Emission Factor Documentation for AP-42 Section 11.1

Hot Mix Asphalt Production

Final Report

For U. S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Emission Inventory Branch

EPA Contract No. 68-D2-0159
Work Assignment No. I-01

MRI Project No. 4601-01

July 1994

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For U. S. Environmental Protection Agency
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Emission Inventory Branch
Research Triangle Park, NC 27711

Attn: Mr. Ron Myers (MD-14)

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PREFACE

This report was prepared by Midwest Research Institute (MRI) for the Office of Air Quality Planning and Standards (OAQPS), U. S. Environmental Protection Agency (EPA), under Contract No. 68-D2-0159, Assignment No. I-01. Mr. Ron Myers was the requester of the work.

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July 28, 1994

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1.0 INTRODUCTION

The document Compilation of Air Pollutant Emissions Factors (AP-42) has been published by the U. S. Environmental Protection Agency (EPA) since 1972. Supplements to AP-42 have been routinely published to add new emission source categories and to update existing emission factors. AP-42 is routinely updated by EPA to respond to new emission factor needs of EPA, State, and local air pollution control programs, and industry.

An emission factor relates the quantity (weight) of pollutants emitted to a unit of activity of the source. The uses for the emission factors reported in AP-42 include:

1. Estimates of areawide emissions;

2. Estimates of emissions for a specific facility; and

3. Evaluation of emissions relative to ambient air quality.

The purpose of this report is to provide background information from test reports and other information to support preparation of AP-42 Section 11.1, Hot Mix Asphalt Production.

This background report consists of five sections. Section 1 includes the introduction to the report. Section 2 gives a description of the hot mix asphalt (HMA) industry. It includes a characterization of the industry, an overview of the different process types, a description of emissions, and a description of the technology used to control emissions resulting from HMA production. Section 3 is a review of emission data collection and analysis procedures. It describes the literature search, the screening of emission data reports, and the quality rating system for both emission data and emission factors. Section 4 details revisions to the existing AP-42 section narrative and pollutant emission factor development. It includes the review of specific data sets and the results of data analysis. Section 5 presents the AP-42 Section 11.1, Hot Mix Asphalt Production.

2.0 INDUSTRY DESCRIPTION[1,3]

Hot mix asphalt (HMA) paving materials are a mixture of well graded, high quality aggregate (which can include reclaimed asphalt pavement [RAP]), and liquid asphalt cement, which is heated and mixed in measured quantities to produce HMA. Aggregate and RAP (if used) constitute over 92 percent by weight of the total mixture. Aside from the amount and grade of asphalt cement used, mix characteristics are determined by the relative amounts and types of aggregate and RAP used. A certain percentage of fine aggregate (less than 74 micrometers [μm] in physical diameter) is required for the production of good quality HMA.

Hot mix asphalt paving materials can be manufactured by: (1) batch mix plants, (2) continuous mix (mix outside drum) plants, (3) parallel flow drum mix plants, and (4) counterflow drum mix plants. This order of listing generally reflects the chronological order of development and use within the HMA Industry.

There are approximately 3,600 active asphalt plants in the United States. Of these, approximately 2,300 are batch plants, 1,000 are parallel flow drum mix plants, and 300 are counterflow drum mix plants. About 85 percent of plants being manufactured today are of the counterflow drum mix design, while batch plants and parallel flow drum mix plants account for 10 percent and 5 percent respectively.

Continuous mix plants (type 2 above) represent a very small fraction of the plants in use (1/2 percent or less) and, therefore, are not discussed further nor are any data presented for this type of plant.

An HMA plant can be constructed as a permanent plant, a skid mounted (easily relocated) plant, or as a portable plant. All plants can have RAP processing capabilities. Virtually all of the plants manufactured today have RAP processing capability.

2.1 CHARACTERIZATION OF THE INDUSTRY

According to the National Asphalt Pavement Association, there are approximately 3,600 active HMA plants in the United States.

2.2 PROCESS DESCRIPTION[1,2,3]

Batch Mix Plants--Figure 2-1 shows the batch mix HMA production process. Raw aggregate normally is stockpiled near the plant. The bulk aggregate moisture content typically stabilizes between 3 to 5 percent by weight.

Processing begins as the aggregate is hauled from the storage piles and is placed in the appropriate hoppers of the cold feed unit. The material is metered from the hoppers onto a conveyer belt and is transported into a rotary dryer (typically gas- or oil-fired). Dryers are equipped with flights designed to shower the aggregate inside the drum to promote drying efficiency.

As the hot aggregate leaves the dryer, it drops into a bucket elevator and is transferred to a set of vibrating screens where it is classified into as many as four different grades (sizes) and dropped into individual "hot" bins according to size. To control aggregate size distribution in the final batch mix, the operator opens various hot bins over a weigh hopper until the desired mix and weight are obtained.

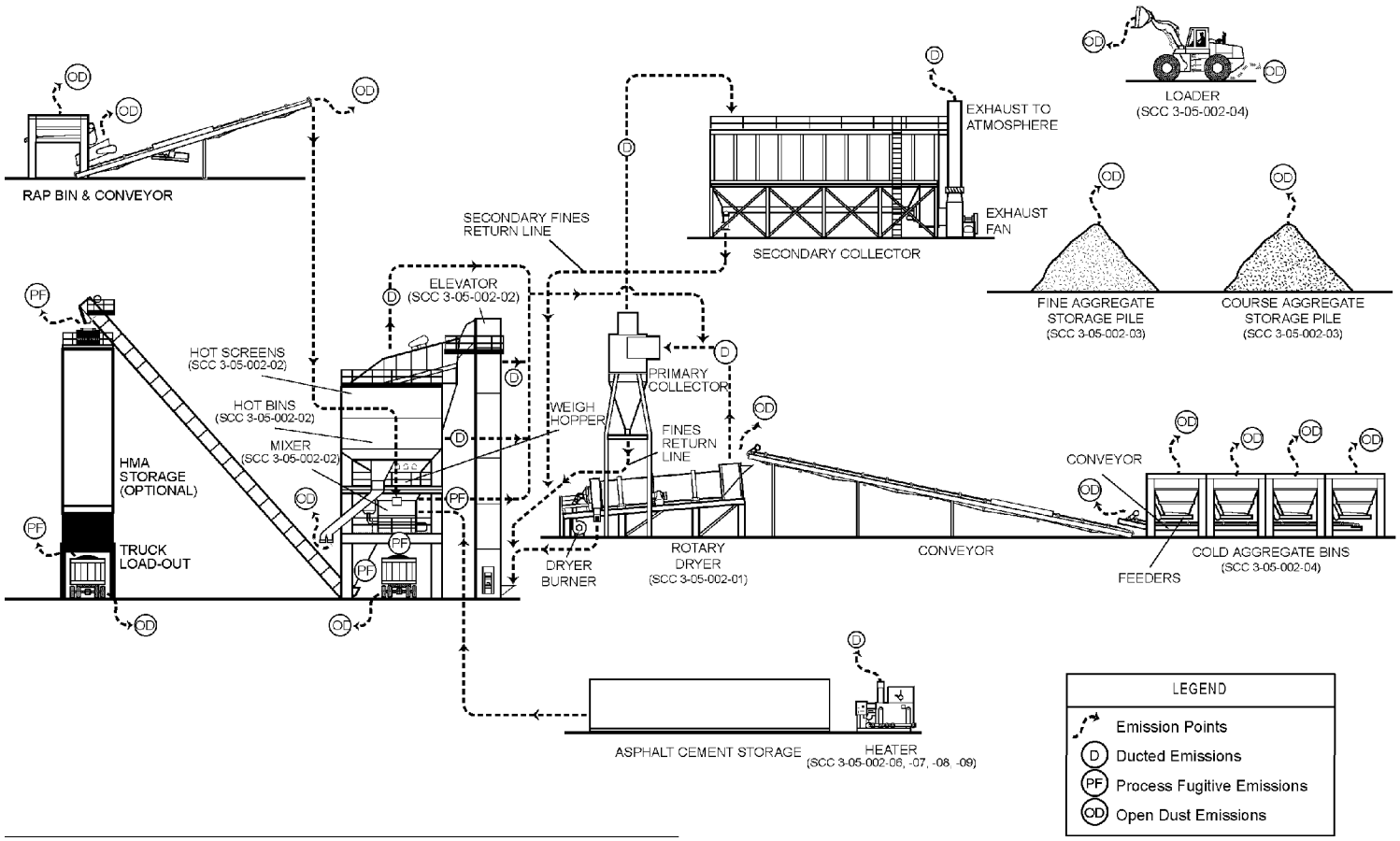

Figure 2-1. General process flow diagram for batch mix asphalt paving plants.[3]

Reclaimed asphalt pavement may be added at this point also. Concurrent with the aggregate being weighed, liquid asphalt cement is pumped from a heated storage tank to an asphalt bucket where it is weighed to achieve the desired aggregate-to-asphalt cement ratio in the final mix.

The aggregate from the weigh hopper is dropped into the pugmill (mixer) and dry-mixed for 6 to 10 seconds. The liquid asphalt is then dropped into the pugmill where it is mixed for an additional period of time. Total mixing time is usually less than 60 seconds. Then the hot mix is conveyed to a hot storage silo or dropped directly into a truck and hauled to the job site.

Parallel Flow Drum Mix Plants--Figure 2-2 shows the parallel flow drum mix process. This process is a continuous mixing type process using proportioning cold feed controls for the process materials. The major difference between this process and the batch process is that the dryer is used not only to dry the material but also to mix the heated and dried aggregates with the liquid asphalt cement. Aggregate, which has been proportioned by gradations, is introduced to the drum at the burner end. As the drum rotates, the aggregates as well as the combustion products move toward the other end of the drum in parallel. Liquid asphalt cement flow is controlled by a variable flow pump which is electronically linked to the virgin aggregate and RAP weigh scales. The asphalt cement is introduced in the mixing zone midway down the drum in a lower temperature zone along with any RAP and particulate matter from collectors.

The mixture is discharged at the end of the drum and conveyed to a surge bin or HMA storage silos. The exhaust gases also exit the end of the drum and pass on to the collection system.

Parallel flow drum mixers have an advantage in that mixing in the discharge end of the drum captures a substantial portion of the aggregate dust, therefore lowering the load on the downstream collection equipment. For this reason, most parallel flow drum mixers are

followed only by primary collection equipment (usually a baghouse or venturi scrubber). However, because the mixing of aggregate and liquid asphalt cement occurs in the hot combustion product flow, organic emissions (gaseous and liquid aerosol) may be greater than in other processes.

Counterflow Drum Mix Plants--Figure 2-3 shows a counterflow drum mix plant. In this type of plant, the material flow in the drum is opposite or counterflow to the direction of exhaust gases. In addition, the liquid asphalt cement mixing zone is located behind the burner flame zone so as to remove the materials from direct contact with hot exhaust gases.

Liquid asphalt cement flow is controlled by a variable flow pump which is electronically linked to the virgin aggregate and RAP weigh scales. It is injected into the mixing zone along with any RAP and particulate matter from primary and secondary collectors.

Because the liquid asphalt cement, virgin aggregate and RAP are mixed in a zone removed from the exhaust gas stream, counterflow drum mix plants will likely have organic emissions (gaseous and liquid aerosol) that are lower than parallel flow drum mix plants. A counterflow drum mix plant can normally process RAP at ratios up to 50 percent with little or no observed effect upon emissions. Today's counterflow drum mix plants are designed for improved thermal efficiencies.

Recycle Processes--In recent years, the use of RAP has been initiated in the HMA industry. Reclaimed asphalt pavement significantly reduces the amount of new (virgin) rock and asphalt cement needed to produce HMA.

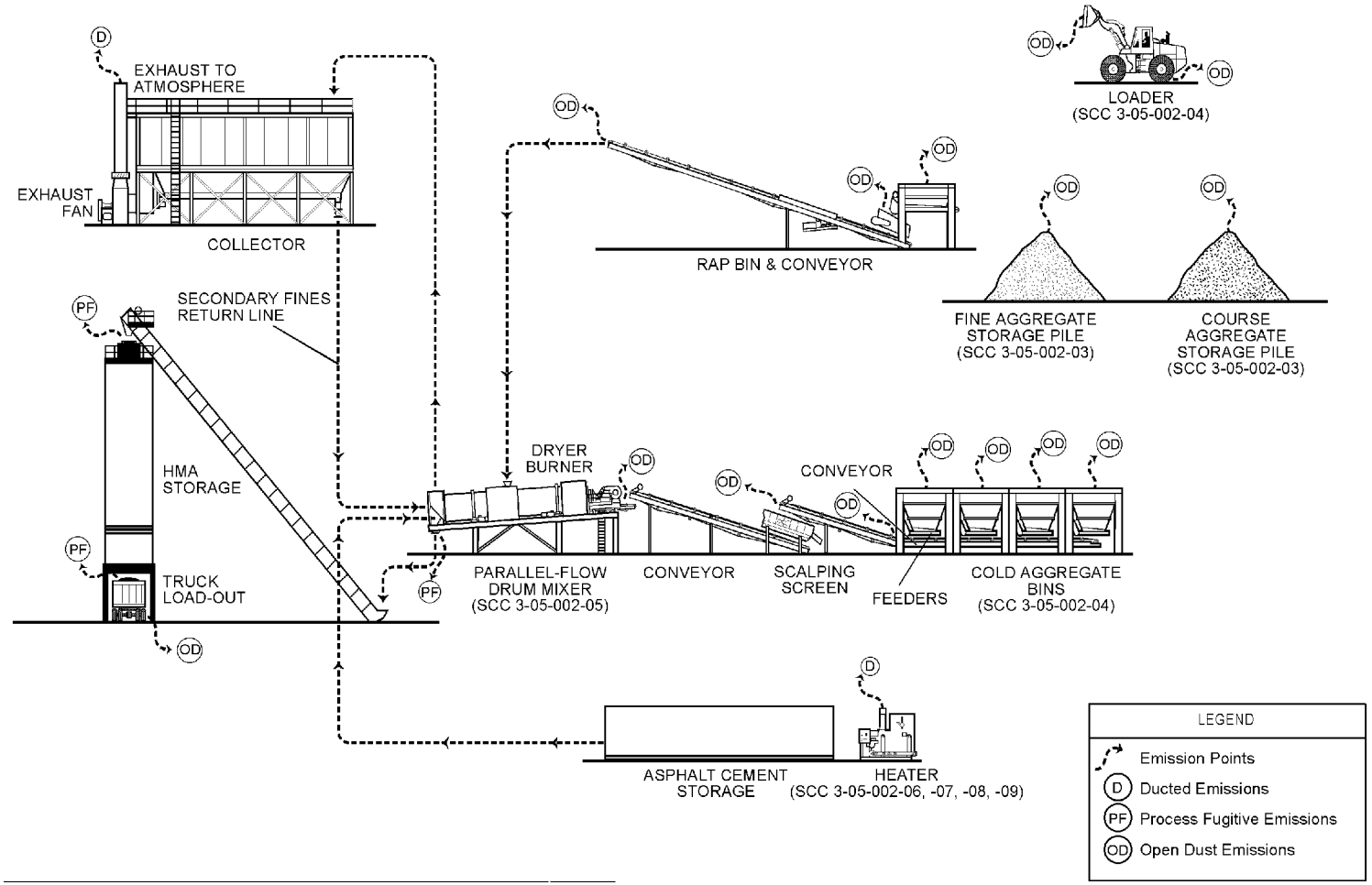

Figure 2-2. General process flow diagram for parallel-flow drum mix asphalt paving plants.[3]

In the reclamation process, old asphalt pavement is removed from the road base. This material is then transported to the plant, and is crushed and screened to the appropriate size for further processing. The paving material is then heated and mixed with new aggregate (if applicable), and the proper amount of new asphalt cement is added to produce a high quality grade of HMA.

2.3 EMISSIONS

Emission points at batch and drum mix asphalt plants discussed below refer to Figures 2-1, -2, and -3 respectively.

Batch Mix Plants--As with most facilities in the mineral products industry, batch mix HMA plants have two major categories of emissions: those that are vented to the atmosphere through some type of stack, vent, or pipe (ducted sources), and those that are not confined to ducts and vents but are emitted directly from the source to the ambient air (fugitive sources). Ducted emissions are usually collected and transported by an industrial ventilation system with one or more fans or air movers, eventually to be emitted to the atmosphere through some type of stack. Fugitive emissions result from process and open sources, and consist of a combination of gaseous pollutants and particulate matter (PM).

The most significant source of ducted emissions from batch mix HMA plants is the rotary drum dryer. Emissions from the dryer consist of water as steam evaporated from the aggregate, PM, and small amounts of volatile organic compounds (VOC) of various species (including HAP) derived from combustion exhaust gases.

Other potential process sources include the hot-side conveying, classifying, and mixing equipment, which are vented to either the primary dust collector along with the dryer gas or to a separate dust collection system. The vents and enclosures that collect emissions from these sources are commonly called "fugitive air" or "scavenger" systems. The scavenger system may or may not have its own separate air mover device, depending on the particular facility. The emissions captured and transported by the scavenger system are mostly aggregate dust, but they may also contain gaseous VOC and a fine aerosol of condensed liquid particles. This liquid aerosol is created by the condensation of gas into particles during cooling of organic vapors volatilized from the asphalt cement in the pugmill. The amount of liquid aerosol produced depends to a large extent on the temperature of the asphalt cement and aggregate entering the pugmill. Organic vapor and its associated aerosol are also emitted directly to the atmosphere as process fugitives during truck loadout, from the bed of the truck itself during transport to the job site, and from the asphalt storage tank. In addition to low molecular weight VOC, these organic emission streams may contain small amounts of polycyclic compounds. Both the low molecular weight VOC and the polycyclic organic compounds can include HAP. The ducted emissions from the heated asphalt storage tanks may include VOC and combustion products from the tank heater.

There are also a number of open dust sources associated with batch mix HMA plants, including vehicular traffic generating fugitive dust on paved and unpaved roads, aggregate material handling, and other aggregate processing operations. Fugitive dust may range from 0.1 μm to more than 300 μm in aerodynamic diameter. On average, 5 percent of cold aggregate feed is less than 74 μm (minus 200 mesh). Fugitive dust that may escape collection before primary control generally consists of PM with 50 to 70 percent of the total mass less than 74 μm. Uncontrolled PM emission factors for various types of fugitive sources in HMA plants can be found in Section 11.2.3 of this document.

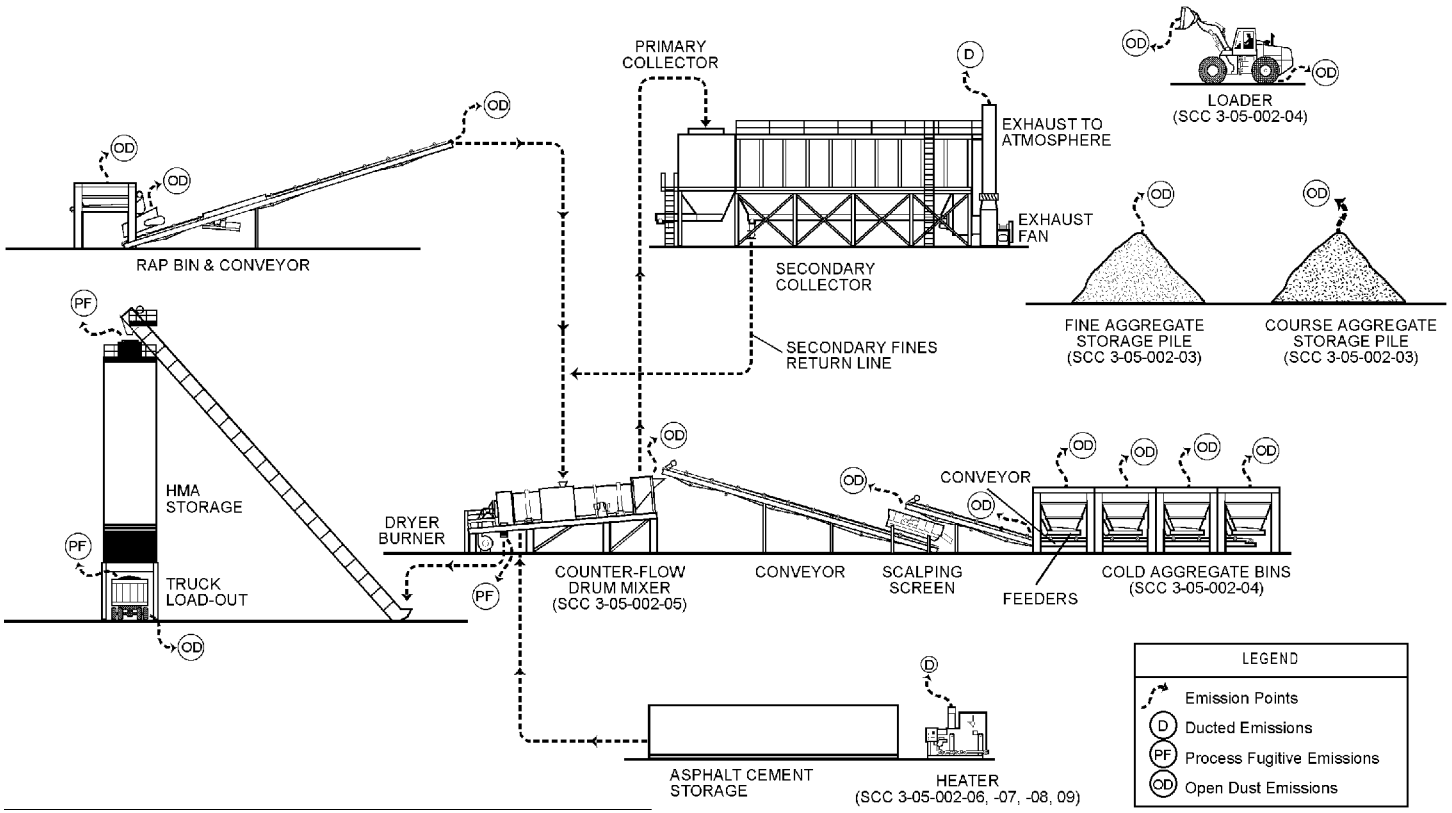

Figure 2- 3. General process diagram for counter- flow drum mix asphalt paving plants. [3]

Parallel Flow Drum Mix Plants--The most significant ducted source of emissions is the rotary drum dryer. Emissions from the drum consist of water as steam evaporated from the aggregate, PM, and small amounts of VOC of various species (including HAP) derived from combustion exhaust gases, liquid asphalt cement, and RAP, if used. The VOC result from incomplete combustion and from the heating and mixing of liquid asphalt cement inside the drum. The processing of RAP materials may increase VOC emissions because of an increase in mixing zone temperature during processing.

Once the VOC cool after discharge from the process stack, some condense to form a fine liquid aerosol or "blue smoke" plume.

A number of process modifications or restrictions have been introduced to reduce blue smoke including installation of flame shields, rearrangement of flights inside the drum, adjustments of the asphalt injection point, and other design changes.

Counterflow Drum Mix Plants--The most significant ducted source of particulate emissions is the rotary drum dryer in a counterflow drum mix plant. Emissions from the drum consist of water as steam evaporated from the aggregate, PM, and small amounts of VOC of various species (including HAP) derived from combustion exhaust gases, liquid asphalt cement, and RAP, if used.

Because liquid asphalt cement, aggregate, and sometimes RAP, are mixed in a zone not in contact with the hot exhaust gas stream, counterflow drum mix plants will likely have lower VOC emissions than parallel flow drum mix plants. The organic compounds that do occur in counterflow drum mix plants are likely products of a slight inefficient combustion, and can include HAP.

