

**PETITION FOR VARIANCE
BEFORE THE HEARING BOARD OF THE
SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT**

PETITIONER: PHILLIPS 66 COMPANY

CASE NO: 4900-117

FACILITY ID: 171109

FACILITY ADDRESS: 1520 East Sepulveda

City, State, Zip: Carson, CA 90745

Telephone: (310) 952-6000

Facsimile: (310) 952-6014

1. TYPE OF VARIANCE REQUESTED (more than one box may be checked; see Attachment A before selecting)

INTERIM SHORT REGULAR EMERGENCY EX PARTE EMERGENCY

2. CONTACT: Name, title, company (if different than Petitioner), address, and phone number of persons authorized to receive notices regarding this Petition (no more than two authorized persons).

Lisa Faichney

Christopher H. Norton

Phillips 66 Company

Latham & Watkins LLP

1660 West Anaheim Street

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3. RECLAIM Permit Yes No Title V Permit Yes No

4. **GOOD CAUSE:** Explain why your petition was not filed in sufficient time to issue the required public notice. (Required only for Emergency and Interim Variances; see Attachment A)

There is Good Cause for the Hearing Board to consider the Emergency Petition (Petition) in this matter.

On February 18, 2026, at approximately 8:30 AM, Petitioner observed damage to two of the panels located near the top of the Coke Barn, which Petitioner uses for storing petroleum coke (Coke). High winds swept through southern California, causing damage to the two panels. According to news reports, the wind speeds reached 25 to 28 mph with stronger gusts. The resulting damage to the Coke Barn was limited to the two panels, and the openings are relatively small.

An emergency variance is needed to replace and repair the two panels on the Coke Barn. The openings created by the wind damage are small, and no visible emissions have been observed at the Coke Barn. See Exhibit 2.

Petitioner is working diligently to replace the two damaged panels on the Coke Barn to achieve compliance in this matter. However, the panels are heavy and located high on the structure, requiring a crane to lift the replacement panels. Petitioner has reached out to Bragg for expedited crane availability.

Once the winds and storm events have calmed, Petitioner can perform the repairs. Petitioner expects that the repair work will be completed and the Coke Barn back in full operation by March 3, 2026.

Petitioner has considered installing temporary covers over the two openings in the Coke Barn in lieu of seeking a variance in this matter. However, the wind remains strong at the Carson Plant. Any attempts to repair the Coke Barn when the winds are gusting would be challenging and may create a safety issue. Furthermore, a crane will be needed to lift the heavy panels into place for installation.

Petitioner also considered performing the repair work under District Rule 1158(k)(10). This "safe harbor" exemption allows for storage of Coke without a complete enclosure for "facilities performing routine maintenance/repair of replacing component parts on/in enclosed storage structures, such as roofing and siding material." However, the safe harbor exemption requires a notification to the District at least 10 working days prior to any maintenance/repair activity, and during this period no movement in structure is allowed.

Petitioner has considered removing all of the Coke from the Coke Barn as an alternative to obtaining a variance. In fact, Petitioner is in the process of removing the coke from the Coke Barn. While only partially full, the Coke Barn contains a substantial amount of coke. It would be difficult to remove all the Coke without creating much larger particulate emissions from Coke movement, and it may take months to complete such work. Petitioner concluded that removal of the Coke was not practicable and that a variance was needed to repair the Coke Barn.

A Copy of a photograph of the Coke Barn showing the two openings is attached to this Petition as Exhibit 2.

5. Briefly describe the type of business and processes at your facility.

Petitioner operates a petroleum refinery at 1520 East Sepulveda, Carson, California 90745 (Carson Plant). The Carson Plant is a major producer of fuel. Processes include refining of crude oil for gasoline and diesel fuel.

This issue involves Coke Barn repairs at the Carson Plant. Coke is a necessary and useful byproduct of the oil refining process. In the Coker Unit, residual oils from the distillation processes are treated at a high temperature and pressure to generate useful fuel products. The residual material from the refining process is Coke, which is a solid containing over 80% carbon. The Coke Barn is needed to store the Coke. District Rule 1158(d)(2) requires the Petitioner to maintain all Coke piles in enclosed storage.

6. List the equipment and/or activity(s) that are the subject of this petition (see Attachment A, Example #1). **Attach copies of the Permit(s) to Construct and/or Permit(s) to Operate for the subject equipment. For RECLAIM or Title V facilities, attach *only* the relevant sections of the Facility Permit showing the equipment or process and conditions that are subject to this petition. You must bring the entire Facility Permit to the hearing.**

Equipment/Activity	Application/Permit No.	RECLAIM Device No.	Date Application/Plan Denied (if relevant)*
Storage Silo, Coke, Nominal Capacity: 72,000 tons, Width: 154 ft; Height: 175 ft.; Length: 600 ft.	A/N: 535233	D-113	N/A

Copies of the relevant sections of the Facility Permit, issued on April 18, 2025, are attached to this Petition as Exhibit 1.

A copy of a photograph of the Coke Barn showing the two openings is attached to this Petition as Exhibit 2.

A copy of a study used to estimate excess emissions in this matter is attached to this Petition as Exhibit 3.

7. Briefly describe the activity or equipment, and why it is necessary to the operation of your business. A schematic or diagram may be attached, in addition to the descriptive text.

The Coke Barn is necessary for the operation of the Carson Plant. The Coke Barn is used to receive and store Coke produced by the Coker Unit. Petitioner must have the ability to store Coke to remain in compliance with District rules and permit conditions, including District Rule 1158(d)(2), which requires Petitioner to maintain all Coke piles in enclosed storage.

See also Paragraphs 4 and 17.

8. Is there a regular maintenance and/or inspection schedule for this equipment? Yes No

If yes, how often: Daily visual inspections are performed. Date of last maintenance and/or inspection. On-going.

Describe the maintenance and/or inspection that was performed.

The subject equipment has been subject to routine inspection, maintenance and on-going repairs.

In 2001, structural maintenance on the main steel framing was performed on the Coke Barn. In 2003, the roof was opened and the internal structural members for the shuttle conveyor were repaired. In 2017, a piping and vessel inspection was performed. In 2019, the roof was opened and I-beams were replaced. Later that year, an I-beam was removed and replaced. In 2023, two new beams and conveyer tube saddle support were replaced. Later that year, additional beams were replaced and sixteen new panels were installed.

Before the incident, the Coke Barn was in good condition. If not for the high winds which caused damage to the two panels located near the top of the structure, Petitioner would not require an emergency variance.

9. List all District rules, and/or permit conditions from which you are seeking variance relief (if requesting variance from Rule 401 or permit condition, see Attachment A). Briefly explain how you are or will be in violation of each rule or condition (see Attachment A, Example #2).

Rule	Explanation
District Rule 1158(d)(2)	District Rule 1158(d)(2) requires the operator to "maintain all piles in enclosed storage." Petitioner will not be able to maintain compliance with these District rules at all times until the repairs to the Coke Barn have been completed.
District Rules 203(b), 2004(f)(1) and 3002(c)(1) [for Section D, Permit Condition Nos. S13.1 and E136.1 and for Section E, Administrative Condition No. 2]	District Rule 203(b) states that permitted equipment "shall not be operated contrary to the conditions specified in the permit to operate." Similarly, RECLAIM Rule 2004(f)(1) requires compliance with all facility permit conditions. In addition, Rule 3002(c)(1) requires compliance with Title V permit conditions. The Facility Permit includes equipment specific and administrative conditions. Petitioner will not be able to maintain compliance with these District rules at all times until the repairs to the Coke Barn have been completed.
Section D, Permit Condition No. S13.1	Permit Condition No. S13.1 requires that all subject devices comply with the applicable requirements for Particulate Matter (PM) set forth under District Rule 1158. Petitioner will not be able to maintain compliance with this permit condition at all times until the repairs to the Coke Barn have been completed.

Section D, Permit Condition No. E136.1	Permit Condition No. E136.1 requires that the operator "store all coke in the coke building and keep all coke in enclosed storage." Petitioner will not be able to maintain compliance with this permit condition at all times until the repairs to the Coke Barn have been completed.
Section E, Administrative Condition No. 2	The Facility Permit includes Administrative Condition No. 2 which requires that the operator maintain all equipment that ensures proper operation of the equipment. Petitioner will not be able to maintain compliance with this permit condition at all times until the repairs to the Coke Barn have been completed.

10. Are the equipment or activities subject to this request currently under variance coverage? Yes No

Case No.	Date of Action	Final Compliance Date	Explanation

11. Are any other equipment or activities at this location currently (or within the last six months) under variance coverage? Yes No

Case No.	Date of Action	Final Compliance Date	Explanation

12. Were you issued any Notice(s) of Violation or Notice(s) to Comply concerning this equipment or activity within the past year? Yes No If yes, you must attach a copy of each notice.

13. Have you received any complaints from the public regarding the operation of the subject equipment or activity within the last six months? Yes No If yes, you should be prepared to present details at the hearing.

14. Explain why it is beyond your reasonable control to comply with the rule(s) and/or permit condition(s):

It is beyond Phillips 66's reasonable control to comply with the District Rules and permit conditions listed above during the ongoing repairs.

District Rule 1158(d)(2) requires the Petitioner to maintain all Coke piles in enclosed storage.

On February 18, 2026, at approximately 8:30 AM, Petitioner observed damage to two of the panels located near the top of the Coke Barn. High winds swept southern California causing damage to the two panels. According to news reports, the wind speeds reached 25 to 28 mph with stronger gusts. The resulting damage to the Coke Barn was limited to the two panels and the openings are relatively small. An emergency variance is needed to replace and repair the two panels on the Coke Barn. However, the openings created by the wind damage were small and no visible emissions have been observed at the Coke Barn. See Exhibit 2.

Petitioner is working diligently to replace the two damaged panels on the Coke Barn to achieve compliance in this matter. However, the panels are heavy and located high on the structure requiring a crane to lift the replacement panels. Petitioner has reached out to Bragg for expedited crane availability. Once the winds and storm events have calmed, Petitioner can effectuate the repairs to the Coke Barn. Petitioner expects that the repair work will be completed and the Coke Barn back in full operation by March 3, 2026.

Petitioner has considered installing temporary covers over the two openings in the Coke Barn in lieu of seeking a variance in this matter. However, the wind remains strong at the Carson Plant. Any attempts to repair the Coke Barn when the winds are gusting would be challenging and may create a safety issue. Furthermore, a crane will be needed to lift the heavy panels into place for installation.

Petitioner has considered removing all the Coke from the Coke Barn as an alternative to obtaining a variance. In fact, Petitioner is in the process of removing the coke from the Coke Barn with the idling of the Carson Plant. While only partially full, the Coke Barn contains about 30 tons of coke. It would be challenging to remove all the Coke without creating much larger particulate emissions from coke movement, and it may take months to complete. Removal of the coke was evaluated but is not practicable as a compliance option for the Coke Barn.

Due to conditions beyond the reasonable control of Phillips 66, requiring compliance in this matter would result in either an arbitrary or unreasonable taking of property, or the practical closing and elimination of a lawful business.

15. When and how did you first become aware that you would not be in compliance with the rule(s) and/or permit condition(s)?

On February 18, 2026, at approximately 8:30 AM, Petitioner observed damage to two of the panels located near the top of the Coke Barn.

16. What actions have you taken since that time to achieve compliance?

Phillips 66 informed the District of this matter via telephone on February 18, 2026, shortly after identifying the damage. Phillips 66 is preparing for maintenance repairs. An emergency variance is needed to provide time to complete the repairs.

17. What would be the harm to your business during and/or after the period of the variance if the variance were not granted?

Economic losses: Potential fines and penalties for noncompliance exceeding \$25,000 per day

Number of employees laid off (if any): None.

Provide detailed information regarding economic losses, if any (anticipated business closure, breach of contracts, hardship on customers, layoffs, and/or similar impacts).

If the variance were denied and the Coke Barn could not be repaired, then Petitioner would not be able to store petroleum coke in compliance with applicable District rules and regulations. When it operates, the Coker produces petroleum coke which must be stored in the Coke Barn prior to shipment and sales. If the Coke Barn is down or unavailable, then Petitioner has no place to store coke at the Carson Plant.

A denial of the request for variance could result in economic losses in excess of \$25,000 per day in fines and penalties from noncompliance with applicable District rules and permit conditions. These losses would result in the practical closing of a lawful business without a corresponding benefit in reducing air contaminants.

18. Can you curtail or terminate operations in lieu of, or in addition to, obtaining a variance? Please explain.

Phillips 66 has considered curtailment of operations in lieu of a variance. However, there is no option that would avoid the need for a variance. If the variance were denied, Petitioner would be subject to fines and penalties from noncompliance with District rules and permit conditions for the Coke Barn. Without an enclosed structure, there would be no place for the coke to be stored and shipped in compliance. There is no alternative that would avoid the need for a variance. Additional time is required to safely complete the Coke Barn repairs at the Carson Plant.

19. Estimate excess emissions, if any, on a daily basis, including, if applicable, excess opacity (the percentage of total opacity above 20% during the variance period). If the variance will result in no excess emissions, skip to No. 20.

Pollutant	(A)	(B)	(C)*
	Total Estimated Excess Emissions (lbs/day)	Reduction Due to Mitigation (lbs/day)	Net Emissions After Mitigation (lbs/day)
PM10	0.44 lbs/day	NA	0.44 lbs/day
PM2.5	0.07 lbs/day	NA	0.07 lbs/day

* Column A minus Column B = Column C

Excess Opacity: 0 %

20. Show calculations used to estimate quantities in No. 19, or explain why there will be no excess emissions.

There will be excess emissions in this matter during the emergency variance period. However, the emissions would be limited to particulate matter (PM10 and PM2.5).

By limiting the opening in the Coke Barn to no more than 2% of the surface area, the excess PM10 emissions are estimated at 0.44 lbs/day and the excess PM2.5 is estimated at 0.07 lbs/day. The estimate of excess emissions is modest. Petitioner is committed to having no visible emissions from the Coke Barn during the variance period.

A copy of a study underlying Petitioner's estimate of excess emissions in this matter is attached to this Petition as Exhibit 3. Petitioner expects that any excess emissions will be fully mitigated by the measures described immediately below (in response to item 21), but Petitioner is not claiming credit for these mitigation measures in its net emissions calculations.

21. Explain how you plan to reduce (mitigate) excess emissions during the variance period to the maximum extent feasible, or why reductions are not feasible.

