D

R

A

F

T

July 2001

D R A F T

Emission Factor Documentation for AP-42
Section 12.2

Coke Production

Revised Draft Report

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

July 2001

EPA Purchase Order 7D-1554-NALX

MRI Project No. 4864

November 1998

Revised by U. S. EPA

July 2001

D

R

A

F

T

July 2001

Emission Factor Documentation for AP-42
Section 12.2

Coke Production

Revised Draft Report

For U. S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Emission Factor and Inventory Group
Research Triangle Park, NC 27711

Attn: Mr. Ron Myers (MD-14)

July 2001

EPA Purchase Order7D-1554-NALX

MRI Project No. 4864

November 1998

Revised by U. S. EPA

July 2001

NOTICE

This document is a preliminary draft. It has not been formally released by the U. S. Environmental Protection Agency and should not at this stage be construed to represent Agency policy. It is being circulated for comments on its technical merit and policy implications.

D

R

A

F

T

July 2001

PREFACE

Portions of this report was prepared by Research Triangle Institute under subcontract to 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, Work Assignment No. I-01 and Purchase Order 7D-1554-NALX. Mr. Ron Myers was the requester of the work. In addition, following submission of the report to EPA by MRI, additional revisions and additions to the report were made.

D

R

A

F

T

July 2001

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF FIGURES

LIST OF TABLES

EMISSION FACTOR DOCUMENTATION FOR AP-42 Section 12.2
Coke Production
1. INTRODUCTION

The document "Compilation of Air Pollutant Emission 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 the EPA to respond to new emission factor needs of the EPA, state and local air pollution control programs, and industry.

An emission factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. Emission factors usually are expressed as weight of pollutant divided by the unit weight, volume distance, or duration of the activity that emits the pollutant. The emission factors presented in AP-42 may be appropriate to use in a number of situations, such as making source-specific emission estimates for areawide inventories for dispersion modeling, developing control strategies, screening sources for compliance purposes, establishing operating permit fees, and making permit applicability determinations. The purpose of this report is to provide background information from test reports and other information to support revisions to AP-42 Section 12.2, Coke Production.

Including the introduction (Section 1), this report contains five sections. Section 2 provides statistics regarding the production of coke as a Byproduct of the iron and steel industry, as well as descriptions of the different production processes, emissions from these processes, and the techniques used to control these emissions.

Section 3 is a review of emissions data collection and analysis procedures. It describes the screening of emission data 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 developments. It includes the review of specific data sets and a description of how candidate emission factors were developed.

Section 5 presents the proposed AP-42 Section 12.2–Coke Production.

2. INDUSTRY DESCRIPTION

Metallurgical coke is produced by the destructive distillation of coal in coke ovens. Prepared coal is heated in an oxygen-free atmosphere (–coked–) until most volatile components in the coal are removed. The material remaining is a carbon mass called coke.

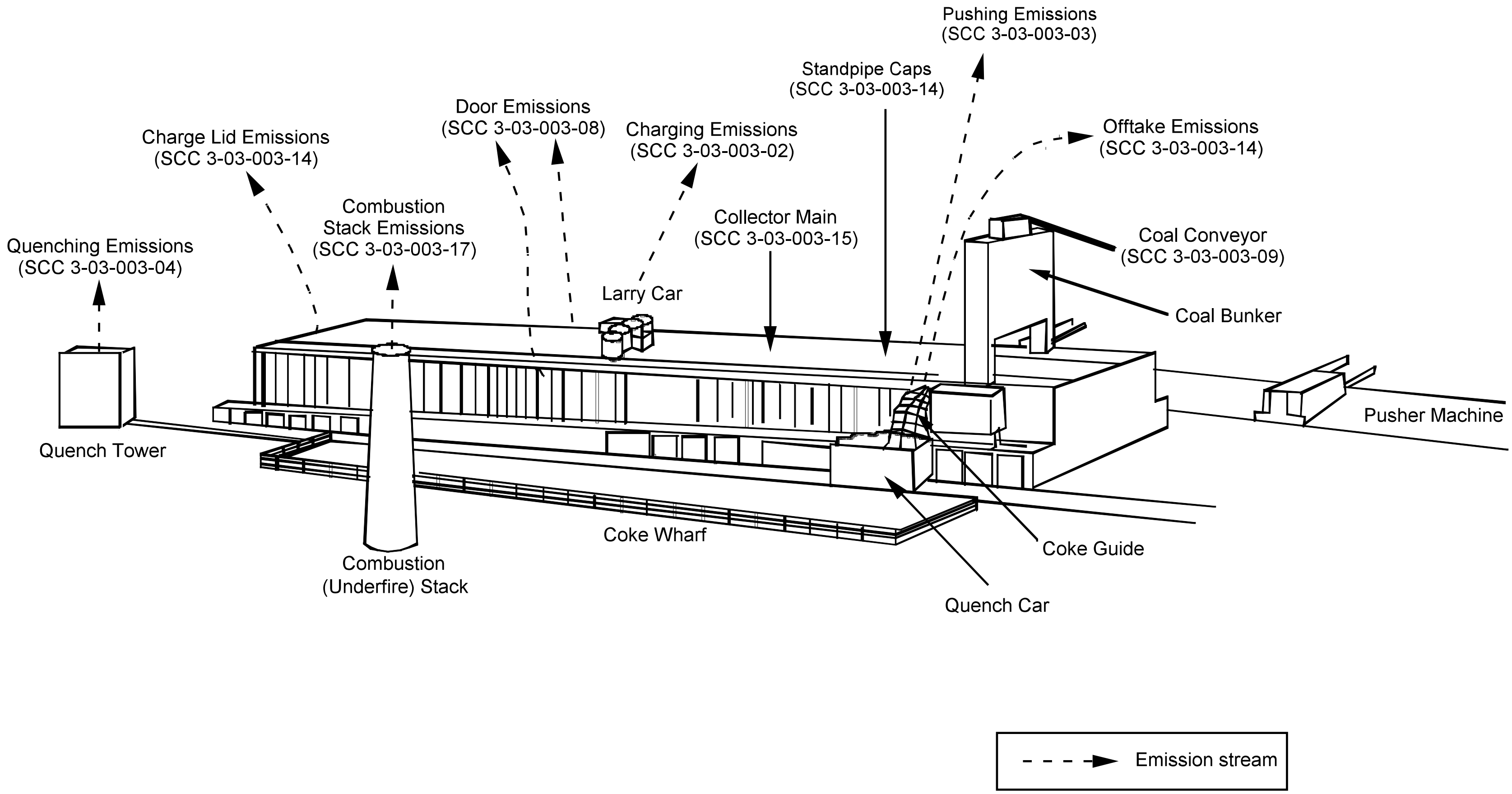
Metallurgical coke is used in iron and steel industry processes (primarily in blast furnaces) to reduce iron ore to iron. Over 90 percent of the total coke production is dedicated to blast furnace operations. Foundry coke comprises most of the balance and is used by foundries in furnaces for melting metal and in the preparation of molds. Foundry coke production uses a different blend of coking coals, longer coking times, and lower coking temperatures relative to those used for metallurgical coke.

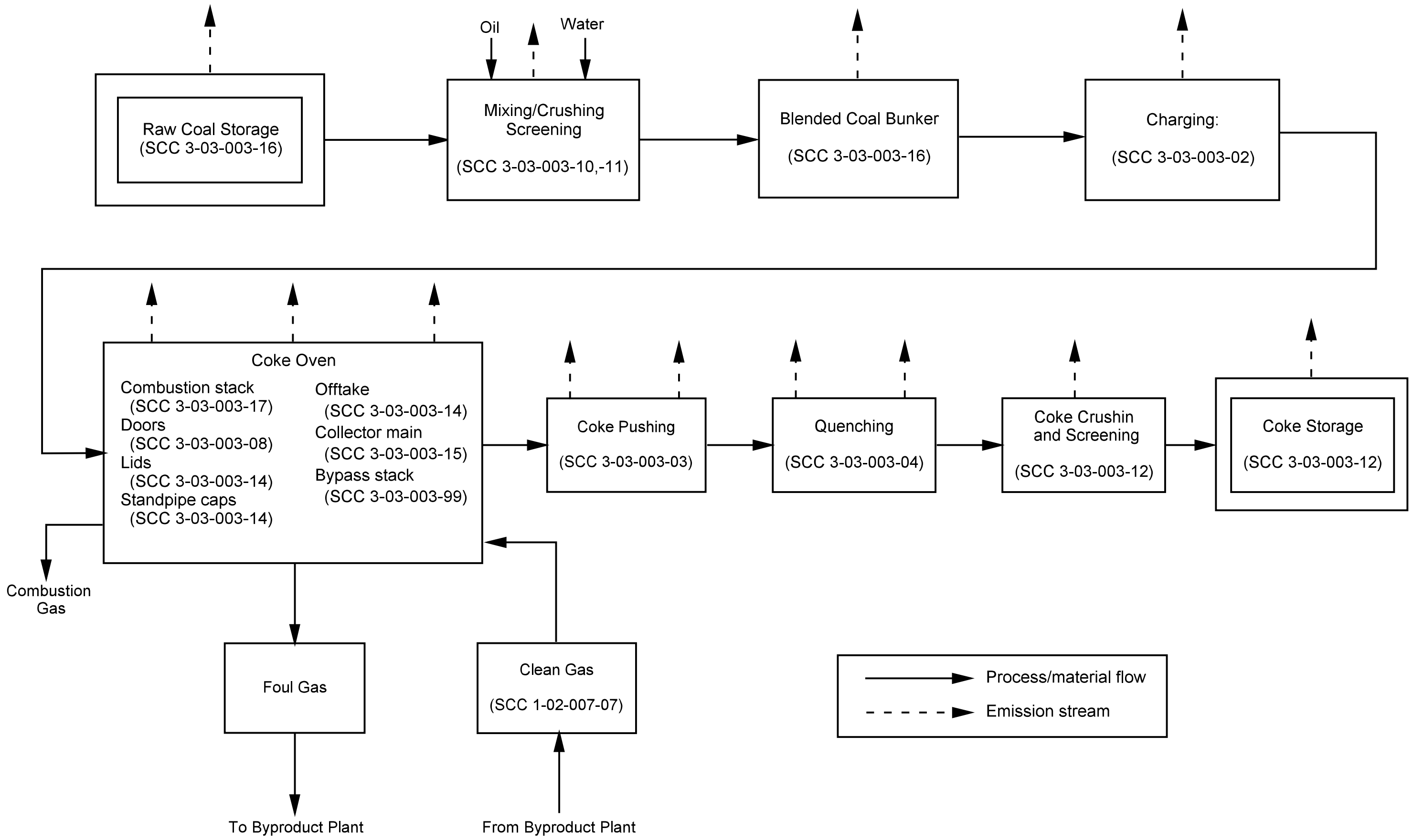
Most coke plants are co-located with iron and steel production facilities, and the demand for coke generally corresponds with the production of iron and steel. There has been a steady decline in the number of coke plants over the past several years for many reasons, including a decline in the demand for iron/steel, increased production of steel by mini-mills (electric arc furnaces that do not use coke), and the lowering of the coke:iron ratio used in the blast furnace (e.g., increased use of pulverized coal injection). There were 28 coke plants operating in the US in 1992.

2.1 PROCESS DESCRIPTION

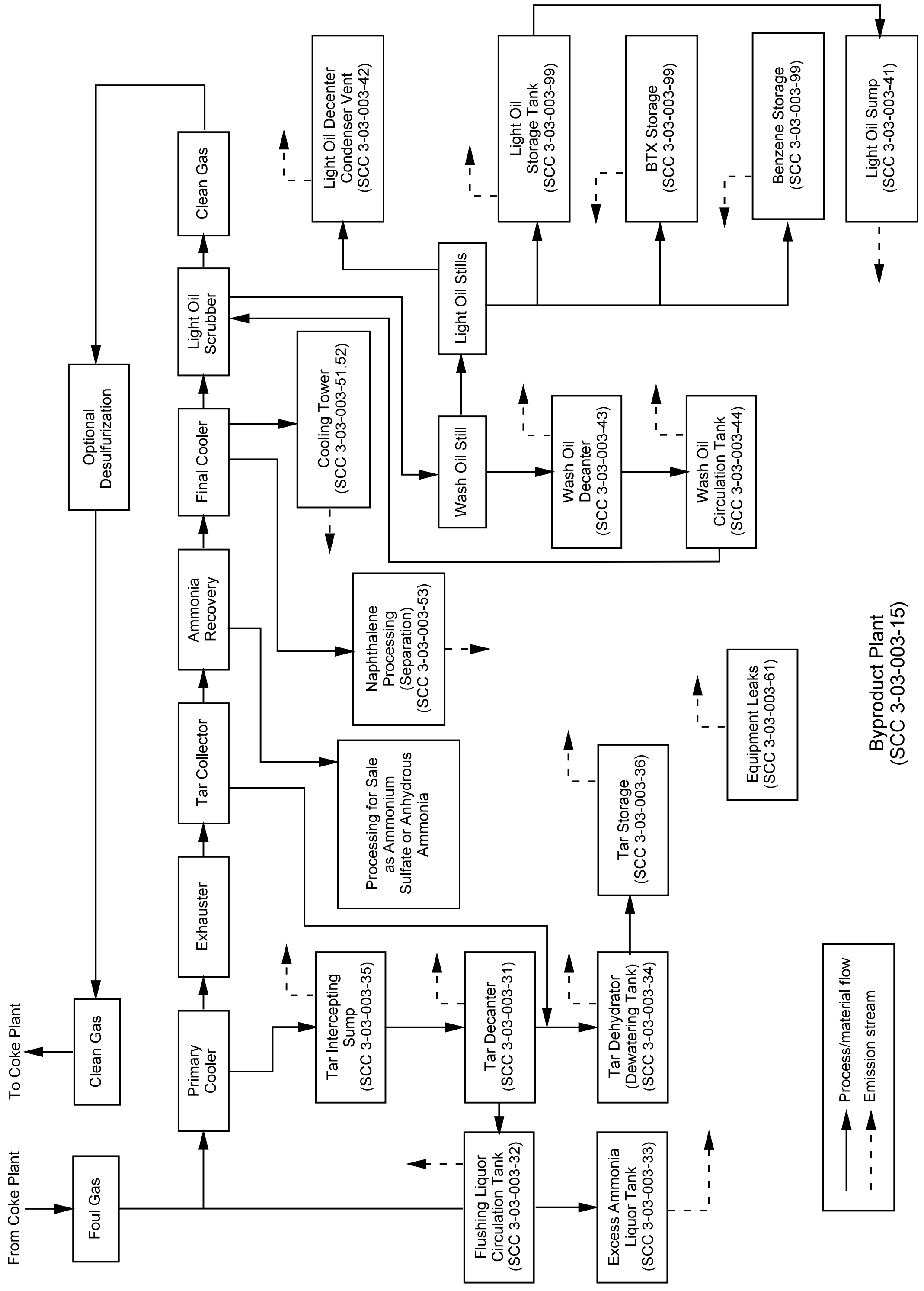
Most coke is produced in the US using the "byproduct" process, and one plant uses a "nonrecovery" process. The following discussion addresses the more common byproduct process first and then describes the nonrecovery process along with the major differences between the two that affect emissions.

Figure 2-1 illustrates the major process equipment in a schematic diagram of a byproduct coke oven battery. Flow diagrams are provided in Figures 2-2 and 2-3 to give an overview of the process from coal preparation to byproduct recovery. These operations will be discussed in greater detail for the three major subprocesses: coal preparation and charging, thermal distillation and pushing, and byproduct recovery.


Pushing Emissions
(SCC 3-03-003-03)
Standpipe Caps
(SCC 3-03-003-14)
Offtake Emissions
(SCC 3-03-003-14)
Door Emissions
(SCC 3-03-003-08)
Charging Emissions
(SCC 3-03-003-02)
Charge Lid Emissions
(SCC 3-03-003-14)
Combustion
Stack Emissions
(SCC 3-03-003-17)
Collector Main
(SCC 3-03-003-15)
Coal Conveyor
(SCC 3-03-003-09)
Quenching Emissions
(SCC 3-03-003-04)
Larry Car
Coal Bunker
Pusher Machine
Quench Tower
Coke Wharf
Coke Guide
Combustion
(Underfire) Stack
Quench Car
Emission stream



Coke Plant (SCC 3-03-003-31)


From Coke Plant
Foul Gas
To Coke Plant
Clean Gas
Optional Desulfurization
Clean Gas
Primary Cooler
Exhauster
Tar Collector
Ammonia Recovery
Final Cooler
Light Oil Scrubber
Tar Intercepting Sump (SCC 3-03-003-35)
Flushing Liquor Circulation Tank (SCC 3-03-003-32)
Tar Decanter (SCC 3-03-003-31)
Excess Ammonia Liquor Tank (SCC 3-03-003-33)
Tar Dehydrator (Dewatering Tank) (SCC 3-03-003-34)
Tar Storage (SCC 3-03-003-36)
Processing for Sale as Ammonium Sulfate or Anhydrous Ammonia
Naphthalene Processing (Separation) (SCC 3-03-003-53)
Cooling Tower (SCC 3-03-003-51,52)
Light Oil Decenter Condenser Vent (SCC 3-03-003-42)
Wash Oil Still
Wash Oil Decanter (SCC 3-03-003-43)
Wash Oil Circulation Tank (SCC 3-03-003-44)
Light Oil Stills
Light Oil Storage Tank (SCC 3-03-003-99)
BTX Storage (SCC 3-03-003-99)
Benzene Storage (SCC 3-03-003-99)
Light Oil Sump (SCC 3-03-003-41)
Equipment Leaks (SCC 3-03-003-61)
Byproduct Plant (SCC 3-03-003-15)
Process/material flow
Emission stream

2.1.1 Coal Preparation and Charging for Byproduct Coke Ovens

The coal that is charged to the ovens is usually a blend of two or more low, medium, or high volatile coals that are generally low in sulfur and ash. Blending is required to control the properties of the resulting coke, to optimize the quality and quantity of byproducts, and to avoid the expansion exhibited by types of coal that may cause excessive pressure on the oven walls during the coking process.

Coal is usually received on railroad cars or barges. Conveyor belts transfer the coal as needed to mixing bins where the various types of coal are stored. The coal is transferred from the mixing bins to the coal crusher where it is pulverized to a preselected size between 0.15 and 3.2 mm (0.006 and 0.13 in). The desired size depends on the response of the coal to coking reactions and the ultimate coke strength that is required.

The pulverized coal is then mixed and blended, and sometimes water and oil are added to control the bulk density of the mixture. The prepared coal mixture is transported to the coal storage bunkers on the coke oven Battery (see Figure 2-1). A weighed amount or specific volume of coal is discharged from the bunker into a larry car, which is the charging vehicle driven by electric motors that can travel the length of the Battery on a wide gauge rail. The larry car is positioned over the empty, hot oven (called "spotting"), the lids on the charging ports are removed, and the coal is discharged from the hoppers of the larry car into the oven. To minimize the escape of gases from the oven during charging, steam aspiration is used at most plants to draw gases from the space above the charged coal into the collecting main.

The discharge of coal from the hoppers is "staged" by controlling the sequence in which each hopper is emptied to avoid peaks of coal that may block the space above the coal, which hinders the removal of gases generated during charging. Near the end of the charging sequence, peaks of coal in the oven are leveled by a steel bar that is cantilevered from the pusher machine through a small door on the side of the oven, called the leveler or "chuck" door. This leveling process aids in uniform coking and provides a clear vapor space and exit tunnel for the gases that evolve during coking to flow to the gas collection system. After the oven is charged with coal, the chuck door is closed, the lids are replaced on the charging ports and sealed ("luted") with a wet clay mixture, the aspiration is turned off, and the gases are directed into the offtake system and collecting main.

2.1.2 Thermal Distillation

The thermal distillation takes place in groups of ovens called batteries. A Battery consists of 20 to 100 adjacent ovens with common side walls that are made of high quality silica and other types of refractory brick. Typically, the individual slot ovens are 11 to 16.8 m (36 to 55 ft) long, 0.35 to 0.5 m (1.1 to 1.6 ft) wide, and 3.0 to 6.7 m (9.8 to 22 ft) high. The wall separating adjacent ovens, as well as each end wall, is made up of a series of heating flues. At any one time, half of the flues in a given wall will be burning gas while the other half will be conveying waste heat from the combustion flues to a "checker brick" heat exchanger and then to the combustion stack. Every 20 to 30 minutes the Battery "reverses," and the former waste heat flues become combustion flues while the former combustion flues become the waste heat flues. This process avoids melting the Battery brick work (the flame temperature is above the melting point of the brick) and provides more uniform heating of the coal mass.

The operation of each oven is cyclic, but the Battery contains a sufficiently large number of ovens to produce an essentially continuous flow of raw coke oven gas. The individual ovens are charged and emptied at approximately equal time intervals during the coking cycle. Coking proceeds for 15 to 18 hours to produce blast furnace coke and 25 to 30 hours to produce foundry coke. The coking time is determined by the coal mixture, moisture content, rate of underfiring, and the desired properties of the coke. When demand for coke is low, coking times can be extended to 24 hours for blast furnace coke and to 48 hours for foundry coke. Coking temperatures generally range from 900 to 1,100°C (1,650 to 2,000°F) and are kept on the higher side of the range to produce blast furnace coke. Air is prevented from leaking into the ovens by maintaining a positive back pressure in the collecting main of about 10 mm (0.4 in) of water. The gases and hydrocarbons that evolve during the thermal distillation are removed through the offtake system and sent to the byproduct plant for recovery.

At the end of the coking cycle, doors on both ends of the oven are removed and the incandescent coke is pushed from the oven by a ram that is extended from the pusher machine. The coke is pushed through a coke guide into a special railroad car called a quench car. The quench car carries the coke to a quench tower where it is deluged with water to prevent the coke from burning after exposure to air.

2.1.3 Coke Handling and Storage

The quenched coke is discharged onto an inclined coke wharf to allow the excess water to drain and to cool the coke to a reasonable handling temperature. Gates along the lower edge of the wharf control the rate of coke falling onto a conveyor belt, which carries the coke to a crushing and screening system. The coke is then crushed and screened to the proper size for the blast furnace operation. The sized coke is transported to a storage area where it is kept until ready for use or shipment.

2.1.4 Byproduct Collection

For ovens not operating to current U.S. practices, gases evolved during coking leave the oven through the standpipes, pass into goosenecks, and travel through a damper valve into the gas collection main. Large exhausters are used to move the coke oven gases, which account for 20 to 35 percent by weight of the initial coal charge and are composed of water vapor, tar, light oils (primarily benzene, toluene, xylene), heavy hydrocarbons, and other chemical compounds. The raw coke oven gas exits the ovens at temperatures of 760° to 870°C (1400° to 1600 °F) and is shock-cooled by spraying recycled "flushing liquor" in the gooseneck. The spray cools the gas to 80° to 100°C (176° to 212°F), precipitates tar, condenses various vapors, and serves as the carrying medium for the condensed compounds. These products are separated from the liquor in a decanter and are subsequently processed to yield tar and tar derivatives.

The gas is then passed either to a final tar extractor or an electrostatic precipitator for additional tar removal. When the gas leaves the tar extractor, it carries three-fourths of the ammonia and 95 percent of the light oil originally present in the raw coke oven gas. The ammonia is recovered either as an aqueous solution by water absorption or as ammonium sulfate salt. Ammonium sulfate is crystallized in a saturator that contains a solution of 5 to 10 percent sulfuric acid, then the crystallized salt is removed, dried, and packaged for sale.

The gas leaving the saturator at about 60°C (140°F) is taken to final coolers or condensers, where it is typically cooled to about 24°C (75°F)and where condensed materials are removed (e.g., water, benzene, naphthalene). The gas then passes into a light oil (benzol) scrubber, which uses a heavy petroleum fraction called wash oil (or straw oil) as the scrubbing medium to absorb light oil. The wash oil absorbs about 2 to 3 percent of its weight in light oil and removes about 95 percent of the light oil from the gas. The rich wash oil is stripped in a steam stripper (still), which sends the light oil and water vapors overhead to a light-oil still and condenser for recovery. The lean (stripped) wash oil leaves the bottom of the stripping column and associated decanter and is recycled to the light oil scrubber. The light oil may be sold as crude or processed to recover benzene, toluene, xylene, and solvent naphtha.

After tar, ammonia, and light oil removal, the gas undergoes a final desulfurization at some plants to remove hydrogen sulfide. The cleaned coke oven gas has a heating value of approximately 20 MJ/Nm^3

(550 Btu/scf) but may be as low as 17MJ/Nm^3 (480 Btu/scf). Typically, 35 to 40 percent of the gas is returned to the Battery as fuel for the combustion system and the remainder is used for other heating needs or is sold.

Over the last two decades, typical U.S. practice has changed so that direct gas coolers are no longer used. Tar-bottom coolers, wash-oil coolers, or other indirect cooling takes the place of direct coolers. Open naphthalene processing is no longer practiced; the naphthalene remains in the tar and is sold with it. Instead of refining light oil in the byproduct plant, the oil is sold to independent refiners who may separate it into benzene, toluene, and xylene fractions for sale.

2.1.5 Nonrecovery Coke Production

In 1994 there was one nonrecovery plant operating in the US (in Vansant, Virginia). As the name implies, this process does not recover the numerous chemical byproducts as discussed in the previous section. All of the coke oven gas is burned, and instead of recovery of chemicals, this process offers the potential for heat recovery and cogeneration of electricity. The plant that is currently operating does not have waste heat recovery; however, any new construction of this process at integrated iron and steel plants is expected to take advantage of the economic incentives of recovering the waste heat.

Nonrecovery ovens are of a horizontal design (as opposed to the vertical slot oven used in the byproduct process) with a typical range of 30 to 60 ovens per battery. The oven is generally between 14.0 and 15.5 m (45 and 50 ft) long and 3.4 to 3.7 m (11 to 12 ft) wide. The internal oven chamber is usually semicylindrical in shape with the apex of the arch 1.5 to 3.7 m (5 to 12 ft) above the oven floor. Each oven is equipped with two doors, but there are no lids or offtakes as found on byproduct ovens. The oven is charged through the oven doorway with a coal conveyor rather than from the top through charging ports. Unlike byproduct ovens, expanding coals pose no problem to non-recovery technology nor do they limit potential coal usage.

After an oven is charged, carbonization begins as a result of the hot oven brick work from the previous charge. Combustion products and volatiles that evolve from the coal mass are burned in the chamber above the coal, in the gas pathway through the walls, and beneath the oven in sole flues. Each oven chamber has two to six downcomers in each oven wall, and the sole flue may be subdivided into separate flues that are supplied by the downcomers. The sole flue is designed to heat the bottom of the coal charge by conduction while radiant and convective heat flow is produced above the coal charge.

Primary combustion air is introduced into the oven chamber above the coal through one of several dampered ports in the door. The dampers are adjusted to maintain the proper temperature in the oven crown. Outside air may also be introduced into the sole flues; however, additional air usually is required in the sole flue only for the first hour or two after charging. All gas flow is a result of the natural draft (there are no exhausters), and the oven is maintained under a negative pressure. Consequently, the ovens do not leak as do the byproduct ovens maintained under a positive pressure. The combustion gases are removed from the ovens and directed to the stack through a waste heat tunnel that is located atop the battery centerline and extends the length of the battery.

Pushing and quenching operations are similar to those at byproduct coke oven batteries. One slight difference in pushing is that the height of fall of the hot coke is less for the nonrecovery oven because of its horizontal rather than vertical design. With respect to emissions, the major differences from conventional byproduct ovens are the operation under negative pressure that eliminates door, lid, and offtake leaks during coking and the absence of the byproduct recovery plant and its associated emission sources.

2.2 EMISSIONS AND CONTROLS

Emissions from coke ovens include conventional pollutants [(particulate matter (PM), sulfur dioxide (SO_2), nitrogen oxide (NO_x), etc.)] and numerous organic compounds, including polycyclic organic matter (POM), volatile organic compounds (VOCs), and others. As portrayed in Figures 2-2 and 2-3, emissions originate from many operations at the coke plant and byproduct plant. At the coke plant, PM is emitted from raw coal unloading, storage, and handling; mixing, crushing, and screening; blending; charging; leaks from doors, lids, and offtakes during coking; soaking; pushing coke from the oven; hot coke quenching; combustion stacks; and coke crushing, sizing, screening, handling, and storage. Volatile organic compounds are emitted from coke oven leaks, coke pushing, and coke quenching. Sulfur dioxide, nitrogen oxides, and carbon monoxide are also emitted from coke oven leaks. Organic compounds soluble in benzene (BSO) are the major constituents of the PM emissions and are also included as VOCs. Among the hazardous air pollutants (HAPs) included in the VOCs are benzene, toluene, xylenes, cyanide compounds, naphthalene, phenol, and polycyclic organic matter (POM), all of which are contained in coke oven gas. Emissions from the byproduct plant are primarily benzene and other light aromatics, POM, cyanides, phenols, and light oils. These compounds are emitted from each of the emission points shown in Figure 2-3. Although not a criteria pollutant or HAP, ammonia is also emitted from the excess ammonia liquor tank. Substantial emissions are also obtained from ancillary operations such as boilers, wastewater treatment, cooling towers, and roads. Emission factors for these operations are available in other parts of AP-42.

Controls for coke plants consist of operation and maintenance practices to reduce oven emissions, and application of control devices to specific operations in the coke-making and byproduct recovery processes. Operation and maintenance practices include steam aspiration and staged charging to reduce charging leaks, and sealing of doors, lids, and offtakes at joints that may leak. A control for pushing and coke-side door leaks is a shed constructed along the coke side of the battery. The shed is ducted to a PM control device, typically a baghouse. An alternate control for pushing is the use of a hooded quench car containing a scrubber that controls PM emissions during pushing and transport to the quench area. Quenching emissions are controlled by installing baffles in the quench tower to impede PM flow, and use of clean water (recycled water that does not include process water) for quenching. Combustion stack PM emissions are controlled by devices such as electrostatic precipitators (ESPs) or baghouses. Gaseous emissions from the bleeder stack may be controlled with a flare. Coal and coke handling PM emissions may use cyclones or traveling hoods ducted to a baghouse for control. For byproduct plants, primary controls are covering and (coke oven) gas blanketing those operations that can be covered, and using covers or process vents vented to an activated carbon canister.

3. GENERAL DATA REVIEW AND ANALYSIS

3.1 LITERATURE SEARCH AND SCREENING

Data for this investigation were obtained from sources within the Office of Air Quality Planning and Standards (OAQPS) and from outside organizations. Background and test report files located in the Emission Factor and Inventory Group and in the Metals Group were reviewed for information on the industry, processes, and emissions. Emissions data and analyses were supplied by industry (through trade associations and individual companies) and by private contractors. A review was also made of information accessible on EPA's Technology Transfer Network (TTN).

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 unless the original reference is not available.

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

2. The referenced study should contain test results based on more than one test run. If results from only one run are presented, the emission factors must be down rated.

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

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 (e.g., comparison of the EPA Method 5 front-half with the 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.

Data sets that were not excluded were assigned a quality rating. The rating system used was that specified by OAQPS for the preparation of AP-42 sections. The data were rated as follows:

A–Multiple tests 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 the EPA Reference Methods, although these methods were certainly 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. Many variations can occur unnoticed and without warning during testing. Such variations can induce wide deviations in sampling results. If a large spread between test results cannot be explained by information contained in the test report, the data are suspect and were 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 the 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 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 industry. As in the A-rating, 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. As in the A-rating, 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 on the individual reviewer.

REFERENCE FOR SECTION 3

1. *Procedures for Preparing Emission Factor Documents*, EPA-454/R-95-015. U. S. Environmental Protection Agency, Research Triangle Park, NC, 27711, May 1997.

4. POLLUTANT EMISSION FACTOR DEVELOPMENT

This section describes how the revised AP-42 section on coke manufacturing was developed. First, descriptions of data sets for this revision are presented, followed by discussions of how candidate emission factors were developed from the data. Finally, tables presenting proposed emission factors are given. Where reliable plant-specific data are available, they should be used in lieu of the emission factors.

4.1 EMISSIONS FROM THE BY PRODUCT COKING PROCESS

Emissions from the coking process occur when coal is charged into the ovens and from door area leaks, lid leaks, and offtake leaks during the coking cycle after the oven is charged. Emissions may also occur from infrequent emergency venting through a bypass or bleeder stack and from leaks in the collecting main. These emission points are subject to the coke oven NESHAP promulgated October 27, 1993 (40 CFR Part 63, Subpart L). Door area leaks include leaks from buckstays or from the brickwork on the vertical face of the oven (i.e., these leaks are counted as door area leaks). Leaks may also occur from brickwork or flue caps on the topside of the battery. These types of leaks are uncommon on well-maintained batteries and are not covered by the NESHAP.

Emissions from leaks and charging are fugitive in nature and are difficult to capture and measure. The rate of emissions depends on numerous factors, such as gap size, oven pressure, time into the coking cycle, etc. Consequently, these leaks change in size, location, and duration throughout the coking cycle. The measurement of these emissions is further complicated by the condensation of tars in the coke oven gas on the surface of collection and sampling equipment. As a result, estimates of fugitive coke oven emissions have an inherent uncertainty because of the limited data available and the problems associated with attempts to capture and measure the emissions.

Most of the limited data available are for emissions of particulate matter (PM) and benzene soluble organics (BSO), which has traditionally been used as an indicator of the polycyclic organic matter (POM) found in coke oven emissions. BSO provides a measure of the organic PM in the emissions and is determined from emission samples by extracting the filterable and condensible particulate catch with benzene, evaporating the benzene, and determining the amount of solids that was extracted. BSO contains the tarry compounds that are recovered for the most part in the byproduct recovery plant as tar. BSO is a component of filterable and condensible PM. Since it is primarily organic compounds, it is also included as VOC.

The approach used in this report to develop emission factors relies primarily on measurements of PM and BSO emissions and typical ratios of other pollutants of interest to BSO or PM. An effort is made to provide emission estimates for poorly-controlled batteries, for batteries controlled to meet State regulations prior to the NESHAP ("pre-NESHAP"), and for batteries that are well-controlled ("post-NESHAP") and achieving the emission limits of the coke oven NESHAP (Subpart L). A "typical" Battery is used to develop estimates in units of "lb/ton of coal", and a site-specific approach is also presented as a way to improve the estimates.

Emission estimates are also provided for combustion stacks, pushing, and quenching. The data for those sources generally include measurements of PM and other criteria pollutants. Emission factors are generally unavailable for pushing and quenching when "green coke" (coal that is incompletely coked) is pushed or when coke oven emissions leak through damaged walls and escape through the combustion stack.

Global warming gases. Methane, carbon dioxide, and nitrous oxide have been found to contribute to overall global warming. All of these compounds are present in coke oven gas, but limited quantitative data suitable for the development of emission factors are available.

Stratospheric ozone-depleting gases. Chlorofluorocarbons, hydrochlorofluorocarbons, carbon tetrachloride, methyl chloroform, and halons have been found to contribute to stratospheric ozone depletion. No evidence that any of these compounds exist in coke oven gas is available.

4.1.1 EMISSIONS FROM TOPSIDE AND DOORS

4.1.1.1 Review of Available Door and Topside Leak Data

Emission rates from door leaks were measured during the 1970s from batteries with coke side sheds. A few batteries have been equipped with a shed that covers the side of the Battery where the coke exits the oven during pushing ("coke side") with the primary purpose of capturing emissions from pushing. Because the shed also covers all of the doors on the coke side of the battery, leaks from doors are also captured by the shed and routed to a control device (typically a baghouse). Consequently, emission measurements made on the shed (prior to the control device) during periods when coke is not being pushed represent the emissions from leaking doors under the shed. These data represent relatively uncontrolled door leaks (up to 78 percent of the doors were observed to be leaking) that are applicable to some batteries in the 1960s and 1970s prior to improved control as a result of State, local, and Federal regulations. The high rate of percent leaking doors is associated with very heavy door leaks and large gap sizes; consequently, batteries that are currently well-controlled with much smaller door leaks (smaller gap sizes) are expected to have average leak rates lower than the range from the coke side shed tests. Consequently, emission factors derived from the coke side shed tests are not representative of current door leak emissions.

4.1.1.1.1 <u>Reference 1</u>. This report provides the details of a coke side shed test sponsored by EPA's Division of Stationary Source Enforcement at Great Lakes Carbon in St. Louis, Missouri in April 1975. Isokinetic sampling (Method 5) was performed for PM emissions (front half and back half) during periods that coke was being pushed and during periods that coke was not being pushed. The purpose of particulate sampling was to measure pushing emissions and to measure the emissions from leaking doors under the shed. During pushing cycles, four runs were performed over testing periods that ranged from 3.0 to 9.5 hours. During non-pushing cycles, three runs were performed over testing periods that ranged from 5 to 8.5 hours. Filterable and total PM emissions were reported for all tests. Since the testing procedure, sampling conditions, and production rate were well documented, the pushing cycle filterable particulate results are assigned an A rating. However, since the door leak emissions were not measured directly and were calculated by the difference between two measurements, the emissions data for door leaks are assigned a D rating. The observed level of door leak emission control (30 to 70% visibly leaking) does not reflect the significant improvements made over the past 10 to 20 years. Although the test data does not reflect current performance, the test does provide an order-of-magnitude estimate for uncontrolled door leak emissions.

4.1.1.1.2. <u>Reference 2</u>. This test report describes a test sponsored by EPA's Division of Stationary Source Enforcement performed on the coke side shed at Bethlehem Steel's coke plant in Chesterton, Indiana in March 1975. During this test, sampling was performed using Method 5 to assess continuous emissions (filterable and total PM) and emissions during pushing only. The emissions from door leaks were estimated from the difference between continuous emissions and pushing emissions. Observations of door leaks under the shed showed that 27 to 69 percent of the doors were leaking. Since the sampling methodology and the production rate information were well documented, the pushing cycle filterable particulate results are assigned an A rating. However, since the door leak emissions were not measured directly and were calculated by the difference between two measurements, the emissions data for door leaks are assigned a D rating. Although the test data does not reflect current performance, the test does provide an order-of-magnitude estimate for uncontrolled door leak emissions.

4.1.1.1.3 Reference 3. This test report provides the details of a coke side shed test sponsored by EPA's Emissions Measurement Branch at Wisconsin Steel in May 1977. Testing was performed during nonpush periods to measure emissions from door leaks. Isokinetic sampling by EPA Method 5 was performed to determine emissions of filterable PM, total PM, and BSO. The number of leaking doors was also determined and ranged from 60 to 78 percent leaking. The sampling procedures were well documented; however the test is assigned a D rating because the number of door leaks is not representative of current door leak control.

4.1.1.1.4 Reference 4. This document reports the results of coke side shed tests at an unidentified plant from data supplied by the American Iron and Steel Institute. Three tests were performed using Method WP50 during periods that coke was not pushed. The details of the test are not known; consequently, the results are assigned a D rating.

Reference 4 also derives filterable PM emission factors from several test reports that were generally unavailable for this review. The reported results included one test for coal crushing controlled by a cyclone, three tests for uncontrolled coal preheaters, five references for preheaters controlled by scrubbers, four tests for preheaters controlled by wet ESP's, two tests of charging controlled by scrubbers on larry cars, and one test (3 runs) for coke handling controlled by a cyclone.

4.1.1.1.5 Reference 5. This test report documents a coke side shed test conducted by EPA's Emissions Measurement Branch at Armco Steel, Houston, Texas in October 1979. A modified Method 5 sampling procedure was used to measure BSO, and an integrated bag sample was withdrawn for analysis of benzene by Method 110. In addition, door leaks were measured and ranged from 16 to 39 percent leaking. Sampling and analytical procedures were well documented. However, the test results are assigned a D rating because they are not representative of the typical emission control associated with door leaks.

4.1.1.1.6 Reference 6. This report describes a theoretical (unvalidated) model that was developed to evaluate potential emission reductions as the percent of doors leaking was reduced. The analysis evaluated typical gap sizes in metal seals, the effect of oven pressure, sealing time, and other factors. Major components of the analysis included a profile of oven pressure through the coking cycle, the effect of pressure drop and gap size on emissions, and the relationship that the percent leaking doors is equal to the average door sealing time divided by the coking cycle (times 100 to convert to percent). The primary value of this model is the prediction that reducing the percent leaking doors (PLD) to about

10 percent results in an exponential reduction in emissions. The average door leak rate is predicted to be proportional to PLD$^{1.5}$, and total emissions from the Battery are proportional to PLD$^{2.5}$.

The model predictions should he used with care because they are not applicable to reductions below 5 to 10 PLD (i.e., exponential reductions are not predicted below this level). The model is based on a relatively constant and low oven pressure, which is not applicable for the first 5 to 10 minutes after charging (oven pressures are highest at this time). The model applies only to self sealing by tar condensation. It does not apply to techniques commonly used today to obtain low levels of door leaks, such as the application of sodium silicate as a supplemental sealant.

4.1.1.1.7 <u>References 7 and 39</u>. These reports describe a research study funded by the American Iron and Steel Institute (AISI) and the American Coke and Coal Chemicals Institute (ACCCI) in 1991. The purpose of the study was to develop a method to capture and measure door leak emissions and to collect additional data to characterize the leak rates. The test design for these studies was coordinated with the US EPA Emissions Measurement Branch and the report states that an EPA observer was on site during the testing. A shroud and emission capture system were constructed and placed over a leaking door to capture the leak and to route it to a sampling device. Door leaks were characterized into broad categories of leak size that ranged from "0" (no leak) to "4" (extraordinarily heavy leak), with most leaks typically falling between 1 and 3. The categorization was performed visually by an observer stationed outside the tracks for the push car. The categorization was performed before and after the emission testing and sampling times of 15 minutes was used to minimize any changes in the visible emissions from the oven. The EPA Method 5G was used for sample collection, and the PM catch was extracted with benzene to determine BSO content. The procedure used either a heated or an unheated probe followed by a pair of filters and a glass impinger with silica gel for removal of moisture. Sampling was also performed using a modified PS-1 sampler as an alternative method that would collect a larger sample volume. However, there were serious blank problems with the polyurethane foam trap used in the PS-1 sampler, and the study concluded that the Method 5G sampling train performed better. For both the heated and unheated probes, approximately 40 percent of the BSO condensed in the probe (all of the BSO was in the probe for 5 of 21 sample runs). This suggests that BSO could also have collected on the shroud or other parts of the collection system before the sampling point, which would bias the results low. Background samples for both tests were collected near the inlet to the shroud. Because run times of four to six hours were required for the NIOSH 5023 sampling cited in Reference 7, background sampling was changed for the second test. As reported in Reference 39, the second test used a modified high volume air sampler. It used the same type of filter and operated simultaneously as the Method 5G trains. However, it operated at a sampling rate of about 300 liters per minute.

The report in Reference 7 also made an uncharacteristically high blank correction that EPA judged not to be an acceptable practice. The blank correction for the test is estimated at between 3.5 and 4.7 mg per sample portion. This blank correction resulted in weight losses for all of the back filters and five of the front filters. These weight losses were carried though the calculations. With the high blank corrections, negative emission rates were reported, which makes the reported test results for small leaks meaningless. This test as presented was assigned a D rating because of these anomalies. However, when the emission rates are recalculated using zero for weight gains, the quality of the test report is improved. Since all of the calculations cannot be recreated, the test is assigned a B rating.

In a continuation of the study, additional testing was performed (Reference 39) to address questions raised in the first test, such as capture efficiency, possible background interference, quantification of blank levels, and lower detection limits. The second test documented in Reference 39 focused on small leaks assigned to the categories of 0.5, 1, and 2 (i.e., no leaks in the category of 3 and 4 were sampled). In addition, three samples were collected during the period between pushing and charging when the ovens were empty. Significant improvements were made as evidenced by lower blank levels, proper calculation of sample portions with weight gains and improved quantification of small leaks. This test was assigned an A rating. However, it is recognized that there is the potential for underestimating emissions due to the deposition of material on the shroud or other parts of the collection system before the sampling point. Additionally, the material deposited during runs of high emissions may be revolatalized during runs with lower emissions thereby creating a high bias during these tests.

4.1.1.1.8 Reference 8. This test report describes an attempt to measure an artificially-created leak on the Battery top. A vent pipe was placed in the charging lid, a leak was created, and the plume was captured and measured. Sampling was performed using a modified Source Assessment Sampling System to obtain a high sampling rate. In this test, two sizes of leaks were investigated: one with a narrow plume of 1 to 2 meters (3 to 6 feet) and a wisp with a plume length on the order of 30 cm (1 ft). There were also problems with this test from the plugging of the vent by tar and from other condensation problems early in the coking cycle. Testing was delayed until after the first hour of coking when oven pressures had decreased and the plugging problem became less severe; consequently, the results are probably not representative of the leaks from doors, lids, and offtakes that occur immediately after charging when the oven pressures are highest. The results of this test showed an average BSO emission rate of 0.021 kg/hour (range of 0.012 to 0.035 kg/hr) for the 1- to 2-meter plume and 0.0033 kg/hour (range of 0.0017 to 0.0053 kg/hr) for the small wisp. In addition to collecting and analyzing seven samples for BSO emissions, two samples were collected and analyzed for individual PAH compounds. For the larger plume, the sum of the PAH compounds was comparable to the BSO emissions. For the smaller plume, the sum of the PAH compounds was 40% of the BSO emissions since only 14 of the 27 PAH compounds were measured. This testing used an untested or new methodology and no testing was performed during the first hour of coking; consequently, this test was assigned a D rating.

4.1.1.1.9 Reference 9. This report is the background information document used to support the NESHAP for coke oven emissions. In this document, the emission test results from two coke side shed tests in which both BSO and percent leaking doors were measured (References 3 and 5) were combined with the theoretical model discussed in Reference 6. The model and test results were used to estimate a range of door leak rates for well-controlled doors. This approach is theoretical and unvalidated; consequently, these estimates of leak rates are assigned a D rating.

4.1.1.1.10 Reference 10. This memorandum provides additional data submitted by USX Clairton to EPA Region III on the composition of raw coke oven gas. These data were generated to provide estimates of emissions of various compounds when the raw coke oven gas is bypassed directly through a bleeder stack and not sent to the byproduct plant for recovery of tar and other byproducts. The composition of this gas should be similar to or the same as the raw coke oven gas that leaks from doors, lids, and offtakes. No information was available on how these measurements and analyses were made; consequently, the results are assigned a D rating.

4.1.1.1.11 Reference 11. This document is a report from Bethlehem Steel that contains an analysis of raw coke oven gas. Three different runs were performed by collecting coke oven gas samples directly from the oven during the first hour of coking. The report contained extensive documentation of the sampling and analytical methods used, calibration data, field data sheets, and laboratory data. Hydrocarbons (one to four carbon atoms) were collected in glass sampling bombs (EPA Method 18) and analyzed by gas chromatograph/flame ionization detector (GC/FID); benzene, toluene, xylene, naphthalene, and hydrocarbons (over 5 carbon atoms) were sampled by EPA Method 18 (Tenax and XAD-2 tubes) and analyzed by gas chromatograph/mass spectrometer (GC/MS); SO_2 was sampled and analyzed by EPA Method 6; and other sulfur species were sampled in glass bombs and analyzed by gas chromatograph/flame photometric detector (GC/FPD).

Results were presented in terms of concentration and lb/hr of emissions for 1,000 standard cubic feet per minute (scfm) of coke oven gas exhaust. The coking production rate was not given; consequently, the results could not be directly used to calculate an emission factor. However, using the value of 12,000 scf of coke oven gas from one ton of coal in Reference 10, the results can be converted to crude estimates of emissions in terms of coal usage.

Some difficulties with this test include testing only during the first hour of coking (because the raw coke oven gas composition varies with the time into the coking cycle) and the lack of production/gas generation data. Many of the POM compounds known to be in coke oven emissions were not detected. Based on the results for benzene and assuming 12,000 scf of gas per ton of coal, benzene was generated at a rate of 0.8 lb/ton. However, the yield of benzene from coking is typically in the range of 14 to 23 lb/ton coal. There was no discussion of procedures to collect tar or other compounds that may have condensed in the sampling equipment. This test is assigned a D rating because of the lack of data on the rates of coal usage and gas generation and its representation of only a part of the coking cycle.

4.1.1.1.12 <u>Reference 12</u>. This document reports an attempt to collect and measure charging emissions during a test at J & L Steel, Pittsburgh in 1973. Six emission points on the charging car were enclosed to collect emissions and to route them to a stack. Emissions were measured with a specialized sampling train containing an in-stack probe followed by a heated cyclone and filter followed by a heated line to a condensate trap. The train was similar to a Method 5 train except the sampling flow rate and time permitted a much smaller sample volume than that recommended by Method 5. The six emission points were sampled over 3.5 minutes of the charging period. Filterable PM was reported as 815 grams per charge. For a typical coal charge of 16.7 tons, the test yields an emission factor of 0.11 lb/ton.

4.1.1.1.13 <u>Reference 13</u>. This paper provides additional details for the test for BSO that is documented in Reference 12. The filterable PM was found to be 57 percent BSO, and the impinger catch, which was approximately equal to the filterable PM, was 60 percent BSO. Consequently, about 60 percent of the total PM was found to be BSO, or the total BSO was about 1.2 times the filterable PM.

There were many difficulties encountered in this test due to the fugitive nature of charging emissions and attempting to sample while maintaining a normal charging schedule. The entire charging period was not sampled (the charging car was moved to replace lids), all emissions were not captured, condensation of tar occurred in the collection equipment, and there was no indication of whether steam aspiration was used on the oven being charged. Consequently, the test results may understate the emissions from an uncontrolled charge. A rating of D is assigned to this test.

Reference 4 reports tests performed at Bethlehem Steel's Burns Harbor plant for charging. The control system included a scrubber, and sampling was performed before and after scrubbing. Uncontrolled emissions of filterable PM were reported as 0.52 lb/ton. This test did not include emissions from the chuck door during leveling or from the coal hoppers after emptying. Specific details of the tests were not available, and these data were assigned a D rating.

Reference 4 also reported data that was judged technically outdated because measurements were made based on deposition on greased plates. A range of 0.1 to 2.4 lb/ton was reported with an average of 1.5 lb/ton.

In Reference 9, a theoretical exponential model is used to estimate emissions from well-controlled charging. Observations and opacity data indicate that the nature of charging emissions changes and opacity decreases when there are less than 30 seconds of emissions per charge. Uncontrolled charges produce heavy clouds of emissions than can obscure the charging car, whereas well-controlled charges emit wisps or puffs of emissions that last a few seconds. The exponential model predicts 13 to 75 g BSO per charge when emissions are in the range of 25 to 30 seconds per charge (pre-NESHAP levels) and 2 to 8 g BSO/charge for about 10 seconds of emissions (post-NESHAP level).

4.1.1.1.14 <u>Reference 14</u>. This document is a technical note to the coke oven NESHAP docket that documents information on the frequency of bypassing coke oven gas. Only limited data are available for the frequency of these venting episodes, and most of the information was obtained from the Allegheny County Bureau of Air Pollution Control. Most batteries appear to bypass coke oven gas intermittently throughout the year, and during a catastrophic failure, the bypass may last several hours. For example, one large coke plant had 12 venting episodes from June 1987 to January 1989 that lasted a total of 38 hours. The length of each venting episode ranged from 15 minutes to 7 hours. At another plant, venting ranged from 10 seconds to 45 minutes with an average of 2 hours of venting per year. At a third plant, venting time ranged from 2 minutes to 9 hours with an average of 6 hours of venting per year. This plant also had an exhauster failure that required five batteries to be vented to the atmosphere for 17 hours. These data indicate that the average Battery was vented for about 4 hours per year, neglecting catastrophic failures. Depending on the frequency of catastrophic failures, these events could contribute significantly to the annual average emissions from bypassed coke oven gas. However, the NESHAP for coke oven emissions requires that these emissions be flared, which significantly reduces emissions of organic compounds and hydrogen sulfide.

4.1.1.1.15 <u>Reference 15</u>. This document is a paper that describes how an emissions inventory was developed for coke batteries in Allegheny County, Pennsylvania. One source of emissions not discussed elsewhere is "soaking." Soaking is described as a routine operation in which the oven is taken off of the gas collecting main for the last 1.5 hours of the 18-hr coking cycle. During this time, offtakes are opened to the atmosphere to vent residual gas and relieve oven pressure. The coke oven gas that is generated during soaking is believed to be primarily hydrogen and methane. The paper assumes that PM emissions are 5 percent of that estimated for pushing, which is 1.2 lb/push for soaking. The PM is assumed to be entirely PM less than 10 microns in aerodynamic diameter (PM-10) because it is either condensible or comes from combustion of raw coke oven gas. Estimates of emissions of other pollutants are based on ratios to PM derived from pushing. The paper acknowledges that no work has been done on measuring soaking emissions, and this is a controversial issue with coke plant operators. Consequently, this emission estimating approach is assigned a D rating.

