e., Equations 3-1 and 4-1).

4.4 REFERENCES FOR SECTION 4

1. Environmental Protection Agency. Compilation of Air Pollution Emission Factors (AP-42). Research Triangle Park, North Carolina. September 1985.

2. Climatic Atlas of the United States. U.S. Department of Commerce, Washington, D.C. June 1968.

3. Rosbury, K. D. 1984. Fugitive Dust Control Techniques at Hazardous Waste Sites. Interim Technical Report No. 1--Proposed Field Sampling Plan, Contract No. 68-02-3512, WA 61, U.S. Environmental Protection Agency, Municipal Environmental Research Laboratory, Cincinnati, Ohio. March 1984.

4. Turner, J. H., et al. 1984. Fugitive Particulate Emissions From Hazardous Waste Sites. Prepared for the U.S. Environmental Protection Agency, Cincinnati, Ohio. September 1984.

5. Cowherd, C., Jr., and J. S. Kinsey. 1986. Identification, Assessment and Control of Fugitive Particulate Emissions. EPA-600/8-86-023, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina.

6. Russell, D., and S. C. Caruso. 1984. The Relative Effectiveness of a Dust Suppressant for Use on Unpaved Roads Within the Iron and Steel Industry. Presented at EPA/AISI Symposium on Iron and Steel Pollution Abatement, Cleveland, Ohio. October 1984.

7. Muleski, G. E., and C. Cowherd, Jr. Evaluation of the Effectiveness of Chemical Dust Suppressants on Unpaved Roads. EPA-600/2-87-102, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina. November 1987.

8. Muleski, G. E., T. Cuscino, Jr., and C. Cowherd, Jr. 1984. Extended Evaluation of Unpaved Road Dust Suppressants in the Iron and Steel Industry. EPA-600/2-84-027, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina. February 1984.1

SECTION 5

STORAGE PILES

Particulate emissions from aggregate storage piles occur whenever the material is disturbed, relocated, or subjected to wind speeds above the material-specific erosion threshold value. The quantity of emissions released from storage pile activity is dependent on the amount of material involved, its moisture content, silt content, and friability. Emissions are also affected by the material load-in, load-out, and maintenance techniques and by the characteristics of vehicles traveling on and around the storage pile area.

Storage piles are found in most operations that use minerals in aggregate form. Materials can be transferred to and from storage piles by a variety of techniques which can include fixed stacker-reclaimer systems, front end-loaders, scrapers, and other types of mobile equipment. Storage piles are usually left exposed to the ambient winds because of the costs associated with enclosing them and because of the impediment that enclosures cause to the usual requirement for frequent material transfer.

There are two generally recognized mechanisms responsible for the direct generation of dust emissions from storage pile operations. They include:

- Materials handling operations, and
- Wind erosion.

In addition, if vehicular traffic is required for stockpiling activities, vehicles can often be the predominant source of PM_{10} emissions from the area. The traffic-related sources can be assessed, controlled and inspected as discussed in detail in Section 4.

Particulate emissions from the two direct storage pile sources (i.e., materials handling and wind erosion) can be controlled by one of three general methods. These include: containments to physically shelter the pile from ambient winds; surface treatments to agglomerate exposed particulate; and source extent control to reduce the amount of material handled and to enhance natural crusting.

5.1 ESTIMATION OF EMISSIONS

Sections 5.1.1 and 5.1.2 provide methods that can be used for predicting the emissions from materials handling and wind erosion sources associated with storage piles. The quantity of emissions estimated by these techniques are dependent on the physical characteristics of the stockpiled material, on the amount of material handled, and on the local meteorology.

If a fairly complete inventory of the area is needed, then the first step toward the determination of storage pile emissions for a given facility is to identify and map each pile within that facility. Figure 5-1 and Figure 5-2 are sample maps of an example facility X and of storage piles located within that facility, respectively. Once the piles have been identified, estimates can be obtained for the material throughput, the frequency with which the pile surface is disturbed, pile perimeter dimensions, average pile height, and vehicle specifications for any mobile equipment used on or around the storage piles. In addition, climatological data from the nearest recording weather station should be obtained.

Finally, any vehicular traffic related to the area must be identified and emissions estimated using the information presented in Section 4. Figure 5-3 shows typical storage pile emissions for vehicular traffic and materials handling operations.

5.1.1 Estimation of Emissions from Materials Handling Stockpiled Material

Adding aggregate material to a storage pile or removing it usually involves the dropping of material onto a receiving surface or receptacle. This can be performed by one of two methods: by continuous feed as exemplified by conventional fixed stacker reclaimers, or by batch operations such as would be performed by mobile equipment (i.e., front-end loader, truck, or pan scraper).

In order to estimate the emissions from the loading of material in and out of storage piles, one must first obtain a sample of the stockpiled material and a record of historical wind data at that location (Summaries of Local Climatological Data).[1] From the Local Climatological Data (LCD), the mean wind speed can be obtained for the nearest recording weather station (as illustrated by Figure 5-4). This wind speed can be adjusted from the recording anemometer height to represent the wind speed at the average storage pile height by using the procedure described in Section 11.2.7 of EPA's *Compilation of Emission Factors* (AP-42).[2] Aggregate sampling and subsequent moisture analysis should then be performed on the sample(s) as described in Appendix F.

Once the mean wind speed and the material moisture content have been determined, the following equation can be used to estimate emissions from the transfer operations (batch or continuous drop):

$$E = k\ (0.0016)\ \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\quad (\text{kg/Mg}) \qquad (5\text{-}1)$$

where: E = emission factor
k = particulate size multiplier (dimensionless) = 0.35 for PM_{10}
U = mean approach wind speed (m/s), at height of transfer operation
M = material moisture content (percent)

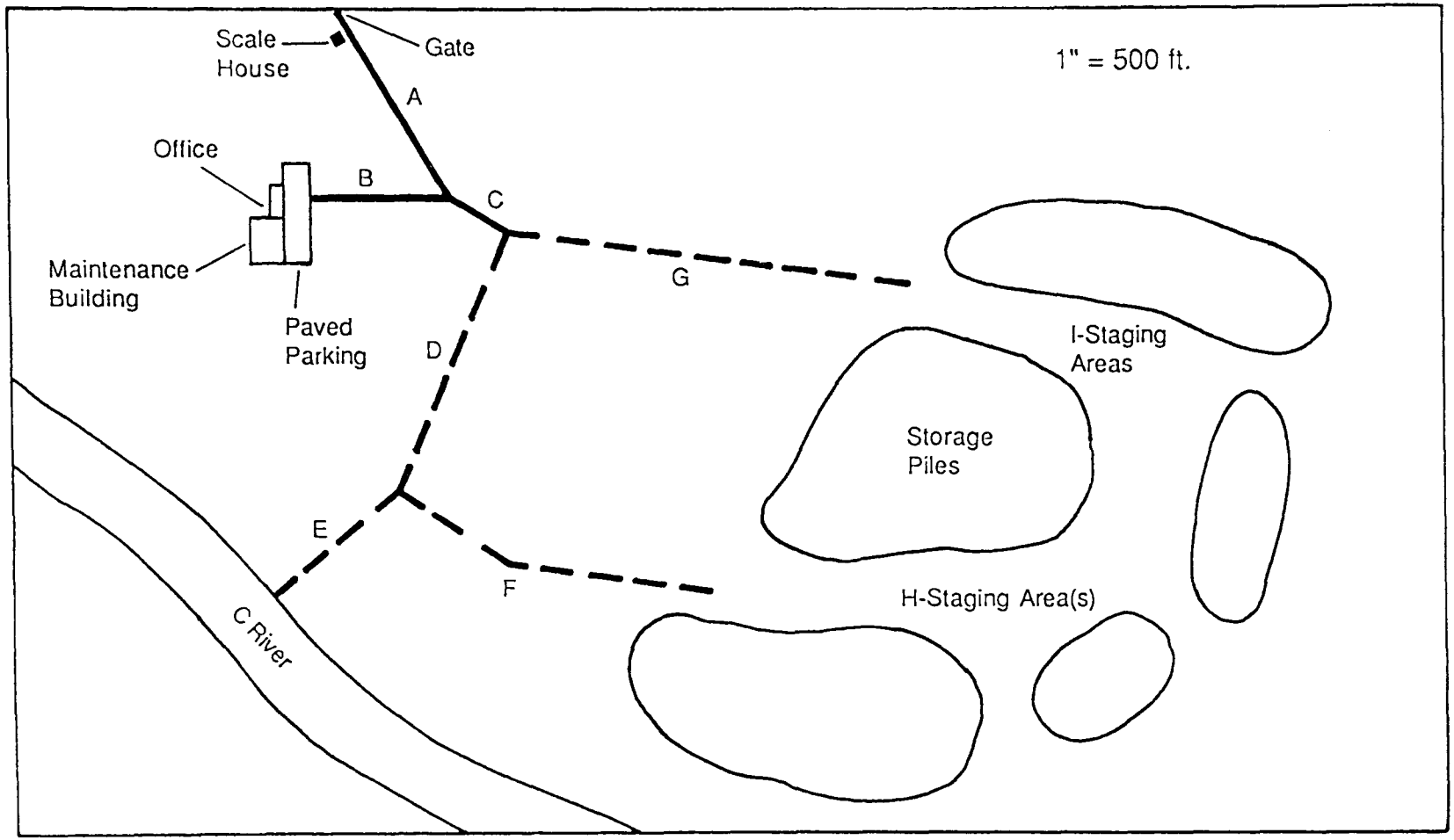


Figure 5-1. Map of example facility X.

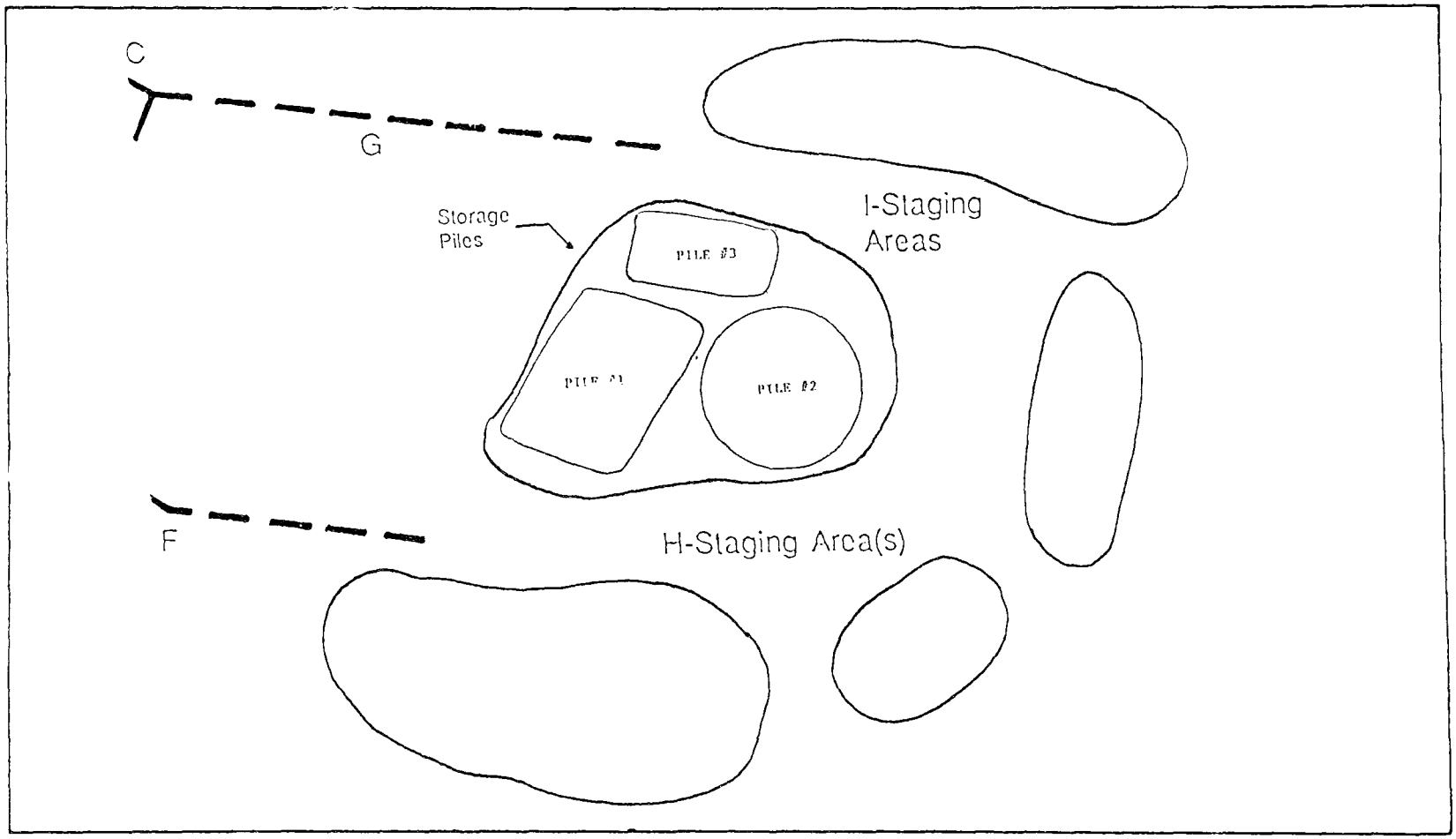
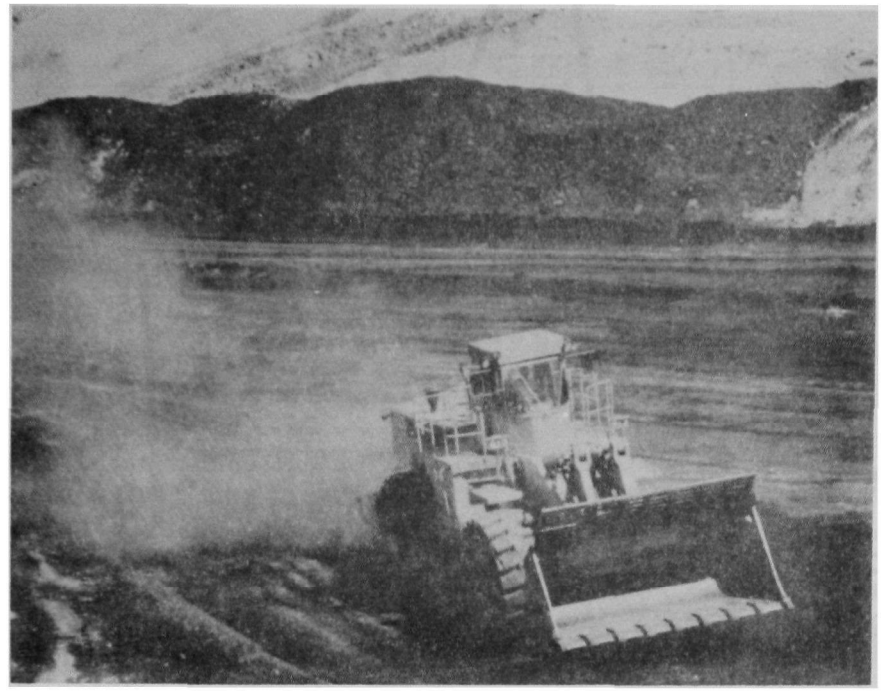


Figure 5-2. Map of storage piles located within facility X.



(a) Storage pile vehicular traffic.

(b) Storage pile load-in with boom stacker.

Figure 5-3. Typical storage pile emission sources.

Standard ti... ...NTRAL 41° 59 N Lo...

| | | |

This equation shows that, for the handling of aggregate materials, emissions increase with the ambient wind speed and are reduced as the material moisture content increases.