In order to reduce emissions to the greatest extent feasible, Petitioner proposes the following emergency variance conditions:

- Petitioner shall have water available to control any accidental fugitive dust emissions from the Coke Barn side openings.
- Petitioner shall ensure that any water spray system or air pollution control equipment associated with Coke Barn the structure will be in use as needed to prevent visible emissions during the repair period.
- Petitioner shall wet paved roads at the refinery three (3) times per day during the variance period. Records shall be made available to District personnel upon request.

22. How do you plan to monitor or quantify emission levels from the equipment or activity(s) during the variance period, and to make such records available to the District? **Any proposed monitoring does not relieve RECLAIM facilities from applicable missing data requirements.**

Petitioner will monitor or quantify any emission levels from the subject equipment during the period of the variance. See Paragraphs 20 and 21.

23. How do you intend to achieve compliance with the rule(s) and/or permit condition(s)? Include a detailed description of any equipment to be installed, modifications or process changes to be made, permit conditions to be amended, etc., dates by which the actions will be completed, and an estimate of total costs.

To achieve final compliance in this matter, Phillips 66 will complete the repairs to the Coke Barn, including the replacement of the panels.

24. State the date by which you expect to achieve final compliance: March 3, 2026.

Petitioner expects that the repairs can be completed on the Coke Barn by March 3, 2026.

If the regular variance is to extend beyond one year, you **must** include a **Schedule of Increments of Progress**, specifying dates or time increments for steps needed to achieve compliance. See District Rule 102 for definition of Increments of Progress (see Attachment A, Example #3).

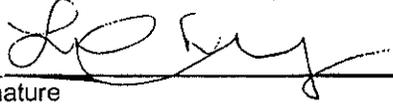
List Increments of Progress here: Increments of Progress should not be required in this matter.

25. List the names of any District personnel with whom facility representatives have had contact concerning this variance petition or any related Notice of Violation or Notice to Comply.

Air Quality Inspector Jentry Kear, is familiar with the facility and equipment.

The undersigned, under penalty of perjury, states that the above petition, including attachments and the items therein set forth, is true and correct.

Executed on February 19, 2026 at Wilmington, California



Signature

Lisa Fa chney

Print Name

Senior Environmental Consultant

Title

26. SMALL BUSINESS: To be eligible for reduced fees (see District Rule 303) you must complete the following:

Declaration Re Small Business

1. I am an officer, partner or owner of the petitioner herein, or a duly authorized agent of the petitioner authorized to make the representations set forth herein.
2. The petitioner is a business that meets the following definition of Small Business as set forth in District Rule 102:

SMALL BUSINESS means a business which is independently owned and operated and meets the following criteria, or if affiliated with another concern, the combined activities of both concerns shall meet these criteria:

- (a) the number of employees is 10 or less; **AND**
 - (b) the total gross annual receipts are \$500,000 or less or
 - (c) the facility is a not-for-profit training center.
3. Therefore, I believe the petitioner qualifies as a small business for purpose of filing fees and excess emission fee calculations, in accordance with Rule 303.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on _____ at _____, California

Signature

Print Name

Title

EXHIBIT 1

FACILITY PERMIT TO OPERATE PHILLIPS 66 COMPANY/LOS ANGELES REFINERY

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FACILITY PERMIT TO OPERATE PHILLIPS 66 COMPANY/LOS ANGELES REFINERY

SECTION D: FACILITY DESCRIPTION AND EQUIPMENT SPECIFIC CONDITIONS

The operator shall comply with the terms and conditions set forth below:

Equipment	ID No.	Connected To	RECLAIM Source Type/ Monitoring Unit	Emissions* And Requirements	Conditions
Process 2: COKING AND RESIDUAL CONDITIONING					P13.2
System 4: COKE HANDLING UNIT #1					S13.1
PIT, ONE COMPARTMENT, SLURRY, NOMINAL CAPACITY 200 TONS, COKE A/N: 535233	D952			PM10: (9) [RULE 405, 2-7-1986]	
MIXER, 5K-2339, COKE FINES, HEIGHT: 6 FT ; DIAMETER: 4 FT A/N: 535233	D108			PM: (9) [RULE 405, 2-7-1986]	A63.2, D323.1, E124.1
CONVEYOR, CH-452, COKE FINES A/N: 535233	D109			PM: (9) [RULE 405, 2-7-1986]	A63.2, D323.1, E124.1
CONVEYOR, 9T-16, COARSE COKE, SHUTTLE-TYPE A/N: 535233	D110			PM: (9) [RULE 405, 2-7-1986]	A63.2, D323.1, E124.1
CONVEYOR, 9T-17, COKE FINES, ENCLOSED IN A 9-FT STEEL TUBE A/N: 535233	D111			PM: (9) [RULE 405, 2-7-1986]	D323.1, E124.1
CONVEYOR, SHUTTLE, 9T-18, COKE FINES A/N: 535233	D112			PM: (9) [RULE 405, 2-7-1986]	A63.2, D323.1, E124.1
STORAGE SILO, COKE, NOMINAL CAPACITY: 72,000 TONS, WIDTH: 154 FT ; HEIGHT: 175 FT ; LENGTH: 600 FT A/N: 535233	D113			PM: (9) [RULE 405, 2-7-1986]	A63.2, D323.1, E136.1, E137.1
PIT, TWO COMPARTMENT, SLURRY, NOMINAL CAPACITY: 2,800 TONS, COKE A/N: 535233	D114			PM: (9) [RULE 405, 2-7-1986]	A63.2, D323.1
CONVEYOR, 9T-15, COARSE COKE, ENCLOSED IN A 9-FT STEEL TUBE A/N: 535233	D115			PM: (9) [RULE 405, 2-7-1986]	D323.1, E124.1
System 5: COKE HANDLING UNIT #2					S13.1

- * (1) (1A) (1B) Denotes RECLAIM emission factor
- (3) Denotes RECLAIM concentration limit
- (5) (5A) (5B) Denotes command and control emission limit
- (7) Denotes NSR applicability limit
- (9) See App B for Emission Limits
- (2) (2A) (2B) Denotes RECLAIM emission rate
- (4) Denotes BACT emission limit
- (6) Denotes air toxic control rule limit
- (8) (8A) (3B) Denotes 40 CFR limit (e.g. NSPS, NESHAPS, etc.)
- (10) See section J for NESHAP/MACT requirements

** Refer to section F and G of this permit to determine the monitoring, recordkeeping and reporting requirements for this device.

FACILITY PERMIT TO OPERATE PHILLIPS 66 COMPANY/LOS ANGELES REFINERY

SECTION D: FACILITY DESCRIPTION AND EQUIPMENT SPECIFIC CONDITIONS

The operator shall comply with the terms and conditions set forth below:

CONTAMINANT	EMISSIONS LIMIT
VOC	Less than 2.5 lbs/mmscf of hydrogen produced

[RULE 1189, 1-21-2000]

[Systems subject to this condition : Process 4, System 1]

S13.1 All devices under this system are subject to the applicable requirements of the following rules or regulations:

Contaminant	Rule	Rule/Subpart
PM	District Rule	1158

[RULE 1158, 7-11-2008]

[Systems subject to this condition : Process 2, System 4 , 5]

S13.2 All devices under this system are subject to the applicable requirements of the following rules or regulations:

Contaminant	Rule	Rule/Subpart
VOC	District Rule	463
VOC	District Rule	1149

[RULE 1149, 5-2-2008; RULE 463, 11-4-2011]

[Systems subject to this condition : Process 10, System 3]

S13.3 All devices under this system are subject to the applicable requirements of the following rules or regulations:

FACILITY PERMIT TO OPERATE PHILLIPS 66 COMPANY/LOS ANGELES REFINERY

SECTION D: FACILITY DESCRIPTION AND EQUIPMENT SPECIFIC CONDITIONS

The operator shall comply with the terms and conditions set forth below:

[Devices subject to this condition : D108, D109, D110, D111, D112, D115, D116, D117, D118, D119, D120, D123, D124, D125]

- E125.1 The operator shall drive all the outgoing petroleum coke trucks, whether filled or empty, through the truck wash system in order to thoroughly wash any residual coke off the exterior of the trucks.

[RULE 1158, 7-11-2008]

[Devices subject to this condition : D124, D125, D126]

- E128.1 The operator shall keep all spent carbon in a tightly covered container which shall remain closed except when it is being transferred into or out of the container.

[RULE 1303(a)(1)-BACT, 5-10-1996; RULE 1303(a)(1)-BACT, 12-6-2002]

[Devices subject to this condition : C435, C484, C519, C520, C521, C523, C525, C527, C728, C830, C977]

- E134.1 The operator shall maintain a layer of diesel oil at least 12" high on top of the ammonium polysulfide in this equipment.

[RULE 1301(b)(1), 12-7-1995]

[Devices subject to this condition : D86]

- E136.1 The operator shall store all coke in the coke building and shall keep all coke in closed storage.

[RULE 1158, 7-11-2008]

FACILITY PERMIT TO OPERATE PHILLIPS 66 COMPANY/LOS ANGELES REFINERY

SECTION E: ADMINISTRATIVE CONDITIONS

The operating conditions in this section shall apply to all permitted equipment at this facility unless superseded by condition(s) listed elsewhere in this permit.

1. The permit shall remain effective unless this permit is suspended, revoked, modified, reissued, denied, or it is expired for nonpayment of permit processing or annual operating fees. [201, 203, 209, 301]
 - a. The permit must be renewed annually by paying annual operating fees, and the permit shall expire if annual operating fees are not paid pursuant to requirements of Rule 301(d). [301(d)]
 - b. The Permit to Construct listed in Section H shall expire one year from the Permit to Construct issuance date, unless a Permit to Construct extension has been granted by the Executive Officer or unless the equipment has been constructed and the operator has notified the Executive Officer prior to the operation of the equipment, in which case the Permit to Construct serves as a temporary Permit to Operate. [202, 205]
 - c. The Title V permit shall expire as specified under Section K of the Title V permit. The permit expiration date of the Title V facility permit does not supercede the requirements of Rule 205. [205, 3004]
2. The operator shall maintain all equipment in such a manner that ensures proper operation of the equipment. [204]
3. This permit does not authorize the emissions of air contaminants in excess of those allowed by Division 26 of the Health and Safety Code of the State of California or the Rules and Regulations of the SCAQMD. This permit cannot be considered as permission to violate existing laws, ordinances, regulations, or statutes of other governmental agencies. [204]
4. The operator shall not use equipment identified in this facility permit as being connected to air pollution control equipment unless they are so vented to the identified air pollution control equipment which is in full use and which has been included in this permit. [204]

FACILITY PERMIT TO OPERATE PHILLIPS 66 COMPANY/LOS ANGELES REFINERY

SECTION E: ADMINISTRATIVE CONDITIONS

5. The operator shall not use any equipment having air pollution control device(s) incorporated within the equipment unless the air pollution control device is in full operation. [204]
6. The operator shall maintain records to demonstrate compliance with rules or permit conditions that limit equipment operating parameters, or the type or quantity of material processed. These records shall be made available to SCAQMD personnel upon request and be maintained for at least: [204]
 - a. Three years for a facility not subject to Title V; or
 - b. Five years for a facility subject to Title V.
7. The operator shall maintain and operate all equipment to ensure compliance with all emission limits as specified in this facility permit. Compliance with emission limits shall be determined according to the following specifications, unless otherwise specified by SCAQMD rules or permit conditions: [204]
 - a. For internal combustion engines and gas turbines, measured concentrations shall be corrected to 15 percent stack-gas oxygen content on a dry basis and be averaged over a period of 15 consecutive minutes; [1110.2, 1134, 204]
 - b. For other combustion devices, measured concentrations shall be corrected to 3 percent stack-gas oxygen content on a dry basis and be averaged over a period of 15 consecutive minutes; [1146, 1146.1, 204]
 - c. For a large NO_x source, compliance with a RECLAIM concentration limit shall be measured over a continuous 60 minutes for that source; [2012]
 - d. For non-combustion sources, compliance with emission limits shall be determined and averaged over a period of 60 minutes; [204]

FACILITY PERMIT TO OPERATE PHILLIPS 66 COMPANY/LOS ANGELES REFINERY

SECTION E: ADMINISTRATIVE CONDITIONS

- e. For the purpose of determining compliance with Rule 407, carbon monoxide (CO) shall be measured on a dry basis and be averaged over 15 consecutive minutes, and sulfur compounds which would exist as liquid or gas at standard conditions shall be calculated as sulfur dioxide (SO₂) and be averaged over 15 consecutive minutes; [407]
 - f. For the purpose of determining compliance with Rule 409, combustion contaminant emission measurements shall be corrected to 12 percent of carbon dioxide (CO₂) at standard conditions and averaged over 15 consecutive minutes. [409]
 - g. For the purpose of determining compliance with Rule 475, combustion contaminant emission measurements shall be corrected to 3 percent of oxygen (O₂) at standard conditions and averaged over 15 consecutive minutes or any other averaging time specified by the Executive Officer. [475]
8. All equipment operating under the RECLAIM program shall comply concurrently with all SCAQMD Rules and Regulations, except those listed in Table 1 of Rule 2001 for NO_x RECLAIM sources and Table 2 of Rule 2001 for SO_x RECLAIM sources. Those provisions listed in Tables 1 or 2 shall not apply to NO_x or SO_x emissions after the date the facility has demonstrated compliance with all monitoring and reporting requirements of Rules 2011 or 2012, as applicable. Provisions of the listed SCAQMD rules in Tables 1 or 2 which have initial implementation dates in 1994 shall not apply to a RECLAIM NO_x or SO_x source, respectively. [2001]
 9. The operator shall, when a source test is required by SCAQMD, provide a source test protocol to SCAQMD no later than 60 days before the proposed test date. The test shall not commence until the protocol is approved by SCAQMD. The test protocol shall contain the following information: [204, 304]
 - a. Brief description of the equipment tested.

FACILITY PERMIT TO OPERATE PHILLIPS 66 COMPANY/LOS ANGELES REFINERY

SECTION E: ADMINISTRATIVE CONDITIONS

- b. Brief process description, including maximum and normal operating temperatures, pressures, through-put, etc.
 - c. Operating conditions under which the test will be performed.
 - d. Method of measuring operating parameters, such as fuel rate and process weight. Process schematic diagram showing the ports and sampling locations, including the dimensions of the ducts/stacks at the sampling locations, and distances of flow disturbances, (e.g. elbows, tees, fans, dampers) from the sampling locations (upstream and downstream).
 - e. Brief description of sampling and analytical methods used to measure each pollutant, temperature, flow rates, and moisture.
 - f. Description of calibration and quality assurance procedures.
 - g. Determination that the testing laboratory qualifies as an "independent testing laboratory" under Rule 304 (no conflict of interest).
10. The operator shall submit a report no later than 60 days after conducting a source test, unless otherwise required by SCAQMD Rules or equipment-specific conditions. The report shall contain the following information: [204]
- a. The results of the source test.
 - b. Brief description of the equipment tested.
 - c. Operating conditions under which test will be performed.
 - d. Method of measuring operating parameters, such as fuel rate and process weight. Process schematic diagram showing the ports and sampling locations, including the dimensions of the ducts/stacks at the sampling locations, and distances of flow disturbances, (e.g. elbows, tees, fans, dampers) from the sampling locations (upstream and downstream).
 - e. Field and laboratory data forms, strip charts and analyses.

