12.2 Coke Production

12.2.1 General

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 collocated 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 18 coke plants operating in the U. S. in 2007.

12.2.1 Process Description[1-9, 16, 194]

Most coke is produced in the U. S. using the “byproduct” process, and three plants used a “nonrecovery” process in 2007. 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 12.2-1 illustrates the major process equipment in a schematic diagram of a byproduct coke oven battery. Flow diagrams are provided in Figures 12.2-2 and -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.

12.2.1.1 Coal Preparation And Charging For By-Product 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 by-products, 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.

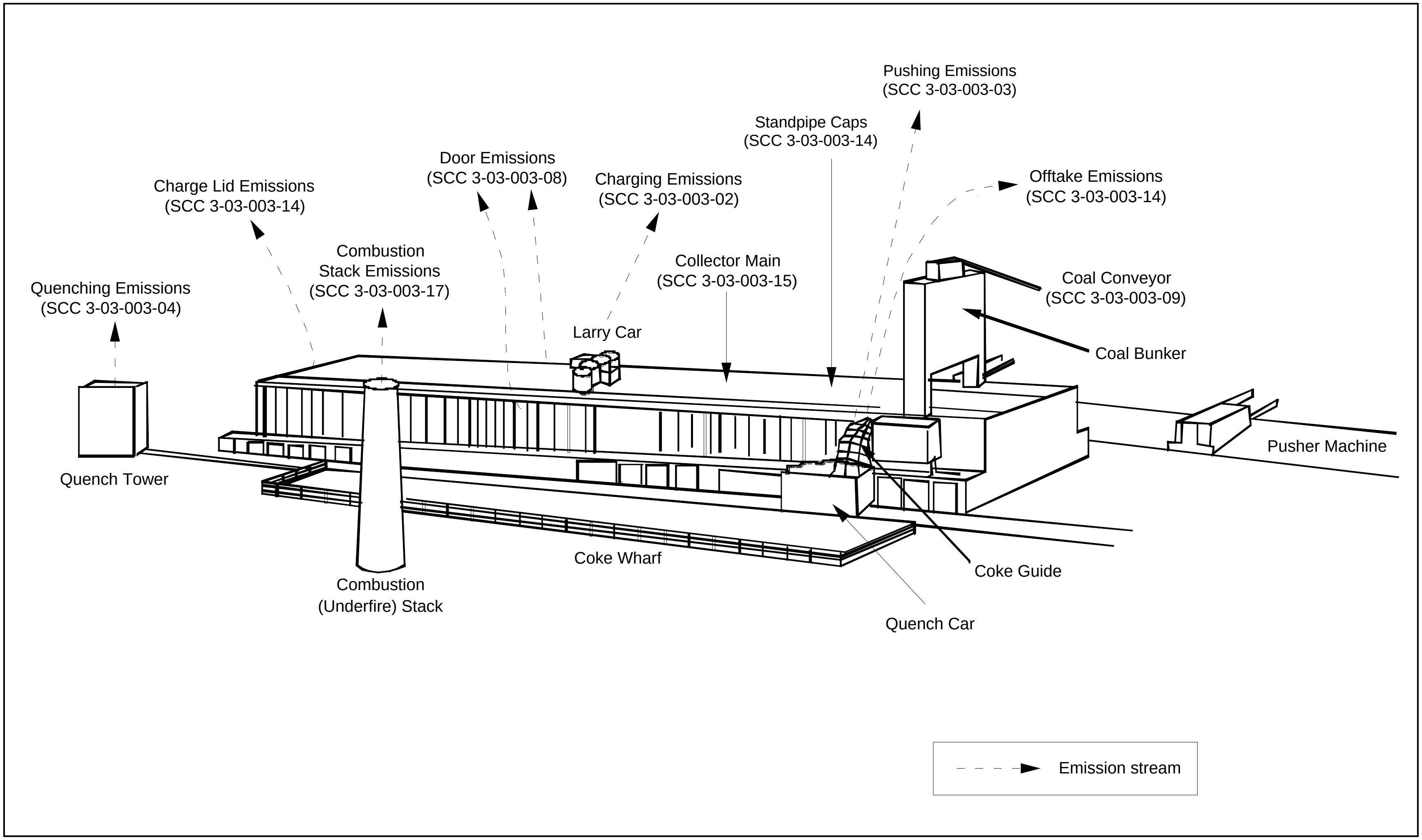

Figure 12.2-1. Byproduct coke oven battery showing major emission points.
(Source Classification Code in parentheses.)

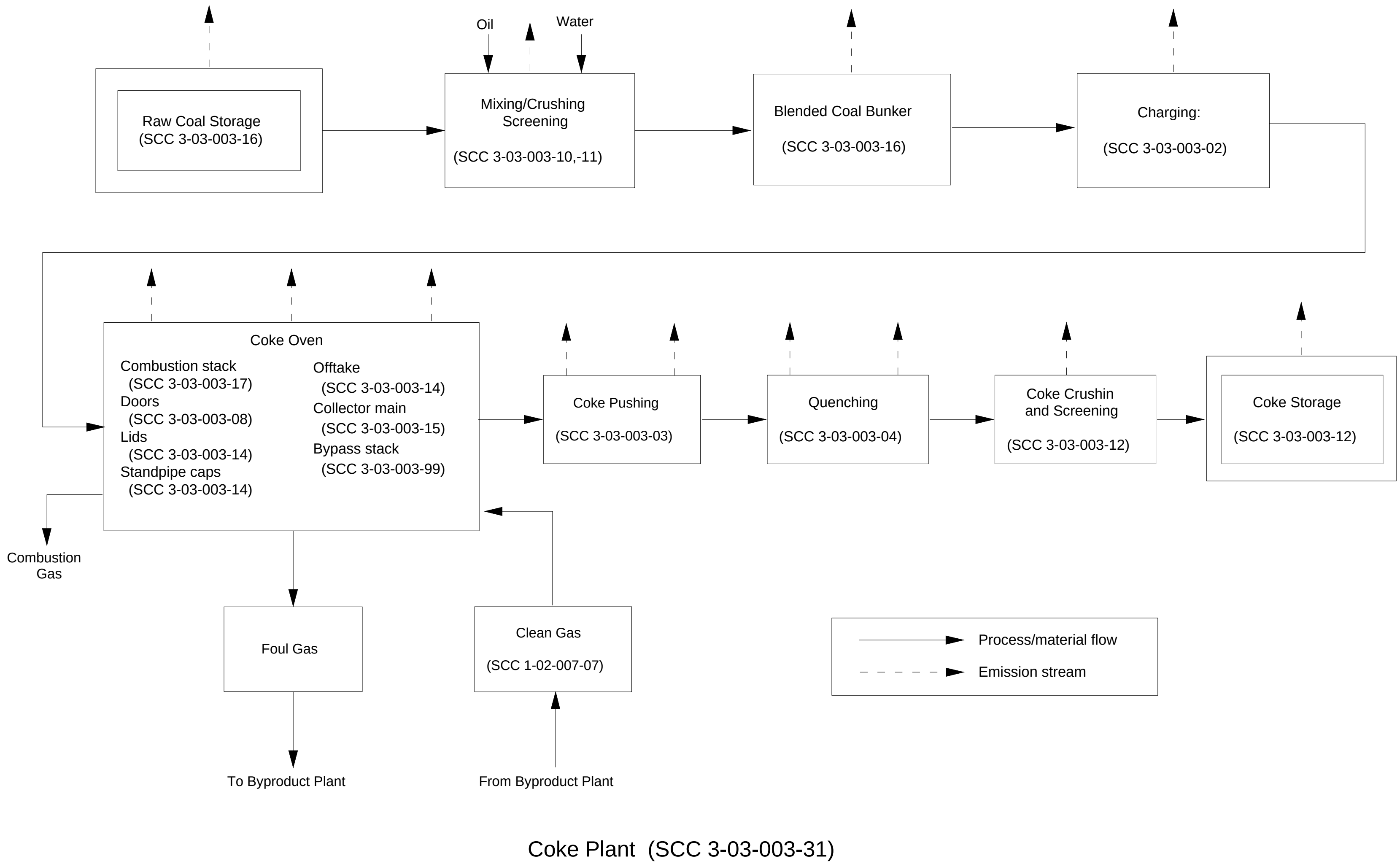

Figure 12.2-2. Flow diagram for byproduct coke production.
(Source Classification Code in parentheses.)