5.1.2 Estimation of Emissions from Wind Erosion of Stockpiled Material

Field testing of various stockpiled surfaces using a portable wind tunnel has demonstrated that;

a. Threshold wind speeds exceed 5 m/s (11 mph) at 15 cm above the pile surface which is equivalent to 10 m/s (22 mph) at 7 m above the pile surface.

b. Particulate emission rates tend to decay rapidly (half life of a few minutes) during an erosion event.

c. Precipitation events cause natural crusting of surface material by binding the erodible material, thereby reducing the erosion potential.

Although in some instances wind erosion can be substantial, wind erosion is usually considered the least significant of the mechanisms responsible for dust emissions from storage piles. In most industrial settings, fugitive emissions from vehicular traffic and materials handling overwhelm emissions from wind erosion. If vehicular traffic is present in and around the storage pile area, those emissions are generally far greater than that due to materials handling.

If it is necessary to estimate the particulate emissions from the wind erosion of storage piles, one must first obtain an aggregate sample of the stockpiled material and a record of historical wind data for the nearest recording meteorological station. From the Local Climatological Data (LCD) the fastest mile of wind can be obtained for the nearest recording weather station (as illustrated by Figure 5-5). The fastest mile of wind should then be adjusted to represent the wind speed that impacts the storage pile surface and an equivalent friction velocity determined as described in Section 11.2.7 of AP-42.[2] Aggregate sampling and determination of the threshold friction velocity should also be performed according to the procedures described in Appendix F and AP-42, respectively.[2]

Once the friction velocity and the threshold friction velocity have been determined, the erosion potential (P) can be calculated as:

$$P = 58\ (u^* - u^*_t)^2 + 25\ (u^* - u^*_t) \qquad (5\text{-}2)$$

where: u^* = friction velocity (m/s)
u_t = threshold friction velocity (m/s)

The emission factor, as a summation over periods between material disturbances, can now be calculated as:

$$\text{Emission factor} = k \sum_{i=1}^{N} P_i \qquad (5\text{-}3)$$

where: k = particle size multiplier = 0.5 for PM_{10}
n = number of disturbances per year
P_i = erosion potential corresponding to the observed (or probable) fastest mile of wind for the ith period between disturbances (g/m^2)

In summary, emissions from wind erosion increase with the speed of wind gusts and with the number of times that the material is disturbed. These emissions can be controlled by reducing wind speeds and the number of disturbances or by increasing the threshold friction velocity (which is a function of the exposed surface particle size distribution).

5.1.3 Material Parameters Affecting Emissions

The two material properties that affect the quantity of emissions from material handling and wind erosion are the materials threshold friction velocity and its unbound moisture content. The threshold friction velocity is a quantitative description of the condition under which the surface material will begin to erode. It is a function of the material aggregate size distribution, density, and moisture content. The threshold friction velocity can be estimated by performing the sieving procedure outlined in Section 11.2.7 of AP-42. The moisture content of a given material simply describes the amount of water retained on the surface of the aggregate material (see Appendix F).

Typical silt values, and unbound moisture content values for some industrial aggregate materials are summarized in Table 5-1. Threshold friction velocities and the associated wind speeds (as measured at 10 m) are presented in Tables 5-2 and 5-3 for typical aggregate materials and soils, respectively. Estimates for emissions are considered more accurate if site specific data are used.

5.2 EMISSION CONTROL METHODS

As described in Table 5-4, there are a variety of options for the control of particulate emissions from storage piles. Note that these controls fall into one of four general categories. Each of these is discussed in greater detail below.

TABLE 5-1. TYPICAL SILT AND MOISTURE CONTENT VALUES OF MATERIALS AT VARIOUS INDUSTRIES

Industry	Material	No. of test samples	Silt, percent		No. of test samples	Moisture, percent	
			Range	Mean		Range	Mean
Iron and steel production[a]	Pellet ore	10	1.4-13	4.9	8	0.64-3.5	2.1
	Lump ore	9	2.8-19	9.5	6	1.6-8.1	5.4
	Coal	7	2-7.7	5	6	2.8-11	4.8
	Slag	3	3-7.3	5.3	3	0.25-2.2	0.92
	Flue dust	2	14-23	18.0	0	NA	NA
	Coke breeze	1		5.4	1		6.4
	Blended ore	1		15.0	1		6.6
	Sinter	1		0.7	0	NA	NA
	Limestone	1		0.4	0	NA	NA
Stone quarrying and processing[b]	Crushed limestone	2	1.3-1.9	1.6	2	0.3-1.1	0.7
Taconite mining and processing[c]	Pellets	9	2.2-5.4	3.4	7	0.05-2.3	0.96
	Tailings	2	NA	11.0	1		0.35
Western surface coal mining[d]	Coal	15	3.4-16	6.2	7	2.8-20	6.9
	Overburden	15	3.8-15	7.5	0	NA	NA
	Exposed ground	3	5.1-21	15.0	3	0.8-6.4	3.4

[a]References 2 through 5. NA = not applicable.
[b]Reference 1.
[c]Reference 6.
[d]Reference 7.

TABLE 5-2. THRESHOLD FRICTION VELOCITIES--ARIZONA SITES

Location	Threshold friction velocity, m/sec	Roughness height, (cm)	Threshold wind velocity at 10 m, m/sec
Mesa - Agricultural site	0.57	0.0331	16
Glendale - Construction site	0.53	0.0301	15
Maricopa - Agricultural site	0.58	0.1255	14
Yuma - Disturbed desert	0.32	0.0731	8
Yuma - Agricultural site	0.58	0.0224	17
Algodones - Dune flats	0.62	0.0166	18
Yuma - Scrub desert	0.39	0.0163	11
Santa Cruz River, Tucson	0.18	0.0204	5
Tucson - Construction site	0.25	0.0181	7
Ajo - Mine tailings	0.23	0.0176	7
Hayden - Mine tailings	0.17	0.0141	5
Salt River, Mesa	0.22	0.0100	7
Casa Grande - Abandoned agricultural land	0.25	0.0067	8

TABLE 5-3. THRESHOLD FRICTION VELOCITIES--INDUSTRIAL AGGREGATES

Material	Threshold friction velocity, m/s	Roughness height, cm	Threshold wind velocity at 10 m (m/s)		Ref.
			z_o = actual	z_o = 0.5 cm	
Overburden[a]	1.02	0.3	21	19	7
Scoria (roadbed material)[a]	1.33	0.3	27	25	7
Ground coal[a] (surrounding coal pile)	0.55	0.01	16	10	7
Uncrusted coal pile[a]	1.12	0.3	23	21	7
Scraper tracks on coal pile[a,b]	0.62	0.06	15	12	7
Fine coal dust on concrete pad[c]	0.54	0.2	11	10	12

[a]Western surface coal mine.
[b]Lightly crusted.
[c]Eastern power plant.

TABLE 5-4. CONTROL TECHNIQUES FOR EMISSIONS FROM STORAGE PILES

Containment	Buildings\Silos Wind fences Selective siting
Surface Treatments	Watering Chemical stabilization - Petroleum resins - Acrylic cements - Other
Source Extent	Reduced transfer operations Reduced disturbance area Reduced vehicular traffic
Natural Events	Previous erosion of fines Crusting by precipitation

5.2.1 Emissions Control by Containment

Storage piles are usually left exposed to the ambient winds because of the costs associated with enclosures and the impediment that enclosures can cause to the frequent material transfer often necessary. Containment of these piles can be described as the physical separation of the storage pile from the ambient air and its associated winds. Typically used containment strategies include shielding by topography, wind fences, neighboring buildings, or other storage piles; or partial or complete enclosure of the storage pile with a dedicated structure.

Containment by selective siting is often an inexpensive method of removing a storage pile from the winds that could generate emissions. It can include the placement of an active storage pile within several more dormant piles, within a natural depression, or among buildings.

The erection of a dedicated structure for containment of storage piles is also practiced within industry. These structures often consist of wind fences, three sided bunkers, silos, or completely enclosed buildings or bins. Although potentially expensive and somewhat restrictive, this is a very effective method of controlling particulate emissions. Often this method is used to protect materials which deteriorate in weather, for the conservation of expensive minerals, or to control emissions from small storage piles of fine, highly erodible material.

5.2.2 Emissions Control by Surface Treatments

Surface treatments are used to wet or agglomerate exposed fine material. Commonly used surface treatments include water (alone, with surfactants, or with salts), petroleum binders, and latex binders. These methods can be very effective until the time when the treated surface is disturbed or covered. Water with or without wetting agents such as salts, surfactants, and foams are commonly used to control emissions from active storage piles. This technique affects material to a much greater depth then can be reached by binding agents and produces a substantially greater control efficiency for emissions from materials handling. Surface treatments accomplish wind erosion control by increasing the threshold friction velocity of an exposed material.

5.2.3 Emissions Controlled by Source Extent Reduction

Source extent control refers to limiting the amount of aggregate material put through storage (materials handling) or the surface area disturbed (wind erosion). This can include reducing the number of material transfer operations necessary in a process, restricting the area disturbed by transfer and pile maintenance operations, or restricting the amount of vehicular traffic permitted on or around stockpiled material.

5.2.4 Emissions Control by Natural Methods

Finally, simply allowing the pile to crust naturally is an effective control technique for wind erosion control of most stockpiled materials. Wind erosion events remove the exposed surface fine particulate, leaving behind the

coarse nonerodible aggregate. In addition, naturally occurring precipitation tends to agglomerate most aggregate material. Inactivity can provide a natural crust comparable to those achieved by surface treatments

5.3 REGULATORY FORMATS AND ASSOCIATED INSPECTION PROCEDURES

Once a specific PM_{10} control strategy has been conceived, approved, and implemented, it becomes necessary for the control agency to assure that it is being complied with and is achieving the desired level of control. This section will discuss methods for determining compliance, along with inspection procedures for various storage pile control strategies.

5.3.1 General Inspection Procedures and Compliance Information

5.3.1.1 General Inspection Procedures--

Figure 5-6 is an example inspection form which may be completed by interviewing plant personnel at the beginning of a Level II or Level III inspection. After discussing any changes in sources since the last inspection with plant personnel, a more through field inspection should be performed.

Field inspections of control programs for dust from storage piles could include the following steps:

1. Verification of sources located within the facility.

2. Qualitative inspection of surface material moisture or crusting.

3. Spot checks on the control application.

4. Spot checks on storage pile source extent.

5. Surface material sampling so that emissions can be estimated.

Each of these is discussed in more detail below.

The first step in any field inspection is a simple drive or walk through the facility to verify the continued existence of previous sources, the absence of new sources, and any changes identified by plant personnel.

To determine the effectiveness of strategies that depend on containment techniques for dust control, a qualitative inspection should be adequate. This inspection would simply require a verification of the existence and integrity of the specified enclosure to determine compliance.

To determine compliance for a watering program, it is often adequate simply to pick up handfuls of the storage pile surface material and examine for wetness or to observe material transfer operations for emissions. Portable moisture instruments may also be useful to estimate the overall moisture content of the pile material. If visible emissions are observed, an aggregate sample may be collected for moisture analysis, as described in Appendix F to determine compliance as appropriate.

Business License Name of Corporation, Company, or Individual Owner or Governmental Agency:

Mailing Address:

Plant Address:

Name and Title of Company Representative:

Telephone Number:

Name of Official Conducting Inspection:

General Questions for Plant Personnel	Yes*	No	N/A	Comments
1. Any new storage piles since last inspection?				
2. Have any storage piles been deleted since last inspection?				
3. Have any storage piles been left dormant since last inspection?				
4. Has any of the source extent associated with storage piles changed since last inspection (i.e., reduced transfer operations, material drops heights, material thruput, and vehicular traffic on or around piles)?				
Controls				
5. Have any changes been made in control program since last inspection?				
Watering				
6. Any new equipment?				
7. Any equipment downtime since last inspection?				
Chemicals				
8. Any receipts since last inspection?				
9. Any new equipment?				
10. Any equipment downtime since last inspection?				
11. Any supplemental control since last inspection?				

* If any answer is yes, complete comment section.

Figure 5-6. **Sample inspection form.**

A qualitative inspection of surface treatment controls on undisturbed portions of storage piles should verify that a control has been applied, and also that it has been applied in a somewhat uniform manner over the entire exposed surface. This is important because the uneven application of a surface treatment can severely compromise the net control efficiency, regardless of the amount applied. Visual inspection is usually adequate to determine where binders have been applied to aggregate material.

If large areas of inspected storage piles are found to be dry or uncrusted (for water and chemically treatments, respectively), then these deficiencies should be noted. If possible, it is recommended that the inspector observe at least one application of any surface control to verify application intensity and the uniformity of the application. This can be done by placing preweighed pans on the stockpile surface during the control application, reweighing them after the application, and dividing the mass collected by the area of the pan.

In addition, note should be made of the source extent of materials handled, of the amount of vehicle traffic on and around the stockpiles, and of any visible emissions from these sources. Visible emissions can indicate inadequacy in the control plan or its implementation.

For storage piles that are controlled simply by their dormant nature, compliance can usually be determined by visual observation that the surface (and any crust) has not been disturbed.

5.3.1.2 Plant Record Keeping Requirements--

Determination of storage pile control compliance by the review of plant records can be performed for surface treatment controls and for reduced source extent strategies. For surface treatments, plant records must be kept to document the date, time, amount, and dilution (if applicable) of water/chemical suppressant applied, and a description of where that control was applied. For strategies based on reductions in source extent, records must be kept of the amount of material transferred, the dates and times of equipment usage for this transfer, or of vehicular usage on and around the storage piles.

Record keeping for a storage pile dust control plan should include the following elements:

<u>Watering</u>

- The amount of water applied to each stock piled material and the proposed frequency of application.

- Any provisions for the reduction or suspension of the control application during periods of inactivity or during specified weather events (e.g., 1/4 in of rainfall to substitute for one treatment; program suspended during freezing periods or during production shutdowns; watering frequency as a function of temperature, cloud cover, etc.).

- Source of water and a description of any additives for performance enhancement (i.e., salts, surfactants, etc.).

Chemical Treatments

- Type of chemical to be applied to each storage pile, the dilution ratio, application intensity, and the frequency of application.

- Any provisions for the reduction or suspension of the control application during periods of material inactivity or during specified weather events (e.g., 1/4 in of rainfall to substitute for one treatment; program suspended during freezing periods; watering frequency as a function of temperature, cloud cover, etc.).

Source Extent Reductions

- The time and identification of any mobile equipment used in the storage pile area before and after implementation of the control plan.

- The times when any fixed stacker-reclaimer equipment would be used, and an estimate of how much material was moved before and after implementation of the control plan.

5.3.2 Watering

5.3.2.1 Record Keeping Review

To determine compliance from plant records, the facility must have records that include:

1. Date of treatment.

2. Operators identification as a signature or initials (note that the operator may keep a separate log from which information is transferred to the environmental staff's data sheets).

3. Start and stop times of the treatment on each storage pile, approximate amount of water used, and the approximate area treated.

4. Description of any additive used (i.e., salts, surfactants, etc.).

Figure 5-7 is an example form which the equipment operator can complete when applying water to storage piles. In addition, plant-wide records must be kept which include:

1. Equipment maintenance records.

2. Meteorological log (to document the influence of weather on the control program).

3. Documentation of any equipment malfunctions or downtime.

Facility X Water Control Program--Operator's Log

Date	Tank Fill Time Start	Tank Fill Time Stop	Road Segments/Areas Treated Start		Road Segments/Areas Treated Stop	Comments	Op. Initials
6/01	6:00	6:10	6:35	pile #1	6:50		JPM
6/01	7:00	7:10	7:30	"	7:55		JPM
6/01			7:50	pile #2	7:56		JPM
6/01	8:10	8:15	8:20	pile #3	8:36		JPM
6/02	5:30	5:40	5:50	pile #1	6:15		JPM
6/02	6:25	6:35	6:45	"	7:00		JPM
6/02			7:05	pile #2	7:15		JPM
6/02	7:20	7:30	7:40	pile #3	8:00		JPM
6/06	7:00	7:10	7:25	pile #1	7:45		JPM
6/06	7:55	8:05	8:15	"	8:30		JPM
6/06			8:40	pile #2	8:50		JPM
6/06	9:00	9:10	9:20		9:35		JPM

Figure 5-7. Operator's log for example facility X.