FACILITY PERMIT TO OPERATE PHILLIPS 66 COMPANY/LOS ANGELES REFINERY

SECTION E: ADMINISTRATIVE CONDITIONS

- f. Calculations for volumetric flow rates, emission rates, control efficiency, and overall control efficiency.
- 11. The operator shall, when a source test is required, provide and maintain facilities for sampling and testing. These facilities shall comply with the requirements of SCAQMD Source Test Method 1.1 and 1.2. [217]
- 12. Whenever required to submit a written report, notification or other submittal to the Executive Officer, SCAQMD, or the District, the operator shall mail or deliver the material to: Deputy Executive Officer, Engineering and Compliance, SCAQMD, 21865 Copley Drive, Diamond Bar, CA 91765-4178. [204]

EXHIBIT 2

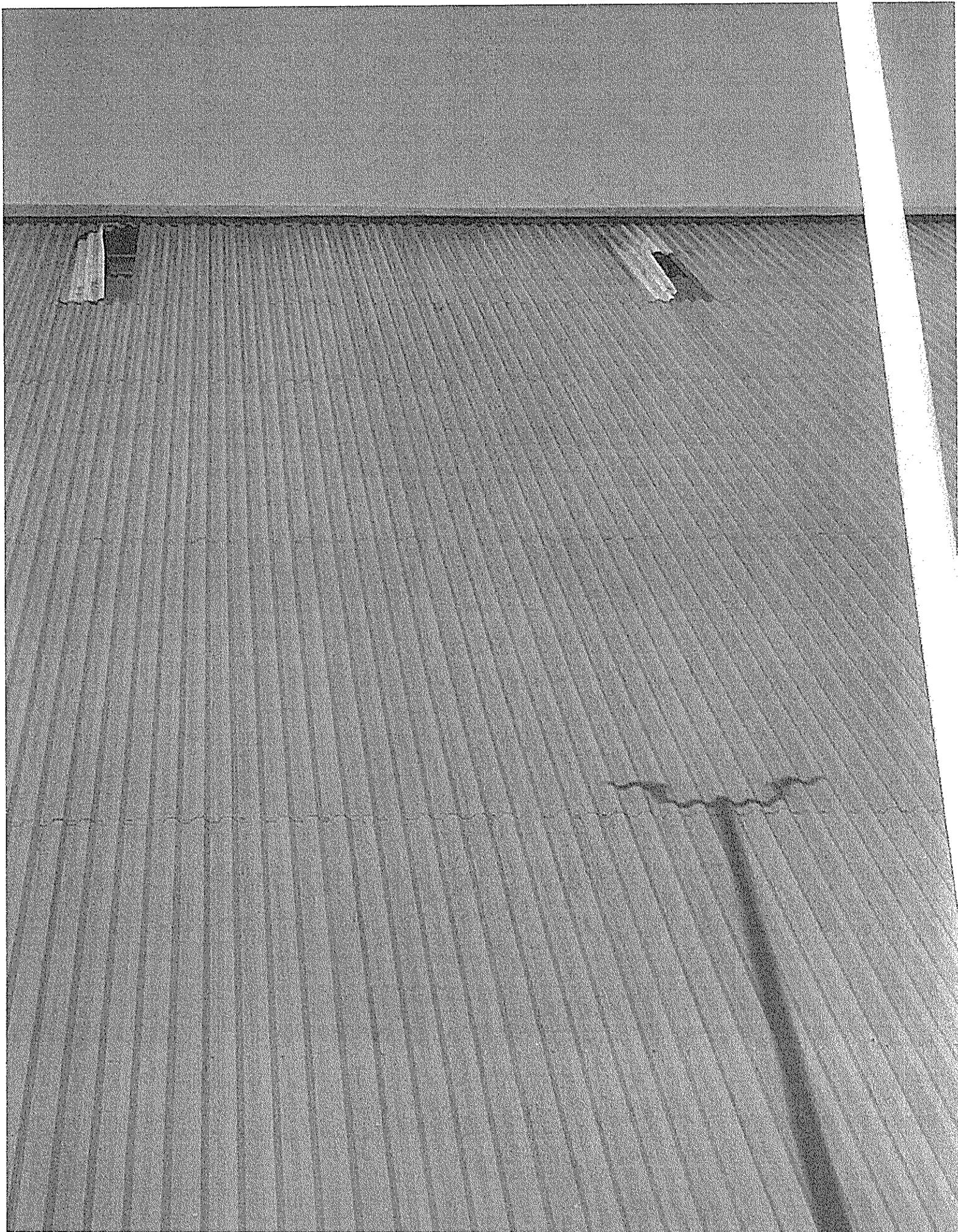
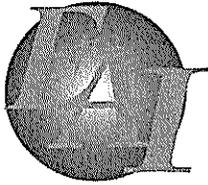


EXHIBIT 3



ENVIRONMENTAL AUDIT, INC.®

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40th ANNIVERSARY
mbaverman@envaudit.com
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sent via email

MEMORANDUM

Project No. 3137

DATE: April 30, 2019

TO: Shelly Micucci
Phillips 66

FROM: Marcia Baverman

RE: Revised Emissions Calculations for Coke Barn Operations

Environmental Audit, Inc. (EAI) was requested to calculate emissions from coke barn operations at the Phillips 66 Carson Refinery in preparation for maintenance activities of the barn. This memo presents the results of the calculations and subsequent review by Phillips 66.

EAI reviewed data presented in the South Coast Air Quality Management District (SCAQMD) staff report prepared for the Proposed Amended Rule 1158 (PAR 1158) that was adopted June 11, 1999 and amended in July 11, 2008. Emission calculations presented in PAR 1158 were based on sections of the U.S. Environmental Protection Agency (U.S. EPA) AP-42 emission factors. EAI reviewed U.S. EPA AP-42 for updates to the emission factors used in PAR 1158. The pile wind erosion factor used in PAR 1158 was based on Section 11.2.3-3, equation 3, May 1983. This has been updated and is now presented in Section 13.2.5. Attachment A shows the components of coke handling emission estimate calculations and the respective emissions associated with each activity. The pertinent sections of PAR 1158 and U.S. EPA AP-42 are presented in Appendix B for reference.

There are four components to coke handling activities: 1) loading of aggregate onto storage piles including conveyor transfer points, 2) equipment traffic in storage area, 3) wind erosion of pile surfaces and ground areas around piles, and 4) loadout of aggregate for shipment. Item 4 relates to truck loading activities, which are not pertinent to coke barn maintenance activities. Emissions from truck loading would not be affected and remain unchanged and, therefore, were not calculated.

The assumptions used for the calculations are consistent with those used in PAR 1158 with the exception of the maximum wind speed for pile erosion calculations. The maximum wind speed used in PAR 1158 was 12 miles per hour. EAI used the 99th percentile maximum wind speed from the SCAQMD meteorology data from the Long Beach monitoring station for modeling purposes, which approximately 17 miles per hour. This change was made to calculate a more conservative emission estimate of uncontrolled emissions, should maintenance activities warrant calculation of emissions with less control. The emissions were calculated using three scenarios and presented in Attachment A. The scenarios are as listed below:

1. Uncontrolled – No control measures used.

The uncontrolled coke PM10 emissions from loading of storage piles are estimated to be 0.64 pounds per day, which includes two transfer points. One transfer point is from conveyor to conveyor and one transfer point from conveyor to storage pile. It is expected that only one conveyor set (15 and 16 or 17 and 18) operate at a time. The uncontrolled coke PM10 emissions from equipment in the storage area are estimated to be 0.06 pounds per day. The uncontrolled coke PM10 emissions from wind erosion are estimated to be 5.62 pounds per day. The total daily PM10 emissions are estimated to be 6.32 pounds per day.

The uncontrolled coke PM2.5 emissions from loading of storage piles are estimated to be 0.10 pounds per day, which includes two transfer points. One transfer point is from conveyor to conveyor and one transfer point from conveyor to storage pile. It is expected that only one conveyor set (15 and 16 or 17 and 18) operate at a time. The uncontrolled coke PM2.5 emissions from equipment in the storage area are estimated to be less than 0.01 pounds per day. The uncontrolled coke PM2.5 emissions from wind erosion are estimated to be 0.04 pounds per day. The total daily PM2.5 emissions are estimated to be 0.95 pounds per day.

2. Controlled – Control measures consistent with Rule 1158.

The controlled coke PM10 emissions from loading of storage piles are estimated to be 0.03 pounds per day, which includes two transfer points. One transfer point is from conveyor to conveyor and one transfer point from conveyor to storage pile. It is expected that only one conveyor set (15 and 16 or 17 and 18) operate at a time. The controlled coke PM10 emissions from equipment in the storage area are estimated to be less than 0.01 pounds per day. The controlled coke PM10 emissions from wind erosion are estimated to be 0.28 pounds per day. The total daily PM10 emissions are estimated to be 0.32 pounds per day.

The controlled coke PM2.5 emissions from loading of storage piles are estimated to be less than 0.01 pounds per day, which includes two transfer points. One transfer point is from conveyor to conveyor and one transfer point from conveyor to storage

pile. It is expected that only one conveyor set (15 and 16 or 17 and 18) operate at a time. The controlled coke PM2.5 emissions from equipment in the storage area are estimated to be less than 0.01 pounds per day. The controlled coke PM2.5 emissions from wind erosion are estimated to be 0.04 pounds per day. The total daily PM2.5 emissions are estimated to be 0.05 pounds per day.

3. Partially Controlled – Control measures consistent with Rule 1158, with 98 percent capture efficiency due to 2 percent exposure during maintenance.

The partially controlled coke PM10 emissions from loading of storage piles are estimated to be 0.04 pounds per day, which includes two transfer points. One transfer point is from conveyor to conveyor and one transfer point from conveyor to storage pile. It is expected that only one conveyor set (15 and 16 or 17 and 18) operate at a time. The partially controlled coke PM10 emissions from equipment in the storage area are estimated to be less than 0.01 pounds per day. The partially controlled coke PM10 emissions from wind erosion are estimated to be 0.39 pounds per day. The total daily PM10 emissions are estimated to be 0.44 pounds per day.

The partially controlled coke PM2.5 emissions from loading of storage piles are estimated to be 0.01 pounds per day, which includes two transfer points. One transfer point is from conveyor to conveyor and one transfer point from conveyor to storage pile. It is expected that only one conveyor set (15 and 16 or 17 and 18) operate at a time. The partially controlled coke PM2.5 emissions from equipment in the storage area are estimated to be less than 0.01 pounds per day. The partially controlled coke PM2.5 emissions from wind erosion are estimated to be 0.06 pounds per day. The total daily PM2.5 emissions are estimated to be 0.07 pounds per day.

Approximately 90 percent of the estimated emissions are from wind erosion of storage piles. Therefore, loss of enclosure would be most influenced by wind erosion of storage piles. Emissions from wind erosion of storage piles are dependent on wind speed, and particle size. Therefore, if control efficiency decreases, wind speed could be monitored and installation of a temporary enclosure could be employed to compensate for high wind speed.

If you have questions or comments, please contact me at (714) 632-8521 ext. 237.

MRB:mc

Attachments

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ATTACHMENT A
EMISSION ESTIMATES

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**Phillips 66 Coke Barn
PM10 Emission Estimate Calculations**

1. Loading of Aggregate onto Storage Piles

$$EF_1(\text{lb/ton}) = k_1 * (0.0032) * (U/5)^{1.3} / (M/2)^{1.4}$$

where, EF_1 = Emission Factor, Storage Piles
 k_1 = Particle Size Multiplier (dimensionless)
 U = Mean Wind Speed, (miles/hr)
 M = Material Moisture Content (%)

Source: U.S. EPA AP-42, 13.2.4 Eq. (1)

Variables:

k_1 = 0.35 Aerodynamic Particle Size Multiplier for PM10, Source: AP-42, k factor table, page 13.2.4-4.
 U = 5.77 mph, Source: SCAQMD Long Beach Met Data 2012-2016.
 M = 12 %, Source: SCAQMD PAR 1158, Appendix E, page E-8.

Operating Data: 2903 maximum tons/day
 2650 average tons/day

Number of Transfer Points = 2 Normal activities would load lump or fines, not both simultaneously, and involve conveyor 17 to conveyor 18 to pile, or conveyor 15 to conveyor 16 to pile.

$$EF_1 = 0.35 * 0.0032 * \frac{5.8^{1.3}}{5} / \frac{12^{1.4}}{2}$$

$$EF_1 = 1.10E-04 \text{ lbs/ton}$$

Uncontrolled Emissions

$$E_1 = 6.38E-01 \text{ lbs/day, maximum}$$

$$E_1 = 5.82E-01 \text{ lbs/day, average}$$

Controlled Emissions

Enclosure Control Efficiency = 95 %, Source SCAQMD PAR 1158, Appendix C, page C-2.

$$E_{1c} = EF_1 * (1 - \text{Control Efficiency}) * \text{Activity}$$

$$E_{1c} = 1.10E-04 * 0.05 * \text{Activity}$$

$$E_{1c} = 5.49E-06 \text{ lb/ton}$$

$$E_{1c} = 0.03 \text{ lbs/day, maximum}$$

$$E_{1c} = 0.03 \text{ lbs/day, average}$$

Partially Controlled Emissions

Enclosure Control Efficiency = 95 %, Source SCAQMD PAR 1158, Appendix C, page C-2.