Reference 15 also describes emissions from decarbonizing, which occurs after the oven is pushed and before the doors, charging lids, and offtake caps are replaced. Carbon that has built up in the oven is removed primarily as carbon monoxide (CO) by heating the open oven. An estimated 102 kg of carbon is removed from a typical oven, and Reference 15 assumes that it is converted to CO because of the low quality of the off gas and poor combustion conditions. This assumption yields an estimated 238 kg of CO per oven decarbonized.

4.1.1.1.16 Reference 16. This paper summarizes NO_x, VOC, SO_2, and CO measurements at several steel plants. Summaries of emissions for several steel plant processes are given, including coke underfiring stacks and coke pushing. For underfiring stacks, SO_2 emissions are given for 6 plants, NO_X emissions for 14 plants, VOC emissions for 12 plants, and CO emissions for 6 plants. Coke pushing emissions are given for the same four criteria pollutants at three plants. These emissions are presented only as summaries of test data, with no process or test descriptions.

A rating of D is assigned to these reported measurements because of the lack of supporting information.

4.1.1.1.17 Reference 17. This source category report summarizes PM emission factors from the operations of coal crushing, coal preheating, wet coal charging, door leaks, coke pushing, quenching, combustion stacks, and coke handling. Sulfur dioxide emission factors are summarized for uncontrolled wet coal charging and uncontrolled combustion stacks. Carbon monoxide, volatile organic, and ammonia emission factors are given for uncontrolled wet coal charging, uncontrolled door leaks, and uncontrolled pushing. Nitrogen oxide emission factors are given for uncontrolled wet coal charging and for uncontrolled door leaks. Size specific PM emission factors are presented for uncontrolled coal preheating and preheating controlled by venturi scrubber, staged (sequential) coal charging, uncontrolled pushing and pushing controlled by venturi scrubber or mobile scrubber car, uncontrolled combustion stacks, and uncontrolled quenching (dirty water and clean water) and quenching controlled by baffles with either clean or dirty water. All PM test data used for these emission factors come from tests performed in 1982 or earlier; most are prior to 1980. The remaining emission factors are derived from pre-1970 documents that are not test reports.

While the emission factor ratings given in the source category report range from A to E (most are C or lower), they are no longer appropriate for batteries operating under NESHAP rules. A rating of E is assigned to any of the emission factors carried over to this revision for coke manufacturing.

4.1.1.1.18 <u>Reference 18</u>. This report compares quench tower PM emissions tests from four plants. Testing was done using a modified Method 5 procedure in which a cyclone was placed ahead of the filter to remove water droplets, velocity measurements were made continuously to account for rapidly changing exhaust flow, and conventional traverse testing was replaced by repeated testing during several quenches. The sites tested included U.S. Steel, Lorain Works; Dofasco (Dominion Foundry and Steel Company), Hamilton, Ontario; U.S. Steel, Gary Works No. 5 tower; and U.S. Steel, Gary Works, No. 3 tower. The Lorain tower differed from the others in being taller (120 ft vs. 37 to 107 ft), quenching green coke, using a quenching method that injected water deeply into the coke bed (this method was also used at Gary Works No. 3), having high exit gas velocity, and having missing baffles. These factors all tend to increase PM emissions. Testing at three of the sites was done with clean quench water (about 500 milligrams per liter of total dissolved solids [mg/L TDS] or less) and dirty water (about 1,200 mg/L TDS or more). The modified Method 5 data are reported as: cyclone with nozzle, front half without cyclone, front half total [filterable emissions], back half [condensible emissions], and full train [total emissions]. The authors compare emissions results from the four plants and attempt to correlate emissions with quench water cleanliness.

A rating of C was assigned to the data extracted from this report. They were obtained with a modified test method and no process data were available.

4.1.1.1.19 <u>Reference 19</u>. This emission test (Project No. 50.50) was performed at the United States Steel's (USS) Clairton Works by Air Pollution Technology, Inc. (APT) in cooperation with United States Steel Corporation (USSC) and Envirotech Corporation (EVT). The compliance test results presented in this report are for tests completed on December 5, 6, 13, and 14, 1984. The results of a precompliance test, which was completed on October 19, 21, 23 and 24 was run under similar operating conditions, are also presented in this report. The emissions test included PM emissions. The source for the test was the EVT Hooded Quench Car No. 104 (HQC) operating on the No. 20 coke batteries located at the USSC's Clairton Cokeworks.

Particulate matter emission tests were conducted using EPA Method 5 modified with two impinger trains in parallel to accommodate the high sample flow rate required to collect a sample volume greater than 30 dry standard cubic feet (dscf). Four pre-compliance and three compliance test were conducted during normal coking conditions. One compliance test (Run number 7.2 in Table 4-12) was completed during upset coking conditions that resulted from an outage caused by a mechanical breakdown in the coke battery. Battery 20 is considered a new source and is subject to the Lowest Achievable Emission Rate (LAER) standard. The applicable LAER emissions standards for PM is less than or equal to 0.04 pounds per ton of coke pushed.

A rating of C was assigned to the PM tests performed on the HQC. Process descriptions were provided and the data were presented with adequate detail. Actual field data with pertinent operating conditions were provided. The manner in which the source was operated is well documented in the report. However, the report infers that the source may not have been operating within typical parameters during the test. During the PM mass emission compliance testing the test car attached to the HQC system, created additional pressure drop to the system which decreases the gas flow rate and the ability of the HQC system to capture fugitive emissions. It is stated in the report that opacity observations with the test car disconnected were permitted in the compliance test protocol and will improve the visible emissions performance. Although the visible emissions readings (Appendix C) are not available, the report does not provide additional statements concerning high particulate or opacity readings except for test 7.2 which was conducted during upset conditions.

4.1.1.1.20 Reference 20. This emission test was performed at the USS's Clairton Works by Air Pollution Technology, Inc. (APT) in cooperation with USSC and EVT. The compliance test results presented in this report are for tests completed on July 24, 25 and 26, 1985. The emissions test included PM emissions. The source for the test was the EVT Hooded Quench Car No. 103 (HQC) operating on the No. 20 coke batteries located at the USSC's Clairton Coke Works.

Particulate matter emission tests were conducted using EPA Method 5 modified with two impinger trains in parallel to accommodate the high sample flowrate required to collect a sample volume greater than 30 dscf. Three compliance test were conducted during normal coking conditions. Battery 20 is considered a new source and is subject to the LAER standard. The applicable LAER emissions standards for PM is less than or equal to 0.04 pounds per ton of coke pushed. The average PM mass emission rate was 0.015 lb/ton of coke for the three compliance tests. In addition, back-half filterable and soluble particulate emissions are presented in Appendix E (Data Reduction). These emissions are assumed to be comparable to the inorganic condensible portion of EPA Method 202. The average inorganic condensible particulate emission rate was 0.12 lb/ton of coke for the three compliance tests.

A rating of C was assigned to the filterable particulate tests performed on the HQC. A rating of D was assigned to the inorganic condensible particulate tests. Process descriptions were provided and the data were presented with adequate detail. Actual field data with pertinent operating conditions were provided. The manner in which the source was operated is well documented in the report. However, the report infers that the source may not have been operating within typical parameters during the test. During the PM emission compliance testing the test car attached to the HQC system, created additional pressure drop to the system which decreases the gas flow rate and the ability of the HQC system to capture fugitive emissions. It is stated in the report that opacity observations with the test car disconnected were permitted in the compliance test protocol and will improve the visible emissions performance. Although the visible emissions readings are not available, the report does not provide additional statements concerning high particulate or opacity readings.

4.1.1.1.21 Reference 21. This emission test was performed at the USS's Clairton Works by APT in cooperation with USSC and EVT. The compliance test results presented in this report are for tests completed on October 9 and 10, 1985. The emissions test included PM mass emissions. The source for the test was the EVT Hooded Quench Car No. 106 (HQC) operating on the Nos. 7, 8 and 9 coke batteries located at the USSC's Clairton Cokeworks.

Particulate matter emission tests were conducted using EPA Method 5 modified with two impinger trains in parallel to accommodate the high sample flowrate required to collect a sample volume greater than 30 dscf. Three compliance test were conducted while the car was receiving and transporting coke from the Nos. 7, 8 and 9 coke batteries. Batteries 7, 8 and 9 are considered a new source and are subject to the LAER standard. The applicable LAER emissions standards for PM is less than or equal to 0.04 pounds per ton of coke pushed. The average PM emission rate was 0.012 lb/ton of coke for the three compliance tests. In addition, back-half filterable and soluble particulate emissions are presented in Appendix E (Data Reduction). These emissions are assumed to be comparable to the inorganic condensible portion of EPA Method 202. The average inorganic condensible particulate emission rate was 0.17 lb/ton of coke for the three compliance tests.

A rating of C was assigned to the filterable particulate tests performed on the HQC. A rating of D was assigned to the inorganic condensible particulate tests. Process descriptions were provided and the data were presented with adequate detail. Actual field data with pertinent operating conditions were provided. The manner in which the source was operated is well documented in the report. However, the report infers that the source may not have been operating within typical parameters during the test. During the PM emission compliance testing the test car attached to the HQC system, created additional pressure drop to the system which decreases the gas flow rate and the ability of the HQC system to capture fugitive emissions. It is stated in the report that opacity observations with the test car disconnected were permitted in the compliance test protocol and will improve the visible emissions performance. Although the visible emissions readings are not available, the report does not provide additional statements concerning high particulate or opacity readings.

4.1.1.1.22 Reference 22. This PM emission test was a compliance demonstration of the baghouse which controls the pushing emissions from the B-Battery operated by USSC's Clairton Coke and Coal Chemical Works, Clairton, Pennsylvania. The demonstration was performed by the Air Quality Engineering Division (AQED) of Keystone Environmental Resources, Inc., on March 12 and 13, 1990.

Particulate matter sampling was performed in accordance with EPA Stationary Source Sampling Methods 1 through 5, and Method 6 for sulfate. The results of the testing showed that the PM emissions rate was 3.799 lb of particles per hour; the allowable LAER is 3.877 lb/hr based on a LAER standard of 0.04 lb/ton of coke pushed. A baghouse controls the emissions that result from the pushing operations from the ovens of B-Battery. The purpose of this testing was to measure the PM emissions rate from the exhaust of the baghouse and compare the measured emissions rate to the allowable emissions rate. A single test run of 12 of the 14 stacks of the module pulse jet unit baghouse were sampled. There were several power outages during the first half of these test, however, the total sampling time was 2 hours.

A rating of A was assigned to the PM tests performed on the baghouse. Process descriptions were provided and the data were presented with adequate detail for data validation. Actual field data with pertinent operating conditions were provided. The sulfate emissions were based on EPA Method 6 and were reported with enough detail for adequate validation.

4.1.1.1.23. Reference 181. This test report describes a test sponsored by EPA’s Office of Research and Development Industrial Environmental Research Laboratory. The test was performed on coke oven number 41, Battery A at the Republic Steel Corporation plant in Youngstown, Ohio. The test program is well documented, however not all sample fractions were analyzed for individual compounds and the interpretation of the data to arrive at reasonable emissions estimates is difficult. As a result the particulate emissions data are rated B with the compound specific data rated D.

During this test, the door emissions for two almost complete coking cycles (13 and 16 hours) were captured using a sealed enclosure that covered the door area with corrugated metal. To cool the door to normal operating conditions, a compressor supplied between 14.5 and 41 scfm of clean air through a [illegible] inch diameter pipe that allowed air to blow upward from the base of the enclosure. This cooling air mixed with the door leakage gases and passed on to the suction blower. The suction blower was operated to maintain a zero gage pressure within the door enclosure to prevent leakage into or out of the enclosure. The gases removed from the enclosure were measured so that the coke oven door leakage could be calculated. The report indicates that gas flows for the second test run were more reliable than the first run. For the second run coke oven door leakage seventeen minutes after charging were measured at 58 scfm. From three hours after charging to the end of the coking cycle, the coke oven door leakage was reduced to between 25 and 32 scfm. However, gas analyses of samples obtained during the test for light hydrocarbon and inorganic components contained between 15.9% and 19.5% oxygen. As indicated in the report, this suggests that the door leakage may have been much less than gas flows indicate.

Although a variety of analyses were performed on the collected particulate and gaseous samples, only the particulate mass emissions rates are suitable for emissions factor development. The report notes that cooler surfaces of the enclosure and ductwork had a coating of black tarry material that varied with location. Although the report does not attribute the quantity of deposits to the temperature of the enclosure surface, the report notes that the coating was progressively heavier from the beginning to the end of the ductwork. The report notes that the temperature drop from the hood exit to the particulate sampler was less than 200°F and the filter temperature was between 180°F and 225°F. In addition, the report notes that there was a tar film on the inside surfaces of ductwork and tubing downstream of the filter. While the deposition on the ductwork and high filter temperatures may have introduced a low bias to the particulate emissions, the bias is probably not significant given the high particulate emissions that were measured. The average filterable particulate emissions rates were 61.[illegible] mg/min ([illegible].0037 kg/hr) for the first run and 195.1 mg/min (0.012 kg/hr) for the second run. These emission rates compare favorably to the combined (visible, bench visible and non-visible) door emissions rate of 0.008 kg/hr for BSO recommended for pre-NESHAP control levels. Additionally, the initial emission rates of 500 mg/min (0.07 lb/hr) for the first run and 1000 mg/min (0.13 lb/hr) compare very favorably with the average emission rate for door emissions that received a grade 3 in references 7 and 39.

The final particulate samples for both of the runs have lower emission rates than the no visible leak rates in reference 7 and 39. However, the emission rates for the final four hours of coking do compare favorably to the no visible leak rates in reference 7 and 39. The last four hours of the first run had an emission rate of 0.5 mg/min (0.0007 lb/hr). The last four hours of the second run had an emission rate of 14.0 mg/min (0.019 lb/hr). One possible explanation is that the average filter temperature for the tests documented in this report averaged 208°F compared to the filter temperatures of between 60°F and 110°F for the tests reported in references 7a and 7b. An indication of the effect of the higher filter temperature is provided in some of the semiquantitative analyses of selected coke oven door sample fractions. Fraction 2 of sample A5F (filter) and A5 (absorbent) were analyzed by a method that measured fused ring aromatics (pyrenes and benzpyrenes etc.). The filter sample measured compounds with vapor pressures from Anthracene to Coronene (including also Fluoranthene, Pyrene, Chrysene, Benzo fluoranthenes, Benzo pyrenes, Benzo perylene and others) that had a total emission rate of 151 mg/hr. The absorbent sample measured compounds with vapor pressures from Indene to Crysene (including also Naphthalene, Methyl naphthalene, Acenaphthalene, Anthracene, Fluoranthene, Pyrene and others) that had a total emission rate of 983 mg/hr. Although the more volatile compounds such as Indene, Naphthalene and Methyl naphthalene may pass through a filter at 100°F, the emission rate for compounds less volatile than Methyl naphthalene was 333 mg/hr. As a result, if the filter temperature for this test were similar to the filter temperatures used in references 7a and 7b, the emission rates for the final filter samples would compare more favorably with the emission rate for doors that had no visible leaks.

Figure 4 in the report is a graphical presentation of the particulate emission rates for these two runs. The individual data are connected by a curve that is asymptotic with the ordinate and abscissa. The data for each particulate filter used during the runs were transferred to a spreadsheet program and graphed. Within the spreadsheet program, the data for the two runs most closely approximated an exponential curve with an exponential constant of approximately -0.46. Figure 4-1 presents the data for each particulate filter for each run, the best fit curve determined by the spreadsheet program and the equations for the best fit curve for each run.

4.1.1.1.24. Reference 182. This test report describes an emission test conducted by TRW Environmental Engineering Division, under contract with EPA's Emission Measurement Branch during the week of July 30 through August 6, 1978. The test was conducted at a battery of coke ovens at U.S. Steel's Clairton, Pennsylvania plant. The purpose of this sampling was two-fold: 1) to provide data associated with emissions of polycyclic organic matter from topside leaks and 2) to verify that a reduction in visible topside emissions would result in an emissions reduction of polycyclic organic material. Sampling was conducted in order to determine the emission rate (mg/min) of pollutants from a simulated coke oven topside leak; two different size leaks were tested. The leaks were simulated by modifying an oven port lid to include a vent tube which utilized a ball valve for controlling the leak rate. Samples were collected by placing the nozzle of the sampling train probe directly above the vent tube.

Pollution emission rates were determined for Benzene Soluble Organics (BSO), Polycyclic Organic Matter (POM), and Benz-a-Pyrene (BaP); determination of a Benzene emission rate was attempted but was not successful. During the testing , seven samples of BSO/POM were taken from the simulated oven leaks on Battery Number 1. During each run the simulated leak was adjusted to give either a large leak (approximately a three to six-foot visible plume) or a small leak (approximately a one-foot visible plume). Sampling was begun between the first and second hours of the 19 hour coking cycle. Separate sampling trains were used for the BSO and the POM/BaP sampling. In order to obtain comparable BSO/POM data, a common nozzle was used so that both trains could simultaneously sample the same leak. The sampling rates were adjusted so that approximately half of the leak went to each train. The BSO fraction was passed through a dry impinger into a filter at 125°F. The filter and first impinger contents were extracted with benzene; the extract was dried and the BSO determined gravimetrically. The POM/BaP fraction was collected on a filter at 125°F and a solid adsorbent resin (XAD-2) which were both extracted with methylene chloride (MeCl). POM analysis was conducted on a Gas Chromatograph/Mass Spectrometer (GC/MS). The BaP analysis was conducted by thin layer chromatography/fluorescence. Although the documentation in the test report is adequate, the report is rated B since the leaks were artificially generated and the test duration were short. The information obtained is not useable to estimate average mass emissions for doors, lids or offtakes for the entire coking cycle. However, the emissions measured assisted in the development of a emissions estimation model described in reference 6 and 9. In addition, the test report contains information on the POM components of BSO. This information is presented in Table 4-8.

4.1.1.1.25. <u>Reference 183</u>. This is a September 22, 2000 e-mail message and attachments from David Ailor of the American Iron and Steel Institute (AISI)/American Coal and Coke Chemicals Institute (ACCCI) Coke Oven Environmental Task Force (COETF) on COETF's 7-PAH Estimates to Marvin Branscome of Research Triangle Institute. This e-mail was in response to an e-mail requesting additional information on the speciation of the seven PAHs discussed in a May 22 comment letter by the COETF on EPA's Draft Persistent Bioaccumulative and Toxic (PBT) National Action Plan for Benzo(a)pyrene. The e-mail included an attached table ("BAP082~1.doc") which summarized the results of the analyses for the seven PAHs. The e-mail stated that the information on the table were based in part on a speciation of estimated coke oven benzene-soluble organic (BSO) emissions, using crude coal tar analytical data previously generated by the ACCCI to develop "Minimum Generic Language for Crude Coal Tar Material Safety Data Sheets" ("Crude Coal Tar MSDS Project"). The e-mail further stated that for the MSDS project, 12 plants submitted samples of crude coal tar to a common laboratory for quantitative analysis of six volatile and 27 semi-volatile chemical constituents, including each of the seven PAHs addressed in the EPA study, as well as additional PAHs. The information presented in table attached to the e-mail is presented in Table 4-9. The data was rated D since the e-mail does not provide information on the analytical method used to determine the PAH concentrations, internal laboratory QA information, the results for individual samples, the methods the samples were obtained nor information on the facilities that supplied the samples.

4.1.1.1.26. Reference 205. This is a keynote address presented at the 2nd International Cokemaking Congress organized by the Institute of Materials and held in London on September 28 - 30, 1992. The paper reviews European research and development work to control air and water pollution in the cokemaking industry. Figure 1 in the paper presents the results of work carried out by BCRA (formerly British Carbonisation Research Association) to sample door leakage emissions. In this work, a specially designed hood was used to capture particulate and sulfide emissions and odor. The paper indicates that very useful correlations were established between the emission of odor, particulate and hydrogen sulfide and the visible appearance of the smoke leakage as assessed by the BCRA method. Emissions information for BCRA grades 0, 1, 2 and 3 were presented. For particulate, the emissions correlating with BCRA grades 0, 1, 2 and 3 were 0.6 mg/sec (0.005lb/hr), 2 mg/sec (0.016 lb/hr), 50 mg/sec (0.4 lb/hr) and 250 mg/sec (2.0 lb/hr) respectively. The report does not present detailed information on the method used to capture the door emissions nor does it provide detailed information on the particulate test method used. Furthermore, the results of individual emission tests (if performed) for each leak grade are not presented. As a result, the report is assigned a D rating. Because of the subjectivity of the BCRA grades and the potential differences in the emission test methodologies, it is difficult to attribute a direct correlation between this data and the data contained in References 7, 39 and 181. Except for the BCRA grade of 0 (no visible emissions) the emissions presented in this report are greater than the emissions presented in References 7, 39 or 181. The emissions presented for BCRA grade 0 are between the emissions quantified in Reference 181 near the completion of the coking cycle and are slightly lower than the average particulate presented in References 7 and 39.

4.1.1.2 Development of Candidate Emission Factors for Leaks and Charging

The emission data for uncontrolled or poorly controlled door leaks are given in Table 4-1. The results from References 1 through 4 are averaged to generate an emission factor of 0.5 lb/ton (0.25 kg/Mg) of coal charged for filterable PM. Door leaks controlled at the pre-NESHAP level are also given in Table 4-1 in terms of coke pushed. The ratios of BSO:filterable PM (1.1) and condensible: filterable PM (0.6) were taken from Reference 3.

As door leak control has improved over the past 20 years, observations and theoretical models suggest that the nature of the leaks have changed from large leaks (with occasional door leak fires) to much smaller leaks. Reference 5 has a higher leak rate than that reported in Reference 3 although the percent leaking doors was higher. Table 4-2 summarizes data from References 3 and 5 that show BSO leak rates of 0.4 to 1.3 lb BSO/hr (0.19 to 0.58 kg/hr) per leaking door for average levels of 70 and 29 percent leaking respectively. The difference may represent variability between batteries that could be due to differences in collecting main pressure, type of coal, or the coking cycle (e.g., 30 hours in Reference 3 and 1[illegible] hours in Reference 5). A theoretical exponential model was developed in Reference 6 to extrapolate from the data presented in References 3 and 5 and used in Reference 9 to estimate emissions from coke oven doors at improved performance levels. This exponential model results in a predicted range of 0.02 to 0.26 lb/hr (0.01 to 0.12 kg/hr) for 10 percent leaking doors. The midrange of these predicted emission rates is 0.14 lb/hr (0.063 kg/hr) and is the value recommended for doors controlled to the pre-NESHAP levels.

Door leak data from References 7 and 39 are given in Table 4-3. Because the calculations in both reports did not follow standard practices, the data for all leaks were recalculated for these tests. This recalculation had the most effect for the Category 0, 0.5 and 1 leaks from Reference 7 because of the high blank corrections, the use of negative numbers in calculations and an inappropriate method for determining the minimum detectible weights. The use of solvents with lower solids and the negative numbers problem was corrected in the subsequent test reported in Reference 39. The Category 4 results for BSO (0.49 lb/hr) are in the same range as those reported in References 3 and 5 for heavy, uncontrolled door leaks but are not representative of the current level of emission control. The BSO results for the smallest leaks (Categories 0.5 and 1) were not statistically different and averaged 0.023 and 0.026 lb/hr (0.011 and 0.012 kg/hr) respectively. The BSO emission rate increased as the visible size of the leak increased with averages of 0.06[illegible] and 0.11 lb/hr (0.028 and 0.05 kg/hr) for Categories [illegible], and 3, respectively. The average emission rate for leak rate Category 3 compares very favorably with the midrange values predicted by the exponential model in Reference 9, which estimated rates of 0.14 lb/hr (0.063 kg/hr) for an average of 10 percent leaking doors. This implies that at least one door would be visibly leaking at about the Category 4 level. At the NESHAP performance level, it is expected that the visible door leaks would be dominated by Category 0.5 and 1 leaks with some Category 2 leaks and a few Category 3 leaks. The available data for Categories 0.5 through 3 leaks are dominated by the 18 Category 0.5 and 1 tests with only 5 Category 2 tests and 3 Category 3 tests. The run by run average leak rate for Categories 0.5 through 3 in Table 4-3 is 0.041 lb/hr (0.019 kg/hr), which is very close to the model prediction of 0.05 lb/hr (0.023 kg/hr) for an average of 5 percent leaking doors and is the value recommended for well-controlled doors with emissions visible from the yard as measured by EPA Method 303.

There are several reasons for not applying the exponential model results from the NESHAP background document for percent leaking doors less than 10 percent in this analysis. First, the exponential model is not applicable for levels below 5 percent leaking doors because it does not account for the higher oven pressures in the first five to 10 minutes after charging. In addition, the model does not account for emissions that are visible from the bench (3 to 15 feet distance) but not the yard (50 to 75 feet distance). Lastly, the model is based on the self-sealing mechanism, and many batteries are now using improved door seal designs and/or sodium silicate as a supplemental sealant to reduce the number of leaking doors. The improved performance of the newer door seal designs and the use of the sealant are not accounted for by the model and does not relate to the calculations of sealing time (due to tar condensation) that the model uses. Heavy door leaks, which should be uncommon under the NESHAP, would have a higher emission rate than 0.06 lb/hr (0.027 kg/hr), and doors with only small wisps of emissions would have a lower rate. The data from References 7 and 39 provides additional support in that even the smallest visible leaks (in Categories 0.5 and 1) have higher emission rates than would be predicted by the exponential model for very low levels of percent leaking doors. Consequently, the use of the exponential model prediction for levels below 5 percent leaking doors would result in a significant underestimate of emissions.

As implied above, EPA Method 303 does not identify all of the doors that have visible emissions. A subset of the data from References 7 and 39 can be used to quantify emissions from doors that are visibly leaking when observed from the bench but are not counted as visibly leaking by EPA Method 303. EPA Method 303 includes an adjustment of 6% for doors observed from the bench rather than the yard. As a result there may be 7 to 8 doors at a typical battery of 62 ovens that have leaks that would be visible from the bench that would not be counted by EPA Method 303. Doors with visible emissions from the bench but not the yard are assigned an emission rate of 0.023 lb/hr (0.011 kg/hr). This is the average emission rate of doors with the lowest (0.5) graded visible emissions. This grade level represents visible emissions that are barely perceptible and may be missed during EPA Method 303 observations. Given that the measured emissions from the lowest two graded visible emissions were not statistically different, it is plausible that emissions that are only visible from the bench would also have comparable emissions.

Data from References 7, 39, 181 and 205 suggest that emissions may exist when there are no visible emissions even from the bench. There are plausible reasons why emissions may exist when there are no visible emissions from doors during normal operations. Data from Reference 39 documented detectible levels of emissions from doors on ovens that were empty. These measured emissions were about three times lower than the smallest visible leak class and were at least five times higher than the background BSO results. The measured emissions from the empty ovens shown in the report ranged from 0.006 to 0.016 lb BSO/h (0.0026 to 0.007 kg BSO/h). The above emissions are based upon a limit of detection of three times the average blank value. However, the Emission Measurement Center (EMC) guidance on limits of detection and quantification (http://www.epa.gov/ttn/emc/facts.html#lab) indicates that the limit of detection is generally based upon a value of three times the standard deviation of the blank value. When this criteria is used, only the middle value is changed from 0.007 lb BSO/h to 0.005 lb BSO/h. At the detection limit, there is a 99.9% probability that the value could be between zero and twice the value, a 99% probability that the value could be between 22% of the value and 1.5 times the value and a 90% probability that the value could be between 0.57 of the value and 1.4 times the value The EMC guidance also indicates that values less than ten times the standard deviation of the blank value are considered to be below the limit of quantification. At the limit of quantification, there is a 99.9% probability that the measured value is between 69% and 130% of the actual value, a 99% probability that the measured value is between 77% and 120% of the actual value and a 90% probability that the measured value is between 87% and 110% of the actual value. Based upon the reported values, two of the three samples were between the limit of detection and the limit of quantification. As a result, the uncertainty of the measured emissions is greater than those typically used to quantify a sources emissions. In addition, some of the reported masses are questionable. The probe catch for run 2 and the second filter catch for run 6 may be anomalies when compared to all other runs. The value reported for the probe catch for run 2 appears to be a typographical error in that the value is an order of magnitude higher that the other two runs. The second filter catch for run 6 has the highest weight gain of all the second filters although this is only slightly above the minimum detection limit. If these two anomalous values are excluded, all three tests of empty ovens would be between the detection limit and the quantification limit. The average emission rate for empty/no visible leak ovens with these two values included is 0.009 lb/hr (0.004 kg/hr) but with these two values excluded is 0.005 lb/hr (0.002 kg/hr). The average emission rate for empty/no visible leak ovens with the two values excluded is assigned to ovens with no visible emissions. Because these emission rates are based on test data that are somewhat above the detection limit but are substantially below the quantification limit the uncertainty associated with the resulting emission factor is greater than most source test based emission factors. Quantitatively the uncertanties are closest to data at the limit of detection. While there may be a higher than typical uncertainty in the data available for quantifying the emissions, there is ample evidence from three independent sources that emissions from doors exist through most if not all of the coking cycle. Therefore, a footnote will be included in the emission factor that indicates that while there is ample evidence that emissions occur from doors during the most if not all of the coking cycle there is a higher than typical degree of uncertainty associated with the non-visibly and bench visible leaking door portions of the emission factor.

When any of the recommended emission factors are applied, the user should be aware that there is a significant amount of uncertainty in the estimate. The uncontrolled emission factor is based upon tests of two batteries with significantly different performance and with emission rates that are not consistent with their relative visual performance. The pre-NESHAP and NESHAP emission factors are based upon more data that is more consistent, there is still a significant amount of uncertainty. For the EPA Method 303 visible leaks portion of the emission factor, there are no data available on the distribution of sizes among door leaks, which probably include both small and large leaks. For leaks that are visible from the bench but not the yard, there is some uncertainty that this class of leaks are adequately represented by the measured emissions from the lowest grade of leak. Lastly the emission estimates for doors that are not visibly leaking from the bench are quantified by only four test runs that are very near the limit of detection of the method and have at least one component of the test excluded due to anomalous values. Therefore, depending on the number of leaks and the typical leak sizes, actual emissions from a given Battery may be several times higher or lower than the estimate provided by these emission factors.

For leaks from lids and offtakes, a range of 0.0075 to 0.048 lb BSO/h (0.0033 to 0.021 kg BSO/h) is recommended from the topside test measuring a 0.3- to 2-meter (1- to 6-foot) plume in Reference 8. It is recommended that emissions of 0.0075 lb BSO/h (0.0033 kg BSO/h) be used for the NESHAP level of control and that emissions of 0.048 lb BSO/h (0.021 kg BSO/h) be used for the pre-NESHAP level of control. Lacking other data, this emission rate can also be applied to other leaks on the topside of the battery, such as leaks from refractory or flue caps.

Very few data are available for charging emissions. However, visible emission observations have shown that the implementation of stage charging over the past 20 years has resulted in dramatic reductions in emissions. When charging was uncontrolled, clouds of emissions occurred throughout the 3- to 5-minute charging period and obscured the charging car. Today, emissions are limited to a few seconds per charge (through the use of steam aspiration and stage charging) and are characterized primarily as wisps or puffs of emissions. To meet the current NESHAP limit of 12 seconds of visible emissions per charge, most batteries will need to average about 10 seconds of emissions per charge.

The information available for uncontrolled charging is summarized in Table 4-4. The recommended emission factor for filterable PM is 0.7 lb/ton of coal charged (0.35 kg/Mg) based on the average of the three results in the table. To estimate controlled emissions from charging, the NESHAP background document (Reference 9) used an exponential model to predict mass emissions when visible emissions are reduced to a few seconds per charge in duration. The pre-NESHAP control level for most batteries was on the order of 25 to 30 seconds per charge. Reference 9 estimates BSO emissions as 0.029 to 0.16 lb BSO (13 to 75 g BSO) per charge. For an average of 10 seconds per charge (NESHAP level), the emissions are estimated as about 0.0001 to 0.018 lb BSO (0.06 to 8.3 g BSO) per charge. These estimates of emissions from charging are the most uncertain of the estimates in this section and are further complicated by the expectation that charging emissions may have a composition somewhat different from that of raw coke oven gas. In addition, if occasional uncontrolled or poorly-controlled charges occur, the emission rate given above could significantly underestimate the quantity of emissions. For this analysis, a midrange value of 0.0093 lb BSO per charge (4.2 g BSO per charge) is recommended to estimate emissions from batteries controlled at the NESHAP level when they are averaging about 10 seconds of visible emissions per charge. For the pre-NESHAP level, a midrange estimate of 0.097 lb BSO per charge (44 g BSO per charge) is recommended. From References 12 and 13, the BSO emission rate is estimated as 1.2 times the filterable PM emission rate. One Battery in the U.S. uses a scrubber to capture emissions in addition to stage charging. Reference 4 reports an emission factor of 0.014 lb/ton (0.007 kg/Mg) for filterable PM.

[Note: There are no batteries in the U.S. that use pipeline charging, and no batteries are expected to be constructed using this technology. Consequently, pipeline charging is not considered in this analysis. Currently (1995), there is only one Battery that uses a scrubber system (lime-based) for charging emissions and another Battery charges dry coal with a Redler conveyor. However, these batteries must meet the NESHAP limits for visible emissions, and the emission estimates given above should also apply to those emissions that escape capture during charging.]

To estimate potential emissions of other pollutants, the use of the BSO estimates and coke oven gas analyses are recommended. Table 4-5 summarizes the emission factors for several pollutants when all of the coke oven gas is emitted (i.e., the gas is bypassed). From Table 4-5, the following constituents are assumed to be the primary contributors to BSO:

	lb/ton
Heavy hydrocarbons	34.6
Tar acids	0.7
Tar bases	0.5
Naphthalene	7
Tar oil	1
Total	43.8

The values reported in Reference 10 were converted to a ratio to BSO by dividing the lb/ton values by 44. These ratios can be used to estimate emissions of other pollutants based on the estimates for BSO.

Tables 4-6 and 4-7 present the results of another analysis of raw coke oven gas from Reference 11. Tables 4-8 and 4-9 present the results of two additional analyses. Table 4-8 is data from Reference 182 which was a test of simulated leaks. Table 4-9 is data from Reference 183 and are analyses of crude coal tar analyses from several byproduct plants. Values for compounds from Reference 11, 182 and 183 are recommended for use only for those pollutants not identified in Reference 10 (Table 4-5) because the production rate was not given and sampling was performed only during the first hour of coking. Values for PAH compounds from Reference 183 are preferred over those in Reference 182 since originate from several coke plants and represent the complete coking cycle. Values presented in both Reference 11 and Reference 182 are averaged when a non-zero value is presented. No data are available for ratios of BSO to compounds other than those listed in Tables 4-5 through 4-9.

The ratio of VOC to BSO is estimated as 2.2 from the following compounds or types of compounds in Table 4-5: propane, butane, ethylene, propylene, butene, pentene, benzene, toluene, xylene, acetylene, tar acids, tar bases, heavy hydrocarbons, solvents, naphthalene, and tar oil. The ratio for TOC to BSO is estimated as 5.2 from the VOC compounds in Table 4-5 plus methane and ethane.

4.1.1.3 Procedure for Estimating Door and Topside Emissions

Emission estimates are illustrated using a model or "typical" Battery developed in Reference 9. This model Battery has 62 4-meter ovens and produces 344,000 Mg/yr (379,000 ton/yr) of metallurgical coke on an 18-hour cycle from 492,000 Mg/yr (542,000 ton/yr) of coal. The Battery has two doors, two offtakes, and four lids per oven. For the "poorly controlled" case, the emission estimates are based on 50 percent leaking doors, 50 percent leaking offtakes and 25 percent leaking lids to develop uncontrolled emission factors for these sources. For current conditions, the estimate is based on the average visible emission performance that would be required to meet the NESHAP as shown in Table 4-10. The emission limits are 30-day rolling averages that are not to be exceeded, and the average shown in the table is the long-term average that would be required to meet the limit a high percentage of the time. Emission estimates in the examples are based on the long-term averages. The preferred approach for a specific Battery is to use the actual number of emission points on the Battery and historical data for control of visible emissions, such as the annual average percent of the doors that leak. The example calculations given below are converted to "kg/Mg coal" based on a typical Battery for use by those who do not have site-specific information to refine the estimate.

Example 1. Poorly-controlled lid and offtake leaks

For the model battery, there are 124 doors, 124 offtakes and 248 lids. For the poorly-controlled case of 50 percent leaking doors, 50 percent leaking offtakes and 25 percent leaking lids, a total of 62 of each type would be leaking.

For doors, the emissions are based on a leak rate of 0.39 kg/h:

62 leaks x 0.39 kg/h/leak x 8,760 h/yr = 211,817 kg/yr
(211,817 kg/yr)/(492,000 Mg/yr) = 0.43 kg/Mg = 0.86 lb/ton coal

For lids and offtakes, the emissions are based on a leak rate of 0.021 kg/h:

62 leaks x 0.021 kg/h/leak x 8,760 h/yr = 11,406 kg/yr
(11,406 kg/yr)/(492,000 Mg/yr) = 0.023 kg/Mg = 0.046 lb/ton coal

Example 2. Well-controlled door, lid, and offtake leaks

For this case, a BSO emission rate of 0.06 kg/h for visibly leaking doors is used to represent the pre-NESHAP level (for a typical State emission limit of 10 percent, excluding 2 door leaks, from Table 7-2 of Reference 9). For the NESHAP level of control, an emission rate of 0.028 kg/hr is used for doors that are visibly leaking as determined by EPA Method 303. For both cases, a BSO emission rate of 0.011 kg/h is used for doors with leaks that are visible from the bench but not the yard and 0.002 kg/hr for doors that are not visibly leaking.

A calculation is presented for the pre-NESHAP case when State regulations obtained average performances on the order of 10 percent leaking doors (Reference 9), and for a post-NESHAP level of 4 percent leaking (the average of the values from Table 4-10). From Reference 9, typical pre-NESHAP levels for percent leaking lids and offtakes are 3.5 and 6.5, respectively. Post-NESHAP levels from Table 4-10 (calculated as averages) are 0.3 and 2.0 percent leaking lids and offtakes, respectively.

Doors (pre-NESHAP)

{(124 x 0.10) leaks x 0.06 kg/h/leak

+ (124 x 0.06) bench leaks x 0.011 kg/h/leak

+ (124 x 0.84) no visible leaks x 0.002 kg/h/door} x 8,760 h/yr = 9058 kg/yr

(9058 kg/yr)/(492,000 Mg/yr) = 0.018 kg/Mg = 0.037 lb/ton coal

Doors (post-NESHAP)

{(124 x 0.04) Method 303 leaks x 0.019 kg/h/leak

+ (124 x 0.06) bench leaks x 0.011 kg/h/leak

+ (124 x 0.90) no visible leaks x 0.002 kg/h/door} x 8,760 h/y = 3498 kg/yr

(3498 kg/yr)/(492,000 Mg/yr) = 0.0071 kg/Mg = 0.014 lb/ton coal

Lids (pre-NESHAP)

(248 x 0.035) leaks x 0.021 kg/h/leak x 8,760 h/yr = 1,597 kg/yr

(1,597 kg/yr)/(492,000 Mg/yr) = 0.0032 kg/Mg = 0.0065 lb/ton coal

Lids (post-NESHAP)

(248 x 0.003) leaks x 0.0033 kg/h/leak x 8,760 h/yr = 22 kg/yr

(22 kg/yr)/(492,000 Mg/yr) = 0.000044 kg/Mg = 0.000087 lb/ton coal

Offtakes (pre-NESHAP)

(124 x 0.065) leaks x 0.021 kg/h/leak x 8,760 h/yr = 1,483 kg/yr

(1,483 kg/yr)/(492,000 Mg/yr) = 0.003 kg/Mg = 0.006 lb/ton coal

Offtakes (post-NESHAP)

(124 x 0.02) leaks x 0.0033 kg/h/leak x 8,760 h/yr = 72 kg/yr

(72 kg/yr)/(492,000 Mg/yr) = 0.00015 kg/Mg = 0.00029 lb/ton coal

Example 3. Stage Charging

As discussed earlier, the typical pre-NESHAP level of charging was an average of 25 to 30 seconds of emissions per charge with a range of 13 to 75 g BSO/charge (midrange = 44 g/charge). For the post-NESHAP level, an average of 10 seconds per charge with 0.06 to 8.3 g BSO/charge (midrange = 4.2 g/charge) is estimated. For the model battery, 62 ovens are charged every 18 hours, which is 3.44 charges per hour. The emissions would be calculated as:

<u>Pre-NESHAP</u>
44 g/charge x 3.44 charges/hr x 8,760 hr/yr x 1 kg/1,000 g = 1,326 kg/yr
(1,300 kg/yr)/(492,000 Mg/yr) = 0.0027 kg/Mg = 0.0054 lb/ton coal

<u>Post-NESHAP</u>
4.2 g/charge x 3.44 charges/hr x 8,760 hr/yr x 1 kg/1,000 g = 127 kg/yr
(125 kg/yr)/(492,000 Mg/yr) = 0.00026 kg/Mg = 0.0005 lb/ton coal

4.1.1.4 <u>Summary of Emission Estimates for Coke Oven Leaks and Charging</u>

The emission factors for filterable PM and BSO are summarized in Table 4-11 for charging and leaks from doors, lids, and offtakes. With the exception of the factors for uncontrolled charging and uncontrolled door leaks, the emission factors in kg/Mg (lb/ton) are based on a model Battery and the assumptions described earlier. However, the footnote in Table 4-11 explains how to calculate the emissions for a specific Battery based on the annual average number of leaks from doors, lids, and offtakes. These data should be available for all batteries as a result of visible emission inspections required by the coke oven NESHAP.

Table 4-12 presents ratios of other pollutants to BSO. Consequently, the emissions of the other pollutants can be estimated by multiplying the ratio by the BSO emission estimate.

All of these emission factors are highly uncertain. Consequently, a rating of "E" (the lowest rating) is assigned to all of the emission factors.

4.1.1.5 <u>Emissions from Bypass or Bleeder Stacks</u>

During certain process upsets or equipment failure, such as the malfunction of the exhausters that move the coke oven gas, raw coke oven gas may bypass the byproduct recovery plant and be vented directly to the atmosphere. The NESHAP requires that this gas be burned by flaring, which destroys most of the organic compounds and converts hydrogen sulfide in the gas to sulfur dioxide. Estimates of these emissions can be made if the historical frequency of the venting is known for a specific plant.

When a Battery bypasses raw coke oven gas (unflared) to the atmosphere, the emission factors in Table 4-13, which are based on data included in Reference 10, can be used to estimate emissions based on the duration of the venting. For example, if the average coal usage is 62 ton/hr (for the model battery) and the Battery vents for 4 hours, carbon monoxide emissions would be:

48 lb/ton x 62 ton/hr x 4 hr = 11,900 lb = 6 tons

The emission factor for BSO derived previously was 44 lb/ton for unflared venting based on those constituents in Table 4-13 likely to contribute to BSO. Filterable PM from uncontrolled venting is estimated as 0.9 x 44 = 40 lb/ton, and condensible PM is also estimated as 40 lb/ton. No data were available for PM after the gas is flared.

4.1.2 EMISSIONS FROM PUSHING, QUENCHING, COMBUSTION STACK AND MISCELLANEOUS SOURCES

Test data for an additional 179 sources were reviewed for inclusion in the emission factor document. Sources tested included combustion stacks, door leaks, pushing, coal pulverizing and crushing, and coke screening. With the exception of data from pushing operations that were mixed with door leak data, the source test data were factored into the coking operations emission factors without adjustments except for capture effectiveness. Discussion of the pushing data that were mixed with the 27 previously described reports are repeated in this section. Discussions of 120 reports for pushing, quenching, combustion stacks and miscellaneous sources are given below.

4.1.2.1 Review of Pushing, Quenching, Combustion Stack and Miscellaneous Sources Data

4.1.2.1.1 Reference 40. This reference documents a single test run on the pushing emissions control system on coke oven Battery A at the Bethlehem Steel plant in Bethlehem, Pennsylvania, on August 27, 1987. Pushing emissions from the Battery are captured by a hood mounted on the door machine and are ducted to a combination venturi scrubber (two parallel scrubbers) and cyclonic separator system before being vented to the atmosphere. The scrubber pressure drops were 33 and 36 inches water column (in. w.c.) during testing. Filterable PM emissions were measured at the control system exhaust stack using EPA Method 5. Weights are also recorded for soluble and insoluble back-half particulate, but the analysis method does not appear to be comparable to EPA-approved methodology for determining condensible PM emissions. Therefore, the condensible PM data were not used to develop emission factors. Process rates, based on a daily average, are provided in units of tons per hour of coke pushed.

The test data are assigned a C rating. The report includes adequate detail, the test methodology was sound, and no problems were reported, but only a single test run was performed on the battery. Although single run test data generally are not used for AP-42, these data were retained because several additional report of single run tests are available for this source.

4.1.2.1.2 <u>Reference 41</u>. This reference documents a single test run on the pushing emissions control system on coke oven Battery A at the Bethlehem Steel plant in Bethlehem, Pennsylvania, on December 15, 198[illegible]. Pushing emissions from the Battery are captured by a hood mounted on the door machine and are ducted to a combination venturi scrubber (two parallel scrubbers) and cyclonic separator system before being vented to the atmosphere. The scrubber pressure drops were about 35 in. w.c. on both scrubbers during testing. Filterable PM emissions were measured at the control system exhaust stack using EPA Method 5. Weights are also recorded for soluble and insoluble back-half particulate, but the analysis method does not appear to be comparable to EPA-approved methodology for determining condensible PM emissions. Therefore, the condensible PM data were not used to develop emission factors. Process rates, based on a daily average, are provided in units of tons per hour of coke pushed.

The test data are assigned a C rating. The report includes adequate detail, the test methodology was sound, and no problems were reported, but only a single test run was performed on the battery. Although single run test data generally are not used for AP-42, these data were retained because several additional report of single run tests are available for this source.

4.1.2.1.3 <u>Reference 42</u>. This reference documents a single test run on the pushing emissions control system on coke oven Battery A at the Bethlehem Steel plant in Bethlehem, Pennsylvania, on August 30, 1990. Pushing emissions from the Battery are captured by a hood mounted on the door machine and are ducted to a combination venturi scrubber (two parallel scrubbers) and cyclonic separator system before being vented to the atmosphere. The scrubber pressure drops were about 33 to 40 in. w.c. on both scrubbers during testing. Filterable PM emissions were measured at the control system exhaust stack using EPA Method 5. Weights are also recorded for soluble and insoluble back-half particulate, but the analysis method does not appear to be comparable to EPA-approved methodology for determining condensible PM emissions. Therefore, the condensible PM data were not used to develop emission factors. Process rates, based on a daily average, are provided in units of tons per hour of coke pushed.

The test data are assigned a C rating. The report includes adequate detail, the test methodology was sound, and no problems were reported, but only a single test run was performed on the battery.

Although single run test data generally are not used for AP-42, these data were retained because several additional report of single run tests are available for this source.

4.1.2.1.4 Reference 43. This reference documents a single test run on the pushing emissions control system on coke oven Battery A at the Bethlehem Steel plant in Bethlehem, Pennsylvania, on August 20, 1991. Pushing emissions from the Battery are captured by a hood mounted on the door machine and are ducted to a combination venturi scrubber (two parallel scrubbers) and cyclonic separator system before being vented to the atmosphere. The scrubber pressure drops are not documented in the report. Filterable PM emissions were measured at the control system exhaust stack using EPA Method 5. Weights are also recorded for soluble and insoluble back-half particulate, but the analysis method does not appear to be comparable to EPA-approved methodology for determining condensible PM emissions. Therefore, the condensible PM data were not used to develop emission factors. Process rates, based on a daily average, are provided in units of tons per hour of coke pushed.

The test data are assigned a C rating. The report includes adequate detail, the test methodology was sound, and no problems were reported, but only a single test run was performed on the battery. Although single run test data generally are not used for AP-42, these data were retained because several additional report of single run tests are available for this source.

4.1.2.1.5 Reference 44. This reference documents a single test run on the pushing emissions control system on coke oven Battery A at the Bethlehem Steel plant in Bethlehem, Pennsylvania, on November 24, 1992. Pushing emissions from the Battery are captured by a hood mounted on the door machine and are ducted to a combination venturi scrubber (two parallel scrubbers) and cyclonic separator system before being vented to the atmosphere. The scrubber pressure drops are not documented in the report. Filterable PM emissions were measured at the control system exhaust stack using EPA Method 5. Weights are also recorded for soluble and insoluble back-half particulate, but the analysis method does not appear to be comparable to EPA-approved methodology for determining condensible PM emissions. Therefore, the condensible PM data were not used to develop emission factors. Process rates, based on a daily average, are provided in units of tons per hour of coke pushed.

The test data are assigned a C rating. The report includes adequate detail, the test methodology was sound, and no problems were reported, but only a single test run was performed on the battery. Although single run test data generally are not used for AP-42, these data were retained because several additional report of single run tests are available for this source.

4.1.2.1.6 Reference 45. This reference documents an emission test conducted on the "C" coke oven combustion stack at Rouge Steel Company in Michigan on July 1, 1986. The Rouge Steel Company uses a Koppers combination gun-flue type byproduct coke oven battery. Enriched blast furnace gas is used as fuel for firing the battery. The waste gas passes through an ESP before being exhausted to the atmosphere. Filterable PM and CO_2 emissions were measured downstream of the ESP using EPA Methods 5 and 3 (with Orsat analyzer), respectively. Three test runs were conducted.

The test data are assigned an A rating. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.7 Reference 46. This reference documents an emission test conducted on the "C" coke oven pushing shed baghouse stack at Rouge Steel Company in Michigan on July 8 through 10, 1986. The Rouge Steel Company uses a Flakt Norfelt, Model 6NF 378-12, Fabric Filter Dust Collector on the pushing shed baghouse. Filterable PM emissions were measured using EPA Method 5. Three test runs were conducted. This emissions test was repeated in March 1987 because the results indicated that the system was not operating as efficiently as expected (see Reference 47).

The test data are assigned an A rating. The report includes adequate detail and the test methodology was sound. One problem was reported during the third test run; the umbilical cord fell from its support and jarred the sample box. A leak check was performed prior to sampling the next point and the train proved to be leak-free. The air volume allocated for the leak check was subtracted from the sample volume for Test No. 3. This problem probably did not affect the emission measurements.

4.1.2.1.8 Reference 47. This reference documents an emission test conducted on the "C" coke oven pushing shed baghouse stack at Rouge Steel Company in Michigan on March 25 through 27, 1987. The Rouge Steel Company uses a Flakt Norfelt, Model 6NF 378-12, Fabric Filter Dust Collector on the pushing shed baghouse. Filterable PM emissions were measured using EPA Method 5. Three test runs were conducted, but the results from Run 3 were not used for emission factor development because of reported problems with the fabric filter. A previous emissions test was performed on this system in July 1986 (see Reference 46).

The test data are assigned a B rating because only two valid test runs were conducted. The report includes adequate detail, the test methodology was sound, and no problems were reported during test Runs 1 and 2.

4.1.2.1.9 Reference 48. This reference documents an emission test conducted on the No. 1 Push Control Scrubber stack for “A” and “Ax” coke oven batteries at Rouge Steel Company in Michigan. Push emissions are carried up an exhaust hood to a high-energy Kinpactor wet scrubber. Filterable and condensible inorganic PM emissions were measured using EPA Method 5. Three test runs were conducted.

The test data are assigned a C rating for the following reasons. The isokinetic sampling ratios for two of the three runs were 113 percent, slightly exceeding the 110 percent limit. Also, due to the intermittent operation of this system and because the flow profile is fairly uniform, the plant chose to use only 16 sampling points per test, rather than the EPA’s recommended 24 sampling points.