Documentation which contains these elements will allow an inspector to determine compliance by reviewing the historical data. Below, a procedure is described which allows the inspector to perform an on-site, independent assessment of the control.

5.3.2.2 Example Compliance Determination--Record Keeping for a Watering Program--

This example considers the hypothetical facility X which is shown in Figure 5-1 with the storage piles shown in greater detail in Figure 5-2. Facility X is located in a PM_{10} nonattainment area and has an approved dust control plan that specifies the following conditions:

1. Application intensity > 0.15 gal/yd^2.

2. Application frequency of once/10 h workday.

3. Watering according to the application parameters is to be performed from April 1 through October 31.

4. Each 1/4 in of rainfall (in the previous 24 h) will be substituted for one treatment, and the program will be suspended for days where the morning temperature (8 a.m.) does not exceed 32°F.

Note that the permit also specifies watering between 11:00 a.m. and 3:00 p.m. when the ambient temperature at 11:00 a.m. is ≥ 40°F for the period from November 1 to March 31.

An example of how records could be used to determine compliance for facility X is given below. Facility X maintains the following three storage piles:

Storage Pile	Height (ft)	Approx. Area (sq. ft)	Throughput (tons/yr)
1	20	5,000	10,000
2	15	1,500	500
3	15	2,500	4,000

The facility leases one 5,000-gal water truck and operator from a contractor on an as needed basis. This equipment has a water cannon capable of spraying water 50 ft. No additives to the water are used at this facility.

Example records kept by facility X to document its program of watering storage piles are shown in Figure 5-8 (meteorological data log), and Figure 5-7 (operator's log). The inspector responsible for the facility would, in practice, compare these two records with the permit conditions to determine compliance. This check should verify that all storage piles have been treated daily (except after significant rainfall or under freezing conditions).

Facility X Meteorological Data Log

Month/Year: 06/89 Observer JPM

Day	Obs. Time	Precipitation (in)	Temperature (°F)	Comments
01	8:05	–	64	
02	8:05	–	64	
03				
04				
05	8:10	0.10	78	Rained on Sunday
06	8:10	–	72	
07	8:10	–	73	
08	8:10	0.08	72	
09	8:10	–	77	
10				
11				
12	8:05	3.12	56	Rained Sat & Sun, Roads Muddy
13	8:05	–	67	Roads still visibly wet (puddles)
14	8:05	–	71	Roads dry enough to water
15	8:05	–	74	
16	8:05	–	77	
17				
18				
19	8:05	0.66	64	Roads wet -- No watering
20	8:05	–	70	
21	8:05	–	74	
22	8:05	0.27	79	Skip morning application
23	8:05	–	79	
24				
25				
26	8:05	T	74	
27	8:05	–	76	
28	8:05	–	76	
29	8:05	–	78	
30	8:05	–	75	
31				

T = Trace

Figure 5-8. Meteorological data for example facility X.

If it is suspected that the documentation is inaccurate (i.e., treatments are logged for periods where no water was applied), then the operator's log can be cross-checked against other records. For example, cross-checking would be performed against facility records for maintenance/service of the water truck, or against contractor invoices if the equipment is leased, as in the above example. Both of these sources typically contain more complete records then those kept for an emissions control program. If these records do not match the operator's log, then the facility should be required to submit a written explanation for the apparent discrepancy.

Information compiled in the operator's log represents critical data against which operations observed during Level II and Level III inspections should be evaluated. For example, Figure 5-7 provides a basis for estimating the typical length of time and number of trucks full of water were required to wet all of the storage piles within a facility. These values can be checked against an application observed during the inspection. If the during the inspection, the observed time for an application or required number of trucks full of water required to treat a group of storage piles varies significantly from what is indicated in the operator's log, then the inspector should require the facility to explain the apparent discrepancy. As stated above, this inspection should also verify that the water is being applied somewhat uniformly to the storage piles surface area.

An example that applies this procedure to facility X is demonstrated below:

1. On June 1, the operator's log indicates that the first two trucks full of water were used to wet storage pile Nos. 1 and 2 and a third truck full of water was used to wet storage pile No. 3.

2. About 10 min was required to fill each of the first two trucks, and only 5 min to fill the third truck.

3. The log also indicates that the treatment of storage pile No. 1 required 25 min to empty the first truck of water, and 15 min to complete the pile with the second truck of water. Treatment of storage pile No. 2 took 6 min, and treatment of storage pile No. 3 took 16 min.

4. During the inspection it is noted that 10 min is required to fill the truck and 12.5 min of actual spraying time to empty it.

From these data it can be assumed that approximately 8,000 gal of water was probably applied to storage pile No. 1 (0.18 gal/yd^2) from the first two trucks; about 2,000 gal was probably applied to storage pile No. 2 (0.1 gal/yd^2) with what was left in the second truck; and finally if 0.15 gal/yd^2 was applied to piles 1 and 2 then truck 2 came back empty, and only about 2,500 gal (5 min to fill the third truck) was available for pile No. 3 (0.1 gal/yd^2). These estimates indicate a potential violation of the minimum application intensity of 0.15 gal/yd^2 specified in the dust control plan.

5.3.2.3 "In-Plant" Inspection Procedures

An "in-plant" inspection to determine compliance with fugitive dust rules or permit conditions for storage piles involves focusing on several items. They include:

- A visual inspection of the facility to verify that all of the existing storage piles are listed in the permit/control plan.
- An examination of the source's records (as described above) documenting frequency of water application, amount applied, storage piles watered, meteorology affecting watering, etc.
- Observation of any spraying operations undertaken during the inspectors visit.

After becoming familiar with the plant facilities and the control plan, the inspector should request that the plant personnel provide the information necessary to complete the example work sheet shown in Figure 5-6. The inspector should then conduct a full inspection of the facility in order to obtain and verify the actual control conditions. If water is being applied on the day of the inspection, then this should be observed as described above.

If there is a minimum moisture content criteria specified in the control plan/operating permit, then the inspector could spot-check the moisture content of stockpiled material by using the procedure described in Appendix F. If there is a question as to whether the current control strategy is adequate, an aggregate sample should be taken so that emissions can be estimated as described in Section 5.1. Finally, the inspector should review the plant records to verify that the controls have been applied appropriately since the last inspection.

5.3.3 Chemical Treatments

5.3.3.1 Example Compliance Determination--Record Keeping for a Chemical Control Program--

This example considers the hypothetical facility X shown in Figure 5-1 with the storage piles shown in greater detail in Figure 5-2. Facility X is located in a PM_{10} nonattainment area and has an approved dust control plan that specifies the following conditions:

1. Application of an emulsified petroleum dust suppressant.
2. Application intensity >0.1 gal/yd^2.
3. Dilution of 1 part suppressant to 10 parts water.
4. Application frequency of twice/work week if material has been disturbed since the last application. Once/2 weeks for dormant material.
5. Chemical suppression according to the application parameters is to be performed from April 1 through October 31.

6. Each 1/4 in of rainfall (in the previous 24 h) will be substituted for one treatment, and the program will be suspended for days where the morning temperature (8 a.m.) does not exceed 32°F.

Note that the permit also specifies chemical suppression between 11:00 a.m. and 3:00 p.m. when the ambient temperature at 11:00 a.m. is ≥ 40°F for the period from November 1 to March 31.

An example of how records could be used to determine compliance for facility X is given below. Facility X maintains the following three storage piles:

Storage pile	Height (ft)	Approx. area (sq ft)	Throughput (tons/yr)
1	20	5,000	10,000
2	15	1,500	500
3	15	2,500	4,000

The facility leases one 5,000-gal water truck and operator from a contractor on an as-needed basis. This equipment has a water cannon capable of spraying the suppressant 50 ft. The facility has a receipt for a 5,000 gal order of Coherex® that was delivered in late March. By multiplying the total storage pile area, 1,000 yd^2 by the required 0.1 gal of Coherex required per yd^2 per application, it can be estimated that about 100 gal of Coherex are used per application day. Example records kept by facility X to document days for which the treatment of storage piles was not necessary, are shown in Figure 5-8 (meteorological data log). Plant personnel indicated that other than rain days, there were no days when treatments were not applied. The inspector responsible for the facility would, in practice, compare the amount of Coherex used from the storage tank with what the records and invoices indicate should have been used.

If there are claims that treatments have been reduced because the material has been dormant, then records kept by the storage yard foreman can often be checked for verification. These checks should verify when storage piles have been treated.

If it is suspected that the documentation is inaccurate (i.e., treatments are logged for periods where no suppressant was applied), then the operator's log can be cross-checked against other records. For example, cross-checking would be performed against facility records for maintenance/service of the water truck or, against contractor invoices if the equipment is leased, as in the above example. Both of these sources typically contain more complete records then those kept for a control program. If the two sets of records do not match, then the facility should be required to submit a written explanation for the apparent discrepancy.

Information compiled in the operator's log also represents critical data against which operations observed during Level II and Level III inspections

should be evaluated. For example, Figure 5-9 provides a basis for estimating the typical length of time and number of trucks full of suppressant required to treat all of the storage piles within a facility. These values can be checked against an application observed during the inspection as described for watering in 5.3.2.

If during the inspection the observed time for an application or required number of trucks full of suppressant necessary to treat a given group of storage piles varies significantly from what is indicated in the operator's log, then the inspector should require that the facility explain the apparent differences. As stated above, this inspection should also verify that the suppressant is being applied somewhat uniformly to the storage piles surface area. This can be performed by placing preweighed pans on the stockpile surface during the control application, reweighing them after the application, and dividing the mass collected by the pans area.

5.3.3.2 "In-Plant" Inspection Procedures--

An "in-plant" inspection to determine compliance with fugitive dust rules or permit conditions for storage piles involves focusing on several items. They include:

- A visual inspection of the facility to verify that all of the existing storage piles are listed in the state permit/control plan.

- An examination of the source's records (as described above) documenting frequency of suppressant application, amount applied, storage piles treated, meteorology and plant activity affecting treatment requirements, etc.

- Observation of any spraying operations undertaken during the inspectors visit.

After becoming familiar with the plant facilities and the control plan, the inspector should request that the plant personnel provide the information necessary to complete the example work sheet shown in Figure 5-6. The inspector should then conduct a full inspection of the facility in order to obtain and verify the actual operating conditions. If suppressant is being applied on the day of the inspection, then this should be observed as described above.

If there is a maximum silt content criteria specified in the control plan/operating permit, then the inspector could spot-check the silt content of stockpiled material by using the procedure described in Appendix F. If there is a question as to whether the current control strategy is adequate, an aggregate sample should be taken so that emissions can be estimated as described in Section 11.2.7 of EPA's AP-42. Finally, the inspector should review the plant records to verify that the controls have been applied appropriately since the last inspection.

Facility X Water Control Program--Operator's Log

Date	Tank Fill Time Start	Tank Fill Time Stop	Areas Treated Start	Areas Treated	Areas Treated Stop	Comments	Op. Initials
6/01	6:30	7:00	7:10	piles #1, 2, & 3	8:10		JMP
6/06	6:40	7:15	7:30	"	8:15		JMP
6/14	6:30	7:05	7:15	"	8:00		JMP
6/16	6:35	7:15	7:30	"	8:15		JMP
6/20	6:45	7:20	7:30	"	8:00		JMP
6/23	6:30	7:15	7:25	"	8:15		JMP
6/27	6:30	7:15	7:30	"	8:30		JMP
6/29	6:40	7:3[illegible]	[illegible]	"	8:15		JMP

Figure 5-9. Operator's log for example facility X.

5.4 REFERENCES FOR SECTION 5

1. Local Climatological Data, Annual Summaries for 1988, Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data and Information Service, National Climatic Data Center, Federal Building, Asheville, NC 28801.

2. *Compilation of Air Pollutant Emission Factors*, Volume 1, Stationary Point and Area Sources, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711.

APPENDIX A

SIP REQUIREMENTS FOR THE CONTROL OF PM_{10}

APPENDIX A

SIP REQUIREMENTS FOR THE CONTROL OF PM_{10}

The following pages contain excerpts from the July 1, 1987, *Federal Register* pertaining to the revision of State Implementation Plans to include PM_{10}.

PART 51—REQUIREMENTS FOR PREPARATION, ADOPTION, AND SUBMITTAL OF IMPLEMENTATION PLANS

For the reasons set forth in the preamble, EPA amends Part 51 of Chapter I of Title 40 of the Code of Federal Regulations as follows:

1. The authority citation for Part 51 is revised to read as follows:

Authority: This rulemaking is promulgated under authority of sections 101(b)(1), 110, 160–169, 171–178, and 301(a) of the Clean Air Act 42 U.S.C. 7401(b)(1), 7410, 7470–7479, 7501–7508, and 7601(a).

2. In § 51.100, paragraphs (oo), (pp), (qq), (rr) and (ss) are added to read as follows:

§ 51.100 Definitions.

* * * * *

(oo) "Particulate matter" means any airborne finely divided solid or liquid material with an aerodynamic diameter smaller than 100 micrometers.

(pp) "Particulate matter emissions" means all finely divided solid or liquid material, other than uncombined water, emitted to the ambient air as measured by applicable reference methods, or an equivalent or alternative method, specified in this chapter, or by a test method specified in an approved State implementation plan.

(qq) "PM_{10}" means particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers as measured by a reference method based

on Appendix J of Part 50 of this chapter and designated in accordance with Part 53 of this chapter or by an equivalent method designated in accordance with Part 53 of this chapter.

(rr) "PM_{10} emissions" means finely divided solid or liquid material, with an aerodynamic diameter less than or equal to a nominal 10 micrometers emitted to the ambient air as measured by an applicable reference method, or an equivalent or alternative method, specified in this chapter or by a test method specified in an approved State implementation plan.

(ss) "Total suspended particulate" means particulate matter as measured by the method described in Appendix B of Part 50 of this chapter.

3. In § 51.151, the third unnumbered subdivision beginning "sulfur dioxide and particulate matter combined" is removed and the second unnumbered subdivision beginning "particulate matter" is revised to read as follows:

§ 51.151 Significant harm levels.

* * * * *

PM_{10}—600 micrograms/cubic meter; 24-hour average.

* * * * *

4. In § 51.165, the fourth entry in the list in paragraph (a)(1)(x) is removed and paragraph (b) is revised to read as follows:

§ 51.151 Permit requirements.

* * * * *

(b)(1) Each plan shall include a preconstruction review permit program or its equivalent to satisfy the requirements of section 110(a)(2)(D)(i) of the Act for any new major stationary source or major modification as defined in paragraphs (a)(1) (iv) and (v) of this section. Such a program shall apply to any such source or modification that would locate in any area designated as attainment or unclassifiable for any national ambient air quality standard pursuant to section 107 of the Act, when it would cause or contribute to a violation of any national ambient air quality standard.

(2) A major source or major modification will be considered to cause or contribute to a violation of a national ambient air quality standard when such source or modification would, at a minimum, exceed the following significance levels at any locality that does not or would not meet the applicable national standard:

	Annual	Averaging time (hours)			
		24	8	3	1
Pollutant					
SO_2	1.0 μg/m³	5 μg/m³		25 μg/m³	
PM_{10}	1.0 μg/m³	5 μg/m³			
NO_2	1.0 μg/m³				
CO			0.5 mg/m³		2 mg/m³

(3) Such a program may include a provision which allows a proposed major source or major modification subject to paragraph (b) of this section to reduce the impact of its emissions upon air quality by obtaining sufficient emission reductions to, at a minimum, compensate for its adverse ambient impact where the major source or major modification would otherwise cause or contribute to a violation of any national ambient air quality standard. The plan shall require that, in the absence of such emission reductions, the State or local agency shall deny the proposed construction.