Parallel and Counterflow Drum Mix Plants--Process fugitive emissions associated with batch plants from hot screens, elevators and the pugmill are not present in the drum mix processes. However, there may be minimal fugitive VOC emissions from the transport and handling of the hot mix from the drum mixer to the storage silo and also from the load out operations to the delivery trucks. Since the drum process is continuous, these plants must have surge bins or storage silos. The open dust sources associated with drum mix plants are similar to those of batch mix plants with regard to truck traffic and aggregate material feed and handling operations.

2.4 CONTROL TECHNOLOGY

The choice of applicable control equipment for the dryer exhaust and vent line ranges from dry mechanical collectors to scrubbers and fabric collectors. Attempts to apply electrostatic precipitators have met with little success. Practically all plants use primary dust collection equipment with large diameter cyclones, skimmers or settling chambers. These chambers are often used as classifiers to return collected material to the hot elevator and to combine it with the drier aggregate. To capture remaining particulate matter, the primary collector effluent is ducted to a secondary collection device. Most plants use either a baghouse or a venturi scrubber for secondary emission control.

References for Section 2

1. Compilation of Air Pollutant Emission Factors (AP-42), U. S. Environmental Protection Agency, Research Triangle Park, North Carolina, October 1986.

2. Hot Mix Asphalt Mixing Facilities, Katherine O'C. Gunkel, Wildwood Environmental Engineering Consultants, Inc.

3. Written communication from R. Gary Fore, National Asphalt Pavement Association, Lanham, MD, to Ronald Myers, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 1, 1994.

3.0 GENERAL DATA REVIEW AND ANALYSIS

3.1 LITERATURE SEARCH AND SCREENING

Data for this investigation were obtained from a number of sources within the Office of Air Quality Planning and Standards (OAQPS) and from outside organizations. The AP-42 Background Files located in the Emission Inventory Branch (EIB) was reviewed for information on the industry, processes, and emissions. The Crosswalk/Air Toxic Emission Factor Data Base Management System (XATEF) and VOC/PM Speciation Data Base Management System (SPECIATE) data bases were searched by SCC code for identification of the potential pollutants emitted and emission factors for those pollutants. A general search of the Air CHIEF CD-ROM also was conducted to supplement the information from these two data bases.

Information on the industry, including number of plants, was obtained from the National Asphalt Pavement Association (NAPA). The Aerometric Information Retrieval System (AIRS) data base also was searched for data on the number of plants, plant location, and estimated annual emissions of criteria pollutants.

A number of sources of information were investigated specifically for emission test reports and data. A search of the Test Method Storage and Retrieval (TSAR) data base was conducted to identify test reports for sources within the asphalt concrete industry. Copies of these test reports were obtained from the files of the Emission Measurement Branch (EMB). The EPA library was searched for additional test reports. A list of plants that have been tested within the past 5 years was compiled from the AIRS data base. Using this information, State and Regional offices were contacted about the availability of test reports. However, the information obtained from these offices was limited. Publications lists from the Office of Research and Development (ORD) and Control Technology Center (CTC) were also searched for reports on emissions from the asphalt concrete industry. In addition, representative trade associations, including the National Asphalt Pavement Association, were contacted for assistance in obtaining information about the industry and emissions.

To screen out unusable test reports, documents, and information from which emission factors could not be developed, the following general criteria were used:

1. Emission data must be from a primary reference:

    a. Source testing must be from a referenced study that does not reiterate information from previous studies.

    b. The document must constitute the original source of test data. For example, a technical paper was not included if the original study was contained in the previous document. If the exact source of the data could not be determined, the document was eliminated.

2. The referenced study must contain test results based on more than one test run.

3. The report must contain sufficient data to evaluate the testing procedures and source operating conditions (e.g., one-page reports were generally rejected).

A final set of reference materials was compiled after a thorough review of the pertinent reports, documents, and information according to these criteria.

3.2 EMISSION DATA QUALITY RATING SYSTEM

As part of the analysis of the emission data, the quantity and quality of the information contained in the final set of reference documents were evaluated. The following data were excluded from consideration:

1. Test series averages reported in units that cannot be converted to the selected reporting units;

2. Test series representing incompatible test methods (i.e., comparison of EPA Method 5 front-half with EPA Method 5 front- and back-half);

3. Test series of controlled emissions for which the control device is not specified;

4. Test series in which the source process is not clearly identified and described; and

5. Test series in which it is not clear whether the emissions were measured before or after the control device.

Test data sets that were not excluded were assigned a quality rating. The rating system used was that specified by EIB for preparing AP-42 sections. The data were rated as follows:

A--Multiple tests that were performed on the same source using sound methodology and reported in enough detail for adequate validation. These tests do not necessarily conform to the methodology specified in EPA reference test methods, although these methods were used as a guide for the methodology actually used.

B--Tests that were performed by a generally sound methodology, but lack enough detail for adequate validation.

C--Tests that were based on an untested or new methodology or that lacked a significant amount of background data.

D--Tests that were based on a generally unacceptable method but may provide an order-of-magnitude value for the source.

The following criteria were used to evaluate source test reports for sound methodology and adequate detail:

1. Source operation. The manner in which the source was operated is well documented in the report. The source was operating within typical parameters during the test.

2. Sampling procedures. The sampling procedures conformed to a generally acceptable methodology. If actual procedures deviated from accepted methods, the deviations are well documented. When this occurred, an evaluation was made of the extent to which such alternative procedures could influence the test results.

3. Sampling and process data. Adequate sampling and process data are documented in the report, and any variations in the sampling and process operation are noted. If a large spread between test results cannot be explained by information contained in the test report, the data are suspect and are given a lower rating.

4. Analysis and calculations. The test reports contain original raw data sheets. The nomenclature and equations used were compared to those (if any) specified by EPA to establish equivalency. The depth of review of the calculations was dictated by the reviewer's confidence in the ability and conscientiousness of the tester, which in turn was based on factors such as consistency of results and completeness of other areas of the test report.

3.3 EMISSION FACTOR QUALITY RATING SYSTEM

The quality of the emission factors developed from analysis of the test data was rated utilizing the following general criteria:

A--Excellent: Developed only from A-rated test data taken from many randomly chosen facilities in the industry population. The source category is specific enough so that variability within the source category population may be minimized.

B--Above average: Developed only from A-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industries. The source category is specific enough so that variability within the source category population may be minimized.

C--Average: Developed only from A- and B-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industry. In addition, the source category is specific enough so that variability within the source category population may be minimized.

D--Below average: The emission factor was developed only from A- and B-rated test data from a small number of facilities, and there is reason to suspect that these facilities do not represent a random sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of the emission factor are noted in the emission factor table.

E--Poor: The emission factor was developed from C- and D-rated test data, and there is reason to suspect that the facilities tested do not represent a random sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of these factors are always noted.

The use of these criteria is somewhat subjective and depends to an extent upon the individual reviewer. Details of the rating of each candidate emission factor are provided in Chapter 4 of this report.

References for Section 3

1. *Technical Procedures for Developing AP-42 Emission Factors and Preparing AP-42 Sections*, EPA-454/B-93-050, Office of Air Quality Planning and Standards, U. S. Environmental Protection Agency, Research Triangle Park, NC, October 1993.

4.0 AP-42 SECTION DEVELOPMENT

4.1 REVISION OF SECTION NARRATIVE

The draft AP-42 section is a revision of Section 11.1, Asphaltic Concrete Plants, in the current version of AP-42. The revised Section 11.1 is entitled "Hot Mix Asphalt Production," as this is the terminology used in the industry. The existing section, which was last revised in 1986, was updated to include additional information on the drum mix process and on the use of reclaimed asphalt pavement (RAP). In addition, emission data from all of the references cited in the 1986 revision were reviewed. Valid data from the old and new references were combined (where applicable) to develop emission factors for several pollutants, including filterable particulate matter (PM), condensible organic PM, condensible inorganic PM, carbon monoxide (CO), carbon dioxide (CO_2), sulfur dioxide (SO_2), nitrogen oxides (NO_X), metals, total organic compounds (TOC), methane, benzene, toluene, ethylbenzene, xylene, polynuclear aromatic hydrocarbons (PAH), aldehydes, polychlorinated dibenzofurans (PCDF), and polychlorinated dibenzo(p)dioxins (PCDD) emitted from hot mix asphalt (HMA) production operations. These emission factors represent emissions from drum mix and batch mix dryers fired by natural gas, propane, fuel oil (Nos. 2, 4, 5, or 6), and waste oil. Additional emission factors were developed for emissions from hot oil heaters. No emission factors for conventional continuous plants are included in the revised section because these plants represent a small percentage of the industry (less than one-half of 1 percent) and no emission data were available for review.

4.2 POLLUTANT EMISSION FACTOR DEVELOPMENT

Twenty references documenting 50 emission tests were obtained for use in developing new emission factors for HMA production. Two test reports, References 42 and 43, were rejected for use in developing emission factors because the process descriptions and production data provided in the reports were incomplete. Ten of the test reports (References 26-30, 32-35, and 41) document industry-sponsored State compliance tests. References 24 and 25 document EPA-sponsored tests conducted for the purpose of updating AP-42. References 31, 36, and 37 document EPA-sponsored tests conducted to determine PM emission levels from plants using RAP. Reference 38 documents the results of an EPA study conducted at a HMA plant. Reference 39 summarizes and documents the results of seven emission tests (four of these seven tests have been received, but have not yet been reviewed) conducted for the National Asphalt Pavement Association (NAPA), and Reference 40 summarizes the results of 25 emission tests (compliance tests for the State of Wisconsin) conducted at HMA plants. In addition to the new information gathered, the 23 references from the current AP-42 section were reviewed and are discussed in the following section.

4.2.1 Review of Specific Data Sets

4.2.1.1 Reference 1. This document contains a description of conventional HMA production operations and presents emission data from 45 HMA plants. Average emission factors were developed for conventional (continuous and batch mix) dryers controlled by spray towers, centrifugal scrubbers, and fabric filters. In addition, the results of an emission study conducted at five HMA plants are presented. The five source test reports are located in the background file. During the study, dryer stack emissions were measured simultaneously with an EPA source sampling train and a Los Angeles source sampling train. The Los Angeles train measured 37 percent higher PM emissions than the EPA train when emissions were sampled following fabric filtration and 20 percent lower PM emissions following wet scrubber systems. Particle size data contained in this document were evaluated in Reference 23 and are not discussed here.

The data from the industry survey were assigned a C rating because the production rates were estimated from the plant capacities and the test data sheets for each test were not provided. The data from three of the five emission tests (EPA sampling train only) conducted as a part of this study were assigned a C rating because the types of plants were not specified and only two test runs were performed during each test. The plants were the conventional type, but batch or continuous operations were not specified. The data for plant No. 1 were not considered valid because problems with the fabric filter were reported during testing, and the emissions were considerably higher than emissions from the other plants tested. The data for plant No. 3 were not considered valid because problems with cyclonic flow were experienced during testing.

4.2.1.2 Reference 2. This document contains information on process operations and control systems for the HMA industry. No emission data for use in developing emission factors were presented.

4.2.1.3 Reference 3. This document presents test data from 25 tests conducted at conventional HMA plants by Los Angeles County Air Pollution Control District personnel prior to 1960. Filterable PM emissions and particle size distribution are included in the data summary. A telephone conversation documented in Reference 23 of this AP-42 background file indicated that the PM sampling train was similar to the EPA Method 5 train, except that the filter was located downstream of the impingers. A "Micromerograph" was used to determine particle size. The data were gathered more than 30 years ago and cannot be validated because little detail about the testing is provided. Therefore, the data were not rated and were not used for emission factor development.

4.2.1.4 Reference 4. This document contains a description of HMA production operations and potential control systems. Some emission data are included in the document, but no production rates are documented. The data presented are the same data presented in Reference 3. Therefore, the data were not rated and were not used for emission factor development.

4.2.1.5 Reference 5. This document is an excerpt from the 1973 edition of the Air Pollution Engineering Manual. Data for filterable PM emissions and particle size distribution from two HMA batching plants are presented, but no indication of the number of test runs performed or the test method used is provided. In addition, control devices are not specified. However, the magnitude of the emissions suggests that the emissions were uncontrolled. Filterable PM and size-specific PM emission factors were developed for batch mix dryers.

All of the data were assigned a D rating because insufficient detail was provided for validation of the emission tests.

4.2.1.6 Reference 6. This document presents emission data from 19 emission tests at 10 HMA batching plants. Data for PM emissions from dryers are presented, but no indication of the number of test runs performed or the test method used is provided. The data were gathered more than 40 years ago and cannot be validated because little detail about the testing is provided. Therefore, the data were not rated and were not used for emission factor development.

4.2.1.7 Reference 7. This document includes a process description for HMA batching plants, control efficiencies for various control devices, and limited emission data. No indication is given of the number of test runs performed or the test method used to quantify emissions. The data were gathered more than 30 years ago and cannot be validated because little detail about the testing is provided. Therefore, the data were not rated and were not used for emission factor development.

4.2.1.8 Reference 8. This document is not located in the background file.

4.2.1.9 Reference 9. This document is the same as Reference 3, which is described in Section 4.2.3.3.

4.2.1.10 Reference 10. This document presents costs and efficiencies for control devices used at HMA batching plants but does not contain emission data that can be used for emission factor development.

4.2.1.11 Reference 11. This document contains a description of the drum mix HMA production process and contains secondary emission data for total PM emissions from drum mixers with various controls. Several deficiencies are noted in the text, including a lack of detail on the control systems and a large variation in emission concentrations. In addition, run-by-run data are not presented. For these reasons, the data presented were assigned a C rating.

4.2.1.12 Reference 12. This document describes in detail the drum-mix process but does not contain any emission data that were used for emission factor development.

4.2.1.13 Reference 13. This document describes the drum mix process and contains limited emission data. No indication is given of the number of test runs performed or the test method used to quantify emissions. In addition, uncontrolled PM emission factors calculated from two of the tests differ by an order of magnitude. The data presented were not rated and were not used for emission factor development.

4.2.1.14 Reference 14. This document describes the production of HMA and discusses proposed (1973) new source performance standards (NSPS) for the industry but does not contain any emission data that were suitable for emission factor development.

4.2.1.15 Reference 15. This document presents the final version of Reference 14. In addition, run-by-run test data for emission tests conducted at 18 HMA facilities are included in Appendix A. Data from 8 of the 18 tests were used for emission factor development. Data were not used if (1) no production rates were documented; (2) only 1 test run was performed; or (3) the data were deemed invalid because of problems encountered during testing. Data for filterable PM, total PM, condensible inorganic PM, and CO_2 emissions from batch mix plants with various control systems were presented.

The data were assigned a B rating because the document is a secondary reference and does not contain sufficient detail about the processes and tests. If only two valid test runs were performed, the data were assigned a C rating. The testing methodologies appeared to be sound, and no problems were reported during the valid test runs.

4.2.1.16 Reference 16. This document contains secondary emission data from several sources. In addition, the results of an industrial survey are presented. The survey was conducted in 1975 by Monsanto Research Corporation. Data for uncontrolled and controlled PM emissions from drum mixers were documented, but sufficient detail were not included for validation of the data.

4.2.1.17 Reference 17. This document presents the results of two test programs conducted at HMA plants. Both plants tested were batch mix plants with wet scrubbers controlling dryer emissions. Some run-by-run data are presented, but the run-by-run emission rates are not included in the document. The data presented could not be used for emission factor development.

4.2.1.18 Reference 18. This document does not contain data or process information that is relevant to this section. The revised AP-42 section does not reference this document.

4.2.1.19 Reference 19. This document does not contain data or process information that is relevant to this section. The revised AP-42 section does not reference this document.

4.2.1.20 Reference 20. This reference is missing from the background file.

4.2.1.21 Reference 21. This document discusses the application of fabric filters to dryers at HMA plants. Some emission data are also presented, but they are insufficient for use in developing emission factors.

4.2.1.22 Reference 22. This document presents the results of VOC emission tests conducted at five drum-mix HMA plants. Method 25 was used to quantify nonmethane VOC (as carbon) emissions, which are referred to as total nonmethane organic comounds (TNMOC) in Section 4.2.4 of this report. In addition, PM emissions were measured (Method 5) at one of the plants. Operating parameters were varied from run to run, but no change in emissions (attributable to a specific variation) was noticeable.

The data from this document were assigned a C rating. Adequate detail about the processes and tests was provided, and no problems were reported during testing. However, the data were downrated to C because a positive bias in Method 25 results may occur when the product of the moisture content and CO_2 concentration of the stack gas is greater than 100, which is typical of stack gas from HMA plants (moisture contents and CO_2 concentrations were not provided in the document). Also, complete run-by-run emission data were not provided, and the actual emission test reports were not available for review.

4.2.1.23 Reference 23. This document presents the background information used for the 1986 revision of AP-42 Section 8.1, Asphaltic Concrete Plants. The main emphasis in the 1986 revision was size-specific PM, and only primary references that contained particle size data were used for emission factor development in the report. The particle size data developed in this document (currently presented in AP-42) are assumed to be valid and are not discussed further. However, the size-specific emission factors presented are based on emission data that are not considered valid. These emission factors are not presented in the revised AP-42 section.

4.2.1.24 Reference 24. The plant tested was a batch mix facility with a natural gas-fired dryer and emissions controlled by a fabric filter. The test included controlled measurements of filterable PM, size-specific PM, trace metals, and PAH emissions and uncontrolled measurements of CO, CO_2, SO_2, NO_x, aldehydes, methane, benzene, toluene, ethylbenzene, xylene, and TOC emissions. All of the tests were performed at the outlet of the fabric filter on the dryer, but fabric filters provide only incidental, if any, control of the above pollutants that are labeled as uncontrolled. Several target pollutants were not detected in any run. Particulate matter and trace metal emissions were sampled using EPA Method 5/Combined Train SW 846 Test Method 0031. Size-specific PM, condensible inorganic PM, and condensible organic PM emissions were determined using EPA Methods 201A and 202. However, the actual cut size for the PM-10 catch was 7.9 micrometers (µm) because the test ports were not large enough to allow the proper nozzle to be used. Measurements of CO, CO_2, and NO_x were taken using continuous emissions monitoring systems (CEMS) following EPA Methods 10, 3A, and 7E, respectively. Sampling for PAH's was performed concurrently with the PM and metals test by EPA SW 846 Test Method 0010 (Semi-VOST), and aldehyde sampling was done using EPA SW 846 Method 0011. Methane, benzene, toluene, ethylbenzene, and xylene emissions were determined using EPA Method 18 (13 samples analyzed for each

pollutant), and TOC emissions were measured using EPA Method 25A (CEMS). The Method 25A results were converted to TOC as methane using the measured emission concentration, the density of methane at standard temperature and pressure (STP), and the volumetric flow rate for each test run. Three test runs were performed for each pollutant measured, except for the pollutants measured by CEMS, as well as methane, benzene, toluene, ethylbenzene, and xylene. The results from the CEMS were averaged over the duration of each test run, thus giving one value for each pollutant from each of three test runs. The second metals run was not included in the development of emission factors because the back-half sample bottle was broken during shipment. The emission factors developed from this test report differ from the emission factors presented in the test report because of the treatment of runs in which the pollutant concentration was found to be below the detection limit. In the test report, runs of this type were not included in emission averages, whereas the emission factors developed from the report use one-half of the detection limit as the emissions from a "nondetect" run. Detection limits were not provided for benzene, toluene, ethylbenzene, and xylene. For these pollutants, assumed detection limits were calculated using 80 percent of the smallest detected amount of each pollutant.

A rating of A was assigned to most of the test data, unless more than one test run did not detect the targeted pollutant, in which case the data were assigned a B rating. Methane, benzene, toluene, ethylbenzene, and xylene emission data were assigned a B rating because detection limits were not provided. Data for PM-10 emissions were assigned a C rating because of the problem with the actual cut size (see above) as well as the use of an average volumetric flow rate for calculating emission rates (measured rates were suspect). Data for condensible PM emissions were assigned a B rating because of the use of an average volumetric flow rate for calculating emission rates (measured rates were suspect). Otherwise, the report included adequate detail, the methodology appeared to be sound, and no problems were reported in the valid test runs.

4.2.1.25 Reference 25. The plant tested was a drum mix facility with a waste oil-fired dryer and emissions controlled by a fabric filter. The test included controlled measurements of filterable PM, condensible inorganic PM, condensible organic PM, PM-10, trace metals, and PAH's from the plant stack (drum mixer/dryer fabric filter outlet). Uncontrolled measurements included CO, CO_2, NO_x, SO_2, aldehydes, methane, benzene, ethylbenzene, toluene, xylene, and TOC emissions from the plant stack. All of the tests were performed at the outlet of the fabric filter, but fabric filters provide only incidental, if any, control of the above pollutants that are labeled as uncontrolled. Filterable PM and trace metal emissions were sampled using EPA Method 5/Combined Train SW 846 Test Method 0031. Size-specific PM and condensible PM emissions were determined using EPA Methods 201A and 202. Measurements of CO, CO_2, NO_X, SO_2, and TOC were taken using a CEMS following EPA Methods 10, 3A, 7E, 6C, and 25A, respectively. The Method 25A results were converted to TOC as methane using the measured emission concentration, the density of methane at STP, and the volumetric flow rate for each test run. Sampling for PAH's was performed concurrently with the PM and metals test using EPA SW 846 Test Method 0010 (Semi-VOST), and aldehyde sampling was done using EPA SW 846 Method 0011. Methane, benzene, toluene, ethylbenzene, and xylene emissions were determined using EPA Method 18. Three test runs were performed for each pollutant measured, except for the pollutants measured by CEMS. The results from the CEMS were averaged over the duration of each test run, thus giving one value for each pollutant from each of three test runs. The emission factors developed using the data from this test report differ from the emission factors presented in the test report because of the treatment of runs in which the pollutant concentration was found to be below the detection limit. In the test report, runs of this type were included in emission averages (zero emissions), whereas the emission factors developed from the report use one-half of the detection limit as the emission from a "nondetect" run. Detection limits were not provided for

ketones, methane, benzene, toluene, ethylbenzene, and xylene. For these pollutants, assumed detection limits were calculated using 80 percent of the smallest detected amount of each pollutant.

A rating of A was assigned to most of the test data, with the following exceptions: methyl ethyl ketone, methane, benzene, ethylbenzene, toluene, and xylene emission data were rated B because detection limits were not provided and at least one "nondetect" run was reported for each pollutant. The report included adequate detail, the methodology was sound, and no problems were reported during the valid test runs.

4.2.1.26 Reference 26. The plant tested was a drum mix facility with the dryer fired by No. 2 fuel oil and emissions controlled by a fabric filter. The test included three runs measuring filterable PM and CO_2 emissions from the drum mixer (drying process) at the fabric filter outlet. The fabric filter controls PM emissions but provides only incidental, if any, control of CO_2 emissions. Filterable PM was sampled using EPA Method 5, and CO_2 was measured using EPA Method 3.

A rating of A was assigned to the test data from the drum mixer. The report included adequate detail, the methodology appeared to be sound, and no problems were reported.

4.2.1.27 Reference 27. The plant tested was a drum mix facility with the dryer fired by No. 2 fuel oil and emissions controlled by a fabric filter. The test included three runs measuring filterable PM and CO_2 emissions from the drum mixer (drying process) at the fabric filter outlet. The fabric filter controls PM emissions but provides only incidental, if any, control of CO_2 emissions. Filterable PM was sampled using EPA Method 5, and CO_2 was measured using EPA Method 3.

A rating of A was assigned to the test data from the drum mixer. The report included adequate detail, the methodology appeared to be sound, and no problems were reported in the valid test runs.