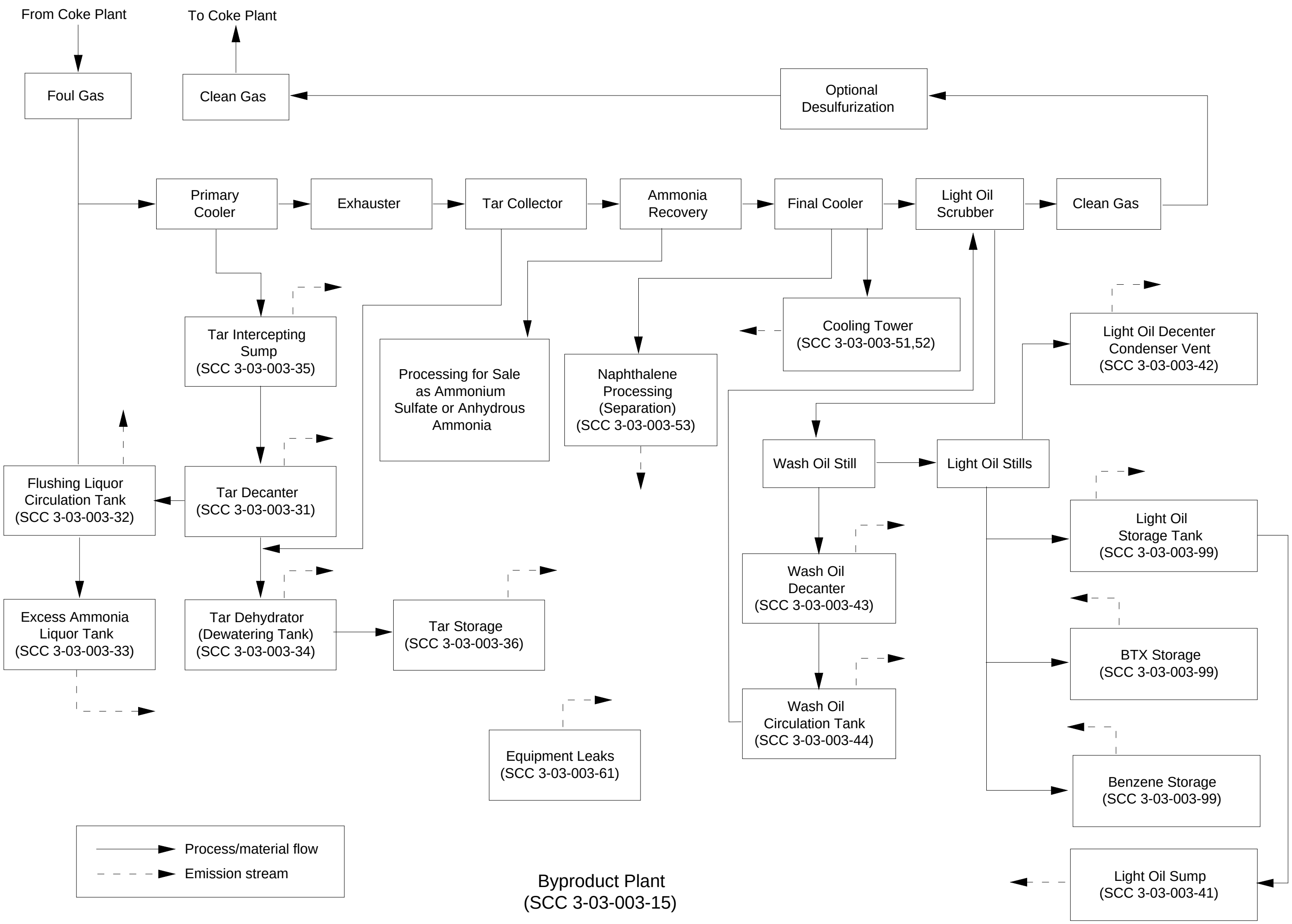

Figure 12.2-3. Flow diagram for coke byproduct recovery plant. (Source Classification Code in parentheses.)

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 12.2-1). 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.

12.2.1.2 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 1100°C (1650° to 2000°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.

12.2.1.3 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.

12.2.1.4 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. This 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/Nm3 (550 Btu/scf) but may be as low as 17 MJ/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, is sold, or is flared in some cases.

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.

12.2.1.5 Nonrecovery Coke Production -

In 2007 there were three nonrecovery plants operating in the U. S. (in Vansant, Virginia, East Chicago, Indiana, and Haverhill, Ohio). 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 recovers the heat. The Vansant plant uses a portion of the hot gases to dry coal, and the other two plants produce steam and electricity.

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. Gas flow is a result of natural or induced draft, and the oven is maintained under a negative pressure. Consequently, the ovens typically do not leak as do the byproduct ovens maintained under a positive pressure. However, door leaks can occur if the pressure in the oven becomes positive because of a plugged uptake damper, fouling of the heat exchanger used for heat recovery, and other operating problems. 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.

At the end of the coking cycle, each oven is inspected to assure coking is complete and that green coke will not be pushed. Since the oven is under negative pressure, a worker can open one of the damper ports on the oven, observe the coke mass, and verify that coking is complete (e.g., if no flames or smoke obscure the opposite end of the oven). This inspection procedure cannot be performed on byproduct coke batteries because they are operated under positive pressure.

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.

12.2.2 Emissions And Controls

Emissions from coke ovens include conventional pollutants (particulate matter [PM], sulfur dioxide [SO_2], nitrogen oxides [NO_x], etc.) and numerous organic compounds, including polycyclic organic matter (POM), volatile organic compounds (VOCs), and others. As portrayed in Figures 12.2-2 and -3, emissions originate from several operations at the coke plant and byproduct recovery plant. The following paragraphs describe emissions and controls characteristic of byproduct coke production, nonrecovery coke production, and byproduct recovery.

12.2.2.1 Byproduct Coke Production -

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. VOCs 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 are the major constituents of the PM emissions and are also included as VOCs. Among the hazardous air pollutants (HAPs) included in the organic emissions are benzene, toluene, xylenes, cyanide compounds, naphthalene, phenol, and POM, all of which are contained in coke oven gas. 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. Operating 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 or baghouse that controls PM emissions during pushing and transport to the quench area. Quenching is controlled by installing baffles in the quench tower to impede PM flow, and use of clean water for quenching. Combustion stack PM emissions are controlled by maintenance of the oven walls or devices such as electrostatic precipitators (ESPs) or baghouses. Gaseous emissions from the bleeder or bypass 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.

Emissions from charging coal into the ovens are controlled by stage charging in which coal is discharged from the larry car hoppers in an ordered sequence that maintains an open tunnel head at the top of the oven to provide an exit space for the gas until the last hopper is emptied. An important aspect of stage charging is adequate aspiration, which is used to pull the gas generated during charging from the ovens into the regular gas handling equipment. Prior to stage charging, uncontrolled charges resulted in heavy clouds of emissions throughout the 3- to 5-minute charging time. Batteries are now controlled to a level that produces only a few seconds of visible emissions during the charge with resulting emissions that are less than those from battery leaks.

During the coking cycle, various types of pollutants are emitted from leaks on the battery, including leaks from doors, from lids that cover the charging ports, and from the offtake system. Because the oven is maintained under a positive pressure, these leaks occur from small openings, such as gaps where metal seals mate against some other part of the oven. Small gaps seal by the condensation of tar. Door leaks on most batteries are controlled by repairing and maintaining doors, door seals, and jambs to prevent large gaps between the metal seal and the jamb. The manual application of a supplemental sealant such as sodium silicate is used at some plants to further reduce door leaks. A few batteries control door leaks by the external application of a luting material to provide a seal (called hand-luted doors). Lid leaks and offtake leaks are controlled by applying luting material around sealing edges to stop leaks and reluting when leaks are observed. The control of leaks requires a diligent work practice program that includes locating leaks and then identifying and correcting their cause.

Pushing coke into the quench car is a significant source of PM emissions. Most facilities control pushing emissions by using mobile scrubber cars with hoods, shed enclosures evacuated to a gas cleaning device, or traveling hoods with a fixed duct leading to a stationary gas cleaner. If the coke has been fully coked, emissions of benzene-soluble organics (BSO) and other organics are not expected to be significant; however, when coke that is still not fully coked (called "green" coke) is pushed, the various types of organic compounds found in coke oven gas are emitted. Emissions may also occur from "soaking" and decarbonizing when the oven is taken off the collecting main and the offtakes are opened to the atmosphere near the end of the coking cycle. There are few data available to characterize these emissions.