Enclosure Capture Efficiency = 98 %, Assumes 2% opening during maintenance.

$$E_{1p} = EF_1 * (1 - \text{Capture Efficiency} * \text{Control Efficiency})$$

$$E_{1p} = 1.10E-04 * 0.069$$

$$E_{1p} = 7.58E-06 \text{ lb/ton}$$

$$E_{1p} = 0.04 \text{ lbs/day, maximum}$$

$$E_{1p} = 0.04 \text{ lbs/day, average}$$

**Phillips 66 Coke Barn
PM10 Emission Estimate Calculations**

2. Equipment Traffic in Storage Area

$$EF_2 \text{ (lb/VMT)} = k_2 * (sL)^{0.91} * (W)^{1.02}$$

where, EF₂ = Emission Factor, Bulldozer
 k₂ = Particle Size Multiplier (lb/VMT)
 sL = Road Surface Silt Loading (g/m²)
 W = Mean Vehicle Weight (tons)

Source: U.S. EPA AP-42, 13.1.3 Eq. (1)

Variables:

k₂ = 0.0022 Aerodynamic Particle Size Multiplier for PM10, Source: AP-42, Table 13.2.2-2, page 13.2.2-5.

sL = 0.015 g/m², Source: AP-42, Table 13.2.1-2, page 13.2.1-8 for limited access.

W = 20 tons, Source: ConocoPhillips

$$EF_2 \text{ (lb/VMT)} = k_2 * (sL)^{0.91} * (W)^{1.02}$$

$$EF_2 = 0.0022 * 0.015^{0.91} * 20^{1.02}$$

$$EF_2 = 0.00102 \text{ lb/VMT}$$

Operating Data: 6.8 mph, maximum speed for dozer full throttle, forward, open area
 3.4 mph, estimated average speed, dozer moving back and forth to move pile to plow conveyor
 8 hrs/day, hours of operation

VMT (max miles/day) = 54 mi/day, max
 VMT (average mile/day) = 27 mi/day, average

Uncontrolled Emissions

E₂ = 0.06 lbs/day, maximum
 0.03 lbs/day, average

Controlled Emissions

Enclosure Control Efficiency = 95 %, Source SCAQMD PAR 1158, Appendix C, page C-2.

$$E_{2c} = EF_2 * (1 - \text{Control Efficiency})$$

$$E_{2c} = 0.03 * 0.05 * \text{VMT}$$

E_{2c} = 0.003 lbs/day, maximum

E_{2c} = 0.001 lbs/day, average

Partially Controlled Emissions

Enclosure Control Efficiency = 95 %, Source SCAQMD PAR 1158, Appendix C, page C-2.

Enclosure Capture Efficiency = 98 %, Assumes 2% opening during maintenance.

$$E_{2P} = EF_2 * (1 - \text{Control Efficiency} * \text{Capture Efficiency})$$

$$E_{2P} = 0.00102 * 0.069$$

E_{2P} = 0.004 lbs/day, maximum

E_{2P} = 0.002 lbs/day, average

**Phillips 66 Coke Barn
PM10 Emission Estimate Calculations**

3. Wind Erosion of Pile Surfaces and Ground Areas Around Piles

$$E_3 = k \sum P_i$$

where, E_3 = Emission Factor g/day, Wind Erosion

k_2 = Particle Size Multiplier, 0.5 for PM10

\sum = Sum from 1 to N, N = number of disturbances per year

P_i = Erosion potential corresponding to the observed (or probable) fastest mile of wind for the i th period between disturbances (g/m^2)

Source: U.S. EPA AP-42, 13.2.5 Eq. (2)

Using the procedure outlined in U.S. EPA AP-42, Section 13.2.5, on page 13.2.5-5.

Step 1: Determine Threshold Friction Velocity (u_t) for erodible material from Table 13.2.5-2

$$u_t = 0.55 \text{ m/s}$$

Step 2: Divide the exposed surface area into subareas of constant frequency of disturbance (N)

The coke barn contains 4 conical piles that are disturbed daily.

$$N = 365$$

Step 3: Tabulate fastest mile values (u^*) for each frequency of disturbance and correct them to 10 m (u^*_{10}) using Eq. 5

Review of the SCAQMD met modeling data for the Long Beach station shows the 99th percentile wind speed to be 17 miles/hr or 7.6 m/s. Data is already at 10 m. Therefore, no adjustment is made.

$$u^* = u^*_{10} = 17.0 \text{ miles/hr}$$

Step 4: Convert fastest mile values ($u+10$) to equivalent friction (u^*), taking into account the nonuniform wind exposure of elevated surfaces (piles) using Eq. 6 and Eq.7

From Table 13.2.5-4, using $u^*_{10} = 16.8 \text{ miles/hr}$,

$$u^* \text{ for } (u_s/u_r=0.2) = 0.15 \text{ m/s}$$

$$u^* \text{ for } (u_s/u_r=0.6) = 0.46 \text{ m/s}$$

$$u^* \text{ for } (u_s/u_r=0.9) = 0.68 \text{ m/s}$$

Step 5: For elevated surfaces (piles), subdivide areas of constant N into subareas of constant u^* and determine the size of each subarea

From Table 13.2.5.3, for a conical pile (Pile A)

Pile Subarea	%	Area (m^2)
0.2a	5	502.5442
0.2b	35	3517.81
0.6a	48	4824.424
0.9	12	1206.106

The coke barn has 4 piles, each with a maximum diameter of 150 ft and maximum height of 87 ft.

$$A = \pi * r * (r^2 + h^2)^{0.5}$$

$$A = 27064 \text{ ft}^2 \text{ per pile}$$

$$A = 108258 \text{ ft}^2$$

Step 6: For each subarea of constant N and u^* , calculate the erosion potential (P_i) using Eq 3.

$$P = 58 * (u^* - u_t^*)^2 + 24 * (u^* - u_t^*) \quad \text{and } P = 0 \text{ for } u^* \leq u_t^*$$

For 15 miles/hr, $u^* < u_t^*$ for pile subareas 0.2a and 0.6a. Therefore, only one P_i is calculated.

$$P_{0.9} = 58(0.68 - 0.55)^2 + 25(0.68 - 0.55)$$

$$P_{0.9} = 4.2302 \text{ g/m}^2$$

Step 7: Multiply the resulting emission factor for each subarea by the size of the subarea, and the sum for all subareas.

Since $P_{0.2}$ and $P_{0.6} = 0$, $P = P_{0.9} * A_{0.9}$.

$$P = 4.2302 * 1206.1$$

$$P = 5102.1 \text{ g/day}$$

**Phillips 66 Coke Barn
PM10 Emission Estimate Calculations**

Uncontrolled Emissions

$$E_3 = k * \sum P_i$$

$$E_3 = 5.62 \text{ lb/day}$$

Controlled Emissions

Enclosure Control Efficiency = 95 %, Source SCAQMD PAR 1158, Appendix C, page C-2.

$$E_{3c} = E_3 * (1-.95)$$

$$E_{3c} = 0.28 \text{ lb/day}$$

Partially Controlled Emissions

Enclosure Control Efficiency = 95 %, Source SCAQMD PAR 1158, Appendix C, page C-2.

Enclosure Capture Efficiency = 98 %, Assumes 2% opening during maintenance.

$$E_{3p} = E_3 * (1-.95*.98)$$

$$E_{3p} = 0.39 \text{ lb/day}$$

**Phillips 66 Coke Barn
PM10 Emission Estimate Calculations**

4. Summary of Emissions

UNCONTROLLED EMISSIONS FROM THE COKE BARN

$$E = E_1 + E_2 + E_3$$

$$E = 0.64 + 0.06 + 5.62$$

$$E = 6.32 \text{ lbs/day}$$

TOTAL CONTROLLED EMISSIONS FROM THE COKE BARN

$$E_c = E_{1c} + E_{2c} + E_{3c}$$

$$E_c = 0.03 + 0.003 + 0.28$$

$$E_c = 0.32 \text{ lbs/day}$$

PARTIALLY CONTROLLED EMISSIONS FROM THE COKE BARN

$$E_p = E_{1p} + E_{2p} + E_{3p}$$

$$E_p = 0.04 + 0.004 + 0.39$$

$$E_p = 0.44 \text{ lbs/day}$$

References: U.S. EPA AP-42 Sections 13.2.4 (1/95) U.S. EPA AP-42 Section 13.2.5 (1/95)

**Phillips 66 Coke Barn
PM2.5 Emission Estimate Calculations**

1. Loading of Aggregate onto Storage Piles

$$EF_1(\text{lb/ton}) = k_1 * (0.0032) * (U/5)^{1.3} / (M/2)^{1.4}$$

where, EF_1 = Emission Factor, Storage Piles

k_1 = Particle Size Multiplier (dimensionless)

U = Mean Wind Speed, (miles/hr)

M = Material Moisture Content (%)

Source: U.S. EPA AP-42, 13.2.4 Eq. (1)

Variables:

k_1 = 0.053 Aerodynamic Particle Size Multiplier for PM2.5, Source: AP-42, k factor table, page 13.2.4-4.

U = 5.77 mph, Source: SCAQMD Long Beach Met Data 2012-2016.

M = 12 %, Source: SCAQMD PAR 1158, Appendix E, page E-8.

Operating Data: 2903 maximum tons/day

2650 average tons/day

Number of Transfer Points = 2 Normal activities would load lump or fines, not both simultaneously, and involve conveyor 17 to conveyor 18 to pile, or conveyor 15 to conveyor 16 to pile.

$$EF_1 = 0.053 * 0.0032 * \frac{5.8^{1.3}}{5} / \frac{12^{1.4}}{2}$$

$$EF_1 = 1.66E-05 \text{ lbs/ton}$$

Uncontrolled Emissions

$$E_1 = 9.66E-02 \text{ lbs/day, maximum}$$

$$E_1 = 8.81E-02 \text{ lbs/day, average}$$

Controlled Emissions

Enclosure Control Efficiency = 95 %, Source SCAQMD PAR 1158, Appendix C, page C-2.

$$E_{1c} = EF_1 * (1 - \text{Control Efficiency}) * \text{Activity}$$

$$E_{1c} = 1.66E-05 * 0.05 * \text{Activity}$$

$$E_{1c} = 8.31E-07 \text{ lb/ton}$$

$$E_{1c} = 0.005 \text{ lbs/day, maximum}$$

$$E_{1c} = 0.004 \text{ lbs/day, average}$$

Partially Controlled Emissions

Enclosure Control Efficiency = 95 %, Source SCAQMD PAR 1158, Appendix C, page C-2.

Enclosure Capture Efficiency = 98 %, Assumes 2% opening during maintenance.

$$E_{1p} = EF_1 * (1 - \text{Capture Efficiency} * \text{Control Efficiency})$$

$$E_{1p} = 1.66E-05 * 0.069$$

$$E_{1p} = 1.15E-06 \text{ lb/ton}$$

$$E_{1p} = 0.01 \text{ lbs/day, maximum}$$

$$E_{1p} = 0.01 \text{ lbs/day, average}$$

**Phillips 66 Coke Barn
PM2.5 Emission Estimate Calculations**

2. Equipment Traffic in Storage Area

$$EF_2 \text{ (lb/VMT)} = k_2 * (sL)^{0.91} * (W)^{1.02}$$

where, EF_2 = Emission Factor, Bulldozer
 k_2 = Particle Size Multiplier (lb/VMT)
 sL = Road Surface Silt Loading (g/m²)
 W = Mean Vehicle Weight (tons)

Source: U.S. EPA AP-42, 13.1.3 Eq. (1)

Variables:

k_2 = 0.00054 Aerodynamic Particle Size Multiplier for PM2.5, Source: AP-42, Table 13.2.2-2, page 13.2.2-5.

sL = 0.015 g/m², Source: AP-42, Table 13.2.1-2, page 13.2.1-8 for limited access.

W = 20 tons, Source: ConocoPhillips

$$EF_2 \text{ (lb/VMT)} = k_2 * (sL)^{0.91} * (W)^{1.02}$$

$$EF_2 = 0.00054 * 0.015^{0.91} * 20^{1.02}$$

$$EF_2 = 0.00025 \text{ lb/VMT}$$

Operating Data: 6.8 mph, maximum speed for dozer full throttle, forward, open area
 3.4 mph, estimated average speed, dozer moving back and forth to move pile to plow conveyor
 8 hrs/day, hours of operation

VMT (max miles/day) = 54 mi/day, max
 VMT (average mile/day) = 27 mi/day, average

Uncontrolled Emissions

E_2 = 0.014 lbs/day, maximum
 0.007 lbs/day, average

Controlled Emissions

Enclosure Control Efficiency = 95 %, Source SCAQMD PAR 1158, Appendix C, page C-2.

$$E_{2c} = EF_2 * (1 - \text{Control Efficiency})$$

$$E_{2c} = 0.01 * 0.05 * \text{VMT}$$

$$E_{2c} = 0.001 \text{ lbs/day, maximum}$$

$$E_{2c} = 0.0003 \text{ lbs/day, average}$$

Partially Controlled Emissions

Enclosure Control Efficiency = 95 %, Source SCAQMD PAR 1158, Appendix C, page C-2.

Enclosure Capture Efficiency = 98 %, Assumes 2% opening during maintenance.

$$E_{2p} = EF_2 * (1 - \text{Control Efficiency} * \text{Capture Efficiency})$$

$$E_{2p} = 0.00025 * 0.069$$

$$E_{2p} = 0.001 \text{ lbs/day, maximum}$$

$$E_{2p} = 0.0005 \text{ lbs/day, average}$$

**Phillips 66 Coke Barn
PM2.5 Emission Estimate Calculations**

3. Wind Erosion of Pile Surfaces and Ground Areas Around Piles

$$E_3 = k \sum P_i$$

where, E_3 = Emission Factor g/day, Wind Erosion

k_2 = Particle Size Multiplier, 0.075 for PM2.5

\sum = Sum from 1 to N, N = number of disturbances per year

P_i = Erosion potential corresponding to the observed (or probable) fastest mile of wind for the ith period between disturbances (g/m^2)

Source: U.S. EPA AP-42, 13.2.5 Eq. (2)

Using the procedure outlined in U.S. EPA AP-42, Section 13.2.5, on page 13.2.5-5.