4.1.2.1.10 Reference 56. This reference documents a compliance demonstration conducted on the combustion stack for Battery 14 at the USS Clairton Works in Clairton, Pennsylvania, on June 20, 1990. Filterable PM and CO_2 emissions were measured at the combustion stack using EPA Methods 5 and 3, respectively. Weights are also recorded for soluble and insoluble back-half particulate, but the analysis method does not appear to be comparable to EPA-approved methodology for determining condensible PM emissions. Therefore, the condensible PM data were not used to develop emission factors. Three test runs were performed. Process rates in units of tons of coke pushed per hour were calculated using push schedules provided in the report in conjunction with an average oven size from a prior compliance test on Battery 14 (12.2 tons per oven). Push schedules are provided for Batteries A13, B13, A14, B14, A15, and B15. The push schedules for A14 and B14 were used to calculate the production rates for Battery 14.

The test data are assigned a B rating because the process information was incomplete and was supplemented with information from another report on the same source. The report included adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.11 Reference 57. This reference documents a compliance demonstration conducted on the combustion stack for Battery 13 at the USS Clairton Works in Clairton, Pennsylvania, on July 10, 1990. Filterable PM and CO_2 emissions were measured at the combustion stack using EPA Methods 5 and 3, respectively. Weights are also recorded for soluble and insoluble back-half particulate, but the analysis method does not appear to be comparable to EPA-approved methodology for determining condensible PM emissions. Therefore, the condensible PM data were not used to develop emission factors. Three test runs were performed. Process rates in units of tons of coke pushed per hour were calculated using push schedules provided in the report in conjunction with an average oven size from a prior compliance test on Battery 13 (12.2 tons per oven). Push schedules are provided for Batteries A13, B13, A14, B14, A15, and B15. The push schedules for A13 and B13 were used to calculate the production rates for Battery 13.

The test data are assigned a B rating because the process information was incomplete and was supplemented with information from another report on the same source. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.12 Reference 58. This reference documents a compliance demonstration conducted on the combustion stack for Battery 7 at the USS Clairton Works in Clairton, Pennsylvania, on August 22, 1990. Filterable PM and CO_2 emissions were measured at the combustion stack using EPA Methods 5 and 3, respectively. Weights are also recorded for soluble and insoluble back-half particulate, but the analysis method does not appear to be comparable to EPA-approved methodology for determining condensible PM emissions. Therefore, the condensible PM data were not used to develop emission factors. Three test runs were performed. Process rates in units of tons of coke pushed per hour were calculated using push schedules provided in the report in conjunction with an average oven size from prior compliance tests on Battery 7 (11 tons per oven). Push schedules are provided for Batteries A7, B7, A8, and B8. The push schedules for A7 and B7 were used to calculate the production rates for Battery 7.

The test data are assigned a B rating because the process information was incomplete and was supplemented with information from another report on the same source. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.13 Reference 59. This reference documents a compliance demonstration conducted on the combustion stack for Battery 19 at the USS Clairton Works in Clairton, Pennsylvania, on November 14, 1990. Filterable PM and CO_2 emissions were measured at the combustion stack using EPA Methods 5 and 3, respectively. Weights are also recorded for soluble and insoluble back-half particulate, but the analysis method does not appear to be comparable to EPA-approved methodology for determining condensible PM emissions. Therefore, the condensible PM data were not used to develop emission factors. Three test runs were performed. Process rates in units of tons of coke pushed per hour were calculated using push schedules provided in the report in conjunction with an average oven size from prior compliance tests on Battery 19 11 tons per oven). Push schedules are provided for Batteries 19 and 20. The push schedules for A19, B19, and C19 were used to calculate the production rates for Battery 19.

The test data are assigned a B rating because the process information was incomplete and was supplemented with information from another report on the same source. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.14 Reference 60. This reference documents a compliance demonstration conducted on the combustion stack for Battery 1 at the USS Clairton Works in Clairton, Pennsylvania, on November 27, 1991. Filterable PM and CO_2 emissions were measured at the combustion stack using EPA Methods 5 and 3, respectively. Weights are also recorded for soluble and insoluble back-half particulate, but the analysis method does not appear to be comparable to EPA-approved methodology for determining condensible PM emissions. Therefore, the condensible PM data were not used to develop emission factors. Three test runs were performed. Process rates in units of tons of coke pushed per hour were calculated using push schedules provided in the report in conjunction with an average oven size from prior compliance tests on Battery 1 (11 tons per oven). Push schedules are provided for Batteries 1, 2, and 3. The push schedules for A1 and B1 were used to calculate the production rates for Battery 1.

The test data are assigned a B rating because the process information was incomplete and was supplemented with information from another report on the same source. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.15 Reference 61. This reference documents a compliance demonstration conducted on the combustion stack for Battery 13 at the USS Clairton Works in Clairton, Pennsylvania, on March 12, 1992. Filterable PM and CO_2 emissions were measured at the combustion stack using EPA Methods 5 and 3, respectively. Weights are also recorded for soluble and insoluble back-half particulate, but the analysis method does not appear to be comparable to EPA-approved methodology for determining condensible PM emissions. Therefore, the condensible PM data were not used to develop emission factors. Three test runs were performed. Process rates in units of tons of coke pushed per hour were calculated using push schedules provided in the report in conjunction with an average oven size from prior compliance tests on Battery 13 (12.2 tons per oven). Push schedules are provided for Batteries 13, 14, and 15. The push schedules for A13 and B13 were used to calculate the production rates for Battery 13.

The test data are assigned a B rating because the process information was incomplete and was supplemented with information from another report on the same source. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.16 Reference 62. This reference documents a compliance demonstration conducted on the combustion stack for Battery 14 at the USS Clairton Works in Clairton, Pennsylvania, on March 24, 1992. Filterable PM and CO_2 emissions were measured at the combustion stack using EPA Methods 5 and 3, respectively. Weights are also recorded for soluble and insoluble back-half particulate, but the analysis method does not appear to be comparable to EPA-approved methodology for determining condensible PM emissions. Therefore, the condensible PM data were not used to develop emission factors. Three test runs were performed. Process rates in units of tons of coke pushed per hour were calculated using push schedules provided in the report in conjunction with an average oven size from prior compliance tests on Battery 14 (12.2 tons per oven). Push schedules are provided for Batteries 13, 14, and 15. The push schedules for A14 and B14 were used to calculate the production rates for Battery 13.

The test data are assigned a B rating because the process information was incomplete and was supplemented with information from another report on the same source. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.17 Reference 63. This reference documents a compliance demonstration conducted on the combustion stack for Battery B at the USS Clairton Works in Clairton, Pennsylvania, on June 7, 1992. Filterable PM and CO_2 emissions were measured at the combustion stack using EPA Methods 5 and 3, respectively. Weights are also recorded for soluble and insoluble back-half particulate, but the analysis method does not appear to be comparable to EPA-approved methodology for determining condensible PM emissions. Therefore, the condensible PM data were not used to develop emission factors. Three test runs were performed. Process rates in units of tons of coke pushed per hour were calculated using push schedules provided in the report in conjunction with an average oven size from prior compliance tests on Battery B (25.1 tons per oven).

The test data are assigned a B rating because the process information was incomplete and was supplemented with information from another report on the same source. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.18 Reference 64. This reference documents a compliance demonstration conducted on the combustion stack for Battery 19 at the USS Clairton Works in Clairton, Pennsylvania, on July 30, 1992. Filterable PM and CO_2 emissions were measured at the combustion stack using EPA Methods 5 and 3, respectively. Weights are also recorded for soluble and insoluble back-half particulate, but the analysis method does not appear to be comparable to EPA-approved methodology for determining condensible PM emissions. Therefore, the condensible PM data were not used to develop emission factors. Three test runs were performed. Process rates in units of tons of coke pushed per hour were calculated using push schedules provided in the report in conjunction with an average oven size from prior compliance tests on Battery 19 (14.8 tons per oven). Push schedules are provided for Batteries 19 and 20. The push schedules for A19 and B19 were used to calculate the production rates for Battery 19.

The test data are assigned a B rating because the process information was incomplete and was supplemented with information from another report on the same source. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.19 <u>Reference 65</u>. This reference documents a compliance demonstration conducted on the combustion stack for Battery 9 at the USS Clairton Works in Clairton, Pennsylvania, on October 8, 1992. Filterable PM and CO_2 emissions were measured at the combustion stack using EPA Methods 5 and 3, respectively. Three test runs were performed. Process rates in units of tons of coke pushed per hour were calculated using push schedules provided in the report in conjunction with an average oven size from prior compliance tests on Battery 9 (11 tons per oven). Push schedules are provided for Batteries 7, 8, and 9. The push schedules labeled A9 and B9 were used to calculate the production rates for Battery 9.

The test data are assigned a B rating because the process information was incomplete and was supplemented with information from another report on the same source. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.20 <u>Reference 66</u>. This reference documents emission testing conducted at the outlet of the fabric filter that controls pushing emissions from Batteries 1, 2, and 3 at USS Clairton Works in Clairton, Pennsylvania, on November 3, 1992. The fabric filter exhausts through four individual stacks. Filterable PM emissions were measured using three EPA Method 5 test runs on each of the 4 stacks. Process information was recorded in tons of coke produced/hr.

The test data are assigned an A rating. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.21 <u>Reference 67</u>. This reference documents a compliance demonstration conducted on the fabric filter which controls pushing emissions from Battery B at USS Clairton Works in Clairton, Pennsylvania, on November 17 and 18, 1992, August 24, 1993, and October 6, 1993. The fabric filter exhausts through 14 individual stacks, 12 of which operate at a given time. A test run was performed on each of the 14 stacks, and several of the runs were repeated because of unusual results (assumed to stem from unidentified sampling problems) from initial testing. Filterable PM emissions were measured using EPA Method 5. Process information was recorded in tons of coke produced/hr.

The test data are assigned a C rating because only one complete test run was conducted (although 14 individual stacks were tested). The report includes adequate detail and the test methodology was sound. It should be noted that four of the twelve stacks were tested at a later date under the same operating conditions because four of the test runs from the original test were flawed.

4.1.2.1.22 Reference 69. This reference documents emission testing conducted at the outlet of the fabric filter that controls pushing emissions from Batteries 7, 8, and 9 at USS Clairton Works in Clairton, Pennsylvania, on December 8 through 10, 1992. The fabric filter exhausts through four individual stacks. Filterable PM emissions were measured using three EPA Method 5 test runs on each of the 4 stacks. Process information was recorded in tons of coke produced/hr. During Run 1, the Method 5 isokinetic requirement was not satisfied on three of the four stacks tested. Therefore, Run 1 was not used for emission factor development.

The test data are assigned a B rating because only two valid test runs were conducted. Otherwise, the report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.23 Reference 70. This reference documents a compliance demonstration conducted on the combustion stack for Battery 3 at the USS Clairton Works in Clairton, Pennsylvania, on August 4 and 5, 1993. Filterable PM and CO_2 emissions were measured at the combustion stack using EPA Methods 5 and 3, respectively. Three test runs were performed. Process rates in units of tons of coke pushed per hour were calculated using push schedules provided in the report in conjunction with an average oven size from prior compliance tests on Battery 3 (11 tons per oven). Push schedules are provided for Batteries 1, 2, and 3. The push schedules labeled A3 and B3 were used to calculate the production rates for Battery 3.

The test data are assigned a B rating because the process information was incomplete and was supplemented with information from another report on the same source. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.24 Reference 71. This reference documents a compliance demonstration conducted on the combustion stack for Battery 2 at the USS Clairton Works in Clairton, Pennsylvania, on August 25 and 26, 1993. Filterable PM and CO_2 emissions were measured at the combustion stack using EPA Methods 5 and 3, respectively. Process rates in units of tons of coke pushed per hour were calculated using push schedules provided in the report in conjunction with an average oven size from prior compliance tests on Battery 2 (11 tons per oven). Push schedules are provided for Batteries 1, 2, and 3. The push schedules labeled A2 and B2 were used to calculate the production rates for Battery 2.

The test data are assigned a B rating because the process information was incomplete and was supplemented with information from another report on the same source. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.25 Reference 72. This reference documents emission testing conducted at the outlet of the fabric filter that controls pushing emissions from Batteries 19 and 20 at USS Clairton Works in Clairton, Pennsylvania, on October 21 through 23, 1992. The fabric filter exhausts through four individual stacks. Filterable PM emissions were measured using three EPA Method 5 test runs on each of the 4 stacks. Therefore, the condensible PM data were not used to develop emission factors. Process information was recorded in tons of coke produced/hr.

The test data are assigned an A rating. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.26 Reference 73. This reference documents emission testing conducted at the outlet of the fabric filter that controls pushing emissions from Batteries 13, 14, and 15 at USS Clairton Works in Clairton, Pennsylvania, on October 19 through 21, 1993. The fabric filter exhausts through four individual stacks. Filterable PM emissions were measured using three EPA Method 5 test runs on each of the 4 stacks. Therefore, the condensible PM data were not used to develop emission factors. Process information was recorded in tons of coke produced/hr.

The test data are assigned an A rating. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.27 Reference 74. This reference documents emission testing conducted at the outlet of the fabric filter that controls pushing emissions from Batteries 1, 2, and 3 at USS Clairton Works in Clairton, Pennsylvania, on February 22 through 24, 1994. The fabric filter exhausts through four individual stacks. Filterable PM emissions were measured using three EPA Method 5 test runs on each of the 4 stacks. Therefore, the condensible PM data were not used to develop emission factors. Process information was recorded in tons of coke produced/hr.

The test data are assigned an A rating. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.28 Reference 75. This reference documents emission testing conducted at the outlet of the fabric filter that controls pushing emissions from Batteries 7, 8, and 9 at USS Clairton Works in Clairton, Pennsylvania, on March 10 through 12, 1994. The fabric filter exhausts through four individual stacks. Filterable PM emissions were measured using three EPA Method 5 test runs on each of the 4 stacks. Therefore, the condensible PM data were not used to develop emission factors. Process information was recorded in tons of coke produced/hr.

The test data are assigned an A rating. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.29 Reference 76. This reference documents a compliance demonstration conducted on the combustion stack for Battery 7 at the USS Clairton Works in Clairton, Pennsylvania, on February 26 and 27, 1994. Filterable PM and CO_2 emissions were measured at the combustion stack using EPA Methods 5 and 3, respectively. Process rates in units of tons of coke pushed per hour were calculated using push schedules provided in the report in conjunction with an average oven size from prior compliance tests on Battery 7 (11 tons per oven). Push schedules are provided for Batteries 7, 8, and 9. The push schedules labeled A7 and B7 were used to calculate the production rates for Battery 7.

The test data are assigned a B rating because the process information was incomplete and was supplemented with information from another report on the same source. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.30 Reference 77. This reference documents a compliance demonstration conducted on the combustion stack for Battery 9 at the USS Clairton Works in Clairton, Pennsylvania, on May 11 and 12, 1994. Filterable PM and CO_2 emissions were measured at the combustion stack using EPA Methods 5 and 3, respectively. Process rates in units of tons of coke pushed per hour were calculated using push schedules provided in the report in conjunction with an average oven size from prior compliance tests on

Battery 9 (11 tons per oven). Push schedules are provided for Batteries 7, 8, and 9. The push schedules labeled A9 and B9 were used to calculate the production rates for Battery 9.

The test data are assigned a B rating because the process information was incomplete and was supplemented with information from another report on the same source. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.31 Reference 78. This reference documents a compliance demonstration conducted on the combustion stack for Battery 13 at the USS Clairton Works in Clairton, Pennsylvania, on July 28 and 29, 1994. Filterable PM and CO_2 emissions were measured at the combustion stack using EPA Methods 5 and 3, respectively. Weights are also recorded for soluble and insoluble back-half particulate, but the analysis method does not appear to be comparable to EPA-approved methodology for determining condensible PM emissions. Therefore, the condensible PM data were not used to develop emission factors. Three test runs were performed. Process rates in units of tons of coke pushed per hour were calculated using push schedules provided in the report in conjunction with an average oven size from prior compliance tests on Battery 13 (12.2 tons per oven). Push schedules are provided for Batteries 13, 14, and 15. The push schedules labeled A13 and B13 were used to calculate the production rates for Battery 13.

The test data are assigned a B rating because the process information was incomplete and was supplemented with information from another report on the same source. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.32 Reference 80. This reference documents a compliance demonstration conducted on the combustion stack for Battery 19 at the USS Clairton Works in Clairton, Pennsylvania, on August 24, 1994. Filterable PM and CO_2 emissions were measured at the combustion stack using EPA Methods 5 and 3, respectively. Process rates in units of tons of coke pushed per hour were calculated using push schedules provided in the report in conjunction with an average oven size from prior compliance tests on Battery 19 (14.8 tons per oven). Push schedules are provided for Batteries 19 and 20. The push schedules labeled A19 and B19 were used to calculate the production rates for Battery 19.

The test data are assigned a B rating because the process information was incomplete and was supplemented with information from another report on the same source. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.33 Reference 81. This reference documents a compliance demonstration conducted on the combustion stack for Battery 20 at the USS Clairton Works in Clairton, Pennsylvania, on September 21, 1994. Filterable PM and CO_2 emissions were measured at the combustion stack using EPA Methods 5 and 3, respectively. Process rates in units of tons of coke pushed per hour were calculated using push schedules provided in the report in conjunction with an average oven size from prior compliance tests on Battery 20 (14.8 tons per oven). Push schedules are provided for Batteries 19 and 20. The push schedules labeled A20, B20, and C20 were used to calculate the production rates for Battery 20.

The test data are assigned a B rating because the process information was incomplete and was supplemented with information from another report on the same source. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.34 Reference 83. This reference documents a compliance demonstration conducted on the combustion stack for Battery 3 at the USS Clairton Works in Clairton, Pennsylvania, on August 1, 1990. Filterable PM and CO_2 emissions were measured at the combustion stack using EPA Methods 5 and 3, respectively. Process rates in units of tons of coke pushed per hour were calculated using push schedules provided in the report in conjunction with an average oven size from prior compliance tests on Battery 3 (11 tons per oven). Push schedules are provided for Batteries 1, 2, and 3. The push schedules labeled A3 and B3 were used to calculate the production rates for Battery 3.

The test data are assigned a B rating because the process information was incomplete and was supplemented with information from another report on the same source. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.43.1.35 Reference 84. This reference documents an emission test conducted on the C and E Coke Oven Battery stack systems at Kaiser Steel Corporation in Fontana, California. Both batteries were fired with coke oven gas during the test period. Emissions from the C and E Coke Oven Batteries are controlled by a fabric filter. The testing for filterable PM and condensible inorganic PM emissions at Battery C consisted of three EPA Method 5 test runs. The testing for filterable PM and condensible inorganic PM emissions at Battery E consisted of three EPA Method 5 test runs and three EPA Method 17 runs (for comparison purposes). Only the Method 5 results were included in the emissions calculations. A Carle Basic gas chromatograph with a thermal conductivity detector was used to determine CO_2 emissions.

The test data are assigned an A rating. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.36 Reference 85. This reference documents an emission test conducted on the Coke Oven Battery E combustion stack at Kaiser Steel Corporation in Fontana, California, on February 12 and 13, 1979. The Battery was heated with blast furnace gas during the test period. Emissions from the combustion stack were controlled by a fabric filter. The testing for filterable PM consisted of three EPA Method 5 test runs. The testing for inorganic condensible PM consisted of the evaporation and gravimetric analysis of the material collected in the back half impinger. The sulfuric acid component of the inorganic condensible PM is also reported in the test report. The testing also included CO_2 measurements using a Horiba MEXA/200 infrared analyzer.

The test data are assigned a B rating because the production data reported (i.e., number of ovens per Battery and tons of coal charged per oven) were plant averages and may not be accurate during the actual test period. Otherwise, the report included adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.37 Reference 86. This reference documents an emission test conducted on the Coke Oven Battery C combustion stack at Kaiser Steel Corporation in Fontana, California, on March 26 and 27, 1979. The Battery was heated with coke oven gas during the test period. Emissions from the combustion stack were controlled by a fabric filter. The testing for filterable PM consisted of three EPA Method 5 test runs. The testing for inorganic condensible PM consisted of the evaporation and gravimetric analysis of the material collected in the back half impinger. The sulfuric acid component of the inorganic condensible PM is also reported in the test report. The testing also included CO_2 measurements using a Horiba MEXA/200 infrared analyzer.

The test data are assigned a B rating because the production data reported (i.e., number of ovens per Battery and tons of coal charged per oven) were plant averages and may not be accurate during the actual test period. Otherwise, the report included adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.38 Reference 87 This reference documents an emission test conducted on the Coke Oven Battery B combustion stack at Kaiser Steel Corporation in Fontana, California, on July 26 and 27, 1979. The Battery was heated with coke oven gas during the test period. Emissions from the combustion stack were controlled by a fabric filter. The testing for filterable PM consisted of three EPA Method 5 test runs. The testing for organic and inorganic condensible PM consisted of the extraction of the organic material from the water and separate evaporation and gravimetric analysis of the material collected in the back half impinger. The sulfuric acid component of the inorganic condensible PM is also reported in the test report. The testing also included CO_2 measurements using a Horiba MEXA/200 infrared analyzer.

The test data are assigned a B rating because the production data reported (i.e., number of ovens per Battery and tons of coal charged per oven) were plant averages and may not be accurate during the actual test period. Otherwise, the report included adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.39 Reference 88 This reference documents an emission test conducted on the Coke Oven Battery D combustion stack at Kaiser Steel Corporation in Fontana, California, on November 27 and 28, 1978. The Battery was heated with coke oven gas during the test period. Emissions from the combustion stack were controlled by a fabric filter. The testing for filterable PM consisted of three EPA Method 5 test runs. The testing for inorganic condensible PM consisted of the evaporation and gravimetric analysis of the material collected in the back half impinger. The sulfuric acid component of the inorganic condensible PM is also reported in the test report. The testing also included CO_2 measurements using a Horiba MEXA/200 infrared analyzer.

The test data are assigned a B rating because the production data reported (i.e., number of ovens per Battery and tons of coal charged per oven) were plant averages and may not be accurate during the actual test period. Otherwise, the report included adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.40 Reference 89. This reference documents an emission test conducted on the Coke Oven Battery B combustion stack at Kaiser Steel Corporation in Fontana, California, on September 17 and 22, 1979. The Battery was heated with coke oven gas during the test period. Emissions from the combustion stack were controlled by a fabric filter. Filterable PM and condensible inorganic PM emissions were measured at the fabric filter inlet and outlet using EPA Method 5 (front- and back-half analyses). Carbon monoxide emissions were measured at the fabric filter outlet using EPA Method 10. Benzene emissions were measured at the fabric filter outlet using an integrated-bag sampling train and GC-FID analysis. Benzo(a)pyrene emissions were measured at the fabric filter inlet and outlet using a modified Method 5 sampling train with a spectrofluorometer. The testing also included CO_2 measurements using EPA Method 3 (with an infrared analyzer).

The test data are assigned a C rating for several reasons. First, the production data reported (i.e., number of ovens per Battery and tons of coal charged per oven) were plant averages and may not be accurate during the actual test period. Second, EPA Reference test methods were not used for the benzo(a)pyrene and benzene tests. Finally, raw data sheets, calibration data, and other details about the testing are not included in the report.

4.1.2.1.41 <u>Reference 91</u>. This reference documents an emission test conducted on the Coke Oven B combustion stack at Rouge Steel Company in Michigan on November 29 through December 2, 1982. The unit tested was a Koppers combination gun-flue type byproduct coke oven Battery fired with blast furnace gas. Uncontrolled filterable PM emissions were measured using EPA Method 5. Six test runs were conducted, and process rates were provided in units of tons of coal charged per test run. Because of discrepancies in the charge rates recorded for each run, an average process rate was calculated for the entire test. This average process rate was used to calculate emission factors for each test run. Several ovens within the Battery were undergoing repairs during testing.

The test data are assigned a B rating because an average process rate was used. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.42 <u>Reference 93</u>. This reference documents an emission test conducted on the hooded quench car system No. 1 at Republic Steel Corporation in Warren, Ohio, on October 12 through 16, 1981. The quench car system includes a hooded quench car and scrubber, but details about the system are not provided in the report. Uncontrolled filterable PM and CO_2 emissions were measured using EPA Methods 5 and 3 (with Fyrite analyzer). Three test runs were conducted, and process rates were provided in units of tons of coke quenched per hour. The reported PM concentration for Run 1 appears to be incorrect based on the reported PM catch and sample volume. The concentration based on the reported PM catch and sample volume was used for emission factor calculations.

The test data are assigned a C rating because details are not provided about the process. Otherwise, the test methodology was sound, and no problems were reported.

4.1.2.1.43 <u>Reference 94</u>. This reference documents an emission test conducted on quench car system No. 2 at Republic Steel Corporation in Warren, Ohio, on October 19 through 23, 1981. The quench car system includes a hooded quench car and scrubber, but details about the system are not provided in the report. Uncontrolled filterable PM and CO_2 emissions were measured using EPA Methods 5 and 3 (with Fyrite analyzer). Three test runs were conducted, and process rates were provided in units of tons of coke quenched per hour.

The test data are assigned a C rating because details are not provided about the process. Otherwise, the test methodology was sound, and no problems were reported.

4.1.2.1.44 Reference 95. This reference documents an emission test conducted on a hooded quench car system at Republic Steel Corporation in Youngstown, Ohio, on October 27 through 29, 1981. The quench car system includes a hooded quench car and scrubber, but details about the system are not provided in the report. Uncontrolled filterable PM and CO_2 emissions were measured using EPA Methods 5 and 3 (with Fyrite analyzer). Three test runs were conducted, and process rates were provided in units of tons of coke quenched per hour.

The test data are assigned a C rating because details are not provided about the process. Otherwise, the test methodology was sound, and no problems were reported.

4.1.2.1.45 Reference 96. This reference documents an emission test conducted on the No. 21 quench car system at Republic Steel Corporation in Cleveland, Ohio, on April 7 through 9, 1981. The quench car system includes a hooded quench car and scrubber, but details about the system are not provided in the report. Uncontrolled filterable PM and CO_2 emissions were measured using EPA Methods 5 and 3 (with Fyrite analyzer). Three test runs were conducted, and process rates were provided in units of tons of coke quenched per hour.

The test data are assigned a C rating because details are not provided about the process. Otherwise, the test methodology was sound, and no problems were reported.

4.1.2.1.46 Reference 97. This reference documents an emission test conducted on the No. 22 quench car system at Republic Steel Corporation in Cleveland, Ohio, on April 14 and 15, 1981. The quench car system includes a hooded quench car and scrubber, but details about the system are not provided in the report. Uncontrolled filterable PM and CO_2 emissions were measured using EPA Methods 5 and 3 (with Fyrite analyzer). Three test runs were conducted, and process rates were provided in units of tons of coke quenched per hour. Test run 1 did not satisfy the Method 5 isokinetic requirements, but the data were used for emission factor development because the test results were consistent with the other test runs.

The test data are assigned a C rating because details are not provided about the process. Otherwise, the test methodology was sound, and no problems were reported.

4.1.2.1.47 Reference 98. This reference documents an EPA-sponsored emission test conducted on the No. 1 coke Battery combustion stack at Republic Steel Corporation in Cleveland, Ohio, during the weeks of October 26, 1981 and December 7, 1981. Filterable PM, condensible inorganic PM, condensible organic PM, SO_2, and CO_2 emissions were measured using EPA Methods 5 (front- and back-half analysis), 8, and 3. Sampling during the week of October 26 was conducted while Battery was heated with non-desulfurized COG, and sampling during the week of December 7 was conducted while Battery was heated with desulfurized COG. The EPA Method 5 and 8 sampling train was modified into a quad sampling train arrangement and two additional sampling trains. A test run consisted of the operation of the quad train and the two single trains. The Method 5 filter temperatures were adjusted from run to run to determine the affect of filter temperature on emissions. The data for filterable PM, condensible inorganic PM, and condensible organic PM were used (for AP-42 emission factor development) only if the filter temperature was within the limits specified by EPA Method 5 (248°F ±25°F). The SO_2 and CO_2 data were used (for AP-42 emission factor development) regardless of the filter temperature. Six test runs were conducted for each fuel type, and process rates were provided in units of tons of coal charged per hour. Test runs that included condensible PM analysis did not include SO_2 analysis (and vice versa) because both analyses require the use of the Method 5 back-half catch.

The test data are assigned an A rating. The report included adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.48 Reference 100. This emission test was performed at USS Clairton Works by APT in cooperation with USSC and EVT. The compliance test results presented in this report are for tests completed on October 1 through 3, 1985. The emissions test included filterable PM and condensible PM emissions from the hooded quench car (HQC) No. 102 operating on the No. 7, 8, and 9 coke batteries.

Filterable PM emissions were measured using EPA Method 5 modified with two impinger trains in parallel to accommodate the high sample flow rate required to collect a sample volume greater than 30 dscf. Weights are recorded for soluble and insoluble back-half particulate. These emissions are assumed to be comparable to the inorganic condensible portion of EPA Method 202. Three compliance test were conducted during normal coking conditions. Batteries 7, 8, and 9 were considered new sources and were subject to the LAER standard. The applicable LAER emissions standard for PM is less than or equal to 0.04 pounds per ton of coke pushed.

A rating of C was assigned to the filterable particulate tests performed on the HQC. A rating of D was assigned to the inorganic condensible particulate tests. Process descriptions were provided and the data were presented with adequate detail. Actual field data with pertinent operating conditions were provided. The manner in which the source was operated is well documented in the report. However, the report infers that the source may not have been operating within typical parameters during the test. During the PM emission compliance testing the test car attached to the HQC system, created additional pressure drop to the system which decreases the gas flow rate and the ability of the HQC system to capture fugitive emissions. It is stated in the report that opacity observations with the test car disconnected were permitted in the compliance test protocol and will improve the visible emissions performance. Although the visible emissions readings are not available, the report does not provide additional statements concerning high particulate or opacity readings.

4.1.2.1.49 Reference 101. This emission test was performed at USS Clairton Works by APT in cooperation with USSC and EVT. The compliance test results presented in this report are for tests completed on August 6, 13, and 14, 1985. The emissions test included filterable PM and condensible PM emissions. The source for the test was the EVT HQC No. 105 operating on the No. 19 coke Battery located at USSC's Clairton Cokeworks.

Filterable PM emissions were measured using EPA Method 5 modified with two impinger trains in parallel to accommodate the high sample flow rate required to collect a sample volume greater than 30 dscf. Weights are recorded for soluble and insoluble back-half particulate. These emissions are assumed to be comparable to the inorganic condensible portion of EPA Method 202. Three compliance test were conducted during normal coking conditions. Battery 19 was considered a new source and was subject to the LAER standard. The applicable LAER emissions standard for PM is less than or equal to 0.04 pounds per ton of coke pushed.

A rating of C was assigned to the filterable particulate tests performed on the HQC. A rating of D was assigned to the inorganic condensible particulate tests. Process descriptions were provided and the data were presented with adequate detail. Actual field data with pertinent operating conditions were provided. The manner in which the source was operated is well documented in the report. However, the report infers that the source may not have been operating within typical parameters during the test. During the PM emission compliance testing the test car attached to the HQC system, created additional pressure drop to the system which decreases the gas flow rate and the ability of the HQC system to capture fugitive emissions. It is stated in the report that opacity observations with the test car disconnected were permitted in the compliance test protocol and will improve the visible emissions performance. Although the visible emissions readings are not available, the report does not provide additional statements concerning high particulate or opacity readings.

4.1.2.1.50 Reference 102. This emission test was performed at USS Clairton Works by APT in cooperation with USSC and EVT. The compliance test results presented in this report are for tests completed on September 12, 16, and 18, 1985. The emissions test included filterable PM and condensible PM emissions. The source for the test was the EVT HQC No. 101 operating on the No. 7, 8, and 9 coke batteries located at USSC's Clairton Cokeworks.

Filterable PM emissions were measured using EPA Method 5 modified with two impinger trains in parallel to accommodate the high sample flow rate required to collect a sample volume greater than 30 dscf. Weights are recorded for soluble and insoluble back-half particulate. These emissions are assumed to be comparable to the inorganic condensible portion of EPA Method 202. Three compliance test were conducted during normal coking conditions. Batteries 7, 8, and 9 were considered new sources and were subject to the LAER standard. The applicable LAER emissions standard for PM is less than or equal to 0.04 pounds per ton of coke pushed.

A rating of C was assigned to the filterable particulate tests performed on the HQC. A rating of D was assigned to the inorganic condensible particulate tests. Process descriptions were provided and the data were presented with adequate detail. Actual field data with pertinent operating conditions were provided. The manner in which the source was operated is well documented in the report. However, the report infers that the source may not have been operating within typical parameters during the test. During the PM emission compliance testing the test car attached to the HQC system, created additional pressure drop to the system which decreases the gas flow rate and the ability of the HQC system to capture fugitive emissions. It is stated in the report that opacity observations with the test car disconnected were permitted in the compliance test protocol and will improve the visible emissions performance. Although the visible emissions readings are not available, the report does not provide additional statements concerning high particulate or opacity readings.

4.1.2.1.51 Reference 103. This emission test was performed at USS Clairton Works by APT in cooperation with USSC and EVT. The compliance test results presented in this report are for tests completed on August 19-25, 1985. The emissions test included filterable PM and condensible PM emissions. The source for the test was the EVT HQC No. 107 operating on the No. 20 coke Battery located at USSC's Clairton Cokeworks.

Filterable PM emissions were measured using EPA Method 5 modified with two impinger trains in parallel to accommodate the high sample flow rate required to collect a sample volume greater than 30 dscf. Weights are recorded for soluble and insoluble back-half particulate. These emissions are assumed to be comparable to the inorganic condensible portion of EPA Method 202. Three compliance test were conducted during normal coking conditions. Battery 20 was considered a new source and was subject to the LAER standard. The applicable LAER emissions standard for PM is less than or equal to 0.04 pounds per ton of coke pushed.

A rating of C was assigned to the filterable particulate tests performed on the HQC. A rating of D was assigned to the inorganic condensible particulate tests. Process descriptions were provided and the data were presented with adequate detail. Actual field data with pertinent operating conditions were provided. The manner in which the source was operated is well documented in the report. However, the report infers that the source may not have been operating within typical parameters during the test. During the PM emission compliance testing the test car attached to the HQC system, created additional pressure drop to the system which decreases the gas flow rate and the ability of the HQC system to capture fugitive emissions. It is stated in the report that opacity observations with the test car disconnected were permitted in the compliance test protocol and will improve the visible emissions performance. Although the visible emissions readings are not available, the report does not provide additional statements concerning high particulate or opacity readings.

4.1.2.1.52 Reference 105. This reference documents an emission test conducted at USSC in Clairton, Pennsylvania, on July 30-31 and August 1-3 and 6, 1984. The individual modules of the fabric filter that controls emissions from the shed on the “B” Battery were tested for filterable PM emissions using EPA Method 5. Production data are provided for each test period. The fabric filter includes 14 modules, 12 of which are operating at any given time. A single test run was conducted on each of the 14 modules, and the results were summed and multiplied by 12/14 to estimate the total emissions from the system at a given time. A letter attached to the report indicated that USSC conducted tests (with an FTIR analyzer) on the PM catch that indicted that between 42 and 78 percent of the PM came from silicone oil that was used to seal joints in the sampling train and from the polyvinyl chloride tubing used in the sampling train. This information was used to try to bring the plant into compliance with the LAER standard for the coke oven battery. This information was not used for developing emission factors for AP-42 because PM samples are not usually analyzed in the manner described above.

The data from this test are assigned a D rating because of the reported contamination of the PM catch and because the 14 tests actually compose a single test run. The report contains adequate detail and no other problems were reported.

4.1.2.1.53 Reference 106. This reference documents an emission test conducted on the No. 2 coke oven combustion stack at USSC's Geneva Works in Orem, Utah, on February 16 through 18, 1982. The unit tested was a Koppers/Becker underjet coke oven Battery fired with coke oven gas. Uncontrolled filterable PM and CO_2 emissions were measured using EPA Methods 5 and 3 (with Orsat Analyzer), respectively. In addition, the used filters and front-half wash were analyzed for sulfates and combined water using a Ba(ClO_4)2. This information was not used for emission factor development. Three test runs were conducted, and process rates were provided in units of tons of coal charged per test run.

The filterable PM and CO_2 test data are assigned an A rating. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.54 Reference 107. This reference documents an emission test conducted on the No. 3 coke oven combustion stack at USSC's Geneva Works in Orem, Utah, on February 3 through 5, 1981. The unit tested was a Koppers/Becker underjet coke oven Battery fired with coke oven gas. Uncontrolled filterable PM and CO_2 emissions were measured using EPA Methods 5 and 3 (with Orsat Analyzer), respectively. In addition, the used filters and front-half wash were analyzed for sulfates and combined water using a Ba(ClO_4)2. This information was not used for emission factor development. Three test runs were conducted, and process rates were calculated (using the number of pushes and oven charge amounts provided in the report) in units of tons of coal charged per test run.

The filterable PM and CO_2 test data are assigned a C rating because documentation from the State of Utah indicates that the process was operating in a manner that would minimize emissions. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.55 Reference 108. This reference documents an emission test conducted on the No. 2 coke oven combustion stack at USSC's Geneva Works in Orem, Utah, on December 20 through 22, 1982. The unit tested was a Koppers/Becker underjet coke oven Battery fired with coke oven gas. Uncontrolled filterable PM and CO_2 emissions were measured using EPA Methods 5 and 3 (with Orsat Analyzer), respectively. In addition, the used filters and front-half wash were analyzed for sulfates and combined water using a Ba(ClO_4)2. This information was not used for emission factor development. Three test runs were conducted, and an average process rate was calculated, using data provided in the report, in units of tons of coal charged.

The filterable PM and CO_2 test data are assigned a B rating because only an average process rate was available. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.56 Reference 109. This reference documents an emission test conducted on the No. 4 coke oven combustion stack at USSC's Geneva Works in Orem, Utah, on May 18 through 20, 1982. The unit tested was a Koppers/Becker underjet coke oven Battery fired with coke oven gas. Uncontrolled filterable PM and CO_2 emissions were measured using EPA Methods 5 and 3 (with Orsat Analyzer), respectively. In addition, the used filters and front-half wash were analyzed for sulfates and combined water using a $Ba(ClO_4)2$. This information was not used for emission factor development. Three test runs were conducted, and process rates were calculated, using data provided in the report, in units of tons of coal charged per test run.

The filterable PM and CO_2 test data are assigned an A rating. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.57 Reference 110. This reference documents an emission test conducted on the No. 1 and 2 coke oven Battery pushing fabric filter system at USSC's Geneva Works in Orem, Utah, on October 19 and 20, 1982. The No. 1 Battery was idle (hot) during testing. Controlled filterable PM emissions were measured using EPA Method 5. The fabric filter system included 10 stacks that independently served 10 modules of the baghouse. One test run was conducted on each of four stacks (two stacks were tested at a time), and the corresponding emission rates were multiplied by 10 to estimate emissions from the entire fabric filter system. Process rates were calculated, using data provided in the report and in an attachment to the report, in units of tons of coal charged per test run.

The filterable PM test data are assigned a C rating because only two of ten stacks were tested during each test run. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.58 Reference 111. This reference documents an emission test conducted on the No. 3 and 4 coke oven Battery pushing fabric filter system at USSC's Geneva Works in Orem, Utah, on December 28 and 29, 1982. Controlled filterable PM emissions were measured using EPA Method 5. The fabric filter system included 10 stacks that independently served 10 modules of the baghouse. One test run was conducted on each of four stacks (two stacks were tested at a time), and the corresponding emission rates were multiplied by 10 to estimate emissions from the entire fabric filter system. An average process rate was calculated, using data provided in the report, in units of tons of coal charged.

The filterable PM test data are assigned a C rating because only two of ten stacks were tested during each test run. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.59 Reference 112. This reference documents an emission test conducted on the No. 9 coke oven Battery pushing fabric filter system at USSC in Birmingham, Alabama, on August 18 through 21, 1980. Filterable PM, condensible inorganic PM, and condensible organic PM emissions were measured using EPA Method 5 (front- and back-half analyses). Three Method 5 test runs were conducted. In addition, one run was conducted using an in-stack sampling technique that appears to be similar to EPA Method 17. Process rates are provided in the report in units of tons of coke pushed.

The test data are assigned a B rating because the report contains very little detail about the process tested. Otherwise, the test methodology was sound and no problems were reported.

4.1.2.1.60 Reference 114. This reference documents an emission test conducted on the No. 3 coke oven Battery combustion stack at USSC in Fairfield, Alabama, on August 19 through 21, 1975. The Battery was fired with COG during testing. Uncontrolled filterable PM emissions were measured using EPA Method 17, and condensible PM emissions were analyzed using an unspecified methodology. Three test runs were conducted and process rates are provided in the report in units of coal charged.

The filterable PM test data are assigned a C rating because the report does not include adequate documentation of the test. The test methodology appears to be sound and no problems were reported. The condensible PM data are not rated because the report does not specify the analysis method, and it is not clear if the data represent the inorganic, organic, or both portions of the condensible PM catch.

4.1.2.1.61 Reference 119. This emission test was performed at Bethlehem Steel corporation in Bethlehem, Pennsylvania. The compliance test results presented in this report are for tests completed on March 7-9, 1979. The emission test included measurements of filterable PM and condensible PM emissions. The source for the test was the EVT HQC (scrubber) that controls pushing emissions from the No. 5 coke battery.

Filterable PM emissions were measured using EPA Method 5. Weights are recorded for soluble and insoluble back-half particulate, but the analysis method does not appear to be comparable to EPA approved methodology for determining condensible PM emissions. Therefore, the condensible PM data were not used to develop emission factors. Three compliance test runs were conducted during normal coking conditions.

A rating of D is assigned to the filterable PM data. Process descriptions are provided and the data are presented with adequate detail. Actual field data with pertinent operating conditions are provided. The manner in which the source was operated is well documented in the report. However, the source was not operating within typical parameters during the test. During testing, a test car attached to the HQC system created additional pressure drop to the system, which decreased the gas flow rate and the ability of the HQC system to capture fugitive emissions.

4.1.2.1.62 Reference 122. This reference documents an emission test conducted on the scrubber that controlled emissions from the No. 3 coke oven Battery pushing operations at Allied Chemical Company in Ashland, Kentucky, on November 10, 1980. Filterable PM emissions were measured using three EPA Method 5 test runs. Process rates are provided in the report in units of tons of coke pushed.

The test data are assigned a B rating because the report contains very little detail about the control device. Otherwise, the test methodology was sound and no problems were reported.

4.1.2.1.63 Reference 121. This reference documents an emission test conducted on the fabric filter that controls the No. 2 coke oven Battery pushing operations at Armco, Inc., in Middletown, Ohio, on December 14 and 15, 1982. Filterable PM emissions were measured at the outlet of the control system using EPA Method 5. Three test runs were conducted. An average process rate was provided in the report in units of tons of coke pushed.

The test data are assigned a B rating because only an average process rate was provided. Otherwise, the report included adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.64 Reference 123. This reference documents an emission test conducted on the No. 10 coke oven Battery combustion stack at Inland Steel Company in East Chicago, Indiana, on October 18, 1984. Uncontrolled filterable PM and CO_2 emissions were measured using EPA Methods 5 and 3 (with

Orsat analyzer). Three test runs were conducted and process rates are provided in the report in units of coal charged.

The filterable PM test data are assigned a B rating because the fuel used to fire the Battery is not reported. Otherwise, the report included adequate documentation, the test methodology was sound and no problems were reported.

4.1.2.1.65 <u>Reference 124</u>. This reference documents an emission test conducted on the No. 2 coke side (pushing) emissions control gas cleaning car (with scrubber) at Inland Steel Company in East Chicago, Indiana, on April 10 and 11, 1980. Filterable PM and CO_2 emissions were measured at the scrubber outlet using EPA Methods 5 and 3 (with Orsat analyzer). Three test runs were conducted and process rates are provided in the report in units of coke pushed.

The filterable PM test data are assigned a B rating because details about the control device are not provided in the report. Otherwise, the report included adequate documentation, the test methodology was sound and no problems were reported.

4.1.2.1.66 <u>Reference 125</u>. This reference documents an emission test conducted on the No. 11 coke side (pushing) emissions control gas cleaning car (with scrubber) at Inland Steel Company in East Chicago, Indiana, on April 10 and 11, 1980. Filterable PM and CO_2 emissions were measured at the scrubber outlet using EPA Methods 5 and 3 (with Orsat analyzer). Three test runs were conducted and process rates are provided in the report in units of coke pushed.

The filterable PM test data are assigned a C rating because the report includes only summary data and details about the control device are not provided in the report. Otherwise, the report included adequate documentation, the test methodology was sound and no problems were reported.

4.1.2.1.67 <u>Reference 126</u>. This reference documents an emission test conducted on the No. 3 coke side (pushing) emissions control gas cleaning car (with scrubber) at Inland Steel Company in East Chicago, Indiana, on December 30 and 31, 1980. Filterable PM and CO_2 emissions were measured at the scrubber outlet using EPA Methods 5 and 3 (with Orsat analyzer). Three test runs were conducted and process rates are provided in the report in units of coke pushed.

The filterable PM test data are assigned a B rating because details about the control device are not provided in the report. Otherwise, the report included adequate documentation, the test methodology was sound and no problems were reported.

4.1.2.1.68 Reference 128. This reference documents an emission test conducted on the No. 2 coke side (pushing) emissions control gas cleaning car (with scrubber) at Inland Steel Company in East Chicago, Indiana, on August 4 through 8, 1980. Filterable PM and CO_2 emissions were measured at the scrubber outlet using EPA Methods 5 and 3 (with Orsat analyzer). Three test runs were conducted and process rates are provided in the report in units of coke pushed.

The filterable PM test data are assigned a B rating because details about the control device are not provided in the report. Otherwise, the report included adequate documentation, the test methodology was sound and no problems were reported.

4.1.2.1.69 Reference 130. This reference documents emission testing conducted on the north and south coke plant (pushing) emissions control gas cleaning cars (with venturi scrubbers) at CF & I Steel Corporation in Pueblo, Colorado, on March 11 through 14, 1980. Filterable PM and CO_2 emissions were measured at the scrubber outlet using EPA Methods 5 and 3 (with Orsat analyzer). “Coal tar pitch volatiles” were also measured during the test. The first two test runs on the north plant were not valid because of process problems. Four additional test runs were conducted on the north plant, and three test runs were conducted on the south plant. During testing, the venturi scrubbers operated with pressure drops ranging from about 30 to 45 in. w.c.. Process rates are provided in the report in units of tons of coke pushed.

The filterable PM and CO_2 test data are assigned an A rating. The report included adequate detail, the test methodology was sound and no problems were reported. The coal tar pitch volatiles data are not rated for use in emission factor development.

4.1.2.1.70 Reference 135. This reference documents an emission test conducted on the No. 1 and 2 coke oven Battery push control system fabric filter at Chattanooga Coke and Chemicals Company, Inc., in Chattanooga, Tennessee, on November 17 through 19, 1980. The coke ovens produce foundry coke. Filterable PM emissions were measured at the outlet of the control system using EPA Method 5. Three Method 5 test runs were conducted. Two Method 5 sampling trains were used simultaneously in order to sample 24 traverse points per test run. An average process rate was provided in the report in units of tons of coke pushed.

The test data are assigned a B rating because only an average process rate was provided. Otherwise, the report included adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.71 Reference 143. This reference documents an emission test conducted on the west (Batteries 5 and 7) pushing fabric filter at USSC, Gary Works, in Gary, Indiana, on May 17 through 19, 1983. Filterable PM emissions were measured at the outlet of the control system using EPA Method 5. Three Method 5 test runs were conducted, but Run 2 was not valid because of a process problem during the test run. An average process rate was provided in the report in units of tons of coke pushed.

The test data are assigned a B rating because only two valid test runs were conducted and an average process rate was provided. Otherwise, the report included adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.72 Reference 144. This reference documents an emission test conducted on the No. 3 coke oven Battery mobile pushing emission scrubber car at USSC, Gary Works, in Gary, Indiana, on September 14 through 16, 1982. Filterable PM and CO_2 emissions were measured at the outlet of the venturi scrubber using EPA Methods 5 and 3. Three test runs were conducted. An average process rate was provided in the report in units of tons of coke pushed.

The test data are assigned a B rating because an average process rate was provided. Otherwise, the report included adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.73 Reference 147. This reference documents an emission test conducted on the Battery A emissions control gas cleaning car (pushing) scrubber at Granite City Steel, in Granite City, Illinois, on December 16 through 20, 1980. Filterable PM and CO_2 emissions were measured at the outlet of the venturi scrubber using EPA Methods 5 and 3 (with Orsat analyzer). Three test runs were conducted, and process rates were provided in the report in units of tons of coke pushed. During testing, the venturi scrubber pressure drop ranged from 33 to 37 in. w.c..

The test data are assigned an A rating. The report included adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.74 Reference 148. This reference documents an emission test conducted on the coke oven Battery push control system (fabric filter) at Philadelphia Coke Company in Philadelphia, Pennsylvania, on January 8 through 13, 1981. The coke ovens produce foundry coke. Filterable PM, condensible inorganic PM, and CO_2 emissions were measured at the outlet of the control system using EPA Methods 5 (front- and back-half analysis and 3 (with Orsat analyzer). Two test runs were conducted, and process rates are provided in the report in units of tons of coal charged.

The test data are assigned a B rating because only two test runs were performed. Otherwise, the report included adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.75 Reference 149. This reference documents an emission test conducted on the coke oven Battery push control system (fabric filter) at Wheeling Pittsburgh Steel Corporation in Monessen, Pennsylvania, on August 3 through 5, 1981. Filterable PM emissions were measured at the outlet of the control system using EPA Method 5. Three test runs were conducted, and process rates are provided in the report in units of tons of coke pushed.

The test data are assigned an A rating. The report included adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.76 Reference 150. This reference documents an emission test conducted on the coke oven Battery push control system (fabric filter) at Wheeling Pittsburgh Steel Corporation in Monessen, Pennsylvania, on March 14 through 16, 1984. Filterable PM emissions were measured at the outlet of the control system using EPA Method 5. Weights are recorded for soluble and insoluble back-half particulate, but the analysis method does not appear to be comparable to EPA approved methodology for determining condensible PM emissions. Therefore, the condensible PM data were not used to develop emission factors. Three test runs were conducted, and process rates are provided in the report in units of tons of coke pushed.

The filterable PM test data are assigned an A rating. The report included adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.77 Reference 153. This reference documents an emission test conducted on the pushing operations at the No. 1, 2A, 2B, 4, and 5 coke oven batteries at Koppers Industries, Inc., in Dolomite, Alabama, on November 15 and 16, 1990. The emissions from batteries 2B and 5 are ducted to a knock out box followed by a fabric filter, and then are discharged to the atmosphere through the north stack. The emissions from batteries 1, 2A, and 4 are ducted to a knock out box followed by a fabric filter, and then are discharged to the atmosphere through the south stack. The north and south stacks were tested for filterable PM emissions using EPA Method 5. Process rates in units of coal charged are provided in the report for each test run.

The test data are assigned an A rating. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.78 Reference 155. This reference documents an emission test conducted on the coke Battery positive pushing control system at Jim Walters Resources in Birmingham, Alabama, on November 6 and 7, 1984. The pushing emissions are ducted to a fabric filter and then are discharged to the atmosphere. The fabric filter outlet was tested for filterable PM emissions using EPA Method 5. Process rates in units of coal charged are provided in the report for each test run.

The test data are assigned an A rating. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.79 Reference 156. This reference documents an emission test conducted on the No. 3 and 4 COG-fired Battery underfiring stack at Sloss Industries in Birmingham, Alabama, on May 16, 1995. Uncontrolled filterable PM, TOC as propane, SO_2, CO_2, NO_x, and CO emissions were measured using EPA Reference test methods. Three test runs were conducted for each pollutant (five CO_2 measurements). Process data are not included in the report, but an average process rate of 34.5 tons per hour of coal charged was calculated using the emission rates from the report in conjunction with emission factors for the test provided by ACCCI.