Coke quenching entrains PM from breakup of the hot coke when it is hit with water. The PM is carried up the quench tower by the velocity of the steam plume. In addition, suspended and dissolved solids from the quench water may become entrained in the steam plume rising from the tower. Trace organic compounds may also be present. As with pushing, other organic compounds may be released during the quenching of green coke. The typical control is to install baffles in the quench tower to reduce these emissions. Another "control" is to use clean water (recycled water that does not include process water) instead of "dirty" water (i. e., water high in solids or other pollutants) to quench the coke.

Combustion of gas in the battery flues produces emissions from the underfire or combustion stack. Sulfur dioxide emissions may also occur if the coke oven gas is not desulfurized to remove hydrogen sulfide. Even after desulfurization, substantial amounts of sulfur dioxides are emitted. In addition, coke oven gas may leak through damaged oven walls and mix with the combustion gases to increase emissions. Battery stack emissions are usually controlled by maintaining oven walls to avoid leakage and by maintaining good combustion conditions. Conventional gas cleaning equipment, including ESPs and fabric filters, have been installed on some battery combustion stacks.

Fugitive particulate emissions are associated with material handling operations. These operations consist of unloading, storing, grinding, and sizing of coals, as well as the screening, crushing, and storing of coke. Emissions from material transfers between conveyors and from screening and crushing operations thst are controlled by wet suppression techniques can be estimated using the procedures in Section 11.19.2. Emissions from material loading and unloading can be estimated using the procedures in Section 13.2.4.

For the purposes of presenting emission factors for coke oven charging, door leaks, lid leaks, and offtake leaks, emission control levels are categorized as uncontrolled, pre-national emission standard for hazardous air pollutants (NESHAP) controls, and post-NESHAP controls. Uncontrolled pertain to the control level that characterized coke ovens up to the 1980s; pre-NESHAP controls pertains to the level of control prior to the effective date of the NESHAP for coke ovens (40 CFR part 63, subpart L); and post-NESHAP controls refer to the level of control required by the NESHAP. Table 12.2-1 summarizes these control levels.

The emission factors available for byproduct coking operations for criteria pollutants, HAPs, and VOCs are given in Table 12.2-2, Table 12.2-3, Table 12.2-4, Table 12.2-5, Table 12.2-6, Table 12.2-7, Table 12.2-8, Table 12.2-9, Table 12.2-10, Table 12.2-11, Table 12.2-12, Table 12.2-13, Table 12.2-14, Table 12.2-15, Table 12.2-16, Table 12.2-17, and Table 12.2.-18. Table 12.2-19 presents particle size information for coking operations; these particle-size data were obtained primarily in the 1970s and may not represent current practice.

With the exception of the factors for uncontrolled charging and uncontrolled door leaks, the emission factors for leaks and charging given in Table 12.2.2 are based on an average or typical battery. These emission factors may be useful if site-specific information (other than capacity) is not available for the battery. 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. This emission estimating approach for batteries with low levels of visible leaks (5 percent leaking doors or offtakes and 1 percent leaking lids) is outlined below for BSO emissions; emissions of other pollutants can be estimated by the ratio of the pollutant to BSO as presented in Table 12.2-4.

Door leaks

$$E_D = [PLD/100 \times N_D \times 0.019] + [F_b \times N_D \times 0.011] + [(1 - F_b - (PLD/100)) \times N_D \times 0.002]$$

where

E_D = BSO emission rate, kg/hr;
PLD = average percent leaking doors as determined by EPA Method 303;
N_D = total number of doors on battery,
0.019 = typical door leak rate for doors that from the yard have visible leaks, kg/hr,
F_b = fraction of doors with visible leaks from the bench but not the yard (use a default value of 0.06 in the absence of battery-specific observations of door leaks from the bench),
0.011 = typical door leak rate for doors that from the bench have visible leaks, kg/hr; and
0.002 = door leak rate for doors without visible leaks, kg/hr.

Similarly, estimations can be made for lid leaks as follows:

$$E_L = PLL/100 \times N_L \times 0.0033$$

where

EL = BSO emission rate, kg/hr;
PLL = average percent leaking lids;
NL = total number of lids on battery; and
0.0033 = typical lid leak rate, kg/hr.

Offtake leaks can be estimated using the same equation as for lid leaks and an emission rate of 0.0033 kg/hr per offtake leak.

Charging

$$E_C = N_T/T \times 0.0042 \times (VE \div 10)$$

where

E_C = BSO emission rate, kg/hr;
N_T = total number of ovens on battery;
T = coking cycle time, hr;
0.0042 = typical emission rate per charge, kg/charge; and
VE = average seconds of visible emissions per charge.

Nonrecovery Coke Production — For the nonrecovery process, emissions from pushing and quenching are expected to be similar in composition and quantity to those from by-product cokemaking. There are no emissions from leaking doors because the ovens are maintained under a negative pressure. There are no charging port lids or coke oven gas offtakes on the nonrecovery batteries. Some emissions occur when the coal is charged into the oven by a drag conveyor, and these emissions are usually minimized by maintaining a high draft on the oven and charging as quickly as possible. All of the nonrecovery batteries have been equipped with a capture hood positioned over the open door through which the coal is charged. During charging, emissions are captured by the hood and sent to a fabric filter (baghouse) for cleaning. Green pushes are prevented by observing the coke mass through one of the damper ports on the oven door prior to pushing and verifying that the opposite end of the oven is not obscured by flames or smoke. One nonrecovery plant is equipped with a shed that serves as a settling chamber for pushing emissions, one has a shed that is evacuated to a fabric filter, and one is equipped with a moveable hood vented to a multiclone.

Emissions also occur from the combustion stack of nonrecovery batteries. These emissions include PM, SO_2, NO_x, and other compounds typical of combustion gas. Two of the nonrecovery plants have controls for these pollutants, including a fabric filter for PM, lime injection dry scrubber for SO_2,and staged combustion for NO_x. Significant levels of volatile organics and BSO have not been found, probably due to the high combustion temperatures, adequate oxygen, and a residence time of several seconds in the combustion system. Tables 12.2-20 present the emission factors for nonrecovery coking combustion stacks. Table 12.2-21 presents emission factors for nonrecovery charging.

By-Product Recovery — Emissions from the by-product recovery plant are primarily organic vapors such as benzene and other light aromatics, POM, cyanides, phenols, and light oils. These emissions occur from the separation processes, process vents, and transfer operations for recovered intermediates or products. These emissions also occur from wastewater that has contacted either the coke-oven gas or is generated from separation processes when the water is handled in open wastewater treatment systems. Although not a criteria pollutant or HAP, ammonia (a particulate precursor) also is emitted from the excess ammonium liquor tank, tar decanter, and flushing liquor tank. Many plants control these emissions using gas blanketing or vapor balance/recovery techniques that collect the organic vapors and contain them within the gas handling system where they are eventually recovered. Some plants use carbon adsorbers to capture emissions, such as those from vents on storage tanks. Emission factors for furnace and foundry by-product recovery plants are given in Table 12.2-22. Additional emission factors for by-product plants are presented in Table 12.2-23 and Table 12.2-24. Emissions from some storage tanks may also be estimated from EPA’s TANKS model as noted in Table 12.2-22 and 12.2.23. However, TANKS is not appropriate for other sources such as process vessels because of factors such as dissolved gases in liquids and hot liquids. For estimating emissions for regulatory purposes, facilities can always use their own data as long as they are acceptable to the Administrator. 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 12.2-24 may be used. The factors are applied to each piece of equipment for the conditions listed in the table, and represent the daily quantity of VOC emissions.

12.2.3 Updates Since The Fifth Edition

Revisions to this section since the Fifth Edition release in January 1995 are summarized below.

Supplement F, April 2000

- Units for the emission factors provided in Tables 12.2-1 and 12.2-3 have been changed from kg of pollutant/Mg of coke produced to kg of pollutant/Mg of coal charged. None of the numerical values were changed. Units for the emission factors provided in Tables 12.2-2 and 12.2-4 have been changed from lb of pollutant/ton of coke produced to lb of pollutant/ton of coal charged. None of the numerical values were changed.

- The October 1986 version of this section reported the emission factor units as lb of pollutant/ton of coal charged (kg of pollutant/Mg of coal charged). The January 1995 revision of this section did not change the numerical value for any of the emission factors but, due to a formatting error, the units were mistakenly reported as lb of pollutant/ton of coke produced (kg of pollutant/Mg of coke produced). Thus the revisions noted above correct errors to the January 1995 revision of this section.