Step 1: Determine Threshold Friction Velocity (u_t) for erodible material from Table 13.2.5-2

$$u_t = 0.55 \text{ m/s}$$

Step 2: Divide the exposed surface area into subareas of constant frequency of disturbance (N)

The coke barn contains 4 conical piles that are disturbed daily.

$$N = 365$$

Step 3: Tabulate fastest mile values (u^+) for each frequency of disturbance and correct them to 10 m (u^+_{10}) using Eq. 5

Review of the SCAQMD met modeling data for the Long Beach station shows the 99th percentile wind speed to be 17 miles/hr or 7.6 m/s. Data is already at 10 m. Therefore, no adjustment is made.

$$u^+ = u^+_{10} = 17.0 \text{ miles/hr}$$

Step 4: Convert fastest mile values (u^+_{10}) to equivalent friction (u^*), taking into account the nonuniform wind exposure of elevated surfaces (piles) using Eq. 6 and Eq. 7

From Table 13.2.5-4, using $u^+_{10} = 16.8 \text{ miles/hr}$,

$$u^* \text{ for } (u_g/u_r=0.2) = 0.15 \text{ m/s}$$

$$u^* \text{ for } (u_g/u_r=0.6) = 0.46 \text{ m/s}$$

$$u^* \text{ for } (u_g/u_r=0.9) = 0.68 \text{ m/s}$$

Step 5: For elevated surfaces (piles), subdivide areas of constant N into subareas of constant u^* and determine the size of each subarea

From Table 13.2.5.3, for a conical pile (Pile A)

Pile Subarea	%	Area (m^2)
0.2a	5	502.5442
0.2b	35	3517.81
0.6a	48	4824.424
0.9	12	1206.106

The coke barn has 4 piles, each with a maximum diameter of 150 ft and maximum height of 87 ft.

$$A = \pi * r * (r^2 + h^2)^{0.5}$$

$$A = 27064 \text{ ft}^2 \text{ per pile}$$

$$A = 108258 \text{ ft}^2$$

Step 6: For each subarea of constant N and u^* , calculate the erosion potential (P_i) using Eq 3.

$$P = 58 * (u^* - u_t^*)^2 + 24 * (u^* - u_t^*) \quad \text{and } P = 0 \text{ for } u^* \leq u_t^*$$

For 15 miles/hr, $u^* < u_t^*$ for pile subareas 0.2a and 0.6a. Therefore, only one P_i is calculated.

$$P_{0.9} = 58(0.68 - 0.55)^2 + 25(0.68 - 0.55)$$

$$P_{0.9} = 4.2302 \text{ g/m}^2$$

Step 7: Multiply the resulting emission factor for each subarea by the size of the subarea, and the sum for all subareas.

Since $P_{0.2}$ and $P_{0.6} = 0$, $P = P_{0.9} * A_{0.9}$.

$$P = 4.2302 * 1206.1$$

$$P = 5102.1 \text{ g/day}$$

**Phillips 66 Coke Barn
PM2.5 Emission Estimate Calculations**

Uncontrolled Emissions

$$E_3 = k * \sum P_i$$

$$E_3 = \quad \mathbf{0.84} \quad \text{lb/day}$$

Controlled Emissions

Enclosure Control Efficiency = 95 %, Source SCAQMD PAR 1158, Appendix C, page C-2.

$$E_{3c} = E_3 * (1-.95)$$

$$E_{3c} = \quad \mathbf{0.04} \quad \text{lb/day}$$

Partially Controlled Emissions

Enclosure Control Efficiency = 95 %, Source SCAQMD PAR 1158, Appendix C, page C-2.

Enclosure Capture Efficiency = 98 %, Assumes 2% opening during maintenance.

$$E_{3P} = E_3 * (1-.95*.98)$$

$$E_{3P} = \quad \mathbf{0.06} \quad \text{lb/day}$$

**Phillips 66 Coke Barn
PM2.5 Emission Estimate Calculations**

4. Summary of Emissions

UNCONTROLLED EMISSIONS FROM THE COKE BARN

$$E = E_1 + E_2 + E_3$$

$$E = 0.10 + 0.014 + 0.84$$

$$E = 0.95 \text{ lbs/day}$$

TOTAL CONTROLLED EMISSIONS FROM THE COKE BARN

$$E_c = E_{1c} + E_{2c} + E_{3c}$$

$$E_c = 0.005 + 0.001 + 0.04$$

$$E_c = 0.05 \text{ lbs/day}$$

PARTIALLY CONTROLLED EMISSIONS FROM THE COKE BARN

$$E_p = E_{1p} + E_{2p} + E_{3p}$$

$$E_p = 0.01 + 0.001 + 0.06$$

$$E_p = 0.07 \text{ lbs/day}$$

References: U.S. EPA AP-42 Sections 13.2.4 (1/95) U.S. EPA AP-42 Section 13.2.5 (1/95)

ATTACHMENT B

PERTINENT SECTIONS OF PAR 1158 AND U.S. EPA AP-42

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APPENDIX E

EMISSION BASELINE AND REDUCTIONS
CALCULATION METHODOLOGIES

The material transfer/continuous/batch drop variables include the load in/out factor, number of transfers to/from a pile and the throughput. The load in/out factor includes the PM <10 micron/<30 micron factor, average wind speed (mph), percent moisture and unit conversion factors. The average annual wind speed used was six miles per hour based on local monitoring data. The average percent coke and coal moisture, the number of transfers (continuous/batch drop transfer to the pile and continuous/batch transfer from the pile), the throughput and other facility specific details are in the following Table E-1.

**TABLE E-1
PILE MATERIAL TRANSFER INPUT DETAIL**

Facility	Moisture Coke/Sulfur %	Moisture Coal %	Primary Thruput Coke/Sulfur tpy	Secondary Thruput Coal/Coke tpy	No. of Transfers Coke/Sulfur	No. of Transfers Coal/Coke
Company 1	4	4	2500000	4400000	3	3
Company 2	4		500000		3	
Company 3	4		181000		3	
Company 4	8	4	2000000	200000	3	0
Company 5	4		950000		3	
Company 6	4	4	2000000	1500000	3	3
Company 7	4	4	750000	750000	3	3
Company 8	4	4	26000	59000	2	2
Company 9	2.5		200000		3	
Company 10	8		900000		3	
Company 11	8		850000		3	
Company 12	8		1131500		3	
Company 13	8		547500		3	
Company 14	0.5	4	450000	630000	3	3
Company 15	2.5		370000		3	
Company 16	4		9820		2	
Company 17	4		9820		2	
Company 18	4		100000		3	

The pile erosion variables include percent silt, number of days a year with at least 0.01 inches of precipitation, percent of time that the wind speed exceeds twelve miles per hour, the PM10/PM30 factor and the acreage of land that the pile occupies. Based on field inspections and various studies, the silt content used for coke was 6 %. Local monitoring data indicates that the average number of days exceeding 0.01 inches a year is 34, and the percentage of time the wind speed exceeds twelve miles per hour is 8%. The PM10/PM ratio is 0.5. The acreage of land that a pile occupies varies depending on the facility, as detailed in Table E-2.

An additional emission source associated with pile activity is attributed to water trucks travelling over silt laden roads and adjacent piles. Water truck pile activity associated with Company 1 was

derived using the “vehicle travel on paved road” equation (AP-42.13.2.1-3, 10/97). The input factors were; silt loading at 2.10 g/m²; vehicle weight at 16.5 tons; and annual distance traveled at 4,817 miles. Vehicle weight was calculated assuming a half-full four ton (3,000 gallon) water truck. The annual vehicle miles were calculated from information provided by Company 1. Water truck pile activity associated with Companies 3 and 7 used the vehicle travel on unpaved road equation (AP-42 13.2.2-3, 9/98). The input factors were; silt content at 12%, vehicle weight at 16.5 tons; and annual distance travelled at 4,560 and 4,585 miles, respectively. Vehicle weight was calculated assuming a half-full four ton (3,000 gallon) water truck. Annual vehicle miles were calculated from information provided by Company 3 and extrapolated to Company 7 based on acreage.

**TABLE E-2
PILE EROSION INPUT DETAIL**

Facility	Primary Coke/Sulfur Acreage	Secondary Coal/Coke Acreage
Company 1	0.7625	10
Company 2	0.91	
Company 3	4.575	
Company 4	0	2
Company 5	0	
Company 6	0.7625	0
Company 7	0	4.6
Company 8	0	1
Company 9	2.2875	
Company 10	0	
Company 11	0	
Company 12	0	
Company 13	0	
Company 14	0	0
Company 15	0	
Company 16	0.1	
Company 17	0.1	
Company 18	6.1	

The endloader/tractor variables include percent silt, endloader/tractor speed, endloader/tractor weight, average number of days with at least 0.01 inches of precipitation and average endloader/tractor miles traveled a year. Due to the crushing of material from the weight of the endloader/tractor, percent silt for coke and coal used was 12% and 5%, respectively. Estimated average four wheeled endloader/tractor speed for coke and coal was 4.3 mph and 12 mph, respectively; endloader/tractor weight is 18 tons (125 ton and 38 ton tractors are used at Company 1, and a 104.3 ton tractor is used at Company 8) based on field inspections; and annual vehicle mileage

was proportioned to the amount stored at each facility, as detailed in Table E-3, based on the know milage at Compy 1. Watering truck activity was also included.

**TABLE E-3
PILE ENDLOADER INPUT DETAIL**

Facility	Primary Coke/Sulfur Annual miles	Secondary Coal/Coke Annual miles
Company 1	27,352	8,085
Company 2	5,470	
Company 3	1,980	
Company 4	21,881	0
Company 5	0	
Company 6	21,881	2,756
Company 7	8,205	8,205
Company 8	0	186
Company 9	2,188	
Company 10	9,847	
Company 11	9,300	
Company 12	12,379	
Company 13	5,990	
Company 14	0	0
Company 15	4,048	
Company 16	107	
Company 17	107	
Company 18	1,094	

Conveyor emissions set-up:

Conveyor emissions were calculated based on the AP-42 material transfer/continuous/batch drop equation. Facilities were assumed to operate 365 days a year. The following equation was used to conveyor emissions.

$$\text{Conveyor Emission Rate, tpy} = \left(\frac{(\text{LF} \times \text{Trans} \times \text{Thru})}{2000 \frac{\text{lbs}}{\text{ton}}} \right) \times \text{Eff}$$

Where :

$$\text{LF} = \text{Load in/out Factor, } \frac{\text{lb}}{\text{metric ton}}$$

$$= k_L \times 0.0032 \times \left(1.1 \frac{\text{ton}}{\text{metric ton}} \right) \times \left(\frac{\text{WS}}{5} \right)^{1.3} \times \left(\frac{\text{M}}{2} \right)^{-1.4}$$

Trans = Number of Transfers

Thru = Annual Facility Throughput

Eff = Efficiency of Fugitive Dust Controls

Water Spray System = 80% (AP - 42, 8.19.1 - 2, 9/85)

Enclosure and Waterspray = 95% (assumed)

Variables :

k_L = Particle Size Multiplier = 0.35 (PM10) & 0.74 (PM30)

WS = Mean Wind Speed, mph

M = Material Moisture Content, %

The material transfer/continuous/batch drop variables include the load in/out factor, number of conveyor transfers and the throughput. The load in/out factor includes the PM <10 micron/<30 micron factor, average wind speed, percent moisture and unit conversion factors. The average annual wind speed used was six miles per hour based on local monitoring data. The average percent coke and coal moisture used was six percent at storage and shiploading facilities, and twelve percent at refinery facilities based on field inspections except a Company 1, where detailed moisture content of shipped materials were kept and provided to the SCAQMD. At Company 1, the percent moisture for conveyed coke and coal was 8.9 and 8.6, respectively. The number of continuous/batch transfers depends on the number of conveyors at each facility. Throughput also depends on the individual facility, as indicated in Table E-4.

TABLE E-4
CONVEYOR MATERIAL TRANSFER INPUT DETAIL

Facility	Primary Coke/Sulfur Moisture %	Secondary Coal/Coke Moisture %	Primary Coke/Sulfur No. Transfer	Secondary Coal/Coke No. Transfer	Primary Coke/Sulfur Thruput tpy	Secondary Coal/Coke Thruput tpy
Company 1	8.9	8.6	20	20	2500000	4400000
Company 2	6		4		500000	
Company 3	6		0		181000	
Company 4	12		5		2000000	
Company 5	6		10		950000	
Company 6	6	6	5	5	2000000	1500000
Company 7	12		4		1500000	
Company 8	6		2		85000	
Company 9	12		0		200000	
Company 10	12		6		900000	
Company 11	12		5		850000	
Company 12	12		5		1131500	
Company 13	12		3		547500	
Company 14	0.5	6	10	4	450000	630000
Company 15	12		0		370000	
Company 18	6		0		100000	

Truck/railcar unloading, loading emissions set-up:

Truck/railcar unloading, loading emissions were calculated based on the AP-42 material transfer/continuous/batch drop equation. Facilities were assumed to operate 365 days a year. The following equation was used to estimate loading and unloading emissions associated with pile activities.

$$\text{Truck Load/Unload Emission Rate, tpy} = \left(\frac{(\text{LF} \times \text{Truck} \times \text{Thru} \times \text{Days})}{2000 \frac{\text{lbs}}{\text{ton}}} \right) \times \text{Eff}$$

Where :

$$\text{LF} = \text{Load in/out Factor, } \frac{\text{lb}}{\text{metric ton}}$$

$$= k_L \times 0.0032 \times \left(1.1 \frac{\text{ton}}{\text{metric ton}} \right) \times \left(\frac{\text{WS}}{5} \right)^{1.3} \times \left(\frac{\text{M}}{2} \right)^{-1.4}$$

Truck = Number of Trucks Per Day

Thru = Annual Facility Throughput, metric ton

Days = Days Per Year Facility Operates = 365

Eff = Efficiency of Fugitive Dust Controls

Water Spray System = 80% (AP - 42, 8.19.1 - 2, 9/85)

Enclosure and Waterspray = 95% (assumed)

Variables :

k_L = Particle Size Multiplier = 0.35 (PM10) & 0.74 (PM30)

WS = Mean Wind Speed, mph

M = Material Moisture Content, %

The truck unloading/railcar unloading activities take place at the storage and shipping facilities; the truck/railcar loading activities take place at the refinery facilities. Variables include the load in/out factor, number of number of trucks per day and the throughput per truck. The load in/out factor includes the PM <10 micron/<30 micron factor, average wind speed, percent moisture and unit conversion factors. The average annual wind speed used was six miles per hour based on local monitoring data. The average percent coke and coal moisture used was six percent at storage and shiploading facilities, and twelve percent at refinery facilities based on field inspections. The number of trucks per day is a function of the throughput, with each truck load carrying 25 metric tons (9 metric tons for small end-user facilities). The facility specific details are as follows in Table E-5.