(4) The requirements of paragraph (b) of this section shall not apply to a major stationary source or major modification with respect to a particular pollutant if the owner or operator demonstrates that, as to that pollutant, the source or modification is located in an area designated as nonattainment pursuant to section 107 of the Act.

5. In § 51.166, paragraph (a)(6)(i) is revised, the fourth entry in the list in paragraph (b)(23)(i) is revised, the entries under the headings "Particulate matter" in the tables in paragraphs (c) and (p)(4) are revised, paragraphs (i)(8)(i) (*c*), (*f*), (*h*), and (*l*) are revised, and new paragraph (i)(10) is added to read as follows:

§ 51.166 Prevention of significant deterioration of air quality.

(a) * * *

(6) * * *

(i) Any State required to revise its implementation plan by reason of an amendment to this section, including any amendment adopted simultaneously with this paragraph, shall adopt and submit such plan revision to the Administrator for approval within 9 months after the effective date of the new amendments.

* * * * *

(b) * * *

(23)(i) * * *

Particulate matter: 25 tpy of particulate matter emissions. 15 tpy of PM_{10} emissions.

* * * * *

(c) * * *

Pollutant	Maximum allowable increases (micrograms per cubic meter)
Class I	
Particulate matter:	
TSP, annual geometric mean	5
TSP, 24-hr maximum	10
* * * * *	
Class II	
Particulate matter:	
TSP, annual geometric mean	19
TSP, 24-hr maximum	37
* * * * *s0	
Class III	
Particulate matter:	
TSP, annual geometric mean	37
TSP, 24-hr maximum	75
* * * * *	

* * * * *

(i) * * *

(8) * * *

(i) * * *

(*c*) Particulate matter—10 μg/m³ TSP, 24-hour average.—10 μg/m³ PM_{10}, 24-hour average.

* * * * *

(*f*) Lead—0.1 μg/m³, 3-month average.

* * * * *

(*h*) Beryllium—0.001 μg/m³, 24-hour average:

* * * * *

(*l*) Hydrogen sulfide—0.2 μg/m³, 1-hour average:

* * * * *

(10) If EPA approves a plan revision under § 51.166 as in effect before July 31, 1987 , any subsequent revision which meets the requirements of this section may contain transition provisions which parallel the transition provisions of § 52.21 (i)(11)(i)(iii), and (m)(1) (vii) and (viii) of this chapter as in effect on that date, these provisions being related to monitoring requirements for particulate matter. Any such subsequent revision may not contain any transition provision which in the context of the revision would operate any less stringently than would its counterpart in § 52.21 of this chapter.

* * * * *

(p) * * *

(4) * * *

Pollutant	Maximum allowable increases (micrograms per cubic meter)
Particulate matter:	
TSP, annual geometric mean	19
TSP, 24-hr maximum	37

Pollutant	Maximum allowable increases (micrograms per cubic meter)
* * * * *	

* * * * *

6. In § 51.322, paragraphs (a)(1) and (b)(1) are revised to read as follows:

§ 51.322 Sources subject to emissions reporting.

(a) * * *

(1) For particulate matter, PM_{10}, sulfur oxides, VOC and nitrogen oxides, any facility that actually emits a total of 90.7 metric tons (100 tons) per year or more of any one pollutant. For particulate matter emissions, the reporting requirement ends with the reporting of calendar year 1987 emissions. For PM_{10} emissions, the reporting requirement begins with the reporting of calendar year 1988 emissions.

* * * * *

(b) * * *

(1) For particulate matter, PM_{10}, sulfur oxides, VOC and nitrogen oxides. 22.7 metric tons (25 tons) per year or more. For particulate matter, the reporting requirement ends with the reporting of calendar year 1987 emissions. For PM_{10}, the reporting requirement begins with the reporting of calendar year 1988 emissions.

* * * * *

7. In § 51.323, paragraphs (a)(1) and (a)(2) are revised and paragraph (a)(3) is added to read as follows:

§ 51.323 Reportable emissions data and information.

(a) * * *

(1) Emissions of particulate matter, sulfur oxides, carbon monoxide, nitrogen oxides, and VOC as specified by AEROS Users Manual, Vol. II (EPA 450/2-76-029, OAQPS No. 1.2-039) to be coded into the National Emissions Data System point source coding form,

(2) Emissions of lead or lead compounds measured as elemental lead as specified by AEROS Users Manual, Vol. II (EPA 45/2-76-029, OAQPS No. 1.2-039) to be coded into the Hazardous and Trace Emissions System points source coding forms, and

(3) Emissions of PM_{10} as will be specified in a future guideline.

* * * * *

8. In Appendix L, paragraphs 1.1 (b), (c), and (d) are amended by removing the unnumbered subdivisions beginning "SO_2 and particulate combined" and by revising the unnumbered subdivisions beginning "Particulate" to read as follows:

Appendix L—[Amended]

APPENDIX L—EXAMPLE REGULATIONS FOR PREVENTION OF AIR POLLUTION EMERGENCY EPISODES

1.1 * * *

(b) * * *

PM_{10}—350 $\mu g/m^3$, 24-hour average.

(c) * * *

PM_{10}—420 $\mu g/m^3$, 24-hour average.

(d) * * *

PM_{10}—500 $\mu g/m^3$, 24-hour average.

* * * * *

Appendix S—[Amended]

9. In Appendix S, the fourth line beginning "Particulate matter" in the list in section 11.A.10(i) is amended by adding the words "of particulate matter emissions" after the words "25 tpy."

* * * * *

PART 52—APPROVAL AND PROMULGATION OF IMPLEMENTATION PLANS

For the reasons set out in the preamble, Part 52 of Chapter I of Title 40 of the Code of Federal Regulations is amended as follows:

1. The authority citation for Part 52 continues to read as follows:

Authority: 42 U.S.C. 7401-7642.

2. In § 52.21, the fourth item in the table in paragraph (b)(23)(i) is revised; the entries under the heading "Particulate matter" in the tables in paragraphs (c) and (p)(5) are revised; paragraphs (i)(4) (ix) and (x) are added; the third, sixth, eighth, and twelfth items in the list in paragraph (i)(8)(i) are revised; paragraph (i)(11), and paragraphs (m)(1)(vii) and (viii) are added; and paragraph (w)(2) is revised as follows:

§ 52.21 Prevention of significant deterioration of air quality.

* * * * *

(b) Definitions. * * *

(23)(i) * * *

Particulate matter: 25 tpy of particulate matter emissions; 15 tpy of PM_{10} emissions.

* * * * *

(c) * * *

Pollutant	Maximum allowable increases (micrograms per cubic meter)
Class I	
Particulate matter:	
TSP, annual geometric mean	5
TSP, 24-hr maximum	10
* * * * *	
Class II	
Particulate matter:	
TSP, annual geometric mean	19
TSP, 24-hr maximum	37
* * * * *	
Class III	
Particulate matter:	
TSP, annual geometric mean	37
TSP, 24-hr maximum	75
* * * * *	

* * * * *

(i) * * *

(4) * * *

(ix) The source or modification was not subject to § 52.21, with respect to particulate matter, as in effect before July 31, 1987, and the owner or operator:

(*a*) Obtained all final Federal, State, and local preconstruction approvals or permits necessary under the applicable State implementation plan before July 31, 1987.

(*b*) Commenced construction within 18 months after July 31, 1987, or any earlier time required under the State implementation plan: and

(*c*) Did not discontinue construction for a period of 18 months or more and completed construction within a reasonable period of time;

(x) The source or modification was subject to 40 CFR 52.21, with respect to particulate matter, as in effect before July 31, 1987 and the owner or operator submitted an application for a permit under this section before that date, and the Administrator subsequently determines that the application as submitted was complete with respect to the particulate matter requirements then in effect in this section. Instead, the requirements of paragraphs (j) through (r) of this section that were in effect before July 31, 1987 shall apply to such source or modification.

* * * * *

(8) * * *

(i) * * *

Particulate matter:

10 $\mu g/m^3$ of TSP, 24-hour average.

10 $\mu g/m^3$ of PM_{10}, 24-hour average;

* * * * *

Lead—0.1 $\mu g/m^3$, 3-month average;

* * * * *

Beryllium—0.001 $\mu g/m^3$, 24-hour average;

* * * * *

Hydrogen sulfide—0.2 $\mu g/m^3$, 1-hour average;

* * * * *

(11)(i) At the discretion of the Administrator, the requirements for air quality monitoring of PM_{10} in paragraphs (m)(1)(i)–(iv) of this section may not apply to a particular source or modification when the owner or operator of the source or modification submits an application for a permit under this section on or before June 1, 1988 and the Administrator subsequently determines that the application as submitted before that date was complete, except with respect to the requirements for monitoring particulate matter in paragraphs (m)(1)(i)–(iv).

(ii) The requirements for air quality monitoring of PM_{10} in paragraphs (m)(1) (iii) and (iv) and (m)(3) of this section shall apply to a particular source or modification if the owner or operator of the source or modification submits an application for a permit under this section after June 1, 1988 and no later than December 1, 1988. The data shall have been gathered over at least the period from February 1, 1988 to the date the application becomes otherwise complete in accordance with the provisions set forth under paragraph (m)(1)(viii) of this section, except that if the Administrator determines that a complete and adequate analysis can be accomplished with monitoring data over a shorter period (not to be less than 4 months), the data that paragraph (m)(1)(iii) requires shall have been gathered over that shorter period.

* * * * *

(m) *Air quality analysis.*

(1) * * *

(vii) For any application that becomes complete, except as to the requirements of paragraph (m)(1) (iii) and (iv) pertaining to PM_{10}, after December 1, 1988 and no later than August 1, 1988 the data that paragraph (m)(1)(iii) requires shall nave been gathered over at least the period from August 1, 1988 to the date the application becomes otherwise complete. except that if the Administrator determines that a complete and adequate analysis can be accomplished with monitoring data over a shorter period (not to be less than 4 months), the data that paragraph (m)(1)(iii) requires shall have been gathered over that shorter period.

(viii) With respect to any requirements for air quality monitoring of PM_{10} under paragraphs (i)(11) (i) and (ii) of this section, the owner or operator of the source or modification shall use a monitoring method approved by the Administrator and shall estimate the ambient concentrations of PM_{10} using the data collected by such approved monitoring method in accordance with estimating procedures approved by the Administrator.

* * * * *

(p) * * *

(5) * * *

Pollutant	Maximum allowable increases (micrograms per cubic meter)
Particulate matter:	
TSP, annual geometric mean	19
TSP 24-hr maximum	37

* * * * *

(w) *Permit rescission.* * * *

(2) Any owner or operator of a stationary source or modification who holds a permit for the source or modification which was issued under § 52.21 as in effect on July 30, 1987, or any earlier version of this section, may request that the Administrator rescind the permit or a particular portion of the permit.

* * * * *

§ 52.24 [Amended]

3. In § 52.24, paragraph (f)(10) is amended by removing the fourth entry, beginning "Particulate matter," from the list of significant emission rates.

[FR Doc. 87-13709 Filed 6-30-87; 8:45 am]

BILLING CODE 6560-50-M

APPENDIX B

OVERVIEW OF CLEAN AIR ACT AUTHORITY FOR INSPECTORS

APPENDIX B

OVERVIEW OF CLEAN AIR ACT AUTHORITY FOR INSPECTORS

The Clean Air Act (CAA) authorizes plant entry for the purposes of inspection. In specific, Section 114 of the Act states:[1]

> ".....the Administrator or his authorized representative, upon presentation of his credentials shall have a right of entry to, upon or through any premises of such person or in which any records required to be maintained.....are located, and may at reasonable times have access to and copy any records, inspect any monitoring equipment or methods....., and sample any emissions which such person is required to sample....."

Inspections conducted under Section 114 extend to all items relating to compliance with the requirements of the CAA which are within the premises being inspected. These may include: records filed, processes, monitoring equipment, controls, sampling methods, and emissions.

Much of the compliance monitoring, including on-site inspections, is accomplished at the state level. Section 114 of the Act provides for the extension of federal authority to the states to carry out that Section. Where a state has been delegated Section 114 authority from EPA, the same authority EPA has to monitor, sample, inspect or copy records, and any other authority under Section 114 can, in like manner, be exercised by the state. No representative of EPA need accompany the state officials.

EPA does not always have the resources available to conduct all of the compliance monitoring functions on its own. To accomplish these functions, EPA frequently hires private contractors to provide technical support for on-site inspections and sampling. EPA maintains that such contractors, upon proper designation, are "authorized representatives" of the administrator within the meaning of Section 114. However, the courts have not unanimously upheld EPA's position. For this reason, EPA has adopted a policy that duly-authorized contractors are only used to conduct on-site inspections in those Circuits where Court of Appeals decisions have not been against the use of contractors as authorized representatives.

---

[1] U. S. Environmental Protection Agency. *The Clean Air Act, Compliance/Enforcement Guidance Manual.* Office of Enforcement and Compliance Monitoring. Washington, DC. 1987.

EPA's current policy on the use of contractors to conduct on-site inspections is as follows:[2]

- First, Second, Third, Fourth, Fifth, Seventh, Eighth, Eleventh, and District of Columbia Circuits. Authorized contractors may be designated to provide technical support for inspections of facilities owned by anyone other than Stauffer Chemical Company.

- Ninth Circuit. Authorized contractors may be designated to provide technical support for any inspections.

- Sixth and Tenth Circuits. Absent express permission from Headquarters, authorized contractors should not be designated to provide technical support for any inspections.

EPA also has the authority to conduct unannounced, off-the-premises inspections, such as visible emission observations.

---

[2] U.S. Environmental Protection Agency. *Air Compliance Inspection Manual*. EPA-340/1-86-200. Office of Air Quality Planning and Standards. Research Triangle Park, NC. September 1985.

APPENDIX C

INSPECTORS RESPONSIBILITIES, SAFETY PROCEDURES, AND PREPARATION

APPENDIX C

INSPECTORS RESPONSIBILITIES, SAFETY PROCEDURES, AND PREPARATION

C.1 INSPECTOR RESPONSIBILITIES

The primary role of the inspector is to gather information needed in the determination of compliance with applicable regulations and other enforcement activities. Closely coupled with these functions are certain responsibilities which include: (1) knowing and abiding by the legal requirements of the inspection; (2) using proper procedures for effective inspection and evidence collection; (3) practicing accepted safety procedures; (4) observing the professional and ethical responsibilities; and (5) maintaining certain quality assurance standards. Each is briefly outlined below.

C.1.1 Legal Responsibilities

It is essential that all inspection activities be conducted within the legal framework established by the Clean Air Act (CAA) or other applicable statutes. In particular, this includes:

- Proper handling of confidential business information.
- Presentation of proper credentials and plant entry at reasonable times.
- Protection of the legal rights of the company and its personnel under the U.S. Constitution.
- Knowledge of all applicable statutes, regulations, and permit conditions.
- Use of notice(s) and receipts, if appropriate.

For federal employees (or their representatives) conducting inspections under the CAA, the guidance provided in Reference 1 should be followed. In the case of state and local inspectors, the appropriate office responsible for legal matters should be consulted regarding the above issues.

---

[1] U.S. Environmental Protection Agency. *The Clean Air Act, Compliance/Enforcement Guidance Manual.* Office of Enforcement and Compliance Monitoring. Washington, DC. 1987.