September 2000

- In Table 12.2-4, the PM factors in Metric units were incorrectly transcribed into the English unit table. This has been corrected. The PM factors in Table 12.2-4 now accurately reflect the English unit factors from the Fourth Edition. Some additional SCC codes were also added for the combustion stack and for oven charging. More errors were found and corrected in Table 12.2-1. The PM factor for uncontrolled combustion stack with an ESP (BFG) was corrected to “ND”, and the PM factor for the same unit with ESP (COG) was corrected to 0.055 kg/MG of coal charged. The PM factors in all of the tables were labeled “filterable” to make the terminology consistent with the present day convention.

May 2008

- All emission factors were revised and new factors were added, and the industry and process descriptions were updated, primarily to provide more details on the newer nonrecovery coke plants. The draft revisions went through the public review and comment process, and all comments, responses, and subsequent revisions are discussed in the background report.

Table 12.2-1. TYPICAL EMISSION CONTROL LEVELS FOR CHARGING AND DOOR, LID, AND OFFTAKE LEAKS [a]

Source	Uncontrolled	Pre-NESHAP Controls [b]	Post-NESHAP Controls [b]
Charging (SCC 3-03-003-02)	3 to 5 minutes/charge [c]	Stage charging, 25 to 30 seconds/charge, 44 g BSO/charge	Stage charging, steam aspiration, 10 seconds/charge, 5 g BSO/charge
Door leaks (SCC 3-03-003-08)	29 to 70 percent leaking (average 50 percent) [d]	10 percent leaking	4 percent leaking
Lid leaks (SCC 3-03-003-14)	25 percent leaking [b]	3.5 percent leaking	0.3 percent leaking
Offtake leaks (SCC 3-03-003-14)	50 percent leaking [b]	6.5 percent leaking	2.0 percent leaking

[a] SCC = Source Classification Code.
[b] Reference 9.
[c] References 4, 12-13.
[d] References 1-4.

Table 12.2-2 (Metric And English Units).
TYPICAL EMISSION FACTORS FOR COKE PRODUCTION: OVEN LEAKS AND CHARGING[a]
EMISSION FACTOR RATING: E

Source [b]	Total PM [c]		BSO [d]	
	kg/Mg	lb/ton	kg/Mg	lb/ton
Charging				
(SCC 3-03-003-02)				
Uncontrolled [e]	0.60	1.2	0.44	0.88
Scrubber [f]	0.0070	0.014	ND	ND
Pre-NESHAP controls [g]	0.0058	0.011	0.0027	0.0053
Post-NESHAP controls [g, h]	0.00053	0.00113	0.00025	0.00050
Door leaks				
(SCC 3-03-003-08)				
Uncontrolled [j]	0.26	0.52	0.43	0.86
Pre-NESHAP controls [g, k]	0.020	0.041	0.018	0.037
Post-NESHAP controls [g, h]	0.0079	0.016	0.0071	0.014
Lid leaks [g]				
(SCC 3-03-003-14)				
Uncontrolled	0.047	0.094	0.023	0.046
Pre-NESHAP controls	0.0065	0.013	0.0032	0.0065
Post-NESHAP controls [h]	0.000086	0.00018	0.000044	0.000087
Offtake leaks [g]				
(SCC 3-03-003-14)				
Uncontrolled	0.047	0.094	0.023	0.046
Pre-NESHAP controls	0.0059	0.012	0.0030	0.0060
Post-NESHAP controls [h]	0.00029	0.00058	0.00015	0.00029

[a] Emission factor units are kg/Mg and lb/ton of coal charged unless otherwise specified. SCC = Source Classification Code. ND = no data.
[b] Refer to Table 12.2-1 for summary of uncontrolled, pre-NESHAP, and post-NESHAP control levels.
[c] Total PM includes both filterable and condensable PM. Based on 1.8 times BSO for lid and offtake leaks and 1.7 times BSO for charging from Table 12.2-4. Total PM for door leaks is based on test data referenced in the footnotes.
[d] BSO = benzene soluble organics.
[e] References 7-8, 11.
[f] Reference 11.
[g] Based on the model battery described in Reference 9 charging 492,000 Mg/yr of coal, the visible emission levels given in Table 12.2-1, and the equations in the text.
[h] For low levels of visible emissions, site-specific estimates of current emissions should be based on battery-specific data on the average number of leaks and seconds of visible emissions from charging and the equations in Section 12.2.2.1. The default emission factors for post-NESHAP control are based on 4 percent leaking doors, 0.3 percent leaking lids, 2 percent leaking offtakes, and 10 seconds of visible emissions per charge.
[j] References 1-4 for PM, References 3, 5 for BSO.
[k] Reference 166 for Filterable PM; emission factor units converted from lb/ton of coke pushed using a factor of 0.69.

Table 12.2-3. EMISSION FACTORS FOR COKE PRODUCTION:
DOOR LEAKS--SO_2, NO_x, TOC, CO [a]
EMISSION FACTOR RATING: E

Operation	SO_2		NO_x		TOC (as propane)		CO	
	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton
Door leaks (SCC 3-03-003-08) Controlled[b]	0.020	0.039	0.0007	0.0013	0.0028	0.0055	0.011	0.021

[a] Reference 166. Emission factor units are pre mass of coal charged, converted from mass of coke pushed using a factor of 0.69. SCC = Source Classification Code.
[b] Pre-NESHAP control.

Table 12.2-4. RATIOS OF OTHER POLLUTANTS TO BSO
EMISSION FACTOR RATING: E

Pollutant	Ratio to BSO [a]	Derived from reference No.
Filterable PM (lid and offtake leaks) [b]	0.9	3
Filterable PM (charging) [b]	0.8	12,13
Condensable PM (lid and offtake leaks) [c]	0.9	3
Condensable PM (charging) [c]	0.9	13
VOC [d]	2.2	10
TOC [e]	5.2	10
Acetylene	0.009	10
Acenaphthylene	0.032	11 [f], 182
Ammonia	0.15	10
Anthracene	0.00001	11 [f]
Benzene	0.5	10
Benzo[a]anthracene	0.00903	183
Benzo(a)fluorine	0.009	182
Benzo[a]pyrene	0.00836	183
Benzo[b]flouranthene	0.00680	183
Benzofuran	0.00007	11 [f]
Benzo(ghi)fluoranthene	0.005	182
Benzo[h]quinoline	0.002	182
Benzo[k]fluoranthene	0.00586	183
Benzonitrile	0.00002	11 [f]
Benzopyrenes	0.15	182
Benzoperylenes	0.054	182
Benzothiophene	0.005	11 [f], 182
Biphenyl	0.0045	182
Butadiene	0.009	11 [f]

Table 12.2-4. (continued)

Pollutant	Ratio to BSO [a]	Derived from reference No.
Butane	0.02	10
Butene	0.07	10
Carbanzole	0.022	
Carbon dioxide	0.5	10
Carbon disulfide	0.001	11 [f]
Carbon monoxide	1.1	10
Carbonyl sulfide	0.001	11 [f]
Crysene	0.01113	183
4H-Cyclopenta phenanthrene	0.016	182
Dibenzoanthacene	0.012	182
Dibenz[a,h]anthracene	0.000517	183
Dibenzothiophene	0.0055	182
Dibenzofuran	0.018	11 [f], 182
Dimethyl phenol	9.0×10^{-6}	11 [f]
Dimethylbiphenyls	0.0090	182
Dimethylnaphthalenes	0.0030	182
Ethane	0.3	10
Ethylene	0.4	10
Ethylmethyl benzene	0.002	11 [f]
Fluoranthene	0.032	11 [f], 182
Fluorene	0.017	11 [f], 182
Heavy hydrocarbons	0.8	10
Hexanoic acid dioctylester	0.00002	11 [f]
Hydrogen cyanide	0.035	10, 11 [f]
Hydrogen chloride	0.0009	11 [f]
Hydrogen fluoride	5.0×10^{-6}	11 [f]
Nitric acid	0.00007	11 [f]
Sulfuric acid	0.0007	11 [f]
Hydrogen sulfide	0.15	10
Indeno[1,2,3-cd]pyrene	0.00374	183
Metals		
arsenic	2×10^{-7}	11 [f]
mercury	2×10^{-7}	11 [f]
selenium	2×10^{-7}	11 [f]
Methane	2.7	10
Methylbenzoanthralenes	0.00275	182
Methylethyl benzene	0.003	11 [f]
Methyl naphthalene	0.0002	11 [f]

Table 12.2-4. (continued)

Pollutant	Ratio to BSO [a]	Derived from reference No.
Methylphenanthrene	0.010	182
2-methyl phenol	0.00007	11 [f]
4-methyl phenol	0.0002	11 [f]
Methylpyrenes	0.0155	182
Naphthalene	0.2	10
Pentene	0.01	10
Phenanthrene	0.075	11 [f], 182
Propane	0.03	10
Phenol	0.0006	11 [f]
Phenylnaphthalene	0.004	182
Propylene	0.08	10
Propyne	0.003	11 [f]
Propanenitrile	9.0×10^{-6}	11 [f]
Propynyl benzene	0.00002	11 [f]
Pyrene	0.033	11 [f], 182
Pyridine	0.0002	11 [f]
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 [f]
Toluene	0.04	10
Trimethyl benzene	0.00005	11 [f]
Xylene	0.005	10

[a] Benzene soluble organics (BSO) in this table includes heavy hydrocarbons, tar acids, tar bases, tar oil, and naphthalene. BSO is a component of filterable PM, Condensable PM, VOC, and TOC. These ratios are applicable only to oven charging and door/topside leaks, not pushing.