TABLE E-5
TRUCK & RAILCAR LOADING & UNLOADING INPUT DETAIL

Facility	Primary Coke/Sulfur Moisture %	Secondary Coal/Coke Moisture %	Rail Moisture %	Primary Coke/Sulfur No. Trucks/ day	Secondary Coal/Coke No. Trucks/ day	No. Rails/ day	Thruput ton	Thruput ton
Company 1	6	N/A	6	274	N/A	120	N/A	100
Company 2	6			55				
Company 3	6			40				
Company 4	12			219				
Company 5	6			104				
Company 6	6	N/A	6	219	N/A	41	N/A	100
Company 7	9			164				
Company 8	4	4		3		2	100	
Company 9	2.5			22				
Company 10	12			99				
Company 11	12			93				
Company 12	12			110				
Company 13	12			60				
Company 14	0.5	6	0.5	49	69	2	25	90
Company 15	2.5			41				
Company 16	4			3				
Company 17	4			3				
Company 18	6			22				

Wind erosion during coke truck transport:

Emissions from wind erosion during transport off the open top truck were calculated based on the AP-42 industrial wind erosion equations. The emissions associated with this activity are tagged to the facility delivering the material (refinery facility) and not to the facility receiving the material (storage, shiploading facility). The following equation was used to estimate transport emissions.

INTRODUCTION

Appendix E summarizes the methodology for calculating the emissions baseline and reductions.

METHODOLOGIES

Reference: EPA's AP-42

1. Chapter 11, Section 11.2.3.3, equation 3, 5/83, Pile erosion.
2. Chapter 13, Section, 13.2.1.3, equation 1, 10/97, Track out.
3. Chapter 13, Section 13.2.2.2, equation 1, 1/95, Endloader/tractor activity.
4. Chapter 13, Section 13.2.4.3, equation 1, 1/95, Material transfer, continuous/batch drop.
5. Chapter 13, Sections 13.2.5, equations 1-5, 1/95, Industrial wind erosion.

Storage and handling emissions set-up:

Storage and handling emissions were calculated based on AP-42's material transfer/continuous/batch drop, pile erosion and endloader/tractor activity equations. All facilities were assumed to operate 365 days a year. The following equation was used to estimate storage and handling emissions associated with pile activities.

Transport Emission Rate, tpy = (EP × SA × Freq × Vehicle × MF × PM10) × Eff

Where :

EP = Erosion Potential

$$= 58 \times (U^* - U_t)^2 + 25 \times (U^* - U_t)$$

SA = Surface Area

Freq = Disturbance Frequency

Vehicle = Number of Vehicles

MF = Moisture Factor

$$= \left(\frac{M}{2} \right)^{-1.4}$$

PM10 = PM10 Ratio

Eff = Efficiency of Fugitive Dust Controls = 95% (assumed)

Slot Tops = 85%

Fiberglass and Sliding Hard Tops = 96.5%

Variables :

U* = Friction Velocity

$$= \frac{0.4 \times WS}{\ln(\text{height/roughness height})}$$

U_t = Threshold Velocity (Environ Study)

WS = Mean Wind Speed, mph

M = Material Moisture Content, %

The associated variables include: erosion potential, exposed surface area; disturbance frequency; number of vehicles; a moisture factor and PM₁₀/PM ratio (0.5); and a default roughness height of 0.3 centimeters. Erosion potential is calculated using the friction velocity and threshold friction velocity. Friction velocity is calculated based on the height above the surface of the material to the top of the trailer, and the fastest mile of wind in miles per hour. The height above the exposed surface is estimated at one foot and the threshold friction velocity is the minimum wind velocity impacting the open top and causing a surface disturbance. The threshold friction velocity of coke is estimated at 1.61 miles per hour based on the Environ Study. A moisture factor was included to impart control efficiency. The disturbance frequency is assumed to be once per trip. Field measurements indicate surface areas of 258 square feet for open top sets, 129 sq. feet for aluminum slot top sets, and 18 sq. feet for fiberglass top sets, and the number of trucks varies, depending on the facility, as indicated in Table E-6.

TABLE E-6
MATERIAL LOSS DURING TRANSPORT INPUT DETAILS

Facility	Moisture %	Wind speed mph	Threshold velocity mph	Surface area, sq. Ft.	Disturbances	No. Trucks per year
Company 1	6	60	1.61	129	0	0
Company 2	6	60	1.61	258	0	0
Company 3	6	60	1.61	258	1	7240
Company 4	12	60	1.61	258	1	80000
Company 5	6	60	1.61	258	0	0
Company 6	6	60	1.61	258	0	0
Company 7	9	45	1.61	258	1	60000
Company 8	3	60	1.61	258	0	0
Company 9	6	60	2.98	258	1	8000
Company 10	12	60	1.61	258	1	36000
Company 11	12	60	1.61	258	1	34000
Company 12	12	60	1.61	129	1	40000
Company 13	12	60	1.61	129	1	21900
Company 14	0.5	45	1.61	18	1	15400
Company 15	6	60	2.98	258	1	14800
Company 16	3	60	1.61	129	0	0
Company 17	3	60	1.61	129	0	0
Company 18	6	60	1.61	258	1	4000

Truck/Vehicle Travel On Paved Roads: Track-out emissions:

A predictive emission equation (AP42 13.2.1, 10/97) for paved roads was applied to calculate a track-out emission rate. Two track-out areas were identified; the first is paved surfaces within the facility where primarily in-plant vehicle traffic exists; and the second is the paved road outside the facility exit where coke trucks and cars co-exist on public thru-ways. In-plant vehicle traffic is assumed to be coke trucks only, and for outside traffic, local vehicle traffic counts were obtained from city and county agencies. The following equation was used to estimate trackout emissions.

Transport Emission Rate, tpy = $(k \times s \times WF \times \text{Vehicle} \times \text{VMT}) \times \text{Eff}$

Where :

k = Particle Size Multiplier

$$= 0.016 \frac{\text{lb}}{\text{VMT}} \text{ (PM10)}$$

$$= 0.082 \frac{\text{lb}}{\text{VMT}} \text{ (PM30)}$$

$$s = \text{Silt Factor} = \left(\frac{\text{Baseline SL}}{2} \right)^{0.65}$$

$$WF = \text{Vehicle Factor} = \left(\frac{W}{3} \right)^{1.5}$$

Vehicle = Number of Vehicles per day

VMT = Vehicle Miles Traveled, $\frac{\text{miles}}{\text{day}}$

Eff = Efficiency of Fugitive Dust Controls = Controlled SL
(Prevention and Streetcleaning)

Variables :

SL = Silt Loading Value, $\frac{\text{g}}{\text{m}^2}$

W = Mean Vehicle Weight, tons

Variables include the particle size PM₁₀/PM₃₀ multiplier (pounds per vehicle mile traveled), silt loading factor (grains per square foot), average vehicle weight factor (tons), number of vehicles and annual miles per vehicle.

Silt loading values were obtained from a review of the sources, AP-42 (1/95), MRI (1996) and Environ (1997) and a study performed SCAQMD by Environmental Audit in 1999, that sampled silt at PAR 1158 affected facilities. To determine the baseline silt loading value for paved surfaces within the facility, a value of 2.10 g/m² was selected from the following sources:

Report	Category	Silt Loading g/m ²
Environ	Dockside	3.28
AP-42	Low ADT, worst case	3
AP-42	Industrial Roads mean values	7/4-292
MRI	Low ADT, noticeable trackout	2.04

To determine the rule limit (controlled) for paved surfaces within the facility, a value of 0.25 g/m² was selected from the following sources:

Report	Category	Silt Loading g/m ²
Environ	Pier G Ave	0.45
AP-42	Low ADT, normal	0.4
MRI	Low ADT, South Coast	0.05-0.184

To determine the baseline silt loading value for paved roads outside the facility, a value of 0.45 g/m² was selected from the following sources:

Report	Category	Silt Loading g/m ²
Environ	Pier G Ave.	0.45
AP-42	Public Roads High ADT, worst case	0.4

Finally, to determine the silt loading value for the controlled (rule limit) emissions for roads outside the facility, a value of 0.05 g/m² was selected from the following sources.

Report	Category	Silt Loading g/m ²
Environ	710 Ramp	0.15
MRI	High ADT, South Coast	0.011-0.046
AP-42	Public roads, normal high ADT	0.1

Average vehicle weight for coke carrying trucks within the facility assumed half the time fully loaded and half the time fully unloaded. Since a fully loaded truck cannot weigh more than 40 tons (36 metric tons) total weight, and assuming 25 metric ton loads, the average weight is estimated at 24 metric tons. The average vehicle weight used for all vehicles traveling outside a facility was 14 metric tons (Environ study). The facility specific input data for inside and outside trackout are presented in the following two tables E-7 and E-8.

**TABLE E-7
INSIDE TRACKOUT INPUT DETAILS**

Facility	Uncontrolled Silt Loading g/m ²	Controlled Silt Loading g/m ²	Weight mt	Distance, miles	No. Trucks per day
Company 1	2.10	0.25	24	0.25	274
Company 2	2.10	0.25	24	0.25	55
Company 3	N/A	0.25	24	0.25	20
Company 4	2.10	0.25	24	0.25	219
Company 5	2.10	0.25	24	0.25	104
Company 6	2.10	0.25	24	0.25	219
Company 7	2.10	0.25	24	0.25	164
Company 8	2.10	0.45	24	0.25	3
Company 9	2.10	0.25	24	0.25	22
Company 10	2.10	0.25	24	0.25	99
Company 11	2.10	0.25	24	0.25	93
Company 12	2.10	0.25	24	0.25	110
Company 13	2.10	0.25	24	0.25	60
Company 14	2.10	0.25	24	0.25	118
Company 15	2.10	0.25	24	0.25	41
Company 16	2.10	0.45	15	0.25	3
Company 17	2.10	0.45	15	0.25	3
Company 18	2.10	0.25	24	0.25	11

**TABLE E-8
OUTSIDE TRACKOUT DETAILS**

Facility	Uncontrolled Silt Loading g/m ²	Controlled Silt Loading g/m ²	Weight mt	Distance miles	No. Vehicles per year
Company 1	0.45	0.05	13	0.25	1551250
Company 2	0.45	0.05	13	0.25	2460465
Company 3	0.45	0.05	13	0.25	1551250
Company 4	0.45	0.05	3.1	0.25	16972500
Company 5	0.45	0.05	13	0.25	1222750
Company 6	0.45	0.05	13	0.25	2460465
Company 7	0.45	0.05	3.1	0.25	4927500
Company 9	0.45	0.05	4.398	0.25	12045000
Company 10	0.45	0.05	3.1	0.25	4380000
Company 11	0.45	0.05	4.398	0.25	16972500
Company 12	0.45	0.05	2.55	0.25	16972500
Company 13	0.45	0.05	3.1	0.25	12045000
Company 14	0.45	0.05	3.1	0.25	12045000
Company 15	0.45	0.05	3.1	0.25	12045000
Company 18	0.45	0.05	13	0.25	1551250

APPENDIX I

**EMISSION BASELINE AND REDUCTIONS
CALCULATION SPREADSHEETS**

SUMMARY TABLES

BASIN-WIDE BASELINE AND PROPOSED PM10 EMISSIONS FROM COKE, COAL & PRILLED SULFUR

	EMISSION, TPY BASELINE	EMISSION, TPY AFTER CONTROL	EMISSION, TPY REDUCTION
COKE STORAGE/HANDLING	44.79	0.94	43.85
COAL STORAGE/HANDLING	7.33	6.82	0.50
PRILLED SULFUR STORAGE/HANDLING	2.60	2.60	0.00
COKE CONVEYOR	4.52	0.36	4.16
COAL CONVEYOR	1.37	0.12	1.25
PRILLED SULFUR CONVEYOR	0.00	0.00	0.00
COKE TRUCK UNLOAD & LOAD	0.56	0.35	0.21
COKE RAILCAR LOAD	0.00	0.00	0.00
COAL RAILCAR UNLOAD	0.03	0.03	0.00
PRILLED SULFUR TRUCK UNLOAD & LOAD	0.33	0.33	0.00
COKE TRACK OUT (INSIDE FACILITY)	43.74	6.65	37.09
COKE TRACK OUT (OUTSIDE FACILITY)	148.95	35.23	111.72
PRILLED SULFUR TRACK OUT (INSIDE)	1.07	0.27	0.80
PRILLED SULFUR TRACK OUT (OUTSIDE)	25.81	6.19	19.62
COKE TRUCK TRANSPORT	53.31	7.93	45.38
PRILLED SULFUR TRUCK TRANSPORT	1.99	1.99	0.00
TOTAL	334	70	265

PM10 BASELINE EMISSIONS PER FACILITY

FACILITY	EMISSION, TPY BASELINE	EMISSION, TPY AFTER CONTROL	EMISSION, TPY REDUCTION
COMPANY 7	41.05	2.19	38.85
COMPANY 6	36.05	6.23	30.82
COMPANY 4	35.02	4.88	30.14
COMPANY 11	31.85	6.17	25.68
COMPANY 1	31.84	10.72	20.92
COMPANY 3	23.09	2.83	20.26
COMPANY 2	21.29	4.31	16.98
COMPANY 9	19.87	7.26	12.61
COMPANY 14	16.69	7.44	9.25
COMPANY 12	14.68	4.99	9.69
COMPANY 18	14.17	2.72	11.45
COMPANY 13	13.10	2.67	10.44
COMPANY 10	12.76	1.57	11.19
COMPANY 15	11.93	4.11	7.82
COMPANY 5	10.21	2.48	7.73
COMPANIES 8, 16 & 17	1.00	0.24	0.77
TOTAL	334	70	265

PM10 BASELINE EMISSIONS PER MATERIAL

	STORAGE	CONVEYING	UNLOAD & LOAD	TRACK OUT	TRANSPORT	TOTAL
COKE	44.79	4.52	0.56	190.68	53.31	293.86
COAL	7.33	1.37	0.03	SEE COKE	0.00	8.73
PRILLED SULFUR	2.60	0.00	0.33	29.89	1.99	31.80
TOTAL	54.72	5.89	0.92	217.57	55.29	334

PM10 AFTER CONTROL EMISSIONS PER MATERIAL

	STORAGE	CONVEYING	UNLOAD & LOAD	TRACK OUT	TRANSPORT	TOTAL
COKE	0.94	0.36	0.35	41.88	7.93	51.46
COAL	6.82	0.12	0.03	SEE COKE	0.00	6.98
PRILLED SULFUR	2.60	0.00	0.33	6.46	1.99	11.37
TOTAL	10.36	0.48	0.71	48.33	9.92	70

PM10 EMISSION REDUCTIONS PER MATERIAL

	STORAGE	CONVEYING	UNLOAD & LOAD	TRACK OUT	TRANSPORT	TOTAL
COKE	43.85	4.16	0.21	148.81	45.38	242.41
COAL	0.50	1.25	0.00	SEE COKE	0.00	1.75
PRILLED SULFUR	0.00	0.00	0.00	20.43	0.00	20.43
TOTAL	44.36	5.40	0.21	169.24	45.38	265