C.1.2 Procedural Responsibilities

The inspector must be familiar with and adhere to, when possible, all general inspection procedures and evidence gathering techniques. This will ensure accurate inspections and avoid the possibility of endangering a legal proceeding on procedural grounds.

- Inspection procedures--Inspectors should observe standard procedures for conducting each portion of the inspection as established by the regulatory agency, when possible. All deviations should be clearly documented.

- Evidence collection--Inspectors must be familiar with general evidence gathering techniques. Because the agency's case in a civil or criminal prosecution depends on the evidence gathered by the inspector, it is imperative that the inspector keep detailed records of each inspection. These records will serve as an aid in preparing the inspection report, in determining the appropriate enforcement response, and in giving testimony in an enforcement case, as required. Specifically, inspectors must:

  - Know how to substantiate facts with items of evidence, including samples, photographs, document copies, statements from persons, and personal observations.

  - Know how to detect lack of good faith during interviews with company personnel.

  - Be familiar with all applicable regulations and permit conditions and know what type of information is required to determine compliance with each.

  - Be able to evaluate what documentation is necessary (routine inspection).

  - Collect evidence in a manner that will be incontestable in legal proceedings.

  - Be able to write clear, informative inspection reports.

  - Know how to testify in court and at administrative hearings.

C.1.3 Safety Responsibilities

The inspection of industrial facilities generally involves potential exposure to numerous hazards. The inspector must at all times avoid putting anyone at unnecessary risk. To accomplish this, it is the inspector's responsibility to:

- Know and observe all plant safety requirements, warning signals, and emergency procedures.

- Know and observe all agency safety requirements, procedures, and policies.

- Remain current in safety practices and procedures by regular participation in safety training.

- Use any safety equipment required by the facility being inspected in addition to that required by the regulatory agency.

- Use safety equipment in accordance with agency guidance and labeling instructions.

- Maintain safety equipment in good condition and proper working order.

- Dress appropriately for each inspection activity, including protective clothing, if appropriate.

Section 2.7 of this manual (and listed references) address inspection safety procedures in more detail.

C.1.4 Professional and Ethical Responsibilities

As professionals, inspectors are expected to perform their duties with the highest degree of honesty and professionalism. Procedures and requirements ensuring ethical actions have been worked out through many years of governmental inspection activities. These procedures and standards of conduct have evolved for the protection of the individual, the regulatory agency, and industry. The inspector is constantly in a position to set an example for private industry and to encourage concern for the health and safety in environment and compliance with the laws that protect them.

Specifically, the EPA inspector should always consider and observe the following responsibilities:

- U.S. Constitution--All investigations are to be conducted within the framework of the United States Constitution and with due regard for individual rights regardless of race, sex, creed, or national origin.

- EPA employee conduct--Inspectors are to conduct themselves at all times in accordance with the regulations prescribing EPA Employee Responsibilities and Conduct, codified in 40 CFR Part 60, Part 3.

- Objectivity--The facts of an investigation are to be developed and reported completely, accurately, and objectively. In the course of an investigation, any act or failure to act motivated by reason of private gain is illegal. Actions which could be construed as such should be scrupulously avoided.

- Knowledge--A continuing effort to improve professional knowledge and technical skill in the investigative field should be made. The inspector should keep abreast of changes in the field of air pollution, including current regulations, EPA and other agency policies, control technology, methodology, and safety considerations.

- Professional attitude--The inspector is a representative of EPA and is often the initial or only contact between the agency and industry. In dealing with facility representatives and employees, inspectors must be dignified, tactful, courteous, and diplomatic. They should be especially careful not to infringe on union/company agreements. A firm but responsive attitude will help to establish an atmosphere of cooperation and should foster good working relations. He should always strive to obtain the respect of, inspire confidence in, and maintain good will with industry and the public.

- Attire--Inspectors should dress appropriately, including wearing protective clothing or equipment, for the activity in which they are engaged.

- Industry, public, and consumer relations--All information acquired in the course of an inspector's duties is for official use only. Inspectors should not speak of any product, manufacturer, or person in a derogatory manner.

- Gifts, favors, luncheons--Inspectors should not accept favors or benefits under circumstances that might be construed as influencing the performance of governmental duties. EPA regulations provide an exemption whereby an inspector could accept food and refreshment of nominal value on infrequent occasions in the ordinary course of a luncheon or dinner meeting or other meeting, or during an inspection tour. Inspectors should use this exemption only when absolutely necessary.

- Requests for information--EPA has an "open door" policy on releasing information to the public. This policy aims at making information about EPA and its work freely and equally available to all interested individuals, groups, and organizations. In fact, EPA employees have both a legal and traditional responsibility for making useful educational and safety information available to the public. This policy, however, does not extend to information relating to the suspicion of a violation, evidence of possible misconduct, or confidential business information.

C.1.5 Quality Assurance Responsibilities

The inspector assumes primary responsibility for ensuring the quality of data generated as a result of the inspection. Thus quality assurance procedures appropriate to the type of data being generated should be adhered to. In general, quality assurance procedures are developed towards the following elements: valid data collection; approved, standard methods; control of service, equipment, supplies; quality analytical techniques; and standard data

handling and reporting. Reference 2 should be consulted for general guidance in this regard.

C.2 PREINSPECTION PREPARATION

Preinspection preparation is always necessary to ensure effective use of the inspector's and facility's time, and to ensure that the inspection is properly focused on collecting relevant data and information. This preparation involves: review of facility background; development of an inspection plan; notifications; and equipment preparation. Each is discussed briefly below.

C.2.1 Review of Facility Background

A review of the available background information on the facility to be inspected is essential to the overall success of the inspection. The review should enable the inspector to: become familiar with the facility's process and emission characteristics; conduct the inspection in a timely manner; minimize inconvenience to the facility by not requesting unnecessary data such as that previously provided to the EPA or another agency; conduct an efficient, but thorough, inspection; clarify technical and legal issues before entry; and prepare a useful inspection report. The following types of information should be reviewed:

* Basic facility information--Names, titles, and phone numbers of facility representatives; maps showing facility location and geographic relationship to residences, etc., potentially impacted by emissions; process and production information; plot plans or maps identifying sources, control equipment and methods, monitors, and other points of interest; and safety equipment requirements.

* Sources and control equipment data--Sources and extent of fugitive emissions; description and operational data for control equipment; and previous inspection checklists (and reports).

* Regulations, requirements, and limitations--Most recent permits for facility sources; applicable federal, state, and local regulations and requirements; special exemptions and waivers, if any; and permitted operating conditions.

* Facility compliance and enforcement history--Previous inspection reports; complaint history including reports, follow-up, findings, remedial action; past conditions of noncompliance; previous enforcement actions; pending enforcement actions, compliance schedules and/or variances; and control performance data and reports.

---

[2] U.S. Environmental Protection Agency. *Air Compliance Inspection Manual.* EPA-340/1-85-020. Office of Air Quality Planning and Standards. Research Triangle Park, NC. September 1985.

The following sources are recommended for obtaining this background information for EPA inspectors:

- Inspectors "working" file--The inspector's own concise file for a facility containing basic plant and process information, maps, dust control plan, chronology of enforcement related actions, recent permits, and safety requirements.

- Regional office files and data bases--These files should include much of the information needed including inspection reports, permits and permit applications, compliance and enforcement history, exemption or waiver information, and control performance monitoring data.

- State/local files and contacts--These should be used to supplement and update the information available in the regional office files.

- Laws and regulations--The Clean Air Act and related regulations establish emission standards, controls, procedures, and other requirements applicable to a facility. State and local laws and regulations should also be considered.

- Technical reports, documents, and guidelines--These can often be valuable in providing information and/or guidance concerning specific processes, control techniques, performance advantages and limitations of particular types of controls, and specific inspection procedures. Table 2-3 lists some of the reference documents available for fugitive sources.

C.2.2 Inspection Plan Development

Based on the review of the facility background information and the intended purpose of the inspection, the EPA inspector should develop an inspection plan. This plan should address the following items:

- Inspection objectives--Identify the precise purpose of the inspection in terms of what it will accomplish.

- Tasks--Decide on specific tasks to accomplish the inspection objectives including the exact information which must be collected.

- Procedures--Determine the procedures to be used in completing the tasks, particularly special or unfamiliar procedures.

- Resources--Determine what equipment and personnel will be required.

- Schedule--Estimate the time requirements for the inspection; determine a reasonable time for the inspection (when plant is operating at representative conditions).

C.2.3 Facility Notification

EPA regional offices vary in their exact policies concerning giving a facility advance notification of an inspection. In an EPA policy memo entitled "Final Guidance on Use of Unannounced Inspections," the Stationary Source Compliance Division recommends that all regional inspection programs incorporate unannounced inspections as part of their overall inspection approach.[2] The advantages of the unannounced inspection are: (1) the opportunity to observe the source under normal operating conditions (since the source does not have time to prepare for the inspection); (2) detection of visible emissions and O&M-type problems and violations; (3) creation of an increased level of attention by a source to its compliance status; and (4) projection of a serious attitude toward surveillance by the agency.

The potential negative aspects of performing unannounced inspections are: (1) the source may not be operating or key plant personnel may not be available; and (2) there could be an adverse impact on EPA/state or EPA/source relations. However, it has been demonstrated by the regional offices who already use the unannounced inspections that, in the majority of cases, these drawbacks can be overcome.[2]

When using the unannounced inspection, an alternative to arriving at the source totally unannounced is to contact the source shortly before the scheduled inspection time. This is left to the discretion of the regional office and/or the inspector and must be done so as not to alter the representativeness of the source operation. The amount of advanced notice given should be noted in the inspection report.

Announced inspections are performed by EPA (and its authorized representatives) when some specific purpose is served by providing such notice. Situations where announced inspections are appropriate are:

- When specific information is being sought which must be prepared by the source, or where the source must make significant accommodations for the inspector to gather the information.

- When the assistance of specific plant personnel is necessary for the successful performance of the inspections (i.e., the information they provide cannot be obtained from other on-duty plant personnel or by a follow-up information request).

- When inspecting the government facilities or sources operating under government contract where entry is restricted due to classified operations.

- When inspecting unmanned or extremely remote sources.

When the inspection is announced in advance, a lead time of five working days is generally appropriate. Notification may be by telephone or letter and it may or may not include the exact date and time of the inspection. Instances where written notification (instead or oral) is appropriate are:

- When requested by the state/local agency or by the source.
- When extensive or specific records are being sought.
- When the inspection is to be performed solely by an EPA contractor.
- When inspecting government facilities with classified operations or otherwise restricted entry.
- Special-purpose inspections (e.g., to establish conditions for a source-specific SIP revision).

A "114 Letter" (Appendix A) is sometimes used for notification if there is a need to request facility information prior to the inspection. The facility representative notified should have the authority to release data and samples and to arrange for access. In addition, when notifying a facility on an inspection, information should be requested in regard to on-site safety regulations. This will avoid problems concerning safety equipment at the time of the inspection.

APPENDIX D

SUMMARY OF STATE METHODS FOR DETERMINING VISIBLE EMISSIONS FROM OPEN DUST SOURCES

APPENDIX D

SUMMARY OF STATE METHODS FOR DETERMINING VISIBLE EMISSIONS FROM OPEN DUST SOURCES

Visible emission methods have been adopted by a number of states as a tool for compliance. Although opacity observations at the property line have commonly been employed in earlier fugitive dust control regulations, recent court decisions in Colorado and Alabama have found that rules of that type are unconstitutional (failing to provide equal protection). It is strongly recommended that property-line opacity observations serve only as an indicator of a potential problem, thus "triggering" further investigation. Source-specific opacity determinations, on the other hand, have long been a court-tested approach to regulation. The following sections describes two states' approach to fugitive dust regulation using visible emission methods.

D.1 TENNESSEE VISIBLE EMISSION METHOD

The State of Tennessee has developed a method (TVEE Method 1) for evaluating visible emissions (VE) from roads and parking lots. The following discussion focuses on TVEE Method 1 (M1) in the technical areas: (1) reader position/techniques, and (2) data reduction/evaluation procedures. Table D-1 summarizes the relevant features of TVEE M1.

D.1.1 Reader Position/Techniques

As indicated in Table D-1, TVEE M1 specifies an observer location of 15 ft from the source. In most cases, this distance should allow an unobstructed view, and at the same time meet observer safety requirements.

M1 also specifies that the plume be read at ~ 4 ft directly above the emitting surface. This specification presumably results from field experiments conducted to support the method. It is probably intended to represent the point (i.e., location) of maximum opacity. While there is no quantitative supporting evidence, it seems likely that the height and location of maximum opacity relative to a passing vehicle will vary depending upon ambient factors (wind speed and direction) as well as vehicle type and speed.

Implied in the M1 specification that the plume be read ~ 4 ft above the emitting surface, is the fact that observations will be made against a terrestrial (vegetation) background. The results of one study using a conventional smoke generator modified to emit horizontal plumes, indicated that under these conditions observers are likely to underestimate opacity levels. More specifically, the study found that as opacity levels increased, opacity

TABLE D-1. SUMMARY OF TVEE M1 REQUIREMENTS

Reader position/techniques

- Sun in 140 degree sector behind the reader
- Observer position ~ 15 ft from source
- Observer line of sight should be as perpendicular as possible to both plume and wind direction
- Only one plume thickness read
- Plume read at ~ 4 ft directly above emitting surface
- Individual opacity readings taken each 15 s, recorded to nearest 5% opacity
- Readings terminated if vehicle obstructs line of sight
- Readings terminated if vehicles passing in opposite direction create intermixed plume

Data reduction

- 2-min time-averages consisting of eight consecutive 15 s readings

Certification

- Per Tennessee requirements

readings showed an increasing negative bias. For example, at 15% opacity, the observers underestimated opacity by about 5%, and at 40% opacity, observations averaged about 11% low.[1] Black plumes were underestimated at all opacity levels.

M1 specifies that only one plume thickness be read. It includes qualifying provisions that: (1) readings terminate if vehicles passing in opposite directions create an intermixed plume; but (2) readings continue if intermixing occurs as a result of vehicles moving in the same direction. Unlike (1), the latter condition is considered representative of the surface. The intent here is probably to minimize the influence of increasing plume density which results from "overlaying" multiple plumes.

D.1.2 Data Reduction/Evaluation Procedures

There are two basic approaches that can be used to reduce opacity readings for comparison with VE regulations. One approach involves the time-averaging of consecutive 15-s observations over a specified time period to produce an average opacity value.

In the development of M1, the State of Tennessee concluded that a short averaging period--2 min (i.e., eight consecutive 15-s readings) was appropriate for roads and parking lots, as these sources typically produce brief, intermittent opacity peaks.

Although not specified in M1, VE from open sources could be evaluated using time-aggregating techniques. For example, the discrete 15-s readings could be employed in the time-aggregating framework. In this case, the individual observations are complied into a histogram from which the number of observations (or equivalent percent of observation time) in excess of the desired opacity may then be ascertained. The principal advantage of using the time-aggregate technique as a method to reduce VE readings is that the resultant indicator of opacity conditions is then compatible with regulations that include a time exemption clause. Under time exemption standards, a source is permitted opacity in excess of the standard for a specified fraction of the time (e.g., 3 min/h). The concept of time exemption was originally developed to accommodate stationary source combustion processes.

Without more detailed supporting information, it is difficult to determine which of the two approaches is most appropriate for evaluating VE from open sources. With respect to time-averaging, statistics of observer bias in reading plumes from a smoke generator do indicate at least a slight decrease in the "accuracy" of the mean observed opacity value as averaging time decreases. In M1 (2-min average), this is reflected in the inclusion of an 8.8% buffer for observational error. This buffer is taken into account before issuing a Notice of Violation.[2]

---

[1] Rose, T. H. Evaluation of Trained Visible Emission Observers for Fugitive Opacity Measurement. EPA-60/3-84-093, U.S. Environmental Protection Agency, Research Triangle Park, NC. October 1984.