4.2.1.28 Reference 28. The plant tested was a drum mix facility with emissions controlled by a fabric filter. The test report included three test runs measuring filterable PM, condensible inorganic PM, and CO_2 emissions from the drum mixer (drying process) at the fabric filter outlet. The fabric filter controls PM emissions but provides only incidental, if any, control of CO_2 emissions. Filterable PM was sampled using EPA Method 5, condensible inorganic PM was analyzed using the Method 5 back-half catch, and CO_2 was measured using EPA Method 3.

A rating of B was assigned to the test data from the drum mixer. The report included some detail, but it provided only an average production rate, and the fuel used to fire the dryer was not specified. The methodology appeared to be sound, and no problems were reported in the valid test runs.

4.2.1.29 Reference 29. The plant tested was a drum mix facility with the dryer fired by No. 2 fuel oil and emissions controlled by a venturi scrubber. The test included three runs measuring filterable PM and CO_2 emissions from the drum mixer (drying process) at the venturi scrubber outlet. The scrubber controls PM emissions but provides only incidental, if any, control of CO_2 emissions. Filterable PM was sampled using EPA Method 5, and CO_2 was measured using EPA Method 3.

A rating of B was assigned to the test data from the drum mixer. The report included some detail, but it provided only an average production rate and did not specify the pressure drop across the venturi section of the scrubber. The methodology appeared to be sound, and no problems were reported in the valid test runs.

4.2.1.30 Reference 30. The plant tested was a drum mix facility with a natural gas-fired dryer and emissions controlled by a fabric filter. The test included three runs measuring filterable PM and CO_2 emissions from the drum mixer (drying process) at the fabric filter outlet. The fabric filter controls PM emissions but provides only incidental, if any, control of CO_2 emissions. Filterable PM was sampled using EPA Method 5, and CO_2 was measured using EPA Method 3.

A rating of A was assigned to the test data from the drum mixer. The report included adequate detail, the methodology appeared to be sound, and no problems were reported in the valid test runs.

4.2.1.31 Reference 31. The plant tested was a drum mix facility with the dryer fired by No. 5 fuel oil and emissions controlled by a fabric filter. The tests were performed at the inlet and outlet of the fabric filter and measured filterable PM and condensible organic PM (referred to as TOC in the test report). The tests were performed during both conventional and recycle operations. The condensible organic PM tests were not considered to be valid because problems were encountered during analysis (the back-half catch adhered to the glassware). During conventional operation, there were two valid test runs at the fabric filter inlet (Run 1 was not isokinetic) and three valid runs at the fabric filter outlet. During recycle operation, there were three valid test runs at the fabric filter inlet and two valid runs at the fabric filter outlet (only two runs were performed). All of the tests measured emissions from the drum mixer.

A rating of A was assigned to the test data from the tests that included three valid runs, and a rating of B was assigned to the test data from the tests that included only two valid runs. The report included adequate detail, the methodology appeared to be sound, and no problems were reported in the valid test runs.

4.2.1.32 Reference 32. The plant tested was a drum mix facility with the dryer fired by No. 2 fuel oil and emissions controlled by a scrubber. The test included three runs measuring filterable PM and CO_2 emissions from the drum mixer (drying process) at the scrubber outlet. The scrubber controls PM emissions, but provides only incidental, if any, control of CO_2 emissions. Filterable PM was sampled using EPA Method 5, and CO_2 was measured using EPA Method 3.

A rating of B was assigned to the test data from the drum mixer. The report included some detail, but it did not provide details about the control system, including the pressure drop across the scrubber. The methodology appeared to be sound, and no problems were reported in the valid test runs.

4.2.1.33 Reference 33. The plant tested was a drum mix facility with the dryer fired by No. 2 fuel oil and emissions controlled by a fabric filter. The test included three runs measuring filterable PM and CO_2 emissions from the drum mixer (drying process) at the fabric filter outlet. The fabric filter controls PM emissions but provides only incidental, if any, control of CO_2 emissions. Particulate matter was sampled using EPA Method 5, and CO_2 was measured using EPA Method 3. The test was conducted while the dryer feed included about 33 percent RAP.

A rating of A was assigned to the test data from the drum mixer. The report included adequate detail, the methodology appeared to be sound, and no problems were reported in the valid test runs.

4.2.1.34 Reference 34. The plant tested was a batch mix facility with the dryer fired by natural gas and emissions controlled by a fabric filter. The test included three runs measuring trace metals, chromium and hexavalent chromium (Cr and Cr^{+6}), PAH's, aldehydes, VOC's, CO, and NO_x emissions from the dryer at the fabric filter outlet. For target pollutants that were not detected in one or two test runs,

emissions from the "nondetect" runs were estimated using one-half of the pollutant detection limit. Several target pollutants were not detected in any run. Trace metals were measured using draft EPA Method 200.7, PAH's were tested using EPA Modified Method 5 (MM5--now known as Semi-VOST), and CO and NO_x were tested using a CEMS. The other pollutants were measured using California Air Resources Board (CARB) test procedures, which are similar to EPA methods for the pollutants tested.

A rating of B or C was assigned to the data from this test. Data were assigned a C rating if a pollutant was detected in only one of three test runs, or if only two valid test runs were performed. The report included some detail, but it provided only an average production rate. The testing methodology appeared to be sound, and no problems were reported in the valid test runs.

4.2.1.35 Reference 35. The plant tested was a drum mix facility with the dryer fired by propane and emissions controlled by a fabric filter. The test included three runs measuring trace metals, total chromium and hexavalent chromium (Cr and Cr^{+6}), PAH's, benzene, toluene, xylene, methyl chloroform, formaldehyde, and hydrogen sulfide emissions from the dryer at the fabric filter outlet. Also included were three test runs measuring PAH's, polychlorinated dibenzofurans (TCDF's, PCDF's, HxCDF's, HpCDF's, and OCDF's), polychlorinated dibenzo(p)dioxins (TCDD's, PeCDD's, HxCDD's, HpCDD's, and OCDD's), benzene, and formaldehyde emissions from the hot oil heater stack. The hot oil heater was fired with No. 2 fuel oil. Trace metals were measured using draft EPA Method 200.7, and PAH's were tested using EPA MM5 (Semi-VOST). The other pollutants were measured using CARB test procedures, which are similar to EPA methods for the pollutants tested. For target pollutants that were not detected in one or two test runs, emissions from the "nondetect" runs were estimated using one-half of the pollutant detection limit. Several target pollutants were not detected in any run. Radionuclide emissions were also sampled during this test, but the information provided is insufficient for emission factor development.

A rating of B was assigned to most of the data from this test. A rating of C was assigned if a pollutant was detected in only one of three test runs. The report included some detail, but it provided only an average production rate and did not describe the control system. The test methodology appeared to be sound, and no problems were reported in the valid test runs.

4.2.1.36 Reference 36. The plant tested was a drum mix facility with a natural gas-fired dryer and emissions controlled by a venturi scrubber (Δp = 15 to 21 in. H_2O). The tests were performed at the inlet and outlet of the scrubber and measured filterable PM and condensible organic PM (referred to as TOC or back-half catch in the report). During conventional and recycle operation, three valid test runs were performed at both the scrubber inlet and outlet. All of the tests measured emissions from the drum mixer.

All of the test data were assigned an A rating. The report included adequate detail, the methodology appeared to be sound, and no problems were reported in the valid test runs.

4.2.1.37 Reference 37. The plant tested was a drum mix facility with a natural gas-fired dryer and emissions controlled by a venturi scrubber (Δp = 12.5 to 14.5 in. H_2O). The tests were performed at the inlet and outlet of the scrubber and measured filterable PM and condensible organic PM (referred to as TOC or back-half catch in the report). During conventional and recycle operation, three valid test runs were performed at both the scrubber inlet and outlet. All of the tests measured emissions from the drum mixer.

All of the test data were assigned an A rating. The report included adequate detail, the methodology appeared to be sound, and no problems were reported in the valid test runs.

4.2.1.38 Reference 38. This document is a study of inhalable PM emissions from drum mix asphalt plants and includes emission data for uncontrolled and controlled filterable PM and size-specific PM emissions from a drum mixer. The particle size data were analyzed during the 1986 revision of AP-42 Section 11.1 and are not discussed here. Filterable PM emissions were measured at both the inlet and outlet of the fabric filter that controls emissions from the drum mixer. The inlet test was conducted using a modified EPA Method 5 train (only six sampling points) for eight runs, and the outlet test was conducted using a modified EPA Method 17 train (only four sampling points) for two runs.

The inlet test data were assigned a B rating, and the outlet test data were assigned a C rating. Both tests were downrated one letter because of the number of sampling points used, and the outlet test was downrated another letter because only two test runs were performed. The report included adequate detail, and no problems were reported in the valid test runs.

4.2.1.39 Reference 39. This document contains summary data from seven emission tests conducted at both drum mix and batch mix HMA plants. Four of these seven tests were provided by NAPA, but they have not yet been reviewed. All of the tests were conducted at the outlets of fabric filters controlling emissions from the drum mixers/dryers (drum mix plants) or dryers (batch mix plants) fired by natural gas, No. 2 fuel oil, or No. 6 fuel oil. Pollutants measured at each plant included CO, CO_2, SO_2, NO_X, TOC, methane, benzene, toluene, ethylbenzene, xylene, PAH's, formaldehyde, and condensible PM. Carbon monoxide, CO_2, SO_2, NO_X, and TOC emissions were quantified using CEMS (EPA Methods 10, 3A, 6C, 7E, and 25A, respectively). The Method 25A results were converted to TOC as methane using the measured emission concentration, the density of methane at STP, and the volumetric flow rate for each test run. Methane, benzene, toluene, ethylbenzene, and xylene emissions were measured using EPA Method 18, PAH emissions were measured using EPA MM5, formaldehyde emissions were measured using EPA Method 0011 (proposed method at the time of testing), and condensible PM emissions were measured using EPA Method 202. Condensible PM and PAH's are the only target pollutants that would be expected to be controlled by the fabric filters.

Most of the test data were assigned a B rating. Data for pollutants whose concentrations were below the detection limit (in one test run) were assigned a C rating because the detection limits were not provided in the report, and the "nondetect" runs were therefore considered void. The data may deserve an A rating, but copies of the actual emission tests are needed to provide adequate validation.

4.2.1.40 Reference 40. This reference includes summary data from 25 emission tests performed in Wisconsin. Particulate matter and formaldehyde emissions were quantified using EPA Method 5 and NIOSH Method 3500, respectively. Both drum mix and batch mix plants using various control systems and fuels were tested.

The filterable PM and total PM data were assigned a B rating because only summary test data were provided. The formaldehyde data were assigned a C rating because the test method suffers from a number of potential interferences, as documented in a letter from Gary McAlister of EPA's Emission Measurement Branch (EMB) (attached to Ref. 40).

4.2.1.41 Reference 41. The plant tested was a batch mix facility with emissions controlled by a fabric filter. The test included three runs measuring filterable PM and CO_2 emissions from the dryer at the

fabric filter outlet. The fabric filter controls PM emissions but provides only incidental, if any, control of CO_2 emissions. Filterable PM was sampled using EPA Method 5, and CO_2 was measured using EPA Method 3.

A rating of B was assigned to the test data from the dryer. The report included some detail, but it provided only an average production rate and did not specify the fuel used to fire the dryer. The test methodology appeared to be sound, and no problems were reported in the valid test runs.

4.2.2 Review of XATEF and SPECIATE Data Base Emission Factors

Emission factors for asphaltic concrete production appear in both XATEF and SPECIATE, but the references for these factors were not obtained. The validity of the references could not be checked, so the information was not used in developing emission factors for the revised AP-42 section.

4.2.3 Review of the AP-42 Background File

The existing AP-42 section addressing the asphaltic concrete industry was last revised in October 1986. Twenty-three references are cited in the existing section, and descriptions of these references are included in Section 4.2.1, Review of Specific Data Sets.

4.2.4 Results of Data Analysis

This section discusses the analysis of the data and describes how the data were combined to develop average emission factors for HMA production. Target pollutants that were not detected during any of the tests that were reviewed are shown in Table 4-1. Emission factors for drum mix facilities are discussed first, followed by emission factors for batch-mix facilities. The test data for drum mix dryers are presented in Table 4-2, data for batch mix dryers are shown in Table 4-3, and data for hot oil heaters are shown in Table 4-4. The data for dryers fired by different fuels are not averaged together, with the exception of the data for filterable PM, which were averaged together because fuel type did not appear to affect the magnitude of the emission factors.

TABLE 4-1. SUMMARY OF POLLUTANTS NOT DETECTED

DRYERS			
Pollutant	Ref. No.	Pollutant	Ref. No.
Sulfur dioxide[a]	24	Fluoranthene[a]	24
Antimony	24,25	Fluorene[a]	24
Arsenic[a]	24	Indeno(1,2,3-cd)pyrene[a]	24,34,35
Beryllium[a]	24,25,35	Perylene[a]	24
Phosphorus[a]	24	Phenanthrene[a]	24
Selenium[a]	24,25,35	Pyrene[a]	24
Thallium	24,25	o-Tolualdehyde	24,25
Acenaphthylene[a]	24	Acrolein[a]	24
Acenaphthene[a]	24	2,5-Dimethylbenzaldehyde	24,25
Anthracene[a]	24	Isophorone	24,25
Benzo(a)anthracene[a]	24,34,35	Isovaleraldehyde[a]	24
Benzo(a)pyrene[a]	24,34,35	p-Tolualdehyde	24,25
Benzo(b)fluoranthene[a]	24	m-Tolualdehyde	24,25
Benzo(e)pyrene[a]	24	Xylene[a]	34,35,39
Benzo(g,h,i)perylene[a]	24,34,35	Methyl Chloroform[a]	34
Benzo(k)fluoranthene[a]	24,34	Hydrogen Sulfide	34,35
2-Chloronaphthalene[a]	24	Chromium[a]	35
Chrysene[a]	24,34	Hexavalent Chromium[a]	35
Dibenz(a,h)anthracene[a]	24,34,35	Copper[a]	35
Dibenzofurans[a]	24	Nickel[a]	35
7,12-Dimethylbenz(a)anthracene	24	Benzene[a]	35,39
Toluene[a]	39	Ethylbenzene[a]	39
HOT OIL HEATERS			
Benzo(a)anthracene	35	2,3,4,6,7,8-HxCDF	35
Chrysene	35	1,2,3,7,8,9-HxCDF	35
Benzo(k)fluoranthene	35	1,2,3,4,7,8,9-HpCDF	35
Benzo(a)pyrene	35	TCDD's (total)	35
Dibenz(a,h)anthracene	35	2,3,7,8-TCDD	35
Benzo(g,h,i)perylene	35	PeCDD's (total)	35
Indeno(1,2,3-cd)pyrene	35	1,2,3,7,8-PeCDD	35
2,3,7,8-TCDF	35	1,2,3,6,7,8-HxCDD	35
2,3,4,7,8-PeCDF	35	Benzene	35
1,2,3,4,7,8-HxCDF	35		

[a]Pollutant was detected in at least one other test referenced.

TABLE 4-2. SUMMARY OF TEST DATA FOR HOT MIX ASPHALT PRODUCTION
DRUM MIX FACILITY--DRYERS

Type of control	Fuel fired	Pollutant	No. of test runs	Data rating	Emission factor range, kg/Mg (lb/ton)[a]	Average emission factor, kg/Mg (lb/ton)[a]	Ref. No.
None	ND	Total PM	ND	C	1.8-3.1 (3.6-6.2)	2.5 (4.9)	11
Cyclone or multiclone	ND	Total PM	ND	C	0.25-0.43 (0.49-0.85)	0.34 (0.67)	11
Wet scrubber	ND	Total PM	ND	C	0.025-0.045 (0.050-0.090)	0.035 (0.070)	11
Venturi scrubber	ND	Total PM	ND	C	0.015-0.030 (0.030-0.060)	0.023 (0.045)	11
Fabric filter[b] (Plant A)	No. 2 fuel oil	TNMOC	2	C	0.085-0.12 (0.17-0.24)	0.11 (0.21)	22
Fabric filter[b] (Plant A)	Natural gas	TNMOC	1	NR	0.11 (0.22)	0.11 (0.22)	22
Fabric filter (Plant A)	No. 2 fuel oil, natural gas	Filterable PM	3	C	0.090-0.13 (0.18-0.25)	0.11 (0.21)	22
Fabric filter[b] (Plant B)	Propane	TNMOC	5	C	0.021-0.055 (0.041-0.11)	0.033 (0.066)	22
Fabric filter[b] (Plant C)	No. 4 fuel oil	TNMOC	4	C	0.042-0.060 (0.083-0.12)	0.050 (0.10)	22
Fabric filter[c] (Plant D)	Natural gas	TNMOC	5	C	0.13-0.22 (0.25-0.44)	0.16 (0.33)	22
None (Plant E)	Natural gas	TNMOC	3	C	0.080-0.30 (0.16-0.59)	0.16 (0.31)	22
Venturi scrubber (Plant E)	Natural gas	TNMOC	5	C	0.065-0.095 (0.13-0.19)	0.080 (0.16)	22
Fabric filter[d]	Waste oil	Filterable PM	6	A	0.0048-0.0099 (0.0097-0.020)	0.0079 (0.016)	25
Fabric filter[d]	Waste oil	Filterable PM-10	3	A	0.0023-0.0030 (0.0046-0.0060)	0.0026 (0.0052)	25
Fabric filter[d]	Waste oil	Condensible inorganic PM	3	A	0.0097-0.018 (0.019-0.036)	0.014 (0.027)	25
Fabric filter[d]	Waste oil	Condensible organic PM	3	A	0.0011-0.0023 (0.0022-0.0046)	0.0016 (0.0032)	25
Fabric filter[b,d]	Waste oil	TOC	10	A	0.040-0.064 (0.081-0.13)	0.050 (0.099)	25
Fabric filter[b,d]	Waste oil	SO_2	10	A	0.035-0.057 (0.070-0.11)	0.050 (0.10)	25
Fabric filter[b,d]	Waste oil	NO_x	10	A	0.026-0.041 (0.051-0.082)	0.035 (0.069)	25

TABLE 4-2. (continued)

Type of control	Fuel fired	Pollutant	No. of test runs	Data rating	Emission factor range, kg/Mg (lb/ton)[a]	Average emission factor, kg/Mg (lb/ton)[a]	Ref. No.
Fabric filter[b,d]	Waste oil	CO_2	9	A	16-23 (31-46)	20 (39)	25
Fabric filter[b,d]	Waste oil	CO	10	A	0.0046-0.079 (0.0092-0.16)	0.018 (0.036)	25
Fabric filter[d]	Waste oil	Arsenic	3	A	$4.9x10^{-7}$-$1.6x10^{-6}$ ($9.7x10^{-7}$-$3.1x10^{-6}$)	$9.5x10^{-7}$ ($1.9x10^{-6}$)	25
Fabric filter[d]	Waste oil	Barium	3	A	$2.0x10^{-7}$-$5.5x10^{-6}$ ($3.9x10^{-7}$-$9.9x10^{-6}$)	$2.4x10^{-6}$ ($4.8x10^{-6}$)	25
Fabric filter[d]	Waste oil	Cadmium	3	A	$1.4x10^{-7}$-$5.5x10^{-7}$ ($2.7x10^{-7}$-$9.9x10^{-7}$)	$3.1x10^{-7}$ ($6.2x10^{-7}$)	25
Fabric filter[d]	Waste oil	Chromium	3	A	$6.5x10^{-7}$-$9.5x10^{-6}$ ($1.3x10^{-6}$-$1.9x10^{-5}$)	$6.0x10^{-6}$ ($1.2x10^{-5}$)	25
Fabric filter[d]	Waste oil	Copper	3	A	$2.2x10^{-6}$-$4.8x10^{-6}$ ($4.3x10^{-6}$-$9.5x10^{-6}$)	$3.1x10^{-6}$ ($6.1x10^{-6}$)	25
Fabric filter[d]	Waste oil	Lead	3	A	$2.4x10^{-6}$-$4.1x10^{-6}$ ($4.7x10^{-6}$-$8.1x10^{-6}$)	$3.0x10^{-6}$ ($6.0x10^{-6}$)	25
Fabric filter[d]	Waste oil	Manganese	3	A	$2.8x10^{-6}$-$7.0x10^{-6}$ ($5.6x10^{-6}$-$1.4x10^{-5}$)	$5.5x10^{-6}$ ($1.1x10^{-5}$)	25
Fabric filter[d]	Waste oil	Nickel	3	A	$2.8x10^{-7}$-$1.3x10^{-5}$ ($5.6x10^{-7}$-$2.5x10^{-5}$)	$7.5x10^{-6}$ ($1.5x10^{-5}$)	25
Fabric filter[d]	Waste oil	Phosphorus	3	A	$2.2x10^{-5}$-$3.7x10^{-5}$ ($4.4x10^{-5}$-$7.3x10^{-5}$)	$2.8x10^{-5}$ ($5.5x10^{-5}$)	25
Fabric filter[d]	Waste oil	Silver	3	A	$5.5x10^{-7}$-$8.5x10^{-7}$ ($1.1x10^{-6}$-$1.7x10^{-6}$)	$7.0x10^{-7}$ ($1.4x10^{-6}$)	25
Fabric filter[d]	Waste oil	Zinc	3	A	$2.0x10^{-5}$-$3.5x10^{-5}$ ($3.9x10^{-5}$-$6.9x10^{-5}$)	$2.7x10^{-5}$ ($5.3x10^{-5}$)	25
Fabric filter[d]	Waste oil	Naphthalene	3	A	0.00018-0.00032 (0.00036-0.00063)	0.00024 (0.00047)	25
Fabric filter[b,d]	Waste oil	Acetaldehyde	4	A	0.00028-0.0013 (0.00055-0.0025)	0.00065 (0.0013)	25
Fabric filter[b,d]	Waste oil	Acetone	4	A	0.00026-0.00055 (0.00052-0.0011)	0.00042 (0.00083)	25
Fabric filter[b,d]	Waste oil	Acrolein	4	A	$1.4x10^{-6}$-$3.3x10^{-5}$ ($2.8x10^{-6}$-$6.6x10^{-5}$)	$1.3x10^{-5}$ ($2.6x10^{-5}$)	25
Fabric filter[b,d]	Waste oil	Benzaldehyde	4	A	$1.3x10^{-5}$-$1.7x10^{-4}$ ($2.5x10^{-5}$-$3.3x10^{-4}$)	$5.5x10^{-5}$ (0.00011)	25
Fabric filter[b,d]	Waste oil	Butyraldehyde/ Isobutyraldehyde	4	A	$5.5x10^{-5}$-$1.4x10^{-4}$ (0.00011-0.00027)	$8.0x10^{-5}$ (0.00016)	25
Fabric filter[b,d]	Waste oil	Crotonaldehyde	4	A	$1.1x10^{-5}$-$1.2x10^{-4}$ ($2.2x10^{-5}$-$2.4x10^{-4}$)	$4.3x10^{-5}$ ($8.6x10^{-5}$)	25

TABLE 4-2. (continued)