The test data are assigned a C rating because of the omission of process rates from the report. A letter has been sent to ACCCI asking that the calculated process rates be confirmed. The data will be assigned new ratings when confirmation or correction of the process rates is received. Otherwise, the report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.80 Reference 157. This reference documents an emission test conducted on the No. 1 COG-fired Battery underfiring stack at Koppers Industries Woodward Coke Plant in Dolomite, Alabama, on January 25, 1995. Uncontrolled filterable PM, TOC as propane, SO_2, CO_2, NO_x, and CO emissions were measured using EPA Reference test methods. In addition, the back half of the EPA Method 5 sampling train was analyzed for condensible PM, but the analysis method is not discussed in the report and it is not stated whether the emissions are condensible inorganic PM, condensible organic PM, or both. In a memo attached to the report, Koppers indicated that the Run 2 filterable PM measurements may have been skewed by the presence of metals in the PM catch. The PM catch was analyzed for metals, and significant quantities were present in the sample. Therefore, the Run 2 filterable PM data are considered invalid. Process data, based on the amount of coal charged, for the 30 day period prior to the test are provided in the report. The process rate during testing was assumed equal to the average rate from the previous 30 days.

The test data are assigned a B rating because the process rate is based on a historic average. It should be noted that the process rate is believed to be accurate because the amount of coal charged did not vary more than about 10 percent above or below the average during the 30 day period. Otherwise, the report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.81 Reference 159. This reference documents an emission test conducted on the No. 1 COG-fired Battery underfiring stack at Koppers Industries in Dolomite, Alabama, on August 21, 1991. Uncontrolled filterable PM, SO_2, CO_2, and NO_x emissions were measured using EPA Reference test methods. Process data, based on the amount of coal charged, are provided in the report for the day of testing. This is the same source discussed in Reference 157.

The test data are assigned an A rating. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.82 Reference 161. This reference documents an emission test conducted on the coke Battery positive pushing control system at Alabama By-Products Corporation in Tarrant, Alabama, on September 9 through 11, 1985. The pushing emissions are ducted to a fabric filter and then are discharged to the atmosphere. The fabric filter outlet was tested for filterable PM and CO_2 emissions using EPA Methods 5 and 3, respectively. Process rates in units of coal charged are provided in the report for each test run.

The test data are assigned an A rating. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.83 Reference 162. This reference documents an emission test conducted on a quench car that controls PM emissions from pushing operations at Erie Coke Corporation in Erie, Pennsylvania, on March 17 and 18, 1994. Filterable PM emissions were measured during two Method 5 test runs, and a process rate was provided in units of tons per hour of coke pushed. Because the test was conducted in

Pennsylvania, the reported PM concentrations are likely to include the back-half insoluble PM as required by the PA DER. The report does not include any raw data sheets or details about the process.

The test data are assigned a C rating because the report only summarizes the testing and does not provide sufficient details about the testing or process. In addition, the reported PM probably includes a small percentage of back-half PM, but the data sheets with this information are not provided in the report.

4.1.2.1.84 Reference 163. This reference documents an emission test conducted on a quench car scrubber system that controls PM emissions from pushing operations at Erie Coke Corporation in Erie, Pennsylvania, on April 18 and 19, 1995. Filterable PM emissions were measured during two Method 5 test runs, and a process rate was provided in units of tons per hour of coke pushed. Because the test was conducted in Pennsylvania, the reported PM concentrations are likely to include the back-half insoluble PM as required by the PA DER. The report does not include any raw data sheets or details about the process.

The test data are assigned a C rating because the report only summarizes the testing and does not provide sufficient details about the testing or process. In addition, the reported PM probably includes a small percentage of back-half PM, but the data sheets with this information are not provided in the report.

4.1.2.1.85 Reference 164. This reference documents an emission test conducted on a quench car scrubber system that controls PM emissions from pushing operations at Erie Coke Corporation in Erie, Pennsylvania, on August 7 and 8, 1996. Filterable PM emissions were measured during two Method 5 test runs, and a process rate was provided in units of tons per hour of coke pushed. Because the test was conducted in Pennsylvania, the reported PM concentrations are likely to include the back-half insoluble PM as required by the PA DER. The report does not include any raw data sheets or details about the process.

The test data are assigned a C rating because the report only summarizes the testing and does not provide sufficient details about the testing or process. In addition, the reported PM probably includes a small percentage of back-half PM, but the data sheets with this information are not provided in the report.

4.1.2.1.86 Reference 165. This reference documents an emission test conducted on the coke Battery No. 1 positive pushing control system at Alabama By-Products Corporation in Tarrant, Alabama, on July 9 through 11, 1985. The pushing emissions are ducted to a fabric filter and then are discharged to the atmosphere. The fabric filter outlet was tested for filterable PM and CO_2 emissions using EPA

Methods 5 and 3, respectively. Process rates in units of coal charged are provided in the report for each test run.

The test data are assigned an A rating. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.87 Reference 166. This reference documents an emission test conducted on the No. 11 coke Battery (pushing), No. 11 coke Battery (no pushing, assumed to represent door leak emissions), and the coke Battery No. 9 combustion stack at Inland Steel Company in East Chicago, Indiana, on January 27 and 29, and February 6 and 7, 1990. The report does not indicate if any air pollution control devices were operating on the sources during testing, but based on the magnitude of emissions, it appears that some type of PM controls were in place for the pushing operations. Comments on the previous draft AP-42 section indicate that the emissions from Battery 11 are captured by a shed, and an assumption was made that the shed ducts to a fabric filter. It should be noted that an earlier test (1980) on the same coke oven Battery indicated that the Battery was equipped with a hooded scrubber car. The combustion stack is assumed to be uncontrolled. Three test runs were conducted on each process for filterable PM, PM-10, TOC, SO_2, NO_x, CO_2, and CO using EPA Methods 5 and 17, 201A, 25A, 6C, 7E, 3, and 10, respectively. Process rates for the pushing and no pushing operations are provided in units of tons of coke pushed, and process rates for the Battery stack are provided in units of tons of coal charged.

The test data summary sheets in the report appear to contain multiple errors, including: (1) for Run 3 on the No. 11 Battery (pushing) and Run 2 (no pushing), the PM concentration is not equal to the concentration calculated using data from the raw data sheets; (2) and emission rates (for SO_2, TOC, and NO_x) from the No. 9 Battery stack were calculated using peak concentrations for some test runs and average concentrations for other test runs within the same series of data. Before using the data for emission factor development, the PM concentrations were calculated using the raw data and the SO_2, TOC, and NO_x emission rates were calculated using the average instead of the peak concentrations. Other discrepancies in the report data and the data used for developing emission factors include: (1) rounding errors, possibly due to the presentation of too few significant figures in the test report; and (2) for emission factor development purposes, emissions from non-detect runs are estimated as one-half of the detection limit.

The PM and PM-10 data from Battery No. 11 pushing and "no pushing" are assigned C ratings because the control device is not specified in the report and is assumed to be a fabric filter (see explanation above). The data for TOC, SO_2, NO_x, CO_2, and CO from all of the sources are assigned a B rating because of the errors identified in the test report. The PM and PM-10 data from the Battery No. 9 combustion stack are also assigned a B rating. Reference test methods were used, no problems were reported, and the test methodology was sound (although several mistakes were identified and corrected during the report review).

4.1.2.1.88 Reference 167. This reference documents an emission test conducted on the P1, P2, P3S, P3N, and P4 combustion stacks at LTV Steel Company in Pittsburgh, Pennsylvania, on August 17 through 19, 1993. Uncontrolled NO_x and CO_2 emissions were measured using EPA Methods 7E and 3A. Process data are not included in the report, but process rates of 46.9 (P1), 46.9 (P2), 54.7 (P3S), 54.7 (P3N), and 64.0 (P4) tons per hour of coal charged were calculated using the emission rates from the report in conjunction with emission factors for the test provided by ACCCI. A single two hour test run was conducted on each stack.

The test data are assigned a C rating because of the omission of process rates from the report and because a single test run was conducted on each stack. A letter has been sent to ACCCI asking that the calculated process rates be confirmed. The data will be assigned new ratings when confirmation or correction of the process rates is received. Otherwise, the report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.89 Reference 168. This reference documents an emission test conducted on the coke oven batteries Nos. 7 and 8 pushing operations at the Bethenergy Lackawanna Coke Division in Lackawanna, New York, on July 9 through 1[illegible], 1991. Filterable PM, phenol, ammonia, TOC, CO_2, CO, benzene, PM-10, cyanide, and PAH emissions were measured at the outlet of the fabric filter that controls emissions from the coke side shed on batteries 7 and 8. The test methods used were EPA Methods 1 through 5 for PM, CO_2, and flow measurements; a modification of the Method 5 back-half analysis for phenol and ammonia (analysis of impingers 1 and 2 using Methods for Analysis of Water and Waste, EPA 600/4-79-020, Method 420.2 for phenol and Method 350.1 for ammonia); EPA Method 25A for TOC; EPA Method 10 for CO; EPA Method 18 for benzene; EPA Method 201A for PM-10; a modification of the Method 201A back-half analysis for cyanide; and modified method 5 (MM5) for PAH. Several PAH were not detected during one or more test runs. Acenaphthene, benzo(b)fluoranthene, and benzo(a)pyrene were not detected during any test run. The detection limit for these pollutants will be noted in the summary tables. Benzo(g,h,i)perylene was not detected during two of three test runs, and benzo(k)fluoranthene and indeno(1,2,3-cd)pyrene were not detected during one of three test runs. For these pollutants, emissions from the non-detect test runs are estimated as one-half of the detection limit. Sufficient information is provided in the report to calculate process rates, in units of tons per hour of coke pushed, for each test run.

Most of the test data are assigned an A rating. The phenol, ammonia, and cyanide test data are assigned a C rating because test/analysis methods that are not validated for quantifying air emissions were used. The data for acenaphthene, benzo(b)fluoranthene, and benzo(a)pyrene were not used for emission factor development because the pollutants were not detected during any test run. The data for benzo(g,h,i)perylene are assigned a C rating because emissions from two of three test runs are estimated as one-half of the detection limit, and the data for benzo(k)fluoranthene and indeno(1,2,3-cd)pyrene are assigned a B rating because emissions from one run are estimated as one-half of the detection limit. The test data for all of the other pollutants are assigned A ratings. The report included adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.90 Reference 169. This reference documents an emission test conducted on the No. 1 Battery combustion stack at the Shenango, Inc. Neville Island Plant in Pittsburgh, Pennsylvania, on September 20-23, 1993. Uncontrolled filterable PM and CO_2 emissions were measured using EPA Methods 5 and 3 (with Fyrite analyzer). Three test runs were conducted. Process data are not included in the report, but an average process rate of 61 tons per hour of coal charged was calculated using the emission rates from the report in conjunction with emission factors for the test provided by ACCCI.

The test data are assigned a C rating because of the omission of process rates from the report. A letter has been sent to ACCCI asking that the calculated process rates be confirmed. The data will be assigned new ratings when confirmation or correction of the process rates is received. Otherwise, the report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.91 Reference 170. This reference documents an emission test conducted on the No. 1B and 2 coke batteries (pushing), No. 1B Battery combustion stack, and No. 2 Battery combustion stack at Koppers Industries in Monessen, Pennsylvania, on September 20 through 23, 1993. Each test included three test runs measuring filterable PM, TOC as propane, CO_2, NO_x, and CO using EPA Reference test methods. The pushing emissions were measured at the outlet of a fabric filter that controls PM emissions from pushing operations, and the pushing emissions were ducted to the fabric filter from a traveling hood system. The combustion stack emissions were not controlled, and the ovens were heated with desulfurized COG. Process data are not included in the report, but average process rates of 460 tons per hour (pushing), 43.5 tons per hour (1B combustion), and 17.5 tons per hour (2 combustion) of coal charged were calculated using the emission rates from the report in conjunction with emission factors for the test provided by ACCCI.

The test data are assigned a C rating because of the omission of process rates from the report. A letter has been sent to ACCCI asking that the calculated process rates be confirmed. The data will be assigned new ratings when confirmation or correction of the process rates is received. Otherwise, the report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.92 Reference 171. This reference documents an emission test conducted on the No. 1 coke Battery push shed fabric filter at Shenango, Incorporated’s Neville Island Plant in Pittsburgh, Pennsylvania, on January 18 through 20, 1988. Filterable PM and CO_2 emissions were measured at the fabric filter outlet using EPA Methods 5 and 3 (with Fyrite analyzer). Process data are not included in the report, but an average process rate of 557 tons per hour of coal charged was calculated using the emission rates from the report in conjunction with emission factors for the test provided by ACCCI.

The test data are assigned a C rating because of the omission of process rates from the report. A letter has been sent to ACCCI asking that the calculated process rates be confirmed. The data will be assigned new ratings when confirmation or correction of the process rates is received. Otherwise, the report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.93 Reference 172. This reference documents testing conducted on the coal crusher and coke screening operations at Bethlehem Steel Corporation in Bethlehem, Pennsylvania, on December 2 through 6, 1991. Particulate matter emissions were measured using EPA Method 5 at the outlet of a rotoclone that controls emissions from the coal crusher and at the stack that vents emissions from the east coke screening operations. Process rates are not provided in the report, but were provided, in units of coal throughput, by the ACCCI. Condensible PM was also measured, but the method required by the PA DER (used during the test) differs from the current EPA condensible PM analysis method. In addition, condensible PM is not expected to be emitted from these types of sources (crushers and screens).

The test data are assigned an A rating. the test methodology was sound, no problems were reported, and adequate detail was provided.

4.1.2.1.94 Reference 173. This reference documents respirable dust (PM-10) sampling conducted on the coal pulverizer buildings at USS Clairton Works in Clairton, Pennsylvania, on December 19 and 20, 1994. Emission rates from the first unit primary and secondary pulverizers and the second unit primary and secondary pulverizers were measured during the test program. Sampling was conducted in accordance with the Allegheny Count Health Department Division of Air Quality Source Testing Manual, Chapter 53, "Determination of Inhalable Fugitive Particulate Emissions from Air Pollution Sources Within a Structure." The method provides for the measurement of PM-10 concentrations using a 10 millimeter Dorr-Oliver cyclone connected to a filter holder loaded with a tared quartz filter and a personal sampling pump. The method also specifies that air velocities be measured with a vane anemometer or Kurtz Model 441 anemometer (or equivalent). Sampling points are selected by choosing the openings in a building that, on inspection, allow the largest amount of fugitive dust to leave the enclosure. Emission rates were calculated using the concentration data in conjunction with approximate flow measurements calculated from the measured velocities and sampling point (window) area openings. The following process data were back-calculated from the emission rates presented in the report and a summary of emission factors provided by ACCCI: (1) the first unit primary pulverizer processed 352 tons of coal per hour; (2) the first unit secondary pulverizer processed 145 tons of coal per hour; (3) the second unit primary pulverizer processed 211 tons of coal per hour; and (4) the second unit secondary pulverizer processed 325 tons of coal per hour.

The test data are assigned a C rating because of uncertainties associated with the test method and because the process rates are not included in the report.

4.1.2.1.95 Reference 174. This reference documents respirable dust (PM-10) sampling conducted on the coal pulverizer buildings at USS Clairton Works in Clairton, Pennsylvania, on November 30 and December 1, 1995. Emission rates from the first unit primary and secondary pulverizers and the second unit primary and secondary pulverizers were measured during the test program. Sampling was conducted in accordance with the Allegheny Count Health Department Division of Air Quality Source Testing Manual, Chapter 53, "Determination of Inhalable Fugitive Particulate Emissions from Air Pollution Sources Within a Structure." The method provides for the measurement of PM-10 concentrations using a 10 millimeter Dorr-Oliver cyclone connected to a filter holder loaded with a tared quartz filter and a personal sampling pump. The method also specifies that air velocities be measured with a vane anemometer or Kurtz Model 441 anemometer (or equivalent). Sampling points are selected by choosing the openings in a building that, on inspection, allow the largest amount of fugitive dust to leave the enclosure. Emission rates were calculated using the concentration data in conjunction with approximate flow measurements calculated from the measured velocities and sampling point (window) area openings. The following process data were back-calculated from the emission rates presented in the report and a summary of emission factors provided by ACCCI: (1) the first unit primary pulverizer processed 350 tons of coal per hour; (2) the first unit secondary pulverizer processed 150 tons of coal per hour; (3) the second unit primary pulverizer processed 213 tons of coal per hour; and (4) the second unit secondary pulverizer processed 250 tons of coal per hour.

The test data are assigned a C rating because of uncertainties associated with the test method and because the process rates are not included in the report.

4.1.2.1.96 Reference 175. This reference documents respirable dust (PM-10) sampling and a subsequent particle size analysis (including PM-2.5 percentage) conducted on the coal pulverizer buildings at USS Clairton Works in Clairton, Pennsylvania, on November 30 and December 1, 1995. Emission rates from the first unit primary and secondary pulverizers and the second unit primary pulverizer were measured during the test program. Sampling was conducted in accordance with the Allegheny Count Health Department Division of Air Quality Source Testing Manual, Chapter 53, “Determination of Inhalable Fugitive Particulate Emissions from Air Pollution Sources Within a Structure.” The method provides for the measurement of PM-10 concentrations using a 10 millimeter Dorr-Oliver cyclone connected to a filter holder loaded with a tared quartz filter and a personal sampling pump. The method also specifies that air velocities be measured with a vane anemometer or Kurtz Model 441 anemometer (or equivalent). Sampling points are selected by choosing the openings in a building that, on inspection, allow the largest amount of fugitive dust to leave the enclosure. Emission rates were calculated using the concentration data in conjunction with approximate flow measurements calculated from the measured velocities and sampling point (window) area openings. The particle size analysis was conducted using computer-controlled scanning electron microscopy. The following process data were back-calculated from the emission rates presented in the report and a summary of emission factors provided by ACCCI: (1) the first unit primary pulverizer processed 333 tons of coal per hour; (2) the first unit secondary pulverizer processed 142 tons of coal per hour; and (3) the second unit primary pulverizer processed 300 tons of coal per hour.

The test data are assigned a C rating because of uncertainties associated with the test method and because the process rates are not included in the report.

4.1.2.1.97 Reference 176. This reference documents an emission test conducted on the coke Battery combustion stack at Erie Coke Corporation in Erie, Pennsylvania, on August 8, 1996. Uncontrolled filterable PM, TOC as propane, CO_2, NO_x, methane, and ethane emissions were measured using EPA Reference test methods. In addition, VOC as propane emission factors were calculated by subtracting the methane and ethane factors from the TOC factors for each test run. Three test runs were conducted. Process data are not included in the report, but an average process rate of 34.7 tons per hour of coal charged was calculated using the emission rates from the report in conjunction with emission factors for the test provided by ACCCI.

The test data are assigned a C rating because of the omission of process rates from the report. A letter has been sent to ACCCI asking that the calculated process rates be confirmed. The data will be assigned new ratings when confirmation or correction of the process rates is received. Otherwise, the report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.98 Reference 177. This test report describes a single run test conducted on August 9, 1985 that was sponsored by Alabama By-Products Corporation. The test was performed by Guardian Systems, Inc. on Alabama By-Products Corporation Tarrant, AL Coke Battery #5 & 6 positive pushing control system. The push control system consists of a movable hood assembly which travels with the car and a baghouse for particulate removal. EPA Methods 1 through 5 were conducted to measure particulate emissions. Sampling started when the pusher ram began moving and stopped when the emissions captured were collected by the baghouse. Only one push was sampled per traverse point and the sampling time varied for each push. Although the stack dimensions indicated that a 24 point traverse would be required, the report states that only 5 points per diameter were sampled for the test. The total run time for the test was slightly over 7 minutes. The reported emissions for the test were 0.023 lb/ton of coal charged. The test report is adequately documented, however the filter weight loss of 3.3 mg was subtracted from the 11.7 mg of particulate collected in the acetone rinse. Therefore, the correctly reported emissions should be 0.032 lb/ton of coal charged. The test report is rated D because only one run was conducted, insufficient points were sampled, the sample duration for each point varied, the negative bias created by the negative filter weight and the low acetone rinse weight that provided the only measurement of mass emissions.

4.1.2.1.99 Reference 178. This is a June 9, 1993 letter from Bradford K. Pease, PE, CEM of Fuels Combustion Consultant to Mr. Thomas E. Kreichelt of Bethlehem Steel Corporation concerning NOx and VOC emissions measurements made between November 30, 1992 and February 5, 1993 at Bethlehem Structural Products in Bethlehem, PA as part of the corporate emission inventory. The measuremnts included coke oven batteries A, No. 2 and No. 3. The letter includes little documentation of the test methods used and no production information. The reported NOx emissions were 0.572, 0.179 and 0.195 lbs/MBtu for Battery A, No. 2 and No. 3 respectively. The reported VOC emissions were 0.002 lbs/MBtu for Batteries No. 2 and No. 3. Since no production information is available, this data is not useable for emission factors development.

4.1.2.1.100 Reference 179. This is a May 7, 1994 letter from John P. Shimshock of Chester Environmental to Mr. Miles Lalley of Bethlehem Steel Corporation concerning revised emissions testing summary report of the No. 7 and No. 8 waste heat stacks at the Bethlehem facility in Lackawanna, NY. Continuous emissions measurements of CO, SO2, NOx and THC were determined on April 21, 1994 for the No. 7 stack and on April 22, 1994 for the No. 8 stack. The letter includes little documentation of the test methods used and no production information. For waste heat stack No. 7, the average emissions for CO, SO2, NOx and THC were 18.4, 258.6, 125.1 and 2.4 lb/hr respectively. For waste heat stack No. 8, the average emissions for CO, SO2, NOx and THC were 9.7, 307.7, 130.4 and 3.7 lb/hr respectively. Since no production information is available, this data is not useable for emission factors development.

4.1.2.1.101 Reference 180. This is March 30, 1994 letter from Bradford K. Pease, PE, CEM of Fuels Combustion Consultants to Mr. Phillip L. Gano of the Bethlehem Steel Corporation Burns harbor Plant concerning an emissions inventory of the Burns Harbor Plant. The emissions inventory of 44 sources at the plant was conducted by measuring the concentrations of oxygen, total gaseous hydrocarbons, carbon monoxide, oxides of nitrogen, sulfur dioxide and methane. The sources tested included coke ovens, sinter plant, power station, blast furnaces, steelmaking facilities, continuous casters, soaking pits, slab and plate mills and finishing facilities. The testing was conducted between September 15, 1993 and December 17, 1993. Two tests of the combustion stack of Battery No. 1 were made. On 9/15/93 and 9/22/93 when Battery No. 1 was combusting 14% blast furnace gas and 86% coke oven gas, the NOx, SO2, CO and VOC emissions averaged 2.32, 0.88, 0.31 and 0.0046 lb/MBtu respectively. On 9/22/93 when Battery No. 1 was combusting coke oven gas, the NOx, SO2 and CO emissions averaged 0.64, 0.98 and 0.11 lb/MBtu respectively. On 9/16/93 and 9/22/93 when Battery No. 2 was combusting coke oven gas, the NOx, SO2, CO and VOC emissions averaged 0.58, 0.85, 0.074 and 0.032 lb/MBtu respectively. For Battery No. 1 on 9/24/93, the NOx, SO2, CO and VOC pushing emissions averaged 0.0186, 0.039, 0.0668 and 0.0046 lb/ton of coal charged respectively. For Battery No. 2 on 9/28/93, the NOx, SO2, CO and VOC pushing emissions averaged 0.0192, 0.033, 0.1371 and 0.0029 lb/ton of coal charged respectively. The letter includes little documentation on the details of the test methods used and no production information. As a result the data for the combustion stack can not be used for emission factor development and the scrubber controlled pushing emissions data is rated D. In addition to the concentrations measured at the various sources, the appendices to the letter include summary results of five particulate tests conducted on the Battery No. 1 and Battery No. 2 pushing controls in 1991 an 1992by Mostardi-Platt Associates. The three Battery No. 1 tests average 6.12 lb/hr. The two Battery No. 2 tests average 12.31 lb/hr. However, there is no production information for the periods covered by the particulate tests and therefore the data can not be used for emission factor development.

4.1.2.1.102 Reference 188. This test report describes an emission test conducted by TRW Environmental Engineering Division, under contract with EPA's Emission Measurement Branch during the week of July 9, 1979. The test was conducted at the coke oven battery stack at Bethlehem Steel Corporation's number 2 battery at the Sparrows Point, Maryland facility. Battery No. 2 is a 60-oven Koppers gun-flue battery, fired with un-desulfurized coke oven gas from the by-product plant. The Battery began operations in 1961 and has not been rehabilitated since start-up. Maintenance techniques used on Battery No. 2 were mobile-gunning and hand-held gun slurry patching. Emission tests were conducted at the outlet of the battery stack to determine concentrations of the following constituents in the flue gas: particulate, benzo-a-pyrene (BaP), oxygen (O_2), carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides (NOx), visible emissions, and sulfates (SO_4). The sampling procedure used was EPA Method 5 with two deviations for sulfate analysis and ether chloroform extraction. After analysis of the particulate samples, a 25ml portion of the H_20 collection was removed for sulfate analysis. Analysis was performed by titrating with 0.0100 N Barium perchlorate. The filter was soaked in 80% Isopropyl alcohol and titrated for sulfate analysis. Ether and chloroform extraction was performed on the H_20 portion of the particulate samples for condensibles. This was performed on the H_20 collection minus the 25ml portion used for sulfate analysis. The remaining portion of the H_20 samples was evaporated and the residue weighed and included in the particulate emissions. The BaP sampling procedure consisted of an EPA Method 5 train, with an XAD-2 adsorbent trap inserted between the heated filter and first impinger. The XAD-2 trap was thermostatically controlled to 127°F. The trap was shielded from visible and ultraviolet light during sampling by wrapping with aluminum foil. Methylene Chloride was used for rinsing the probe, filter holder, and connecting glass-ware up to the trap. Acetone was used for rinsing the remainder of the train. The samples were refrigerated until analysis was performed. Filtered particulates and solid samples were extracted for eight hours in Cyclohexane before analysis. Some liquid samples which were darkly colored, contained abundant suspended material, or were extremely viscous were diluted with Cyclohexane prior to analysis. Final analysis was performed by fluorescence spectrophotometry to determine concentrations of BaP. The test data are assigned an A rating. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.103 Reference 189. This test report describes an emission test conducted jointly by Clayton Environmental Consultants, Inc., TRW Environmental Engineering Division and York Research Corporation, under contract with EPA's Emission Measurement Branch during the week of August 7, 1979. The test was conducted at the coke oven battery stack at C. F. & I. Steel Corporation's battery D at the Pueblo, Colorado facility. Battery D is a 31-oven Koppers gun-flue battery, fired with undesulfurized coke oven gas from the by-product plant. The D battery started operating in 1929, was completely rebuilt in 1960, and was rehabilitated in 1975. Normal coking time for Battery D is 18 hours and each oven is charged with 18.49 tons of coal. Systematic maintenance techniques used on the battery include spray patching, nozzle and gun block repairs, and cleaning collecting mains, stem jet ejectors, and standpipes. In addition, the portable O_2 and combustible gas monitors are used, along with observation of emissions from the stack, to identify ovens or flues that may cause an increase in emissions. When these have been identified, the cause of the problem is investigated and necessary corrective action taken. Emission tests were conducted at the outlet of the battery stack to determine concentrations of the following constituents in the flue gas: particulate, benzo-a-pyrene (BaP), oxygen (O_2), carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides (NOx), visible emissions, and sulfates (SO_4). The sampling procedure used was EPA Method 5 with two deviations for sulfate analysis and ether chloroform extraction. After analysis of the particulate samples, a 50 ml portion of the H_20 collection was removed for sulfate analysis. Analysis was performed by titrating with 0.0100 N Barium perchlorate. The filter was soaked in 80% Isopropyl alcohol and titrated for sulfate analysis. Ether and chloroform extraction was performed on the H_20 portion of the particulate samples for condensibles. This was performed on the H_20 collection minus the 50 ml portion used for sulfate analysis. The remaining portion of the H_20 samples was evaporated and the residue weighed and included in the particulate emissions. The BaP sampling procedure consisted of an EPA Method 5 train, with an XAD-2 adsorbent trap inserted between the heated filter and first impinger. The XAD-2 trap was thermostatically controlled to 127°F. The trap was shielded from visible and ultraviolet light during sampling by wrapping with aluminum foil. Methylene Chloride was used for rinsing the probe, filter holder, and connecting glass-ware up to the trap. Acetone was used for rinsing the remainder of the train. The samples were refrigerated until analysis was performed. Filtered particulates and solid samples were extracted for eight hours in Cyclohexane before analysis. Some liquid samples which were darkly colored, contained abundant suspended material, or were extremely viscous were diluted with Cyclohexane prior to analysis. Final analysis was performed by fluorescence spectrophotometry to determine concentrations of BaP. The test data are assigned an A rating. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.1.2.1.104 Reference 190. This test report describes an emission test conducted jointly by Clayton Environmental Consultants, Inc. and TRW Environmental Engineering Division, under contract with EPA's Emission Measurement Branch during the week of May 1, 1979. The test was conducted at the coke oven battery stack at Jones and Laughlin Steel Corporation's battery P4 at the Pittsburgh, Pennsylvania facility. Battery P4 is a 79-oven Koppers underjet battery, underfired with undesulfurized coke oven gas. A gas desulfurization unit is nearing completion but was not in operation during the testing. The P4 battery was originally started up in 1953. It underwent a hot end-flue rehabilitation in 1976 and was placed back in operation in early 1977. The battery was operating on a 17-hr coking time during the testing and each oven was charged with 16 to 16.5 tons of coal to produce about 11 tons of coke. Maintenance techniques used on the battery include silica dusting coupled with spray patching and troweling. Emission tests were conducted at the outlet of the battery stack to determine concentrations of the following constituents in the flue gas: particulate, benzo-a-pyrene (BaP), benzene, oxygen (O_2), carbon dioxide (CO_2), carbon monoxide (CO), visible emissions, and sulfates (SO_4). The sampling procedure used was EPA Method 5 with two deviations for sulfate analysis and ether chloroform extraction. After analysis of the particulate samples, a 5 ml portion of the $H_2$0 collection was removed for sulfate analysis. Analysis was performed by titrating with 0.0100 N Barium perchlorate. The filter was soaked in 80% Isopropyl alcohol and titrated for sulfate analysis. Ether and chloroform extraction was performed on the $H_2$0 portion of the particulate samples for condensibles. This was performed on the $H_2$0 collection minus the 5 ml portion used for sulfate analysis. The remaining portion of the $H_2$0 samples was evaporated and the residue weighed and included in the particulate emissions. The benzene sampling procedure consisted of the collecting an integrated flue gas sample into a Tedlar® bag and analysis by EPA portable gas chromatographic Method 110, “Determination of benzene from Stationary Sources.” The BaP sampling procedure consisted of an EPA Method 5 train, with an XAD-2 adsorbent trap inserted between the heated filter and first impinger. The XAD-2 trap was thermostatically controlled to between 120 and 127°F. Methylene Chloride was used for rinsing the probe, filter holder, and connecting glass-ware up to the trap. Acetone was used for rinsing the remainder of the train. Final analysis was performed by fluorescence spectrophotometry to determine concentrations of BaP. The test data are assigned an A rating. The report includes adequate detail, the test methodology was sound, and no significant problems were reported.

4.1.2.1.105 Reference 191. This test report describes a July 26 to 28, 1979 emission test conducted jointly by Clayton Environmental Consultants, Inc. and TRW Environmental Engineering Division, under contract with EPA's Emission Measurement Branch. The test was conducted at the coke oven battery stack at National Steel Corporation's battery C at the Granite City, Illinois facility. Battery C is a 61-oven Koppers-Becker gun-flue battery, underfired with undesulfurized coke oven gas supplied by the by-product plant. During the period covering the emission tests, 36 coke ovens were operating on a coking period of 17.5 hr with two ovens (Nos. 155 and 163) on an extended coking cycle. The other 25 ovens (Nos. 123-126, 131, 132, 144, 146, 147, 154, 157, 161, 162, 174-177, 181, and 193) were bricked-up or out of service. The C Battery started operating in 1961 and was rehabilitated in 1976. This cold end-flue rehabilitation included gun flue, crossover flue and end flue repairs. In March 1979, an ESP with three parallel modules began operating at Battery C. Each ESP module has a collection area of 2,550 M^2 (27,440 ft^2) and all three modules together have a collection area of 7,650 M^2 (82,320 ft^2). However, the test report states that two independent inlet and outlet test programs provide evidence that the ESP was not an effective particulate control device for this source. Although discussions in the test report identify potential causes for the poor particulate control, the high (700°F inlet) flue gas temperatures and particulate characteristics were not discussed. The report states that normal coking time for the battery is 17-hr and each oven was charged with 16.6 tons of coal. Emission tests were conducted at the inlet and outlet of the battery stack ESP to determine concentrations of the following constituents in the flue gas: particulate, benzo-a-pyrene (BaP), benzene, oxygen (O_2), carbon dioxide (CO_2), carbon monoxide (CO), visible emissions, and sulfates (SO_4). The sampling procedure used was EPA Method 5 with several deviations. The train was modified by adding a cyclone upstream of the filter to prevent the filters from blinding (plugging or clogging) due to an unusual resinous character of the particulate in the exhaust gas. A flexible unheated Teflon® tubing connected the glass probe to the heated cyclone. Only acetone was used for rinses of the probe, nozzle, and Teflon® flex-line because water had no observable effect on the accumulation of the unusual particulate matter. An undetermined amount of sample was lost in the field on Run 3 of the inlet when a front-half acetone rinse sample bottle was accidentally broken. The H_2O samples were evaporated at 105° C, the solvent samples were evaporated at room temperature and the residue weighed and included in the particulate emissions. Sulfates were determined from the residues of each liquid fraction after analysis of the particulate samples. Analysis was performed by titrating with 0.0100 N Barium perchlorate. The filter was soaked in 80% Isopropyl alcohol and titrated for sulfate analysis. The benzene sampling procedure consisted of the collecting an integrated flue gas sample into a Tedlar® bag and analysis by EPA portable gas chromatographic Method 110, "Determination of benzene from Stationary Sources." The BaP sampling procedure consisted of an EPA Method 5 train, with an XAD-2 adsorbent trap inserted between the heated filter and first impinger. The XAD-2 trap was thermostatically controlled to between 120 and 127°F. Methylene Chloride was used for rinsing the probe, filter holder, and connecting glass-ware up to the trap. Acetone was used for rinsing the remainder of the train. Final analysis was performed by fluorescence spectrophotometry to determine concentrations of BaP. Due to the sampling difficulties encountered and the reported results, the test data are assigned an C rating. The report includes adequate detail, the test methodology was sound, and clearly characterizes the problems encountered and modifications to address the problems. Because of the lack of demonstrated particulate control (possibly due to high operating temperature) the tests at the outlet of the ESP are not suitable for emission factor development.

4.1.2.1.106 Reference 192. This test report describes an August 11 to 15, 1998 emission test conducted by Pacific Environmental Services, Inc. under contract with EPA's Emission Measurement Center. The test was conducted at Bethlehem Steel Corporation's Burns Harbor Division coke oven battery Number 2 in Chesterton, Indiana. Battery No. 2 is a Still/Otto design which began operation in 1972 and was rebuilt from the pad up in 1994. The battery consists of 82 six meter ovens that charge an average of 3 1.5 tons of coal to produce an average of 23.8 tons of coke. The normal coking time(from coal charge to coke push) for the battery is 18 hours. The battery uses 100% undesulfurized COG in a twin flue combustion system with double pair flues that uses multiple staged air undejet system. The battery combustion monitoring includes an 0_2 monitor, a continuous opacity monitor (COM), and a waste heat temperature monitor. Pushing emissions are captured by a moveable hood attached to a fixed duct system. The hood connects with the hooded coke guide and covers the quench car during pushing. When the dampers are open, the duct is open to the baghouse where a fan evacuates emissions from the hood. The hood in place at Battery No. 2 is a modified Minister Stein design; a tripper car moves under the belt which seals the top of the duct; the tripper car and fume hood are connected by a telescoping duct. The six compartment pulse jet baghouse has a volumetric flow rate of 205,000 to 216,000 acfm. At least 4 baghouse compartments are always on-line; one is usually out of service for cleaning, and one can be out of service for maintenance at any given time. Each compartment houses 352 12-foot-long Nomex bags. The bags are precoated with 1.5 pounds of lime per pulse jet cleaning cycle. A total of 3,100 pounds of lime is injected into the baghouse per day. Pressure drop (delta p) is measured across the baghouse rather than across individual compartments, and ranges from 4.4 to 8.8 inches of water. Air temperature in the baghouse ranges from 300°F at the inlet to 140 - 160°F at the outlet. The gross filtering area is 40,440 ft^2, the net filtering area (with one module offline for cleaning) is 33,700 ft^2, and the net air-to-cloth ratio is 5.94 $acfm/ft^2$.

The testing was performed to quantify uncontrolled and controlled air emissions of filterable particulate matter (PM), toluene extractable matter (EOM) and 19 polycyclic aromatic hydrocarbons (PAHs) [acenaphthene, acenapthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(e)pyrene, benzo(k)fluoranthene, benzo(ghi)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 2-methylnapthalene, napthalene, perylene, phenanthrene, and pyrene]. Although the case narative from the analytical laboratory states that toluene was the extracting solvent the test report correctly states that methylene chloride was used to extract the samples. In addition, following the PM and EOM analyses, the samples were analyzed to screen for the presence of 17 trace metals. Baghouse dust samples were also collected and analyzed for the same 16 trace metals. EPA Method 315 procedures were used to determine PM, EOM, and 17 metals at the baghouse inlet and outlet and underfire stack. The metals analyses consisted of a nitric acid digestion of the filters and impinger residues. The metals analysis was by Direct Aspiration Flame Atomic Absorption Spectrophotometry (FLAAS), Graphite Furnace Atomic Absorption Spectrophotometry (GFAAS), and Inductively Coupled Plasma - Optical Emission (ICP). Mercury analysis was by Cold Vapor Atomic Adsorption Spectrophotometry (CVAAS). The target metals included: antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), chromium

(Cr), cobalt (Co), copper (Cu), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni), phosphorous (P), selenium (Se), silver (Ag), thallium (Tl), and zinc (Zn). Due to the method used to collect and extract the metals from the samples, the analyses would consistently underestimate the actual emissions as may be determined by a more appropriate (e.g. EPA Methods 29, 101 or 108) sampling and analysis method. The polycyclic aromatic hydrocarbons (PAHs) were collected using CARB Method 429, “Determination of Polycyclic Aromatic Hydrocarbons from Stationary Sources.” This method was used to determine 19 individual PAHs. Particulate and gaseous phase PAHs were extracted isokinetically from each source and collected in the probe, Teflon® filter, XAD®-2 resin and impinger portions of the sampling train. Simultaneous testing was performed at the inlet and outlet of the baghouse controlling emissions from the coke oven pushing operation. Outlet sampling was also performed on the combustion stack. In addition to pollutant testing, oxygen (0_2) and carbon dioxide (CO_2) were measured at each location. During the sampling program, Research Triangle Institute (RTI), another EPA contractor, monitored and recorded process and emission control system operating parameters. Emissions for PM and extractable organic matter reported in the test report are calculated by subtracting the mass from the field blank sample. This subtraction is inconsistent with the published test methods (Method 5 and Method 315). Metals emissions calculated in the test report do not subtract the blank filter and pan values where there is a reported value above the minimum detection value. Additionally, for the underfire stack, all of the metals calculations were incorrect. The calculational inconsistencies were corrected and revised run by run emission factors are presented in Table 4-15 and 4-24. Except for the metals which are assigned a D rating, the data are assigned an A rating. The report includes adequate detail, the test methodology was sound, and no significant problems were reported.

4.1.2.1.107 Reference 193. This test report describes an September 21 to 25, 1998 emission test conducted by Pacific Environmental Services, Inc. under contract with EPA's Emission Measurement Center. The test was conducted at Alabama Byproduct Corporation's coke oven battery Number 5/6 in Birmingham, Alabama. Batteries 5 & 6 are four meter Koppers-Becker design which began operation in 1941 and 1951 respectively. Battery 5 has 25 ovens and battery 6 has 29 ovens. Both ovens charge an average of 15.33 tons of coal to produce an average of 12.26 tons of foundry coke. The normal coking time(from coal charge to coke push) for the battery is 24 hours. The battery uses 100% undesulfurized COG in a gun flue combustion system. The battery combustion monitoring includes stack draft, fuel gas flow, fuel gas pressure and waste heat temperature. Pushing emissions are captured by a moveable hood attached to a fixed duct system. The hood connects to a tripper car which moves under the belt that seals the top of the duct. The hood lines up with the hooded coke guide and covers the quench car during pushing. When the dampers are open, the duct is open to the baghouse where a fan evacuates emissions from the hood. The four compartment pulse jet baghouse has a volumetric flow rate of 130,000 acfm.

Each compartment houses 352 singed polyester bags. Pressure drop (delta p) is measured across each compartment and across the baghouse and equals 8 inches of water. Air temperature in the baghouse does not exceed 275°F. The air-to-cloth ratio is 6.46 acfm/ft^2.

The testing was performed to quantify uncontrolled and controlled air emissions of filterable particulate matter (PM), methylene chloride extractable matter (MCEM/EOM) and 19 polycyclic aromatic hydrocarbons (PAHs) [acenaphthene, acenapthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(e)pyrene, benzo(k)fluoranthene, benzo(ghi)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 2-methylnapthalene, napthalene, perylene, phenanthrene, and pyrene]. In addition, following the PM and EOM analyses, the samples were analyzed to screen for the presence of 17 trace metals. Baghouse dust samples were also collected and analyzed for the same 16 trace metals. EPA Method 315 procedures were used to determine PM, EOM, and 17 metals at the baghouse inlet and outlet and underfire stack. The metals analyses consisted of a nitric acid digestion of the filters and impinger residues. The metals analysis was by Direct Aspiration Flame Atomic Absorption Spectrophotometry (FLAAS), Graphite Furnace Atomic Absorption Spectrophotometry (GFAAS), and Inductively Coupled Plasma - Optical Emission (ICP). Mercury analysis was by Cold Vapor Atomic Adsorption Spectrophotometry (CVAAS). The target metals included: antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni), phosphorous (P), selenium (Se), silver (Ag), thallium (Tl), and zinc (Zn). Due to the method used to collect and extract the metals from the samples, the analyses would consistently underestimate the actual emissions as may be determined by a more appropriate (e.g. EPA Methods 29, 101 or 108) sampling and analysis method. The polycyclic aromatic hydrocarbons (PAHs) were collected using CARB Method 429, "Determination of Polycyclic Aromatic Hydrocarbons from Stationary Sources." This method was used to determine 19 individual PAHs. Particulate and gaseous phase PAHs were extracted isokinetically from each source and collected in the probe, Teflon® filter, XAD®-2 resin and impinger portions of the sampling train. Simultaneous testing was performed at the inlet and outlet of the baghouse controlling emissions from the coke oven pushing operation. Outlet sampling was also performed on the combustion stack. In addition to pollutant testing, oxygen (0_2) and carbon dioxide (CO_2) were measured at each location. During the sampling program, Research Triangle Institute (RTI), another EPA contractor, monitored and recorded process and emission control system operating parameters. Emissions for PM and extractable organic matter reported in the test report are calculated by subtracting the mass from the field blank sample. This subtraction is inconsistent with the published test methods (Method 5 and Method 315). Metals emissions calculated in the test report do not subtract the blank filter values where there is a reported value above the minimum detection value. Additionally, for the underfire stack, all of the metals calculations were incorrect. The calculational inconsistencies were corrected and revised run by run emission factors are presented in Table 4-15 and 4-24. Except for the metals which are assigned a D rating, the data are assigned an A rating. The report includes adequate detail, the test methodology was sound, and no significant problems were reported.

4.1.2.1.108 Reference 194. This document is the background information used in the development of MACT standards for the coke ovens: pushing, quenching, and battery stacks source category. Information contained in the document includes an overview of the industry and cokemaking process, emission points and emission control technologies and their performance, an analysis to determin regulatory floor, the development of model plants for use in estimating potential impacts and options for emission control and monitoring, estimates of environmental and energy impacts for the model plants, estimated costs for emission control and monitoring and a summary of emissions data used in the report. Chapter 5 of this document presents information on environmental impacts associated with the regulation of HAP emissions from the pushing, combustion stack and quenching of coke. A significant portion of the chapter presents the derivation of emission factors that allow for evaluating the potential emissions reductions that may result from implementing different control technologies. The emission factors derived are based upon data from three emission tests that are also cited elsewhere in this “Emission Factor Documentation for AP-42, Section 12.2, Coke Production” report. Extractable Organic Material and PAH data from References 192 and 193 in “Emission Factor Documentation for AP-42, Section 12.2, Coke Production” are used to derive emission factors for pushing that depend on the number of “green coke pushes.” The same type of data from these references are used to derive emission factors for combustion stacks that depend on the in stack opacity measured by a continuous opacity monitor. Emissions data from Reference 140 was used to derive emission factors for coke quenching that depend on the number of “green coke pushes.” Within reference 194, non-green pushes are defined as pushes with visible opacities of less than 30%, moderately green pushes are defined as pushes with opacities between 30% to less than 50% and severely green pushes are defined as pushes with 50% or greater opacity. Based upon the definitions of “green pushes” in Reference 194, the number of non-green, moderately green and severely green pushes during the tests documented in References 192 and 193 were as follows:

	Bethlehem Steel, Burns Harbor Reference 192			ABC Coke, Birmingham, AL Reference 193		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
Total pushes during test run	46	47	42	21	21	22
Non-green pushes	43	41	39	17	17	18
Moderately green pushes	3	6	3	3	4	4
Severely green pushes	0	0	0	1	0	0

To develop the relationship between emissions in lb/ton coke pushed and the classification of the greenness of the coke, the reported emissions data were adjusted for the capture effectiveness of the hood and multiple equations with the percentage of each classification of push were solved to arrive at the emission factors for each classification. It was estimated that 90% of the emissions from non-green pushes were captured by the hoods, 40% of the emissions from moderately green pushes were captured and only 10% of the emissions were captured from severely green pushes. Emission factors for each greenness classification were calculated for both test series. The final emission factor by push classification was the average of the resulting factors. The extractable organic emission factors that were developed were 0.0024 lb/ton of coke for non-green pushes, 0.067 lb/ton of coke for moderately green pushes and 2.3 lb/ton of coke for severely green pushes.

To develop a relationship between underfire (battery combustion) stack opacity and emissions rate (lb/hr) a theoretical relationship between mass concentration and opacity was combined with the extractable organic matter emission concentration reported in Reference 193 and the volumetric flow rate. Data from Reference 192 was not used. It is stated at the beginning of the discussion on the development of emission factors for Battery Stacks that this data was not used because Run 3 at Burns Harbor had about 10 times more naphthalene and 3 times more extractable organics than the other runs and the extractable organics were 20 to 30 times higher at Bethlehem Steel, but the PAH were the same order of magnitude as at ABC Coke. It is further stated that these results indicate that extractable organics are not a good surrogate for POM for the Bethlehem test because it may include compounds that are not POM or PAH. The theoretical relationship between concentration (C) and opacity (Op) that was used was $C = - \ln (- Op/100)/constant$. Values for the term "- ln (1- Op/100)" were calculated for the average opacity recorded during the Reference 193 emission tests (1.7%) and other opacities from 5% to 15%. Ratios between the value for the term for the other opacities and the value for the average opacity during the tests documented in Reference 193 were calculated. The resulting ratios that were calculated were 3 for 5% opacity, 6.2 for 10% opacity and 9.4 for 15% opacity. These ratios are used to adjust the concentration reported in Reference 193 to higher opacities. Additional adjustments are made for differences in the volumetric flow rate reported in Reference 193 and the volumetric flow rate for the facility whose emissions are being estimated.

Emissions presented in Reference 140 were used to develop two emission factors for coke quenching. Emission factors for non-green and green pushes using clean water and dirty water are presented for the sum of 7 PAH compounds, 16 PAH compounds and total PAH. Emission factors for extractable organic material are developed based upon the average of 8% PAH that was contained in the extractable organic matter reported in Reference 193 (ABC Coke). Sixteen PAH emission factors of 0.00058 lb/ton coal for not severely green pushes and 0.0014 lb/ton coal for severely green pushes were presented. Extractable organic emission factors of 0.007 lb/ton coal for not severely green pushes and 0.018 lb/ton coal for severely green pushes were also presented.

Since no additional emission test data is presented in this report, an emission factor test quality rating is not assigned. However, the analysis of the test data presented in References 140, 192 and 193 provide a reasonable means to accommodate variations in plant operation when the required information on green pushes and battery stack opacity is available.

4.1.2.1.109 <u>Reference 195</u>. This U. S. Steel Corporation Interorganization Correspondence documents a five run particulate emission test of the Clairton Works No. 11 coke oven battery combustion stack that was conducted during the weeks of November 28 and December 5, 1977. The front half (probe and filter catch) emissions averaged 12.7 lb/hr, the back half inorganic particulate averaged about 7.2 lb/hr and the back half organic particulate averaged about 2.8 lb/hr. However, since no production information is contained in the test report, this information can not be used for emission factor development.

4.1.2.1.110 <u>Reference 196</u>. This report documents emission testing that appears to have been conducted by the Pennsylvania Department of Environmental Resources Bureau of Air Quality Control is a single run test. The test was performed on the combustion stack of the Jones & Laughlin A-5 coke oven battery in Aliquippa, PA on June 7, 1978. The weight of soluble and insoluble front half and soluble and insoluble back half particulate were determined. The total particulate emission rate for the one run was 52 lb/hr of which 47.6 lb/hr was front half particulate and 4.3 lb/hr was back half particulate. The coal charged during the sampling time averaged 52.4 tons/hr. The test report is adequately documented however since there is only one run, the data is not used for emission factor development when other data are available.

4.1.2.1.111 Reference 197. This report documents emission testing that was performed on the No. 3 and No. 4 combustion stacks of Keystone Coke Companies Conshohcken, PA plant between July 24 and 26 of 1979. The total particulate emission (front and back half less sulfates) emission rates were 8.24 lb/hr for battery 3 and 9.44 for battery 4. The front half portion of these emission rates were 76% of the total for battery 3 and 84% of the total for battery 4. The sulfates subtracted for the total were 17% of the total for battery 3 and 13% for battery 4. The hourly coal charged to both batteries was stated to be 11.8 tons/hr. The test report is adequately documented however, since there is only one run, the data is not used for emission factor development when other data are available.

4.1.2.1.112 Reference 198. This report documents emission testing that was performed on the No. 3 and No. 4 combustion stacks of Keystone Coke Companies Conshohcken, PA plant between July 5 and 6 of 1978. The total particulate emission (front and back half) emission rates were 3.94 lb/hr for battery 3 and 7.10 for battery 4. The front half portion of these emission rates were 53% of the total for battery 3 and 52% of the total for battery 4. Although the hourly coal charged to both batteries was not stated in the test report, it is likely to be similar to the 11.8 tons/hr documented in the test report (Reference 197) performed one year later. The test report is adequately documented however, since there is only one run, the data is not used for emission factor development when other data are available.

4.1.2.1.113 Reference 199. This report documents emission testing that was performed on the No. 15 combustion stack of U. S. Steel Corporations Gary, Indiana plant between October 31 and November 1 of 1979. The total front half particulate emission rate averaged 26.5 lb/hr. The test report is well documented and includes detailed process information. However, neither information on the quantity of coal charged per oven or coke produced was available. Therefore, the data presented in the test report is not useable for developing emission factors.

4.1.2.1.114 Reference 200. This report documents a series of emissions tests that were performed on the combustion stacks of batteries F and G at Kaiser Steel Corporations Fontana, California plant between January 7 and 10 of 1980. Both battery F and battery G were controlled by a fabric filter. The particulate tests determined mass emissions of front half filterable particulate, back half organic extract and aqueous soluble and insoluble back half particulate. It is unlikely that the inorganic back half analysis incorporated the additional procedures to minimize conversion of SO_2 to sulfate and as a result may be biased high. Carbon dioxide and carbon monoxide were measured with a Horiba IR analyzer. The test report contained adequate documentation however, the production data was estimated from information contained in Reference 85. Because the production information was estimated from a separate emission test, the data for front half particulate, organic condensable particulate, CO2 and CO are rated C. Data for inorganic condensable particulate are rated D.