THROUGHPUT AND OPEN STORAGE DATA FROM FACILITIES IN EMISSIONS ESTIMATES

FACILITY	COKE		COAL		SULFUR	
	THRUPUT TPY	OPEN STORAGE TONS	THRUPUT TPY	OPEN STORAGE TONS	THRUPUT TPY	OPEN STORAGE TONS
COMPANY 6	2,000,000	50,000	1,500,000	0	35,000	0
COMPANY 1	2,500,000	50,000	4,400,000	855,737	0	0
COMPANY 7	1,500,000	60,328	0	0	0	0
COMPANY 4	2,000,000	0	0	0	125,000	0
COMPANY 2	500,000	59,672	0	0	0	0
COMPANY 12	1,131,500	0	0	0	128,000	0
COMPANY 5	950,000	0	0	0	200,000	0
COMPANY 10	900,000	0	0	0	160,000	0
COMPANY 11	850,000	0	0	0	0	0
COMPANY 13	547,500	0	0	0	0	0
COMPANY 14	450,000	0	0	0	0	0
COMPANY 3	181,000	300,000	0	0	0	0
COMPANY 18	100,000	400,000	0	0	0	0
COMPANY 9	0	0	0	0	200,000	150,000
COMPANY 15	0	0	0	0	370,000	0
COMPANIES 8, 16 & 17	45600	19840	59000	25000	0	0
TOTAL	13,655,600	939,638	5,959,000	880,737	1,218,000	150,000

THROUGHPUT AND ENCLOSED STORAGE DATA FROM FACILITIES IN EMISSIONS ESTIMATES

FACILITY	COKE		COAL		SULFUR	
	THRUPUT TPY	ENCLOSED TONS	THRUPUT TPY	ENCLOSED TONS	THRUPUT TPY	ENCLOSED TONS
COMPANY 6	2,000,000	0	1,500,000	100,000	35,000	0
COMPANY 1	2,500,000	100,000	4,400,000	0	0	0
COMPANY 7	1,500,000	130,000	0	0	0	0
COMPANY 4	2,000,000	100,000	0	0	125,000	0
COMPANY 2	500,000	200,000	0	0	0	0
COMPANY 12	1,131,500	5,000	0	0	128,000	0
COMPANY 5	950,000	64,000	0	0	200,000	0
COMPANY 10	900,000	70,000	0	0	160,000	0
COMPANY 11	850,000	65,000	0	0	0	0
COMPANY 13	547,500	2,000	0	0	0	0
COMPANY 14	450,000	80,000	0	0	0	0
COMPANY 3	181,000	0	0	0	0	0
COMPANY 18	100,000	0	0	0	0	0
COMPANY 9	0	0	0	0	200,000	0
COMPANY 15	0	0	0	0	370,000	50,000
COMPANIES 8, 16 & 17	45600	2000	59000	0	0	0
TOTAL	13,655,600	818,000	5,959,000	100,000	1,218,000	50,000

BASIN-WIDE BASELINE AND PROPOSED TSP EMISSIONS FROM COKE, COAL & PRILLED SULFUR

	EMISSION, TPY BASELINE	EMISSION, TPY AFTER CONTROL	EMISSION, TPY REDUCTION
COKE STORAGE/HANDLING	111.23	2.05	109.18
COAL STORAGE/HANDLING	15.54	14.51	1.03
PRILLED SULFUR STORAGE/HANDLING	10.90	10.90	0.00
COKE CONVEYOR	9.56	0.77	8.79
COAL CONVEYOR	2.89	0.26	2.63
PRILLED SULFUR CONVEYOR	0.00	0.00	0.00
COKE TRUCK UNLOAD & LOAD	1.19	0.74	0.45
COKE RAILCAR LOAD	0.01	0.00	0.01
COAL RAILCAR UNLOAD	0.07	0.07	0.00
PRILLED SULFUR TRUCK UNLOAD & LOAD	0.69	0.69	0.00
COKE TRACK OUT (INSIDE FACILITY)	191.18	34.06	157.11
COKE TRACK OUT (OUTSIDE FACILITY)	753.10	180.55	572.55
PRILLED SULFUR TRACK OUT (INSIDE)	5.51	1.38	4.12
PRILLED SULFUR TRACK OUT (OUTSIDE)	132.29	31.72	100.58
COKE TRUCK TRANSPORT	108.61	15.86	90.75
PRILLED SULFUR TRUCK TRANSPORT	3.88	3.88	0.00
TOTAL	1345	298	1047

TSP BASELINE EMISSIONS PER FACILITY

FACILITY	EMISSION, TPY BASELINE	EMISSION, TPY AFTER CONTROL	EMISSION, TPY REDUCTION
COMPANY 11	140.15	30.71	109.44
COMPANY 6	139.28	26.04	113.24
COMPANY 7	129.51	9.55	119.96
COMPANY 4	124.17	22.85	101.32
COMPANY 1	115.42	33.98	81.48
COMPANY 2	98.79	21.97	76.82
COMPANY 9	91.88	27.25	64.63
COMPANY 3	89.53	13.88	75.64
COMPANY 14	69.75	23.69	46.07
COMPANY 12	66.85	19.02	47.83
COMPANY 18	62.22	13.54	48.68
COMPANY 15	61.49	21.42	40.08
COMPANY 13	59.44	13.33	46.10
COMPANY 5	52.10	12.61	39.49
COMPANY 10	41.76	7.08	34.67
COMPANIES 8, 16 & 17	2.39	0.61	1.78
TOTAL	1345	298	1047

TSP BASELINE EMISSIONS PER MATERIAL

	STORAGE	CONVEYING	UNLOAD & LOAD	TRACK OUT	TRANSPORT	TOTAL
COKE	111.23	9.56	1.19	944.27	106.61	1172.67
COAL	15.54	2.89	0.07	SEE COKE	0.00	18.50
PRILLED SULFUR	10.90	0.00	0.69	137.80	3.98	153.37
TOTAL	137.67	12.45	1.95	1082.07	110.59	1345

TSP AFTER CONTROL EMISSIONS PER MATERIAL

	STORAGE	CONVEYING	UNLOAD & LOAD	TRACK OUT	TRANSPORT	TOTAL
COKE	2.05	0.77	0.74	214.61	15.86	234.03
COAL	14.51	0.26	0.07	SEE COKE	0.00	14.83
PRILLED SULFUR	10.90	0.00	0.69	33.10	3.98	48.67
TOTAL	27.46	1.02	1.51	247.71	19.84	298

TSP EMISSION REDUCTIONS PER MATERIAL

	STORAGE	CONVEYING	UNLOAD & LOAD	TRACK OUT	TRANSPORT	TOTAL
COKE	109.18	8.79	0.45	729.66	90.75	938.83
COAL	1.03	2.63	0.00	SEE COKE	0.00	3.67
PRILLED SULFUR	0.00	0.00	0.00	104.70	0.00	104.70
TOTAL	110.21	11.42	0.45	834.36	90.75	1047

BASIN-WIDE BASELINE AND PROPOSED PM10 EMISSIONS FROM COKE, COAL & PRILLED SULFUR

	EMISSION, TPY BASELINE	EMISSION, TPY AFTER CONTROL	EMISSION, TPY REDUCTION
REFINERY	117.87	22.20	95.67
HARBOR	160.23	37.45	122.78
TRANSPORT	55.29	9.92	45.38
ENDUSERS	1.00	0.24	0.77
TOTAL	334	70	265

BASIN-WIDE BASELINE AND PROPOSED TSP EMISSIONS FROM COKE, COAL & PRILLED SULFUR

	EMISSION, TPY BASELINE	EMISSION, TPY AFTER CONTROL	EMISSION, TPY REDUCTION
REFINERY	537.08	110.91	426.26
HARBOR	894.69	166.28	528.41
TRANSPORT	110.59	19.84	90.75
ENDUSERS	2.39	0.61	1.78
TOTAL	1345	298	1047

METHODOLOGY

WIND ASSUMPTIONS

cont

FACILITY	% SILT	RAINY DAYS > 0.01 INCH	% WIND > 12 MPH	% WIND > 12 MPH - 12 MPH	ACRE	ACRE	OPERATING DAYS	PM10/PM FACTOR	WATER EFFICIENCY	ENCLOSURE EFFICIENCY	BH EFFICIENCY	BASELINE TPY COKE	BASELINE TPY COAL	BASELINE TPY SULFUR	CONTROLLED TPY COKE	CONTROLLED TPY COAL	CONTROLLED TPY SULFUR										
COMPANY 1	5	6	3	0	0.7625	10	385	0.5/1	50	95	95	0.0711	0.5722	0.00355	0.33223	0											
COMPANY 3	6	34	0	0	4.375	0	385	0.5/1	80	95	95	0.4285	0	0.02133	0	0											
COMPANY 5	6	34	0	0	0	0	385	0.5/1	80	95	95	0	0	0	0	0											
COMPANY 6	6	34	0	0	6.1	0	385	0.5/1	80	95	89	0.5687	0	0.02843	0	0											
COMPANY 10	6	34	0	0	0.7625	0	385	0.5/1	80	95	95	0.0711	0	0.00355	0	0											
COMPANY 4	6	34	0	0	0	2	366	0.5/1	80	95	95	0.1864	0	0.00932	0	0											
COMPANY 11	6	34	0	0	0	0	385	0.5/1	80	95	95	0	0	0	0	0											
COMPANY 12	6	34	0	0	0	0	385	0.5/1	80	95	95	0	0	0	0	0											
COMPANY 13	6	34	0	0	0	0	385	0.5/1	80	95	39	0.4289	0	0.02144	0	0											
COMPANY 14	6	34	0	0	0	0	385	0.5/1	80	95	95	0.0818	0	0.00424	0	0											
COMPANY 7	6	34	0	0	0	4.8	385	0.5/1	80	95	95	0.0465	1.066237	0.00233	0	1.06623											
COMPANY 2	6	34	0	0	0.31	0	385	0.5/1	80	95	95	0.0465	0	0.00233	0	0											
COMPANY 15	6	34	0	0	2.2875	0	366	0.5/1	80	95	95	0.0465	0	0.00233	0	0											
COMPANY 9	6	34	0	0	0.1	0	385	0.5/1	80	95	95	0	0	0	0	0											
COMPANY 16	6	34	0	0	0.1	0	385	0.5/1	80	95	95	0	0	0	0	0											
COMPANY 17	6	34	0	0	0	1	385	0.5/1	80	95	95	0	0	0	0	0											
COMPANY 8	6	34	0	0	0	0	385	0.5/1	80	95	95	0	0	0	0	0											
(SUB TOTAL)																											
												1.97	7.40	1.07	0.4661	0.4661	0	0.4661	1.97	7.40	1.07	0.34	6.92	2.60	0.34	6.92	2.60

PILE MATERIAL TRANSFER ASSUMPTIONS

FACILITY	MOISTURE %	MOISTURE %	WIND MPH	WIND MPH	THRUPUT TPY	THRUPUT TPY	TRANSFER NO.	TRANSFER NO.	OPERATING DAYS	PM10/PM FACTOR	WATER EFFICIENCY	ENCLOSURE EFFICIENCY	BH EFFICIENCY	BASELINE TPY COKE	BASELINE TPY COAL	BASELINE TPY SULFUR	CONTROLLED TPY COKE	CONTROLLED TPY COAL	CONTROLLED TPY SULFUR									
COMPANY 1	4	4	6	6	260000	440000	3	3	385	0.350/74	50	95	95	0.813593	3.905249	0.02219	0.00181	3.90524	0.02219	0.00181								
COMPANY 3	4	4	6	6	181000	181000	3	3	385	0.350/74	80	95	95	0.042159	0	0.00083	0.00083	0	0.00083	0								
COMPANY 5	4	4	6	6	99000	99000	3	3	385	0.350/74	80	95	95	0.08756	0	0.00089	0.00089	0	0.00089	0								
COMPANY 18	4	4	6	6	10000	10000	3	3	385	0.350/74	80	95	95	1.775111	0.066567	0.01775	0.00093	0.06657	0.01775	0.00093								
COMPANY 10	8	8	6	6	200000	160000	3	3	385	0.350/74	80	95	95	0.003632	0	0.00083	0.00083	0	0.00083	0								
COMPANY 4	8	8	6	6	200000	200000	3	3	385	0.350/74	80	95	95	0.014294	0	0.00285	0.00285	0	0.00285	0								
COMPANY 11	8	8	6	6	847500	847500	3	3	385	0.350/74	80	95	95	0.019027	0	0.00381	0.00381	0	0.00381	0								
COMPANY 12	8	8	6	6	450000	450000	3	3	385	0.350/74	80	95	95	0.031628	0	0.00928	0.00928	0	0.00928	0								
COMPANY 14	0.5	4	6	6	530000	530000	3	3	385	0.350/74	80	95	95	0.01331	0	0.00444	0.00444	0	0.00444	0								
COMPANY 7	4	4	6	6	750000	750000	3	3	385	0.350/74	80	95	95	0.0317	0.0317	0.00028	0.00028	0.0317	0.00028	0.00028								
COMPANY 2	4	4	6	6	500000	500000	3	3	385	0.350/74	80	95	95	0.005811	0.005811	0.00023	0.00023	0.005811	0.00023	0.00023								
COMPANY 15	2.5	4	6	6	200000	200000	3	3	385	0.350/74	80	95	95	0.009789	0.009789	0.00088	0.00088	0.009789	0.00088	0.00088								
COMPANY 9	4	4	6	6	9820	9820	2	2	385	0.350/74	80	95	95	4.76	4.91	0.37	0.16	4.91	0.37	0.16								
COMPANY 17	4	4	6	6	26000	26000	2	2	385	0.350/74	80	95	95	34.71	7.33	2.60	0	34.71	7.33	2.60								
COMPANY 8	4	4	6	6	26000	26000	2	2	385	0.350/74	80	95	95	0	0.34	0.82	0	0.34	0.82	0.82								
(SUB TOTAL)																												
												4.76	4.91	0.37	0.16	4.91	0.37	0.16	4.91	0.37	0.16	0	0.34	0.82	0.82	0.34	0.82	2.60