Type of control	Fuel fired	Pollutant	No. of test runs	Data rating	Emission factor range, kg/Mg (lb/ton)[a]	Average emission factor, kg/Mg (lb/ton)[a]	Ref. No.
Fabric filter[b,d]	Waste oil	Formaldehyde	4	A	0.00030-0.0026 (0.00060-0.0051)	0.0010 (0.0020)	25
Fabric filter[b,d]	Waste oil	Hexanal	4	A	$2.8x10^{-5}$-$1.1x10^{-4}$ ($5.5x10^{-5}$-$2.2x10^{-4}$)	$5.5x10^{-5}$ (0.00011)	25
Fabric filter[b,d]	Waste oil	Isovaleraldehyde	4	A	$2.0x10^{-6}$-$3.0x10^{-5}$ ($4.1x10^{-6}$-$6.0x10^{-5}$)	$1.6x10^{-5}$ ($3.2x10^{-5}$)	25
Fabric filter[b,d]	Waste oil	Methyl Ethyl Ketone	4	B	$1.8x10^{-6}$-$2.8x10^{-5}$ ($3.5x10^{-6}$-$5.6x10^{-5}$)	$1.0x10^{-5}$ ($2.0x10^{-5}$)	25
Fabric filter[b,d]	Waste oil	Propionaldehyde	4	A	$2.4x10^{-5}$-$1.7x10^{-4}$ ($4.7x10^{-5}$-$3.3x10^{-4}$)	$6.5x10^{-5}$ (0.00013)	25
Fabric filter[b,d]	Waste oil	Quinone	4	A	$1.8x10^{-5}$-$1.8x10^{-4}$ ($3.5x10^{-5}$-$3.5x10^{-4}$)	$8.0x10^{-5}$ (0.00016)	25
Fabric filter[b,d]	Waste oil	Valeraldehyde	4	A	$1.3x10^{-5}$-$7.5x10^{-5}$ ($2.6x10^{-5}$-$1.5x10^{-4}$)	$3.4x10^{-5}$ ($6.7x10^{-5}$)	25
Fabric filter[b,d]	Waste oil	Methane	19	B	0.00036-0.12 (0.00072-0.23)	0.012 (0.025)	25
Fabric filter[b,d]	Waste oil	Benzene	19	B	$2.5x10^{-5}$-$4.1x10^{-4}$ ($4.9x10^{-5}$-$8.1x10^{-4}$)	0.00020 (0.00041)	25
Fabric filter[b,d]	Waste oil	Toluene	19	B	$2.4x10^{-5}$-$8.9x10^{-4}$ ($4.7x10^{-5}$-$1.8x10^{-3}$)	0.00037 (0.00075)	25
Fabric filter[b,d]	Waste oil	Ethylbenzene	19	B	$1.1x10^{-6}$-$1.2x10^{-3}$ ($2.1x10^{-6}$-$2.3x10^{-3}$)	0.00019 (0.00038)	25
Fabric filter[b,d]	Waste oil	Xylene	19	B	$3.9x10^{-5}$-$1.2x10^{-3}$ ($7.9x10^{-5}$-$2.3x10^{-3}$)	$8.2x10^{-5}$ ($1.6x10^{-4}$)	25
Fabric filter[b]	No. 2 fuel oil	CO_2	19	B	15-22 (30-43)	19 (37)	26
Fabric filter	No. 2 fuel oil	Filterable PM	3	A	0.0085-0.017 (0.017-0.033)	0.014 (0.027)	26
Fabric filter[b]	No. 2 fuel oil	CO_2	3	A	14-17 (27-35)	15 (30)	27
Fabric filter	No. 2 fuel oil	Filterable PM	3	A	0.0055-0.013 (0.011-0.027)	0.0085 (0.017)	27
Fabric filter[b]	ND	CO_2	3	B	17-18 (33-36)	17 (34)	28
Fabric filter	ND	Filterable PM	3	B	0.0010-0.0035 (0.0020-0.0070)	0.0022 (0.0043)	28
Fabric filter	ND	Condensible inorganic PM	3	B	0.0075-0.0085 (0.015-0.017)	0.0080 (0.016)	28
Venturi scrubber[b]	No. 2 fuel oil	CO_2	3	B	14-17 (28-33)	16 (31)	29

TABLE 4-2. (continued)

Type of control	Fuel fired	Pollutant	No. of test runs	Data rating	Emission factor range, kg/Mg (lb/ton)[a]	Average emission factor, kg/Mg (lb/ton)[a]	Ref. No.
Venturi scrubber	No. 2 fuel oil	Filterable PM	3	B	0.0055-0.012 (0.011-0.023)	0.0080 (0.016)	29
Fabric filter[b]	Natural gas	CO_2	3	A	9.6-9.8 (19-20)	9.6 (19)	30
Fabric filter	Natural gas	Filterable PM	3	A	0.013-0.015 (0.025-0.029)	0.014 (0.027)	30
None	No. 5 fuel oil	Filterable PM	2	B	20-30 (41-60)	25 (50)	31
Fabric filter	No. 5 fuel oil	Filterable PM	3	A	0.0035-0.012 (0.0069-0.024)	0.0088 (0.018)	31
None[d]	No. 5 fuel oil	Filterable PM	3	A	2.2-3.4 (4.3-6.7)	2.7 (5.4)	31
Fabric filter[d]	No. 5 fuel oil	Filterable PM	2	B	0.0024-0.0025 (0.0047-0.0051)	0.0025 (0.0049)	31
Scrubber[b]	No. 2 fuel oil	CO_2	3	B	19 (37-39)	19 (38)	32
Scrubber	No. 2 fuel oil	Filterable PM	3	B	0.008-0.015 (0.016-0.031)	0.012 (0.024)	32
Fabric filter[b,d]	No. 2 fuel oil	CO_2	3	A	7.8-16 (16-32)	11 (22)	33
Fabric filter[d]	No. 2 fuel oil	Filterable PM	3	A	0.010-0.013 (0.020-0.025)	0.012 (0.023)	33
Fabric filter	Propane	Acenaphthene	3	B	2.2×10^{-7}-3.8×10^{-7} (4.4×10^{-7}-7.6×10^{-7})	2.9×10^{-7} (5.7×10^{-7})	35
Fabric filter	Propane	Acenaphthylene	3	B	3.7×10^{-8}-7.0×10^{-8} (7.4×10^{-8}-1.4×10^{-7})	5.0×10^{-8} (1.0×10^{-7})	35
Fabric filter	Propane	Anthracene	3	B	2.2×10^{-8}-5.5×10^{-8} (4.4×10^{-8}-1.1×10^{-7})	3.7×10^{-8} (7.3×10^{-8})	35
Fabric filter	Propane	Chrysene	3	C	2.2×10^{-9}-3.5×10^{-9} (4.4×10^{-9}-7.0×10^{-9})	2.7×10^{-9} (5.4×10^{-9})	35
Fabric filter	Propane	Fluorene	3	B	3.2×10^{-7}-5.5×10^{-7} (6.3×10^{-7}-1.1×10^{-6})	4.1×10^{-7} (8.1×10^{-7})	35
Fabric filter	Propane	Naphthalene	3	B	5.5×10^{-6}-7.5×10^{-6} (1.1×10^{-5}-1.5×10^{-5})	6.0×10^{-6} (1.2×10^{-5})	35
Fabric filter	Propane	Phenanthrene	3	B	6.5×10^{-7}-3.7×10^{-6} (1.3×10^{-6}-7.4×10^{-6})	1.8×10^{-6} (3.6×10^{-6})	35
Fabric filter	Propane	Fluoranthene	3	B	3.9×10^{-9}-1.7×10^{-8} (7.8×10^{-9}-3.4×10^{-8})	8.5×10^{-9} (1.7×10^{-8})	35
Fabric filter	Propane	Pyrene	3	B	7.0×10^{-9}-2.8×10^{-8} (1.4×10^{-8}-5.5×10^{-8})	1.5×10^{-8} (2.9×10^{-8})	35

TABLE 4-2. (continued)

Type of control	Fuel fired	Pollutant	No. of test runs	Data rating	Emission factor range, kg/Mg (lb/ton)[a]	Average emission factor, kg/Mg (lb/ton)[a]	Ref. No.
Fabric filter	Propane	Benzo(b)fluoranthene	3	B	2.9×10^{-9}-4.8×10^{-8} (5.7×10^{-9}-9.5×10^{-8})	2.8×10^{-8} (5.6×10^{-8})	35
Fabric filter	Propane	Benzo(k)fluoranthene	3	C	8.0×10^{-10}-3.5×10^{-8} (1.6×10^{-9}-7.0×10^{-8})	1.4×10^{-8} (2.7×10^{-8})	35
Fabric filter[b]	Propane	Formaldehyde	3	B	3.9×10^{-5}-5.5×10^{-4} (7.8×10^{-5}-1.1×10^{-3})	0.00034 (0.00067)	35
Fabric filter	Propane	Arsenic	3	B	1.2×10^{-7}-1.4×10^{-7} (2.3×10^{-7}-2.7×10^{-7})	1.3×10^{-7} (2.5×10^{-7})	35
Fabric filter	Propane	Cadmium	3	B	5.0×10^{-8}-2.8×10^{-7} (9.9×10^{-8}-5.5×10^{-7})	1.3×10^{-7} (2.5×10^{-7})	35
Fabric filter	Propane	Mercury	3	B	9.0×10^{-10}-6.0×10^{-9} (1.8×10^{-9}-1.2×10^{-8})	3.7×10^{-9} (7.3×10^{-9})	35
Fabric filter	Propane	Lead	3	B	8.0×10^{-8}-7.0×10^{-7} (1.6×10^{-7}-1.4×10^{-6})	3.1×10^{-7} (6.2×10^{-7})	35
Fabric filter	Propane	Zinc	3	B	2.5×10^{-6}-4.1×10^{-5} (5.1×10^{-6}-8.2×10^{-5})	1.6×10^{-5} (3.1×10^{-5})	35
Fabric filter[b]	Propane	Toluene	3	B	1.4×10^{-5}-1.4×10^{-4} (2.7×10^{-5}-2.7×10^{-4})	8.5×10^{-5} (0.00017)	35
Fabric filter[b]	Propane	Methyl chloroform	3	C	1.4×10^{-5}-4.4×10^{-5} (2.7×10^{-5}-8.8×10^{-5})	2.4×10^{-5} (4.8×10^{-5})	35
None[d]	Natural gas	Filterable PM	3	A	1.9-2.5 (3.7-4.9)	2.2 (4.4)	36
None[d]	Natural gas	Condensible organic PM	3	A	0.018-0.022 (0.035-0.044)	0.021 (0.041)	36
Venturi scrubber[d]	Natural gas	Filterable PM	3	A	0.040-0.055 (0.079-0.11)	0.049 (0.097)	36
Venturi scrubber[d]	Natural gas	Condensible organic PM	3	A	0.007-0.010 (0.014-0.020)	0.0090 (0.018)	36
None[d]	Natural gas	Filterable PM	6	A	0.90-2.0 (1.8-3.9)	1.3 (2.6)	37
None[d]	Natural gas	Condensible organic PM	6	A	0.011-0.10 (0.022-0.20)	0.034 (0.067)	37
Venturi scrubber[d]	Natural gas	Filterable PM	6	A	0.0055-0.018 (0.011-0.035)	0.0095 (0.019)	37
Venturi scrubber[d]	Natural gas	Condensible organic PM	6	A	0.0047-0.016 (0.0094-0.032)	0.011 (0.021)	37
None[d]	Natural gas	Filterable PM	8	B	8.1-21 (16-43)	16 (31)	38
Fabric filter[d]	Natural gas	Filterable PM	2	C	0.031-0.034 (0.061-0.068)	0.032 (0.064)	38

TABLE 4-2. (continued)

Type of control	Fuel fired	Pollutant	No. of test runs	Data rating	Emission factor range, kg/Mg (lb/ton)[a]	Average emission factor, kg/Mg (lb/ton)[a]	Ref. No.
Fabric filter[d]	Natural gas	CO_2	3	B	13 (25-26)	13 (25)	39[e]
Fabric filter[b,d]	Natural gas	SO_2	3	B	0.0014-0.0030 (0.0028-0.0059)	0.0021 (0.0041)	39[e]
Fabric filter[b,d]	Natural gas	NO_x	3	B	0.0075 (0.015)	0.0075 (0.015)	39[e]
Fabric filter[b,d]	Natural gas	TOC	3	B	0.032-0.060 (0.064-0.12)	0.044 (0.088)	39[e]
Fabric filter[b,d]	Natural gas	Methane	3	B	0.013-0.032 (0.025-0.063)	0.019 (0.038)	39[e]
Fabric filter[b,d]	Natural gas	Benzene	3	B	0.00053-0.00068 (0.0011-0.0014)	0.00060 (0.0012)	39[e]
Fabric filter[b,d]	Natural gas	Toluene	3	B	$5.5x10^{-5}$-$2.1x10^{-4}$ (0.00011-0.00041)	0.00011 (0.00022)	39[e]
Fabric filter[b,d]	Natural gas	Ethyl benzene	2	C	$5.5x10^{-5}$-$2.4x10^{-4}$ (0.00011-0.00047)	0.00015 (0.00029)	39[e]
Fabric filter[b,d]	Natural gas	Xylene	3	B	$6.5x10^{-5}$-$3.1x10^{-4}$ (0.00013-0.00062)	0.00020 (0.00040)	39[e]
Fabric filter[d]	Natural gas	Naphthalene	3	B	$2.5x10^{-5}$-$2.9x10^{-5}$ ($4.9x10^{-5}$-$5.7x10^{-5}$)	$2.6x10^{-5}$ ($5.3x10^{-5}$)	39[e]
Fabric filter[d]	Natural gas	2-Methylnaphthalene	3	B	$2.2x10^{-5}$-$2.9x10^{-5}$ ($4.3x10^{-5}$-$5.7x10^{-5}$)	$2.5x10^{-5}$ ($4.9x10^{-5}$)	39[e]
Fabric filter[d]	Natural gas	Phenanthrene	3	B	$4.9x10^{-6}$-$5.5x10^{-6}$ ($9.7x10^{-6}$-$1.1x10^{-5}$)	$5.1x10^{-6}$ ($1.0x10^{-5}$)	39[e]
Fabric filter[b]	Natural gas	Formaldehyde	3	B	0.0039-0.0050 (0.0078-0.010)	0.0043 (0.0086)	39[e]
Fabric filter[d]	Natural gas	Condensible PM	3	B	0.0017-0.0034 (0.0034-0.0067)	0.0023 (0.0046)	39[e]
Fabric filter[b,d]	Natural gas	CO_2	3	B	16 (31-32)	16 (31)	39[f]
Fabric filter[b,d]	Natural gas	SO_2	3	B	0.00060-0.00065 (0.0012-0.0013)	0.00062 (0.0012)	39[f]
Fabric filter[b,d]	Natural gas	NO_x	3	B	0.0085-0.0099 (0.017-0.020)	0.0091 (0.018)	39[f]
Fabric filter[b,d]	Natural gas	TOC	3	B	0.017-0.027 (0.035-0.054)	0.021 (0.043)	39[f]
Fabric filter[b,d]	Natural gas	Methane	3	B	0.00082-0.0031 (0.0016-0.0062)	0.0016 (0.0032)	39[f]
Fabric filter[b,d]	Natural gas	Benzene	2	C	0.00012-0.00028 (0.00024-0.00056)	0.00020 (0.00040)	39[f]

TABLE 4-2. (continued)

Type of control	Fuel fired	Pollutant	No. of test runs	Data rating	Emission factor range, kg/Mg (lb/ton)[a]	Average emission factor, kg/Mg (lb/ton)[a]	Ref. No.
Fabric filter[d]	Natural gas	Naphthalene	3	B	3.2×10^{-5}-3.7×10^{-5} (6.3×10^{-5}-7.4×10^{-5})	3.5×10^{-5} (7.0×10^{-5})	39[f]
Fabric filter[d]	Natural gas	2-Methylnaphthalene	3	B	1.5×10^{-5}-1.9×10^{-5} (3.0×10^{-5}-3.7×10^{-5})	1.7×10^{-5} (3.3×10^{-5})	39[f]
Fabric filter[d]	Natural gas	Acenaphthylene	3	B	1.1×10^{-5}-1.3×10^{-5} (2.1×10^{-5}-2.5×10^{-5})	1.1×10^{-5} (2.3×10^{-5})	39[f]
Fabric filter[d]	Natural gas	Fluorene	3	B	4.4×10^{-6}-5.0×10^{-6} (8.8×10^{-6}-1.0×10^{-5})	4.9×10^{-6} (9.8×10^{-6})	39[f]
Fabric filter[d]	Natural gas	Phenanthrene	3	B	2.9×10^{-6}-3.7×10^{-6} (5.7×10^{-6}-7.4×10^{-6})	3.3×10^{-6} (6.6×10^{-6})	39[f]
Fabric filter[d]	Natural gas	Fluoranthene	3	B	2.9×10^{-7}-4.0×10^{-7} (5.7×10^{-7}-8.0×10^{-7})	3.6×10^{-7} (7.2×10^{-7})	39[f]
Fabric filter[d]	Natural gas	Pyrene	2	C	2.7×10^{-7}-4.3×10^{-7} (5.3×10^{-7}-8.6×10^{-7})	3.5×10^{-7} (6.9×10^{-7})	39[f]
Fabric filter[b,d]	Natural gas	Formaldehyde	3	B	0.00010-0.0012 (0.00020-0.0023)	0.00070 (0.0014)	39[f]
Fabric filter[b]	Natural gas	CO	5	B	0.021-0.044 (0.042-0.087)	0.028 (0.056)	39[g]
Fabric filter[b]	Natural gas	CO_2	6	B	13-21 (26-41)	17 (34)	39[g]
Fabric filter[b]	Natural gas	SO_2	5	B	0.00082-0.0047 (0.0016-0.0093)	0.0024 (0.0047)	39[g]
Fabric filter[b]	Natural gas	NO_x	6	B	0.017-0.065 (0.034-0.13)	0.028 (0.057)	39[g]
Fabric filter[b]	Natural gas	TOC	6	B	0.0025-0.021 (0.0050-0.041)	0.011 (0.022)	39[g]
Fabric filter	Natural gas	Naphthalene	3	B	2.8×10^{-5}-2.9×10^{-5} (5.5×10^{-5}-5.7×10^{-5})	2.8×10^{-5} (5.6×10^{-5})	39[g]
Fabric filter	Natural gas	2-Methylnaphthalene	3	B	6.6×10^{-5}-7.3×10^{-5} (1.3×10^{-4}-1.5×10^{-4})	6.9×10^{-5} (1.4×10^{-4})	39[g]
Fabric filter	Natural gas	2-Chloronaphthalene	3	B	8.5×10^{-7}-9.2×10^{-7} (1.7×10^{-6}-1.8×10^{-6})	8.9×10^{-7} (1.8×10^{-6})	39[g]
Fabric filter	Natural gas	Acenaphthylene	3	B	8.5×10^{-7}-1.3×10^{-6} (1.7×10^{-6}-2.7×10^{-6})	1.1×10^{-6} (2.3×10^{-6})	39[g]
Fabric filter	Natural gas	Acenaphthene	3	B	5.5×10^{-7}-1.8×10^{-6} (1.1×10^{-6}-3.6×10^{-6})	9.9×10^{-7} (2.0×10^{-6})	39[g]
Fabric filter	Natural gas	Phenanthrene	3	B	4.4×10^{-6}-1.0×10^{-5} (8.8×10^{-6}-2.1×10^{-5})	6.7×10^{-6} (1.3×10^{-5})	39[g]
Fabric filter	Natural gas	Anthracene	3	B	1.2×10^{-7}-2.7×10^{-7} (2.3×10^{-7}-5.3×10^{-7})	1.7×10^{-7} (3.5×10^{-7})	39[g]

TABLE 4-2. (continued)

Type of control	Fuel fired	Pollutant	No. of test runs	Data rating	Emission factor range, kg/Mg (lb/ton)[a]	Average emission factor, kg/Mg (lb/ton)[a]	Ref. No.
Fabric filter	Natural gas	Fluoranthene	3	B	2.6×10^{-7}-8.5×10^{-7} (5.1×10^{-7}-1.7×10^{-6})	5.2×10^{-7} (1.0×10^{-6})	39[g]
Fabric filter	Natural gas	Pyrene	3	B	2.9×10^{-7}-5.7×10^{-7} (5.7×10^{-7}-1.1×10^{-6})	4.4×10^{-7} (8.8×10^{-7})	39[g]
Fabric filter	Natural gas	Benzo(a)anthracene	3	B	2.7×10^{-8}-2.2×10^{-7} (5.5×10^{-8}-4.5×10^{-7})	1.0×10^{-7} (2.0×10^{-7})	39[g]
Fabric filter	Natural gas	Chrysene	3	B	8.8×10^{-8}-2.3×10^{-7} (1.8×10^{-7}-5.5×10^{-7})	1.8×10^{-7} (3.5×10^{-7})	39[g]
Fabric filter	Natural gas	Benzo(b)fluoranthene	3	B	4.0×10^{-8}-1.2×10^{-7} (8.0×10^{-8}-2.5×10^{-7})	7.4×10^{-8} (1.5×10^{-7})	39[g]
Fabric filter	Natural gas	Benzo(k)fluoranthene	3	B	1.4×10^{-8}-4.4×10^{-8} (2.7×10^{-8}-8.8×10^{-8})	2.6×10^{-8} (5.3×10^{-8})	39[g]
Fabric filter	Natural gas	Benzo(e)pyrene	3	B	1.5×10^{-8}-1.2×10^{-7} (3.0×10^{-8}-2.3×10^{-7})	5.2×10^{-8} (1.0×10^{-7})	39[g]
Fabric filter	Natural gas	Benzo(a)pyrene	3	B	1.3×10^{-9}-1.1×10^{-8} (2.6×10^{-9}-2.2×10^{-8})	4.6×10^{-9} (9.2×10^{-9})	39[g]
Fabric filter	Natural gas	Perylene	2	C	4.1×10^{-9}-8.2×10^{-9} (8.3×10^{-9}-1.6×10^{-8})	6.2×10^{-9} (1.2×10^{-8})	39[g]
Fabric filter	Natural gas	Indeno(1,2,3-cd) pyrene	3	B	2.6×10^{-9}-4.1×10^{-9} (5.3×10^{-9}-8.3×10^{-9})	3.6×10^{-9} (7.3×10^{-9})	39[g]
Fabric filter	Natural gas	Dibenz(a,h)anthracene	2	C	1.3×10^{-9}-1.4×10^{-9} (2.6×10^{-9}-2.7×10^{-9})	1.3×10^{-9} (2.7×10^{-9})	39[g]
Fabric filter	Natural gas	Benzo(g,h,i)perylene	3	B	8.3×10^{-9}-2.6×10^{-8} (1.7×10^{-8}-5.2×10^{-8})	1.9×10^{-8} (3.9×10^{-8})	39[g]
Fabric filter	Natural gas	Condensible PM	3	B	0.00092-0.0018 (0.0018-0.0036)	0.0014 (0.0028)	39[g]
Fabric filter[b,d]	No. 2 fuel oil	CO_2	9	B	29-37 (57-73)	32 (65)	39[h]
Fabric filter[b,d]	No. 2 fuel oil	SO_2	5	B	0.0033-0.0085 (0.0066-0.017)	0.0054 (0.011)	39[h]
Fabric filter[b,d]	No. 2 fuel oil	NO_x	9	B	0.031-0.049 (0.062-0.098)	0.041 (0.081)	39[h]
Fabric filter[b,d]	No. 2 fuel oil	TOC	9	B	0.013-0.027 (0.026-0.055)	0.020 (0.039)	39[h]
Fabric filter[b,d]	No. 2 fuel oil	Methane	9	B	0.0025-0.010 (0.0051-0.020)	0.0071 (0.014)	39[h]
Fabric filter[d]	No. 2 fuel oil	Naphthalene	3	B	7.2×10^{-5}-8.5×10^{-5} (0.00014-0.00017)	7.6×10^{-5} (0.00015)	39[h]
Fabric filter[d]	No. 2 fuel oil	2-Methylnaphthalene	3	B	8.3×10^{-5}-8.8×10^{-5} (0.00017-0.00018)	8.5×10^{-5} (0.00017)	39[h]

TABLE 4-2. (continued)