4.1.2.1.115 Reference 201. This report documents emission testing that was performed on the No. 3 combustion stack of U. S. Steel Corporations Gary, Indiana plant between February 1 and 6 of 1980. Three runs were performed while using coke oven gas as fuel and three runs were performed while using blast furnace gas as fuel. The total front half particulate emission rate averaged 26.2 lb/hr with coke oven gas and 8.9 lb/ hr with blast furnace gas. The total sulfate particulate emission rate averaged 15.3 lb/hr with coke oven gas and 7.8 lb/ hr with blast furnace gas. The test report is well documented and includes detailed process information. However, neither information on the quantity of coal charged per oven or coke produced was available. Therefore, the data presented in the test report is not useable for developing emission factors.

4.1.2.1.116 Reference 202. This report documents emission testing that was performed on the No. 1 combustion stack of U. S. Steel Corporations Gary, Indiana plant between February 1 and 3 of 1980. Three runs were performed while using coke oven gas as fuel. The total front half particulate emission rate averaged 29.6 lb/hr. The total sulfate particulate emission rate averaged 22.9 lb/hr. The test report is well documented and includes detailed process information. However, neither information on the quantity of coal charged per oven or coke produced was available. Therefore, the data presented in the test report is not useable for developing emission factors.

4.1.2.1.117 Reference 203. This report documents emission testing that was performed on the P4 combustion stack of J & L Steel Corporations Pittsburgh, PA Works between April 16 and 17 of 1980. Three Method 5 and three Method 17 runs were performed while using coke oven gas as fuel. The Method 5 front half particulate emission rate averaged 9.8 lb/hr and the Method 17 front half average 2.8 lb/hr.. The sulfate particulate averaged 40% of the Method 5 particulate. The test report is well documented however, neither information on the quantity of coal charged or coke produced was available. Therefore, the data presented in the test report is not useable for developing emission factors.

4.1.2.1.118 Reference 204. This report documents emission testing that was performed on the combustion stacks of the P3 South and P4 coke oven batteries of J & L Steel Corporations Pittsburgh, PA Works between April 14 and 23 of 1975. The testing consisted of twenty particulate, SO_2, and NOx test runs. In addition, six particle sizing tests were conducted using an Anderson eight stage Impactor. The particulate tests included analyses as required by Method 5, analyses for back half particulate as required by the State of Pennsylvania which appears to require an analysis for organic condensable particulate. The NOx testing was performed with a Dynasciences Model NX130 Air Pollution Monitor. The Sox sampling was performed by a method specified in the Source Testing Manual of the Air Pollution Control District, County of Los Angeles dated November 1963. The EPA Method 5 data averaged [illegible]6.7 lb/hr for battery P3 South and 42.8 lb/hr for battery P4. The total particulate by the Pennsylvania method averaged 102.6 lb/hr for the P3 South battery and 99.9 lb/hr for the P4 battery. The condensable organic particulate averaged 31.7 lb/hr for battery P3 South and 22.6 lb/hr for battery P4. The SO2 concentrations average 3140 ppm for the P3 South battery and 2660 ppm for the P4 battery. The Nox concentrations and mass emission rates averaged 485 ppm (213 lb/hr) for the P3 South battery and 186 ppm (73.4 lb/hr) for the P4 battery. The test report is well documented however, neither information on the quantity of coal charged or coke produced was available. Therefore, the data presented in the test report is not useable for developing emission factors.

4.1.2.1.119 Reference 206. This report documents emission testing that was performed by Mostardi-Platt Associates, Inc. on Bethlehem Steel Corporations No. 1 Coke Battery Underfire Stack at Burns Harbor, Indiana between March 20 and 22, 1995. The testing consisted of six particulate test runs by Method 5, three gaseous pollutant test runs by Summa Canister and analysis by TO Method 14, one semi-volatile pollutants test run by Method SW-846-0010 with an unspecified analysis method, continuous emissions analysis for NOx by Method 7E and continuous emissions analysis for Total Organic Compounds by Method 25A. The table of contents indicates that the test report was in excess of 170 pages that include detailed information on the sampling and analysis procedures, quality analysis procedures, calculations, calibration data, field data sheets and chain of custody records. However, only those pages that provide a summary of the test procedures and the final emission factors obtained are available. The general descriptions of the test procedures indicate that appropriate methodologies were used for most pollutants. However, the use of Summa canisters to obtain samples for flue gas analysis has more recognized deficiencies than indicated in the general description in the test report. The general description states that Method TO-14 can be used to quantify most volatile organic compounds that have boiling points below 200°C and that are insoluble or slightly soluble in water. EPA's experience using Summa canisters for flue gases is that many compounds that are collected are retained in the canister. As a result the analysis is useful as a qualitative analysis to indicate a lower bound estimate of emissions. Because the test report lacks adequate documentation, all of the data presented in the report are rated D. The data on volatile orgainc compound determined by TO-14 are considered only as qualitiative indicators of emissions and would be rated D even with additional documentation.

4.1.2.1.120 Reference 207. This report documents emission testing that was performed by Mostardi-Platt Associates, Inc. on Bethlehem Steel Corporations No. 1 Coke Battery Pushing Control

Stack at Burns Harbor, Indiana between March 20 and 22, 1995. The testing consisted of three particulate test runs by Method 5, three gaseous pollutant test runs by Summa Canister and analysis by TO Method 14, two semi-volatile pollutants test run by Method SW-846-0010 with an unspecified analysis method, continuous emissions analysis for NOx by Method 7E and continuous emissions analysis for Total Organic Compounds by Method 25A. The table of contents indicates that the test report was in excess of 199 pages that include detailed information on the sampling and analysis procedures, quality analysis procedures, calculations, calibration data, field data sheets and chain of custody records. However, only those pages that provide a summary of the test procedures and the final emission factors obtained are available. The test report does not state what air pollution control equipment is installed on the pushing control system, however data available in Table 2-5 of Reference 194 indicates that a wet scrubber is used at this battery. The general descriptions of the test procedures indicate that appropriate methodologies were used for most pollutants. However, the use of Summa canisters to obtain samples for flue gas analysis has more recognized deficiencies than indicated in the general description in the test report. The general description states that Method TO-14 can be used to quantify most volatile organic compounds that have boiling points below 200°C and that are insoluble or slightly soluble in water. EPA's experience using Summa canisters for flue gasses is that many compounds that are collected are retained in the canister. As a result the analysis is useful as a qualitative analysis to indicate a lower bound estimate of emissions. Because the test report lacks adequate documentation, all of the data presented in the report are rated D. The data on volatile orgainc compound determined by TO-14 are considered only as qualitiative indicators of emissions and would be rated D even with additional documentation.

4.1.2.2 Development of Candidate Emission Factors for Pushing, Quenching, Combustion Stacks and Miscellaneous Emission Sources

4.1.2.2.1 Pushing Emissions

Pushing emissions data are presented in Tables 4-15. This table also includes the averages that are recommended for inclusion in the AP-42 section and statistical information such as minimum and maximum values, number of data and standard deviation. The majority of data included in the Table are for identified coke oven batteries. However, there is some data supplied by the industry that are from coke oven batteries that are not identified. All of this information are believed to be representative of emissions found at plants currently in operation. Because of the general lack of A and B rated data, C and D rated data are averaged with A and B rated data when the grouped data are consistent with the A and B rated data. There were three instances where data were not averaged with the remaining data to develop a recommended emission factor. Fabric filter controlled data from Reference 193 for Perylene was excluded because all of the data were below the minimum detection limits and ½ of these values were greater than the greatest emission factor quantified in Reference 192 which was the only other available test. The benzene data from Reference 207 was not used because a Summa canister was used to collect the emissions. Summa canisters retain a significant portion of many organic compounds when used to collect flue gasses. Since data which was collected by EPA Method 18 was available, the Summa canister data was excluded from averaging. Two of the Methylene Chloride runs from Reference 207 were excluded since they were below minimum detection limits and ½ of these values were greater than the one value that was quantified. Additionally, eight averages for uncontrolled emissions of polycyclic aromatic hydrocarbons (PAH) were less than the controlled emissions. This resulted due to the situation that uncontrolled emissions were based upon the average of two facilities (References 192 and 193) while controlled emissions were based upon four facilities. For these eight PAH compounds (Naphthalene, Acenaththalene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene and Benzo(a)antracene), uncontrolled emissions were based upon the controlled emission factor adjusted for the average control efficiency documented in References 192 and 193.

The emission factor ratings are based upon primarily the test report ratings and the number of data that were averaged to arrive at the recommended emission factor. Generally, 20 or more tests (of 2 to 3 runs) that are rated A or B are required to receive an initial factor rating of A. For B, C and D ratings the required number of tests are 10, 5 and 3. An E rating is assigned when there are one or two tests. Two C or three D rated tests are considered equivalent to an A or B rated test for the purposes of assigning the final emission factor rating. When there are more than seven supporting data, additional adjustments to the emission factor rating may be made based upon the relative standard deviation of the supporting data. If the relative standard deviation is less than 50%, the emission factor rating may be improved by one letter grade. However, if the relative standard deviation is greater than 200%, the emission factor rating may be reduced by one letter grade.

Few of the data in Table 4-15 include adjustments for the capture efficiency of the sheds or hoods installed to collect the emissions. The few references which estimated capture efficiency provided little relationship between variations in the volume of gasses generated due to the differences in the greenness of the coke pushed and the capability of the shed or hood to capture the emissions generated. Except for information available for tests documented in References 192 and 193, there was no simple methodology provided to assess the greenness of the coke from the visible appearance of the emissions and relate the visible appearance to control equipment capture effectiveness. Reference 194 provides a simple methodology based upon visible emissions to accommodate variations in the volume of gasses generated to the ability of control equipment to capture and control emissions. In Reference 194, a 90% capture efficiency is assumed for non-green, 40% for moderately green, and 10% for severely green pushes. A non-green push is defined as one with an average opacity less than 30%, moderately green pushes have opacities from 30% to less than 50%, and severely green pushes have opacities of 50% or greater. The percentage of non-green, moderately green and severely green pushes for the emission tests documented in References 192 and 193 are documented in Reference 194. Averaging this information yields the prevalence of non-green, moderately green and severely green pushes for typical well operated coke oven batteries. The resulting prevalence of the three classes of green pushes are 86.25% non-green, 13% moderately green and 0.75% severely green. Combining the assumed capture efficiency with the prevalence of green pushes yields a multiplier of 1.35 {0.86 X (1 ÷ 0.9) + 0.13 X (1 ÷ 0.4) + 0.0075 X (1 ÷ 0.1)}that can be used to adjust the captured uncontrolled emissions to obtain total uncontrolled emissions. For estimating controlled emissions where uncontrolled emission factors are available 25.9% of the uncontrolled emission factor is added to the controlled emission presented in Table 4-15 to calculate the recommended emission factors for pushing. Additionally, Reference 194 presents a methodology that accommodates both the change in capture efficiency and the concentration change for estimating extractable organic emissions from pushing that is based upon the greenness of the coke being pushed. This methodology is recommended as an alternative to the single value emission factor when opacity data is available from a facility.

The emission factors recommended for inclusion in AP-42 are presented in Tables 4-16 through 4-21. Tables 4-16 and 4-17 present the filterable and condensible particulate emission factors while Table 4-18 presents that portion of total particulate that is extractable by a solvent such as benzene, toluene or methylene chloride. Table 4-19 presents emission factors for various volatile and semi-volatile organic vapors and inorganic gasses. Table 4-20 presents emission factors for metals. Table 4-21 presents emission factors for 19 polycyclic aromatic hydrocarbons.

4.1.2.2.2 Quenching Emissions

A series of emissions tests at four baffle-controlled quenching towers is described in Reference 18. While these PM data, shown in Table 4-22, have been used for previous emission factors, facility characteristics suggest that they should be revised. The Lorain tower was taller than many, quenched green coke, used a proprietary quenching method that injected water deeply into the coke bed, and had higher gas velocity; it also had missing baffles when tested. These factors would tend to increase PM emissions. The remaining towers had emission levels about 20 percent of the Lorain tower. The recommended new emission factors, shown in Table 4-23, divide the controlled towers into two categories: tall or poorly maintained towers and well maintained towers. These emission factors are based on only the filterable PM catch in the Method 5 sampling train. Values are given for clean quench water (500 mg/L TDS or less) and dirty quench water (about 1,500 mg/L TDS or more). Tall towers are about 120 ft or taller. An emission factor rating of D is suggested for controlled quenching. For quench water having a TDS value between those for clean and dirty water, an interpolation procedure is suggested. For example, for a quench water TDS value of 1,000 mg/L, for a properly maintained tower of normal height, the following PM emission factor would be found:

$$[(1{,}000 - 500)/(1{,}500 - 500) \times (0.54 - 0.31)] + 0.31 = 0.425 \text{ lb/ton of coal.}$$

4.1.2.2.3 Combustion Stack Emissions

Emissions data for controlled and uncontrolled combustion stacks are given in Table 4-24. This table also includes the averages that are recommended for inclusion in the AP-42 section and statistical information such as minimum and maximum values, number of data and standard deviation. The majority of data included in the table are for identified coke oven batteries. However, there is some data supplied by the industry that are from coke oven batteries that are not identified. All of this information are believed to be representative of emissions found at plants currently in operation. Because of the general lack of A and B rated data, C and D rated data are averaged with A and B rated data when the grouped data are consistent with the A and B rated data. There were twelve instances where data were not averaged with the remaining data to develop a recommended emission factor. There were eight test data that were not averaged with the remaining data because the pollutant was below the minimum detection limit and ½ of these values were greater than the greatest emission factor for the remaining tests where the pollutant was quantified. One set of data (Reference 191 for filterable particulate) was not averaged with the remaining six sets of data since the emissions were over ten standard deviations higher than the average of the remaining six data sets and was over five times higher than any of the remaining data. One run from reference 206 for acetone was not averaged with the remaining two runs since this value was ten times greater than either remaining run, was greater than 14 of the 18 tests for total organic compounds (TOC, of which acetone is typically a small portion) and the average acetone factor with this run included would be greater than the average TOC from eighteen tests. Since the TOC data from this test was not available, the percentage acetone in TOC could not be used to develop the VOC emission factor and the alternative value of the average acetone value for the two lower test runs is recommended as a replacement. The VOC emission factor presented in Reference 176 was not used since there is more information available for TOC emissions. Although the VOC emission factor from Reference 176 is not used, the ratio of methane to TOC and ethane to TOC derived from this reference is used in conjunction with the THC emission factor to arrive at a value representing the non-methane non-ethane portion of the TOC. Because the uncontrolled emissions were available, the outlet data for Benz-a-pyrene from Reference 191 was not averaged with the remaining data although this data was higher than the inlet data.

The emission factor ratings are based upon primarily the test report ratings and the number of data that were averaged to arrive at the recommended emission factor. Generally, 20 or more tests (of 2 to 3 runs) that are rated A or B are required to receive an initial factor rating of A. For B, C and D ratings the required number of tests are 10, 5 and 3. An E rating is assigned when there are one or two tests. Two C or three D rated tests are considered equivalent to an A or B rated test for the purposes of assigning the final emission factor rating. When there are more than seven supporting data, additional adjustments to the emission factor rating may be made based upon the relative standard deviation of the supporting data. If the relative standard deviation is less than 50%, the emission factor rating may be improved by one letter grade. However, if the relative standard deviation is greater than 200%, the emission factor rating may be reduced by one letter grade.

The emission factors recommended for inclusion in AP-42 are presented in Tables 4-25 through 4-29. Tables 4-25 and 4-26 present the filterable and condensible particulate emission factors while Table 4-27 presents that portion of total particulate that is extractable by a solvent such as benzene, toluene or methylene chloride. In addition, Table 4-27 presents emission factors for various volatile and semi-volatile organic vapors and inorganic gasses. Table 4-28 presents emission factors for metals. Table 4-29 presents emission factors for 19 polycyclic aromatic hydrocarbons.

4.1.2.2.4 Particle Size Data

Particle size data for several coking operations were collected in the 1970s and early 1980s, and were presented in the previous version of AP-42. It is not clear that those data are applicable to post-NESHAP batteries. Appendix A lists the particle size data as presented in the original document that contained them (Reference 17).

4.1.2.2.5 Miscellaneous Emission Sources

Table 4-14 summarizes emissions from miscellaneous sources, including coal crushing, coal preheaters, coke handling, soaking, and decarbonization. The emission factors for coal crushing, coal preheating, and coke handling were taken from Reference 4 and were not re-evaluated because of the absence of the original test reports.

Emissions may also occur from leaks in the collecting main; however, these leaks are usually easily repaired and are required to be repaired under the coke oven NESHAP. There are no data available on the frequency of occurrence of these small leaks or the quantity emitted.

Soaking emissions are estimated in Reference 15. Particulate matter emissions are estimated as 1.2 lb/push for a 18-ton charge, and the PM is expected to be entirely PM-10. This value assumes no control by combustion of vented gases. For emission factor estimates, 80 percent control is assumed.

From Reference 15, CO emissions result during decarbonization when 224 lb of carbon per oven is converted to 523 lb of CO. For the model Battery described earlier (18 tons of coal per oven), this results in a CO emission factor of:

523/18 = 29 lb/ton coal

4.1.3 PROCEDURE FOR ESTIMATING EMISSIONS - BYPRODUCT PLANTS

Descriptive material for this new section of AP-42 was taken from 13 sources including test reports described below and two draft and one final environmental impact statements (EISs). It should be emphasized that nearly all the emissions information from these references is for benzene. Some toluene and xylene emissions data are available in one of the references. All other VOC and organic HAP emission values are extrapolations derived from ratios applied to the benzene emissions.

All of the emission measurements were performed in byproduct plants serving coke ovens producing furnace coke, as defined in the NESHAP rules for coke oven byproduct plants. Emission factors for byproduct plants serving coke ovens producing foundry coke have been derived from the furnace coke test results. For the NESHAP and the purposes of this document, foundry coke is defined as coke that is produced from raw materials with less than 26 percent volatile material by weight and that is subject to a coking period of 24 hours or more. Furnace coke refers to all other coke produced in byproduct ovens that is not foundry coke. A foundry coke byproduct recovery plant is one that serves batteries whose annual coke production is at least 75 percent foundry coke. The remaining coke byproduct recovery plants are furnace coke byproduct plants. A procedure for developing emission factors for coke byproduct plants where foundry coke is produced (by the NESHAP definition) is provided.

4.1.3.1 Review of Available Data

4.1.3.1.1 Reference 26. This EIS and background information document for coke byproduct plants contains, among other elements, process descriptions, emission summaries, emission control technologies, and impacts of potential control options on future emissions. Of particular interest are data in Appendix F that provide an estimate of the quantity and value of organic compounds other than light oil in byproduct plant emissions. Emissions of other organics are estimated by multiplying the benzene emissions listed in Chapter 7 of the document by the ratio of the other organic's concentration to the benzene concentration. Emissions of VOCs, as defined at the time of the report (1984), are also estimated and include the quantity of total chromatographic organics (TCO), boiling point of 200° to 300 °C (390° to 570°F) and the quantity of light oil (benzene, toluene, and xylene). Emissions of VOCs are estimated by adding light oil emissions (benzene emissions divided by 0.7) and TCO emissions (benzene emissions multiplied by the ratio of TCO concentration to benzene concentration). Emissions of C_1 to C_7 hydrocarbons are not included as VOC because the average molecular weight (16 to 22) indicates that this fraction is mostly methane and ethane. Assumptions used in developing the ratios of organics to benzene included generalizations to byproduct plant processes from limited data and assignment of emissions from one process to similar processes.

4.1.3.1.2 Reference 27. This EIS and background information document is a successor to the 1984 document referenced above. It contains, among other topics, a summary of changes since that document, revised emission estimates for uncontrolled processes, and emission estimates for equipment leaks. Appendix A of the document distinguishes between furnace and foundry plant emissions based on differences in processing conditions at the two types of plants. Definitions for the two types of plants are given later. Uncontrolled benzene emission factors are presented for cooling towers, naphthalene separation and processing, light-oil condenser vents, tar intercepting sumps, tar dewatering, tar decanters, tar storage light-oil sumps light-oil storage, BTX (benzene, toluene, and xylene) storage, benzene storage, flushing-liquor circulation tanks, excess-ammonia liquor tanks, wash-oil decanters, wash-oil circulation tanks, and equipment leaks. The latter include pump seals, valves, pressure-relief devices, exhausters, sample connections, and open-ended lines. All of the emission factors are given for furnace plants and for foundry plants.

Because these emission factors are based on few data and on assumptions regarding the differences between furnace and foundry plants, they are assigned a rating of E.

4.1.3.1.3 Reference 28. This document is the final EIS and background document for coke byproduct recovery plants. It also contains responses to technical comments for 1989 final decisions. The major topics of interest for estimating emission factors are control efficiencies for byproduct plant process and equipment leaks. Effects of controls on emission sources at furnace and foundry plants are based on coke-oven gas blanketing for all processes except the final cooler, benzene storage tanks, and light-oil sumps. The final cooler is presented with control either by use of a tar-bottom final cooler or wash-oil final cooler. Benzene storage tanks are presented as controlled by nitrogen blanketing, and light-oil sumps are presented as controlled by covers. Controls for pumps, valves, exhausters, and pressure-relief devices are presented as quarterly or monthly inspections, with alternate controls of dual mechanical seals for pumps, sealed bellows valves, degassing reservoirs for exhausters, and rupture discs for pressure relief devices. Sampling connections and open-ended lines are capped or plugged, while naphthalene processing and handling use mixer-settlers.

4.1.3.1.4 Reference 29. This emission test (Report 80-BYC-1) was sponsored by the Emissions Measurement Branch of EPA and was conducted from July 7 to 24, 1980. The emissions measured were benzene from six sources in the byproduct recovery plant. Those sources included the direct water final cooling tower, tar decanter, light oil condenser vent, naphthalene drying tank (batch process, steam drives water off naphthalene), Denver flotation units (naphthalene skimmed off surface of water from cooling tower), and naphthalene melt pit (batch process, receives naphthalene skimmed off surface).

Benzene emissions were measured using EPA Method 110 (samples collected in a Tedlar bag) with some modifications made because of special sampling problems encountered. A trap was added to collect moisture. Naphthalene condensation in the sampling lines was addressed by bubbling the sample gas stream through propylene carbonate. The probe, sampling lines, and impingers were rinsed with propylene carbonate. Recovered benzene from the rinses was added to that measured in the bag. Four of the six sources had stacks, or had stack extensions that were added to permit a traverse or single point measurement. To enable calculation of mass emission rates, velocity and temperature measurements were made in the stacks. A vane anemometer was used for the velocity measurements.

The Denver flotation units and melt pit had large open surfaces exposed to the atmosphere. The method for measuring benzene emission rates from these sources involved the use of a tracer gas (isobutane) dispersed at a known rate over the surface of the tank. Downwind samples were taken to measure both isobutane and benzene concentrations, from which the benzene emission rate could be calculated. No controls for benzene emissions were in place on any of the sources.

A rating of A was assigned to the benzene emission tests performed on the cooling tower, tar decanter, light oil condenser vent, and naphthalene drying tank. Process descriptions were provided and the data were presented with adequate detail. Specific production and process data were reported in a trip report written to accompany the test report. Although the drying tank tests were performed with a propylene carbonate solution in an impinger to prevent plugging with naphthalene, steps were taken to check the procedure and recover benzene that may have been captured. A rating of C was assigned to the benzene emission tests performed on the Denver flotation unit and naphthalene melt pit. The method involving the use of tracer gas to obtain benzene emission rates from the Denver flotation unit and melt pit was a new method. Both process and production data were available for these tests.

4.1.3.1.5 Reference 30. This emission test (Report 80-BYC-5) was sponsored by the Emissions Measurement Branch of EPA and was conducted from September 23 to 24, 1980. The emissions measured were benzene from two sources in the byproduct recovery plant. Those sources were a tar decanter and tar dehydrator (tar dewatering).

Benzene emissions were measured using EPA Method 110 (samples collected in a Tedlar bag) modified to include a moisture trap. Condensate was saved and analyzed along with probe and sample rinses (propylene carbonate) for benzene content. To enable calculation of mass emission rates, velocity and temperature measurements were made in the stacks. A vane anemometer was used for the velocity measurements. No controls for benzene emissions were in place on either of these sources.

A rating of A was assigned to the benzene emission tests performed on both the tar decanter and tar dehydrator. Process descriptions were provided and the data were presented with adequate detail. Specific production and process data were reported in a trip report written to accompany the test report.

4.1.3.1.6 Reference 31. This emission test (Report 80-BYC-3) was sponsored by the Emissions Measurement Branch of EPA and was conducted from August 12 to 13, 1980. The emissions measured were benzene from three sources in the byproduct recovery plant. Those sources were a tar storage tank, light oil storage tank, and tar intercepting sump.

For the tar storage tank and light oil storage tank, benzene emissions were measured using EPA Method 110 (samples collected in a Tedlar bag) modified to include a moisture trap. Condensate was saved and analyzed along with probe and sample rinses (propylene carbonate) for benzene content. To enable calculation of mass emission rates, velocity and temperature measurements were made in the stacks. A vane anemometer was used for the velocity measurements. Unfortunately, no flow could be detected at the light oil storage tank stack, so no mass emission rate could be calculated for this source. No controls for benzene emissions were in place on either of these sources.

The tar intercepting sump had a large open surface exposed to the atmosphere. The method for measuring benzene emission rates from this source involved the use of a tracer gas (isobutane) dispersed at a known rate over the surface of the tank. Downwind samples were taken to measure both isobutane and benzene concentrations, from which the benzene emission rate could be calculated. No controls for benzene emissions were in place on this source.

A rating of A was assigned to the benzene emission tests performed on the tar storage tank. A process description was provided and the data were presented with adequate detail. Specific production and process data were reported in a trip report written to accompany the test report. A rating of C was assigned to the benzene emission tests performed on the tar intercepting sump. The method involving the use of tracer gas to obtain benzene emission rates from the sump was a new method. Both process and production data were also available for this test.

4.1.3.1.7 Reference 32. This emission test (Report 80-BYC-8) was sponsored by the Emissions Measurement Branch of EPA and was conducted from July 28 to August 8, 1980. The emissions measured were benzene from four sources in the byproduct recovery plant. Those sources were a direct water final cooler, wash oil decanter, and two tar dehydrators (tar dewatering).

Benzene emissions were measured using EPA Method 110 (samples collected in a Tedlar bag) with some modifications made because of special sampling problems encountered. A trap was added to collect moisture. Naphthalene condensation in the sampling lines was addressed by bubbling the sample gas stream through propylene carbonate (for tar dehydrator sampling). The probe, sampling lines, and impingers were rinsed with propylene carbonate. Recovered benzene from the rinses was added to that measured in the bag. All of the sources had stacks, or stack extensions that were added to permit a traverse or single point measurement. To enable calculation of mass emission rates, velocity and temperature measurements were made in the stacks. A vane anemometer was used for the velocity measurements.

A rating of A was assigned to the benzene emission tests performed on all four sources. Process descriptions were provided and the data were presented with adequate detail. Specific production and process data were reported in a trip report written to accompany the test report. Although the tar dehydrator tests were performed with a propylene carbonate solution in an impinger to prevent plugging with naphthalene, steps were taken to check the procedure and recover benzene that may have been captured. Specific production and process data were reported in a trip report written to accompany the test report.

4.1.3.1.8 <u>Reference 33</u>. This emission test (Report 80-BYC-6) was sponsored by the Emissions Measurement Branch of EPA and was conducted from October 6 to 7, 1980. The emissions measured were benzene from two sources in the byproduct recovery plant. Those sources were a tar storage tank (during tar dewatering) and a tar bottom final cooler.

For the tar storage tank and tar bottom final cooling tower, benzene emissions were measured using EPA Method 110 (samples collected in a Tedlar bag) modified to include a moisture trap. Condensate was saved and analyzed along with probe and sample rinses (propylene carbonate) for benzene content. Both sources had stacks that enabled a traverse or single point measurement. To enable calculation of mass emission rates, velocity and temperature measurements were made in the stacks. A vane anemometer was used for the velocity measurements. No controls for benzene emissions were in place on either of these sources. However, tar bottom final coolers are believed to release less benzene than an equivalently sized direct water final cooler used in other facilities.

A rating of A was assigned to the benzene emission tests performed on both sources. A process description was provided in a trip report written to accompany the test report. Specific production and process data were reported in that trip report. The trip report was claimed to be Confidential Business Information by the facility owner and is retained in EPA files. Emission factors from this test previously were calculated and reported in a memorandum from D. Coy, RTI, to Le Beck, EPA (1991); this memorandum is not CBI and the emission factors reported here are from the memorandum.

4.1.3.1.9 <u>Reference 34</u>. This emission test (Report 80-BYC-4) was sponsored by the Emissions Measurement Branch of EPA and was conducted from October 16 to 17, 1980. Benzene emissions were measured from one source in the byproduct recovery plant–a light oil intercepting sump.

The light oil intercepting sump had a large open surface exposed to the atmosphere. The method for measuring benzene emission rates from this source involved the use of a tracer gas (isobutane) dispersed at a known rate over the surface of the tank. Downwind samples were taken to measure both isobutane and benzene concentrations, from which the benzene emission rate could be calculated. No controls for benzene emissions were in place on this source.

A rating of C was assigned to the benzene emission tests performed on the light oil intercepting sump. The method involving the use of tracer gas to obtain benzene emission rates from the sump was a new method. A limited process description was contained in the test report. No accompanying trip report was located, but production data were provided in a report, "Report on the Basis of Emission Factors and Industry Wide Estimate of Emissions of Benzene from Coke Byproduct Plants."[1]

4.1.3.1.10 Reference 35. This emission test (Report 80-BYC-2) was sponsored by the Emissions Measurement Branch of EPA and was conducted from July 28 to August 8, 1980. Benzene emissions were measured from one source in the byproduct recovery plant–a light oil contaminated sump. Benzo(a)pyrene [B(a)P] emissions were measured from two sources, a pitch storage tank, and a pitch prilling tank (generates pitch pellets).

The light oil contaminated sump had a large open surface exposed to the atmosphere. The method for measuring benzene emission rates from this source involved the use of a tracer gas (isobutane) dispersed at a known rate over the surface of the tank. Downwind samples were taken to measure both isobutane and benzene concentrations, from which the benzene emission rate could be calculated. No controls for benzene emissions were in place on this source.

Sampling for B(a)P was performed with a draft method involving a Method 5 sampling train in which the filter was followed by an adsorbent tube packed with XAD resin to adsorb any B(a)P that passed through the filter. At EPA's recommendation, the first impinger was filled with tetrahydrofuran to absorb any methyl naphthalene that passed through the sampling train. The B(a)P was extracted and measured by fluorescence spectrometry. No control device was in use on the prilling tank. Samples were taken upstream and downstream of a scrubber on the pitch storage tank.

A rating of C was assigned to the benzene emission tests performed on the light oil intercepting sump. The method involving the use of tracer gas to obtain benzene emission rates from the sump was a new method. A process description was provided in the test report, however no production data were included. Production data were subsequently provided in a report, "Report on the Basis of Emission

---

[1] Coy, D. W. transmitted to L. L. Beck, US EPA on October 14, 1981.

Factors and Industry Wide Estimate of Emissions of Benzene from Coke Byproduct Plants.[2]" A rating of C was also assigned to the B(a)P emission tests performed on the pitch storage and prilling tanks. The method was developmental. Also, one of the three tests performed on the prilling tank was voided due to sampling problems, leaving only two valid tests.

4.1.3.1.11 Reference 36. This emission test (Report EPA-600/2-79-016) was sponsored by the Industrial Environmental Research Laboratory of EPA and was conducted during December 1977. The tests were conducted as part of a Level 1 Environmental Assessment of coke oven byproduct operations. Sources sampled included final cooler cooling tower, tar decanter, tar storage tank, light oil storage tank, chemical oil (volatile product of tar distillation) storage tank, primary cooler condensate tank, naphthalene drying tank, and froth flotation tank (naphthalene separation).

Gaseous samples were obtained using the Source Assessment Sampling System (SASS) (samples drawn through adsorbent resin, XAD-2), gas bulbs, and evacuated stainless steel canisters. None of the sampling was done using EPA Reference Methods. Gas velocities through discharge points were determined by the use of a vane anemometer. In the case of storage tanks, flows due to working losses were estimated from production data for the liquids stored in the tanks. Volatile chemical species collected in gas bulbs or evacuated canisters were analyzed onsite with gas chromatography for benzene, toluene, xylenes, ethyl benzene, and sulfur compounds (reported as H_2S, would include H_2S, CS_2 and other sulfide compounds). Other samples collected with the SASS train were extracted with a solvent prior to analysis for volatile TCO organic material and nonvolatile (gravimetric) organic material.

A rating of D was assigned to all of the emission tests performed in this program. The tests performed with gas bulbs and evacuated canisters were grab samples as opposed to integrated samples, therefore yielding only instantaneous concentration measurements. The grab samples were taken at hatches and manways as opposed to process vent stacks. Samples collected with the SASS train were time integrated. However, the analytical procedures only identified classes of compounds as opposed to specific compound identification. Several of the sources tested had no measurable flow rates, making it impossible to calculate emission factors even though concentrations of pollutants were measured. A process description was provided in the report and limited production data were included.

4.1.3.1.12 Reference 37. This report (Report 81-BYC-12) was assembled by the Emissions Measurement Branch to report the results of a statistical analysis of test data for fugitive emissions from

---

[2] Coy, D. W. transmitted to L. L. Beck, US EPA on October 14, 1981.

coke byproduct plants. Data were compiled and analyzed from tests conducted at three coke byproduct facilities (Reports 80-BYC-9, 10, and 11). Pumps, valves, flanges, and exhausters were counted and screened. Mass emissions of benzene, and non-methane hydrocarbons were measured at each leaking source. A limited sampling and analysis program was performed to determine if the coke byproduct fugitive emissions were similar to the more extensively characterized petroleum refinery industry fugitive sources.

Screening was done in accordance with EPA's draft (at the time) Method 21 using an organic vapor analyzer. Leaking equipment was identified for the collection of bagged samples for mass measurements. The nonmethane compounds in the samples were measured with a total hydrocarbon analyzer and benzene was measured by a GC/FID. From the limited test program it was concluded that the coke byproduct results were sufficiently similar to petroleum refinery results to use the more extensively studied petroleum refinery emission factors as the basis for byproduct plant emission factors. In fact, the emission factors derived for development of the coke oven byproduct plant NESHAP impacts were estimated from the petroleum refinery fugitive leaks VOC emission factors.

4.1.3.1.13 <u>Reference 38</u>. This report was sponsored by the American Coke and Coal Chemicals Institute. Testing was performed in four plants during August through November 1989. Sources tested included direct water final cooling towers, tar decanters, tar storage tanks, ammonia liquor storage tanks, flushing liquor circulation tanks, naphthalene processing, light oil storage tanks, light oil sumps, wash oil decanters, and light oil condenser vents.

Sampling for benzene was performed using EPA Method 18, modified during testing on some processes to include a condensibles trap where significant moisture was apparent. Where condensed material was collected, it was analyzed for benzene using EPA Method 602. Analysis of the gaseous samples was by GC. Velocity and sampling traverses on vents and stacks were performed using EPA Methods 1 through 3. Several of the sampled sources had large open surfaces areas that presented a problem in measuring emissions. In these cases sampling was done using an isolation chamber that floated on the liquid surface in the process unit. Out of all the sources sampled, only one source at one of the plants was controlled to reduce benzene emissions. Naphthalene processing operations at one facility used activated carbon canisters on process vents to collect benzene from discharged gases.

All of the data from these tests could be excluded because emissions were reported as a function of the amount of coal charged to the process as opposed to the amount of coke produced, the units used in this report. Coke production quantities were not reported, so exact conversions cannot be made.

Information can be salvaged from these tests by using approximate conversion ratios for coal to coke. Even with this step, some data must be excluded because of insufficient description of process operations during tests to characterize the results as representing typical operations, e.g., was sampling conducted through a representative period of batch operations. Sampled results from final coolers were rejected by the report authors in favor of mass balance calculations. However, the mass balance procedure is not likely any better than the rejected tests in terms of accuracy. The mass balance results are therefore excluded from consideration. Those tests made using the isolation chamber have also been excluded because of the significantly low bias introduced by not allowing wind effects to influence results. Losses due to wind flow across the open surfaces are likely responsible for a major component of the process unit's emissions and were not evaluated in these tests.

A rating of B was assigned to those tests that were not excluded for the above reasons. These B-rated tests included measurements on the tar decanter, tar storage tank, ammonia liquor storage tank, controlled naphthalene processing, and flushing liquor circulation tank. The B rating was selected because the report did not include enough detail to validate the tests.

4.1.3.1.14 Reference 184. This test report describes an emission test conducted by Radian Corporation, under contract with EPA's Emission Measurement Branch during the week of December 8 through 12, 1980. The test was conducted at the byproduct recovery plant for the coke oven at Republic Steels Gadsden, Alabama plant. During the testing period, the coke ovens were producing 1470 tons per day of coke and 22.5 MMSCFD of coke oven gas. The light oil recovery unit was recovering 5,630 gallons per day of crude BTX light oil. The purpose of this sampling program was to measure fugitive VOC (Volatile Organic Compounds) and benzene emissions to support a National Emission Standard for Hazardous Air Pollutants for benzene from coke oven by-products recovery units in steel mills. The tests that were conducted included screening potential sources of fugitive benzene emissions with a portable hydrocarbon detector to estimate the frequency of leak occurrence, collecting (bagging) and analyzing samples of liquid and vapor benzene from leaking fittings to quantify the emission rates and obtaining liquid samples from process lines to provide data on the proportion of benzene in process lines relative to the proportion of benzene in emissions from fittings in those lines. Actual screening value determined by EPA Method 21 were recorded. All exhausters, every accessible valve and pump, and one-third of the flanges, on lines handling at least 4 weight percent benzene were screened. Bagging and measuring procedures of all the screened sources were carried out according to methods developed in previous petroleum refinery testing. The test used reference test methods and is well documented and is rated A. The information in this report was one of several test reports that were used to develop uncontrolled emissions estimates that are contained in reference 28.

4.1.3.1.15 Reference 185. This test report describes an emission test conducted by Radian Corporation, under contract with EPA's Emission Measurement Branch during the week of January 20 through 28, 1981. The test was conducted at the byproduct recovery plant for the coke oven at Bethlehem Steels Bethlehem, Pennsylvania plant. During the testing period, the coke ovens were producing 3520 tons per day of coke and 67.4 MMSCFD of coke oven gas. The light oil recovery unit was recovering 12,678 gallons per day of crude light oil. The purpose of this sampling program was to measure fugitive VOC (Volatile Organic Compounds) and benzene emissions to support a National Emission Standard for Hazardous Air Pollutants for benzene from coke oven by-products recovery units in steel mills. The tests that were conducted included screening potential sources of fugitive benzene emissions with a portable hydrocarbon detector to estimate the frequency of leak occurrence, collecting (bagging) and analyzing samples of liquid and vapor benzene from leaking fittings to quantify the emission rates and obtaining liquid samples from process lines to provide data on the proportion of benzene in process lines relative to the proportion of benzene in emissions from fittings in those lines. Actual screening value determined by EPA Method 21 were recorded. Fugitive emissions testing was performed in all areas of the plant with at least 4 weight percent or more benzene. This included the benzolized wash oil, still overhead, rectifier overhead, intermediate oil, and secondary oil line, and the secondary oil storage and loading areas. The benzolized wash oil line and the exhausters were screened, although they contained less than 4 percent benzene. All exhausters, every accessible valve and pump, and one-third of the flanges were screened. Bagging and measuring procedures of all the screened sources were carried out according to methods developed in previous petroleum refinery testing. The test used reference test methods and is well documented and is rated A. The information in this report was one of several test reports that were used to develop uncontrolled emissions estimates that are contained in reference 28.

4.1.3.1.16 Reference 186. This test report describes an emission test conducted by Radian Corporation, under contract with EPA's Emission Measurement Branch during the week of November 24 through December 5, 1980. The test was conducted at the byproduct recovery plant for the coke oven at Wheeling-Pittsburgh Steels Monessen, Pennsylvania plant. During the testing period, the coke ovens were producing 560 tons per day of coke and 8.27 MMSCFD of coke oven gas. The light oil recovery unit was recovering 2,730 gallons per day of crude light oil. The purpose of this sampling program was to measure fugitive VOC (Volatile Organic Compounds) and benzene emissions to support a National Emission Standard for Hazardous Air Pollutants for benzene from coke oven by-products recovery units in steel mills. The tests that were conducted included screening potential sources of fugitive benzene emissions with a portable hydrocarbon detector to estimate the frequency of leak occurrence, collecting (bagging) and analyzing samples of liquid and vapor benzene from leaking fittings to quantify the emission rates and obtaining liquid samples from process lines to provide data on the proportion of benzene in process lines relative to the proportion of benzene in emissions from fittings in those lines. Actual screening value determined by EPA Method 21 were recorded. Fugitive emissions testing was performed in all areas of the plant with at least 4 weight percent or more benzene. This included the scrubber cleaning oil, the stripper overhead, condensables, and light oil product. The benzolized wash oil line and the exhausters were screened, although they contained less than 4 percent benzene. All exhausters, every accessible valve and pump, and one-third of the flanges were screened. Bagging and measuring procedures of all the screened sources were carried out according to methods developed in previous petroleum refinery testing. The test used reference test methods and is well documented and is rated A. The information in this report was one of several test reports that were used to develop uncontrolled emissions estimates that are contained in reference 28.

4.1.3.1.17 Reference 1[illegible]7. This test report describes a program to correlate measured benzene emissions rates and the headspace benzene concentration of a liquid sample. Scott Environmental Services conducted a benzene sampling program at seven coke by-product plants during the summer of 1980 for the U.S. Environmental Protection Agency. Fugitive process emissions from eight sources were determined by measuring the benzene concentration in the stack gas and the gas flow rate and temperature. The processes included a wash oil decanter, two tar decanters, three tar dehydrators and two tar storage vessels. Process liquid samples were also collected from each source. A laboratory test program was conducted to determine if any correlation existed between the benzene emission rate from a process and the benzene concentration in the headspace over a liquid sample from that process. The samples were heated in enclosed vessels and headspace samples were extracted and analyzed by gas chromatography. Two separate sets of experimental conditions were used. Initially the samples were heated to process temperature in vented flasks. Due to the great variability in the results a new procedure was devised wherein the samples were all heated to 212°F while maintaining a constant pressure as thermal expansion of the headspace gas occurred. No gas was vented. The report states that a there was a lack of any close correlation between the headspace benzene concentration and the source ccncentration measured in the field tests of multi-phase processes. The report further attributes the lack of correlation to the many other variables which affect the benzene emitted by these sources. The report indicates that these variables include:

1. Type of Process - continuous, steady state; continuous, variable; batch.
2. Nature of Material - tar, oil, aqueous, combination of tar and aqueous.
3. Dynamic residence time of continuous processes.
4. Degree of agitation of process material.
5. Concentration of water and light organics in tars and oils.

6. Thickness of aqueous layer in aqueous organic systems.
7. Process headspace volume vs. process surface area.
8. Temporal variations in temperature, liquid level, liquid composition, throughput, etc.
9. Ambient temperature and pressure.

The report states that a detailed discussion of the role of each variable is beyond the scope of their task, but provides a brief discussion of a tar decanter to demonstrate the complex nature of the systems. The report is well documented but is not useable for emission factor development. However, it does provide evidence of the difficult nature of estimating emissions of complex processes with simplifying assumptions.

4.1.3.2 Development of Candidate Emission Factors for Coke Byproduct Plants

Table 4-33 summarizes the test data from References 29 through 38, and Table 4-34 presents the candidate benzene emission factors that were developed from data collected from coke byproduct plants serving coke ovens producing furnace coke. From these base emission factors, emission factors were derived for foundry coke plant benzene emissions. Correction factors were developed from historical industry data showing relative production of light oil, tar, and benzene content of light oil in byproducts produced during furnace versus foundry cokemaking (Reference 27). In general, less benzene, light oil, and tar are produced during the production of foundry coke than furnace coke. Coke yields are higher per unit weight of coal coked for foundry coke than furnace coke. The statistical data used to draw these conclusions are applicable only to U.S. coking coals and do not necessarily apply to foreign coals and coking practices. Table 4-35 presents derived emission factors for VOCs.

All emission factors in Tables 4-34 and 4-35 for uncontrolled sources represent conditions prior to promulgation of the NESHAP for coke oven byproduct plants. Emission factors for controlled sources represent conditions after promulgation of the NESHAP. In both tables, direct water and tar-bottom final cooler cooling towers represent uncontrolled conditions. For naphthalene processing, the NESHAP allows no emissions; the activated carbon control shown would not comply with the provisions of the NESHAP.

Benzene emission factors are converted to VOC emission factors using information in References 28 (1984) and 29 (1988). For the purposes of this document, VOCs from byproduct plant sources include the three major compounds contained in light oil (benzene, toluene, and xylene, or BTX) plus other organic compounds measured as TCOs. The TCOs should not be confused with total organic compounds (TOC). The TCOs have boiling points in the range of 200° to 300°C (390° to 570°F). The benzene emission factors in Table 4-34 are available for each of the emission sources shown in Figure 2-3. These emission factors are used to estimate a BTX emission factor for furnace coke byproduct plants from the following equation:

$$BTX = \frac{BZEF}{0.7}$$

where:

BTX = light-oil (benzene, toluene, xylene) emission factor, g/Mg coke
BZEF = benzene emission factor, g/Mg coke.

For foundry coke byproduct plants, the divisor is 0.635 rather than 0.7. An emission factor for TCOs can be estimated from the following equation:

$$TCOEF = \frac{TCO}{C_6H_6} \times BZEF$$

where:

TCOEF = total chromatographable hydrocarbon emission factor, g/Mg coke
C_6H_6 = benzene concentration, milligrams per standard cubic meter (mg/sm^3)
TCO = total chromatographable hydrocarbons, mg/sm^3.

The two equations above can be combined for a VOC estimate using the following equation:

$$VOC = \frac{BZEF}{0.7} + \frac{TCO}{C_6H_6} \times BZEF$$

where:

VOC = emission factor for the combination of light oil and TCO components found in furnace coke byproduct plants. For foundry coke byproduct plants the 0.7 divisor should be replaced by 0.635.

Methane and ethane, greenhouse gases, are not expected to be a significant part of the emissions estimated from this equation.

Emission factors for HAPs are derived by assuming that benzene emissions divided by 0.7 are equivalent to the light-oil components (benzene, toluene, xylene) as indicated above. These components are taken as being the predominant HAPs emitted.

Because total chromatographable hydrocarbon data are not available, emission factor estimates for VOCs that depend on those data are obtained by using the ratio of VOC to benzene found from the equation given above.

For light oil, BTX, and benzene storage tanks, emission factors were derived from theoretical calculations similar to ones used in EPA's Tank emissions estimation program called TANKS. For the user who has tank characteristics and meteorological information, TANKS may be obtained from EPA through its CHIEF electronic bulletin board, a part of the Technology Transfer Network (TTN), or from its web site: http://www.epa.gov/ttn/. Calculations are performed according to AP-42 [Chapter 7]. Information about downloading TANKS may be obtained by calling (919) 541-5384. The model does not account for such things as dissolved gases or heated input streams, therefor is not appropriate for any vessels other than typical storage tanks. Further, because of the many factors in the model developed from engineering judgement and technology transfer from data at significantly disparate conditions from those at which most U.S. batteries are performing, the uncertainties of the estimates are considered to be greater than those presented in AP-42. For estimating emissions for regulatory purposes, facilities can always use their own data as long as they are acceptable to the Administrator.

Although most of the test data for byproduct plant testing were obtained using EPA methodology, translation to VOC and HAP emission factors from benzene emission factors required several assumptions. For this reason, all of the byproduct plant emission factors are rated E.

4.1.3.3 Light-Oil Storage Tanks

The concentration of benzene in the vapor space in tanks (or other types of containers) depends on benzene concentration in the liquid in the tank, the temperature of the tank contents, and the presence of surface layers that may inhibit transfer of benzene from liquid to vapor. For covered, vented tanks, uncontrolled emissions also depend on the rate and frequency of filling (working losses) and diurnal changes in tank volume due to ambient temperature changes (breathing losses). Measurement of working and breathing losses can be difficult because the flow rate through the tank vent may be low.

Theoretical calculations were used to estimate benzene emissions from working losses from light oil tanks during the development of the NESHAP ("Report on the Basis of Emission Factors and Industry Wide Estimate of Emissions of Benzene from Coke Byproduct Plants,"[3] October 14, 1981). The

---

[3] Coy, D. W. transmitted to L. L. Beck, US EPA on October 14, 1981.

recommended emission factor is 0.0058 kg/Mg (0.0116 lb/ton) of coke produced. Test results were supplied by ACCCI, Reference 38, for a light oil tank with a carbon canister controlled vent. Insufficient process information, lack of detail regarding the tests, and conflicting units (coal or coke basis) reported, however, led to exclusion of these data from consideration as a candidate emission factor.

4.1.3.4 Tar Decanter

Emissions from tar decanters are sensitive to residence time of the tar/flushing liquor mixture, temperature (especially if optional heating is used), composition of the flushing liquor, possible presence of a light organic phase layer at the liquid/gas interface, decanter dimensions and layout, size and location of vents, and wind effects. Information from ACCCI, Reference 38, can be combined with previous data obtained by EPA, References 29 and 30, to provide an estimated emission factor for uncontrolled benzene emissions of 0.054 kg/Mg (0.108 lb/ton) of coke.

4.1.3.5 Naphthalene Separation and Processing

Under the NESHAP, many plants may have chosen alternative methods of recovering and processing naphthalene to those on which tests to derive emission factors were performed. The NESHAP requires zero emissions of benzene from naphthalene separation and processing, which suggests the possibility of process changes in existing plants to comply.

One set of tests was performed on naphthalene separation and processing sources by EPA in the development of the NESHAP (Reference 29). Based on these tests, the candidate emission factor is 0.11 kg/Mg (0.22 lb/ton) of coke by summing all of the operations emissions. Two sets of data were reported by ACCCI, Reference 38, for naphthalene separation: one for a covered sump vented through an activated carbon canister and the other for an open sump. The latter was tested for benzene emissions by means of an isolation chamber floating on the sump surface. Because several system parameters were not known or not reported, and no effort was made to provide a chamber purge rate simulating wind effects, the isolation chamber data were not used. The discussion of tests performed on the process controlled by a carbon canister included no description of the operations occurring during the testing program. For example, were the naphthalene melting operations continuous or batch, what was the cycle period of the operations, and were the operations during the sampling period representative of a typical operating period?

4.1.3.6 Cooling Tower

4.1.3.6.1 Direct Water Final Cooler Cooling Tower. Emissions from the final cooler depend on temperature and composition of the water mixture entering the cooling tower. In the direct water cooler type of tower, the water being cooled has been in contact with coke oven gas and has absorbed some components of the gas. Benzene and hydrogen cyanide have been identified as major pollutants from this source. The tower acts like an air stripper to remove soluble components. The NESHAP is likely to have caused many plants to modify their cooling operations to avoid direct contact of the media contaminated by coke oven gas with air, as opposed to installing a control device.

The EPA performed tests in two facilities to measure benzene emissions (References 29, 32) yielding test data rated A. In tests conducted for ACCCI (Reference 38) emissions were estimated from a benzene mass balance on water entering and leaving the cooling towers at two locations. These data were rated C because of limited information about the flow measurements and the use of an indirect, as opposed to a direct, method to estimate emissions. The recommended benzene emission factor is 0.27 kg/Mg (0.54 lb/ton) of coke based on the A-rated data. The mass balance estimates by ACCCI at different times of the year showed higher emissions in August and lower emissions in November for the one plant tested at the two different times. Although these emission data were not included in the emission factor basis, the trend indicated is probably valid. The difference (0.21 kg/Mg of coke to 0.070 kg/Mg of coke) is likely attributable in part to ambient air temperature differences between the test dates. The recommended emission factor was based on test data gathered during July and August, suggesting it may be at the upper end of the range of emissions during the course of a year.

Hydrogen cyanide emissions were also measured during EPA sponsored tests as part of an environmental assessment of coke byproduct plants (Reference 36). Based on the single facility test with D-rated test data, the candidate emission factor is 0.30 kg/Mg (0.60 lb/ton) of coke.

4.1.3.6.2 Tar Bottom Final Cooler Cooling Tower. Emissions from this type of cooling tower depend on the same parameters identified for the direct water type described above. The main difference is that the cooling water is passed through a tar-containing vessel that will absorb some of the benzene present in the contaminated cooling water, thereby preventing the benzene from being stripped by the cooling air stream. The NESHAP requirements may have led to the replacement of these types of cooling processes in some facilities.