[b] Filterable PM is that PM collected on or before the filter of an EPA Method 5 (or equivalent) sampling train.

[c] Condensable PM is that PM collected in the impingers portion of a PM sampling train.

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

[e] TOC = total organic compounds as measured using EPA Method 25A (or equivalent) sampling train; includes all organic compounds in this table.

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

Table 12.2-5 (English Units).
EMISSION FACTORS FOR COKE PRODUCTION: BYPASSED COKE OVEN GAS[a]
(SCC 3-03-003-99)
EMISSION FACTOR RATING: E

Pollutant	Uncontrolled	Flared
Benzene soluble organics (BSO)	44	ND
Filterable PM[b]	40	ND
Condensable PM[c]	40	ND
Carbon monoxide	48	4.8
Carbon dioxide	21	780
Hydrogen sulfide	6.6	0.10
Ammonia	6.5	0.065[d]
Hydrogen cyanide	2.1	0.021[d]
Heavy hydrocarbons	35	1.7
Sulfur dioxide	0	13
Methane	120	1.2[d]
Ethane	12	0.12[d]
Propane	1.1	0.010[d]
Butane	0.70	0.0070[d]
Ethylene	17	0.17[d]
Propylene	3.5	0.035[d]
Butene	2.9	0.029[d]
Pentene	0.60	0.0060[d]
Benzene	22	0.22[d]
Toluene	1.9	0.019[d]
Xylene	0.20	0.0020[d]
Acetylene	0.40	0.0040[d]
Tar acids (CxHxOH)	0.70	0.0070[d]
Tar bases (CxHxN)	0.50	0.0050[d]
Solvents	0.70	0.0070[d]
Naphthalene	7.0	0.07[d]
Tar oil	1.0	0.010[d]

[a] Reference 10. SCC = Source Classification Code. ND = no data. Factor units are lb/ton of coal charged and are used to estimate emissions of bypassed coke oven gas that is vented directly to atmosphere or flared as required by the NESHAP. To estimate total emissions per episode, multiply emission factor by average coal usage rate (ton/hr) and duration of venting episode in hours. To obtain emission factor units of kg/Mg of coal charged, multiply table values by 0.5.

[b] Filterable PM is that PM collected on or before the filter of an EPA Method 5 (or equivalent) sampling train.

[c] Condensable PM is that PM collected in the impingers portion of a PM sampling train.

[d] Emissions after flaring are considered as “trace”. The factors are based on an assumed 99 percent destruction.

Table 12.2-6 (Metric And English Units).
EMISSION FACTORS FOR FILTERABLE PM EMISSIONS FROM COKE OVEN PUSHING [a]
(SCC 3-03-003-03)

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	0.20	0.39

[a] Expressed as kg/Mg and lb/ton of coal charged and includes both fugitive uncaptured emissions plus emissions from the control device. Based upon an average capture efficiency of 74.1%. Facilities with test data on the frequency and relative greenness of coke pushed may calculate controlled emissions based upon site specific capture efficiency as described in Reference 209.

[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 12.2-7 (Metric And English Units).
EMISSION FACTORS FOR CONDENSABLE PM EMISSIONS FROM COKE OVEN PUSHING [a]
(SCC 3-03-003-03)

Process	EMISSION FACTOR RATING	Condensable Inorganic Emissions		Condensable 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%. Facilities with test data on the frequency and relative greenness of coke pushed may calculate controlled emissions based upon site specific capture efficiency as described in Reference 209.

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

[c] Condensable Inorganic References 112, 148.

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

Table 12.2-8 (Metric And English Units).
EMISSION FACTORS FOR EXTRACTABLE ORGANIC PARTICULATE (EOM)
FROM COKE OVEN PUSHING [a] (SCC 3-03-003-03)

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 12.2-9 (Metric And English Units).
EMISSION FACTORS FOR CO, CO2, NOX, SOX, TOC AND ORGANIC COMPOUNDS FROM COKE OVEN PUSHING [a] (SCC 3-03-003-03)

Pollutant	EMISSION FACTOR RATING	Emissions, kg/Mg	Emissions, lb/ton
Carbon Monoxide [b]	D	0.032	0.063
Carbon Dioxide [c]	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	0.016	0.032
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] Ratio of benzene to TOC from Reference 168 (0.32) times the emission factor for TOC.

Table 12.2-10 (Metric And English Units).
EMISSION FACTORS FOR METALS FROM COKE OVEN PUSHING [a] (SCC 3-03-003-03)

Metal	EMISSION FACTOR RATING	Uncontrolled		Controlled Emissions [b]	
		kg/Mg	lb/ton	kg/Mg	lb/ton
Antimony	E	7.05e-07	1.41e-06		
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	3.32e-07	6.63e-07	1.03e-07	2.05e-07
Cadmium	E	1.92e-07	3.84e-07	7.85e-08	1.57e-07
Chromium	E	5.70e-06	1.14e-05	2.49e-06	4.98e-06
Cobalt	E	1.02e-06	2.04e-06	5.80e-07	1.16e-06
Copper	E	9.85e-06	1.97e-05	3.83e-06	7.65e-06
Manganese	E	1.49e-05	2.97e-05	5.15e-06	1.03e-05
Mercury	E	1.69e-07	3.38e-07		
Lead	E	2.74e-05	5.48e-05	7.65e-06	1.53e-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	5.15e-05	1.03e-04	1.74e-05	3.47e-05

[a] Expressed as kg/Mg and lb/ton of coal charged. References 192 - 193. Based upon an average capture efficiency of 74.1%. Facilities with test data on the frequency and relative greenness of coke pushed may calculate controlled emissions based upon site specific capture efficiency as described in Reference 209. Emission factor should be considered an underestimate since sample analysis was performed on only the residual material following EPA Method 315 solvent extraction.

Table 12.2-11 (Metric And English Units).
EMISSION FACTORS FOR POLYCYCLIC AROMATIC HYDROCARBONS
FROM COKE OVEN PUSHING [a] (SCC 3-03-003-03)

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. References 192 - 193 except where noted. Based upon an average capture efficiency of 74.1%. Facilities with test data on the frequency and relative greenness of coke pushed may calculate controlled emissions based upon site specific capture efficiency as described in Reference 209.
[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 12.2-12 (Metric And English Units).
FILTERABLE PM EMISSION FACTORS FOR QUENCHING. (SCC 3-03-003-04)

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. 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)] x [(0.54 - 0.31) + 0.31] = 0.425 lb/ton of coal.

Table 12.2-13 (Metric And English Units).
EMISSION FACTORS FOR COMBUSTION STACK EMISSIONS--FILTERABLE PM [a]
(SCC 3-03-003-17, COG; SCC 3-03-003-18, BFG)

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)	D	0.031	0.063

[a] Emission factor units are kg/Mg of coal charged or lb/ton of coal charged. A wide range of emissions is possible, depending on the condition of the oven, from black smoke in cracked ovens to clear stacks in well maintained ovens.
[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 12.2-14 (Metric And English Units).
EMISSION FACTORS FOR COMBUSTION STACK EMISSIONS CONDENSABLE PM [a]
(SCC 3-03-003-17, COG; SCC 3-03-003-18, BFG)

Process	EMISSION FACTOR RATING	Condensable Inorganic Emissions		Condensable Organic Emissions [b]	
		kg/Mg	lb/ton	kg/Mg	lb/ton
With COG	B	0.11 [c]	0.216 [c]	0.006	0.012
With BFG	E	0.014 [d]	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 12.2-15 (Metric And English Units).
EMISSION FACTORS FOR METALS FROM COMBUSTION STACKS [a]
(SCC 3-03-003-17, COG; SCC 3-03-003-18, BFG)

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	9.95e-08	1.99e-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	2.22e-06	4.44e-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	7.55e-06	1.51e-05

[a] Expressed as kg/Mg and lb/ton of coal charged. References 192 - 193. Emission factor should be considered an underestimate since sample analysis was performed on only the residual material following EPA Method 315 solvent extraction.