Type of control	Fuel fired	Pollutant	No. of test runs	Data rating	Emission factor range, kg/Mg (lb/ton)[a]	Average emission factor, kg/Mg (lb/ton)[a]	Ref. No.
Fabric filter[d]	No. 2 fuel oil	Acenaphthylene	3	B	9.5×10^{-6}-1.4×10^{-5} (1.9×10^{-5}-2.8×10^{-5})	1.1×10^{-5} (2.2×10^{-5})	39[h]
Fabric filter[d]	No. 2 fuel oil	Fluorene	3	B	8.0×10^{-6}-9.4×10^{-6} (1.6×10^{-5}-1.9×10^{-5})	8.5×10^{-6} (1.7×10^{-5})	39[h]
Fabric filter[d]	No. 2 fuel oil	Phenanthrene	3	B	2.6×10^{-5}-3.0×10^{-5} (5.2×10^{-5}-6.0×10^{-5})	2.8×10^{-5} (5.5×10^{-5})	39[h]
Fabric filter[d]	No. 2 fuel oil	Anthracene	3	B	1.6×10^{-6}-2.2×10^{-6} (3.2×10^{-6}-4.4×10^{-6})	1.8×10^{-6} (3.6×10^{-6})	39[h]
Fabric filter[d]	No. 2 fuel oil	Pyrene	2	C	1.1×10^{-6}-1.9×10^{-6} (2.1×10^{-6}-3.9×10^{-6})	1.5×10^{-6} (3.0×10^{-6})	39[h]
Fabric filter[b,d]	No. 2 fuel oil	Formaldehyde	3	B	0.0011-0.0017 (0.0022-0.0033)	0.0014 (0.0027)	39[h]
Fabric filter[d]	No. 2 fuel oil	Condensible PM	3	B	0.0083-0.012 (0.017-0.023)	0.010 (0.019)	39[h]
Fabric filter[d]	Natural gas	Filterable PM	3	B	0.0071-0.0089 (0.014-0.018)	0.0077 (0.015)	40
Fabric filter[b,d]	Natural gas	Formaldehyde	3	C	0.0021-0.0025 (0.0043-0.0049)	0.0023 (0.0046)	40
Wet scrubber[d]	No. 2 fuel oil	Filterable PM	3	B	0.011-0.013 (0.021-0.027)	0.012 (0.024)	40
Wet scrubber[b,d]	No. 2 fuel oil	Formaldehyde	3	C	0.00029-0.00034 (0.00057-0.00069)	0.00031 (0.00063)	40
Fabric filter[d]	Waste oil	Filterable PM	3	B	0.00075-0.0014 (0.0015-0.0027)	0.00098 (0.0020)	40
Fabric filter[b,d]	Waste oil	Formaldehyde	3	C	0.00020-0.00024 (0.00040-0.00049)	0.00021 (0.00043)	40
Venturi scrubber[d]	Natural gas	Filterable PM	3	B	0.0084-0.011 (0.017-0.023)	0.010 (0.021)	40
Venturi scrubber[d]	Natural gas	Formaldehyde	3	C	0.00066-0.00090 (0.0013-0.0018)	0.00079 (0.0016)	40
Venturi scrubber[d]	Waste oil	Filterable PM	3	B	0.015-0.016 (0.030-0.033)	0.016 (0.032)	40
Venturi scrubber[d]	Waste oil	Formaldehyde	3	C	0.00015-0.00027 (0.00029-0.00054)	0.00021 (0.00041)	40
Fabric filter[d]	Natural gas	Filterable PM	3	B	0.00055-0.00087 (0.0011-0.0017)	0.00067 (0.0013)	40
Fabric filter[b,d]	Natural gas	Formaldehyde	3	C	0.00019-0.00024 (0.00038-0.00048)	0.00022 (0.00043)	40
Fabric filter[d]	ND	Filterable PM	3	B	0.0019-0.0030 (0.0037-0.0060)	0.0024 (0.0048)	40

TABLE 4-2. (continued)

Type of control	Fuel fired	Pollutant	No. of test runs	Data rating	Emission factor range, kg/Mg (lb/ton)[a]	Average emission factor, kg/Mg (lb/ton)[a]	Ref. No.
Fabric filter[b,d]	ND	Formaldehyde	3	C	0.00044-0.00049 (0.00089-0.00098)	0.00047 (0.00094)	40
Fabric filter[d]	Waste oil	Filterable PM	3	B	0.0062-0.011 (0.012-0.022)	0.0078 (0.016)	40
Fabric filter[b,d]	Waste oil	Formaldehyde	3	C	0.0020-0.0050 (0.0039-0.010)	0.0033 (0.0066)	40
Fabric filter[d]	Waste oil	Filterable PM	3	B	0.00043-0.00045 (0.00087-0.00091)	0.00044 (0.00089)	40
Fabric filter[b,d]	Waste oil	Formaldehyde	3	C	0.00054-0.0012 (0.0011-0.0023)	0.00089 (0.0018)	40
Fabric filter[d]	Waste oil	Filterable PM	3	B	0.0030-0.0042 (0.0061-0.0084)	0.0035 (0.0071)	40
Fabric filter[b,d]	Waste oil	Formaldehyde	3	C	0.0025-0.0049 (0.0050-0.0098)	0.0035 (0.0071)	40
Fabric filter[d]	ND	Filterable PM	3	B	0.0098-0.013 (0.020-0.025)	0.011 (0.022)	40
Fabric filter[b,d]	ND	Formaldehyde	3	C	0.00031-0.00032 (0.00062-0.00064)	0.00032 (0.00063)	40
Fabric filter[d]	Waste oil	Filterable PM	3	B	0.0041-0.0059 (0.0083-0.012)	0.0049 (0.0097)	40
Fabric filter[b,d]	Waste oil	Formaldehyde	3	C	0.0011-0.0036 (0.0022-0.0073)	0.0020 (0.0040)	40
Fabric filter[d]	ND	Filterable PM	3	B	0.017-0.032 (0.033-0.065)	0.026 (0.053)	40
Fabric filter[b,d]	ND	Formaldehyde	3	C	0.00048-0.00092 (0.00096-0.0018)	0.00063 (0.0013)	40
Fabric filter[d]	Waste oil	Filterable PM	3	B	0.0015-0.0027 (0.0030-0.0053)	0.0019 (0.0038)	40
Fabric filter[b,d]	Waste oil	Formaldehyde	3	C	0.0018-0.0020 (0.0036-0.0039)	0.0019 (0.0038)	40
Fabric filter[d]	Waste oil	Filterable PM	3	B	0.0055-0.0083 (0.011-0.017)	0.0069 (0.014)	40
Fabric filter[b,d]	Waste oil	Formaldehyde	3	C	0.00029-0.00037 (0.00058-0.00075)	0.00034 (0.00067)	40
Fabric filter[d]	No. 2 fuel oil	Filterable PM	3	B	0.0018-0.0037 (0.0037-0.0074)	0.0026 (0.0053)	40

TABLE 4-2. (continued)

Type of control	Fuel fired	Pollutant	No. of test runs	Data rating	Emission factor range, kg/Mg (lb/ton)[a]	Average emission factor, kg/Mg (lb/ton)[a]	Ref. No.
Fabric filter[b,d]	No. 2 fuel oil	Formaldehyde	3	C	0.00025-0.00044 (0.00050-0.00088)	0.00033 (0.00065)	40

ND = No data available NR = Not rated

[a]Emission factors in kg/Mg of hot mix asphalt produced.

[b]Control device may provide only incidental control.

[c]Fabric filters may provide only incidental control of TOC. Emission factor includes test runs while processing between 0 and 30 percent RAP. Processing of RAP did not have a significant effect on TOC emission measurements.

[d]Feed material includes RAP.

[e]Plant A. Feed included 30 percent RAP except during formaldehyde test (0 percent RAP).

[f]Plant B. Feed included 15 percent RAP.

[g]Plant E. Parallel flow drum mixer.

[h]Plant G. Feed included 35 percent RAP.

TABLE 4-3. SUMMARY OF TEST DATA FOR HOT MIX ASPHALT PRODUCTION BATCH MIX FACILITY--DRYERS

Type of control	Fuel fired	Pollutant	No. of test runs	Data rating	Emission factor range, kg/Mg (lb/ton)[a]	Average emission factor, kg/Mg (lb/ton)[a]	Ref. No.
Spray tower[b]	ND	Filterable PM	ND	C	ND	0.32 (0.65)	1
Centrifugal scrubber[b]	ND	Filterable PM	ND	C	ND	0.14 (0.28)	1
Fabric filter[b]	ND	Filterable PM	ND	C	ND	0.067 (0.13)	1
Fabric filter[c]	Natural gas	Filterable PM	2	C	0.026-0.029 (0.053-0.058)	0.028 (0.055)	1
Fabric filter[d]	No. 2 fuel oil	Filterable PM	2	C	0.068-0.074 (0.14-0.15)	0.071 (0.14)	1
Fabric filter[e]	Natural gas	Filterable PM	2	C	0.050-0.057 (0.10-0.11)	0.054 (0.11)	1
None	No. 2 fuel oil	Filterable PM	ND	D	ND	18 (37)	5
None	No. 2 fuel oil	PM-10	ND	D	ND	3.9 (7.8)	5
None	No. 2 fuel oil	Filterable PM	ND	D	ND	14 (27)	5
None	No. 2 fuel oil	PM-10	ND	D	ND	2.9 (5.9)	5
Fabric filter[f]	No. 2 fuel oil	Filterable PM	3	B	0.015-0.024 (0.030-0.048)	0.018 (0.036)	15
Fabric filter[f,g]	No. 2 fuel oil	CO_2	3	B	9.2-10 (18-21)	9.4 (19)	15
Venturi scrubber[h]	No. 2 fuel oil	Filterable PM	2	C	0.025-0.028 (0.049-0.055)	0.026 (0.052)	15
Venturi scrubber[h]	No. 2 fuel oil	Condensible inorganic PM	2	C	0.0080-0.0086 (0.016-0.017)	0.0083 (0.017)	15
Multiple wet scrubbers[i]	ND	Total PM	2	C	0.041-0.049 (0.081-0.098)	0.045 (0.089)	15
Multiple wet scrubbers[j]	ND	Total PM	2	C	0.0020-0.0070 (0.0040-0.014)	0.0045 (0.0090)	15
Multiple wet scrubbers[g,j]	ND	CO_2	2	C	13-14 (27-29)	14 (28)	15
Wet cyclonic scrubber[k]	ND	Filterable PM	3	B	0.015-0.026 (0.029-0.052)	0.020 (0.041)	15

TABLE 4-3. (continued)

Type of control	Fuel fired	Pollutant	No. of test runs	Data rating	Emission factor range, kg/Mg (lb/ton)[a]	Average emission factor, kg/Mg (lb/ton)[a]	Ref. No.
Wet cyclone[l]	Natural gas	Filterable PM	3	B	0.027-0.047 (0.056-0.094)	0.035 (0.069)	15
Wet cyclone[l]	Natural gas	Condensible inorganic PM	2	C	0.00050 (0.0010)	0.00050 (0.0010)	15
Wet cyclone[g,l]	Natural gas	CO_2	3	B	15-16 (30-31)	15 (31)	15
Low-energy scrubber[m]	Natural gas	Filterable PM	3	B	0.052-0.069 (0.10-0.14)	0.061 (0.12)	15
Low-energy scrubber[m]	Natural gas	Condensible inorganic PM	3	B	0.00050-0.0030 (0.0010-0.0060)	0.0017 (0.0033)	15
Low-energy scrubber[g,m]	Natural gas	CO_2	3	B	11 (22)	11 (22)	15
Wet scrubber[n]	Natural gas	Filterable PM	2	C	0.060-0.062 (0.12-0.12)	0.061 (0.12)	15
Wet scrubber[n]	Natural gas	Condensible inorganic PM	2	C	0.0015-0.0040 (0.0030-0.0080)	0.0030 (0.0060)	15
Wet scrubber[g,n]	Natural gas	CO_2	2	C	12-12 (24-25)	12 (24)	15
Fabric filter[g]	Natural gas	CO	4	B	0.42-0.57 (0.85-1.1)	0.50 (1.0)	24
Fabric filter[g]	Natural gas	NO_X	9	A	0.016-0.027 (0.033-0.055)	0.020 (0.040)	24
Fabric filter[g]	Natural gas	CO2	12	A	26-33 (51-65)	28 (55)	24
Fabric filter[g]	Natural gas	TOC	9	A	0.0092-0.015 (0.018-0.031)	0.011 (0.023)	24
Fabric filter[g]	Natural gas	Methane[o]	13	B	8.1×10^{-5}-0.010 (0.00019-0.020)	0.0021 (0.0042)	24
Fabric filter[g]	Natural gas	Benzene[o]	13	B	7.5×10^{-6}-2.9×10^{-4} (1.5×10^{-5}-5.7×10^{-4})	9.6×10^{-5} (0.00019)	24
Fabric filter[g]	Natural gas	Toluene[o]	13	B	3.3×10^{-7}-7.0×10^{-3} (6.6×10^{-7}-1.4×10^{-2})	0.00099 (0.0020)	24
Fabric filter[g]	Natural gas	Ethyl benzene[o]	13	B	3.9×10^{-7}-1.9×10^{-2} (7.7×10^{-7}-3.8×10^{-2})	0.0028 (0.0057)	24
Fabric filter[g]	Natural gas	Xylene[o]	13	B	1.4×10^{-6}-4.2×10^{-2} (2.8×10^{-6}-8.4×10^{-2})	0.0035 (0.0069)	24
Fabric filter	Natural gas	Barium	2	B	6.4×10^{-7}-8.3×10^{-7} (1.3×10^{-6}-1.7×10^{-6})	7.3×10^{-7} (1.5×10^{-6})	24

TABLE 4-3. (continued)

Type of control	Fuel fired	Pollutant	No. of test runs	Data rating	Emission factor range, kg/Mg (lb/ton)[a]	Average emission factor, kg/Mg (lb/ton)[a]	Ref. No.
Fabric filter	Natural gas	Cadmium	2	B	1.4×10^{-7}-2.4×10^{-7} (2.8×10^{-7}-4.8×10^{-7})	1.9×10^{-7} (3.8×10^{-7})	24
Fabric filter	Natural gas	Chromium	2	B	1.6×10^{-7}-7.3×10^{-7} (3.2×10^{-7}-1.5×10^{-6})	4.5×10^{-7} (8.9×10^{-7})	24
Fabric filter	Natural gas	Copper	2	B	9.6×10^{-7}-1.0×10^{-6} (1.9×10^{-6}-2.0×10^{-6})	9.9×10^{-7} (2.0×10^{-6})	24
Fabric filter	Natural gas	Lead	2	B	1.1×10^{-7}-9.5×10^{-7} (2.2×10^{-7}-1.9×10^{-6})	5.3×10^{-7} (1.1×10^{-6})	24
Fabric filter	Natural gas	Manganese	2	B	6.2×10^{-6}-8.0×10^{-6} (1.2×10^{-5}-1.6×10^{-5})	7.1×10^{-6} (1.4×10^{-5})	24
Fabric filter	Natural gas	Nickel	2	B	1.7×10^{-7}-6.3×10^{-6} (3.3×10^{-7}-1.3×10^{-5})	3.2×10^{-6} (6.4×10^{-6})	24
Fabric filter	Natural gas	Zinc	2	B	2.4×10^{-6}-4.0×10^{-6} (4.7×10^{-6}-7.9×10^{-6})	3.2×10^{-6} (6.3×10^{-6})	24
Fabric filter	Natural gas	Filterable PM	3	A	0.002-0.0035 (0.0039-0.0069)	0.0026 (0.0053)	24
Fabric filter	Natural gas	PM-10	3	C	0.00081-0.0011 (0.0016-0.0023)	0.0010 (0.0020)	24
Fabric filter	Natural gas	Condensible inorganic PM	3	B	0.0014-0.0034 (0.0028-0.0068)	0.0021 (0.0042)	24
Fabric filter	Natural gas	Condensible organic PM	2	B	0.00058-0.00065 (0.0012-0.0013)	0.00061 (0.0012)	24
Fabric filter	Natural gas	2-Methylnaphthalene	3	A	5.0×10^{-5}-6.5×10^{-5} (0.00010-0.00013)	5.8×10^{-5} (0.00012)	24
Fabric filter[g]	Natural gas	Acetaldehyde	3	A	0.00025-0.00044 (0.00051-0.00088)	0.00032 (0.00064)	24
Fabric filter[g]	Natural gas	Acetone	2	B	0.0012-0.0053 (0.0024-0.011)	0.0032 (0.0064)	24
Fabric filter[g]	Natural gas	Benzaldehyde	3	A	5.0×10^{-5}-7.9×10^{-5} (0.00010-0.00016)	6.4×10^{-5} (0.00013)	24
Fabric filter[g]	Natural gas	Butyraldehyde/ Isobutyraldehyde	3	A	2.3×10^{-6}-2.8×10^{-5} (4.7×10^{-6}-5.7×10^{-5})	1.5×10^{-5} (3.0×10^{-5})	24
Fabric filter[g]	Natural gas	Crotonaldehyde	3	A	7.5×10^{-6}-2.4×10^{-5} (1.5×10^{-5}-4.9×10^{-5})	1.5×10^{-5} (2.9×10^{-5})	24
Fabric filter[g]	Natural gas	Formaldehyde	3	A	0.00091-0.0012 (0.0018-0.0023)	0.0010 (0.0021)	24
Fabric filter[g]	Natural gas	Hexanal	3	A	7.5×10^{-6}-1.6×10^{-5} (1.5×10^{-5}-3.2×10^{-5})	1.2×10^{-5} (2.4×10^{-5})	24

TABLE 4-3. (continued)

Type of control	Fuel fired	Pollutant	No. of test runs	Data rating	Emission factor range, kg/Mg (lb/ton)[a]	Average emission factor, kg/Mg (lb/ton)[a]	Ref. No.
Fabric filter[g]	Natural gas	Quinone	3	A	7.0×10^{-6}-0.00039 (1.4×10^{-5}-0.00078)	0.00014 (0.00027)	24
Fabric filter[g]	Natural gas	CO	3	B	0.027-0.075 (0.053-0.15)	0.055 (0.11)	34
Fabric filter[g]	Natural gas	NO_X	3	B	0.010-0.016 (0.020-0.031)	0.013 (0.026)	34
Fabric filter	Natural gas	Acenaphthene	3	B	8.5×10^{-10}-4.4×10^{-7} (1.7×10^{-9}-8.7×10^{-7})	2.9×10^{-7} (5.7×10^{-7})	34
Fabric filter	Natural gas	Acenaphthylene	3	B	8.5×10^{-10}-3.2×10^{-7} (1.7×10^{-9}-6.3×10^{-7})	1.6×10^{-7} (3.2×10^{-7})	34
Fabric filter	Natural gas	Anthracene	3	B	1.7×10^{-9}-9.5×10^{-8} (3.3×10^{-9}-1.9×10^{-7})	4.4×10^{-8} (8.8×10^{-8})	34
Fabric filter	Natural gas	Benzo(b)fluoranthene	3	C	1.7×10^{-9}-3.0×10^{-8} (3.3×10^{-9}-6.0×10^{-8})	1.1×10^{-8} (2.2×10^{-8})	34
Fabric filter	Natural gas	Benzo(k)fluoranthene	3	C	8.5×10^{-10}-3.4×10^{-8} (1.7×10^{-9}-6.7×10^{-8})	1.2×10^{-8} (2.4×10^{-8})	34
Fabric filter	Natural gas	Fluoranthene	3	B	3.4×10^{-9}-3.4×10^{-8} (6.7×10^{-9}-6.7×10^{-8})	2.2×10^{-8} (4.4×10^{-8})	34
Fabric filter	Natural gas	Fluorene	3	B	8.5×10^{-10}-6.5×10^{-7} (1.7×10^{-9}-1.3×10^{-6})	3.3×10^{-7} (6.5×10^{-7})	34
Fabric filter	Natural gas	Naphthalene	3	B	8.5×10^{-10}-1.6×10^{-5} (1.7×10^{-9}-3.2×10^{-5})	9.5×10^{-6} (1.9×10^{-5})	34
Fabric filter	Natural gas	Phenanthrene	3	B	6.0×10^{-7}-1.6×10^{-6} (1.2×10^{-6}-3.1×10^{-6})	1.0×10^{-6} (2.0×10^{-6})	34
Fabric filter	Natural gas	Pyrene	3	B	1.7×10^{-9}-3.5×10^{-8} (3.3×10^{-9}-7.0×10^{-8})	2.4×10^{-8} (4.8×10^{-8})	34
Fabric filter[g]	Natural gas	Benzene	3	C	1.9×10^{-5}-6.0×10^{-5} (3.7×10^{-5}-0.00012)	3.5×10^{-5} (7.0×10^{-5})	34
Fabric filter[g]	Natural gas	Toluene	3	C	2.5×10^{-5}-5.5×10^{-5} (5.0×10^{-5}-0.00011)	3.7×10^{-5} (7.3×10^{-5})	34
Fabric filter[g]	Natural gas	Formaldehyde	3	C	2.5×10^{-5}-5.5×10^{-5} (5.0×10^{-5}-0.00011)	3.8×10^{-5} (7.6×10^{-5})	34
Fabric filter[g]	Natural gas	Acetaldehyde	2	C	5.5×10^{-8}-1.2×10^{-6} (1.1×10^{-7}-2.3×10^{-6})	6.0×10^{-7} (1.2×10^{-6})	34
Fabric filter	Natural gas	Arsenic	3	C	1.6×10^{-8}-4.7×10^{-7} (3.2×10^{-8}-9.3×10^{-7})	1.7×10^{-7} (3.3×10^{-7})	34
Fabric filter	Natural gas	Beryllium	3	C	1.0×10^{-8}-1.7×10^{-7} (2.0×10^{-8}-3.3×10^{-7})	1.1×10^{-7} (2.2×10^{-7})	34

TABLE 4-3. (continued)

Type of control	Fuel fired	Pollutant	No. of test runs	Data rating	Emission factor range, kg/Mg (lb/ton)[a]	Average emission factor, kg/Mg (lb/ton)[a]	Ref. No.
Fabric filter	Natural gas	Cadmium	3	B	3.5×10^{-7}-1.2×10^{-6} (7.0×10^{-7}-2.3×10^{-6})	6.5×10^{-7} (1.3×10^{-6})	34
Fabric filter	Natural gas	Chromium	3	C	1.2×10^{-7}-1.7×10^{-7} (2.3×10^{-7}-3.3×10^{-7})	1.5×10^{-7} (3.0×10^{-7})	34
Fabric filter	Natural gas	Hexavalent Chromium	3	C	4.2×10^{-10}-1.4×10^{-8} (8.3×10^{-10}-2.7×10^{-8})	4.9×10^{-9} (9.7×10^{-9})	34
Fabric filter	Natural gas	Copper	3	B	9.0×10^{-7}-5.5×10^{-6} (1.8×10^{-6}-1.1×10^{-5})	2.7×10^{-6} (5.3×10^{-6})	34
Fabric filter	Natural gas	Mercury	3	B	1.2×10^{-8}-4.9×10^{-7} (2.3×10^{-8}-9.7×10^{-7})	2.3×10^{-7} (4.5×10^{-7})	34
Fabric filter	Natural gas	Manganese	3	B	1.2×10^{-6}-5.5×10^{-6} (2.4×10^{-6}-1.1×10^{-5})	2.9×10^{-6} (5.8×10^{-6})	34
Fabric filter	Natural gas	Nickel	3	B	1.5×10^{-7}-2.5×10^{-6} (3.0×10^{-7}-5.0×10^{-6})	1.0×10^{-6} (2.0×10^{-6})	34
Fabric filter	Natural gas	Lead	3	B	1.2×10^{-8}-3.4×10^{-7} (2.3×10^{-8}-6.7×10^{-7})	1.9×10^{-7} (3.7×10^{-7})	34
Fabric filter	Natural gas	Selenium	3	C	2.5×10^{-8}-6.5×10^{-8} (5.0×10^{-8}-1.3×10^{-7})	4.6×10^{-8} (9.2×10^{-8})	34
Fabric filter	Natural gas	Zinc	3	B	1.3×10^{-6}-8.0×10^{-6} (2.6×10^{-6}-1.6×10^{-5})	3.7×10^{-6} (7.3×10^{-6})	34
Fabric filter[g,p]	Natural gas	CO	9	B	0.0021-0.048 (0.0043-0.097)	0.019 (0.038)	39
Fabric filter[g,p]	Natural gas	CO_2	9	B	9.4-13 (19-26)	11 (22)	39
Fabric filter[g,p]	Natural gas	SO_2	9	B	0.0013-0.0051 (0.0025-0.010)	0.0032 (0.0065)	39
Fabric filter[g,p]	Natural gas	NO_x	9	B	0.0041-0.0090 (0.0081-0.018)	0.0072 (0.014)	39
Fabric filter[g,p]	Natural gas	TOC	3	B	0.0034-0.0049 (0.0068-0.0097)	0.0042 (0.0084)	39
Fabric filter[g,p]	Natural gas	Methane	2	C	0.00041-0.00075 (0.00081-0.0015)	0.00058 (0.0012)	39
Fabric filter[g,p]	Natural gas	Benzene	3	B	2.4×10^{-5}-0.00065 (4.8×10^{-5}-0.0013)	0.00025 (0.00050)	39
Fabric filter[g,p]	Natural gas	Toluene	3	B	4.8×10^{-5}-0.0022 (9.5×10^{-5}-0.0044)	0.00077 (0.0015)	39