The EPA sponsored tests were performed at a single facility with a tar bottom final cooler (Reference 33). The candidate emission factor for this process is 0.70 kg/Mg (0.14 lb/ton) of coke.

4.1.3.7 Tar Intercepting Sump

Sump emissions are affected by dimensions and layout, size and location of vents (if the sump is covered), and wind effects. Information from EPA-sponsored tests was used to develop this candidate benzene emission factor (Reference 31). The candidate emission factor is 0.0095 kg/Mg (0.019 lb/ton) of coke.

4.1.3.8 Tar Dewatering Tank

Emissions from this type of tank depend on the same parameters given for light oil storage tanks described above. Because the tar dewatering tanks are intentionally heated to evaporate water from the tar, volatile organics contained in the tar are also driven off.

Data from three EPA-sponsored A-rated tests were used to develop a benzene emission factor. The candidate emission factor is 0.021 kg/Mg (0.042 lb/ton) of coke.

4.1.3.9 Tar Storage Tank

Emissions from this type of tank depend on the same parameters given for light oil storage tanks described above. Because the tar storage tanks are heated, temperature is important. Data from one plant tested by ACCCI (Reference 38) show an average benzene emission factor of 0.0022 kg/Mg (0.0044 lb/ton) of coke. Data from EPA (Reference 31) show an emission factor of 0.011 kg/Mg (0.022 lb/ton) of coke. The recommended emission factor is an average of both plants: 0.0066 kg/Mg (0.0132 lb/ton) of coke.

4.1.3.10 Light-Oil Condenser Vent

Benzene emissions in the light-oil condenser vents are a function of benzene concentration in the vapor entering the condenser, condenser cooling water temperature and the heat transfer surface area. Data from EPA-sponsored tests lead to a candidate benzene emission factor of 0.089 kg/Mg (0.115 lb/ton) of coke at a vent discharge temperature of about 38°C (100°F).

Data from ACCCI (Reference 38) show a benzene emission factor of 1.3 kg/Mg (2.6 lb/ton) for another vent at 60°C (140°F). Proper maintenance of the condenser and an adequate cooling water supply should be capable of maintaining a much lower discharge temperature. Therefore, this data was excluded from consideration. One other test conducted by ACCCI was also excluded because no discussion of process conditions was included in the report.

4.1.3.11 <u>Light-Oil Sump</u>

Emissions from an uncovered sump depend on temperature, composition, presence or absence of a floating phase of light organics, sump shape and dimensions, and prevailing wind.

The EPA-sponsored tests were performed in two plants (References 34, 35) using a tracer gas test procedure. The C-rated emission data from these plants yield a candidate emission factor for an uncovered sump of 0.015 kg/Mg (0.030 lb/ton) of coke.

Data supplied by ACCCI (Reference 38) were excluded from consideration. One plant with an open sump, was sampled with an isolation chamber. Because no effort was made to provide a chamber purge rate that simulated wind efforts, the isolation chamber data were not used. No process or test description details were provided for the tests performed at the other plant.

4.1.3.12 <u>BTX And Benzene Storage Tank</u>

The same factors affect emissions from these tanks as describe above for light oil storage tanks. In fact, the candidate emission factor is the same as the theoretically-based estimate for light oil storage tanks, 0.0058 kg/Mg (0.0106 lb/ton) of coke. The benzene concentration of liquids stored in these tanks is higher than that of light oil. However, BTX and benzene are distilled products from light oil, so the volume pumped into and out of these tanks is proportionally lower.

4.1.3.13 <u>Flushing Liquor Circulation Tank</u>

Flushing liquor is used to cool raw coke oven gas as it exits the ovens. Tar is separated from the flushing liquor in the tar decanter and the liquor is recirculated to the collecting main for gas cooling. The circulation tanks are used as a reservoir in the flushing liquor circuit and may be partially covered or completely open to the atmosphere in an uncontrolled state.

Benzene emissions from flushing liquor circulation tanks were tested by ACCCI (Reference 38) in two plants. For one of the tested plants, the emissions data were B-rated. Data from the second plant tested were excluded because no discussion of the process being tested was provided and no diagram of the tank and sampling point was provided. The recommended benzene emission factor is 0.013 kg/Mg (0.026 lb/ton) of coke pushed.

4.1.3.14 Excess Ammonia Liquor Tank

Emissions from an excess ammonia liquor storage tank vent depend at least on temperature, composition, tank geometry, and filling rate. Information from ACCCI (Reference 38) provides benzene emissions B-rated tests results from two plants. The average of the two data sets 0.0014 kg/Mg (0.0028 lb/ton) of coke pushed is recommended as a revised benzene emission factor for uncontrolled excess ammonia liquor storage tanks. The previous value was based on data taken from another process as opposed to direct measurements from the specific source.

4.1.3.15 Wash-Oil Decanter and Circulation Tank

Wash oil is used to scrub coke oven gas to recover the light oil components from the gas stream. Benzene and other light oil components are stripped from the wash oil and the wash oil circulated. The wash oil composition is expected to be about the same in either of the above process vessels.

The EPA sponsored tests at one facility on a wash oil decanter. The A-rated emission test data yield a candidate benzene emission factor of 0.0038 kg/Mg (0.0076 lb/ton) of coke. Emissions tests were also conducted by ACCCI (Reference 38) at two plants. In one plant, the isolation chamber was used to extract a sample from the surface of the decanter. As noted above, tests using this equipment were excluded from consideration because the procedure did not provide purge stream through the chamber that would simulate wind effects. In the case of the second facility, the report did not provide any data on process operations during the test or detailed descriptions of the test.

4.1.3.16 Equipment Leaks

Emission factors for VOCs from equipment leaks are given in Reference 28. These factors are presented in Table 4-36. The factors are applied to each piece of equipment for the conditions listed in the table, and represent the daily quantity of VOC emissions. For facilities that have an effective leak detection and repair (LDAR) program, and that have screening values required by EPA's *Protocol for*

Equipment Leak Emission Estimates (EPA-453/R-95-017), EPA believes the correlation approach for refineries described therein is appropriate. However, for facilities not having an LDAR program and screening values, the emission factors in Table 4-36 may be used.

4.2 NONRECOVERY COKING

In 1995, there was only one nonrecovery coke plant operating in the U.S.: Jewell Coal and Coke Company in Vansant, Virginia. Emissions data were available for the combustion stack and for charging. These batteries operate under negative pressure; consequently, there are no door leaks. In addition, there are no lids and offtakes from which emissions can escape from the topside of the battery. Emissions from pushing and quenching are expected to be similar to those from byproduct coke oven batteries.

4.2.1 Review of Available Data

4.2.1.1 Reference 23. This test report describes an emission test conducted on the Battery stack in October 1989. The Battery operates on a 48-hr coking cycle, and because half of the ovens are charged on one shift each day rather than uniformly through the cycle, the emissions are expected to vary depending on the time into the coking cycle. Consequently, representative sampling requires measurements at different times over a 24-hr period to ensure the entire cycle is represented.

During this test, three runs were made throughout the cycle: (1) a 60-minute run 2.5 to 3.5 hours after charging, (2) an 84-minute run 13 to 14 hours after charging, and (3) an 84-minute run 21 to 22 hours after charging. Sampling for filterable PM was performed using EPA Method 5, which was altered as allowed in EPA Method 8 to also determine SO_2. The PM was analyzed for metals using the inductively-coupled plasma technique. Emissions of NO_x were sampled by Method 7, and an integrated Tedlar bag sample was collected for analysis of CO and total hydrocarbons. A Method 5 train with an organic sampling module between the heated filter and first impinger was used to collect semivolatile organics for analysis by GC/MS. A volatile organic sampling train (VOST) was used to sample for volatile organics using SW-846 Methods 0030 and 5040. The test methods, QA/QC, production rate, and other information was well documented. Consequently, a rating of A was assigned for this test.

4.2.1.2 Reference 24. This test report describes a test funded by the EPA that was performed in the fall of 1991. Sampling periods were divided into four parts over a 24-hr period to provide representative sampling of the cycle, and the results were averaged to derive overall emission rates. Method 5 was used to determine filterable PM, Method 202 was used for condensible PM, and an unspecified method was used to determine toluene soluble organics (TSO), which was used as a measure of organic PM similar to the BSO testing performed for byproduct plants. Semivolatile organics were sampled using SW-846 Method 0010 and volatile organics were measured using Method 0030. Emissions of SO_2 were determined by EPA Method 6C, NO_x emissions were measured by EPA Method 7E, and CO emissions were measured using EPA Method 10.

The test methods, procedures, QA/QC, and production rate were well documented. The report noted that toluene was found in all blanks and that the toluene results could be high because of this. A relatively high level of acrolein was measured, which was not expected based on knowledge of coke oven emissions. The report noted that acrolein is a component of wood smoke, and contamination could have occurred from forest fires in the area. This test was assigned an A rating.

4.2.1.3 Reference 25. This document is a test report of measurements of charging emissions conducted in June 1992. A charging hood system had been installed to collect charging emissions and to route them to a baghouse for control. Testing was performed on the baghouse exhaust, and the dust collected in the baghouse was analyzed to provide insight into uncontrolled charging emissions and emissions that escaped capture. An important component and source of uncertainty in this test was the capture efficiency of the hood system. Capture was observed with the exhaust fans on and off, and the overall capture efficiency was estimated as 70 percent.

The test program included sampling the baghouse exhaust by EPA Methods 5 and 202 for filterable and condensible PM and TSO, a VOST train (Method 0030) for volatile organics, and a modified EPA Method TO-13 train for semivolatile organics. Four hours of sampling were performed during charging each day for 3 days. All details of the testing were provided in the report. However, this test is assigned a rating of C because of the uncertainty introduced by the estimate of capture efficiency.

4.2.1.4 Reference 49. This reference documents an emission test conducted on the No. 3-C Coke Battery stack system at Jewell Coal and Coke Company in Vansant, Virginia. This plant uses a non-recovery coking technology. Filterable PM emissions were measured using EPA Method 5, and SO_2 emissions were measured using EPA Method 6C. A Fyrite analyzer was used to determine CO_2 emissions. Three test runs were conducted.

The test data are assigned an A rating. The report includes adequate detail, the test methodology was sound, and no problems were reported.

4.2.2 Development of Candidate Emission Factors for Nonrecovery Coking

The test results for the combustion stack for pollutants measured in References 23, 24 and 49 are summarized in Table 4-30. The results from the tests are averaged and presented as recommended emission factors in Table 4-31. Table 4-31 also includes the test results from Reference 24 for other pollutants, and because this is the only source of data for these compounds, they are also recommended as candidate emission factors.

Reference 24 provided an analysis of semivolatile and volatile compounds with a quantitative analysis for benzo(a) pyrene, cresol, naphthalene, phenol, xylenes, toluene, and benzene. Cresols and xylenes were not detected. Phenol was observed in 5 of 19 samples, and benzo(a) pyrene was detected in only one sample. Naphthalene was detected in all but three runs. Toluene was detected in all runs; however, the report notes that toluene is a common laboratory solvent, and blank levels for toluene were high.

The testing in Reference 24 also analyzed for TSO. The report notes that the TSO levels were about the same as those found on the field blank. Consequently, no emission factor was developed for TSO.

The emission factors for the combustion stack are assigned a "B" rating because they were developed from multiple A-rated test data for the only nonrecovery plant in operation in the U.S.

Reference 25 provided a means to estimate controlled and uncontrolled charging emissions from nonrecovery ovens. A charging hood system was installed to capture charging emissions and route them to a baghouse. Sampling using EPA methods was performed on the baghouse exhaust to measure the emission rate (E_1). The baghouse catch was weighed and analyzed to provide a measure of captured pollutants (E_2). The capture efficiency was estimated as 70 percent based on observations with the exhaust fans on and off. All of these three determinations are important to estimate controlled and uncontrolled emissions.

Controlled emissions were estimated from the sum of those escaping capture and those emitted from the stack:

$$\text{controlled emissions} = E_1/0.7 + (0.3/0.7)*E_2.$$

where E_1 = baghouse exhaust emission rate, and

E_2 = baghouse collection rate.

Uncontrolled emissions were estimated from the emissions that were captured by the hood (baghouse catch plus the stack) and those not captured by the hood:

$$\text{Uncontrolled emissions} = (E_1 + E_2)/0.7.$$

where E_1 and E_2 are as defined above.

The results from Reference 25 are summarized in Table 4-28. Some corrections were required to the calculations presented in the report for controlled emissions, which appeared to be calculated erroneously for TSO from:

$$\text{controlled emissions} = E_1 + (0.3/0.7) * E_2.$$

where E_1 and E_2 are as defined above.

The baghouse catch was not analyzed for volatile organics. Consequently, the uncontrolled emission estimates assume that no significant quantity of volatiles was captured by the baghouse. Toxic metals were not analyzed in the baghouse exhaust because that quantity was expected to be insignificant (after control by the baghouse) relative to the 30 percent of the total emissions that escaped capture. The emission factors for charging are rated "D" because of the limited amount of testing and uncertainty of estimates (e.g., capture efficiency) used to derive them.

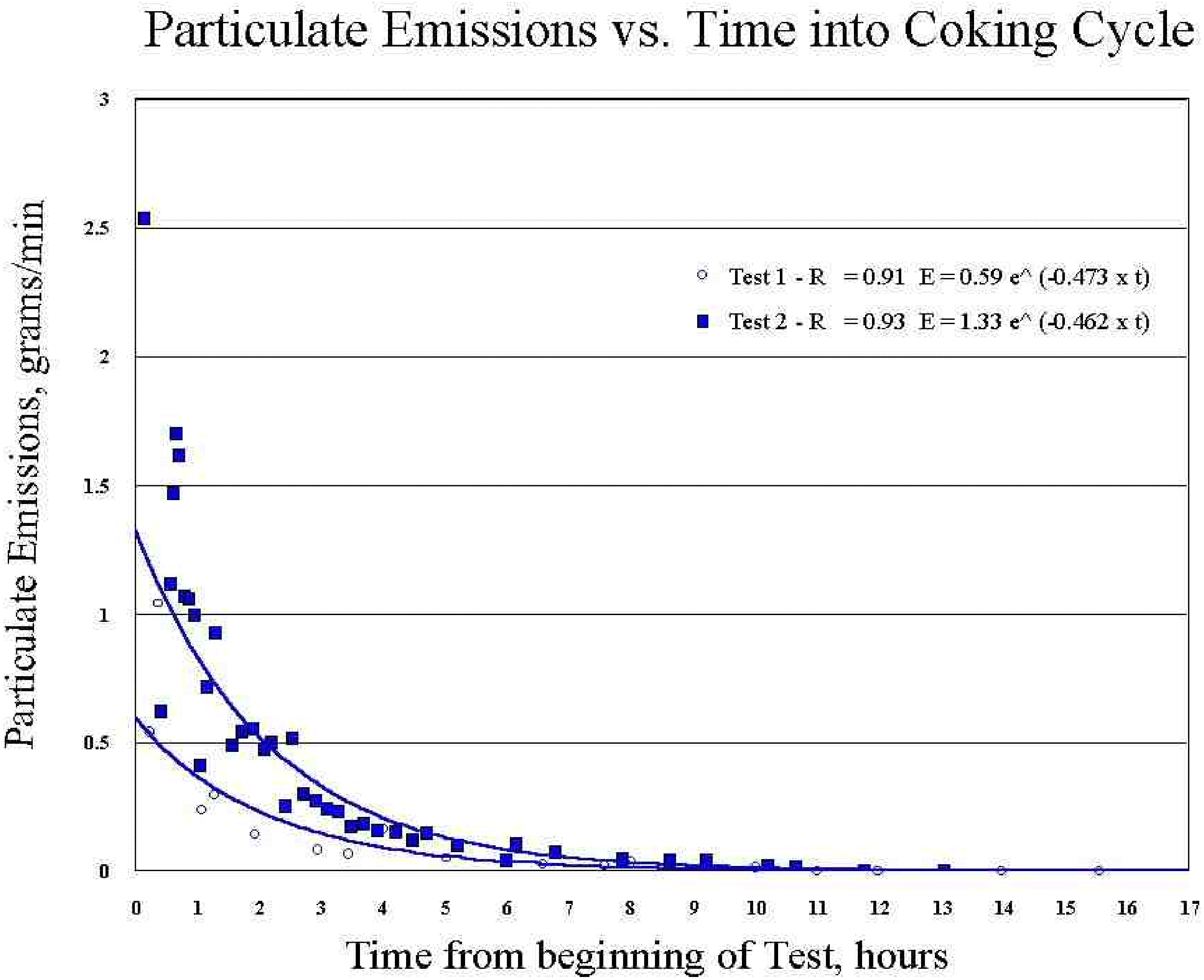


FIGURE 4-1. Coke Oven Door Emissions Verses Time After Charging from Reference 181.

TABLE 4-1. SUMMARY OF UNCONTROLLED AND CONTROLLED DOOR LEAK EMISSIONS

Reference	Pollutant	No. of runs	Emission factor		Units[a]	Rating
			Range	Average		
1	Filterable PM Uncontrolled	3	0.4-1.0 0.2-0.5	0.72 0.36	lb/ton kg/Mg	D
2	Filterable PM Uncontrolled	3	0.08-0.8 0.04-0.4	0.44 0.22	lb/ton kg/Mg	D
3	Filterable PM Uncontrolled	4	0.4-0.9 0.2-0.5	0.57 0.29	lb/ton kg/Mg	D
	Condensable PM Uncontrolled	4	0.1-0.5 0.05-0.3	0.36 0.18	lb/ton kg/Mg	D
	BSO Uncontrolled	4	0.6-0.7 0.3-0.4	0.62 0.31	lb/ton kg/Mg	D
4	Filterable PM Uncontrolled	3	0.3-0.5 0.2-0.3	0.36 0.18	lb/ton kg/Mg	D
166	Filterable PM pre-NESHAP Controlled	3	0.03-0.2 0.02-0.1	0.066 0.05	lb/ton[b] kg/Mg[b]	E
	CO Controlled	3	--	0.021 0.011	lb/ton[b] kg/Mg[b]	E
	TOC as propane Controlled	3	--	0.0055 0.0028	lb/ton[b] kg/Mg[b]	E
	SO_2 Controlled	3	--	0.039 0.020	lb/ton[b] kg/Mg[b]	E
	NO_x Controlled	3	--	0.0013 0.0007	lb/ton[b] kg/Mg[b]	E

[a] Based on lb/ton or kg/Mg of coal charged unless otherwise specified.
[b] Converted from lb/ton of coke pushed using factors of 0.69 for lb/ton and 0.345 for kg/Mg.

TABLE 4-2. BSO ESTIMATES FOR DOOR LEAKS

Reference	Percent leaking doors	BSO rate per door		Comment
		kg/hr	lb/hr	
5	29	0.58	1.3	Coke side shed test
3	70	0.19	0.42	Coke side shed test
9	5	0.0036-0.041	0.008-0.089	Model prediction[a]
9	10	0.01-0.12	0.02-0.26	Model prediction[a]

[a] Model prediction estimates from reference 9 are extrapolated from test data from references 3 and 5.

TABLE 4-3. DOOR LEAK EMISSIONS DATA

Reference	Run	Leak category[a]	Particulate matter, lb/hr[b, c]		BSO, lb/hr[c]	
			Reported	Revised	Reported	Revised
39	2h	0 (empty oven)	0.028	0.025	0.016	0.016/0.002
39	6h	0 (empty oven)	0.019	0.011	0.006	0.006/0.004
39	7h	0 (empty oven)	0.014	0.010	0.007	0.005
7	11	0 (no visible)	0.010	0.010	-0.009	0.0075
		Average	0.018	0.014	0.005	0.009/0.005
39	11h	0.5	0.048	0.044	0.052	0.052
39	11c	0.5	0.033	0.027	0.036	0.035
39	3h	0.5	0.043	0.043	0.019	0.018
39	3c	0.5	0.068	0.058	0.027	0.026
39	4h	0.5	0.045	0.044	0.018	0.016
39	4c	0.5	0.042	0.040	0.023	0.023
7	5	0.5	0.029	0.029	0.008	0.018
7	10	0.5	0.014	0.014	-0.005	0.010
7	12	0.5	-0.002	0.016	0.004	0.012
		Average	0.036	0.035	0.020	0.023
39	5h	1	0.085	0.085	0.047	0.047
39	5c	1	0.062	0.062	0.042	0.038
39	1c	1	0.037	0.031	0.027	0.024
39	1h	1	0.046	0.040	0.033	0.019
39	10c	1	0.041	0.041	0.030	0.030
39	10h	1	0.058	0.058	0.024	0.022
7	4	1	0.039	0.039	0.010	0.020
7	6	1	0.033	0.033	0.008	0.020
7	9	1	0.010	0.013	-0.002	0.013
		Average	0.046	0.045	0.024	0.027
39	9c	2	0.049	0.048	0.030	0.028
39	9h	2	0.055	0.054	0.033	0.028
39	8c	2	0.087	0.086	0.060	0.065
39	8h	2	0.089	0.088	0.063	0.064
7	3	2	0.128	0.130	0.109	0.120
		Average	0.082	0.081	0.059	0.061
7	2	3	0.119	0.124	0.086	0.096
7	1	3	0.088	0.088	0.050	0.059
7	8	3	0.202	0.202	0.164	0.173
		Average	0.136	0.138	0.100	0.109
7	7	4	0.579	0.580	0.485	0.494

[a] Leak categories are based on range of light leaks to dense leaks with 0.5 as the leak category with least visible or intermittently visible leaks and 4 as the leak category with the highest density.

[b] The PM includes filterable and condensible PM.

[c] Two BSO emissions rate values are presented, the first is as was presented in the test report which used three times the average blank value as the detection limit, the second (revised) uses a detection limit of three times the standard deviation of the blank values for test reference 39 where individual blank results were available and for test reference 7 recalculates emission rates by using a zero weight gain for filters that showed weight loss. All emissions estimates for Catagory 0 leaks are highly suspect because samples were near the detection limit and anomolies that exist with individual sample portions.

TABLE 4-4. DATA FOR UNCONTROLLED CHARGING

Reference	Pollutant	Emission factor		Rating
		kg/Mg	lb/ton	
12	Filterable PM	0.055	0.11	D
12,13,	Benzene soluble organics	0.065	0.13	D
	Condensible PM	0.055	0.11	D
4	Filterable PM	0.26	0.52	D
4	Filterable PM	0.75	1.5	D

TABLE 4-5. COMPONENTS OF RAW COKE OVEN GAS[a]

	lb/ton	Ratio to BSO[b]
Carbon monoxide	48.2	1.1
Carbon dioxide	20.9	0.5
Hydrogen sulfide	6.6	0.15
Ammonia	6.5	0.15
Hydrogen cyanide	2.1	0.05
Heavy hydrocarbons	34.6	0.8
Methane	119	2.7
Ethane	11.7	0.3
Propane	1.1	0.03
Butane	0.7	0.02
Ethylene	17.3	0.4
Propylene	3.5	0.08
Butene	2.9	0.07
Pentene	0.6	0.01
Benzene	22	0.5
Toluene	1.9	0.04
Xylene	0.2	0.005
Acetylene	0.4	0.009
Tar acids (CxHxOH)	0.7	0.02
Tar bases (CxHxN)	0.5	0.01
Solvents	0.7	0.02
Naphthalene	7	0.2
Tar oil	1	0.02

[a] Reference 10.

[b] Based on an estimate of 44 lb/ton BSO.

TABLE 4-6. MAJOR COMPONENTS OF RAW COKE OVEN GAS[a]

Compound	Concentration		lb/ton[b]	Ratio to BSO[c]
	Volume percent	ppmv		
Methane	29.2	--	145	3.3
Ethane	1.22	--	11	0.25
Ethene	3.47	--	30	0.68
Acetylene	--	943	0.76	0.02
Propane	—	403	0.55	0.01
Propene	--	2,070	2.7	0.06
Propyne	--	100	0.12	0.003
Propadiene	--	20	0.025	--
n-Butane	--	30	0.054	--
iso-Butene	--	140	0.24	0.005
trans-butene	--	25	0.044	--
Butadiene	--	240	0.40	0.009
Carbon monoxide	4.27	--	37	0.84
Carbon dioxide	1.34	--	18	0.41
Hydrogen sulfide	--	559	0.59	0.01
Carbonyl sulfide	--	27	0.05	0.001
Carbon disulfide	--	23	0.05	0.001
Thiophenes		47	0.12	0.003

[a] Reference 11.

[b] Based on the compound's molecular weight and the assumption that one ton of coal produces 12,000 scf of raw coke gas.

[c] Based on BSO at 44 lb/ton.

TABLE 4-7. OTHER CONSTITUENTS IN COKE OVEN GAS[a]

Compound	Emission rate		Ratio to BSO[c]
	lb/hr[b]	lb/ton[c]	
Ammonia and acids:			
HCN	4.9	1.0	0.02
HCl	0.20	0.04	0.0009
HF	0.001	0.0002	5x10^{-6}
HNO_3	0.015	0.003	7x10^{-5}
H_2SO_4	0.16	0.03	0.0007
NH_3	4.3	0.9	0.02
Metals:			
Arsenic	4.9x10^{-5}	1x10^{-5}	2x10^{-7}
Mercury	3.7x10^{-5}	7x10^{-6}	2x10^{-7}
Selenium	6.5x10^{-5}	1x10^{-5}	2x10^{-7}
Semivolatiles:			
Acenaphthylene	0.008	0.002	5x10^{-5}
Anthracene	0.003	0.0006	1x10^{-5}
Benzofuran	0.015	0.003	7x10^{-5}
Benzonitrile	0.007	0.001	2x10^{-5}
Benzothiophene	0.22	0.04	9x10^{-4}
Dibenzofuran	0.002	0.0004	9x19^{-6}
Dimethyl phenol	0.002	0.0004	9x10^{-6}
Ethylmethyl benzene	0.37	0.074	0.002
Fluoranthene	0.001	0.0002	5x10^{-6}
Fluorene	0.006	0.001	2x10^{-5}
Hexanoic acid dioctylester	0.006	0.001	2x10^{-5}
Methyl naphthalene	0.046	0.009	0.0002
2-methyl phenol	0.014	0.003	7x10^{-5}
4-methyl phenol	0.034	0.007	2x10^{-4}
Naphthalene	0.60	0.12	0.003
Phenanthrene	0.003	0.0006	1x10^{-5}
Phenol	0.14	0.028	6x10^{-4}
Propanenitrile	0.002	0.0004	9x10^{-6}
Propynyl benzene	0.004	0.0008	2x10^{-5}
Pyrene	0.004	0.0008	2x10[illegible]
Pyridine	0.042	0.008	[illegible]
Trimethyl benzene	0.011	0.002	[illegible]
Volatile organics:			
Benzene	4.2	0.84	0.02
Methylethyl benzene	0.60	0.12	0.003
Toluene	2.9	0.58	0.01
Trimethyl benzene	0.26	0.05	0.001
Xylenes	2.1	0.42	0.01

[a] Reference 11.

[b] Reported rate based on 1,000 scfm of raw coke oven gas

[c] Assumes 12,000 scf of gas from one ton of coal.

[d] Based on 44 lb/ton of BSO.

TABLE 4-8. RATIO OF PAH TO BSO – USS CLAIRTON TOPSIDE TEST (1978) [a]

PAH Compound	**Percent of BSO**	
	Large leak	**Small leak**
7 PAHs		
Benzo(a)anthracene	7.4	
Benzo(a)pyrene	1.8	1.4
Benzo(b)fluoranthene		
Benzo(k)fluoranthene		
Chrysene	0.4	5.0
Dibenzo(a,h)anthracene		
Ideno(1,2,3-cd)pyrene		
Total 7 PAHs	9.6	6.4
16 PAHs		
Acenaphthene		
Acenaphthylene	6.4	
Anthracene		
Benzo(g,h,i)perylene		
Fluoranthene	7.4	2.3
Fluorene	4.0	1.1
Naphthalene	15.8	10.5
Phenanthrene	18.3	4.2
Pyrene	7.4	2.4
Total 16 PAHs	59.5	20.6
Other PAH Compound		
Biphenyl	0.7	0.2
Dimethylnaphthalenes	0.5	0.1
Dibenzofuran	3.6	0.0
Dimethylbiphenyls	0.9	0.0
Dibenzothiophene	1.0	0.1
Benzo(h)quinoline	0.2	0.0
Carbanzole	2.2	0.0
Methylphenanthrene	1.7	0.3
4H-Cyclopenta phenanthrene	1.6	0.0
Phenylnaphthalene	0.4	0.0
Benzo(a)fluorene	1.3	0.5
Methylpyrenes	2.3	0.8
Benzo(ghi)fluoranthene	0.5	0.0
Terphenyl	0.2	0.0
Methylbenzoanthralenes	1.4	0.8
Benzothiophene	0.9	0.0
Benzopyrenes	14.9	10.3
Benzoperylenes	5.4	0.0
Dibenzoanthacene	1.2	0.0
Total -- all POMs	108.4	38.9

[a] Reference 182.

TABLE 4-9. ACCCI MSDS PROJECT CRUDE COAL TAR ANALYSES [a]

Compound	Average Concentration (ppm)	Range in Concentration (ppm)
Benzo[a]anthracene	9,026	5,710 - 14,600
Benzo[a]pyrene	8,365	4,600 - 12,500
Benzo[b]flouranthene	6,804	3,740 - 11,200
Benzo[k]fluoranthene	5,863	3,720 - 9,960
Chrysene	11,125	7,950 - 21,900
Dibenz[a,h]anthracene	517	153 - 1,060
Indeno[1,2,3-cd]pyrene	3,738	2,050 - 5,290

[a] Reference 183.

TABLE 4-10. AVERAGES ASSOCIATED WITH NESHAP EMISSION LIMITS

Source and compliance date for NESHAP	Limit[a]	Average[b]
Doors–risk extension track		
1993	7.0	5.8
1998 (6-meter)	4.3	3.4
1998 (<6-meter)	3.8	2.9
2010 (6-meter)	4.0	3.1
2010 (<6-meter)	3.3	2.5
Doors–MACT track		
1995 (6-meter)	6.0	4.9
1995 (<6-meter)	5.5	4.4
2003 (6-meter)	5.5	4.4
2003 (<6-meter)	5.0	4.0
Lids–extension track, 1993	0.87	0.45
Lids–extension track, 1998	0.40	0.17
Lids–1995 MACT track	0.6	0.3
Offtakes–extension track, 1993	4.2	3.3
Offtakes–extension track, 1998	2.5	1.8
Offtakes–1995 MACT track	3.0	2.2
Charging (all cases)	12	10

[a] These emission limits are 30-day averages for percent leaking doors, lids, and offtakes and seconds of emissions for charging.

[b] These are the long-term average levels associated with the not-to-be-exceeded limits.

TABLE 4-11. SUMMARY OF EMISSION FACTORS FOR COKE OVEN LEAKS AND CHARGING[a]
(All factors rated "E")

	Filterable PM		BSO		
	kg/Mg	lb/ton	kg/Mg	lb/ton	Reference
Charging					
Uncontrolled	0.35	0.7	0.44	0.88	4,12,13
Scrubber	0.007	0.014	--	--	4
pre-NESHAP controls	0.0034[b]	0.0066[b]	0.0027	0.0053	c
post-NESHAP controls[d]	0.00031[b]	0.00063[b]	0.00025	0.0005	c
Door leaks					
Uncontrolled	0.26	0.52	0.43	0.86	PM (1,2,3,4), BSO (3,5)
pre-NESHAP controls[e]	0.020[b]	0.041[b]	0.018	0.037	166, c
post-NESHAP controls[d]	0.0079[b]	0.016[b]	0.0071	0.014	c
Lid leaks					
Uncontrolled	0.026	0.052	0.023	0.046	c
pre-NESHAP controls	0.0036[b]	0.0072[b]	0.0032	0.0065	c
post-NESHAP controls[d]	0.000048[b]	0.000098[b]	0.000044	0.000087	c
Offtake leaks					
Uncontrolled	0.026	0.052	0.023	0.046	c
pre-NESHAP controls	0.0033[b]	0.0067[b]	0.0037	0.006	c
post-NESHAP controls[d]	0.00016[b]	0.00032[b]	0.00015	0.00029	c

[a] Based on the model Battery described in the text charging 492,000 Mg/yr of coal.

[b] BSO and filterable PM estimates are based on a ratio of PM:BSO of 1.2 for charging and 1.1 for leaks.

[c] Derived as described in the text.

[d] Estimates of current emissions should be based on the results of daily visible emission inspections using EPA Method 303. When visible emission data are available, the annual average seconds of visible emissions (for charging) and annual average number of leaks (for doors, lids, and offtakes) should be used in the following equations:

Charging emissions (kg/hr) = number of charge/hr x (average seconds/charge ÷ 10) x 4.2 x 10^{-3}.

Door leak emissions (kg/hr) = average number of doors observed from the yard with visible leaks x 0.019 + average number of doors observed from the bench with visible leaks x 0.011 + average number of doors without visible leaks x 0.002. In the absence of observations from the bench, 6% of the doors in service should be used for the average number of doors with bench visible leaks.

Lid leak emissions (kg/hr) = annual average number of lids leaking x 0.0033.

Offtake leak emissions (kg/hr) = annual average number of offtakes leaking x 0.0033.

[e] Filterable particulate matter emission factor based upon measured emissions from Reference 166; emission factor units converted from lb/ton of coke pushed using a factor of 0.69.

TABLE 4-12. RATIOS OF OTHER POLLUTANTS TO BSO

Pollutant	Ratio to BSO[a]	Derived from reference No.
Filterable PM (leaks)	0.9	3
Filterable PM (charging)	0.8	12,13
Condensible PM (leaks)	0.9	3
Condensible PM (charging)	0.9	13
VOC[b]	2.2	10
TOC[c]	5.2	10
Acetylene	0.009	10
Acenaphthylene	3.2e-02	11, 182
Ammonia	0.15	10
Anthracene	1.0e-05	11
Benzene	0.5	10
Benzo[a]anthracene	0.00903	183
Benzo(a)fluorene	0.009	182
Benzo[a]pyrene	0.00836	183
Benzo[b]flouranthene	0.00680	183
Benzofuran	7.0e-05	11
Benzo(ghi)fluoranthene	0.005	182
Benzo[h]quinoline	0.002	182
Benzo[k]fluoranthene	0.00586	183
Benzonitrile	2.0e-05	11
Benzopyrenes	1.5e-01	182
Benzoperylenes	5.4e-02	182
Benzothiophene	5.0e-03	11, 182
Biphenyl	0.0045	182
Butadiene	0.009	11[d]
Butane	0.02	10
Butene	0.07	10
Carbanzole	0.022	
Carbon dioxide	0.5	10
Carbon disulfide	0.001	11
Carbon monoxide	1.1	10
Carbonyl sulfide	0.001	11
Crysene	0.01113	183
4H-Cyclopenta phenanthrene	0.016	182

TABLE 4-12. (continued)

Pollutant	Ratio to BSO[a]	Derived from reference No.
Dibenzoanthacene	0.012	182
Dibenz[a,h]anthracene	0.000517	183
Dibenzothiophene	5.5e-03	182
Dibenzofuran	1.8e-02	11, 182
Dimethyl phenol	9.0e-06	11
Dimethyl biphenyls	0.0090	182
Dimethylnaphthalenes	0.0030	182
Ethane	0.3	10
Ethylene	0.4	10
Ethylmethyl benzene	0.002	11
Fluoranthene	0.032	11, 182
Fluorene	0.017	11, 182
Heavy hydrocarbons	0.8	10
Hexanoic acid dioctylester	2.0e-05	11
Hydrogen cyanide	0.035	10, 11
Hydrogen chloride	0.0009	11
Hydrogen fluoride	5.0e-06	11
Nitric acid	7.0e-05	11
Sulfuric acid	0.0007	11
Hydrogen sulfide	0.15	10
Indeno[1,2,3-cd]pyrene	0.00374	183
Metals arsenic mercury selenium	 2×10^{-7} 2×10^{-7} 2×10^{-7}	 11 11 11
Methane	0.7	10
Methylbenzoanthralenes	0.00275	182
Methylethyl benzene	0.003	11
Methyl naphthalene	2.0e-04	11
Methylphenanthrene	0.010	182
2-methyl phenol	7.0e-05	11
4-methyl phenol	2.0e-04	11
Methylpyrenes	0.0155	182
Naphthalene	0.2	10
Pentene	0.01	10
Phenanthrene	0.075	11, 182

TABLE 4-12. (continued)

Pollutant	Ratio to BSO[a]	Derived from reference No.
Propane	0.03	10
Phenol	6.0e-04	11
Phenylnaphthalene	0.004	182
Propylene	0.08	10
Propyne	0.003	11
Propanenitrile	9.0e-06	11
Propynylbenzene	2.0e-05	11
Pyrene	0.033	11, 182
Pyridine	2.0e-04	11
Solvents	0.02	10
Tar acids	0.02	10
Tar bases	0.01	10
Tar oil	0.02	10
Terphenyl	0.002	182
Thiophenes	0.003	11
Toluene	0.04	10
Trimethyl benzene	5.0e-05	11
Xylene	0.005	10

[a] BSO in this table includes heavy hydrocarbons, tar acids, tar bases, tar oil, and naphthalene. Note that the ratios given here are applicable only to oven charging and door/topside leaks, not pushing.
BSO is a component of filterable PM, condensible PM, VOC, and TOC.

[b] VOC includes all organic compounds in this table except methane and ethane.

[c] TOC = total organic compounds as measured using EPA Method 25A or equivalent; includes all organic compounds in this table.

[d] Reference 11 assumes 12,000 scf of coke oven gas/ton of coal.

TABLE 4-13. EMISSIONS FROM BYPASSED COKE OVEN GAS[a]

	Uncontrolled, lb/ton	Flared, lb/ton
Carbon monoxide	48.2	4.8
Carbon dioxide	20.9	780
Hydrogen sulfide	6.6	0.1
Ammonia	6.5	0.065[b]
Hydrogen cyanide	2.1	0.021[b]
Heavy hydrocarbons	34.6	1.7
Sulfur dioxide	0	13
Methane	119	1.2[b]
Ethane	11.7	0.12[b]
Propane	1.1	0.01[b]
Butane	0.7	0.007[b]
Ethylene	17.3	0.17[b]
Propylene	3.5	0.035[b]
Butene	2.9	0.029[b]
Pentene	0.6	0.006[b]
Benzene	22	0.22[b]
Toluene	1.9	0.019[b]
Xylene	0.2	0.002[b]
Acetylene	0.4	0.004[b]
Tar acids (CxHxOH)	0.7	0.007[b]
Tar bases (CxHxN)	0.5	0.005[b]
Solvents	0.7	0.007[b]
Naphthalene	7	0.07[b]
Tar oil	1	0.01[b]

[a] Reference 10.

[b] These emissions were estimated after flaring as "trace." The numbers with footnotes are estimated based on an assumed 99 percent destruction.

TABLE 4-14. EMISSION FACTORS FOR MISCELLANEOUS SOURCES

Source	Pollutant	Emission factor		Rating	Reference
		kg/Mg	lb/ton		
Coal crushing-cyclone	Filterable PM	0.055	0.11	D	4
Coal crushing-rotoclone[a]	Filterable PM	0.027	0.054	E	172
Primary coal pulverizer with building enclosure[a]	Filterable PM-10	9.0×10^{-5}	1.8×10^{-4}	E	173-175
Secondary coal pulverizer with building enclosure[a]	Filterable PM-10	4.4×10^{-5}	8.7×10^{-5}	E	173-175
Preheater-uncontrolled	Filterable PM	1.8	3.5	D	4
Preheater-scrubber	Filterable PM	0.13	0.25	D	4
Preheater-Wet ESP	Filterable PM	0.006	0.012	D	4
Coke handling cyclone	Filterable PM	0.003	0.006	D	4
Coke screening[a]	Filterable PM	0.011	0.022	E	172
Decarbonization	CO	15	29	E	15
Soaking	Total particulate matter[b]	0.008	0.015	E	15
Soaking	SO_2	0.050	0.099	E	15
Soaking	NO_x	0.0005	0.001	E	15
Soaking	VOC	0.003	0.006	E	15
Soaking	CO	0.001	0.002	E	15

[a] Emission factor units are lb of pollutant per ton of coal crushed.
[b] Includes filterable and condensible PM.

TABLE 4-15. SUMMARY OF EMISSION FACTOR DEVELOPMENT FOR COKE OVEN PUSHING to be inserted following this page. (Pg. 125 through 188 depending on your printer)

TABLE 4-16. EMISSION FACTORS FOR FILTERABLE PM EMISSIONS FROM COKE OVEN PUSHING [a]

Process	EMISSION FACTOR RATING	Emissions, kg/Mg	Emissions, lb/ton
Uncontrolled[b]	D	0.695	1.39
With Hood and FF control[c]	B	0.19	0.37
With Hood and scrubber[d]	A	0.19	0.38
With Shed and FF[e]	B	0.19	0.38

[a] Expressed as kg/Mg and lb/ton of coal charged. Based upon an average capture efficiency of 74.1%.

[b] References 1 - 2, 192 - 193. Based upon Reference 1, PM-10 is 46% and PM-2.5 is 23% of filterable PM.

[c] References 112, 121, 135, 143, 148 - 150, 153, 155, 161, 165, 170,192 - 193.

[d] References 19 - 21, 40 - 44, 48, 93 - 97, 100 - 103, 119 - 120, 124 - 126, 128, 130, 144, 147, 162 - 164.

[e] References 46 - 47, 66 - 67, 69, 72 - 75, 105, 110 - 111, 166, 168, 171. Based upon References 166 and 168, PM-10 is 62% of filterable PM.

TABLE 4-17. EMISSION FACTORS FOR CONDENSABLE PM EMISSIONS FROM COKE OVEN PUSHING [a]

Process	EMISSION FACTOR RATING	Condensible Inorganic Emissions		Condensible Organic Emissions[b]	
		kg/Mg	lb/ton	kg/Mg	lb/ton
With Hood and FF control[c]	E	0.036	0.073	0.011	0.021
With Hood and scrubber[d]	D	0.0094	0.019		

[a] Expressed as kg/Mg and lb/ton of coal charged as measured by EPA Method 202. Based upon an average capture efficiency of 74.1%.

[b] References 1, 112. When data on visible emissions are available, Condensible Organic Emissions may be calculated using the procedure for Extractable Organic Particulate.

[c] Condensible Inorganic References 112, 14[illegible].

[d] References 20 - 21, 48, 100 - 103.

TABLE 4-18. EMISSION FACTORS FOR EXTRACTABLE ORGANIC PARTICULATE (EOM) FROM COKE OVEN PUSHING [a]

Process	EMISSION FACTOR RATING	Emissions kg/Mg	Emissions lb/ton
Uncontrolled	E	4.30e-03	8.59e-03
With Hood and FF	E	4.21e-03	8.41e-03

[a] Expressed as kg/Mg and lb/ton of coal charged. As measured by EPA Method 315. Based upon an average capture efficiency of 74.1%. References 192 - 193. Estimates of extractable organic particulate may be made based upon the frequency and relative greenness of coke pushed. Based upon an analysis in Reference 194, the EOM emission factor for non green pushes is 0.0024 lb/ton, for moderately green pushes is 0.067 lb/ton and for severely green pushes is 2.3 lb/ton. A non-green push is defined as one with an average opacity less than 30%, moderately green is 30% to less than 50%, and severely green is 50% or greater. For batteries that have capture and control, capture efficiencies are assumed to be 90% for non-green, 40% for moderately green, and 10% for severely green pushes. Control efficiencies in References 192 - 193 for the captured emissions ranged from zero to 57% and averaged 27%.

TABLE 4-19. EMISSION FACTORS FOR CO, CO2, NOX, SOX, TOC AND ORGANIC COMPOUNDS FROM COKE OVEN PUSHING [a]

Pollutant	EMISSION FACTOR RATING	Emissions, kg/Mg	Emissions, lb/ton
Carbon Monoxide [b]	D	0.032	0.063
Carbon Dioxide	A	8.00	16.0
Nitrogen Oxides [d]	D	0.0097	0.019
Sulfur Oxides [e]	E	0.049	0.098
Total Organic Compounds [f]	E	0.050	0.100
Acetone [g]	E	0.012	0.023
VOC [h]	E	0.038	0.077
Ammonia [k]	E	0.006	0.012
Cyanide [k]	E	3.21e-04	6.41e-04
Phenol [k]	E	3.37e-03	6.73e-03
Benzene [k]	E	0.37	0.73
Toluene [g]	E	2.51e-05	5.02e-05
Styrene [g]	E	2.43e-05	4.85e-05
1,1,2,2-Tetrachloroethane [g]	E	3.91e-05	7.81e-05
Methanol [g]	E	4.12e-03	8.23e-03
Ethanol [g]	E	4.19e-05	8.38e-05
Isopropanol [g]	E	5.45e-05	1.09e-04
Acrolein [g]	E	5.10e-05	1.02e-04
Acetonitrile [g]	E	4.64e-05	9.27e-05
Acrylonitrile [g]	E	2.29e-04	4.57e-04
Vinyl Acetate [g]	E	7.85e-05	1.57e-04
Tetrahydrofuran [g]	E	6.55e-05	1.31e-04
1,4-Dioxane [g]	E	8.00e-05	1.60e-04
2-Butanone [g]	E	6.55e-05	1.31e-04
Methyl Methacrylate [g]	E	9.10e-05	1.82e-04
4-Methyl-2-Pentanone [g]	E	9.10e-05	1.82e-04
Methylene Chloride [g]	E	4.05e-06	8.10e-06

[a] Expressed as kg/Mg and lb/ton of coal charged. Based upon an average capture efficiency of 74.1%.

[b] References 16, 166, 168, 170.

[c] References 93 - 97, 100 - 103, 124 - 126, 128, 130, 144, 14 - 148, 155, 161, 165, 168, 170 - 171, 192 - 193.

[d] References 16, 166, 170.

[e] References 16, 166.

[f] References 166, 168, 170.

[g] Reference 207. Emission factor should be considered an underestimate since sample collection was by Summa canister.

[h] VOC is TOC minus Acetone.

[k] Reference 168.

TABLE 4-20. EMISSION FACTORS FOR METALS FROM COKE OVEN PUSHING [a]

Metal	EMISSION FACTOR RATING	Uncontrolled		Controlled Emissions [b]	
		kg/Mg	lb/ton	kg/Mg	lb/ton
Antimony	E	2.07e-07	4.14e-07		
Arsenic	E	1.75e-05	3.50e-05	4.69e-06	9.37e-06
Barium	E	1.96e-05	3.92e-05	7.15e-06	1.43e-05
Beryllium	E	3.41e-07	6.81e-07	1.05e-07	2.10e-07
Cadmium	E	4.62e-07	9.24e-07	1.53e-07	3.06e-07
Chromium	E	5.70e-06	1.14e-05	2.49e-06	4.98e-06
Cobalt	E	1.34e-06	2.68e-06	6.60e-07	1.32e-06
Copper	E	9.85e-06	1.97e-05	3.83e-06	7.65e-06
Manganese	E	1.53e-05	3.06e-05	5.40e-06	1.08e-05
Lead	E	2.75e-05	5.49e-05	7.70e-06	1.54e-05
Nickel	E	2.00e-05	3.99e-05	5.60e-06	1.12e-05
Phosphorus	E	3.10e-05	6.19e-05	1.39e-05	2.78e-05
Selenium	E	4.50e-06	9.00e-06	1.30e-06	2.59e-06
Silver	E	1.27e-07	2.54e-07	1.27e-07	2.53e-07
Thallium	E	1.15e-06	2.29e-06	3.29e-07	6.57e-07
Zinc	E	5.30e-06	1.06e-05	1.78e-05	3.55e-05

[a] Expressed as kg/Mg and lb/ton of coal charged. References 192 - 193. Based upon an average capture efficiency of 74.1%.

TABLE 4-21. EMISSION FACTORS FOR POLYCYCLIC AROMATIC HYDROCARBONS FROM COKE OVEN PUSHING [a]

PAH Compound	EMISSION FACTOR RATING	Uncontrolled		Controlled Emissions	
		kg/Mg	lb/ton	kg/Mg	lb/ton
Naphthalene	E	5.50e-04	1.10e-03 [b]	5.50e-04	1.10e-3 [c]
2-methylnaphthalene	E	2.09e-05	4.18e-5	1.78e-05	3.55e-5 [d]
Acenaphthylene	E	3.88e-04	7.75e-04 [e]	2.33e-04	4.65e-4 [c]
Acenaphthene	E	3.72e-06	7.44e-6	1.82e-06	3.64e-6 [c]
Fluorene	E	1.05e-04	2.11e-04 [f]	1.16e-04	2.32e-4 [c]
Phenanthrene	E	3.87e-04	7.74e-04 [g]	2.09e-04	4.18e-4 [c]
Anthracene	E	4.86e-05	9.71e-05 [h]	5.05e-05	1.01e-4 [c]
Fluoranthene	E	1.72e-04	3.44e-04 [k]	1.14e-04	2.27e-4 [c]
Pyrene	E	3.83e-04	7.66e-04 [m]	1.92e-04	3.83e-4 [c]
Benzo(a)anthracene	E	9.75e-05	1.95e-04 [n]	7.80e-06	1.56e-5 [c]
Crysene	E	8.75e-06	1.75e-5	3.68e-06	7.35e-6 [c]
Benzo(b)fluoranthene	E	5.25e-06	1.05e-5	1.55e-06	3.10e-6 [c]
Benzo(k)fluoranthene	E	2.82e-06	5.64e-6	1.63e-06	3.26e-6 [c]
Benzo(e)pyrene	E	2.04e-06	4.07e-6	5.60e-07	1.12e-6
Benzo(a)pyrene	E	1.50e-06	3.00e-6	5.55e-07	1.11e-6 [c]
Perylene	E	2.62e-07	5.23e-7	6.95e-08	1.39e-7 [c]
Indeno(1,2,3-cd)pyrene	E	3.12e-06	6.24e-6	9.95e-07	1.99e-6 [c]
Dibenzo(a,h)anthracene	E	8.15e-07	1.63e-6	5.75e-07	1.15e-6 [c]
Benzo(ghi)perylene	E	2.98e-06	5.95e-6	9.55e-07	1.91e-6 [c]

[a] Expressed as kg/Mg and lb/ton of coal charged. Based upon an average capture efficiency of 74.1%. References 192 - 193 except where noted.

[b] Based upon controlled emission factor and 50% average control efficiency from References 192-193.

[c] References 168, 192 - 193, 207.

[d] References 192 - 193, 207.

[e] Based upon controlled emission factor and 70% average control efficiency from References 192-193.

[f] Based upon controlled emission factor and 45% average control efficiency from References 192-193.

[g] Based upon controlled emission factor and 73% average control efficiency from References 192-193.

[h] Based upon controlled emission factor and 48% average control efficiency from References 192-193.

[k] Based upon controlled emission factor and 67% average control efficiency from References 192-193.

[m] Based upon controlled emission factor and 75% average control efficiency from References 192-193.

[n] Based upon controlled emission factor and 96% average control efficiency from References 192-193.

TABLE 4-22. EMISSION FACTORS FOR FILTERABLE PM EMISSIONS FROM COKE OVEN QUENCHING[a]

Plant	Filterable emissions, kg/Mg of coal	Filterable emissions, lb/ton of coal
Clean water[b] Lorain	0.73	1.46
DOFASCO	0.14	0.27
Gary No. 3	0.17	0.33
Gary No. 5	0.16	0.32
Average	0.298	0.595
Average omitting Lorain	0.154	0.307
Average, based on coke	0.438	0.875
Average, omitting Lorain and based on coke	0.226	0.451
Dirty water[b] Lorain	1.37	2.73
Gary No. 3	0.22	0.43
Gary No. 5	0.32	0.64
Average	0.635	1.27
Average, omitting Lorain	0.268	0.535
Average, based on coke	0.935	1.87
Average, based on coke and omitting Lorain	0.394	0.787

[a] Reference 18.

[b] Clean water: less than or equal to 500 mg/L TDS; dirty water: at least 1, 500 mg/L TDS.