[2] Telecon. Englehart, P., Midwest Research Institute, with J. Walton, Tennessee Division of Air Pollution Control. Nashville, Tennessee. September 1984.

One potential problem with applying time-averaging to opacity from roads and parking lots, is that the resulting average will be sensitive to variations in source activity. For example, interpreting one conclusion offered in support of M1, it is likely that under moderate wind conditions a single vehicle pass will produce only two opacity readings $\geq$ 5%.[2] Averaging these with six zero (0) readings yields a 2-min value below any reasonable opacity standard. Yet, under the same conditions with two or more vehicle passes, the average value will suggest elevated opacity levels. While there is no information available on the use of time aggregation for open source opacity, it appears that this approach would more easily accommodate variations in level of source activity. For this reason alone, it may be the evaluation approach better suited to roads and parking lots.

D.2 OHIO DRAFT RULE 3745-17-(03)(B)

The State of Ohio submitted a fugitive dust visible emission measurement technique which the EPA proposed to approve in the *Federal Register* on January 2, 1987. Unlike the Tennessee method, the Ohio draft rule contains provisions for sources other than roads and parking lots. Average opacity values are based on 12 consecutive readings. Table D-2 summarizes the Ohio method; as can be seen from the table, many features of the Ohio draft rule are similar to TVEE M1. Consequently, the remarks made earlier in this section are equally applicable here.

TABLE D-2. SUMMARY OF OHIO DRAFT RULE 3745-17-(03)(B)

Reader position/techniques

- Roadways and parking lots:
  - * Line of vision approximately perpendicular to plume direction
  - * Plume read at ~ 4 ft above surface
  - * Readings suspended if vehicle obstructs line of sight; subsequent readings considered consecutive to that taken before the obstruction
  - * Readings suspended if vehicles passing in opposite direction create an intermixed plume; subsequent readings considered consecutive to that taken before intermixing
  - * If unusual condition (e.g., spill) occurs, another set of readings must be conducted

- All other sources:
  - * Sun behind observer
  - * Minimum of 15 ft from source
  - * Line of sight approximately perpendicular to flow of fugitive dust and to longer axis of the emissions
  - * Opacity observed for point of highest opacity

APPENDIX E

EPA REFERENCE METHOD 22 FOR VISUAL DETERMINATION OF FUGITIVE EMISSIONS

APPENDIX E

EPA REFERENCE METHOD 22 FOR VISUAL DETERMINATION OF FUGITIVE EMISSIONS

The following pages outline EPA Reference Test Method 22 for the visual determination of fugitive emissions from material sources and smoke emissions from flares.

METHOD 22—VISUAL DETERMINATION OF FUGITIVE EMISSIONS FROM MATERIAL SOURCES AND SMOKE EMISSIONS FROM FLARES

1. *Introduction*

This method involves the visual determination of fugitive emissions, i.e., emissions not emitted directly from a process stack or duct. Fugitive emissions include emissions that (1) escape capture by process equipment exhaust hoods; (2) are emitted during material transfer; (3) are emitted from buildings housing material processing or handling equipment; and (4) are emitted directly from process equipment. This method is used also to determine visible smoke emissions from flares used for combustion of waste process materials.

This method determines the amount of time that any visible emissions occur during the observation period, i.e., the accumulated emission time. This method does not require that the opacity of emissions be determined. Since this procedure requires only the determination of whether a visible emission occurs and does not require the determination of opacity levels, observer certification according to the procedures of Method 9 are not required. However, it is necessary that the observer is educated on the general procedures for determining the presence of visible emissions. As a minimum, the observer must be trained and knowledgeable regarding the effects on the visibility of emissions caused by background contrast, ambient lighting, observer position relative to lighting, wind, and the presence of uncombined water (condensing water vapor). This training is to be obtained from written materials found in References 7.1 and 7.2 or from the lecture portion of the Method 9 certification course.

2. *Applicability and Principle*

2.1 Applicability. This method applies to the determination of the frequency of fugitive emissions from stationary sources (located indoors or outdoors) when specified as the test method for determining compliance with new source performance standards.

This method also is applicable for the determination of the frequency of visible smoke emissions from flares.

2.2 Principle. Fugitive emissions produced during material processing, handling, and transfer operations or smoke emissions from flares are visually determined by an observer without the aid of instruments.

3. *Definitions*

3.1 Emission Frequency. Percentage of time that emissions are visible during the observation period.

3.2 Emission Time. Accumulated amount of time that emissions are visible during the observation period.

3.3 Fugitive Emissions. Pollutant generated by an affected facility which is not collected by a capture system and is released to the atmosphere.

3.4 Smoke Emissions. Pollutant generated by combustion in a flare and occurring immediately downstream of the flame. Smoke occurring within the flame, but not downstream of the flame, is not considered a smoke emission.

3.5 Observation Period. Accumulated time period during which observations are conducted, not to be less than the period specified in the applicable regulation.

4. *Equipment*

4.1 Stopwatches. Accumulative type with unit divisions of at least 0.5 seconds; two required.

4.2 Light Meter. Light meter capable of measuring illuminance in the 50- to 200-lux range; required for indoor observations only.

5. *Procedure*

5.1 Position. Survey the affected facility or building or structure housing the process to be observed and determine the locations of potential emissions. If the affected facility is located inside a building, determine an observation location that is consistent with the requirements of the applicable regulation (i.e., outside observation of emissions escaping the building/structure or inside observation of emissions directly emitted from the affected facility process unit). Then select a position that enables a clear view of the potential emission point(s) of the affected facility or of the building or structure housing the affected facility, as appropriate for the applicable subpart. A position at least 15 feet, but not more than 0.25 miles, from the emission source is recommended. For outdoor locations, select a position where the sun is not directly in the observer's eyes.

5.2 Field Records.

5.2.1 Outdoor Location. Record the following information on the field data sheet (Figure 22-1): company name, industry, process unit, observer's name, observer's affiliation, and date. Record also the estimated wind speed, wind direction, and sky condition. Sketch the process unit being observed and note the observer location relative to the source and the sun. Indicate the potential and actual emission points on the sketch.

5.2.2 Indoor Location. Record the following information on the field data sheet (Figure 22-2): company name, industry, process unit, observer's name, observer's af-

filiation, and date. Record as appropriate the type, location, and intensity of lighting on the data sheet. Sketch the process unit being observed and note observer location relative to the source. Indicate the potential and actual fugitive emission points on the sketch.

5.3 Indoor Lighting Requirements. For indoor locations, use a light meter to measure the level of illumination at a location as close to the emission source(s) as is feasible. An illumination of greater than 100 lux (10 foot candles) is considered necessary for proper application of this method.

5.4 Observations. Record the clock time when observations begin. Use one stopwatch to monitor the duration of the observation period; start this stopwatch when the observation period begins. If the observation period is divided into two or more segments by process shutdowns or observer rest breaks, stop the stopwatch when a break begins and restart it without resetting when the break ends. Stop the stopwatch at the end of the observation period. The accumulated time indicated by this stopwatch is the duration of the observation period. When the observation period is completed, record the clock time.

During the observation period, continously watch the emission source. Upon observing an emission (condensed water vapor is not considered an emission), start the second accumulative stopwatch; stop the watch when the emission stops. Continue this procedure for the entire observation period. The accumulated elapsed time on this stopwatch is the total time emissions were visible during the observation period, i.e., the emission time.

5.4.1 Observation Period. Choose an observation period of sufficient length to meet the requirements for determining compliance with the emission regulation in the applicable subpart. When the length of the observation period is specifically stated in the applicable subpart, it may not be necessary to observe the source for this entire period if the emission time required to indicate noncompliance (based on the specified observation period) is observed in a shorter time period. In other words, if the regulation prohibits emissions for more than 6 minutes in any hour, then observations may (optional) be stopped after an emission time of 6 minutes is exceeded. Similarly, when the regulation is expressed as an emission frequency and the regulation prohibits emissions for greater than 10 percent of the time in any hour, then observations may (optional) be terminated after 6 minutes of emissions are observed since 6 minutes is 10 percent of an hour. In any case, the observation period shall not be less than 6 minutes in duration. In some cases, the process operation may be intermittent or cyclic. In such cases, it may be convenient for the observation period to coincide with the length of the process cycle.

5.4.2 Observer Rest Breaks. Do not observe emissions continuously for a period of more than 15 to 20 minutes without taking a rest break. For sources requiring observation periods of greater than 20 minutes, the observer shall take a break of not less than 5 minutes and not more than 10 minutes after every 15 to 20 minutes of observation. If continuous observations are desired for extended time periods, two observers can alternate between making observations and taking breaks.

5.4.3 Visual Interference. Occasionally, fugitive emissions from sources other than the affected facility (e.g., road dust) may prevent a clear view of the affected facility. This may particularly be a problem during periods of high wind. If the view of the potential emission points is obscured to such a degree that the observer questions the validity of continuing observations, then the observations are terminated, and the observer clearly notes this fact on the data form.

5.5 Recording Observations. Record the accumulated time of the observation period on the data sheet as the observation period duration. Record the accumulated time emissions were observed on the data sheet as the emission time. Record the clock time the observation period began and ended, as well as the clock time any observer breaks began and ended.

6. *Calculations*

If the applicable subpart requires that the emission rate be expressed as an emission frequency (in percent), determine this value as follows: Divide the accumulated emission time (in seconds) by the duration of the observation period (in seconds) or by any minimum observation period required in the applicable subpart, if the acutal observation period is less than the required period and multiply this quotient by 100.

7. *References.*

7.1 Missan, Robert and Arnold Stein. Guidelines for Evaluation of Visible Emissions Certification, Field Procedures, Legal Aspects, and Background Material. EPA Publication No. EPA-340/1-75-007. April 1975

7.2 Wohlschlegel, P. and D. E. Wagoner. Guideline for Development of a Quality Assurance Program: Volume IX—Visual Determination of Opacity Emissions From Stationary Sources. EPA Publication No. EPA-650/4-74-005-i. November 1975.

FUGITIVE OR SMOKE EMISSION INSPECTION
OUTDOOR LOCATION

Company _____	Observer _____
Location _____	Affiliation _____
Company representative _____	Date _____
Sky Conditions _____	Wind direction _____
Precipitation _____	Wind speed _____
Industry _____	Process unit _____

Sketch process unit; indicate observer position relative to source and sun; indicate potential emission points and/or actual emission points.

OBSERVATIONS

	Clock time	Observation period duration, min:sec	Accumulated emission time, min:sec
Begin Observation			
End observation			

Figure 22-1

Fugitive Emission Inspection Indoor Location Table

FUGITIVE EMISSION INSPECTION
INDOOR LOCATION

Company _____ Observer _____

Location _____ Affiliation _____

Company Representative _____ Date _____

Industry _____ Process unit _____

Light type (fluorescent, incandescent, natural _____

Light location (overhead, behind observer, etc.) _____

Illuminance (lux or footcandles) _____

Sketch process unit; indicate observer position relative to source; indicate potential emission points and/or actual emission points.

OBSERVATIONS

	Clock time	Observation period duration, min:sec	Accumulated emission, time, min:sec
Beginning observation	_____		
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
End observation	_____		

Figure 22-2

APPENDIX F

MATERIAL SAMPLING AND ANALYSIS PROCEDURES

APPENDIX F

MATERIAL SAMPLING AND ANALYSIS PROCEDURES

F.1 SAMPLING TECHNIQUES

The following are recommended procedures for collection of appropriate road surface and aggregate material samples. Where practical, the recommended procedure is structured identically to the standard method published by the American Society of Testing and Materials (ASTM).

F.1.1 Unpaved Roads

The main objective in sampling the surface material from an unpaved road is to collect a minimum gross sample of 23 kg (50 lb) for every 4.8 km (3 mi) of unpaved road. However, for unpaved road segments significantly < 4.8 km (3 mi) found in industrial facilities, a traverse strip ~ 20 to 60 cm wide across the travel lanes every 0.8 km (1/2 mi) is usually adequate. For unpaved roads treated with a chemical dust suppressant, the sampling strips will typically be wider (~ 45 to 125 cm) in order to collect adequate sample mass. Where possible, incremental samples taken from unpaved roads should ideally be distributed over the road segment, as shown in Figure F-1. In these cases at least four incremental samples should be collected and composited to form the gross sample.

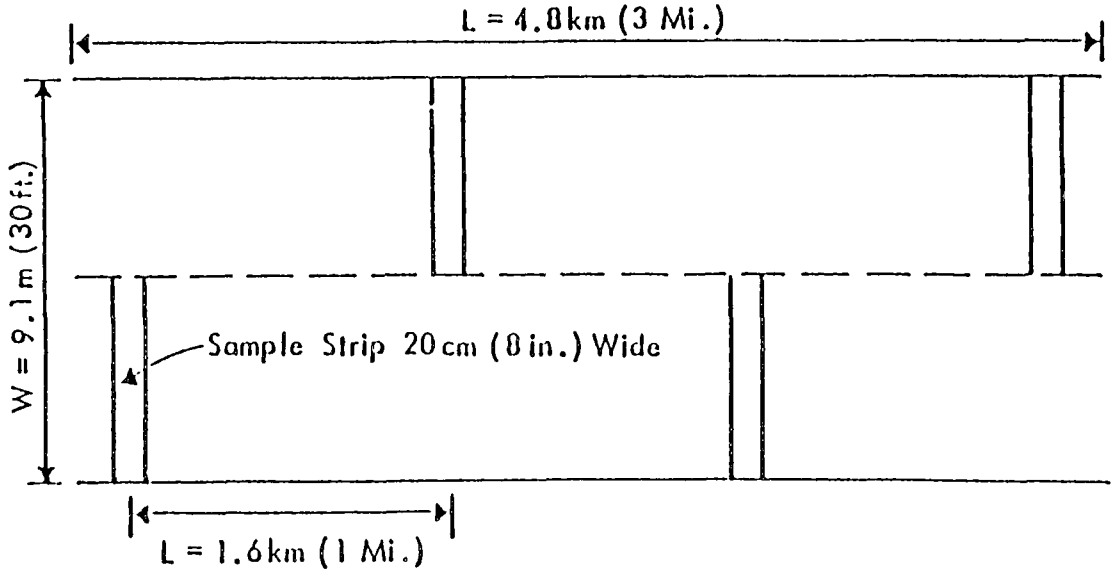


Figure F-1. Location of incremental sampling sites on an unpaved road.

To collect each sample, loose surface material is removed from the hard road base with a whisk broom and dustpan. The material should be swept carefully so that the fine dust is not injected into the atmosphere. The hard road base below the loose surface material should not be abraded so as to generate more fine material than exists on the road in its normal state. Figure F-2 presents a data form to be used for the sampling of unpaved roads. Figure F-3 shows the use of a dust pan and broom for unpaved road sampling as well as a sample strip across the road.

F.1.2 Paved Roads

Ideally, for a given paved road, one gross sample per every 8 km (5 mi) of paved roads should be collected. For industrial roads, one gross sample should be obtained for each road segment in the plant. The gross sample should consist of at least two separate increments per travel lane or each 0.8-km (0.5-mi) of road length should have a separate sample.

Figure F-4 presents a diagram showing the location of incremental samples for a four-lane road. Each incremental sample should consist of a lateral strip 0.3 to 3 m (1 to 10 ft) in width across a travel lane. The exact width is dependent on the amount of loose surface material on the paved roadway. For a visually dirty road, a width of 0.3 m (1 ft) is sufficient; but for a visually clean road, a width of 3 m (10 ft) is needed to obtain an adequate sample.