TABLE 4-3. (continued)

Type of control	Fuel fired	Pollutant	No. of test runs	Data rating	Emission factor range, kg/Mg (lb/ton)[a]	Average emission factor, kg/Mg (lb/ton)[a]	Ref. No.
Fabric filter[g,p]	Natural gas	Ethylbenzene	3	B	$2.4x10^{-5}$-0.0012 ($4.8x10^{-5}$-0.0024)	0.00043 (0.00085)	39
Fabric filter[g,p]	Natural gas	Xylene	3	B	$7.2x10^{-5}$-0.0022 (0.00014-0.0044)	0.00079 (0.0016)	39
Fabric filter[p]	Natural gas	Naphthalene	3	B	$2.4x10^{-5}$-$6.5x10^{-5}$ ($4.7x10^{-5}$-$1.3x10^{-4}$)	$4.1x10^{-5}$ ($8.1x10^{-5}$)	39
Fabric filter[p]	Natural gas	Acenaphthylene	3	B	$6.1x10^{-7}$-$7.2x10^{-7}$ ($1.2x10^{-6}$-$1.4x10^{-6}$)	$6.8x10^{-7}$ ($1.4x10^{-6}$)	39
Fabric filter[p]	Natural gas	Acenaphthene	3	B	$7.2x10^{-7}$-$1.4x10^{-6}$ ($1.4x10^{-6}$-$2.9x10^{-6}$)	$9.5x10^{-7}$ ($1.9x10^{-6}$)	39
Fabric filter[p]	Natural gas	Fluorene	3	B	$1.4x10^{-6}$-$2.6x10^{-6}$ ($2.9x10^{-6}$-$5.3x10^{-6}$)	$1.8x10^{-6}$ ($3.7x10^{-6}$)	39
Fabric filter[p]	Natural gas	Phenanthrene	3	B	$2.1x10^{-6}$-$3.7x10^{-6}$ ($4.3x10^{-6}$-$7.3x10^{-6}$)	$2.7x10^{-6}$ ($5.5x10^{-6}$)	39
Fabric filter[p]	Natural gas	Anthracene	3	B	$1.9x10^{-7}$-$3.7x10^{-7}$ ($3.8x10^{-7}$-$7.3x10^{-7}$)	$2.6x10^{-7}$ ($5.3x10^{-7}$)	39
Fabric filter[p]	Natural gas	Fluoranthene	3	B	$4.8x10^{-8}$-$6.2x10^{-7}$ ($9.5x10^{-8}$-$1.2x10^{-6}$)	$2.4x10^{-7}$ ($4.9x10^{-7}$)	39
Fabric filter[p]	Natural gas	Pyrene	3	B	$2.4x10^{-8}$-$4.8x10^{-8}$ ($4.8x10^{-8}$-$9.5x10^{-8}$)	$3.7x10^{-8}$ ($7.5x10^{-8}$)	39
Fabric filter[p]	Natural gas	Benzo(a)anthracene	3	B	$2.0x10^{-9}$-$2.4x10^{-9}$ ($4.1x10^{-9}$-$4.8x10^{-9}$)	$2.3x10^{-9}$ ($4.5x10^{-9}$)	39
Fabric filter[p]	Natural gas	Chrysene	3	B	$2.0x10^{-9}$-$4.8x10^{-9}$ ($4.1x10^{-9}$-$9.5x10^{-9}$)	$3.1x10^{-9}$ ($6.1x10^{-9}$)	39
Fabric filter[p]	Natural gas	Benzo(b)fluoranthene	3	B	$2.0x10^{-9}$-$2.4x10^{-9}$ ($4.1x10^{-9}$-$4.8x10^{-9}$)	$2.3x10^{-9}$ ($4.5x10^{-9}$)	39
Fabric filter[g,p]	Natural gas	Formaldehyde	3	B	$6.2x10^{-5}$-$2.5x10^{-4}$ (0.00012-0.00049)	0.00017 (0.00035)	39
Fabric filter[p]	Natural gas	Condensible PM	3	B	0.00017-0.0017 (0.00033-0.0035)	0.00083 (0.0017)	39
Fabric filter[g,q]	Natural gas	CO	8	B	0.041-0.14 (0.082-0.27)	0.095 (0.19)	39
Fabric filter[g,q]	Natural gas	CO_2	8	B	19-23 (39-46)	21 (43)	39
Fabric filter[g,q]	Natural gas	SO_2	8	B	0.00093-0.0028 (0.0019-0.0056)	0.0017 (0.0034)	39
Fabric filter[g,q]	Natural gas	NO_X	8	B	0.0082-0.014 (0.016-0.028)	0.011 (0.022)	39

TABLE 4-3. (continued)

Type of control	Fuel fired	Pollutant	No. of test runs	Data rating	Emission factor range, kg/Mg (lb/ton)[a]	Average emission factor, kg/Mg (lb/ton)[a]	Ref. No.
Fabric filter[g,q]	Natural gas	TOC	8	B	0.0062-0.017 (0.012-0.035)	0.010 (0.021)	39
Fabric filter[g,q]	Natural gas	Methane	8	B	0.0046-0.017 (0.0092-0.033)	0.0099 (0.020)	39
Fabric filter[q]	Natural gas	Naphthalene	3	B	$1.1x10^{-5}$-$1.4x10^{-5}$ ($2.2x10^{-5}$-$2.7x10^{-5}$)	$1.3x10^{-5}$ ($2.5x10^{-5}$)	39
Fabric filter[q]	Natural gas	2-Methylnaphthalene	3	B	$1.5x10^{-5}$-$1.9x10^{-5}$ ($2.9x10^{-5}$-$3.7x10^{-5}$)	$1.6x10^{-5}$ ($3.3x10^{-5}$)	39
Fabric filter[q]	Natural gas	Fluorene	3	B	$7.8x10^{-7}$-$1.1x10^{-6}$ ($1.6x10^{-6}$-$2.2x10^{-6}$)	$8.8x10^{-7}$ ($1.8x10^{-6}$)	39
Fabric filter[q]	Natural gas	Phenanthrene	3	B	$9.3x10^{-7}$-$1.2x10^{-6}$ ($1.9x10^{-6}$-$2.5x10^{-6}$)	$1.1x10^{-6}$ ($2.2x10^{-6}$)	39
Fabric filter[q]	Natural gas	Fluoranthene	3	B	$1.6x10^{-7}$-$3.1x10^{-7}$ ($3.1x10^{-7}$-$6.2x10^{-7}$)	$2.1x10^{-7}$ ($4.1x10^{-7}$)	39
Fabric filter[g,q]	Natural gas	Formaldehyde	3	B	$3.3x10^{-5}$-$7.9x10^{-5}$ ($6.5x10^{-5}$-$1.6x10^{-4}$)	$6.2x10^{-5}$ ($1.2x10^{-4}$)	39
Fabric filter[q]	Natural gas	Condensible PM	2	C	0.0055-0.0061 (0.011-0.012)	0.0058 (0.012)	39
Fabric filter[g,r]	No. 6 fuel oil	CO	9	B	0.019-0.065 (0.038-0.13)	0.035 (0.069)	39
Fabric filter[g,r]	No. 6 fuel oil	CO_2	9	B	25-32 (50-63)	29 (59)	39
Fabric filter[g,r]	No. 6 fuel oil	SO_2	9	B	0.10-0.15 (0.21-0.30)	0.12 (0.24)	39
Fabric filter[g,r]	No. 6 fuel oil	NO_X	9	B	0.068-0.10 (0.14-0.20)	0.084 (0.17)	39
Fabric filter[g,r]	No. 6 fuel oil	TOC	9	B	0.016-0.031 (0.033-0.061)	0.023 (0.046)	39
Fabric filter[g,r]	No. 6 fuel oil	Methane	8	B	0.00013-0.0048 (0.00026-0.0096)	0.0022 (0.0043)	39
Fabric filter[r]	No. 6 fuel oil	Naphthalene	3	B	$1.7x10^{-5}$-$2.9x10^{-5}$ ($3.4x10^{-5}$-$5.8x10^{-5}$)	$2.2x10^{-5}$ ($4.5x10^{-5}$)	39
Fabric filter[r]	No. 6 fuel oil	2-Methylnaphthalene	3	B	$2.5x10^{-5}$-$3.5x10^{-5}$ ($4.9x10^{-5}$-$6.9x10^{-5}$)	$3.0x10^{-5}$ ($6.0x10^{-5}$)	39
Fabric filter[r]	No. 6 fuel oil	Phenanthrene	2	C	$1.3x10^{-5}$-$2.4x10^{-5}$ ($2.6x10^{-5}$-$4.8x10^{-5}$)	$1.8x10^{-5}$ ($3.7x10^{-5}$)	39
Fabric filter[r]	No. 6 fuel oil	Fluoranthene	3	B	$5.3x10^{-6}$-$2.4x10^{-5}$ ($1.1x10^{-5}$-$4.8x10^{-5}$)	$1.2x10^{-5}$ ($2.4x10^{-5}$)	39

TABLE 4-3. (continued)

Type of control	Fuel fired	Pollutant	No. of test runs	Data rating	Emission factor range, kg/Mg (lb/ton)[a]	Average emission factor, kg/Mg (lb/ton)[a]	Ref. No.
Fabric filter[r]	No. 6 fuel oil	Pyrene	3	B	$7.1x10^{-6}$-$6.7x10^{-5}$ ($1.4x10^{-5}$-$1.3x10^{-4}$)	$2.7x10^{-5}$ ($5.5x10^{-5}$)	39
Fabric filter[g,r]	No. 6 fuel oil	Formaldehyde	3	B	$1.5x10^{-5}$-$1.1x10^{-3}$ ($3.0x10^{-5}$-$2.1x10^{-3}$)	0.00040 (0.00081)	39
Fabric filter[r]	No. 6 fuel oil	Condensible PM	3	B	0.013-0.028 (0.027-0.055)	0.022 (0.045)	39
Wet scrubber	No. 2 fuel oil	Total PM	3	B	0.20-0.22 (0.40-0.45)	0.21 (0.43)	40
Wet scrubber[g]	No. 2 fuel oil	Formaldehyde	3	C	0.0063-0.010 (0.013-0.020)	0.0078 (0.016)	40
Wet scrubber	ND	Total PM	3	B	0.32-0.40 (0.65-0.80)	0.37 (0.75)	40
Wet scrubber[g]	ND	Formaldehyde	3	C	0.0019-0.0021 (0.0037-0.0043)	0.0020 (0.0040)	40
Wet scrubber	No. 2 fuel oil	Total PM	3	B	0.027-0.032 (0.054-0.064)	0.029 (0.058)	40
Wet scrubber[g]	No. 2 fuel oil	Formaldehyde	3	C	0.00050-0.00055 (0.0010-0.0011)	0.00053 (0.0011)	40
Fabric filter	No. 2 fuel oil	Filterable PM	3	B	0.0024-0.0030 (0.0047-0.0060)	0.0026 (0.0053)	40
Fabric filter[g]	No. 2 fuel oil	Formaldehyde	3	C	$7.9x10^{-5}$-0.00011 (0.00016-0.00021)	0.00010 (0.00019)	40
Fabric filter	Waste oil	Filterable PM	3	B	0.0025-0.0030 (0.0049-0.0061)	0.0027 (0.0054)	40
Fabric filter[g]	Waste oil	Formaldehyde	3	C	0.00076-0.00099 (0.0015-0.0020)	0.00088 (0.0018)	40
Fabric filter	Waste oil	Total PM	3	B	0.036-0.043 (0.073-0.085)	0.039 (0.078)	40
Fabric filter[g]	Waste oil	Formaldehyde	3	C	0.00084-0.0011 (0.0017-0.0021)	0.00097 (0.0019)	40
Fabric filter	Waste oil	Total PM	3	B	0.059-0.062 (0.12-0.12)	0.061 (0.12)	40
Fabric filter[g]	Waste oil	Formaldehyde	3	C	0.00039-0.00050 (0.00078-0.0010)	0.00044 (0.00089)	40
Fabric filter	ND	Filterable PM	3	B	0.018-0.019 (0.036-0.039)	0.019 (0.037)	40
Fabric filter[g]	ND	Formaldehyde	3	C	0.0037-0.0049 (0.0073-0.0098)	0.0044 (0.0087)	40

TABLE 4-3. (continued)

Type of control	Fuel fired	Pollutant	No. of test runs	Data rating	Emission factor range, kg/Mg (lb/ton)[a]	Average emission factor, kg/Mg (lb/ton)[a]	Ref. No.
Fabric filter	ND	Filterable PM	3	B	0.077-0.12 (0.15-0.24)	0.093 (0.19)	40
Fabric filter[g]	ND	Formaldehyde	3	C	0.0029-0.0049 (0.0058-0.0098)	0.0039 (0.0079)	40
Fabric filter	ND	Arsenic	3	C	$2.1x10^{-7}$-$1.0x10^{-6}$ ($4.1x10^{-7}$-$2.0x10^{-6}$)	$4.9x10^{-7}$ ($9.9x10^{-7}$)	40
Fabric filter	ND	Filterable PM	3	B	0.0014-0.0015 (0.0027-0.0030)	0.0014 (0.0028)	41
Fabric filter[g]	ND	CO_2	3	B	15-15 (30-31)	15 (31)	41

ND = No data available
[a]Emission factors in kg/Mg (lb/ton) of hot mix asphalt produced.
[b]Emission factors developed from data collected during a plant survey.
[c]Plant 2.
[d]Plant 4.
[e]Plant 5.
[f]Plant O.
[g]Control device may provide only incidental control.
[h]Plant U.
[i]Plant X.
[j]Plant AA.
[k]Plant BB.
[l]Plant DD.
[m]Plant EE.
[n]Plant FF.
[o]Average emission factor computed using an assumed detection limit.
[p]Plant C.
[q]Plant D.
[r]Plant F. Feed included 30 percent RAP.

TABLE 4-4. SUMMARY OF TEST DATA FOR ASPHALTIC CONCRETE PRODUCTION DRUM MIX FACILITY-HOT OIL HEATERS

Type of control	Fuel fired	Pollutant	No. of test runs	Data rating	Emission factor range, kg/l (lb/gal) fuel consumed	Average emission factor, kg/l (lb/gal) fuel consumed	Ref. No.
None	No. 2 fuel oil	Naphthalene	3	B	$1.2x10^{-6}$-$2.8x10^{-6}$ ($1.1x10^{-5}$-$2.3x10^{-5}$)	$2.0x10^{-6}$ ($1.7x10^{-5}$)	35
None	No. 2 fuel oil	Acenaphthylene	3	B	$1.7x10^{-8}$-$3.0x10^{-8}$ ($1.4x10^{-7}$-$2.5x10^{-7}$)	$2.4x10^{-8}$ ($2.0x10^{-7}$)	35
None	No. 2 fuel oil	Acenaphthene	3	B	$6.2x10^{-8}$-$6.7x10^{-8}$ ($5.2x10^{-7}$-$5.6x10^{-7}$)	$6.4x10^{-8}$ ($5.3x10^{-7}$)	35
None	No. 2 fuel oil	Fluorene	3	B	$1.6x10^{-7}$-$4.6x10^{-7}$ ($1.3x10^{-6}$-$3.8x10^{-6}$)	$2.8x10^{-7}$ ($2.3x10^{-6}$)	35
None	No. 2 fuel oil	Phenanthrene	3	B	$4.8x10^{-7}$-$8.2x10^{-7}$ ($4.0x10^{-6}$-$6.8x10^{-6}$)	$5.9x10^{-7}$ ($4.9x10^{-6}$)	35
None	No. 2 fuel oil	Anthracene	3	B	$1.7x10^{-8}$-$2.9x10^{-8}$ ($1.4x10^{-7}$-$2.4x10^{-7}$)	$2.2x10^{-8}$ ($1.8x10^{-7}$)	35
None	No. 2 fuel oil	Fluoranthene	3	B	$3.4x10^{-9}$-$6.2x10^{-9}$ ($2.8x10^{-8}$-$5.2x10^{-8}$)	$5.3x10^{-9}$ ($4.4x10^{-8}$)	35
None	No. 2 fuel oil	Pyrene	3	B	$3.2x10^{-9}$-$4.7x10^{-9}$ ($2.7x10^{-8}$-$3.9x10^{-8}$)	$3.8x10^{-9}$ ($3.2x10^{-8}$)	35
None	No. 2 fuel oil	Benzo(b)fluoranthene	3	B	$7.2x10^{-9}$-$1.8x10^{-8}$ ($6.0x10^{-8}$-$1.5x10^{-7}$)	$1.2x10^{-8}$ ($1.0x10^{-7}$)	35
None	No. 2 fuel oil	TCDF's (total)	3	B	$6.7x10^{-14}$-$8.2x10^{-13}$ ($5.6x10^{-13}$-$6.8x10^{-12}$)	$4.0x10^{-13}$ ($3.3x10^{-12}$)	35
None	No. 2 fuel oil	PCDF's (total)	3	C	$2.4x10^{-14}$-$1.2x10^{-13}$ ($2.0x10^{-13}$-$1.0x10^{-12}$)	$5.8x10^{-14}$ ($4.8x10^{-13}$)	35
None	No. 2 fuel oil	HxCDF's (total)	2	B	$1.6x10^{-14}$-$5.8x10^{-13}$ ($1.3x10^{-13}$-$4.8x10^{-12}$)	$2.4x10^{-13}$ ($2.0x10^{-12}$)	35
None	No. 2 fuel oil	HpCDF's (total)	2	B	$3.8x10^{-14}$-$2.6x10^{-12}$ ($3.2x10^{-13}$-$2.2x10^{-11}$)	$1.2x10^{-12}$ ($9.7x10^{-12}$)	35
None	No. 2 fuel oil	1,2,3,4,6,7,8-HpCDF	3	C	$9.4x10^{-14}$-$1.0x10^{-12}$ ($7.6x10^{-13}$-$8.4x10^{-12}$)	$4.2x10^{-13}$ ($3.5x10^{-12}$)	35
None	No. 2 fuel oil	OCDF	3	B	$1.2x10^{-13}$-$3.7x10^{-12}$ ($1.0x10^{-12}$-$3.1x10^{-11}$)	$1.4x10^{-12}$ ($1.2x10^{-11}$)	35
None	No. 2 fuel oil	HxCDD's (total)	3	B	$2.3x10^{-13}$-$1.3x10^{-12}$ ($1.9x10^{-12}$-$1.1x10^{-11}$)	$7.4x10^{-13}$ ($6.2x10^{-12}$)	35
None	No. 2 fuel oil	1,2,3,7,8,9-HxCDD	3	C	$3.8x10^{-14}$-$1.2x10^{-13}$ ($3.2x10^{-13}$-$1.0x10^{-12}$)	$9.1x10^{-14}$ ($7.6x10^{-13}$)	35
None	No. 2 fuel oil	1,2,3,4,7,8-HxCDD	3	C	$3.8x10^{-14}$-$1.1x10^{-13}$ ($3.2x10^{-13}$-$9.2x10^{-13}$)	$8.3x10^{-14}$ ($6.9x10^{-13}$)	35
None	No. 2 fuel oil	HpCDD's (total)	3	C	$1.7x10^{-13}$-$6.7x10^{-12}$ ($1.4x10^{-12}$-$5.6x10^{-11}$)	$2.4x10^{-12}$ ($2.0x10^{-11}$)	35
None	No. 2 fuel oil	1,2,3,4,6,7,8-HpCDD	3	B	$1.7x10^{-13}$-$4.6x10^{-12}$ ($1.4x10^{-12}$-$3.8x10^{-11}$)	$1.8x10^{-12}$ ($1.5x10^{-11}$)	35
None	No. 2 fuel oil	OCDD	3	B	$1.2x10^{-12}$-$5.3x10^{-11}$ ($1.0x10^{-11}$-$4.4x10^{-10}$)	$1.9x10^{-11}$ ($1.6x10^{-10}$)	35
None	No. 2 fuel oil	Formaldehyde	3	B	0.0019-0.0053 (0.016-0.044)	0.0032 (0.027)	35

The emission factor ratings assigned to each of the average emission factors developed for HMA production are based on the emission data ratings and the number of tests conducted. Of the 364 data sets from which emission factors were developed, 63 were A-rated, 224 were B-rated, 83 were C-rated, and 4 were D-rated. A- and B-rated data were not averaged with C- and D-rated data, which were only used when no A- or B-rated data were available.

4.2.4.1 Drum Mix Dryers.[1,5,11,15,22,25-41] Emission factors for drum mix dryers were developed using the data presented in Table 4-2. The average emission factors for drum mix dryers are shown in Table 4-5.

Filterable PM. Emission factors for uncontrolled filterable PM emissions from drum mix dryers were developed from three A-rated and two B-rated tests. The results of these five tests ranged from 1.3 to 25 kg/Mg (2.6 to 50 lb/ton), with an average emission factor of 9.4 kg/Mg (19 lb/ton) for uncontrolled filterable PM emissions. This emission factor is rated D.

Emission factors for filterable PM emissions from fabric filter-controlled drum mix dryers were developed from 6 A-rated, 15 B-rated, and 2 C-rated tests. Only the A- and B-rated data were used to determine the average emission factor. The results of these 21 tests ranged from 0.00044 to 0.026 kg/Mg (0.00089 to 0.053 lb/ton), with an average emission factor of 0.0070 kg/Mg (0.014 lb/ton). This emission factor is rated C.

Emission factors for filterable PM emissions from venturi scrubber-controlled drum mix dryers were developed from two A-rated and five B-rated tests. The results of these seven tests ranged from 0.0080 to 0.049 kg/Mg (0.016 to 0.097 lb/ton), with an average emission factor of 0.017 kg/Mg (0.033 lb/ton). This emission factor is rated D.

Filterable PM-10. The particle-size data from the 1986 revision of AP-42 Section 11.1 (particle-size data contained in Reference 23) were used in combination with the filterable PM emission factors described in the preceding paragraphs to develop filterable PM-10 emission factors. For uncontrolled drum-mix dryers, 23 percent of the filterable PM emissions are PM-10, yielding an uncontrolled filterable PM-10 emission factor of 2.2 kg/Mg (4.3 lb/ton). This emission factor is rated D. For fabric filter-controlled drum mix dryers, 32 percent of the filterable PM emissions are PM-10, yielding an emission factor of 0.0022 kg/Mg (0.0045 lb/ton). This emission factor is rated D. The controlled filterable PM-10 emission factor of 0.0022 kg/Mg (0.0045 lb/ton) compares favorably to an emission factor developed using data from an EPA Method 201A test (Reference 25) for filterable PM-10 emissions from a fabric filter-controlled drum mix dryer (0.0026 kg/Mg [0.0052 lb/ton]).