TABLE 4-23. FILTERABLE PM EMISSION FACTORS FOR QUENCHING

Process	EMISSION FACTOR RATING	Emission factor, kg/Mg of coal	Emission factor, lb/ton of coal
Uncontrolled, clean water[a]	E	0.57	1.1
Uncontrolled, dirty water[a,b]	E	2.6	5.2
Clean water, tall tower and/or poor maintenance[c,d]	D	0.73	1.46
Clean water normal tower height and proper maintenance[c,d]	D	0.15	0.31
Dirty water, tall tower and/or poor maintenance[c,d]	D	1.37	2.73
Dirty water, normal tower height and proper maintenance[c,d]	D	0.27	0.54

[a] Reference 17.

[b] Dirty water: at least 5,000 mg/L TDS.

[c] Reference 18.

[d] Clean water: less than or equal to 500 mg/L TDS; dirty water: at least 1,500 mg/L TDS.

TABLE 4-24. SUMMARY OF EMISSION FACTOR DEVELOPMENT FOR RECOVERY COKE OVEN COMBUSTION STACKS to be inserted following this page. (About pager 194 through 239 depending on your printer)

TABLE 4-25. EMISSION FACTORS FOR COMBUSTION STACK EMISSIONS--FILTERABLE PM[a]

Source	EMISSION FACTOR RATING	Filterable PM	
		kg/Mg	Lb/ton
Uncontrolled (Raw COG)[b]	B	0.20	0.40
Uncontrolled (BFG)[c]	E	0.10	0.21
Uncontrolled (Desulfurized COG)[c]	A	0.034	0.067
With FF (Raw COG)[d]	C	0.11	0.21
With FF or ESP (BFG)[e]	D	0.031	0.063

[a] Emission factor units are kg/Mg of coal charged or lb/ton of coal charged.

[b] References 89, 98, 106-109, 114, 123, 156, 157, 159, 166, 188 - 193.

[c] Reference 91.

[d] References 56 - 59, 60 - 65, 70 - 71, 76 - 78, 80 - 82, 98, 169 - 170, 176.

[e] References 45, 85, 200.

TABLE 4-26. EMISSION FACTORS FOR COMBUSTION STACK EMISSIONS CONDENSABLE PM [a]

Process	EMISSION FACTOR RATING	Condensible Inorganic Emissions		Condensible Organic Emissions [b]	
		kg/Mg	lb/ton	kg/Mg	lb/ton
With COG	B	0.11	0.216 [c]	0.006	0.012
With BFG	E	0.014	0.028 [d]	0.006	0.012

[a] Expressed as kg/Mg and lb/ton of coal charged as measured by Method 202.

[b] References 87, 98, 188 - 189, 200.

[c] References 84, 86 - 89, 98, 157, 188 - 191, 200. Although no data are available for ovens fueled with desulfurized coke oven gas, it is expected that emissions will be significantly lower. It is recommended that the emission factor for ovens fueled with blast furnace gas be used for ovens fueled with desulfurized coke oven gas.

[d] References 85, 200.

TABLE 4-27. EMISSION FACTORS FOR COMBUSTION STACK EMISSIONS EXTRACTABLE ORGANIC MATTER, CO, CO2, NOX, SOX, TOC AND ORGANIC COMPOUNDS [a]

Pollutant	EMISSION FACTOR RATING	Emissions, kg/Mg	Emissions, lb/ton
Extractable Organic Matter [b]	E	0.012	0.024
Carbon Monoxide [c]	C	0.6	1.20
Carbon Dioxide (BFG) [d]	E	482	963
Carbon Dioxide (COG) [e]	A	148	296
Nitrogen Oxides	B	0.82	1.64
Sulfur Oxides (Raw COG) [g]	C	1.47	2.93
Sulfur Oxides (DCOG)	E	0.12	0.23
Total Organic Compounds [k]	C	0.19	0.37
Methane [m]	E	0.10	0.21
Ethane [m]	E	0.0050	0.010
Acetone [n]	E	0.0295	0.059
VOC [m, n]	E	0.047	0.094
Benzene [p]	D	0.0075	0.015
Toluene [r]	E	0.0033	0.0066
Chloromethane [r]	E	0.0032	0.0064
Benzoic Acid [r]	E	4.14e-05	8.27e-05
Bis(2-ethylhexyl)phthalate [r]	E	3.40e-06	6.79e-06
Diethyl phthalate [r]	E	9.90e-06	1.98e-05
2,4-Dimethylphenol [r]	E	4.17e-06	8.33e-06
Phenol [r]	E	2.56e-06	5.11e-06

[a] Expressed as kg/Mg and lb/ton of coal charged.

[b] Extractable Organic Matter as measured by EPA Method 315. References 192 - 193.

[c] References 16, 89, 156 - 157, 166, 170, 188 - 191.

[d] References 45, 85.

[e] References 56 - 59, 60 - 62, 63 - 65, 70 - 71, 76 - 78, 80 - 82, 84 - 85, 87 - 89, 98, 100 - 109, 121, 156 - 157, 159, 166 - 167, 169, 170, 176, 188 - 193, 200.

[f] References 16, 156 - 157, 159, 166 - 167, 170, 188 - 189.

[g] References 16, 98, 156 - 157, 159, 166.

[h] References 98.

[k] Total Organic Compounds (TOC) as measured by EPA Method 25a. References 16, 156 - 157, 166, 170, 176.

[m] Based upon ratio to TOC in References 176 and average TOC emission factor.

[n] References 206. Acetone emission factor should be considered an underestimate since sample collection was by Summa canister. VOC calculated as TOC less methane, ethane and acetone.

[p] References 89, 190 - 191, 206.

[r] Reference 206. Emission factors should be considered an underestimate since sample collection was by Summa canister.

TABLE 4-28. EMISSION FACTORS FOR METALS FROM COMBUSTION STACKS [a]

Metal	EMISSION FACTOR RATING	Emission Factor	
		kg/Mg	lb/ton
Arsenic	E	1.64e-06	3.27e-06
Barium	E	2.36e-06	4.71e-06
Beryllium	E	1.97e-08	3.94e-08
Cadmium	E	1.12e-07	2.23e-07
Chromium	E	3.60e-06	7.19e-06
Copper	E	1.71e-06	3.41e-06
Manganese	E	1.26e-06	2.52e-06
Lead	E	2.27e-06	4.54e-06
Nickel	E	9.35e-07	1.87e-06
Phosphorus	E	1.40e-05	2.80e-05
Selenium	E	1.76e-06	3.52e-06
Thallium	E	3.36e-07	6.71e-07
Zinc	E	7.70e-06	1.54e-05

[a] Expressed as kg/Mg and lb/ton of coal charged. References 192 - 193.

TABLE 4-29. EMISSION FACTORS FOR COMBUSTION STACKS POLYCYCLIC AROMATIC HYDROCARBONS [a]

PAH Compound	EMISSION FACTOR RATING	Emission Factor	
		kg/Mg	lb/ton
Naphthalene	E	4.15e-05	8.29e-05
2-methylnaphthalene	E	1.46e-06	2.91e-06
Acenaphthylene	E	5.40e-06	1.08e-05
Acenaphthene	E	1.13e-07	2.26e-07 [b]
Fluorene	E	4.41e-07	8.81e-07
Phenanthrene	E	3.90e-06	7.79e-06
Anthracene	E	1.01e-07	2.02e-07 [b]
Fluoranthene	E	1.76e-06	3.52e-06
Pyrene	E	2.32e-06	4.64e-06 [b]
Benzo(a)anthracene	E	4.64e-08	9.28e-08 [b]
Crysene	E	1.64e-07	3.28e-07
Benzo(b)fluoranthene	E	9.70e-08	1.94e-07
Benzo(k)fluoranthene	E	3.35e-08	6.70e-08 [b]
Benzo(e)pyrene	E	1.69e-07	3.38e-07 [b]
Benzo(a)pyrene	C	8.15e-06	1.63e-05 [c]
Perylene	E	1.48e-08	2.96e-08 [b]
Indeno(1,2,3-cd)pyrene	E	2.06e-08	4.11e-08 [b]
Dibenzo(a,h)anthracene	E	1.48e-08	2.96e-08 [b]
Benzo(ghi)perylene	E	2.78e-08	5.55e-08 [b]

[a] Expressed as kg/Mg and lb/ton of coal charged. References 192 - 193, 206 except where noted.

[b] References 192 - 193.

[c] References 89, 188 - 193, 206.

TABLE 4-30. SUMMARY OF NONRECOVERY COMBUSTION STACK TESTS

Pollutant	Emission factor		Reference
	kg/Mg	lb/ton	
Filterable PM	1.7	3.4	23
Filterable PM	0.49	0.98	24
Filterable PM	0.218	0.436	49
Condensible PM	0.075	0.15	24
SO_2	6	12.0	23
SO_2	4.55	9.1	24
SO_2	4.825	9.65	49
NO_x	0.33	0.66	23
NO_x	0.445	0.89	24
CO	0.065	0.13	23
CO	0.0	0.0	24
CO_2	555	1110	49
Lead	1.70e-03	0.0034	23
Lead	1.70e-03	0.0034	24
Naphthalene	3.30e-04	6.6E-04	23
Naphthalene	1.05e-05	2.1E-05	24
Benzene	1.80e-04	3.6E-04	23
Benzene	3.30e-04	6.6E-04	24

[a] Results for Reference 23 were in lb/ton of dry coal. They were divided by 0.89 to place on a common basis with References 24 and 49 (lb/ton coal as charged) based on a typical moisture content of 11 percent.

TABLE 4-31. EMISSION FACTORS FOR NONRECOVERY COMBUSTION STACKS
EMISSION FACTOR RATING: B

Pollutant	Emission factor		Reference
	kg/Mg	lb/ton	
Filterable PM	0.8	1.6	23,24,49
Condensable PM	0.075	0.15	24
SO_2	5.1	10.3	23,24,49
NO_x	0.36	0.71	23,24
CO	0.025	0.05	23,24
CO_2	550	1,100	49
Benzene	2.4 x 10^{-4}	4.8 x 10^{-4}	23,24
Toluene [a]	2.6 x 10^{-4}	5.1 x 10^{-4}	24
Naphthalene	1.4 x 10^{-4}	2.7 x 10^{-4}	23,24
Phenol [b]	3.6 x 10^{-5}	7.1 x 10^{-5}	24
Benzo(a) pyrene [c]	5.0 x 10^{-7}	1.0 x 10^{-6}	24
Acetone [d]	1.1 x 10^{-3}	2.3 x 10^{-3}	24
Bromomethane	2.8 x 10^{-4}	5.6 x 10^{-4}	24
Chloromethane	3.8 x 10^{-4}	7.6 x 10^{-4}	24
Methylene Chloride	3.3 x 10^{-4}	6.6 x 10^{-4}	24
Carbon Disulfide	8.1 x 10^{-6}	1.6 x 10^{-5}	24
2-Butanone	3.2 x 10^{-5}	6.3 x 10^{-5}	24
1,1,1-Trichloroethane [d, e]	1.3 x 10^{-6}	2.5 x 10^{-6}	24
Trichloroethene [d, f]	4.4 x 10^{-6}	8.7 x 10^{-6}	24
Ethylbenzene	1.6 x 10^{-6}	3.2 x 10^{-6}	24
m-/p-Xylene	6.5 x 10^{-6}	1.3 x 10^{-5}	24
o-Xylene	1.6 x 10^{-6}	3.2 x 10^{-6}	24
Iodomethane [d, g]	3.2 x 10^{-6}	6.3 x 10^{-6}	24
Dibromomethane	6.[illegible] x 10^{-6}	1.2 x 10[illegible]	24
Trichlorofluoromethane [d, e]	4.[illegible] x 10^{-6}	8.2 x 10^{-6}	24
n-Hexane [d, h]	7.3 x 10^{-6}	1.5 x 10[illegible]	24
Isooctane [d, j]	8.0 x 10^{-6}	1.6 x 10^{-5}	24
P-Cymene [d, g]	5.5 x 10^{-7}	1.1 x 10^{-6}	24
Cumene [d, g]	7.1 x 10^{-7}	1.4 x 10^{-6}	24
2-Hexanone	1.4 x 10^{-5}	2.8 x 10^{-5}	24
Ethyl Methacrylate [d, e]	1.7 x 10^{-6}	3.4 x 10^{-6}	24
Styrene [d, e]	3.4 x 10^{-6}	6.9 x 10^{-6}	24
Vinyl Acetate	3.5 x 10^{-6}	6.9 x 10^{-6}	24
1,2,3-Trichloropropane [d, g]	2.2 x 10^{-6}	4.4 x 10^{-6}	24
Chloroform	5.7 x 10^{-6}	1.1 x 10^{-5}	24

TABLE 4-31 (continued)

Pollutant	Emission factor		Reference
	kg/Mg	lb/ton	
Dibromochloromethane	1.2 x 10^{-7}	2.4 x 10^{-7}	24
1,1,2-Trichloroethane	2.9 x 10^{-7}	5.8 x 10^{-7}	24
Bromoform [d, k]	5.7 x 10^{-7}	1.2 x 10^{-6}	24
4-Methyl-2-Pentanone [d, k]	4.5 x 10^{-6}	8.9 x 10^{-6}	24
1,1,2,2-Tetrachloroethane [d, k]	1.1 x 10^{-6}	2.0 x 10^{-6}	24
1,4-Dichloro-2-butene [d, k]	6.9 x 10^{-7}	1.4 x 10^{-6}	24
Tetrachloroethane [d, k]	2.0 x 10^{-7}	4.1 x 10^{-7}	24
Tert-Butyl methyl ether [d, k]	2.4 x 10^{-8}	4.7 x 10^{-8}	24
Chlorobenzene [d, k]	6.1 x 10^{-7}	1.2 x 10^{-6}	24
Dimethyl Sulfide	1.6 x 10^{-6}	3.2 x 10^{-6}	24
Antimony	6.3 x 10^{-5}	1.3 x 10^{-4}	24
Arsenic	6.3 x 10^{-4}	1.3 x 10^{-3}	24
Barium	6.3 x 10^{-5}	1.3 x 10^{-4}	24
Beryllium	1 x 10^{-5}	2 x 10^{-5}	24
Cadmium	9 x 10^{-5}	1.8 x 10^{-4}	24
Chromium	3.2 x 10^{-4}	6.3 x 10^{-4}	24
Copper	1.4 x 10^{-3}	2.8 x 10^{-3}	24
Lead	1.7 x 10^{-3}	3.4 x 10^{-3}	23,24
Manganese	1.5 x 10^{-4}	3.0 x 10^{-4}	24
Mercury	1.7 x 10^{-4}	3.3 x 10^{-4}	24
Nickel	2.9 x 10^{-4}	5.8 x 10^{-4}	24
Phosphorus	7.0 x 10^{-3}	1.4 x 10^{-2}	24
Selenium	1.6 x 10^{-4}	3.2 x 10^{-4}	24
Silver	2.[illegible] x 10^{-5}	4.5 x 10^{-5}	24
Thallium	9.[illegible] x 10^{-5}	1.8 x 10[illegible]	24
Zinc	2.6 x 10^{-3}	5.1 x 10^{-3}	24

[a] Based on the VOST results and an estimated rate of 30 ton/hr of coal charged.

[b] Detected in only 5 of 19 samples.

[c] Detected in only one sample.

[d] Semi-quantitative result.

[e] Detected in only 3 of 9 samples.

[f] Detected in only 5 of 9 samples.

[g] Detected in only 3 of 6 samples.

[h] Detected in only 7 of 12 samples.

[j] Detected in only 4 of 6 samples.

[k] Detected in only 1 of 3 samples.

TABLE 4-32. EMISSION FACTORS FOR NON RECOVERY CHARGING[a]
EMISSION FACTOR RATING: D

Pollutant	Uncontrolled emissions		Controlled emissions	
	kg/Mg	lb/ton	kg/Mg	lb/ton
Filterable PM	0.013	0.027	0.0041	0.0081
TSO	0.0013	0.0026	0.0011	0.0022
Benzene	1.8×10^{-5}	3.6×10^{-5}	1.8×10^{-5}	3.6×10^{-5}
Toluene	8.4×10^{-6}	1.7×10^{-5}	8.4×10^{-6}	1.7×10^{-5}
Xylene	3.4×10^{-6}	6.7×10^{-6}	3.4×10^{-6}	6.7×10^{-6}
Carbon disulfide	1.1×10^{-6}	2.1×10^{-6}	1.1×10^{-6}	2.1×10^{-6}
Chloromethane	1.0×10^{-6}	2.0×10^{-6}	1.0×10^{-6}	2.0×10^{-6}
Ethyl benzene	3.6×10^{-7}	7.3×10^{-7}	3.6×10^{-7}	7.3×10^{-7}
Naphthalene	1.2×10^{-5}	2.3×10^{-5}	1.2×10^{-5}	2.3×10^{-5}
Total PAHs	1.4×10^{-5}	2.7×10^{-5}	1.2×10^{-5}	2.3×10^{-5}
Manganese	7.5×10^{-7}	1.5×10^{-6}	2.3×10^{-7}	4.6×10^{-7}
Arsenic	4.0×10^{-7}	7.9×10^{-7}	1.2×10^{-7}	2.4×10^{-7}
Nickel	2.5×10^{-7}	5.0×10^{-7}	7.5×10^{-8}	1.5×10^{-7}
Lead	1.7×10^{-7}	3.4×10^{-7}	5.0×10^{-8}	1.0×10^{-7}
Chromium	1.7×10^{-7}	3.4×10^{-7}	5.0×10^{-8}	1.0×10^{-7}
Cobalt	1.2×10^{-7}	2.4×10^{-7}	3.6×10^{-8}	7.1×10^{-8}
Beryllium	1.5×10^{-8}	2.9×10^{-8}	4.4×10^{-9}	8.7×10^{-9}
Mercury	1.3×10^{-9}	2.6×10^{-9}	4.0×10^{-10}	7.9×10^{-10}

[a] Reference 25.

TABLE 4-33. SUMMARY OF TEST DATA FOR UNCONTROLLED COKE OVEN BYPRODUCT PLANTS

Ref.	Source	Pollutant	No. of runs	Emission factor, kg/Mg (lb/ton)[a] Range	Average	Data rating
29	Direct water final cooling tower	Benzene	3	0.20-0.25 (0.40-0.49)	0.23 (0.46)	A
29	Tar decanter	Benzene	3	0.046-0.12 (0.092-0.24)	0.085 (0.17)	A
29	Light oil condenser vent	Benzene	3	0.078-0.096 (0.156-0.192)	0.089 (0.178)	A
29	Naphthalene drying tank	Benzene	8	0.00001-0.0004 (0.00002-0.0008)	0.00008 (0.00016)	A
29	Naphthalene flotation tanks	Benzene	3	0.080-0.10 (0.160-0.20)	0.087 (0.174)	C
29	Naphthalene melt pit	Benzene	5	0.009-0.092 (0.018-0.184)	0.024 (0.048)	C
30	Tar dehydrator	Benzene	3	0.0088-0.01 (0.0176-0.02)	0.0095 (0.019)	A
30	Tar decanter	Benzene	3	0.058-0.091 (0.116-0.182)	0.07 (0.140)	A
31	Tar storage tank	Benzene	3	0.0057-0.019 (0.0114-0.038)	0.011 (0.022)	A
31	Tar intercepting sump	Benzene	3	0.0068-0.011 (0.0136-0.022)	0.0095 (0.019)	C
32	Direct water final cooling tower	Benzene	3	0.27-0.36 (0.54-0.72)	0.31 (0.62)	A
32	Tar dehydrator	Benzene	3	0.0096-0.082 (0.0192-0.0164)	0.041 (0.082)	A
32	Wash oil decanter	Benzene	3	0.0036-0.0041 (0.0072-0.0082)	0.0038 (0.0076)	A
33	Tar dehydrator	Benzene	3	0.0094-0.016 (0.0188-0.032)	0.013 (0.026)	A
33	Tar bottom final cooling tower	Benzene	3	0.065-0.073 (0.13-0.146)	0.070 (0.140)	A
34	Light oil sump	Benzene	3	0.022-0.033 (0.044-0.066)	0.027 (0.054)	C
35	Light oil sump	Benzene	3	0.0030-0.0034 (0.0060-0.0068)	0.0033 (0.0066)	C
36	Direct water final cooling tower	Benzene	2	0.053-0.06 (0.106-0.12)	0.056 (0.112)	D
36	Direct water final cooling tower	HCN	2	0.27-0.32 (0.54-0.64)	0.30 (0.60)	D
36	Tar decanter	Benzene	3	0.016-0.018 (0.032-0.036)	0.017 (0.034)	D
36	Tar decanter	Toluene	3	0.0016-0.0019 0.0032-0.0038	0.0017 (0.0034)	D
36	Tar decanter	o-Xylene	1	NA	0.000075 (0.000150)	D
36	Tar decanter	m/p Xylene	1	NA	0.00034 (0.00068)	D

TABLE 4-33. (continued)

Ref.	Source	Pollutant	No. of runs	Emission factor, kg/Mg (lb/ton)[a]		Data rating
				Range	Average	
36	Tar decanter	Ethyl benzene	1	NA	0.000014 (0.000028)	D
36	Tar decanter	H_2S	2	0.012-0.015 (0.024-0.030)	0.014 (0.028)	D
36	Tar storage tank	Benzene	3	0.0000098-0.00001 (0.0000196-0.000020)	0.0000099 (0.0000198)	D
36	Tar storage tank	Toluene	3	0.0000031-0.0000032 (0.0000062-0.0000064)	0.0000032 (0.0000064)	D
38	Direct water final cooling tower	Benzene	8	0.05-0.28 (0.10-0.56)	0.12 (0.24)	C
38	Tar decanter	Benzene	9	0.006-0.049 (0.012-0.098)	0.027 (0.054)	B
38	Ammonia liquor storage tank	Benzene	5	0.0011-0.0018 (0.0022-0.0036)	0.0014 (0.0028)	B
38	Flushing liquor circulation tank	Benzene	3	0.011-0.014 (0.22-0.028)	0.013 (0.026)	B
38	Tar storage tank	Benzene	3	0.0014-0.0038 (0.0028-0.0076)	0.0022 (0.0044)	B
38	Naphthalene separation and processing	Benzene	2	Unknown	0.00035[a] (0.00070)	B
38	Light oil storage tank	Benzene	--	NA	0.0058 (0.0116)	D

[a] Controlled by carbon canister.

TABLE 4-34. COKE BYPRODUCT PLANT EMISSION FACTORS FOR BENZENE AND BTX[a]
EMISSION FACTOR RATING: E, EXCEPT AS NOTED

Type of byproduct plant operation	Control device	Benzene				BTX			
		Furnace plant		Foundry plant		Furnace plant		Foundry plant	
		kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton
Light-oil storage tank[b]	Uncontrolled	0.0058	0.0116	0.0031	0.0062	0.0083	0.0166	0.0049	0.0098
	Gas blanketing	0.00012	0.00024	0.00006	0.00012	0.00017	0.00034	0.000094	0.000188
Tar decanter	Uncontrolled	0.054[c]	0.108[c]	0.025	0.050	0.077	0.154	0.039	0.078
	Gas blanketing	0.0011[c]	0.0022[c]	0.0005	0.0010	0.0016	0.0032	0.00079	0.00158
Naphthalene separation and processing	Uncontrolled	0.11	0.22	0.08	0.16	0.16	0.32	0.13	0.26
	Activated carbon	0.00035	0.00070	0.00025	0.00050	0.00050	0.0010	0.00039	0.00078
Cooling tower	Direct-water, uncontrolled	0.27	0.54	0.20	0.40	0.69	1.38	0.61	1.22
	Tar-bottom, uncontrolled	0.070	0.14	0.051	0.102	0.10	0.20	0.080	0.16
Tar intercepting sump	Uncontrolled	0.0095	0.019	0.0045	0.0090	0.014	0.028	0.0071	0.014
Tar dewatering tank	Uncontrolled	0.021[d]	0.042[d]	0.0099	0.0198	0.030	0.060	0.016	0.032
	Gas blanketing	0.00045	0.00084	0.00020	0.00040	0.00060	0.0012	0.00031	0.00062
Tar storage tank	Uncontrolled	0.0066[d]	0.0132[d]	0.0031	0.0062	0.0094	0.0188	0.0049	0.0098
	Gas blanketing	0.00038	0.00076	0.00018	0.00036	0.00054	0.00108	0.00028	0.00056
Light-oil condenser vent	Uncontrolled	0.089	0.178	0.048	0.096	0.13	0.26	0.076	0.152
	Gas blanketing	0.0018	0.0036	0.00097	0.00194	0.0026	0.0052	0.0015	0.0030
Light-oil sump	Uncontrolled	0.015[d]	0.030[d]	0.0081	0.0162	0.021	0.042	0.013	0.026
	Gas blanketing	0.00030	0.00060	0.00016	0.00032	0.00043	0.00086	0.0025	0.0050
BTX storage[b]	Uncontrolled	0.0058	0.0116	0.0031	0.0062	0.0083	0.0166	0.0049	0.0098
	Gas blanketing	0.00012	0.00024	0.000060	0.00012	0.00017	0.00034	0.000094	0.000188
Benzene storage[b]	Uncontrolled	0.0058	0.0116	0.0031	0.0062	0.0058	0.0116	0.0031	0.0062
	Gas blanketing	0.00012	0.00024	0.00006	0.00012	0.00012	0.00024	0.00006	0.00012
Flushing liquor circulation tank	Uncontrolled	0.013[c]	0.026[c]	0.0095	0.019	0.019	0.038	0.015	0.030
	Gas blanketing	0.00026	0.00052	0.00019	0.00038	0.00037	0.00074	0.00030	0.00060

TABLE 4-34. (continued)

Type of byproduct plant operation	Control device	Benzene				BTX			
		Furnace plant		Foundry plant		Furnace plant		Foundry plant	
		kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton
Excess-ammonia liquor tank	Uncontrolled	0.0014	0.0028	0.0010	0.0020	0.0020	0.0040	0.0016	0.0032
	Gas blanketing	0.000028	0.000056	0.000020	0.000040	0.000040	0.00008	0.000031	0.000062
Wash-oil decanter	Uncontrolled	0.0038	0.0076	0.0021	0.0042	0.0054	0.0108	0.0033	0.0066
	Gas blanketing	0.000076	0.00015	0.000041	0.000082	0.00011	0.00022	0.000065	0.00013
Wash-oil circulation tank	Uncontrolled	0.0038	0.0076	0.0021	0.0042	0.0054	0.0108	0.0033	0.0066
	Gas blanketing	0.000076	0.00015	0.000041	0.000082	0.00011	0.00022	0.000065	0.00013

[a] Emission factor units are kg/Mg and lb/ton of coke pushed. BTX = benzene, toluene and xylene. Benzene emission factors in this table are derived from References 29 through 38. The emission factors for BTX are estimated from equations given in the text and developed from References 26 and 27. Uncontrolled emission factors represent pre-byproduct plant pre-NESHAP control levels; controlled emission factors represent post-NESHAP control levels. No emissions are allowed from naphthalene processing.

[b] Reference 208. The reader may also use EPA's TANKS program to estimate emissions from this source. The program is available in electronic form through EPA's Technology Transfer Network. For information call (919) 541-5285.

[c] The benzene emission factor rating for this furnace plant operation is D.

[d] The benzene emission factor rating for this furnace plant operation is B.

TABLE 4-35. COKE BYPRODUCT PLANT EMISSION FACTORS FOR VOCs[a]
EMISSION FACTOR RATING: E.

Type of byproduct plant operation	Control device	Furnace plant		Foundry plant	
		kg/Mg	lb/ton	kg/Mg	lb/ton
Light-oil storage tank[b]	Uncontrolled	0.0083	0.017	0.0049	0.0098
	Gas blanketing	0.00017	0.00034	0.000094	0.00018
Tar decanter	Uncontrolled	0.12	0.24	0.057	0.11
	Gas blanketing	0.0023	0.0046	0.011	0.0022
Naphthalene separation and processing	Uncontrolled	0.17	0.34	0.14	0.28
	Activated carbon	0.00055	0.0011	0.00043	0.00086
Cooling tower	Direct-water, uncontrolled	4.2	8.4	3.2	6.4
	Tar-bottom, uncontrolled	1.1	2.2	0.81	1.6
Tar intercepting sump	Uncontrolled	0.14	0.28	0.0071	0.014
Tar dewatering tank	Uncontrolled	0.030	0.060	0.016	0.032
	Gas blanketing	0.00060	0.0012	0.00031	0.00062
Tar storage tank	Uncontrolled	0.16	0.32	0.073	0.146
	Gas blanketing	0.0089	0.018	0.0043	0.0086
Light-oil condenser vent	Uncontrolled	0.13	0.26	0.076	0.15
	Gas blanketing	0.0026	0.0052	0.0015	.030
Light-oil sump	Uncontrolled	0.021	0.042	0.013	0.026
	Gas blanketing	0.00043	0.00086	0.00025	0.00050
BTX storage[b]	Uncontrolled	0.0083	0.0166	0.0049	0.0098
	Gas blanketing	0.00017	0.00034	0.000094	0.00019
Benzene storage[b]	Uncontrolled	0.0058	0.012	0.0031	0.0062
	Gas blanketing	0.00012	0.00024	0.000060	0.00012
Flushing liquor circulation tank	Uncontrolled	0.019	0.038	0.015	0.030
	Gas blanketing	0.00037	0.00074	0.00030	0.00060
Excess -ammonia liquor tank	Uncontrolled	0.002	0.004	0.0016	0.0032
	Gas blanketing	0.000040	0.000080	0.000031	0.000062
Wash-oil decanter	Uncontrolled	0.0054	0.0108	0.0033	0.0066
	Gas blanketing	0.00011	0.00022	0.000065	0.00013
Wash-oil circulation tank	Uncontrolled	0.0054	0.0108	0.0033	0.0066
	Gas blanketing	0.00011	0.00022	0.000065	0.00013

---

[a] Emission factor units are kg/Mg and lb/ton of coke pushed. These values are derived from equations presented in the text and applied to data from References 29 through 38. The equations were developed from References 26 and 27, 1984 and 1988 documents. Uncontrolled emission factors represent pre-byproduct plant NESHAP values; controlled emission factors represent post NESHAP values. No emissions are allowed from naphthalene processing.

[b] Reference 208. The reader may also use EPA's TANKS program to estimate emissions from this source. The program is available in electronic form through EPA's Technology Transfer Network. For information call (919) 541-5285.

TABLE 4-56. EQUIPMENT LEAK EMISSION FACTORS FOR VOCs AT BYPRODUCT PLANTS[a]
EMISSION FACTOR RATING: E

Source	Control	VOC	
		kg/source-d	lb/source-d
Pumps	Uncontrolled	2.7	6.0
	Quarterly inspections	0.78	1.7
	Monthly inspections	0.46	1.0
	Dual mechanical seals	0	0
Valves	Uncontrolled	0.26	0.57
	Quarterly inspections	0.12	0.26
	Monthly inspections	0.07	0.15
	Sealed-bellows valves	0	0
Exhausters	Uncontrolled	1.2	2.6
	Quarterly inspections	0.54	1.2
	Monthly inspections	0.43	0.95
	Degassing reservoir	0	0
Pressure relief devices	Uncontrolled	3.9	8.6
	Quarterly inspections	2.2	4.9
	Monthly inspections	1.9	4.2
	Rupture disc system	0	0
Sampling connection systems	Uncontrolled	0.36	0.79
	Cap or plug	0	0
Open ended lines	Uncontrolled	0.055	0.[illegible]2
	Cap or plug	0	0

[a] Reference 28. Facilities having an effective leak detection and repair (LDAR) program and screening values required by EPA's *Protocol for Equipment Leak Emission Estimates* (EPA-453/R-95-017), may use the correlation approach for refineries contained in the document.

REFERENCES FOR SECTION 4

1. *Source Testing of a Stationary Coke-Side Enclosure: Great Lakes Carbon Corporation, St. Louis, MO*, EPA-340/1-76-014(a) and (b), U. S. Environmental Protection Agency, Washington, DC, August 1977.

2. *Source Testing of a Stationary Coke-Side Enclosure: Burns Harbor Plant, Bethlehem Steel Corporation, Chesterton, IN*, EPA-340/1-76-012, U. S. Environmental Protection Agency, Washington, DC, May 1977.

3. *Emission Testing at a Byproduct Coke Oven Battery, Wisconsin Steel, Chicago, IL,* EMB 77-CKO-11, U. S. Environmental Protection Agency, Washington, DC, May 1978.

4. *Particulate Emission Factors Applicable to the Iron and Steel Industry*, EPA-450/4-79-028, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1979.

5. *Emission Test Report: Armco Steel, Houston, TX*. EMB 79-CKO-22. U. S. Environmental Protection Agency, Research Triangle Park, NC, November 1979.

6. C. Allen, *A Model to Estimate Hazardous Emissions from Coke Oven Doors*, EPA Contract No. 68-02-1408, Docket Item II-A-38 in Docket No. A-79-15, March 1980.

7. *Final Phase I Method Validation Report for Quantitative Coke Oven Door Leak Measurement Study*, ENSR Consulting and Engineering, for American Iron and Steel Institute, Washington, DC. December 1991.

8. *Emission Test Report - U.S. Steel Corporation, Clairton, Pennsylvania*, EMB Report No. 7 78-CKO-13. TRW, Inc. July 1980.

9. *Coke Oven Emissions from Wet-Coal Charged Byproduct Coke Oven Batteries - Background Information for Proposed Standards*, EPA-450/3-85-028a, U. S. Environmental Protection Agency, Research Triangle Park, NC. April 1987.

10. Memorandum from Ackerman, E., USEPA Region III, to A. Agnew, EPA/OAQPS. Transmitting information on bypassed coke oven gas. April 8, 1991.

11. Coke Oven Gas Study Performed for Bethlehem Steel Corporation, Mostardi-Platt Associates, Inc., December 1992.

12. R W. Bee et al, *Coke Oven Charging Emission Control Test Program*, EPA-650/2-74-062, U. S. Environmental Protection Agency, July 1974.

13. A. Trenholm and L. Beck, *Assessment of Hazardous Organic Emissions from Slot Type Coke Oven Batteries, unpublished paper*, U. S. Environmental Protection Agency, Research Triangle Park, NC, March 1978.

14. *Assessment of Bypassed Coke Oven Gas: Evaluation of Emissions and Controls.* USEPA Docket Number A-79-15, Docket Item VIII-B-2.

15. G. Leney, *Emissions Inventory Development for Byproduct Coke Plants in Allegheny County, PA,* presented at AWMA meeting, Raleigh, NC, November 1994.

16. T. W. Easterly, *Selecting the Appropriate Emission Factor for Estimating Emissions from Iron and Steel Sources*, Presented at the 87th Annual Meeting of the Air and Waste Management Association, Cincinnati, OH, June 1994.

17. *Metallurgical Coke Industry Particulate Emissions: Source Category Report*, EPA-600/7-86-050, U. S. Environmental Protection Agency, Air and Energy Research Laboratory, Research Triangle Park, NC, December 1986.

18. B. Bloom and J. D. Jeffrey, *Review of Coke Plant Quench Tower Particulate Emission Rates*, Environmental Protection Agency, *circa* 1982.

19. *Compliance Tests of the Envirotech Hooded Quench Car No. 104*, Volume I - Test Report, Project No. 50.50, United States Steel Clairton Works, Clairton, PA, February 12, 1985.

20. *Compliance Tests of the Envirotech Hooded Quench Car No. 103 Operated on the Number 20 Coke Battery Located at the United States Steel Clairton Works*, Project No. 40.74, Clairton, PA, September 11, 1985.

21. *Compliance Tests of the Envirotech Hooded Quench Car No. 106 Operated on the Number 7, 8 and 9 Batteries Located at the United States Steel Clairton Works*, Project No. 50.74, Clairton, PA, October 28, 1985.

22. *United States Steel Corporation Clairton Coke and Coal Chemical Works, Results of the Compliance Demonstration of the Pushing Emissions Control for B-Battery,* Project No. 601000-15, Monroeville, PA, April 1990.

23. *Non-Recovery Coke Oven Waste Heat and Air Pollution Characterization, Revision 1.0*, IT 406000.12, International Technology Corporation, Knoxville, TN, January 1991.

24. *Testing Non-Recovery Coke Ovens for Standards Development*, Final Report, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1992.

25. *Engineering Evaluation of the Charging Machine Hood System*, IT 406258.17, International Draft EIS Technology Corporation, Knoxville, TN, December 1992.

26. *Benzene Emissions from Coke Byproduct Recovery Plants - Background Information for Proposed Standards, Draft EIS*, EPA-450/3-83-016a, U. S. Environmental Protection Agency, Research Triangle Park, NC, May 1984.

27. *Benzene Emissions from Coke Byproduct Recovery Plants - Background Information for Revised Proposed Standards, Draft EIS,* EPA-4/4503-83-016b, U. S. Environmental Protection Agency, Research Triangle Park, NC June 1988.

28. *Benzene Emission from Coke Byproduct Recovery Plants, Benzene Storage Vessels, Equipment Leaks, and Ethylbenzene /Styrene Process Vents - Background Information and Responses to Technical Comments for 1989 Final Decisions. Final EIS,* EPA-450/3-89-31, U. S. Environmental Protection Agency, Research Triangle Park, NC, 1989.

29. *Benzene Coke Oven Byproduct Plants Emission Test Report--Bethlehem Steel, Bethlehem, Pennsylvania.* EMB Report 80-BY-1, U. S. Environmental Protection Agency, Research Triangle Park, NC, March 1981.

30. *Benzene Coke Oven Byproduct Plants--Emission Test Report--Bethlehem Steel Corporation, Burns Harbor, Indiana.* EMB Report 80-BYC-5, U. S. Environmental Protection Agency, Research Triangle Park, NC, March 1981.

31. *Benzene Coke Oven Byproduct Plants Emission Test Report--Wheeling-Pittsburgh Steel Corporation, Monessen, Pennsylvania.* EMB Report 80-BYC-3, U. S. Environmental Protection Agency, Research Triangle Park, NC, March 1981.

32. *Benzene Coke Oven Byproduct Plants Emission Test Report--U.S. Steel, Fairless Hills, Pennsylvania.* EMB Report 80-BYC-8, U. S. Environmental Protection Agency, Research Triangle Park, NC, March 1981.

33. *Benzene Coke Oven Byproduct Plants Emission Test Report--CF&I Steel Corporation, Pueblo, Colorado.* EMB Report 80-BYC-6. U. S. Environmental Protection Agency, Research Triangle Park, NC, March 1981.

34. *Benzene Coke Oven Byproduct Plants Emission Test Report--Republic Steel Corporation, Gadsden, Alabama.* EMB Report 80-BYC-4, U. S. Environmental Protection Agency, Research Triangle Park, NC, March 1981.

35. *Benzene Coke Oven Byproduct Plants Emission Test Report--United States Steel Corporation, Clairton, Pennsylvania.* EMB Report 80-BYC-2, U. S. Environmental Protection Agency, Research Triangle Park, NC, March 1981.

36. *Environmental Assessment of Coke Byproduct Recovery Plants.* EPA-600/2-79-016, U. S. Environmental Protection Agency, Research Triangle Park, NC, January 1979.

37. *Benzene Fugitive Leaks Coke Oven Byproduct Plants, Leak Frequency and Emission Factors for Fittings In Coke Oven Byproduct Plants,* EMB Report 81-BYC-12, U. S. Environmental Protection Agency, Research Triangle Park, NC, January 1982.

38. *Keystone Environmental Resources, Inc., Development and Evaluation of Emission Factors for Byproduct Plant Processes in Coke Plants,* Project No. 374400, Monroeville, PA, May 1990.

39. *Draft Final Phase II Method Validation Report for Quantitative Coke Oven Door Leak Measurement Study,* ENSR Consulting and Engineering, for American Iron and Steel Institute, Washington, DC. January 1992.

40. *Emission Evaluation of the "A" Battery Push Emission Scrubber, Bethlehem Steel Corporation, Bethlehem, PA,* BCM Eastern Inc., Plymouth Meeting, PA, November 1987.

41. *Particulate Emission Determination of the Coke Battery "A"Scrubber Stack, Bethlehem Steel Corporation, Bethlehem, PA*, BCM Engineers, Planners, and Scientists, Plymouth Meeting, PA, January 1989.

42. *Compliance Particulate Emission Determination of the Coke Battery "A"Scrubber Stack, Bethlehem Steel Corporation, Bethlehem, PA*, BCM Engineers, Planners, and Scientists, Plymouth Meeting, PA, October 1990.

43. *Particulate Evaluation of Coke Battery "A"Scrubber Stack, Bethlehem Steel Corporation, Bethlehem, PA*, BCM Engineers Inc., Pittsburgh , PA, September 1991.

44. *Particulate Emission Evaluation "A" Battery Scrubber Stack, Bethlehem Steel Corporation, Bethlehem, PA*, BCM Engineers, Planners, Scientist and Laboratory Services, Pittsburgh , PA, December 1992.

45. *Rouge Steel Company, "C" Coke Oven Combustion Stack Particulate Compliance Survey*, Ford Motor Company Stationary Source Environmental Control Office, Michigan, July 1, 1986.

46. *Rouge Steel Company, "C" Coke Oven Pushing Shed Baghouse Particulate Compliance Survey*, Ford Motor Company Stationary Source Environmental Control Office, Michigan, July 8-10, 1986.

47. *Rouge Steel Company, "C" Coke Oven Pushing Shed Baghouse Particulate Compliance Survey*, Ford Motor Company Stationary Source Environmental Control Office, Michigan, March 25-27, 1986.

48. *Rouge Steel Company, No. 1 Push Control System "A" and "Ax" Coke Oven Batteries Particulate Emission Survey*, Ford Motor Company Stationary Source Environmental Control Office, Michigan, August 20-22, 1985.

49. *Results of Particulate and SO_2 Stack Emission Tests During a 48 Hour Coking Cycle (#3-C Coke Battery)*, Prepared for Jewell Coal and Coke Company, Vansant, VA, IT Air Quality Services, Knoxville, TN, May 8, 1991.

50. *Particulate Emissions Compliance Testing #1 and 2 Incinerator Outlet Stacks, Mountaineer Carbon Company, Moundsville, West Virginia*, Entropy Environmentalist Inc., Research Triangle Park, NC, September 1984.

51. *Particulate Emissions Compliance Testing #1 and 2 Incinerator Outlet Stacks, Mountaineer Carbon Company, Moundsville, West Virginia*, Entropy Environmentalist Inc., Research Triangle Park, NC, December 1984.

52. *Particulate Evaluation of Coke Oven Battery No. 1 Combustion Stack at Shenango Incorporated, Neville Island Plant, Pittsburgh, PA*, BCM Engineers, Inc., Pittsburgh, PA, October 10, 1989.

53. *Particulate Evaluation of Coke Oven Battery No. 1 Combustion Stack at Shenango Incorporated, Neville Island Plant, Pittsburgh, PA*, BCM Engineers, Inc., Pittsburgh, PA, December 18, 1989.

54. *Particulate Evaluation of Coke Oven Battery No. 4 Combustion Stack at Shenango Incorporated, Neville Island Plant, Pittsburgh, PA*, BCM Engineers, Inc., Pittsburgh, PA, December 27, 1984.

55. *Compliance Tests of the Envirotech Hooded Quench Car No. 102 Operated on the Number 7, 8, and 9 Coke Batteries Located at the United States Steel Clairton Works*, Air Pollution Technology, Inc., San Diego, CA, October 28, 1985.

56. *Compliance Demonstration of the #14 Battery Combustion Stack, USS Clairton Works, Clairton, PA*, Keystone Environmental Resources, Inc., Monroeville, PA, November 1990.

57. *Compliance Demonstration #13 Battery Combustion Stack, USS Clairton Works, Clairton, PA*, Keystone Environmental Resources, Inc., Monroeville, PA, September 1990.

58. *Compliance Demonstration No. 7 Battery Combustion Stack, USS Clairton Works, Clairton, PA*, Keystone Environmental Resources, Inc., Monroeville, PA, September 1990.

59. *Compliance Demonstration No.19 Battery Combustion Stack, USS Clairton Works, Clairton, PA*, Keystone Environmental Resources, Inc., Monroeville, PA, January 1991.

60. *Compliance Demonstration #1 Battery Combustion Stack, USS Clairton Works, Clairton, PA*, Keystone Environmental Resources, Inc., Monroeville, PA, February 1992.

61. *Compliance Demonstration #13 Battery Combustion Stack, USS Clairton Works, Clairton, PA*, Keystone Environmental Resources, Inc., Monroeville, PA, April 1992.

62. *Compliance Demonstration #14 Battery Combustion Stack, USS Clairton Works, Clairton, PA*, Keystone Environmental Resources, Inc., Monroeville, PA, May 1992.

63. *Compliance Demonstration B Battery Combustion Stack, USS Clairton Works, Clairton, PA*, Keystone Environmental Resources, Inc., Monroeville, PA, August 1992.

64. *Compliance Demonstration #19 Battery Combustion Stack, USS Clairton Works, Clairton, PA*, Keystone Environmental Resources, Inc., Monroeville, PA, August 1992.

65. *Compliance Demonstration # 9 Battery Combustion Stack, USS Clairton Works, Clairton, PA*, Keystone Environmental Resources, Inc., Monroeville, PA, November 1992.

66. *Compliance Demonstration 1, 2, and 3 Battery Pushing Emission Control, USS Clairton Works, Clairton, PA*, Chester Environmental, Monroeville, PA, February 1993.

67. *Compliance Demonstration Battery B Baghouse, USS Clairton Works, Clairton, PA*, Chester Environmental, Monroeville, PA, December 1993.

68. *Compliance Demonstration, #7 Battery Combustion Stack, USS Clairton Works, Clairton, PA*, Chester Environmental, Monroeville, PA, January 1993.

69. *Compliance Demonstration No. 7, 8, and 9 Battery Pushing Emission Control, USS Clairton Works, Clairton, PA*, Chester Environmental, Monroeville, PA, February 1993.

70. *Compliance Demonstration #3 Battery Combustion Stack, USS Clairton Works, Clairton, PA*, Chester Environmental, Monroeville, PA, September 1993.

71. *Compliance Demonstration No. 2 Battery Combustion Stack, USS Clairton Works, Clairton, PA*, Chester Environmental, Monroeville, PA, October 1993.

72. *Compliance Demonstration 19 and 20 Battery Pushing Emission Control, USS Clairton Works, Clairton, PA*, Chester Environmental, Monroeville, PA, February 1993.

73. *Compliance Demonstration No. 13, 14, and 15 Battery Pushing Emission Control, USS Clairton Works, Clairton, PA*, Chester Environmental, Monroeville, PA, December 1993.

74. *Compliance Demonstration No. 1, 2, and 3 Battery Pushing Emission Control, USS Clairton Works, Clairton, PA*, Chester Environmental, Monroeville, PA, April 1994.

75. *Compliance Demonstration No. 7, 8, and 9 Battery Pushing Emission Control, USS Clairton Works, Clairton, PA*, Chester Environmental, Monroeville, PA, April 1994.

76. *Compliance Demonstration No. 7 Battery Combustion Stack, USS Clairton Works, Clairton, PA*, Chester Environmental, Monroeville, PA, June 1994.

77. *Compliance Demonstration No. 9 Battery Combustion Stack, USS Clairton Works, Clairton, PA*, Chester Environmental, Monroeville, PA, June 1994.

78. *Compliance Demonstration No. 13 Battery Combustion Stack, USS Clairton Works, Clairton, PA*, Advance Technology Systems, Inc., Monroeville, PA, August 1994.

79. *Compliance Demonstration, No. 14 Battery Combustion Stack, USS Clairton Works, Clairton, PA*, Chester Environmental, Monroeville, PA, September 1994.

80. *Compliance Demonstration No.19 Battery Combustion Stack, USS Clairton Works, Clairton, PA*, Advanced Technology Systems, Inc., Monroeville, PA, September 1994.

81. *Compliance Demonstration No.20 Battery Combustion Stack, USS Clairton Works, Clairton, PA*, Advanced Technology Systems, Inc., Monroeville, PA, October 1994.

82. *Compliance Demonstration of the #3 Battery Combustion Stack, USS Clairton Works, Clairton, PA*, Keystone Environmental Resources, Inc., Monroeville, PA, September 1990.

83. *Compliance Demonstration, No. 1 Battery Combustion Stack, USS Clairton Works, Clairton, PA*, Chester Environmental, Monroeville, PA, November 1993.

84. *Iron and Steel (Coke Oven Battery Stack), Emission Test Report--Kaiser Steel Corporation, Fontana, California*, EMB Report 80-CKO-25, U. S. Environmental Protection Agency, Research Triangle Park, NC, August 1980.

85. *Report on Source Tests, Visible Emissions, and Plant Observations, Kaiser Steel Corporation, Fontana, California, Coke Oven Battery E, February 12-13, 1979*, Engineering-Science, Arcadia, California, April 1979.

86. *Report on Source Tests, Visible Emissions, and Plant Observations, Kaiser Steel Corporation, Fontana, California, Coke Oven Battery C, March 26-27, 1979*, Engineering-Science, Arcadia, California, May 1979.

87. *Report on Source Tests, Visible Emissions, and Plant Observations, Kaiser Steel Corporation, Fontana, California, Coke Oven Battery B, July 26-27, 1979*, Engineering-Science, Arcadia, California, August 1979.

88. *Report on Source Tests, Visible Emissions, and Plant Observations, Kaiser Steel Corporation, Fontana, California, Coke Oven Battery D, July 26-27, 1979*, Engineering-Science, Arcadia, California, January 1979.

89. *Iron and Steel (Coke Oven Battery Stack), Emission Test Report--Kaiser Steel Corporation, Fontana, California*, EMB Report 80-CKO-14, U. S. Environmental Protection Agency, Research Triangle Park, NC, July 1979.

90. *Emission Evaluation of Pusher Coke Oven Baghouse for Keystone Coke Company, Conshohocken, Pennsylvania*, Betz, Converse, Murdoch, Inc., Plymouth Meeting, Pennsylvania, February 1980.

91. *Rouge Steel Company, Coke Ovens Combustion Stack B Particulate and Opacity Survey*, Ford Motor Company Stationary Source Environmental Control Office, Michigan, November 29-December [illegible], 1982.

92. *Proposal to Republic Steel Corporation for a Source Emission Testing of the Envirotech/Chemico Enclosed Quench Car system at the Warren Mill of Republic Steel Corporation*, Betz, Converse, Murdoch, Inc., Plymouth Meeting, PA, January 29, 1981.

93. *Republic Steel Corporation, Warren, Ohio, Particulate Emission Evaluation of the No. 1 Envirotech/Chemico One Spot Quench Car at the Coke Oven Battery*, Betz, Converse, Murdoch, Inc., Pittsburgh, PA, January 1982.

94. *Republic Steel Corporation, Warren, Ohio, Particulate Emission Evaluation of the No. 2 Envirotech/Chemico One Spot Quench Car at the Coke Oven Battery*, Betz, Converse, Murdoch, Inc., Pittsburgh, PA, January 1982.

95. *Particulate Emission Evaluation of the Envirotech/Chemico One Spot Quench Car at the Coke Oven Batteries of Republic Steel Corporation Youngstown Works, Youngstown, Ohio*, Betz, Converse, Murdoch, Inc., Pittsburgh, PA, January 1982.

96. *Republic Steel Corporation, Cleveland, Ohio, Particulate Emission Evaluation, Envirotech/Chemico No. 21 One Spot Quench Car at the Coke Oven Battery*, Betz, Converse, Murdoch, Inc., Plymouth Meeting, PA, June 1981.

97. *Republic Steel Corporation, Cleveland, Ohio, Particulate Emission Evaluation, Envirotech/Chemico No. 22 One Spot Quench Car at the Coke Oven Battery*, Betz, Converse, Murdoch, Inc., Plymouth Meeting, PA, June 1981.

98. *Coke Battery Stack Sulfate Emissions, Emission Test Report--Republic Steel, Cleveland Works, Cleveland, Ohio*, EMB Report 81-CBS-1, U. S. Environmental Protection Agency, Research Triangle Park, NC, November and December 1981.

99. *Particulate Matter Emission Tests for No. 1 Coke Battery Combustion Stack at Republic Steel, Cleveland, Ohio*, Acurex Corporation, Mountain View, CA, May 1980.

100. *Compliance Tests of the Envirotech Hooded Quench Car No. 101 Operated on the Number 7, 8, and 9 Coke Batteries Located at the United States Steel Clairton Works*, Air Pollution Technology, Inc., San Diego, CA, October 28, 1985.