Table 12.2-16 (Metric And English Units).
EMISSION FACTORS FOR COMBUSTION STACK EMISSIONS EXTRACTABLE ORGANIC MATTER, CO, CO_2, NO_X, SO_X, HCl, TOC AND ORGANIC COMPOUNDS [a]
(SCC 3-03-003-17, COG; SCC 3-03-003-18, BFG)

Pollutant	EMISSION FACTOR RATING	Emissions, kg/Mg	Emissions, lb/ton
Extractable Organic Matter [b]	E	0.012	0.024
Carbon Monoxide [c]	C	0.34	0.68
Carbon Dioxide (BFG) [d]	E	482	963
Carbon Dioxide (COG) [e]	A	143	285
Nitrogen Oxides [f]	B	0.82	1.64
Sulfur Oxides (Raw COG) [g]	C	1.47	2.93
Sulfur Oxides (DCOG) [h]	E	0.12	0.23
HCl (DCOG)[k]	D	0.013	0.026
HCl (DCOG)[l]	D	<7.0e-06	<1.4e-05
Total Organic Compounds [m]	C	0.19	0.37
Methane [n]	E	0.10	0.21
Ethane [n]	E	0.0050	0.010
Acetone[p]	E	0.0295	0.059
VOC [n, p]	E	0.047	0.094
Benzene [r]	D	0.0075	0.015
Toluene [s]	E	0.0033	0.0066
Chloromethane [s]	E	0.0032	0.0064
Benzoic Acid [r]	E	4.14e-05	8.27e-05
Bis(2-ethylhexyl)phthalate [s]	E	3.40e-06	6.79e-06
Diethyl phthalate [s]	E	9.90e-06	1.98e-05
2,4-Dimethylphenol [s]	E	4.17e-06	8.33e-06
Phenol [s]	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 - 190.
[d] References 45, 85.
[e] References 56 - 59, 60 - 62, 63 - 65, 70 - 71, 76 - 78, 80 - 82, 84 - 85, 87 - 89, 98, 106 - 109, 123, 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] References 210-216, 219. This HCl emission factor is based on testing at only one coke plant, and this plant uses a unique cryogenic process for byproduct recovery and for desulfurization of the coke oven gas that is used to underfire the battery. We have no evidence that these HCl test results are representative of the coke industry in general.
[l] Reference 220. Results were below the method detection limit. This HCl emission factor is also based on testing at only one coke plant, and this plant uses conventional processes for byproduct recovery and scrubbing with an aqueous solution of ferric chelate for desulfurization, which may also remove HCl. We have no evidence that these HCl test results are representative of the coke industry in general.
[m] Total Organic Compounds (TOC) as measured by EPA Method 25a. References 16, 156 - 157, 166, 170, 176.
[n] Based upon ratio to TOC in References 176 and average TOC emission factor.
[p] 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.
[r] References 89, 190 - 191, 206.
[s] Reference 206. Emission factors should be considered an underestimate since sample collection was by Summa canister.

Table 12.2-17 (Metric And English Units).
EMISSION FACTORS FOR COMBUSTION STACKS POLYCYCLIC AROMATIC HYDROCARBONS [a] (SCC 3-03-003-17, COG; SCC 3-03-003-18, BFG)

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 12.2-18 (Metric And English Units).
EMISSION FACTORS FOR MISCELLANEOUS COKE PRODUCTION SOURCES [a]

Source	Pollutant [b]	Emission Factor		EMISSION FACTOR RATING
		kg/Mg	lb/ton	
Coal crushing, with cyclone [c] (SCC-03-003-10)	Filterable PM	0.055	0.11	D
Coal crushing, with rotoclone [d] (SCC-03-003-10)	Filterable PM	0.027	0.054	E
Primary coal pulverizer with building enclosure [e] (SCC-03-003-99)	Filterable PM-10	0.9×10^{-4}	1.8×10^{-4}	E
Secondary coal pulverizer with building enclosure [e] (SCC-03-003-99)	Filterable PM-10	4.4×10^{-5}	8.7×10^{-5}	E
Preheater [c] (SCC-03-003-13)	Filterable PM	1.8	3.5	D
Preheater, with scrubber [c] (SCC-03-003-13)	Filterable PM	0.13	0.25	D
Preheater, with wet ESP [c] (SCC-03-003-13)	Filterable PM	0.0060	0.012	D
Coke handling, with cyclone [c] (SCC-03-003-12)	Filterable PM	0.0030	0.0060	D
Coke screening [d] (SCC-03-003-12)	Filterable PM	0.011	0.022	E
Decarbonization [f] (SCC-03-003-99)	CO	15	29	E
Soaking [f] (SCC-03-003-99)	Total particulate matter	0.008	0.015	E
Soaking [f] (SCC-03-003-99)	SO_2	0.050	0.099	E
Soaking [f] (SCC-03-003-99)	NO_x	0.0005	0.0010	E
Soaking [f] (SCC-03-003-99)	VOC	0.003	0.006	E
Soaking [f] (SCC-03-003-99)	CO	0.001	0.002	E

[a] Emission factor units are kg/Mg and lb/ton of coal charged. SCC = Source Classification Code. [Note: Emissions from material transfers between conveyors and from screening and crushing operations thst are controlled by wet suppression techniques can be estimated using the procedures in Section 11.19.2. Emissions from material loading and unloading can be estimated using the procedures in Section 13.2.4.]

[b] Filterable PM is that PM collected on or before the filter of an EPA Method 5 (or equivalent) sampling train. Total PM includes the filterable PM and the PM collected in the impingers of a PM sampling train.

[c] Reference 4.

[d] Reference 172.

[e] References 173-175.

[f] Reference 15.

Table 12.2-19 (Metric Units).
PARTICLE SIZE DATA FOR COKE PRODUCTION [a]

Source	Cumulative Mass Percent Less Than Stated Size, µm						
	15.0	10.0	5.0	2.5	2.0	1.0	0.5
Coal preheating (SCC 3-03-003-13)	99.9	97.5	79.5	59.5	55	48.5	44
Coal preheating, with venturi scrubber (SCC 3-03-003-13)	96.5	94	88	84	83	80	78
Coal charging (sequential or stage) (SCC 3-03-003-02)	49	48.9	45.8	39.1	33.6	25.2	13.5
Coke pushing (SCC 3-03-003-03)	50	43.3	26.6	16.7	14.8	7.7	3.1
Coke pushing, with venturi scrubber (SCC 3-03-003-03)	92	87	75	73.5	66.5	47	24
Coke pushing, with mobile scrubber car (SCC 3-03-003-03)	35	32	30	30	29.5	28	ND
Quenching, with dirty water (SCC 3-03-003-04)	26.4	22.8	21.4	19.3	ND	13.8	ND
Quenching, with clean water (SCC 3-03-003-04)	37.4	30.1	19.1	11.1	ND	4.0	ND
Quenching, with baffles and dirty water (SCC 3-03-003-04)	49.8	32.3	24.8	20.4	ND	8.5	ND
Quenching, with baffles and clean water (SCC 3-03-003-04)	15.1	9.8	7.0	6.0	ND	1.2	ND
Combustion stack (SCC 3-03-003-17)	96	95.9	95.8	93.5	85.7	77.4	ND

[a] Reference 17. These data were collected primarily in the 1970s and their applicability to post-NESHAP batteries is unknown. The data are described in Reference 17, where they are accompanied by graphs of cumulative percent of particles vs. particle size. SCC = Source Classification Code. ND = no data.