Condensible organic PM. Emission factors for uncontrolled condensible organic PM emissions from natural gas-fired drum mix dryers were developed from two A-rated tests. The results of these two tests were 0.021 and 0.034 kg/Mg (0.041 and 0.067 lb/ton), with an average emission factor of 0.027 kg/Mg (0.054 lb/ton) for uncontrolled condensible organic PM emissions. This emission factor is rated D.

Emission factors for venturi scrubber-controlled condensible organic PM emissions from natural gas-fired drum mix dryers were developed from two A-rated tests. The results of these two tests were 0.0090 and 0.011 kg/Mg (0.018 and 0.021 lb/ton), with an average emission factor of 0.010 kg/Mg (0.020 lb/ton) for venturi scrubber-controlled condensible organic PM emissions. This emission factor is rated D.

TABLE 4-5. SUMMARY OF EMISSION FACTORS FOR HOT MIX ASPHALT PRODUCTION DRUM MIX FACILITY--DRYERS

Type of control	Fuel fired	Pollutant	No. of tests	Emission factor rating	Average emission factor, kg/Mg (lb/ton)[a]	Ref. Nos.
Fabric filter	Natural gas	2-Chloronaphthalene	1	D	8.9×10^{-7} (1.8×10^{-6})	39
Fabric filter[b]	Natural gas	2-Methylnaphthalene	3	D	3.7×10^{-5} (7.4×10^{-5})	39
Fabric filter[b]	No. 2 fuel oil	2-Methylnaphthalene	1	D	8.5×10^{-5} (0.00017)	39
Fabric filter	Natural gas/ propane	Acenaphthene	2	D	6.4×10^{-7} (1.3×10^{-6})	35,39
Fabric filter[b]	Natural gas/ propane	Acenaphthylene	3	D	4.2×10^{-6} (8.4×10^{-6})	35,39
Fabric filter[b]	No. 2 fuel oil	Acenaphthylene	1	D	1.1×10^{-5} (2.2×10^{-5})	39
None[b]	Waste oil	Acetaldehyde	1	D	0.00065 (0.0013)	25
None[b]	Waste oil	Acetone	1	D	0.00042 (0.00083)	25
None[b]	Waste oil	Acrolein	1	D	1.3×10^{-5} (2.6×10^{-5})	25
Fabric filter	Natural gas/ propane	Anthracene	2	D	1.0×10^{-7} (2.1×10^{-7})	35,39
Fabric filter[b]	No. 2 fuel oil	Anthracene	1	D	1.8×10^{-6} (3.6×10^{-6})	39
Fabric filter	Propane/ waste oil	Arsenic	2	D	5.5×10^{-7} (1.1×10^{-6})	25,35
Fabric filter[b]	Waste oil	Barium	1	D	2.4×10^{-6} (4.8×10^{-6})	25
None[b]	Waste oil	Benzaldehyde	1	D	5.5×10^{-5} (0.00011)	25
None[b]	Natural gas	Benzene	1	D	0.00060 (0.0012)	39
None[b]	Waste oil	Benzene	1	D	0.00020 (0.00041)	25
Fabric filter	Natural gas	Benzo(a)anthracene	1	D	1.0×10^{-7} (2.0×10^{-7})	39
Fabric filter	Natural gas	Benzo(a)pyrene	1	D	4.6×10^{-9} (9.2×10^{-9})	39
Fabric filter	Natural gas/ propane	Benzo(b)fluoranthene	2	D	5.1×10^{-8} (1.0×10^{-7})	35, 39
Fabric filter	Natural gas	Benzo(e)pyrene	1	D	5.2×10^{-8} (1.0×10^{-7})	39
Fabric filter	Natural gas	Benzo(g,h,i)perylene	1	D	1.9×10^{-8} (3.9×10^{-8})	39
Fabric filter	Natural gas	Benzo(k)fluoranthene	1	D	2.6×10^{-8} (5.3×10^{-8})	39
None[b]	Waste oil	Butyraldehyde/ Isobutyraldehyde	1	D	8.0×10^{-5} (0.00016)	25
Fabric filter	Propane/ waste oil	Cadmium	2	D	2.2×10^{-7} (4.4×10^{-7})	25,35
Fabric filter[b]	Waste oil	Chromium	1	D	6.0×10^{-6} (1.2×10^{-5})	25
Fabric filter	Natural gas	Chrysene	1	D	1.8×10^{-7} (3.5×10^{-7})	39
None	Natural gas	CO	1	D	0.028 (0.056)	39
None[b]	Waste oil	CO	1	D	0.018 (0.036)	25
None	Natural gas	CO_2	4	D	14 (27)	30,39
None[b]	No. 2 fuel oil/ waste oil	CO_2	7	D	19 (37)	25,26,27,29, 32,33,39

TABLE 4-5. (continued)

Type of control	Fuel fired	Pollutant	No. of tests	Emission factor rating	Average emission factor, kg/Mg (lb/ton)[a]	Ref. Nos.
Fabric filter[b]	No. 2 fuel oil/ waste oil	Condensible inorganic PM	2	D	0.012 (0.023)	25,39
Fabric filter[b]	No. 2 fuel oil/ waste oil	Condensible organic PM	2	D	0.0013 (0.0026)	25,39
None[b]	Natural gas	Condensible organic PM	2	D	0.027 (0.054)	36,37
Venturi scrubber[b]	Natural gas	Condensible organic PM	2	D	0.010 (0.020)	36,37
Fabric filter[b]	Natural gas	Condensible PM	2	D	0.0019 (0.0037)	39
Fabric filter[b]	No. 2 fuel oil/ waste oil	Condensible PM	2	D	0.013 (0.025)	25,39
Fabric filter[b]	Waste oil	Copper	1	D	$3.1x10^{-6}$ ($6.1x10^{-6}$)	25
None[b]	Waste oil	Crotonaldehyde	1	D	$4.3x10^{-5}$ ($8.6x10^{-5}$)	25
Fabric filter	Natural gas	Dibenz(a,h)anthracene	1	E	$1.3x10^{-9}$ ($2.7x10^{-9}$)	39
None[b]	Natural gas	Ethylbenzene	1	E	0.00015 (0.00029)	39
None[b]	Waste oil	Ethylbenzene	1	D	0.00019 (0.00038)	25
Fabric filter[b]	NA[c]	Filterable PM	21	C	0.0070 (0.014)	25,26,27,28, 31,33,40
Fabric filter[b]	NA[c]	Filterable PM-10	NA	D	0.0022 (0.0045)	23,25,26,27, 28,31,33,40
None[b]	NA[c]	Filterable PM	5	D	9.4 (19)	31,36,37,38
None[b]	NA[c]	Filterable PM-10	NA	D	2.2 (4.3)	23,31,36,37, 38
Venturi scrubber[b]	NA[c]	Filterable PM	7	D	0.017 (0.033)	29,32,36,37, 40
Fabric filter[b]	Natural gas/ propane	Fluoranthene	3	D	$3.0x10^{-7}$ ($5.9x10^{-7}$)	35,39
Fabric filter[b]	Natural gas/ propane	Fluorene	2	D	$2.7x10^{-6}$ ($5.3x10^{-6}$)	35,39
Fabric filter[b]	No. 2 fuel oil	Fluorene	1	D	$8.5x10^{-6}$ ($1.7x10^{-5}$)	39
None	Natural gas/ propane	Formaldehyde	3	D	0.0018 (0.0036)	35,39
None[b]	No. 2 fuel oil/ waste oil	Formaldehyde	2	D	0.0012 (0.0024)	25,39
Venturi scrubber[b]	Natural gas	Formaldehyde	1	E	0.00079 (0.0016)	40
Venturi scrubber[b]	Waste oil	Formaldehyde	1	E	0.00021 (0.00041)	40
Wet scrubber[b]	No. 2 fuel oil	Formaldehyde	1	E	0.00031 (0.00063)	40
None[b]	Waste oil	Hexanal	1	D	$5.5x10^{-5}$ (0.00011)	25
Fabric filter	Natural gas	Indeno(1,2,3-cd) pyrene	1	D	$3.6x10^{-9}$ ($7.3x10^{-9}$)	39

TABLE 4-5. (continued)

Type of control	Fuel fired	Pollutant	No. of tests	Emission factor rating	Average emission factor, kg/Mg (lb/ton)[a]	Ref. Nos.
None[b]	Waste oil	Isovaleraldehyde	1	D	$1.6x10^{-5}$ ($3.2x10^{-5}$)	25
Fabric filter[b]	Propane/ waste oil	Lead	2	D	$1.7x10^{-6}$ ($3.3x10^{-6}$)	25,35
Fabric filter[b]	Waste oil	Manganese	1	D	$5.5x10^{-6}$ ($1.1x10^{-5}$)	25
Fabric filter	Propane	Mercury	1	D	$3.7x10^{-9}$ ($7.3x10^{-9}$)	35
None[b]	Natural gas	Methane	2	D	0.010 (0.021)	39
None[b]	No. 2 fuel oil/ waste oil	Methane	2	D	0.0096 (0.020)	25,39
None	Propane	Methyl chloroform	1	E	$2.4x10^{-5}$ ($4.8x10^{-5}$)	35
None[b]	Waste oil	Methyl Ethyl Ketone	1	D	$1.0x10^{-5}$ ($2.0x10^{-5}$)	25
Fabric filter	Natural gas/ propane	Naphthalene	4	D	$2.4x10^{-5}$ ($4.8x10^{-5}$)	35,39
Fabric filter[b]	No. 2 fuel oil/ waste oil	Naphthalene	2	D	0.00016 (0.00031)	25,39
Fabric filter[b]	Waste oil	Nickel	1	D	$7.5x10^{-6}$ ($1.5x10^{-5}$)	25
None	Natural gas	NO_x	3	D	0.015 (0.030)	39
None[b]	No. 2 fuel oil/ waste oil	NO_x	2	D	0.038 (0.075)	25,39
Fabric filter	Natural gas	Perylene	1	E	$6.2x10^{-9}$ ($1.2x10^{-8}$)	39
Fabric filter[b]	Natural gas/ propane	Phenanthrene	4	D	$4.2x10^{-6}$ ($8.3x10^{-6}$)	35,39
Fabric filter[b]	No. 2 fuel oil	Phenanthrene	1	D	$2.8x10^{-5}$ ($5.5x10^{-5}$)	39
Fabric filter[b]	Waste oil	Phosphorus	1	D	$2.8x10^{-5}$ ($5.5x10^{-5}$)	25
None[b]	Waste oil	Propionaldehyde	1	D	$6.5x10^{-5}$ (0.00013)	25
Fabric filter	Natural gas/ propane	Pyrene	2	D	$2.3x10^{-7}$ ($4.5x10^{-7}$)	35,39
Fabric filter[b]	No. 2 fuel oil	Pyrene	1	E	$1.5x10^{-6}$ ($3.0x10^{-6}$)	39
None[b]	Waste oil	Quinone	1	D	$8.0x10^{-5}$ (0.00016)	25
Fabric filter[b]	Waste oil	Silver	1	D	$7.0x10^{-7}$ ($1.4x10^{-6}$)	25
None[b]	Natural gas	SO_2	3	D	0.0017 (0.0033)	39
None[b]	No. 2 fuel oil/ waste oil	SO_2	2	D	0.028 (0.056)	25,39
None[d]	Natural gas/ propane	TNMOC	4	NR	0.11 (0.21)	22
None	Nos. 2 and 4 fuel oil	TNMOC	2	NR	0.078 (0.16)	22
None[b]	Natural gas/ propane	Toluene	2	D	0.00010 (0.00020)	35,39
None[b]	Waste oil	Toluene	1	D	0.00037 (0.00075)	25

TABLE 4-5. (continued)

Type of control	Fuel fired	Pollutant	No. of tests	Emission factor rating	Average emission factor, kg/Mg (lb/ton)[a]	Ref. Nos.
None[b]	Natural gas	TOC	3	D	0.025 (0.051)	39
None[b]	No. 2 fuel oil/ waste oil	TOC	2	D	0.035 (0.069)	25,39
None[b]	Waste oil	Valeraldehyde	1	D	$3.4x10^{-5}$ ($6.7x10^{-5}$)	25
None[b]	Natural gas	Xylene	1	D	0.00020 (0.00040)	39
None[b]	Waste oil	Xylene	1	D	$8.2x10^{-5}$ (0.00016)	25
Fabric filter[b]	Propane/ waste oil	Zinc	2	D	$2.1x10^{-5}$ ($4.2x10^{-5}$)	25,35

NA = Not applicable; ND = no data available; NR = not rated.
[a]Emission factor in kg/Mg (lb/ton) of hot mix asphalt produced.
[b]Feed material includes RAP.
[c]Filterable PM emission factors were developed using data from plants fired by natural gas, No. 2 fuel oil, No. 5 fuel oil, waste oil, and unspecified fuels. Fuel type did not significantly effect the emission factors.
[d]Emission factor includes test runs while processing between 0 and 30 percent RAP. Processing of RAP did not have a significant effect on TNMOC emission measurements.

One A-rated test for condensible organic PM emissions from fabric filter-controlled oil-fired drum mix dryers was used to develop an emission factor of 0.0016 kg/Mg (0.0032 lb/ton). For consistency, the ratio of the condensible organic to total condensible PM measured during this test was multiplied by the average total condensible PM emission factor, to develop an emission factor of 0.0013 kg/Mg (0.0026 lb/ton). This emission factor is rated D.

Condensible inorganic PM. For fabric filter-controlled condensible inorganic PM emissions from drum-mix dryers, data from two emission tests were available: one A-rated test from a waste oil-fired dryer, and one B-rated test from a dryer fired with an unspecified fuel. Although the emission factors are somewhat similar, the data from the dryer fired with an unspecified fuel were not used to develop the average emission factor. For consistency, the ratio of the condensible inorganic to total condensible PM (measured during the test on the oil-fired dryer) was multiplied by the average total condensible PM emission factor, to develop an emission factor of 0.012 kg/Mg (0.023 lb/ton). The condensible inorganic PM emission factor is rated D.

Total condensible PM. Emission factors for total condensible PM emissions from fabric filter-controlled drum mix dryers fired with natural gas were developed from two B-rated tests. The results of these two tests were 0.0014 and 0.0023 kg/Mg (0.0028 and 0.0046 lb/ton), with an average emission factor of 0.0019 kg/Mg (0.0037 lb/ton). This emission factor is rated D.

Two B-rated tests for condensible PM emissions from fabric filter-controlled oil-fired drum mix dryers were used to develop an emission factor of 0.013 kg/Mg (0.025 lb/ton). This emission factor is rated D.

Total PM. The total PM emission factors shown in the Section 5 tables represent the sum of filterable and total condensible PM. These emission factors are rated the same as the lowest rated emission factor used in the summation.

Carbon monoxide. For uncontrolled CO emissions from drum-mix dryers, data from two emission tests were available: one B-rated test from a natural gas-fired dryer and one A-rated test from a waste oil fired dryer. Although the emission factors are similar, these data were not combined because of the different fuel types. The CO emission factors are rated D.

Carbon dioxide. Emission factors for uncontrolled CO_2 emissions from natural gas-fired drum mix dryers were developed from one A-rated and three B-rated tests. The results of these four tests ranged from 9.6 to 17 kg/Mg (19 to 34 lb/ton), with an average emission factor of 14 kg/Mg (27 lb/ton). This emission factors is rated D.

Emission factors for uncontrolled CO_2 emissions from six No. 2 fuel oil-fired drum mix dryers and one waste oil-fired drum mix dryer were developed from three A-rated and four B-rated tests. The results of these seven tests ranged from 11 to 32 kg/Mg (22 to 65 lb/ton), with an average emission factor of 19 kg/Mg (37 lb/ton). This emission factor is rated D.

Nitrogen oxides. Emission factors for uncontrolled NO_X emissions from natural gas-fired drum mix dryers were developed from three B-rated tests. The results of these three tests ranged from 0.0075 to 0.028 kg/Mg (0.015 to 0.057 lb/ton), with an average emission factor of 0.015 kg/Mg (0.030 lb/ton). This emission factor is rated D.

One A-rated and one B-rated test for uncontrolled NO_X emissions from oil-fired drum mix dryers were used to develop an emission factor of 0.038 kg/Mg (0.075 lb/ton). This emission factor is rated D.

Sulfur dioxide. Emission factors for uncontrolled SO_2 emissions from natural gas-fired drum mix dryers were developed from three B-rated tests. The results of these three tests ranged from 0.00062 to 0.0024 kg/Mg (0.0012 to 0.0047 lb/ton), with an average emission factor of 0.0017 kg/Mg (0.0033 lb/ton). This emission factor is rated D.

Single A- and B-rated tests for uncontrolled SO_2 emissions from oil-fired drum mix dryers were used to develop an emission factor of 0.028 kg/Mg (0.056 lb/ton). This emission factor is rated D.

Total nonmethane organic compounds. Emission factors for TNMOC emissions from uncontrolled natural gas-fired drum mix dryers were developed from three C-rated tests, and an emission factor for TNMOC emissions from uncontrolled propane-fired drum mix dryers was developed from one C-rated test. The results of these four tests ranged from 0.033 to 0.16 kg/Mg (0.066 to 0.33 lb/ton), with an average emission factor of 0.11 kg/Mg (0.21 lb/ton). This emission factor is not rated and is not included in the revised AP-42 section because higher quality data are available for TOC and methane emissions.

Emission factors were developed for uncontrolled TNMOC emissions from drum mix dryers fired with No. 2 fuel oil and No. 4 fuel oil. These emission factors were combined to develop an average emission factor of 0.078 kg/Mg (0.16 lb/ton). This emission factor is not rated and is not included in the revised AP-42 section because higher quality data are available for TOC and methane emissions.

Total organic compounds. Emission factors for uncontrolled TOC (as methane) emissions from natural gas-fired drum mix dryers were developed from three B-rated tests. The results of these three tests ranged from 0.011 to 0.044 kg/Mg (0.022 to 0.088 lb/ton), with an average emission factor of 0.025 kg/Mg (0.051 lb/ton). This emission factor is rated D.

One A-rated and one B-rated test for uncontrolled TOC emissions from oil-fired drum mix dryers were used to develop an emission factor of 0.035 kg/Mg (0.069 lb/ton). This emission factor is rated D.

Methane, benzene, ethylbenzene, toluene, and xylene. Emission factors for uncontrolled methane emissions from natural gas-fired drum mix dryers were developed from two B-rated tests. The results of these two tests were 0.0016 and 0.019 kg/Mg (0.0032 and 0.038 lb/ton), with an average emission factor of 0.010 kg/Mg (0.021 lb/ton). This emission factor is rated D.

Uncontrolled emission factors for methane, benzene, ethylbenzene, toluene, and xylene emissions from natural gas-, No. 2 fuel oil-, propane-, and waste oil-fired drum mix dryers were developed from A- and B-rated tests. The data from natural gas- and propane-fired dryers were combined, and the data from the oil-fired dryers were combined. These emission factors are rated D.

Polynuclear aromatic hydrocarbons. Most of the emission factors developed for PAH's are based on single emission tests. Single test emission factors were developed for 2-chloronaphthalene, 2-methylnaphthalene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(e)pyrene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluorene, indeno(1,2,3-cd)pyrene, perylene, phenanthrene, and pyrene emissions from fabric filter-controlled drum mix dryers fired by various fuels. Emission factors from dryers fired by natural gas and propane were combined, and emission factors for dryers fired by different types of oil were combined. The emission

factors developed from single tests are rated D or E, depending on the data rating (A- or B-rated data produced D-rated emission factors and C-rated data produced E-rated emission factors). Emission factors were developed from multiple tests for 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo(b)fluoranthene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene emissions from fabric filter-controlled natural gas- or propane-fired drum mix dryers. These emission factors are rated D.

Formaldehyde. Emission factors for uncontrolled formaldehyde emissions from natural gas- and propane-fired drum mix dryers were developed from three B-rated tests. The results of these three tests ranged from 0.00034 to 0.0043 kg/Mg (0.00067 to 0.0086 lb/ton), with an average emission factor of 0.0018 kg/Mg (0.0036 lb/ton). This emission factor is rated D.

Emission factors for uncontrolled formaldehyde emissions from drum mix dryers fired with unspecified fuel were developed from three C-rated tests. These data were not used to develop average emission factors because data specifying fuel type were available from other references.

Formaldehyde emission factors were also developed for several other control/fuel combinations, including uncontrolled emission factors for No. 2 fuel oil- and waste oil-fired drum mix dryers; venturi scrubber-controlled, natural gas-fired drum mix dryers; venturi or wet scrubber-controlled, oil-fired drum mix dryers. These emission factors are rated D or E, depending on the data rating (A- or B-rated data produced D-rated emission factors, and C-rated data produced E-rated emission factors).

Aldehydes and ketones. With the exception of formaldehyde, emission factors for all aldehydes and ketones were developed from single tests. Uncontrolled emission factors were developed for acetaldehyde, acetone, acrolein, benzaldehyde, butyraldehyde/isobutyraldehyde, crotonaldehyde, hexanal, isovaleraldehyde, methyl ethyl ketone, propionaldehyde, quinone, and valeraldehyde emissions from waste oil-fired drum mix dryers. These emission factors are rated D.

Trace metals. Emission factors were developed for fabric filter-controlled drum mix dryers fired by propane or waste oil. These data were combined because the emission factors were of similar magnitudes. Emission factors for arsenic, barium, cadmium, chromium, copper, lead, manganese, mercury, nickel, phosphorus, silver, and zinc were developed. These emission factors are rated D.

Methyl chloroform. An emission factor for uncontrolled methyl chloroform emissions from waste oil-fired dryers was developed from one C-rated test. This emission factor is rated E.

4.2.4.2 Hot Oil Heaters.[35] Emission factors for hot oil heaters, which are used to heat asphalt oil, were developed using the data presented in Table 4-4. The average emission factors for hot oil heaters are shown in Table 4-6.