101. *Compliance Tests of the Envirotech Hooded Quench Car No. 105 Operated on the Number 19 Coke Battery Located at the United States Steel Clairton Works*, Air Pollution Technology, Inc., San Diego, CA, October 2, 1985.

102. *Compliance Tests of the Envirotech Hooded Quench Car No. 101 Operated on the Number 7, 8, and 9 Coke Batteries Located at the United States Steel Clairton Works*, Air Pollution Technology, Inc., San Diego, CA, October 28, 1985.

103. *Compliance Tests of the Envirotech Hooded Quench Car No. 107 Operated on the Number 20 Coke Battery Located at the United States Steel Clairton Works*, Air Pollution Technology, Inc., San Diego, CA, October 2, 1985.

104. Written communication from R. A. Weiland, U. S. Steel Corporation, to U. S. Environmental Protection Agency, Region III, Philadelphia, PA, October 21, 1985.

105. Written communication from J. Hawthorne, U. S. Steel Corporation, Monroeville, PA, to J. D. Graham, Allegheny County Health Department, Pittsburgh, PA, March 20, 1985.

106. Audit and Review Report on Particulate Emissions Testing at United States Steel Company's Coke Plant Combustion Stack Number 2 in Orem, Utah, Prepared for U. S. Environmental Protection Agency, Region VIII, by TRC Environmental Consultants, Inc., Englewood, CO, June 16, 1982.

107. *Particulate Compliance Testing, Coker Unit #3, U. S. Steel - Geneva, February, 1980*, Energy and Environmental Measurement Corporation, Billings, Montana, March 23, 1981.

108. *Particulate Matter Compliance Tests Conducted at USS Geneva Works Coke Plant, No. 2 Combustion Stack*, Timp Environmental Testing Company, American Fork, Utah, January 14, 1983.

109. *Particulate Matter Compliance Tests Conducted at U. S. Steel Geneva Plant, Coke Plant Combustion Stack 4, May 18-20, 1982*, Timp Environmental Testing Company, American Fork, Utah, July 7, 1982.

110. *Particulate Matter Compliance Tests Conducted at U. S. Steel Geneva Works, Coke Pushing Baghouse System, October 19-20, 1982*, Timp Environmental Testing Company, American Fork, Utah, October 29, 1982.

111. *Particulate Matter Compliance Tests Conducted at U. S. Steel Geneva Works, Coke Pushing Baghouse System, December 28-29, 1982*, Timp Environmental Testing Company, American Fork, Utah, January 10, 1983.

112. *Mass Emission Tests Conducted on the Baghouse for the #9 Battery in Birmingham, Alabama for U. S. Steel on August 18-21, 1980*, Guardian Systems, Inc., Birmingham, Alabama, August 1980.

113. *Particulate Emission Measurement on #2 Coke Oven Battery at United States Steel Corporation, Fairfield, Alabama*, CH2M Hill, Montgomery, Alabama, March 1979.

114. *Stack Test - Battery No. 3, U. S. Steel, Fairfield, Alabama*, U. S. Steel Corporation, Fairfield, Alabama, August 1975.

115. *Particulate Emission Measurement on #2 Coke Oven Battery at United States Steel Corporation, Fairfield, Alabama*, CH2M Hill, Montgomery, Alabama, October 1979.

115a. *Particulate Emission Measurement on #2 Coke Oven Battery at United States Steel Corporation, Fairfield, Alabama*, CH2M Hill, Montgomery, Alabama, January 1979.

116. Testing Conducted at Bethlehem Steel Corporation, Johnstown, PA, December 3, 1975.

117. *Report on Emission Test, #18 Coke Oven Battery Combustion Stack, Franklin Coke Plant*, Bethlehem Steel Corporation, Johnstown, Pennsylvania, September 28, 1978.

118. *Report on Emission Tests, #18 Coke Oven Battery Combustion Stack, Franklin Coke Plant*, Bethlehem Steel Corporation, Johnstown, Pennsylvania, August 15, 1978.

119. *Particulate Emission Evaluation of the Envirotech/Chemico One Spot Quench Car System at the No. 5 Coke Oven Battery of Bethlehem Steel Corporation*, Betz, Converse, Murdoch, Inc., Pittsburgh, PA, March 1979.

120. Written communication from R. A. Washburn, Allied Chemical Corporation, Ashland, KY, to W. S. Coakley, Kentucky Bureau of Environmental Quality, Frankfort, KY, December 15, 1980.

121. *Stationary Source Sampling Report, Armco, Inc., Middletown, Ohio, Particulate Emissions Compliance Testing, Pushing Process Baghouse Outlet, #2 Coke Battery*, Entropy Environmentalists, Research Triangle Park, North Carolina, December 1982.

122. *Determination of Atmospheric Emissions During Coke Oven Battery Pushing for Inland Steel Coke Plant 2, Battery 9, Calderon Experiment, Coke Quench in the Guide*, Inland Steel Corporation, East Chicago, IN, March 29, 1977.

123. *Plant No. 2 Coke Plant, No. 10 Battery - Waste Heat Stack, Particulate Sampling, Inland Steel Company, East Chicago, Indiana*, The Almega Corporation, Bensenville, Illinois, October 18, 1984.

124. *No. 2 Coke Side Emissions Control Gas Cleaning Car Scrubber Stack Exhaust, Particulate Emissions Testing, Inland Steel Company, East Chicago, Indiana*, The Almega Corporation, Bensenville, Illinois, April 25, 1980.

125. *No. 11 Battery: Coke Side Emission Control System Scrubber Exhaust, Particulate Emission Test, Inland Steel Company, East Chicago, Indiana*, The Almega Corporation, Bensenville, Illinois, April 25, 1979.

126. *No. 3 Coke Side Emissions Control Gas Cleaning Car Scrubber Stack Exhaust, Particulate Emissions Testing, Inland Steel Company, East Chicago, Indiana*, The Almega Corporation, Bensenville, Illinois, December 1980.

127. *Plant 2: No. 4 Coke Car, Particulate and Visible Emissions Testing, Inland Steel Company, East Chicago, Indiana*, The Almega Corporation, Bensenville, Illinois, June 1985.

128. *No. 2 Coke Side Emissions Control Gas Cleaning Car Scrubber Stack Exhaust, Particulate Emissions Testing, Inland Steel Company, East Chicago, Indiana*, The Almega Corporation, Bensenville, Illinois, August 1980.

129. *Donner-Hanna PECT System*, Donner-Hanna Coke Corporation, Buffalo, New York, September 23, 1976.

130. *Emission Testing of North and South Coke Plant Cleaning Cars, Final Report, CF & I Steel Corporation, Pueblo, Colorado*, The Almega Corporation, Bensenville, Illinois, April 15, 1980.

131. *Final Audit Report of Compliance Testing at CF&I Coke Plant Pushing Operations in Pueblo, Colorado*, TRC Environmental Consultants, Inc., Englewood, Colorado, July 17, 1980.

132. *Final Observation Report of Compliance Testing at CF&I Coke Plant Pushing Operations in Pueblo, Colorado,* TRC Environmental Consultants, Inc., Englewood, Colorado, July 16, 1980.

133. Unpublished Test Results from Carpentertown Coal and Coke Co., Boggs Township, PA, October 17, 1973.

134. Written communication Michael Maillard, Wayne County (MI) Enforcement Section, to Enforcement Section Files, Wayne County (Michigan) Air Pollution Control Agency, December 20, 1979.

135. *Source Test Conducted on Coke Batteries Push Control System Baghouse at Chattanooga Coke and Chemicals Company, Inc.*, Resource Consultants, Inc., Brentwood, Tennessee, November 17-19, 1980

136. *Ontario Ministry of the Environment in Conjunction with Dominion Foundries and Steel, Limited, Hamilton, Ontario, PAH Source Emission Study, Coke Oven Pushing Fume Collection System*, Envirocon Limited, Willowdale, Ontario, Canada, March 1977.

137. *Determination of Emissions from the Coke Pushing Control System for Dominion Foundries and Steel Limited, Hamilton, Ontario*, Ontario Research Foundation, Mississauga, Ontario, Canada, February 8, 1979.

138. *Emission Testing and Evaluation of Ford/Koppers Coke Pushing Control System. Volume I. Final Report*, EPA-600/2-77-187a, Industrial Environmental Research Lab, Research Triangle Park, NC, September 1977.

139. *Emission Testing and Evaluation of Ford/Koppers Coke Pushing Control System. Volume II. Appendices*, EPA-600/2-77-187b, Industrial Environmental Research Lab, Research Triangle Park, NC, September 1977.

140. *Coke Quench Tower Emission Testing Program*, EPA-600/2-79-082, U. S. Environmental Protection Agency, Research Triangle Park, North Carolina, April 1979.

141. *Evaluation of Quench Tower Emissions, Parts I and II*, prepared for U. S. Environmental Protection Agency, Washington, D. C., 1976.

142. Jacko, R. B., *et al*, *Plume Parameters and Particulate Emissions from the By-Product Coke Oven Pushing Operation*, Presented at the 71st Annual Meeting of APCA, June 1978.

143. *Particulate Emission Measurement, West Pushing Emission Control, Baghouse Stack, U. S. Steel Corporation - Gary Works*, U. S. Steel Corporation, Gary, Indiana, May 1983.

144. *Gary Works, No. 3 Coke Battery Mobile Pushing Emission Control System, Particulate Emission Measurement*, U. S. Steel Corporation, Gary, Indiana, September 24, 1982.

145. *Observation of Particulate Testing and Process Operations During U. S. Steel Scrubber Car Demonstration, Coke Oven Battery No. 3, U. S. Steel Corporation, Gary Works, Gary, Indiana*, Acurex Corporation, Hickory Hills, Illinois, September 1982.

146. *No. 2 Pushing Emissions Control, No. 2 Coke Plant Stack Test*, Great Lakes Steel, River Rouge, Michigan, November 1979.

147. *Particulate Emissions Testing, No. 2 Coke Side Emissions Control, Gas Cleaning Car Scrubber Stack Exhaust, Coke Battery "A," Granite City Steel*, The Almega Corporation, Bensenville, Illinois, December 30, 1980.

148. *Report of Official Air Pollution Tests Conducted on the Coke Oven "Hot Car" Baghouse Air Pollution Control System at the Philadelphia Coke Co., Inc., in Philadelphia, PA, on January 8, 9, 12, 13, & 14, 1981*, Rossnagel & Associates, Medford, New Jersey, February 4, 1981.

149. *Report on the Particulate Emission Tests Conducted for Wheeling Pittsburgh Steel at Their Monessen Plant Coke Ovens*, Clean Air Engineering, Inc., Morgan, PA, August 26, 1981.

150. *Report on the Particulate Emissions Testing with Visible Emission Readings Conducted for the Wheeling Pittsburgh Steel Corporation at Their Monessen Work's Coke Oven Baghouse*, Clean Air Engineering, Inc., Morgan, PA, April 5, 1984.

151. *Compliance Evaluation of Particulate Emissions from the Coke Works Boiler Baghouse Outlet Stack at Wheeling Pittsburgh Steel Corporation, Steubenville East Coke Plant, Follansbee, West Virginia*, Betz, Converse, Murdoch, Inc., Pittsburgh, Pennsylvania, January 1981.

152. *Stationary Source Sampling Report, Weirton Steel, Weirton, West Virginia, Particulate Emissions Testing, Coke Quench Tower Stack-Battery #8*, Entropy Environmentalists, Research Triangle Park, North Carolina, September 1980.

153. *Report on Compliance Testing Preformed at Koppers Industries, Inc., Dolomite, Alabama, CAE Project No: 5238*, Clean Air Engineering, Palatine, Illinois, December 13, 1990.

154. *Hydrocarbon and Particulate Emissions Test Report for Koppers Industries, Dolomite, Alabama, Coke Battery*, Sanders Engineering & Analytical Services, Inc., Mobile, Alabama, September 26, 1991.

155. *Mass Emission Tests Conducted on the Coke Battery Positive Pushing Control System in Birmingham, Alabama, for Jim Walter Resources on November 6-7, 1984*, Guardian Systems, Inc., Birmingham, Alabama, November 6-7, 1984.

156. *Flue Gas Characterization Studies Conducted on the #3 & #4 Underfire Stack In Birmingham, Alabama, for Sloss Industries on May 16, 1995*, Guardian Systems, Inc., Birmingham, Alabama, May 16, 1995.

157. *Emission Testing, Koppers Industries--Woodward Coke Plant, Dolomite, Alabama, Entec Project No.: 96-1002*, Entec Services, Inc., Hueytown, Alabama, February 12, 1996.

158. *Particulate Emission Tests on Stack #4 at Alabama By-Products Company, March 9, 1981, Conducted in Tarrant City, Alabama*, Guardian Systems, Inc., Birmingham, Alabama, March 9, 1981.

159. *Oxides of Nitrogen, Sulfur Dioxide, and Particulate Emissions Test Report for Koppers Industries, Dolomite, Alabama, Coke Battery*, Sanders Engineering & Analytical Services, Inc., Mobile, Alabama, August 21, 1991.

160. *Particulate Emission Tests on Stack #1-A at Alabama By-Product Company, March 5, 1981, Conducted in Tarrant City, Alabama*, Guardian Systems, Inc., Birmingham, Alabama, March 5, 1981.

161. *Mass Emission Tests Conducted on Coke Battery #1 Positive Pushing Control System in Tarrant, Alabama, for Alabama By-Products Corporation on September 9-11, 1985*, Guardian Systems, Inc., Birmingham, Alabama, September 9-11, 1985.

162. *Report on Coke Quench Car Compliance Demonstration, Erie Coke Corporation, Erie, Pennsylvania*, Chester Environmental, Monroeville, PA, April 1994.

163. *Report on Compliance Demonstration, Coke Quench Car Exhaust Stack, Erie Coke Corporation, Erie, Pennsylvania*, Advanced Technology Systems, Monroeville, PA, May 1995.

164. *Report on Measurement of Particulate Matter Emissions from a Coke Quench Car Scrubber Exhaust Duct, Compliance Demonstration-August 7 & 8, 1996, Erie Coke Corporation, Erie, Pennsylvania*, Advanced Technology Systems, Monroeville, PA, September 1996.

165. *Mass Emission Tests Conducted on Coke Battery #1 Positive Pushing Control System in Tarrant, Alabama, for Alabama By-Products Corporation on July 9-11, 1985,* Guardian Systems, Inc., Birmingham, Alabama, July 9-11, 1985.

166. *Emissions Testing of Various Sources at Inland Steel Company, Plant #2, January 22 - February 7, 1990, East Chicago, Indiana*, The Almega Corporation, Bensenville, IL, March 27, 1990.

167. *Coke Battery and Boiler Stacks, Emission Test Results, LTV Steel Company By-Products Plant, Pittsburgh, Pennsylvania*, Chester Environmental, Monroeville, PA, February 1994.

168. *Bethenergy, Lackawanna Coke Division Compliance Test Program, Baghouse Exhaust Stack*, Keystone Environmental Resources, Inc., Monroeville, PA, August 1991.

169. *Particulate Emission Evaluation of the No. 1 Coke Oven Battery Combustion Stack at Shenango Incorporated, Neville Island Plant, Pittsburgh, PA*, BCM Engineers, Inc., Pittsburgh, PA, September 24, 1993.

170. *Final Report, Emission Evaluation of Batteries 1B and 2 Pushing Emissions Control System, Battery 1B Combustion Stack, Battery 2 Combustion Stack, Koppers Industries Monessen Coke Plant, Monessen, Pennsylvania*, Optimal Technologies, Pittsburgh, PA, December 6, 1996.

171. *Particulate Evaluation of Battery No. 1 Coke Push Shed Particulate Emission Control System at Shenango Incorporated, Neville Island Plant, Pittsburgh, PA*, BCM Eastern, Inc., Pittsburgh, PA, February 2, 1988.

172. *Report to Bethlehem Steel Corporation, Bethlehem, Pennsylvania, for Compliance Particulate Emission Determination of the Coal Crusher Rotoclone and Coke Screening Stacks*, BCM Engineers, Inc., Pittsburgh, PA, January 1992.

173. Written Communication from J. P. Shimshock, Advanced Technology Systems, Inc., Monroeville, PA, to C. M. Hart, USS Clairton Works, Clairton, PA, March 22, 1995.

174. Written Communication from J. P. Shimshock, Advanced Technology Systems, Inc., Monroeville, PA, to C. M. Hart, USS Clairton Works, Clairton, PA, December 20, 1995.

175. Written Communication from J. P. Shimshock, Advanced Technology Systems, Inc., Monroeville, PA, to C. M. Hart, USS Clairton Works, Clairton, PA, May 24, 1996.

176. *Erie Coke Corporation, Erie Pennsylvania, Report on Measurement of Particulate Matter, Volatile Organic Compound and Nitrogen Oxide Emissions from the Coke Battery Combustion Stack, Diagnostic Test Program - August 8, 1996,* Advanced Technology Systems, Inc, Monroeville, Pennsylvania, October 1996.

177. *Mass Emission Tests Conducted on Coke Battery #'s 5 & 6 Positive Pushing Control System in Tarrant, Alabama, for Alabama By-Products Corporation on August 9, 1985*, Guardian Systems, Inc., Birmingham, Alabama, August 9, 1985.

178. Written communication from B. K. Pease, Fuels and Combustion Consultant, Allentown, Pennsylvania, to T. E. Kreichelt, Bethlehem Steel Corporation, Bethlehem, Pennsylvania, June 9, 1993.

179. Written communication from J. P. Shimshock, Chester Environmental, Monroeville, Pennsylvania, to M. Lalley, Bethlehem Steel Corporation, Lackawanna, New York, May 7, 1994.

180. Pease, B. K., *Emission Inventory Report, Bethlehem Steel Corporation Burns Harbor Division*, March 30, 1994.

181. *Sampling and Analysis of Coke-Oven Door Emissions*, EPA-600/2-77-213, U. S. Environmental Protection Agency, Washington, DC, October 1977.

182. Hartman, M. W. *Source Test at U.S. Steel Clairton Coke Oven, Clairton Pennsylvania*. TRW Environmental Engineering Division. EMB 78-CKO-13, U. S. Environmental Protection Agency, Research Triangle Park, NC, July 1980.

183. Electronic mail from Ailor, David, American Coal and Coke Chemicals Institute, Washington D.C. to Branscome, Marvin, Research Triangle Institute, Research Triangle Park, NC. Transmitting information on Coke Oven Emissions Task Force's 7-PAH estimates. September 22, 2000.

184. Wiesenborn, D. P., Steinmetz, J. I., Harris, G. E. *Emission Test Report, Fugitive Emissions Testing at the Republic Steel Gasden Plant*. Radian Corporation. EMB 80-BYC-10, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1981.

185. Wiesenborn, D. P., Steinmetz, J. I., Harris, G. E. *Emission Test Report, Fugitive Emissions Testing at the Bethlehem Steel Bethlehem Plant*. Radian Corporation. EMB 80-BYC-9, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1981.

186. Wiesenborn, D. P., Steinmetz, J. I., Harris, G. E. *Emission Test Report, Fugitive Emissions Testing at the Wheeling-Pittsburgh Steel Monessen Plant*. Radian Corporation. EMB 80-BYC-11, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1981.

187. *Headspace Benzene Concentration Over Liquid Samples from Coke By-Product Plants*. Scott Environmental Services. EMB 80-BYC-13, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1981.

188. Webster, Mack L., *Coke Oven Emission Testing, Bethlehem Steel Corporation Sparrows Point Maryland*. TRW Environmental Engineering Division. EMB 79-CKO-15, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1979.

189. *Emission Testing at a By-Product Coke Plant (Battery D Stack), C. F. & I. Steel Corporation Pueblo Colorado*. Clayton Environmental Consultants, Inc. EMB 79-CKO-16, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1979.

190. *By-Product Coke Plant, Battery P4, Jones and Laughlin Steel Corporation Pittsburgh Pennsylvania*. Clayton Environmental Consultants, Inc. EMB 79-CKO-17, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1979.

191. *By-Product Coke Plant, Granite City Steel, Division of National Steel, Granite City, Illinois.* Clayton Environmental Consultants, Inc. EMB 79-CKO-18, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1979.

192. *Emissions Testing of Combustion Stack and Pushing Operations at Coke battery No. 2 at Bethlehem Steel Corporation's Burns Harbor Division in Chesterton, Indiana.* Pacific Environmental Services, Inc. EPA 454/R-99-001a, EPA 454/R-99-001b & EPA 454/R-99-001c U. S. Environmental Protection Agency, Research Triangle Park, NC, February 1999.

193. *Emissions Testing of Combustion Stack and Pushing Operations at Coke battery No. 5/6 at ABC Coke in Birmingham, Alabama.* Pacific Environmental Services, Inc. EPA 454/R-99-002a, EPA 454/R-99-002b & EPA 454/R-99-002c U. S. Environmental Protection Agency, Research Triangle Park, NC, February 1999.

194. *National Emission Standard for Hazardous Air Pollutants (NESHAP) for Coke Ovens: Pushing, Quenching, and Battery Stacks - Background Information for Proposed Standards.* Research Triangle Institute. EPA 453/R-01-006, U. S. Environmental Protection Agency, Research Triangle Park, NC, February 2001.

195. Memorandum from J. H. Gross, Director - Research United States Steel Corporation to Mr. R. L Wells, General Superintendent, Clairton Works, Subject: Emission Tests on No. 11 Battery Combustion Stack at Clairton Works 18-D-504 (003). March 10, 1978

196. Test No. 1978 conducted at Jones & Laughlin Steel Corp. Aliquippa, PA, Commonwealth of Pennsylvania, Department of Environmental Resources, Bereau of Air Quality and Noise Control. June 7, 1978.

197. *Particulate Emission Evaluation for Keystone Coke Company of Conshocken, Pennsylvania,* Betz-Converse-Murdoch Inc., July 24 - 26, 1979.

198. *Particulate Emission Evaluation for Keystone Coke Company of Conshocken, Pennsylvania,* Betz-Converse-Murdoch Inc., July 5 - 6, 1978.

199. *Emission Testing for U. S. Steel Gary, Indiana*, Kemron Environmental Services, February [illegible], 1980.

200. *Report on Source Tests, Visible Emissions, and Plant Observations, Kaiser Steel Corporation, Fontana, California, Coke Oven Batteries F and G,* Engineering Science, February 1980.

201. *Emission Testing of No. 3 Battery Stack for U. S. Steel Gary, Indiana*, Kemron Environmental Services, March 19, 1980.

202. *Emission Testing of Nol 1 Battery Stack for U. S. Steel Gary, Indiana*, Kemron Environmental Services, March 19, 1980.

203. *Particulate Testing P4 Combustion Stack, J & L Steel Corporation, Pittsburgh Works, April 16 and 17, 1980,* WFI Sciences Company, May 16, 1980.

204. *Comprehensive emission testing at the Jones & Laughlin Steel Corporation's P3 and P4 Coke Oven Batteries,* Betz Environmental Engineers, Inc., April 14 - 23, 1975.

205. R. Fisher, *Progress in pollution abatement in European cokemaking industry,* Ironmaking and Steelmaking, pp 449 - 456, Volume 19, No. 6, 1992.

206. *Particulate and Gaseous Emission Diagnostic Study Performed for Bethlehem Steel Corporation at the No. 1 Coke Battery Underfire Stack Burns Harbor, Indiana March 20 through 22, 1995*, Mostardi-Platt Associates, Inc, Elmhurst, Il, May 3, 1995.

207. *Particulate and Gaseous Emission Diagnostic Study Performed for Bethlehem Steel Corporation at the No. 1 Coke Battery Pushing Control Stack Burns Harbor, Indiana March 21 through 23, 1995*, Mostardi-Platt Associates, Inc, Elmhurst, Il, May 3, 1995.

208. Written communication from D. Coy, Research Triangle Institute, Research Triangle Park, NC, to L. L. Beck, U. S. Environmental Protection Agency, Research Triangle Park, NC, October 14, 1981.

5. Summary of Comments to first Draft and Responses

Comments received on the AP-42 draft chapter for coke manufacture (Chapter 12.2) are summarized below. Responses to the comments are also given. The comments and responses are divided by subject. Commenters are identified by the following acronyms or names.

American Coke and Coal Chemicals Institute	ACCCI
American Iron and Steel Institute	AISI
Jefferson County (AL) Health Department	JCHD
Bethlehem Steel Corporation	Bethlehem
Jewell Smokeless Coal Corporation	Jewell
Allegheny County (PA) Health Department	ACHD

A. LEAKS AND CHARGING EMISSIONS

Comment A-1: (ACCCI/AISI) The commenter believes that emission factors for coke ovens at uncontrolled, pre-NESHAP, and post-NESHAP LEVELS should not be listed. Control levels and emission estimates based on an average or typical plant should be deleted and/or revised.

Response A-1: The EPA agrees that the emission estimates given for uncontrolled and pre-NESHAP do not represent the current control levels that have been achieved by the industry, which have resulted in significant reductions in emissions over the past several years. The uncontrolled and pre-NESHAP levels are presented only because they may be useful for purposes other than estimating current emission levels, such as estimating emissions from batteries in other countries that may have poor emission control or for estimating emissions for some period in the past (e.g., estimating the trends in emission reduction). The EPA also agrees that reductions were occurring in the 1980s in the pre-NESHAP period, and many batteries probably had better emission control than that indicated by the "pre-NESHAP" emission estimates given in the draft document. However, the Background Information Document for the NESHAP provides an estimate of the "baseline" based on State regulations that were in place prior to the NESHAP. Consequently, the "pre-NESHAP" emission estimates are based on the regulations that were in place rather than the varying levels of emission control that different batteries were achieving at the time. Additionally, support for any emission factor is no better than an order of magnitude because there are few measured emissions data at the level of control of the NESHAP.

Comment A-2: The commenter recommends that leak and charging emissions be estimated from actual battery design and performance data rather than from a typical battery.

Response A-2: (ACCCI/AISI) The EPA agrees that the use of site-specific data on battery design, operation, and performance should result in improved emission estimates, and this approach will be incorporated into AP-42. However, the traditional way of presenting emission factors in AP-42 (i.e., mass normalized by throughput, such as lb/ton) will also be retained because some users of AP-42 may not have basic design and performance data for a given battery.

The revision relies on site-specific data in terms of emission control performance, such as the monthly or annual average number of doors that leak on a given battery. For example, if a battery has data from inspections that show the annual average number of doors that leak, then that number of leaks can be multiplied by an average or representative leak rate for a leaking door to estimate emissions. A similar approach is incorporated for lid and offtake leaks based on the average number that are leaking. For charging, an alternate approach is presented similar to that used in the background information document (BID) that supports the NESHAP for coke ovens: *Coke Oven Emissions from Wet-Coal Charged Byproduct Coke Oven Batteries - Background Information for Proposed Standards*, EPA-450/3-85-028a, U.S. Environmental Protection Agency, Research Triangle Park, NC. April 1987. The method is based on the number of charges per year, the average seconds of emissions per charge, and the grams of BSO emitted per charge (expressed as a function of the seconds of visible emissions).

Comment A-3a: (ACCCI/AISI, JCHD, Bethlehem, ACHD) The commenters believe that the emission estimating procedure for door leaks is not supported by data or valid models and should use the exponential model that was developed in the late 1970s and was presented in the background information document (BID) for the Coke Oven NESHAP. Experience from Burns Harbor and Lackawanna plant retrofits should have been considered (Bethlehem). More clarification would be helpful regarding the relationships among BSO and filterable, condensible, and total PM (ACHD).

Response A-3a: There are several reasons why the exponential model is not appropriate for estimating emissions from doors leaks considering current techniques for controlling these emissions and the levels of control that are being achieved. Details are given below.

- The theoretical model is based solely on the self-sealing mechanism and does not consider the current widespread use of supplementary sealants (such as sodium silicate or hand luting), new door designs, and adjustments to the door or seal to reduce leakage.

As stated in the BID, the model was based on self sealing doors that rely on the condensation of tar to seal gaps gradually after the oven is charged. However, some batteries are using supplemental sealants to reduce doors leaks in order to meet the low levels of percent leaking doors (PLD) currently required by the NESHAP. In addition, hand luted doors do not rely on condensation of tar to seal gaps. Consequently, the theoretical basis for the exponential model does not apply to these batteries. Another complication is that the NESHAP does not distinguish between large leaks and small leaks -- any size leak from a door is counted as a door leak. When a supplemental sealant is used, the easiest leaks to seal quickly with the sealant are small leaks. Larger quantities and reapplication are required for large leaks. For these reasons, the exponential model is not applicable when supplemental sealants or hand luting are used to assist in reducing door leaks. In addition, a door leak may occur after charging that is a very heavy leak that perhaps would not self seal for several hours. However, the operator may adjust the door or seal to reduce the gap size and the leakage rate. Additionally, door designs that rely more on their design than on condensation to achieve low leak rates, may not have emissions profiles like self-sealing doors. In these cases, the model could underestimate emissions by not accounting for the very high leak rate prior to door adjustment or sealing.

- The BID clearly states that the exponential model (with an exponent of 2.5) becomes inappropriate for levels below 10 PLD (see page 3-48). The exponent is predicted to change at about 10 PLD (the model becomes more linear), and the model is not appropriate for low levels of PLD.

The model was used in the late 1970s and early 1980s to estimate the emission reductions that would be achieved if doors leaks were reduced from a maximum allowable of 12 to 15 percent to a maximum allowable of 5 to 10 percent. (For example, State limits in Pennsylvania were 10 percent excluding 2 door leaks, which is about 12 PLD, and limits in Alabama were 15 PLD). After promulgation of the much lower limits in the coke oven NESHAP, batteries currently are achieving very low levels of PLD (most batteries are achieving maximum door leak rates well below 5 PLD and have 30-day averages in the range of 1 to 2 PLD). The exponential model is not applicable at these current levels, and the BID clearly states that the model becomes linear (i.e., emissions rates as a function of PLD) for low levels of PLD. [The model is not applicable for low percent leaking doors (a low PLD means that the sealing time following charging is short) because it is based on the constant small positive pressure that is reached and maintained in the oven 0.5 to 1 hour after charging. For short sealing times or low percent leaking doors, the oven pressures may still be quite high, which would result in much higher leak rates (for a given gap size) than those leaks that are seen after the oven pressure has dropped.]

- Even when or if the exponential model is applicable, it is used in a way that underestimates emissions because the estimates are based on an arithmetic average for percent leaking doors.

To illustrate this with an example, assume that the model is applicable and that emissions can be estimated from the exponential relationship:

$$E = a\ (PLD)^{2.5}$$

where E = emission rate, a = constant, and PLD = percent leaking doors. Assume that 3 door leak inspections measured values of 5 PLD, 10 PLD, and 15 PLD for an average of 10 PLD. When the emission estimates are based on a battery's average performance, the emissions would be:

$$E = a\ (10)^{2.5} = \mathbf{316\ a.}$$

However, if the exponential model is appropriate, the average emission rate **<u>should</u>** be calculated from the average emissions of the 3 levels of PLD:

$$E = [a\ (5)^{2.5} + a\ (10)^{2.5} + a\ (15)^{2.5}]/\ 3 = [56\ a + 316\ a + 871\ a]/3 = \mathbf{414\ a}.$$

In all cases, emissions estimated from a single arithmetic average **will be lower** than the average estimate determined from the various levels of PLD using the exponential model. Most plants will have available some long term measure of PLD expressed as an arithmetic average and would find it cumbersome to estimate annual emissions from 365 different values of PLD (collected from the daily inspections).

- Considering the uncertainty in any estimates of emissions from door leaks, the exponential model provides a false sense of accuracy. The use of an average or typical leak rate for a leaking door is just as accurate and is simpler to use.

The exponential model is not validated, primarily because of the difficulties of measuring door leak emissions and the lack of good data. It has the potential to underestimate emissions significantly for low levels of PLD. Using a typical leak rate (or a range of leak rates to represent the uncertainty) is probably more reasonable than using the model, especially when considering the variations in plume size that are seen. If the exponential model is applied to the current situation of very low levels of PLD, the estimates from the model would presume that all of the door leaks are only small wisps.

The exponential model uses a theoretical extrapolation from high levels of door leaks to low levels, and this great extrapolation introduces significant uncertainty. The only data available at the time the model was developed showed door leak rates on the order of 0.2 to 0.7 kg BSO/hr per leaking door (when the percent leaking doors was in the range of 29 to 70 percent). The model extrapolates these measured values down to theoretical levels that give emission rates that are 10 to 100 times lower than the measured emission rates (assuming door leaks are much smaller at current levels of control).

Another complication is that not all door leaks are visible. The model would predict no emissions when PLD is measured as zero. However, EPA data indicate that doors are leaking even when they are not visible from the yard. (Method 303 inspections are made from the yard and not from a close inspection of the doors.) EPA studies showed that when doors are observed more closely (e.g., from the bench rather than the yard), more leaks are seen. The coke oven NESHAP also acknowledges this observation and allows a correction factor of 6 PLD when doors are inspected from the bench (under cokeside sheds). For example, if the inspection measured 6 PLD from the bench, the actual reported PLD (yard equivalent) would be 0 PLD. The model would estimate no emissions, but the inspector saw 6 percent of the doors leaking!

<u>Comment A-3b</u>: (ACCCI/AISI) The commenter recommends that the emission estimating approach presented in the BID be used for AP-42 because it was developed through a process that involved numerous meetings, public technical advisory committee meetings, and public hearings.

<u>Response A-3b</u>: Prior to 1990, industry representatives, the trade association, and contractors hired by the industry to review EPA's work criticized the exponential model and the emission estimates. They argued that it was unvalidated and overestimated the emission reduction that would be achieved by any new national standards. An example is the report "A Critical Review of EPA's Background Information Document for NESHAP on Coke Oven Charging, Door Leaks, and Topside Leaks for Wet-Coal Charged Batteries" prepared by TRC Environmental Consultants, Inc. for the American Iron and Steel Institute and submitted to EPA on November 24, 1982. The report is critical of all of EPA's models and approaches for estimating emissions, including charging and topside leaks as well as door leaks. There has been no industry endorsement of the BID approach during public hearings or during the regulatory negotiations. The emission estimating procedure was never discussed as an issue during the negotiations.

<u>Comment A-3c</u>: (ACCCI/AISI) The commenter believes that the data in the ENSR report (Phase I) should not be used to estimate emissions from doors leaks because it was only a method validation study. The ENSR Phase II study shows that the emissions from small leaks are more than a factor of two lower than the emission factor presented in the draft AP-42 document.

<u>Response A-3c</u>: There are perhaps some problems with the study, but the results confirm what other tests have shown: there is a great deal of variability and uncertainty in quantifying the mass emission rate from these fugitive leaks, and the range of these rates can cover an order of magnitude. Almost all of the available reports and studies have significant problems with them because of the difficulty of capturing and accurately measuring highly variable emission rates. The problem is compounded by the tendency of the organic particulate matter (which is tarry material) to condense on capture devices and sampling equipment. The EPA is grateful for the commenter providing additional data from the second phase of the ENSR/AISI study. These data are considered in developing an improved emission estimate for door leaks. The only other data available are for heavy door leaks, which show emission rates that are over 10 times higher than those measured by ENSR for small leaks.

After reviewing the additional data and considering the theoretical model predictions, the EPA agrees that the estimated door leak rate could be revised from 0.05 to 0.019 kg/hr. This estimated leak rate is a technical judgement of a reasonable midrange value; consequently, the AP-42 document acknowledges the uncertainty and states that actual emissions may be much higher or lower. For example, the leak rate of 0.019 kg/hr presumes the leaks at current levels of emission control are small, and if heavy door leaks occur (such as those in Class 4 in the ENSR study), emissions would be much higher.

<u>Comment A-4</u>: (ACCCI/AISI) The commenter states that the estimates for lid and offtake leaks are high. The estimates from the BID should be used.

<u>Response A-4</u>: The EPA agrees to revise the emission estimates for lid and offtake leaks and to use the procedure presented in the BID. The emission estimate are based on the average emission rate of small and large leaks.

<u>Comment A-5</u>: (ACCCI/AISI) The commenter believes that the emission factor for charging is 20 percent too high. The exponential model from the BID should be used, and the facility should be allowed to take credit for reduced mass emissions when the seconds of charging emissions are reduced.

Response A-5: The value of 5 g/charge in the AP-42 estimate was taken from Table 3-6 of the BID as the midrange from two exponential models (the range was 2 to 8 g/charge). The commenter recommends a value of 4.2 g/charge based on the midrange value given in Table 7-1 for an arithmetic average of 10 s/charge (corresponding to an emission limit of 16 s expressed as a log average). Considering that the uncertainty is at least a factor of 10 (i.e., actual emissions may be a factor of 10 higher or lower), the change does not make much difference. The EPA agrees to use a value of 4.2 g/charge and to acknowledge the great amount of uncertainty in the estimate. This quantity will be associated with an arithmetic average of 10 s/charge. Site-specific variations in performance can be accommodated by an adjustment in the quantity of BSO per charge that is proportional to the seconds of visible emissions per charge.

The exponential model for charging emissions has all of the problems described for the door leak exponential model and more. It is completely speculative and the uncertainty is acknowledged in the BID as being great (orders of magnitude). Consequently, the simplified approach presented in AP-42 was recommended because it is easy to use and there is no loss in accuracy.

Comment A-6: (JCHD) The commenter believes that the emission factors for coke oven leaks and charging based on Method 303 inspections of byproduct coke plants are too low. He bases his assertion on the argument that daily inspections are performed over a short duration, are almost never time varied, and may thus be biased below true plant performance.

Response A-6: The commenter offered no data to support his belief that Method 303 inspection results are not representative. In the absence of better data, these daily inspections provide the best information on the number of leaks at a given battery and offer a means to perform site-specific emission estimates. Additionally, facilities with daily inspection that are significantly biased low with respect to true plant performance are in jeopardy of being found in non-compliance with the NESHAP.

Comment A-7: (JCHD) The commenter suggests that a means for using individual plant performance be found for estimating door and topside leaks and charging emissions based on Method 303 (which measures seconds of visible emissions).

Response A-7: The emission factors and estimation methods given in Table 4-9 of the background document and Table 12.2.2 of the emission factors document have been revised. Average annual number of leaks or seconds of visible emissions from charging can be used for site-specific estimates of emissions as explained in the table.

Comment A-8: (JCHD) Certain emission points have not been addressed, for example, NO_x for doors, but older versions of AP-42 have such information. How should the reader estimate emissions for these cases?

Response A-8: New data have been submitted for several emission points. These data are now included in the emission factor tables.

Comment A-9: (JCHD) The commenter finds that the uncontrolled door leak emission factor for filterable PM in Table 4-9 of the background document and Table 12.2.2 of the emission factor document should be 0.25 kg/Mg of coal charged. He also asks for references to the this value and values for lids and offtakes.

Response A-9: The value has been changed. Sources for the emission factor values are given in the revised tables.

Comment A-10: (JCHD) The commenter asks if SO_x [in clean coke oven gas] can be estimated from knowledge of H_2S concentration in the clean coke oven gas and the ratio of H_2S to BSO given in Tables 4-10 and 12.2.3. Should other sulfur compounds be speciated from BSO values?

Response A-10: No data are available to substantiate using such a procedure. Given the reducing atmosphere present in the coke oven, the amount of oxidation of sulfur compounds leaving the oven is problematic.

Comment A-11: (JCHD) The commenter asks for more background and instruction for using speciation values in Table 12.2.3 so that double counting or omissions can be avoided.

Response A-11: The background document now contains more information about BSO and the relation to emission quantities. The procedures for estimating door, lid, and offtake leaks and for charging have been modified to give BSO directly, from which other compounds in Table 12.2.3 can be estimated. Double counting should not be inferred from the table.

Comment A-12: (JCHD) Does AP-42 consider the use by some plants of large quantities (thousands of gallons) of diesel oil mixed with the coal before charging.

Response A-12: No data are available to provide emission factor adjustments for diesel oil addition. Emissions may change in proportion to battery performance changes associated with the diesel oil addition.

Comment A-13: (JCHD) The commenter requests clarification of filterable matter and condensible values in deriving criteria pollutants from BSO values.

Response A-13: Table 4-10 of the background document and 12.2.3 of the emission factors document provide ratios of BSO to several compounds including filterable PM, condensible PM, VOC, carbon monoxide, and others. Definitions of filterable particulate matter and condensible particulate matter are given in the tables and are discussed in the introduction to AP-42.

Comment A-14: (Bethlehem) The commenter suggests that another reason for declining industry is the more economical purchase of foreign coke.

Response A-14: This additional reason for decline is added to section 12.2.1 of the emission factors document.

Comment A-15: (Bethlehem) The commenter suggests adding text to section 12.2-6 regarding longer coking times used under some circumstances. He also suggests added text for clarifications in several places.

Response A-15: Section 12.2-6 is changed to include reasons for extended coking times such as decreased production. The clarifying text is also added.

Comment A-16: (Jewell) Several text additions and table corrections are suggested, primarily for non-recovery coking.

Response A-16: The suggested additions and corrections are included in the revised documents.

Comment A-17: (ACHD) The commenter asks for more guidance as to when condensible PM is a particulate, a separate pollutant, or a VOC.

Response A-17: Guidance is given in the footnotes to Table 4-10 of the background document and Table 12.2-3 in the emission factors document; discussion is also given in the introduction to the emission factors document. Because filterable PM is the portion (the front half) of the Method 5 train that is typically used for regulatory purposes, it is reported in Tables 4-9 of the background document and Table 12.2.2 of the emission factors document. Using the BSO emission factors in the tables, and the ratios of BSO to filterable PM and to condensible PM in Tables 4-10 and 12.2-3, condensible emissions can be estimated when needed. Similarly, VOC or other other pollutants can be estimated when needed. These estimates apply only to charging, door leaks and topside leaks.

Comment A-18: (ACHD) Can AP-42 specify which pollutants are likely to be adsorbed on PM, emitted as VOC, or neither?

Response A-18: Data are not available that answer the question. There is too much uncertainty to speculate about which pollutants take what route when being emitted.

Comment A-19: (ACHD) In the absence of particle size distribution data for leaks, does EPA agree with the Coke Oven NESHAP BID that PM10 is 94 percent of total suspended particulate (TSP)?

Response A-19: Given the method of generation, most emission points are expected to be essentially 100 percent PM2.5. However, pushing, quenching, and charging particulate emissions are expected to be some unknown value less than 100 percent PM10.

Comment A-20: (ACHD) Can an estimate be given of the quantity of coke oven gas (COG) vented in association with Table 12.2-4 and can emission factors be given in terms of lb/mmcf?

Response A-20: The reference given for emission factors for bypassed coke oven gas does not give the associated quantity of gas. However, Reference 11 (and Table 4-6) of the background document uses a value of 12,000 scf of coke oven gas from one ton of coal. This value is added as a footnote to Table 12.2-3 of the emission factors document. Readers can use this value to convert emission factors to a lb/mmcf basis if they do not have a site-specific value to use.

Comment A-21: (ACHD) Stack tests in Allegheny County suggest uncontrolled coke oven gas emissions are less than 0.1 lb/ton rather than the value of 0.47 lb/ton listed in Table 12.2-7 of the emission factors document.

Response A-21: The experience in Allegheny County is noted. However, in the absence of supporting data, the value of 0.47 lb/ton is retained. This value is based on the average of 18 sets of tests, all with A ratings. Of the 18 sets, only two averaged less than 0.1 lb/ton.

Comment A-22: (ACHD) The commenter suggests simplifying the leak equations to, for example, 0.05 x (no. of leaking doors) x (charging rate) for door leaks.

Response A-22: Based on other comments and consideration of the original equations, revisions to the leak equations are made that estimate BSO emissions from leaks in terms of the number of oven doors, the percentage of doors that leak, and a typical door leak rate. This equation form allows estimation of any compound for which a BSO ratio is available. The equation also allows adjustment for known site-specific leak rates.

B. COKE PUSHING, QUENCHING, AND BATTERY UNDERFIRING

Comment B-1a: (ACCCI/AISI) The commenter believes that older emission factors for pushing should not be used. Present pushing emissions are significantly less than at the time of the tests used for the listed emission factors.

Response B-1a: Pushing emission factors have been revised to include results of additional test data.

Comment B-1b: (ACCCI/AISI) The commenter suggests cautioning the reader that BSO speciation ratios given in Table 12.2-3 are only for oven charging and door/topside leaks, not for pushing.

Response B-1b: Cautions have been added in the emission factor chapter and in its supporting document.

Comment B-2: (ACCCI/AISI) The commenter suggests a revision to the definitions of clean and dirty quenching water for the category of tall towers and/or poor maintenance: clean water should be less than 1,050 mg/L total dissolved solids (TDS) and dirty water should be greater than 9,850 mg/L TDS. The commenter also suggests that linear interpolation between emission factors be used for intermediate values of TDS.

Response B-2: The definitions for clean and dirty water have been reviewed and changed as appropriate. An interpolation procedure is also included for facilities that measure the TDS content of their quench water.

Comment B-3 (ACCCI/AISI) The commenter believes that combustion stack emission factors do not reflect current practice and should be replaced with factors derived from more recent data.

Response B-3: Test data have been supplied that allow revisions to the emission factors. These revisions are reflected in the emission factor tables.

Comment B-4: (JCHD, ACHD) The commenters contend that emission factors for combustion stacks are based on northern plants that use desulfurization, therefore have much lower emissions than southern plants that typically do not have desulfurization (JCHD). The lack of desulfurization leading to higher emission factors is supported by ACHD.

Response B-4: The emission factors given in the draft documents have been revised upward based on receiving new data. Northern and southern plants are included in the range of test data.

Comment B-5: (Bethlehem) The commenter notes that incorrect emission factor values have bee supplied for combustion stacks (Tables 4-19 and 4-20 of the background document and Tables 12.2-8 and 12.2-9 of the emission factors document). Corrected values are suggested.

Response B-5: The original values have been corrected.

Comment B-6: (Bethlehem) The VOC emission factors for pushing in Table 12.2-8 are based on old test data not representative of current practice. The emission factors should be lower.

Response B-6: No new supportable data were found for VOC emission factors. However, test data for total organic carbon (TOC) measured as propane were submitted and have been added to the table. The TOC value was 0.0023 lb/ton of coal charged compared to the older VOC value of 0.20 lb/ton of coal charged.

Comment B-7: (ACHD) The commenter believes that the emission factors for coke production, pushing, and combustion stacks for SO_x and NO_x and should be replaced with values from the FIRE database.

Response B-7: Part of the process of revising the AP-42 section is the evaluation of all factors in the FIRE database. New factors with supporting data or a reasonable technical basis will replace existing factors in FIRE. The remaining factors in FIRE will be evaluated for reasonableness. Those factors that are not unreasonable will be retained with a "U" rating. The remainder will be deleted. It is EPA's belief that the FIRE values may not be correct and may lack supporting data. Without the supporting data, the original values are retained.

C. SOAKING

Comment C-1: (ACCCI/AISI, JCHD, Bethlehem, ACHD) One commenter suggests that Leney's method in estimating soaking emissions is flawed because of improper assumptions and the method should be replaced by an estimation procedure developed by LTV company. Leney's method assumes, among other things, that standpipe emissions during soaking do not ignite or are not ignited. Bethlehem suggests removing the CO emission factor. ACHD suggests using 244 lb CO/oven and 0.044 lb SO_2/ton.

Response C-1: EPA prefers to use Leney's method with revisions for combustion of escaping oven gases. During periods of soaking it is assumed that 80 percent control is obtained due to combustion of the gases from open standpipes. Instead of Leney's 1.2 pounds of particulate matter below 10 μm (PM10) per push from 16 tons of coal coked, emissions are estimated at 0.24 lb/16 tons. On a unit basis, the emission factor is 0.015 lb PM10/ton of coal charged. Revised emission factors based on this value for total PM, SO_2, No_x, VOC, and CO are presented in the draft chapter and background document.

D. DECARBONIZATION

Comment D-1: (ACCCI/AISI) The commenter contends that the draft emission factor for decarbonization is three to four orders of magnitude too high. Data presented by the commenter suggest that the draft emission factor should be reduced to 0.00[illegible] lb CO/ton of coal charged from 23 lb CO/ton of coal charged.

Response D-1: While a considerable amount of data were presented by the commenter, EPA was unable to verify them through inspection of the test reports associated with the tests from which the data were derived. The commenter also made assumptions about the quantity of decarbonizing offgas that was converted to CO_2 fro CO. Until EPA is able to review test reports and to verify or support the commenter's assumptions, the emission factor remains at 0.29 lb CO/ton of coal charged.

E. BYPRODUCT PLANTS

Comment E-1: (ACCCI/AISI) The commenter believes that the draft benzene and VOC emission factors are too high, not supported by recent data, and do not account for plant variability. He suggests using models such as EPA's TANKS for individual plant estimates.

Response E-1: The commenter's suggestion for using the TANKS model is appropriate only for typical storage tanks at ambient temperatures. Several features of the model make it inappropriate for estimating emissions from reaction vessels, distillation columns and the like. For example, the model does not account for dissolved gases that may be present in byproduct plant liquids and may increase vessel emissions. The model does not account for heated input streams that increase emissions except when Antoines' constants based upon head space concentrations at the required tank temperature are available. The model's basis also lies in data from equipment across many industries, engineering judgements about storage vessels, and technology transfer from storage tanks significantly different from coke byproduct process vessels. The differences between general use storage tanks and coke byproduct plant process vessels are sufficient to make the TANKS model inappropriate for estimating process vessel emissions. When estimating emissions for regulatory purposes, facilities also have the choice of obtaining and using their own data as long as the measurement methods are acceptable to the Administrator.

F. BYPRODUCT PLANT EQUIPMENT LEAKS

Comment F-1a: (ACCCI/AISI) The commenter believes that the draft emission factors for equipment leaks for VOCs are outdated and too high. He asserts that leak programs have significantly reduced current emissions. He suggests using the third most refined version of the 1995 EPA leak protocol document, the EPA Correlation Approach, in place of the draft emission factors.

Response F-1a: For facilities that have an effective leak detection and repair (LDAR) program, and that have screening values required by the protocol document, EPA believes the correlation approach for refineries is appropriate. Text and table footnotes are added to the background and emission factors documents to introduce use of the correlation approach. However, for facilities not having an LDAR program and screening values, the emission factors in the draft documents are retained.

Comment F-1b: (ACCCI/AISI) The commenter requests amplification of the manner in which VOC emission factors should be used in regard to inspection programs and suggests that more emphasis be given to using average emission factors for a specific facility only in the absence of leak detection data for that facility.

Response F-1b: The requested amplification and emphasis have been added to the draft chapter and to its supporting document.

G. MATERIALS HANDLING

Comment G-1: (JCHD, ACHD) Are emission factors available for materials handling total suspended particulate (TSP)?

Response G-1: The only emission factors available are for coal crushing controlled by cyclone or rotoclone, primary and secondary coal pulverizers with building enclosures, coke screening, and coke handling controlled with a cyclone. Table 4-12 in the background document and Table 12.2.6 in the emission factors document present these emission factors. The data for coal crushing controlled by a rotoclone, pulverization, and coke screening are additions to the draft documents.

H. BYPRODUCT PLANT

Comment H-1: (Bethlehem) The commenter suggests that the byproduct plant description is outdated and should be revised to reflect current practice. He also believes the emission factors should be revised based on new measurements for plants complying with subparts L and FF (40 CFR 61).

Response H-1: Because the descriptions of byproduct plants in the background and emission factor documents are used for historical purposes and for non-U.S. plants as well as current U.S. plants, the basic descriptions are retained. However comments are added to the text and illustrations to show trends in post-NESHAP plants. In the absence of supportable data, no changes are made to the emission factors.

I. GENERAL COMMENTS

Comment I-1: (ACHD) The commenter suggest numerous clarifying or corrective additions and changes to text and tables in the emission factors document.

Response I-1: Most of the suggested changes are made to the emission factors document (and , as applicable, to the background document). Suggested changes not made are generally discussed in responses to comments given above.

Comment I-2: (ACHD) The commenter requests additional emission factors for soaking, decarbonizing, pushing emission control baghouses, traveling hot cars, pushing emission control baghouse and fugitives, and uncontrolled pushes.

Response I-2 Changes to emission factors for soaking and decarbonizing are discussed in the responses to comments C-1 and D-1 above. Additional emission factors are available for hooded quench cars and pushing emissions controlled by baghouses. No usable data are available for the remaining operations.

6. PROPOSED AP-42 SECTION

A proposed AP-42 Section 12.2, Coke Production, is presented in the following pages as it would appear in the document.