Table 12.2-20 (Metric And English Units).
EMISSION FACTORS FOR COKE PRODUCTION:
NONRECOVERY COMBUSTION STACKS[a] (SCC 3-03-003-17)
EMISSION FACTOR RATING: B

Pollutant	Emission Factor	
	kg/Mg	lb/ton
Filterable PM [b]	0.90	1.8
Condensable PM [c]	0.075	0.15
SO_2 [d]	4.7	9.3
NO_x [d]	0.36	0.71
CO [d]	0.025	0.05
Benzene [e]	0.00024	0.00048
Toluene [f]	0.00026	0.00051
Naphthalene [g]	0.00014	0.00027
Phenol [f, h]	3.6×10^{-5}	7.1×10^{-5}
Benzo(a) pyrene [j]	5.0×10^{-7}	1.0×10^{-6}
Acetone [f]	1.1×10^{-3}	2.3×10^{-3}
Bromomethane [f]	2.8×10^{-4}	5.6×10^{-4}
Chloromethane [f]	3.8×10^{-4}	7.6×10^{-4}
Methylene Chloride [f]	3.3×10^{-4}	6.6×10^{-4}
Carbon Disulfide [f]	8.1×10^{-6}	1.6×10^{-5}
2-Butanone [f]	3.2×10^{-5}	6.3×10^{-5}
1,1,1-Trichloroethane [f]	1.3×10^{-6}	2.5×10^{-6}
Trichloroethene [f]	4.4×10^{-6}	8.7×10^{-6}
Ethylbenzene [f]	1.6×10^{-6}	3.2×10^{-6}
m-/p-Xylene [f]	6.5×10^{-6}	1.3×10^{-5}
o-Xylene [f]	1.6×10^{-6}	3.2×10^{-6}
Iodomethane [f]	3.2×10^{-6}	6.3×10^{-6}
Dibromomethane [f]	6.0×10^{-6}	1.2×10^{-5}
Trichlorofluoromethane [f]	4.1×10^{-6}	8.2×10^{-6}
n-Hexane [f]	7.3×10^{-6}	1.5×10^{-5}
Isooctane [f]	8.0×10^{-6}	1.6×10^{-5}
P-Cymene [f]	5.5×10^{-7}	1.1×10^{-6}
Cumene [f]	7.1×10^{-7}	1.4×10^{-6}
2-Hexanone [f]	1.4×10^{-5}	2.8×10^{-5}
Ethyl Methacrylate [f]	1.7×10^{-6}	3.4×10^{-6}
Styrene [f]	3.4×10^{-6}	6.9×10^{-6}
Vinyl Acetate [f]	3.5×10^{-6}	6.9×10^{-6}
1,2,3-Trichloropropane [f]	2.2×10^{-6}	4.4×10^{-6}

Table 12.2-20. (continued)

Pollutant	Emission Factor	
	kg/Mg	lb/ton
Chloroform [f]	5.7×10^{-6}	1.1×10^{-5}
Dibromochloromethane [f]	1.2×10^{-7}	2.4×10^{-7}
1,1,2-Trichloroethane [f]	2.9×10^{-7}	5.8×10^{-7}
Bromoform [f]	5.7×10^{-7}	1.2×10^{-6}
4-Methyl-2-Pentanone [f]	4.5×10^{-6}	8.9×10^{-6}
1,1,2,2-Tetrachloroethane [f]	1.1×10^{-6}	2.0×10^{-6}
1,4-Dichloro-2-butene [f]	6.9×10^{-7}	1.4×10^{-6}
Tetrachloroethane [f]	2.0×10^{-7}	4.1×10^{-7}
Tert-Butyl methyl ether [f]	2.4×10^{-8}	4.7×10^{-8}
Chlorobenzene [f]	6.1×10^{-7}	1.2×10^{-6}
Dimethyl Sulfide [f]	1.6×10^{-6}	3.2×10^{-6}
Antimony [g]	6.3×10^{-5}	0.00013
Arsenic [g]	0.00063	0.0013
Barium [g]	6.3×10^{-5}	0.00013
Beryllium [g]	1.0×10^{-5}	2.0×10^{-5}
Cadmium [g]	9.0×10^{-5}	0.00018
Chromium [g]	0.00032	0.00063
Copper [g]	0.0014	0.0028
Lead [d]	0.0016	0.0031
Manganese [g]	0.00015	0.00030
Mercury [g]	0.0017	0.00033
Nickel [g]	0.00029	0.00058
Phosphorus [g]	0.0070	0.014
Selenium [g]	0.00016	0.00032
Silver [g]	2.3×10^{-5}	4.5×10^{-5}
Thallium [g]	9.0×10^{-5}	0.00018
Zinc [g]	0.0026	0.0051

[a] Emission factor units are kg/Mg and lb/ton of coal charged. SCC = Source Classification Code. Na = not applicable.
[b] References 23-24, 49. Filterable PM is that PM collected on or before the filter of an EPA Method 5 (or equivalent) sampling train.
[c] References 24. Condensable PM is that PM collected in the impinger portion of a PM sampling train.
[d] References 23-24, 49.
[e] References 23-24. Based on volatile organic sampling train (VOST) results and an estimated rate of 30 ton/hr of coal charged.
[f] References 24. Based on volatile organic sampling train (VOST) results and an estimated rate of 30 tons/hr of coal charged.
[g] References 24.

Table 12.2-21 (Metric And English Units).
EMISSION FACTORS FOR COKE PRODUCTION: NONRECOVERY CHARGING[a]
(SCC 3-03-003-02)
EMISSION FACTOR RATING: D

Pollutant	Uncontrolled Emissions		Controlled Emissions[b]	
	kg/Mg	lb/ton	kg/Mg	lb/ton
Filterable PM[c]	0.013	0.027	0.0041	0.0081
TSO[d]	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[e]	1.4×10^{-5}	2.7×10^{-5}	1.1×10^{-5}	2.1×10^{-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] References 25. Emission factor units are kg/Mg and lb/ton of coal charged. SCC = Source Classification Code.
[b] Fabric filter control system; based on estimated 70 percent capture efficiency and analysis of baghouse catch as described in Reference 209.
[c] Filterable PM is that PM collected on or before the filter of an EPA Method 5 (or equivalent) sampling train.
[d] Toluene soluble organics.
[e] Polyaromatic hydrocarbons.

Table 12.2-22 (Metric And English Units).
EMISSION FACTORS FOR COKE BYPRODUCT RECOVERY PLANTS--BENZENE AND BTX [a]
EMISSION FACTOR RATING: E

Type Of Byproduct Plant Operation	Benzene				BTX [c]			
	Furnace Plant		Foundry Plant [b]		Furnace Plant		Foundry Plant	
	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton
Light-oil storage tank [d] (SCC 3-03-003-99)	0.0058	0.012	0.0031	0.0062	0.0083	0.017	0.0049	0.0098
with gas blanketing	0.00012	0.00024	0.000060	0.00012	0.00017	0.00034	0.000094	0.00019
Tar decanter [e] (SCC 3-03-003-31)	0.054	0.11	0.025	0.050	0.077	0.15	0.039	0.078
with gas blanketing	0.0011	0.0022	0.0005	0.0010	0.0016	0.0032	0.00079	0.00158
Naphthalene separation and processing [f] (SCC 3-03-003-53)	0.11	0.22	0.080	0.16	0.16	0.32	0.13	0.26
with activated carbon [g]	0.00035	0.00070	0.00025	0.00050	0.00050	0.0010	0.00039	0.0078
Cooling tower, direct-water [h] (SCC 3-03-003-51)	0.27	0.54	0.20	0.40	0.69	1.4	0.61	1.2
Cooling tower, tar-bottom [j] (SCC 3-03-003-52)	0.070	0.14	0.051	0.10	0.10	0.20	0.080	0.16
Tar intercepting sump [k] (SCC 3-03-003-35)	0.0095	0.019	0.0045	0.0090	0.014	0.028	0.0071	0.014
Tar dewatering tank [m] (SCC 3-03-003-34)	0.021	0.042	0.0099	0.020	0.030	0.060	0.016	0.032
with gas blanketing	0.00045	0.00084	0.00020	0.00040	0.00060	0.0012	0.00031	0.00062
Tar storage tank [n] (SCC 3-03-003-36)	0.0066	0.013	0.0031	0.0062	0.0094	0.019	0.0049	0.0098
with gas blanketing	0.00038	0.00076	0.00018	0.00036	0.00054	0.0011	0.00028	0.00056
Light-oil condenser vent [f] (SCC 3-03-003-42)	0.089	0.18	0.048	0.096	0.13	0.26	0.076	0.15
with gas blanketing	0.0018	0.0036	0.00097	0.0019	0.0026	0.0052	0.0015	0.0030
Light-oil sump [p] (SCC 3-03-003-41)	0.015	0.030	0.0081	0.016	0.021	0.042	0.013	0.026
with gas blanketing	0.00030	0.00060	0.00016	0.00032	0.00043	0.00086	0.0025	0.0050
BTX storage [d] (SCC 3-03-003-99)	0.0058	0.012	0.0031	0.0062	0.0083	0.017	0.0049	0.0098
with gas blanketing	0.00012	0.00024	0.000060	0.00012	0.00017	0.00034	0.000094	0.00019