TABLE 4-6. SUMMARY OF EMISSION FACTORS FOR HOT MIX ASPHALT PRODUCTION DRUM MIX FACILITY--HOT OIL HEATERS

Type of control	Fuel fired	Pollutant	No. of tests	Emission factor rating	Average emission factor, kg/l (lb/gal) fuel consumed	Ref. No.
None	No. 2 fuel oil	Naphthalene	1	D	2.0×10^{-6} (1.7×10^{-5})	35
None	No. 2 fuel oil	Acenaphthylene	1	D	2.4×10^{-8} (2.0×10^{-7})	35
None	No. 2 fuel oil	Acenaphthene	1	D	6.4×10^{-8} (5.3×10^{-7})	35
None	No. 2 fuel oil	Fluorene	1	D	2.8×10^{-7} (2.3×10^{-6})	35
None	No. 2 fuel oil	Phenanthrene	1	D	5.9×10^{-7} (4.9×10^{-6})	35
None	No. 2 fuel oil	Anthracene	1	D	2.2×10^{-8} (1.8×10^{-7})	35
None	No. 2 fuel oil	Fluoranthene	1	D	5.3×10^{-9} (4.4×10^{-8})	35
None	No. 2 fuel oil	Pyrene	1	D	3.8×10^{-9} (3.2×10^{-8})	35
None	No. 2 fuel oil	Benzo(b)fluoranthene	1	D	1.2×10^{-8} (1.0×10^{-7})	35
None	No. 2 fuel oil	TCDF's (total)	1	D	4.0×10^{-13} (3.3×10^{-12})	35
None	No. 2 fuel oil	PCDF's (total)	1	E	5.8×10^{-14} (4.8×10^{-13})	35
None	No. 2 fuel oil	HxCDF's (total)	1	D	2.4×10^{-13} (2.0×10^{-12})	35
None	No. 2 fuel oil	HpCDF's (total)	1	D	1.2×10^{-12} (9.7×10^{-12})	35
None	No. 2 fuel oil	1,2,3,4,6,7,8-HpCDF	1	E	4.2×10^{-13} (3.5×10^{-12})	35
None	No. 2 fuel oil	OCDF	1	B	1.4×10^{-12} (1.2×10^{-11})	35
None	No. 2 fuel oil	HxCDD's (total)	1	D	7.4×10^{-13} (6.2×10^{-12})	35
None	No. 2 fuel oil	1,2,3,7,8,9-HxCDD	1	E	9.1×10^{-14} (7.6×10^{-13})	35
None	No. 2 fuel oil	1,2,3,4,7,8-HxCDD	1	E	8.3×10^{-14} (6.9×10^{-13})	35
None	No. 2 fuel oil	HpCDD's (total)	1	E	2.4×10^{-12} (2.0×10^{-11})	35
None	No. 2 fuel oil	1,2,3,4,6,7,8-HpCDD	1	D	1.8×10^{-12} (1.5×10^{-11})	35
None	No. 2 fuel oil	OCDD	1	D	1.9×10^{-11} (1.6×10^{-10})	35
None	No. 2 fuel oil	Formaldehyde	1	D	0.0032 (0.027)	35

Uncontrolled emission factors were developed for PAH's, formaldehyde, and several polychlorinated dibenzofurans and dibenzo(p)dioxins, including 1,2,3,7,8,9-hexachlorodi-benzo(p)dioxin (HxCDD), 1,2,3,4,7,8-HxCDD, total HxCDD's, 1,2,3,4,6,7,8-heptachloro-dibenzo(p)dioxin (HpCDD), total HpCDD's, total octachlorodibenzo(p)dioxins (OCDD's), total trichlorodibenzofurans (TCDF's), total pentachlorodibenzofurans (PeCDF's), total hexachlorodibenzofurans (HxCDF's), total heptachlorodibenzofurans (HpCDF's), 1,2,3,4,6,7,8-HpCDF, and total octachlorodibenzofurans (OCDF's). All of the emission factors were developed from single tests and are rated E because C-rated data were used.

4.2.4.2 Batch Mix Dryers.[1,5,15,24,34,39-41] Emission factors for batch mix dryers were developed using the data presented in Table 4-3. The average emission factors for drum mix dryers are shown in Table 4-7.

Filterable PM. Emission factors for uncontrolled filterable PM emissions from batch mix dryers were developed from two D-rated tests. The results of these two tests were 14 and 18 kg/Mg (27 and 37 lb/ton), with an average emission factor of 16 kg/Mg (32 lb/ton) for uncontrolled filterable PM emissions. This emission factor is rated E.

Emission factors for filterable PM emissions from fabric filter-controlled batch mix dryers were developed from one A-rated, six B-rated, and four C-rated tests. Only the A- and B-rated data were used to determine the average emission factor. The results of these seven tests ranged from 0.0014 to 0.093 kg/Mg (0.0028 to 0.19 lb/ton), with an average emission factor of 0.020 kg/Mg (0.040 lb/ton). This emission factor is rated D.

Emission factors for filterable PM emissions from venturi scrubber-controlled batch mix dryers were developed from a single C-rated test. This emission factor is rated E.

Emission factors for filterable PM emissions from low-energy wet scrubber-controlled batch mix dryers were developed from three B-rated and three C-rated tests. Only the B-rated data were used to determine the average emission factor. The results of these three tests ranged from 0.020 to 0.061 kg/Mg (0.041 to 0.12 lb/ton), with an average emission factor of 0.039 kg/Mg (0.077 lb/ton). This emission factor is rated D.

Filterable PM-10. The particle-size data from the 1986 revision of AP-42 Section 11.1 (these particle-size data are contained in Reference 23) were used in combination with the filterable PM emission factors described in the preceding paragraphs to develop filterable PM-10 emission factors. For uncontrolled batch-mix dryers, 14 percent of the filterable PM emissions are PM-10, yielding an uncontrolled filterable PM-10 emission factor of 2.2 kg/Mg (4.5 lb/ton). This emission factor is rated E. For fabric filter-controlled batch mix dryers, 40 percent of the filterable PM emissions are PM-10, yielding an emission factor of 0.0080 kg/Mg (0.016 lb/ton). This emission factor is rated D. The uncontrolled emission factor compares favorably with test data from Reference 5 (two tests), which indicate a PM-10 emission factor of 3.4 kg/Mg (6.8 lb/ton). The controlled emission factor appears reasonable when compared to the controlled filterable PM-10 emission factor for drum mix dryers.

TABLE 4-7. SUMMARY OF EMISSION FACTORS FOR HOT MIX ASPHALT PRODUCTION BATCH MIX FACILITY--DRYERS

Type of control	Fuel fired	Pollutant	No. of tests	Emission factor rating	Average emission factor, kg/Mg (lb/ton)[a]	Ref. Nos.
Fabric filter	Natural gas	2-Methylnaphthalene	2	D	$3.8x10^{-5}$ ($7.7x10^{-5}$)	24,39
Fabric filter	No. 6 fuel oil	2-Methylnaphthalene	1	D	$3.0x10^{-5}$ ($6.0x10^{-5}$)	39
Fabric filter	Natural gas	Acenaphthene	2	D	$6.2x10^{-7}$ ($1.2x10^{-6}$)	34,39
Fabric filter	Natural gas	Acenaphthylene	2	D	$4.3x10^{-7}$ ($8.6x10^{-7}$)	34,39
None	Natural gas	Acetaldehyde	1	D	0.00032 (0.00064)	24
None	Natural gas	Acetone	1	D	0.0032 (0.0064)	24
Fabric filter	Natural gas	Anthracene	2	D	$1.5x10^{-7}$ ($3.1x10^{-7}$)	34,39
Fabric filter	ND	Arsenic	2	E	$3.3x10^{-7}$ ($6.6x10^{-7}$)	34,40
Fabric filter	Natural gas	Barium	1	D	$7.3x10^{-7}$ ($1.5x10^{-6}$)	24
None	Natural gas	Benzaldehyde	1	D	$6.4x10^{-5}$ (0.00013)	24
None	Natural gas	Benzene	2	D	0.00017 (0.00035)	24,39
Fabric filter	Natural gas	Benzo(a)anthracene	1	D	$2.3x10^{-9}$ ($4.5x10^{-9}$)	39
Fabric filter	Natural gas	Benzo(b)fluoranthene	1	D	$2.3x10^{-9}$ ($4.5x10^{-9}$)	39
Fabric filter	ND	Benzo(k)fluoranthene	1	E	$1.2x10^{-8}$ ($2.4x10^{-8}$)	34
Fabric filter	ND	Beryllium	1	E	$1.1x10^{-7}$ ($2.2x10^{-7}$)	34
None	Natural gas	Butyraldehyde/ Isobutyraldehyde	1	D	$1.5x10^{-5}$ ($3.0x10^{-5}$)	24
Fabric filter	Natural gas	Cadmium	2	D	$4.2x10^{-7}$ ($8.4x10^{-7}$)	24,34
Fabric filter	Natural gas	Chromium	1	D	$4.5x10^{-7}$ ($8.9x10^{-7}$)	24
Fabric filter	Natural gas	Chrysene	1	D	$3.1x10^{-9}$ ($6.1x10^{-9}$)	39
None	Natural gas	CO	4	D	0.17 (0.34)	24,34,39
None	No. 6 fuel oil	CO	1	D	0.035 (0.069)	39
None	Natural gas	CO_2	5	D	17 (35)	15,24, 39
None	Nos. 2 and 6 fuel oil	CO_2	2	D	19 (39)	15,39
Fabric filter	Natural gas	Condensible PM	2	D	0.0018 (0.0035)	24,39
Fabric filter	Natural gas	Condensible inorganic PM	2	D	0.0014 (0.0027)	24,39
Low-energy scrubber	Natural gas	Condensible inorganic PM	1	D	0.0017 (0.0033)	15
Fabric filter	Natural gas	Condensible organic PM	2	D	0.00039 (0.00078)	24,39
Fabric filter	No. 6 fuel oil	Condensible PM	1	D	0.022 (0.045)	39
Venturi scrubber	No. 2 fuel oil	Condensible inorganic PM	1	E	0.0083 (0.017)	15
Fabric filter	Natural gas	Copper	2	D	$1.8x10^{-6}$ ($3.7x10^{-6}$)	24,34
None	Natural gas	Crotonaldehyde	1	D	$1.5x10^{-5}$ ($2.9x10^{-5}$)	24
None	Natural gas	Ethylbenzene	2	D	0.0016 (0.0033)	24,39
Fabric filter	NA	Filterable PM	7	D	0.020 (0.040)	15,24,40, 41

TABLE 4-7. (continued)

Type of control	Fuel fired	Pollutant	No. of tests	Emission factor rating	Average emission factor, kg/Mg (lb/ton)[a]	Ref. Nos.
Low-energy scrubber	NA	Filterable PM	3	D	0.039 (0.077)	15
Venturi scrubber	NA	Filterable PM	1	E	0.026 (0.052)	15
None	NA	Filterable PM	2	E	16 (32)	5
None	NA	Filterable PM-10	NA	E	2.2 (4.5)	5,23
Fabric filter	NA	Filterable PM-10	NA	D	0.0080 (0.016)	15,23,24, 40,41
Fabric filter	Natural gas	Fluoranthene	3	D	$1.6x10^{-7}$ ($3.1x10^{-7}$)	34,39
Fabric filter	No. 6 fuel oil	Fluoranthene	1	D	$1.2x10^{-5}$ ($2.4x10^{-5}$)	39
Fabric filter	Natural gas	Fluorene	3	D	$9.8x10^{-7}$ ($2.0x10^{-6}$)	34,39
None	Natural gas	Formaldehyde	3	D	0.00043 (0.00086)	24,39
None	No. 6 fuel oil	Formaldehyde	1	D	0.00040 (0.00081)	39
None	Natural gas	Hexanal	1	D	$1.2x10^{-5}$ ($2.4x10^{-5}$)	24
Fabric filter	Natural gas	Hexavalent Chromium	1	E	$4.9x10^{-9}$ ($9.7x10^{-9}$)	34
Fabric filter	Natural gas	Lead	2	D	$3.7x10^{-7}$ ($7.4x10^{-7}$)	24,34
Fabric filter	Natural gas	Manganese	2	D	$5.0x10^{-6}$ ($9.9x10^{-6}$)	24,34
Fabric filter	Natural gas	Mercury	1	D	$2.3x10^{-7}$ ($4.5x10^{-7}$)	34
None	Natural gas	Methane	2	D	0.0060 (0.012)	24,39
None	No. 6 fuel oil	Methane	1	D	0.0022 (0.0043)	39
Fabric filter	Natural gas	Naphthalene	3	D	$2.1x10^{-5}$ ($4.2x10^{-5}$)	34,39
Fabric filter	No. 6 fuel oil	Naphthalene	1	D	$2.2x10^{-5}$ ($4.5x10^{-5}$)	39
Fabric filter	Natural gas	Nickel	2	D	$2.1x10^{-6}$ ($4.2x10^{-6}$)	24,34
None	Natural gas	NO_X	4	D	0.013 (0.025)	24,34,39
None	No. 6 fuel oil	NO_X	1	D	0.084 (0.17)	39
Fabric filter	Natural gas	Phenanthrene	3	D	$1.6x10^{-6}$ ($3.3x10^{-6}$)	34,39
Fabric filter	No. 6 fuel oil	Phenanthrene	1	E	$1.8x10^{-5}$ ($3.7x10^{-5}$)	39
Fabric filter	Natural gas	Pyrene	2	D	$3.1x10^{-8}$ ($6.2x10^{-8}$)	34,39
Fabric filter	No. 6 fuel oil	Pyrene	1	D	$2.7x10^{-5}$ ($5.5x10^{-5}$)	39
None	Natural gas	Quinone	1	D	0.00014 (0.00027)	24
Fabric filter	Natural gas	Selenium	1	E	$4.6x10^{-8}$ ($9.2x10^{-8}$)	34
None	Natural gas	SO_2	2	D	0.0025 (0.0050)	39
None	No. 6 fuel oil	SO_2	1	D	0.12 (0.24)	39
None	Natural gas	Toluene	2	D	0.00088 (0.0018)	24,39
None	Natural gas	TOC	3	D	0.0084 (0.017)	24,39
None	No. 6 fuel oil	TOC	1	D	0.023 (0.046)	39
None	Natural gas	Xylene	2	D	0.0021 (0.0043)	24,39
Fabric filter	Natural gas	Zinc	2	D	$3.4x10^{-6}$ ($6.8x10^{-6}$)	24,34

TABLE 4-7. (continued)

ND = No data available NA = Not applicable
[a]Emission factors in kg/Mg (lb/ton) of hot mix asphalt produced.

Condensible organic PM. One B-rated test for fabric filter-controlled condensible organic PM emissions from a natural gas-fired batch mix dryer was used to develop an emission factor of 0.00061 kg/Mg (0.0012 lb/ton). For consistency, the ratio of the condensible organic to total condensible PM measured during this test was multiplied by the average total condensible PM emission factor, to develop an emission factor of 0.00039 kg/Mg (0.00078 lb/ton). This emission factor is rated D.

Condensible inorganic PM. One B-rated test was used to develop an emission factor for condensible inorganic PM emissions from a fabric filter-controlled natural gas-fired batch mix dryer of 0.0021 kg/Mg (0.0042 lb/ton). For consistency, the ratio of the condensible inorganic to total condensible PM measured during this test was multiplied by the average total condensible PM emission factor, to develop an emission factor of 0.0014 kg/Mg (0.0027 lb/ton). This emission factor is rated D.

Emission factors for low-energy wet scrubber-controlled, natural gas-fired batch-mix dryers were developed from one B-rated and two C-rated tests. Only the B-rated test was used to determine the average emission factor of 0.0017 kg/Mg (0.0033 lb/ton). This emission factor is rated D.

One C-rated test was used to develop an emission factor for condensible inorganic PM emissions from venturi scrubber-controlled No. 2 fuel oil-fired batch mix dryers. This emission factor is rated E.

Total condensible PM. Two B-rated tests were used to develop an emission factor of 0.0018 kg/Mg (0.0035 lb/ton) for total condensible PM emissions from fabric filter-controlled natural gas-fired batch mix dryers. This emission factor is rated D.

One B-rated test was used to develop an emission factor for total condensible PM emissions from fabric filter-controlled No. 6 fuel oil-fired batch mix dryers. This emission factor is rated D.

Total PM. The total PM emission factors shown in the Section 5 tables represent the sum of filterable and total condensible PM. These emission factors are rated the same as the lowest rated emission factor used in the summation.

Carbon monoxide. Emission factors for uncontrolled CO emissions from natural gas-fired batch mix dryers were developed from four B-rated tests. The results of these four tests ranged from 0.019 to 0.50 kg/Mg (0.038 to 1.0 lb/ton), with an average emission factor of 0.17 kg/Mg (0.34 lb/ton). This emission factor is rated D.

An emission factor for uncontrolled CO emissions from No. 6 fuel oil-fired batch mix dryers was developed from one B-rated test. This emission factor is rated D.

Carbon dioxide. Emission factors for uncontrolled CO_2 emissions from natural gas-fired batch mix dryers were developed from one A-rated, four B-rated, and one C-rated tests. Only the A- and B-rated data were used to determine the average emission factor. The results of these five tests ranged from 11 to 28 kg/Mg (22 to 55 lb/ton), with an average emission factor of 17 kg/Mg (35 lb/ton). This emission factors is rated D.

Two B-rated tests for uncontrolled CO_2 emissions from oil-fired batch mix dryers were used to develop an emission factor of 19 kg/Mg (39 lb/ton). This emission factor is rated D.

One B-rated test for uncontrolled CO_2 emissions from a batch mix dryer fired by an unspecified fuel was used to develop an emission factor of 15 kg/Mg (31 lb/ton). Data from one C-rated test were available but were not used to develop this emission factor. This emission factor is not included in the revised AP-42 section because data that specify fuel type were available.

Nitrogen oxides. Emission factors for uncontrolled NO_X emissions from natural gas-fired batch mix dryers were developed from one A-rated and three B-rated tests. The results of these four tests ranged from 0.0072 to 0.020 kg/Mg (0.014 to 0.040 lb/ton), with an average emission factor of 0.013 kg/Mg (0.025 lb/ton). This emission factor is rated D.

One B-rated test for uncontrolled NO_X emissions from a No. 6 fuel oil-fired batch mix dryer was used to develop an emission factor of 0.084 kg/Mg (0.17 lb/ton). This emission factor is rated D.

Sulfur dioxide. Emission factors for uncontrolled SO_2 emissions from natural gas-fired batch mix dryers were developed from two B-rated tests. The results of these two tests were 0.0017 and 0.0032 kg/Mg (0.0034 and 0.0065 lb/ton), with an average emission factor of 0.0025 kg/Mg (0.0050 lb/ton). This emission factor is rated D.

One B-rated test for uncontrolled SO_2 emissions from a No. 6 fuel oil-fired batch mix dryer was used to develop an emission factor of 0.12 kg/Mg (0.24 lb/ton). This emission factor is rated D.

Total organic compounds. Emission factors for uncontrolled TOC (as methane) emissions from natural gas-fired batch mix dryers were developed from one A-rated and two B-rated tests. The results of these three tests ranged from 0.0042 to 0.011 kg/Mg (0.0084 to 0.023 lb/ton), with an average emission factor of 0.0084 kg/Mg (0.017 lb/ton). This emission factor is rated D.

One B-rated test for uncontrolled TOC (as methane) emissions from a No. 6 fuel oil-fired batch mix dryer was used to develop an emission factor of 0.023 kg/Mg (0.046 lb/ton). This emission factor is rated D.

Methane, benzene, ethylbenzene, toluene, and xylene. Emission factors for uncontrolled methane emissions from natural gas-fired batch mix dryers were developed from two B-rated and one C-rated tests. Only the B-rated tests were used to develop the average emission factor for this source. The results of these two tests were 0.0021 and 0.0099 kg/Mg (0.0042 and 0.020 lb/ton), with an average emission factor of 0.0060 kg/Mg (0.012 lb/ton). This emission factor is rated D.

One B-rated test for uncontrolled methane emissions from a No. 6 fuel oil-fired batch mix dryer was used to develop an emission factor of 0.0022 kg/Mg (0.0043 lb/ton). This emission factor is rated D.

Emission factors for uncontrolled benzene emissions from natural gas-fired batch mix dryers were developed from two B-rated tests. The results of these two tests were 0.00025 and 9.6×10^{-5} kg/Mg (0.00050 and 0.00019 lb/ton), with an average emission factor of 0.00017 kg/Mg (0.00035 lb/ton). This emission factor is rated D.

One C-rated test for uncontrolled benzene emissions from a batch mix dryer fired by an unspecified fuel was used to develop an emission factor of 3.5×10^{-5} kg/Mg (7.0×10^{-5} lb/ton). This emission factor is not rated and is not included in the AP-42 section.

Emission factors for uncontrolled ethylbenzene emissions from natural gas-fired batch mix dryers were developed from two B-rated tests. The results of these two tests were 0.0028 and 0.00043 kg/Mg (0.0057 and 0.00085 lb/ton), with an average emission factor of 0.0016 kg/Mg (0.0033 lb/ton). This emission factor is rated D.

Emission factors for uncontrolled toluene emissions from natural gas-fired batch mix dryers were developed from two B-rated tests. The results of these two tests were 0.00077 and 0.00099 kg/Mg (0.0015 and 0.0020 lb/ton), with an average emission factor of 0.00088 kg/Mg (0.0018 lb/ton). This emission factor is rated D.

One C-rated test for uncontrolled toluene emissions from a batch mix dryer fired by an unspecified fuel was used to develop an emission factor of 3.7×10^{-5} kg/Mg (7.3×10^{-5} lb/ton). This emission factor is not rated and is not included in the AP-42 section.

Emission factors for uncontrolled xylene emissions from natural gas-fired batch mix dryers were developed from two B-rated tests. The results of these two tests were 0.00079 and 0.0035 kg/Mg (0.0016 and 0.0069 lb/ton), with an average emission factor of 0.0021 kg/Mg (0.0043 lb/ton). This emission factor is rated D.

Polynuclear aromatic hydrocarbons. Most of the emission factors developed for PAH's are based on single emission tests. Single test emission factors were developed for 2-methylnaphthalene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, naphthalene, phenanthrene, and pyrene emissions from fabric filter-controlled batch mix dryers fired by various fuels. Emission factors from No. 2 fuel oil-, No. 6 fuel oil-, and waste oil-fired dryers were combined, and emission factors from natural gas-fired dryers and dryers fired with unspecified fuel (Reference 34) were combined because the emission factors were similar. The emission factors developed from single tests are rated D or E, depending on the data rating (A- or B-rated data produced D-rated emission factors and C-rated data produced E-rated emission factors). Emission factors were developed from multiple tests for 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene emissions from fabric filter-controlled natural gas-fired batch mix dryers. These emission factors are rated D.

Formaldehyde. Emission factors for uncontrolled formaldehyde emissions from natural gas-fired batch mix dryers were developed from one A-rated and two B-rated tests. The results of these three tests ranged from 6.2×10^{-5} to 0.0010 kg/Mg (0.00012 to 0.0021 lb/ton), with an average emission factor of 0.00043 kg/Mg (0.00086 lb/ton). This emission factor is rated D.

Emission factors for uncontrolled formaldehyde emissions from No. 2 fuel oil-fired batch mix dryers were developed from three C-rated tests. The results of these three tests ranged from 0.00010 to 0.0078 kg/Mg (0.00019 to 0.016 lb/ton), with an average emission factor of 0.0028 kg/Mg (0.0056 lb/ton). This emission factor is rated E.

Emission factors for uncontrolled formaldehyde emissions from oil-fired batch mix dryers were developed from one B-rated and seven C-rated tests. The results of these three tests ranged from 3.8×10^{-5} to 0.0044 kg/Mg (7.6×10^{-5} to 0.0087 lb/ton), with an average emission factor of 0.0016 kg/Mg (0.0032 lb/ton). This emission factor is rated E.

Aldehydes and ketones. With the exception of formaldehyde, emission factors for all aldehydes and ketones were developed from single tests. Uncontrolled emission factors were developed from single A- or B-rated tests for acetaldehyde, acetone, benzaldehyde, butyraldehyde/isobutyraldehyde, crotonaldehyde, hexanal, and quinone emissions from natural gas-fired batch mix dryers. These emission factors are rated D. One C-rated test for uncontrolled acetaldehyde emissions from a batch mix dryer fired by an unspecified fuel was used to develop an emission factor of 6.0×10^{-7} kg/Mg (1.2×10^{-6} lb/ton). This emission factor is not rated and is not included in the AP-42 section.

Trace metals. Trace metal emission factors based on one or two tests were developed for fabric filter-controlled batch mix dryers. Single test emission factors were developed for barium, beryllium, chromium, hexavalent chromium, mercury, and selenium. Emission factors based on two tests were developed for arsenic, cadmium, copper, lead, manganese, nickel, and zinc. These emission factors are rated D or E, depending on the data rating (A- or B-rated data produced D-rated emission factors, and C-rated data produced E-rated emission factors).

4.2.4.3 Conventional: Continuous Mix Facilities. Emission factors were not developed for continuous mix asphalt plants.

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