The above sampling procedure may be considered as the preferred method of collecting surface dust from paved roadways. In many instances, however, the collection of eight sample increments may not be feasible because of manpower, equipment, and traffic/hazard limitations. As an alternative method, samples can be obtained from a single strip across all travel lanes. When it is necessary to resort to this sampling strategy, care must be taken to select sites that have dust loading and traffic characteristics typical of the entire roadway segment of interest. In this situation, sampling from a strip 3 to 9 m (10 to 30 ft) in width is suggested, where possible. From this width, sufficient sample can be collected and a step toward representativeness in sample acquisition will be accomplished.

Samples are removed from the road surface by vacuuming, preceded by broom sweeping if large aggregate is present. The samples should be taken from the traveled portion of the lane with the area measured and recorded on the appropriate data form. With a whisk broom and a dust pan, the larger particles are collected from the sampling area and placed in a clean, labeled sample container (plastic jar or bag). The remaining smaller particles are then swept from the road with an electric broom-type vacuum sweeper. The sweeper must be equipped with a preweighed, prelabeled, disposable vacuum bag. Care must be taken when installing the bags in the sweeper to avoid torn bags which can result in sample loss. After the sample has been collected, the bag should be removed from the sweeper, checked for leaks and stored in a prelabeled, gummed envelope, and sealed for transport. Figure F-5 presents a data form to be used for the sampling of paved roads and Figure F-6 provides photos of sampling procedures for industrial roads and city streets.

Sampling Data for Unpaved Roads

Date Sample Collected _____ Recorded by_____

Type of Material Sampled: _____
Site of Sampling*:_____

SAMPLING METHOD

1. Sampling device: whisk broom and dust pan
2. Sampling depth: loose surface material (do not abrade road base)
3. Sample container: metal or plastic bucket with sealed poly liner
4. Gross sample specifications:
   (a) 1 sample of 23kg (50 lb) minimum for every 3.8 km (3 mi) sampled
   (b) composite of 4 increments: lateral strips of 6" width extending over traveled portion of roadway

Indicate deiviations from above methods and general meteorology:_____

_____

_____

_____

SAMPLING DATA

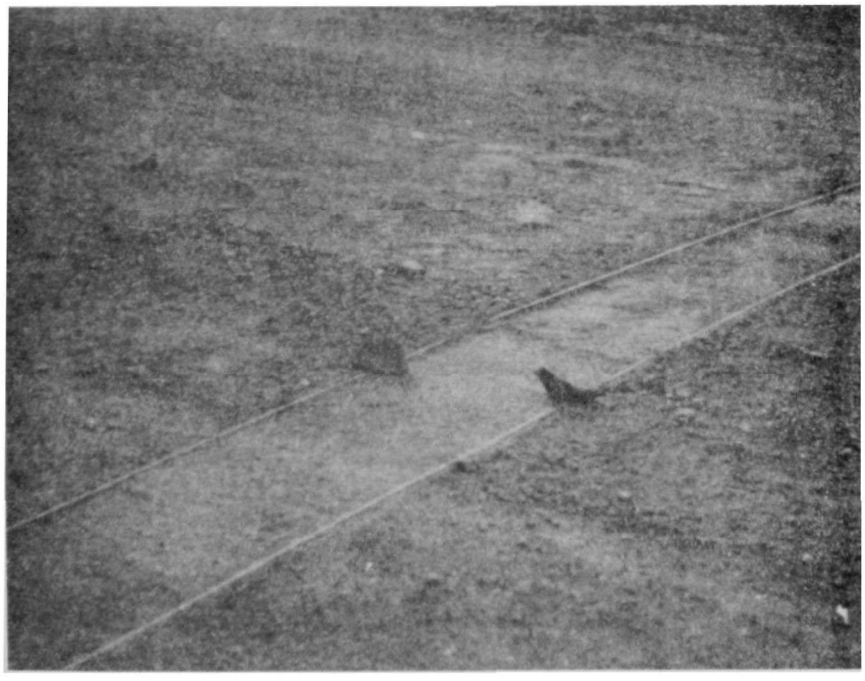
Sample No.	Time	Location*	Surface Area	Depth	Quantity of Sample

* Use code given on plant or road map for segment identification and indicate sample on map.

DIAGRAM

Figure F-2. Data form for unpaved road sampling.

(a) Wisk broom and pan for surface sampling.



(b) Sample strip across road width.

Figure F-3. Unpaved road sampling.

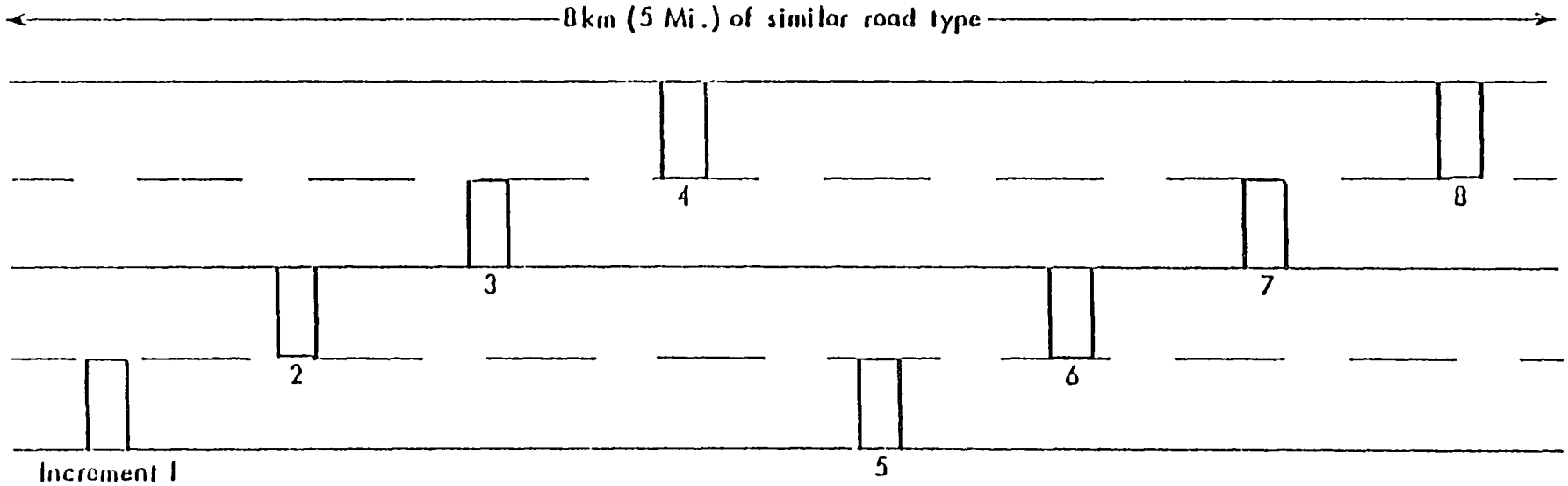


Figure F-4. Location of incremental sampling sites on a paved road.

Figure F-5. Data form for paved road sampling.

Paved Road Loading

Date Sample Collected _____ Recorded by _____

Type of Material Sampled: _____ No. of Traffic Lanes: _____
Sampling Location*: _____ Surface Condition: _____

* Use code given on plant or road map for segment identification and indicate sample on map.

SAMPLING METHOD

1. Sampling device: Portable vacuum cleaner (broom sweep first if loading is heavy)
2. Sampling depth: Loose surface material
3. Sample container: Tared and numbered vacuum cleaner bags
4. Gross sample specifications:
   (a) 1 sample every 8 kg (5 mi) of road length
   (b) Composite two segments per travel lane (each 0.5 mi or 0.8 km should have separate sample): lateral strips of 0.3 m minimum width extending from curb to curb
   (c) Do not sample curb areas

Indicate deiviations from above method: _____

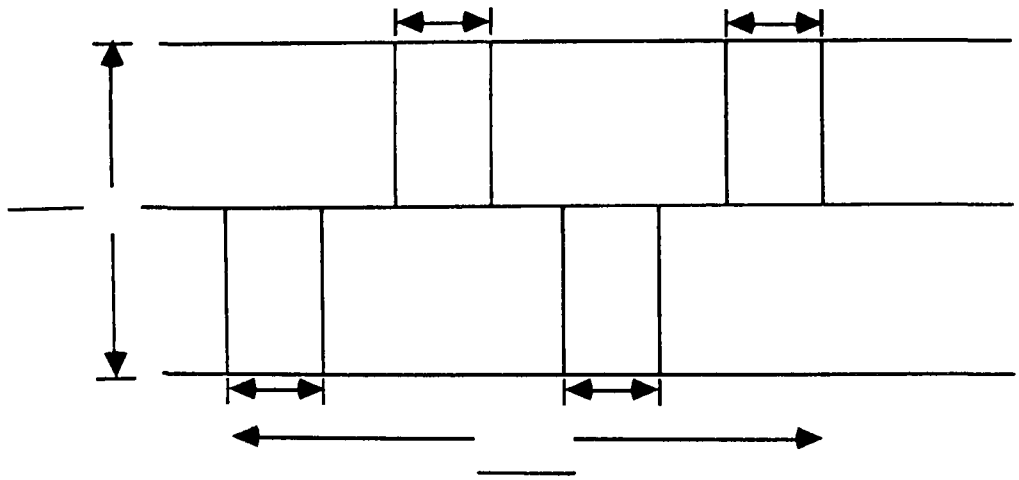
_____

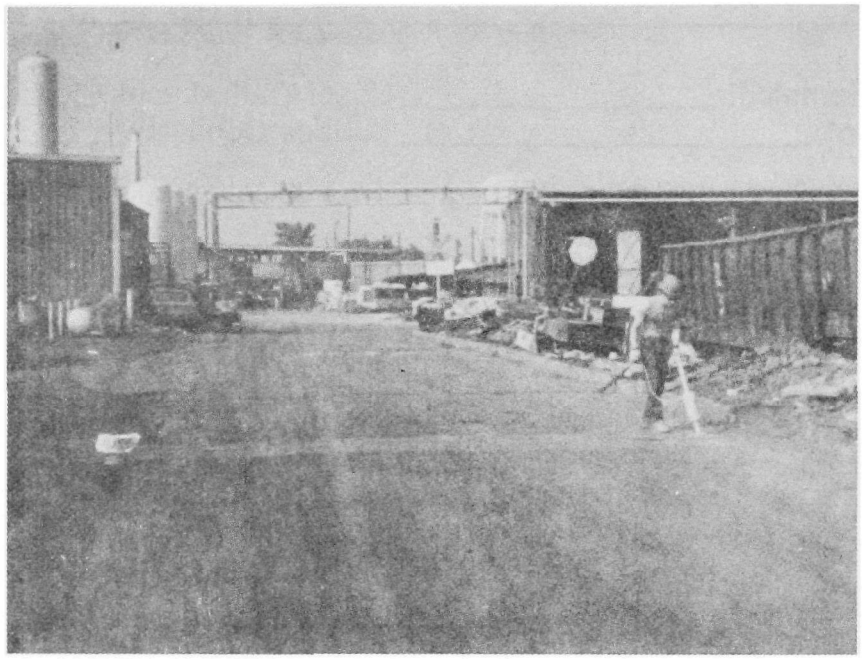
SAMPLING DATA

Sample No.	Vac Bag	Time	Surface Area	Broom Swept?

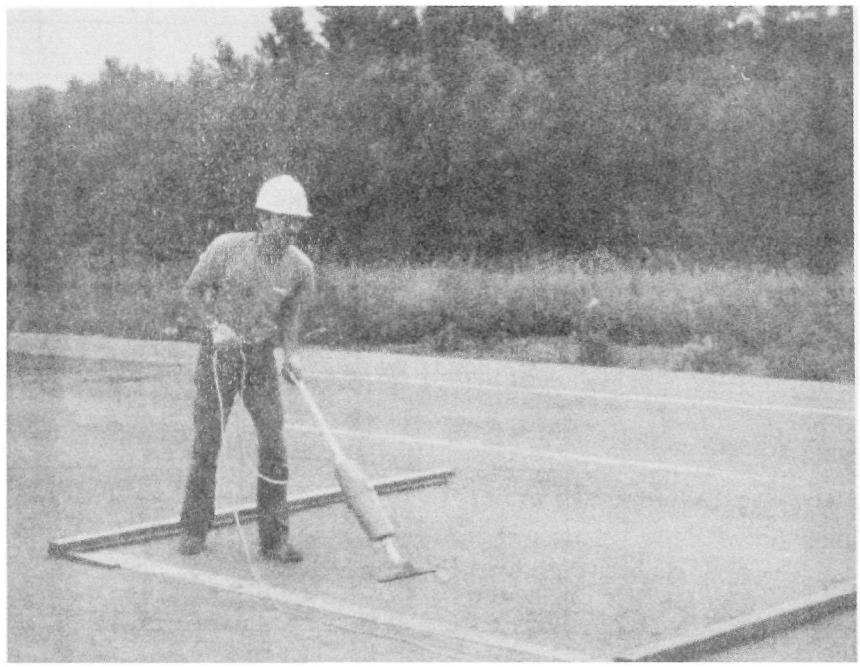
Sample No.	Vac Bag	Time	Surface Area	Broom Swept?

DIAGRAM (mark each segment with vacuum bag number)





(a) Sampling of industrial paved roads.



(b) Sampling of city street.

Figure F-6. Paved road sampling procedures.

F.1.3 Storage Piles

In sampling the surface of a pile to determine representative properties for use in the wind erosion (or materials handling) equation, a gross sample made up of top, middle, and bottom incremental samples should ideally be obtained since the wind disturbs the entire surface of the pile. However, it is impractical to climb to the top or even middle of most industrial storage piles because of the large size.

The most practical approach in sampling from large piles is to minimize the bias by sampling as near to the middle of the pile as practical and by selecting sampling locations in a random fashion. Incremental samples should be obtained along the entire perimeter of the pile. The spacing between the samples should be such that the entire pile perimeter is traversed with approximately equidistant incremental samples. If small piles are sampled, incremental samples should be collected from the top, middle, and bottom.

An incremental sample (e.g., one shovelful) is collected by skimming the surface of the pile in a direction upward along the face. Every effort must be made by the person obtaining the sample not to purposely avoid sampling larger pieces of raw material. Figure F-7 presents a data form to be used for the sampling of storage piles.

In obtaining a gross sample for the purpose of characterizing a load-in or load-out process, incremental samples should be taken from the portion of the storage pile surface (1) which has been formed by the addition of aggregate material or (2) from which aggregate material is being reclaimed.

F.2 LABORATORY ANALYSIS

F.2.1 Sources Other Than Paved Roads

F.2.1.1 Sample Preparation--

Once the gross sample is brought to the laboratory, it must be prepared for silt analysis. This entails dividing the sample to a workable size.

A 23-kg (50-lb) gross sample can be divided by using: (1) mechanical devices; (2) alternative shovel method; (3) riffle; or (4) coning and quartering method. Mechanical division devices are not discussed in this section since they are not found in many laboratories. The alternative shovel method is actually only necessary for samples weighing hundreds of pounds. Therefore, this section discusses only the use of the riffle and the coning and quartering method.

Sampling Data for Storage Piles

Date Sample Collected _____ Recorded by _____

Type of Material Sampled: _____

Site of Sampling: _____

SAMPLING METHOD

1. Sampling device: pointed shovel
2. Sampling depth: 4-6 inches (10-15 cm)
3. Sample container: metal or plastic bucket with sealed poly liner
4. Gross sample specifications:
   (a) 1 sample of 23kg (50 lb) minimum for every pile sampled
   (b) composite of 10 increments
5. Minimum portion of stored material (at one site) to be sampled: 25%

Indicate deiviations from above method: _____

SAMPLING DATA

Sample No.	Time	Location (Refer to map)	Surface Area	Depth	Quantity of Sample

Figure F-7. Data form for storage pile sampling.