Table 12.2-22. (continued)

Type Of Byproduct Plant Operation	Benzene				BTX [c]			
	Furnace Plant		Foundry Plant [b]		Furnace Plant		Foundry Plant	
	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton	kg/Mg	lb/ton
Benzene storage [q] (SCC 3-03-003-99)	0.0058	0.0116	0.0031	0.0062	0.0058	0.0116	0.0031	0.0062
with gas blanketing	0.00012	0.00024	0.00006	0.00012	0.00012	0.00024	0.000060	0.00012
Flushing liquor circulation tank [r] (SCC 3-03-003-32)	0.013	0.026	0.0095	0.019	0.019	0.038	0.015	0.030
with gas blanketing	0.00026	0.00052	0.00019	0.00038	0.00037	0.00074	0.00030	0.00060
Excess-ammonia liquor tank [g] (SCC 3-03-003-33)	0.0014	0.0028	0.0010	0.0020	0.0020	0.0040	0.0016	0.0032
with gas blanketing	0.000028	0.000056	0.000020	0.000040	0.000040	0.00008	0.000031	0.000062
Wash-oil decanter [s] (SCC 3-03-003-43)	0.0038	0.0076	0.0021	0.0042	0.0054	0.011	0.0033	0.0066
with gas blanketing	0.000076	0.00015	0.000041	0.000082	0.00011	0.00022	0.000065	0.00013
Wash-oil circulation tank [s] (SCC 3-03-003-44)	0.0038	0.0076	0.0021	0.0042	0.0054	0.011	0.0033	0.0066
with 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. SCC = Source Classification Code. Uncontrolled emission factors represent byproduct-plant pre-NESHAP values; controlled emission factors represent post-NESHAP values. Refer to Table 12.2-1 for summary of pre- and post-NESHAP controls. The NESHAP prohibits emissions from naphthalene processing.
[b] Emission factors for foundry plants based on corresponding factor for furnace plants as derived in Reference 5.
[c] BTX = benzene, toluene, and xylene. Factors for BTX based on corresponding factors for benzene emissions as derived in Reference 5.
[d] Reference 208. Toluene ranges from 17 to 26 percent of BTX, and xylene ranges from 4 to 13 percent of BTX. The reader may also use EPAs TANKS program to estimate emissions from this source. The program is available in electronic form through EPAs Technology Transfer Network. For information call (919) 541-5285.
[e] References 29-30,38. Benzene factor for furnace plant rated D.
[f] Reference 29.
[g] Reference 38.
[h] References 29,32.
[j] Reference 33.
[k] Reference 31.
[m] References 30,32-33. Benzene factor for furnace plant rated B.
[n] References 31, 38. Benzene factor for furnace plant rated B.
[p] References 34-35. Benzene factor for furnace plant rated B.
[q] Reference 208. The reader may also use EPAs TANKS program to estimate emissions from this source. The program is available in electronic form through EPAs Technology Transfer Network. For information call (919) 541-5285.
[r] Reference 38. Benzene factor for furnace plant rated D.
[s] Reference 32.

Table 12.2-23 (Metric And English Units).
EMISSION FACTORS FOR COKE BYPRODUCT RECOVERY PLANTS--VOCs[a]
EMISSION FACTOR RATING: E

Type Of Byproduct Plant Operation	VOC, Furnace Plant		VOC, Foundry Plant	
	kg/Mg	lb/ton	kg/Mg	lb/ton
Light-oil storage tank[b] (SCC 3-03-003-99)	0.0083	0.017	0.0049	0.0098
with gas blanketing	0.00017	0.00034	0.000094	0.00018
Tar decanter[c] (SCC 3-03-003-31)	0.12	0.24	0.057	0.11
with gas blanketing	0.0023	0.0046	0.011	0.0022
Naphthalene separation and processing[d] (SCC 3-03-003-53)	0.17	0.34	0.14	0.28
with activated carbon[e]	0.00055	0.0011	0.00043	0.00086
Cooling tower, direct-water[f] (SCC 3-03-003-51)	4.2	8.4	3.2	6.4
Cooling tower, tar-bottom[g] (SCC 3-03-003-52)	1.1	2.2	0.81	1.6
Tar intercepting sump[h] (SCC 3-03-003-35)	0.14	0.28	0.0071	0.014
Tar dewatering tank[j] (SCC 3-03-003-34)	0.030	0.060	0.016	0.032
with gas blanketing	0.00060	0.0012	0.00031	0.00062
Tar storage tank[k] (SCC 3-03-003-36)	0.16	0.32	0.073	0.15
with gas blanketing	0.0089	0.018	0.0043	0.0086
Light-oil condenser vent[d] (SCC 3-03-003-42)	0.13	0.26	0.076	0.15
with gas blanketing	0.0026	0.0052	0.0015	0.030
Light-oil sump[m] (SCC 3-03-003-41)	0.021	0.042	0.013	0.026
with gas blanketing	0.00043	0.00086	0.00025	0.00050
BTX storage[b] (SCC 3-03-003-99)	0.0083	0.0166	0.0049	0.0098
with gas blanketing	0.00017	0.00034	0.000094	0.00019
Benzene storage[b] (SCC 3-03-003-99)	0.0058	0.012	0.0031	0.0062
with gas blanketing	0.00012	0.00024	0.000060	0.00012
Flushing liquor circulation tank[e] (SCC 3-03-003-32)	0.019	0.038	0.015	0.030
with gas blanketing	0.00037	0.00074	0.00030	0.00060
Excess ammonia liquor tank[e] (SCC 3-03-003-33)	0.002	0.004	0.0016	0.0032
with gas blanketing	0.000040	0.000080	0.000031	0.000062

Table 12.2-23. (continued)

Type Of Byproduct Plant Operation	VOC, Furnace Plant		VOC, Foundry Plant	
	kg/Mg	lb/ton	kg/Mg	lb/ton
Wash-oil decanter[h] (SCC 3-03-003-43)	0.0054	0.0108	0.0033	0.0066
with gas blanketing	0.00011	0.00022	0.000065	0.00013
Wash-oil circulation tank[n] (SCC 3-03-003-44)	0.0054	0.0108	0.0033	0.0066
with gas blanketing	0.00011	0.00022	0.000065	0.00013

[a] Emission factor units are kg/Mg and lb/ton of coke pushed. SCC = Source Classification Code. Uncontrolled emission factors represent byproduct-plant pre-NESHAP values; controlled emission factors represent post-NESHAP values. The NESHAP prohibits emissions from naphthalene processing. Emission factors for VOC are based on corresponding factors for benzene emissions as derived in Reference 209 and presented in Table 12.2-19.

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

[c] References 29-30, 38.

[d] Reference 29.

[e] Reference 38.

[f] References 29, 32.

[g] Reference 33.

[h] Reference 31.

[j] References 30, 32-33.

[k] References 31, 38.

[m] References 34-35.

[n] Reference 32.

Table 12.2-24 (Metric And English Units).
EMISSION FACTORS FOR COKE BYPRODUCT RECOVERY PLANTS:
EQUIPMENT LEAKS--VOCs [a]
EMISSION FACTOR RATING: E

Source	VOC	
	kg/d	lb/d
Pumps (SCC 3-03-003-61)	2.7	6.0
with quarterly inspections	0.78	1.7
with monthly inspections	0.46	1.0
with dual mechanical seals	0	0
Valves (SCC 3-03-003-61)	0.26	0.57
with quarterly inspections	0.12	0.26
with monthly inspections	0.07	0.15
with sealed-bellows valves	0	0
Exhausters (SCC 3-03-003-61)	1.2	2.6
with quarterly inspections	0.54	1.2
with monthly inspections	0.43	0.95
with degassing reservoir	0	0
Pressure relief devices (SCC 3-03-003-61)	3.9	8.6
with quarterly inspections	2.2	4.9
with monthly inspections	1.9	4.2
rupture disc system	0	0
Sampling connection systems (SCC 3-03-003-61)	0.36	0.79
with cap or plug	0	0
Open ended lines (SCC 3-03-003-61)	0.055	0.12
with cap or plug	0	0

[a] Reference 208. Emission factor units are kg and lb per piece of equipment per day. SCC = Source Classification Code. Facilities having an effective leak detection and repair (LDAR) program and screening values required by EPAs *Protocol for Equipment Leak Emission Estimates* (EPA-453/R-95-017), may use the correlation approach for refineries contained in the document.

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