ASTM standards describe the selection of the correct riffle size and the correct use of the riffle. Riffle slot widths should be at least three times the size of the largest aggregate in the material being divided. The following quote describes the use of the riffle.[1]

> "Divide the gross sample by using a riffle. Riffles properly used will reduce sample variability but cannot eliminate it. Riffles are shown in Figure F-8(a) and (b). Pass the material through the riffle from a feed scoop, feed bucket, or riffle pan having a lip or opening the full length of the riffle. When using any of the above containers to feed the riffle, spread the material evenly in the container, raise the container, and hold it with its front edge resting on top of the feed chute, then slowly tilt it so that the material flows in a uniform stream through the hopper straight down over the center of the riffle into all the slots, thence into the riffle pans, one-half of the sample being collected in a pan. Under no circumstances shovel the sample into the riffle, or dribble into the riffle from a small-mouthed container. Do not allow the material to build up in or above the riffle slots. If it does not flow freely through the slots, shake or vibrate the riffle to facilitate even flow."

The procedure for coning and quartering is best illustrated in Figure F-9. The following is a description of the procedure: (1) mix the material and shovel it into a neat cone; (2) flatten the cone by pressing the top without further mixing; (3) divide the flat, circular pile into equal quarters by cutting or scraping out two diameters at right angles; (4) discard two opposite quarters; (5) thoroughly mix the two remaining quarters, shovel them into a cone, and repeat the quartering and discarding procedures until the sample has been reduced to 0.9 to 1.8 kg (2 to 4 lb). Samples likely to be affected by moisture or drying must be handled rapidly, preferably in an area with a controlled atmosphere, and sealed in a container to prevent further changes during transportation and storage. Care must be taken that the material is not contaminated by anything on the floor or that a portion is not lost through cracks or holes. Preferably, the coning and quartering operation should be conducted on a floor covered with clean paper or plastic.

The size of the laboratory sample is important--too little sample will not be representative and too much sample will be unwieldy. Ideally, one would like to analyze the entire gross sample in batches, but this is not practical. While all ASTM standards acknowledge this impracticality, they disagree on the exact size, as indicated by the range of recommended samples, extending from 0.05 to 27 kg (0.1 to 60 lb).

---

1 D2013-72. Standard Method of Preparing Coal Samples for Analysis. Annual Book of ASTM Standards, 1977.

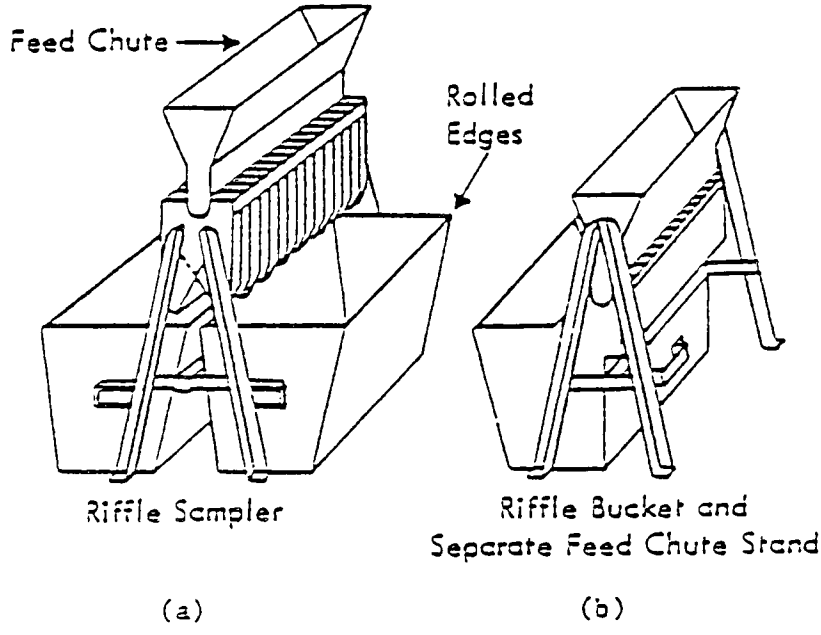


Figure F-8. Sample dividers (riffles).

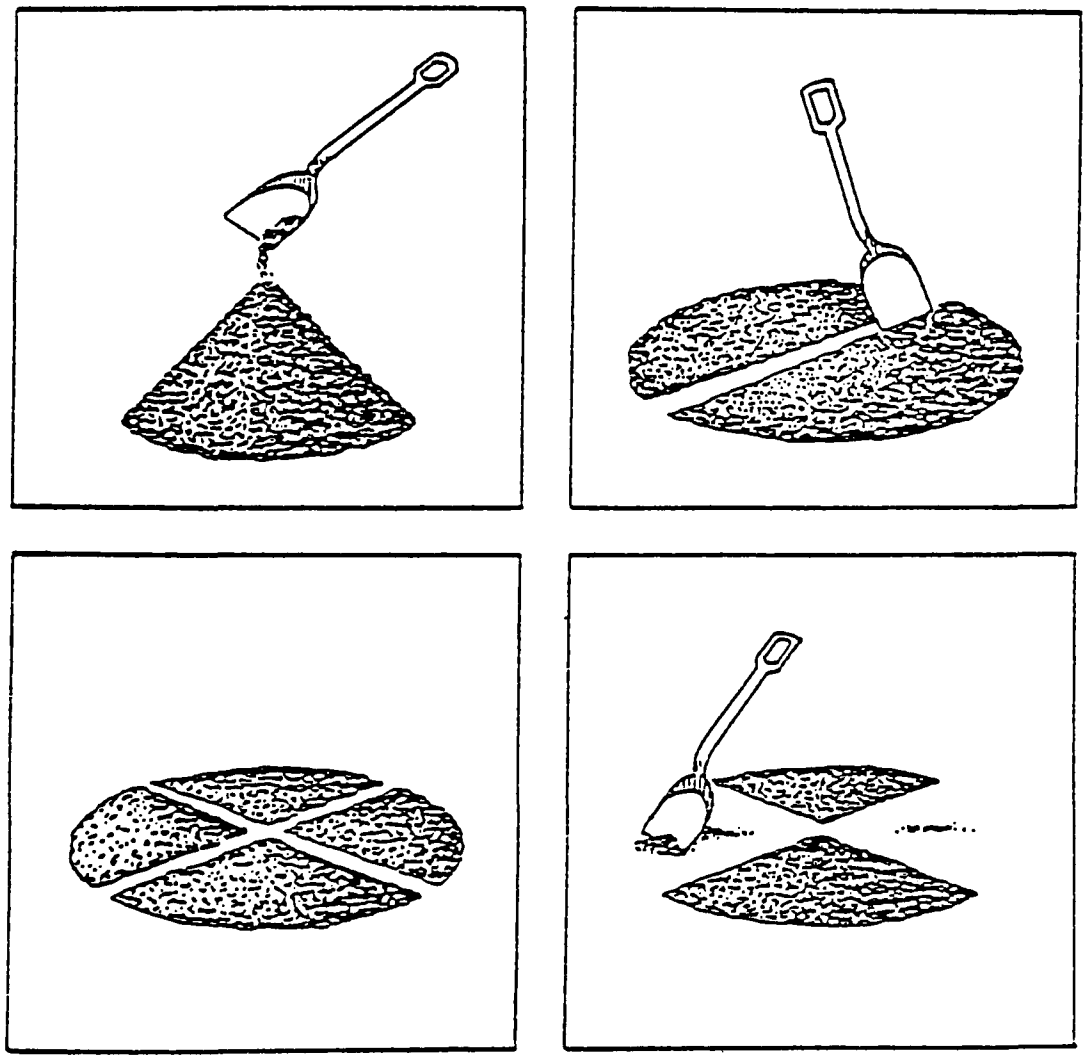


Figure F-9. Coning and quartering.

The main principle in sizing the laboratory sample is to have sufficient coarse and fine portions to be representative of the material and to allow sufficient mass on each sieve so that the weighing is accurate. A recommended rule of thumb is to have twice as much coarse sample as fine sample. A laboratory sample of 800 to 1,600 g is recommended since that is the largest quantity that can be handled by the scales normally available (1,600-g capacity). Also, more sample than this can produce screen blinding for the 8-in-diameter screens normally available.

F.2.1.2 Laboratory Analysis of Samples for Silt Content--

The basic recommended procedure for silt analysis is mechanical dry sieving after moisture analysis. A step-by-step procedure is given in Tables F-1 and F-2. The sample should be oven-dried for 24 h at 230°F (110°C) before sieving. The sieving time is variable; sieving should be continued until the net sample weight collected in the pan increases by less than 3.0% of the previous net sample weight collected in the pan. A minor variation of 3.0% is allowed since some sample grinding due to interparticle abrasion will occur, and consequently, the weight will continue to increase. When the change reduces to 3.0%, it is thought that the natural silt has been passed through the No. 200 sieve screen (75 μmP) and that any additional increase is due to grinding. Both the sample preparation operations and the sieving results can be recorded on Figures F-10 and F-11.

F.2.2 Samples From Paved Roads

F.2.2.1 Sample Preparation and Analysis for Total Loading--

The gross sample of paved road dust will arrive at the laboratory in two types of containers: (1) the broom-swept dust will be in plastic bags; and (2) the vacuum-swept dust will be in vacuum bags.

Both the broom-swept dust and the vacuum-swept dust are weighed on a beam balance. The broom-swept dust is weighed in a tared container. The vacuum-swept dust is weighed in the vacuum bag which was tared and equilibrated in the laboratory before going to the field. The vacuum bag and its contents should be equilibrated again in the laboratory before weighing.

The total surface dust loading on the traveled lanes of the paved road is then calculated in units of kilograms of dust on the traveled lanes per kilometer of road. When only one strip is taken across the traveled lanes, the total dust loading on the traveled lanes is calculated as follows:

$$L = \frac{m_b + m_v}{\ell} \qquad \text{(F-1)}$$

where: L = surface dust loading (kg/km)

m_b = mass of the broom-swept dust (kg)

m_v = mass of the vacuum-swept dust (kg)

ℓ = length of strip as measured along the centerline of the road (km)

TABLE F-1. MOISTURE ANALYSIS PROCEDURE

1. Preheat the oven to approximately 110°C (230°F). Record oven temperature.

2. Tare the laboratory sample containers which will be placed in the oven. Tare the containers with the lids on if they have lids. Record the tare weight(s). Check zero before weighing.

3. Record the make, capacity, smallest division, and accuracy of the scale.

4. Weigh the laboratory sample in the container(s). Record the combined weight(s). Check zero before weighing.

5. Place sample in oven and dry overnight.[a]

6. Remove sample container from oven and (a) weigh immediately if uncovered, being careful of the hot container; or (b) place tight-fitting lid on the container and let cool before weighing. Record the combined sample and container weight(s). Check zero before weighing.

7. Calculate the moisture as the initial weight of the sample and container minus the oven-dried weight of the sample and container divided by the initial weight of the sample alone. Record the value.

8. Calculate the sample weight to be used in the silt analysis as the oven-dried weight of the sample and container minus the weight of the container. Record the value.

[a]Dry materials composed of hydrated minerals or organic materials like coal and certain soils for only 1-1/2 h. Because of this short drying time, material dried for only 1-1/2 h must not be more than 2.5 cm (1 in.) deep in the container.

TABLE F-2. SILT ANALYSIS PROCEDURES

1. Select the appropriate 8-in. diameter, 2-in. deep sieve sizes. Recommended U.S. Standard Series sizes are: 3/8 in., No. 4, No. 20, No. 40, No. 100, No. 140, No. 200, and a pan. Comparable Tyler Series sizes can also be utilized. The No. 20 and the No. 200 are mandatory. The others can be varied if the recommended sieves are not available or if buildup on one particulate sieve during sieving indicates that an intermediate sieve should be inserted.

2. Obtain a mechanical sieving device such as vibratory shaker or a Roto-Tap.

3. Clean the sieves with compressed air and/or a soft brush. Material lodged in the sieve openings or adhering to the sides of the sieve should be removed (if possible) without handling the screen roughly.

4. Obtain a scale (capacity of at least 1,600 g) and record make, capacity, smallest division, date of last calibration, and accuracy (if available).

5. Tare sieves and pan. Check the zero before every weighing. Record weights.

6. After nesting the sieves in decreasing order with pan at the bottom, dump dried laboratory sample (probably immediately after moisture analysis) into the top sieve. Brush fine material adhering to the sides of the container into the top sieve and cover the top sieve with a special lid normally purchased with the pan.

7. Place nested sieves into the mechanical device and sieve for 20 min. Remove pan containing minus No. 200 and weigh. Replace pan beneath the sieves and sieve for another 10 min. Remove pan and weigh. When the differences between two successive pan sample weighings (where the tare of the pan has been subtracted) is less than 3.0 percent, the sieving is complete.

8. Weigh each sieve and its contents and record the weight. Check the zero before every weighing.

9. Collect the laboratory sample and place the sample in a separate container if further analysis is expected.

Sample No: _____
Material: _____

Split Sample Balance:
Make _____
Capacity _____
Smallest Division _____

Total Sample Weight: _____
(Excl. Container)
Number of Splits: _____

Split Sample Weight (before drying)
Pan + Sample: _____
Pan: _____
Wet Sample: _____

Oven Temperature: _____
Date In _____ Date Out _____
Time In _____ Time Out _____
Drying Time _____

Material Weight (after drying)
Pan + Material: _____
Pan: _____
Dry Sample: _____

MOISTURE CONTENT:
(A) Wet Sample Wt. _____
(B) Dry Sample Wt. _____
(C) Difference Wt. _____

$$\frac{C \times 100}{A} = _____ \%\ \text{Moisture}$$

Figure F-10. Example moisture analysis form.

Sample No: _____
Material: _____

Split Sample Balance:
Make _____
Capacity _____
Smallest Division _____

Material Weight (after drying)
Pan + Material: _____
Pan: _____
Dry Sample: _____

Final Weight: _____

$$\% \text{ Silt} = \frac{\text{Net Weight} < 200 \text{ Mesh}}{\text{Total Net Weight}} \times 100 = _____ \%$$

SIEVING

Time: Start:	Weight (Pan Only)
Initial (Tare):	
20 min:	
30 min:	
40 min:	

SIZE DISTRIBUTION

Screen	Tare Weight (Screen)	Final Weight (Screen + Sample)	Net Weight (Sample)	%
3/8 in.				
4 mesh				
10 mesh				
20 mesh				
40 mesh				
100 mesh				
140 mesh				
200 mesh				
Pan				

Figure F-11. Example silt analysis form.

When several incremental samples are collected on alternate roadway halves as shown in Figure F-4, the total surface dust loading is calculated as follows:

$$L = \frac{m_{b1} + m_{v1} + m_{b5} + m_{v5}}{\ell_1 + \ell_5} + \frac{m_{b2} + m_{v2} + m_{b6} + m_{v6}}{\ell_2 + \ell_6} + \frac{m_{b3} + m_{v3} + m_{b7} + m_{v7}}{\ell_3 + \ell_7} + \frac{m_{b4} + m_{v4} + m_{b8} + m_{v8}}{\ell_4 + \ell_8} + \qquad \text{(F-2)}$$

where: L = surface dust loading (kg/km)

m_{b_i} = mass of broom sweepings for increment i (kg)

m_{v_i} = mass of vacuum sweepings for increment i (kg)

ℓ = length of increment i is measured along the road centerline (km)

F.2.2.2 Sample Preparation and Analyses for Road Dust Silt Content--

After weighing the sample to calculate total surface dust loading on the traveled lanes, the broom-swept and vacuum-swept dust is composited. The composited sample is usually small and requires no sample splitting in preparation for sieving. If splitting is necessary to prepare a laboratory sample of 800 to 1,600 g, the techniques discussed in Section F.2.1.1 can be used. The laboratory sample is then sieved using the techniques described in Section F.2.1.2.