TRACKOUT INSIDE ASSUMPTIONS

FACILITY	SILT LOADING GM/M ²	SILT LOADING WT MT	WEIGHT MT	WATER TRUCK LOADING WT MT	SILT %	MOISTURE %	DISTANCE MILESTRUCK	NO. TRUCKS PER DAY	OPERATING DAYS	PH/10PM FACTOR	BASELINE TPY	CONTROLLED TPY
COMPANY 1	2.1	0.25	24	24	N/A	N/A	0.25	274	365	0.01600.002	4.8716	1.1714
COMPANY 2	N/A	0.25	24	24	12	4	0.25	20	365	0.01600.002	2.2189	0.2885
COMPANY 3	2.1	0.25	24	24	N/A	N/A	0.25	104	365	0.01600.002	1.7732	0.4446
COMPANY 4	2.1	0.25	24	24	N/A	N/A	0.25	11	365	0.01600.002	0.1876	0.047
COMPANY 5	2.1	0.25	24	24	N/A	N/A	0.25	219	365	0.01600.002	3.734	0.9363
COMPANY 6	2.1	0.25	24	24	N/A	N/A	0.25	59	365	0.01600.002	1.683	0.4232
COMPANY 7	2.1	0.25	24	24	N/A	N/A	0.25	219	365	0.01600.002	3.734	0.9363
COMPANY 8	2.1	0.25	24	24	N/A	N/A	0.25	93	365	0.01600.002	1.8957	0.4767
COMPANY 9	2.1	0.25	24	24	N/A	N/A	0.25	110	368	0.01600.002	1.8785	0.4767
COMPANY 10	2.1	0.25	24	24	N/A	N/A	0.25	60	366	0.01600.002	1.623	0.2385
COMPANY 11	2.1	0.25	24	24	N/A	N/A	0.25	118	365	0.01600.002	2.0119	0.5046
COMPANY 12	2.1	0.25	24	24	12	4	0.25	184	365	0.01600.002	16.196	0.7011
COMPANY 13	2.1	0.25	24	24	N/A	N/A	0.25	88	365	0.01600.002	0.9378	0.2351
COMPANY 14	2.1	0.25	24	24	N/A	N/A	0.25	41	365	0.01600.002	0.6906	0.1783
COMPANY 15	2.1	0.25	24	24	N/A	N/A	0.25	22	365	0.01600.002	0.37511	0.0941
COMPANY 16	2.1	0.25	15	15	N/A	N/A	0.25	3	365	0.01600.002	0.0263	0.0091
COMPANY 17	2.1	0.48	15	15	N/A	N/A	0.25	3	365	0.01600.002	0.0512	0.0168
COMPANY 18	2.1	0.48	24	24	N/A	N/A	0.25	3	365	0.01600.002	0.0512	0.0168
TOTAL											43.74	6.65
TOTAL											1.07	0.27

TRACKOUT OUTSIDE ASSUMPTIONS

FACILITY	SILT LOADING GM/M ²	SILT LOADING WT MT	WEIGHT MT	NO. VEHICLES YEAR	DISTANCE MILESTRUCK	PH/10PM FACTOR	BASELINE TPY	CONTROLLED TPY
COMPANY 1	0.45	0.06	13	1851250	0.25	0.01600.002	10.61362	2.6445
COMPANY 2	0.45	0.05	13	1851250	0.25	0.01600.002	10.61362	2.6445
COMPANY 3	0.45	0.05	13	1322760	0.25	0.01600.002	8.498051	2.0977
COMPANY 4	0.45	0.05	13	1851250	0.25	0.01600.002	10.61362	2.6445
COMPANY 5	0.45	0.05	13	2480445	0.25	0.01600.002	16.83445	4.0322
COMPANY 6	0.45	0.06	3.1	4300000	0.25	0.01600.002	3.483862	0.8492
COMPANY 7	0.45	0.05	3.1	16921500	0.25	0.01600.002	13.32244	3.2149
COMPANY 8	0.45	0.05	4.398	16921500	0.25	0.01600.002	22.85049	5.4782
COMPANY 9	0.45	0.05	2.08	16921500	0.25	0.01600.002	10.88041	2.6186
COMPANY 10	0.45	0.05	2.08	12045000	0.25	0.01600.002	9.258677	2.3007
COMPANY 11	0.45	0.05	3.1	12045000	0.25	0.01600.002	9.258677	2.3007
COMPANY 12	0.45	0.05	3.1	4327600	0.25	0.01600.002	3.59371	0.8412
COMPANY 13	0.45	0.05	3.1	4327600	0.25	0.01600.002	3.59371	0.8412
COMPANY 14	0.45	0.05	3.1	1441465	0.25	0.01600.002	1.653445	0.40359
COMPANY 15	0.45	0.05	3.1	12045000	0.25	0.01600.002	10.88041	2.6186
COMPANY 16	0.45	0.05	4.398	12045000	0.25	0.01600.002	16.83445	4.0322
TOTAL							146.55	36.23
TOTAL							2.81	0.71

WATER TRUCK ASSUMPTIONS

FACILITY	SILT %	SILT LOADING 94q.meter	WEIGHT TONS	DISTANCE VMT	MOISTURE %	BASELINE TPY	CONTROLLED TPY
COMPANY 1	N/A	2.1	16.5	4817	N/A	0.51307538	0
COMPANY 3	12		18.5	4860	4	4.724817	0
COMPANY 7	12		16.5	4335	4	4.73864652	0
TOTAL						10.83	0.00

13.2.4 Aggregate Handling And Storage Piles

13.2.4.1 General

Inherent in operations that use minerals in aggregate form is the maintenance of outdoor storage piles. Storage piles are usually left uncovered, partially because of the need for frequent material transfer into or out of storage.

Dust emissions occur at several points in the storage cycle, such as material loading onto the pile, disturbances by strong wind currents, and loadout from the pile. The movement of trucks and loading equipment in the storage pile area is also a substantial source of dust.

13.2.4.2 Emissions And Correction Parameters

The quantity of dust emissions from aggregate storage operations varies with the volume of aggregate passing through the storage cycle. Emissions also depend on 3 parameters of the condition of a particular storage pile: age of the pile, moisture content, and proportion of aggregate fines.

When freshly processed aggregate is loaded onto a storage pile, the potential for dust emissions is at a maximum. Fines are easily disaggregated and released to the atmosphere upon exposure to air currents, either from aggregate transfer itself or from high winds. As the aggregate pile weathers, however, potential for dust emissions is greatly reduced. Moisture causes aggregation and cementation of fines to the surfaces of larger particles. Any significant rainfall soaks the interior of the pile, and then the drying process is very slow.

Silt (particles equal to or less than 75 micrometers [μm] in diameter) content is determined by measuring the portion of dry aggregate material that passes through a 200-mesh screen, using ASTM-C-136 method.¹ Table 13.2.4-1 summarizes measured silt and moisture values for industrial aggregate materials.

Table 13.2.4-1. TYPICAL SILT AND MOISTURE CONTENTS OF MATERIALS AT VARIOUS INDUSTRIES^a

Industry	No. Of Facilities	Material	Silt Content (%)			Moisture Content (%)		
			No. Of Samples	Range	Mean	No. Of Samples	Range	Mean
Iron and steel production	9	Pellet ore	13	1.3 - 13	4.3	11	0.64 - 4.0	2.2
		Lump ore	9	2.8 - 19	9.5	6	1.6 - 8.0	5.4
		Coal	12	2.0 - 7.7	4.6	11	2.8 - 11	4.8
		Slag	3	3.0 - 7.3	5.3	3	0.25 - 2.0	0.92
		Flue dust	3	2.7 - 23	13	1	—	7
		Coke breeze	2	4.4 - 5.4	4.9	2	6.4 - 9.2	7.8
		Blended ore	1	—	15	1	—	6.6
		Sinter	1	—	0.7	0	—	—
		Limestone	3	0.4 - 2.3	1.0	2	ND	0.2
		Crushed limestone	2	1.3 - 1.9	1.6	2	0.3 - 1.1	0.7
		Various limestone products	8	0.8 - 14	3.9	8	0.46 - 5.0	2.1
		Pellets	9	2.2 - 5.4	3.4	7	0.05 - 2.0	0.9
		Tailings	2	ND	11	1	—	0.4
Western surface coal mining	4	Coal	15	3.4 - 16	6.2	7	2.8 - 20	6.9
		Overburden	15	3.8 - 15	7.5	0	—	—
		Exposed ground	3	5.1 - 21	15	3	0.8 - 6.4	3.4
Coal-fired power plant	1	Coal (as received)	60	0.6 - 4.8	2.2	59	2.7 - 7.4	4.5
		Sand	1	—	2.6	1	—	7.4
Municipal solid waste landfills	4	Slag	2	3.0 - 4.7	3.8	2	2.3 - 4.9	3.6
		Cover	5	5.0 - 16	9.0	5	8.9 - 16	12
		Clay/dirt mix	1	—	9.2	1	—	14
		Clay	2	4.5 - 7.4	6.0	2	8.9 - 11	10
		Fly ash	4	78 - 81	80	4	26 - 29	27
		Misc. fill materials	1	—	12	1	—	11

^a References 1-10. ND = no data.

13.2.4.3 Predictive Emission Factor Equations

Total dust emissions from aggregate storage piles result from several distinct source activities within the storage cycle:

1. Loading of aggregate onto storage piles (batch or continuous drop operations).
2. Equipment traffic in storage area.
3. Wind erosion of pile surfaces and ground areas around piles.
4. Loadout of aggregate for shipment or for return to the process stream (batch or continuous drop operations).

Either adding aggregate material to a storage pile or removing it usually involves dropping the material onto a receiving surface. Truck dumping on the pile or loading out from the pile to a truck with a front-end loader are examples of batch drop operations. Adding material to the pile by a conveyor stacker is an example of a continuous drop operation.

The quantity of particulate emissions generated by either type of drop operation, per kilogram (kg) (ton) of material transferred, may be estimated, with a rating of A, using the following empirical expression:¹¹

$$E = k(0.0016) \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \text{ (kg/megagram [Mg])}$$

(1)

$$E = k(0.0032) \frac{\left(\frac{U}{5}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \text{ (pound [lb]/ton)}$$

where:

- E = emission factor
- k = particle size multiplier (dimensionless)
- U = mean wind speed, meters per second (m/s) (miles per hour [mph])
- M = material moisture content (%)

The particle size multiplier in the equation, k, varies with aerodynamic particle size range, as follows:

Aerodynamic Particle Size Multiplier (k) For Equation 1				
< 30 μm	< 15 μm	< 10 μm	< 5 μm	< 2.5 μm
0.74	0.48	0.35	0.20	0.053 ^a

^a Multiplier for < 2.5 μm taken from Reference 14.

The equation retains the assigned quality rating if applied within the ranges of source conditions that were tested in developing the equation, as follows. Note that silt content is included, even though silt content does not appear as a correction parameter in the equation. While it is reasonable to expect that silt content and emission factors are interrelated, no significant correlation between the 2 was found during the derivation of the equation, probably because most tests with high silt contents were conducted under lower winds, and vice versa. It is recommended that estimates from the equation be reduced 1 quality rating level if the silt content used in a particular application falls outside the range given:

Ranges Of Source Conditions For Equation 1			
Silt Content (%)	Moisture Content (%)	Wind Speed	
		m/s	mph
0.44 - 19	0.25 - 4.8	0.6 - 6.7	1.3 - 15

To retain the quality rating of the equation when it is applied to a specific facility, reliable correction parameters must be determined for specific sources of interest. The field and laboratory procedures for aggregate sampling are given in Reference 3. In the event that site-specific values for

correction parameters cannot be obtained, the appropriate mean from Table 13.2.4-1 may be used, but the quality rating of the equation is reduced by 1 letter.

For emissions from equipment traffic (trucks, front-end loaders, dozers, etc.) traveling between or on piles, it is recommended that the equations for vehicle traffic on unpaved surfaces be used (see Section 13.2.2). For vehicle travel between storage piles, the silt value(s) for the areas among the piles (which may differ from the silt values for the stored materials) should be used.

Worst-case emissions from storage pile areas occur under dry, windy conditions. Worst-case emissions from materials-handling operations may be calculated by substituting into the equation appropriate values for aggregate material moisture content and for anticipated wind speeds during the worst case averaging period, usually 24 hours. The treatment of dry conditions for Section 13.2.2, vehicle traffic, "Unpaved Roads", follows the methodology described in that section centering on parameter p. A separate set of nonclimatic correction parameters and source extent values corresponding to higher than normal storage pile activity also may be justified for the worst-case averaging period.

13.2.4.4 Controls¹²⁻¹³

Watering and the use of chemical wetting agents are the principal means for control of aggregate storage pile emissions. Enclosure or covering of inactive piles to reduce wind erosion can also reduce emissions. Watering is useful mainly to reduce emissions from vehicle traffic in the storage pile area. Watering of the storage piles themselves typically has only a very temporary slight effect on total emissions. A much more effective technique is to apply chemical agents (such as surfactants) that permit more extensive wetting. Continuous chemical treating of material loaded onto piles, coupled with watering or treatment of roadways, can reduce total particulate emissions from aggregate storage operations by up to 90 percent.¹²

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13.2.1 Paved Roads

13.2.1.1 General

Particulate emissions occur whenever vehicles travel over a paved surface such as a road or parking lot. Particulate emissions from paved roads are due to direct emissions from vehicles in the form of exhaust, brake wear and tire wear emissions and resuspension of loose material on the road surface. In general terms, resuspended particulate emissions from paved roads originate from, and result in the depletion of, the loose material present on the surface (i.e., the surface loading). In turn, that surface loading is continuously replenished by other sources. At industrial sites, surface loading is replenished by spillage of material and trackout from unpaved roads and staging areas. Figure 13.2.1-1 illustrates several transfer processes occurring on public streets.

Various field studies have found that public streets and highways, as well as roadways at industrial facilities, can be major sources of the atmospheric particulate matter within an area.¹⁻⁹ Of particular interest in many parts of the United States are the increased levels of emissions from public paved roads when the equilibrium between deposition and removal processes is upset. This situation can occur for various reasons, including application of granular materials for snow and ice control, mud/dirt carryout from construction activities in the area, and deposition from wind and/or water erosion of surrounding unstabilized areas. In the absence of continuous addition of fresh material (through localized track out or application of antiskid material), paved road surface loading should reach an equilibrium value in which the amount of material resuspended matches the amount replenished. The equilibrium surface loading value depends upon numerous factors. It is believed that the most important factors are: mean speed of vehicles traveling the road; the average daily traffic (ADT); the number of lanes and ADT per lane; the fraction of heavy vehicles (buses and trucks); and the presence/absence of curbs, storm sewers and parking lanes.¹⁰

The particulate emission factors presented in a previous version of this section of AP-42, dated October 2002, implicitly included the emissions from vehicles in the form of exhaust, brake wear, and tire wear as well as resuspended road surface material. EPA included these sources in the emission factor equation for paved roads since the field testing data used to develop the equation included both the direct emissions from vehicles and emissions from resuspension of road dust.

This version of the paved road emission factor equation only estimates particulate emissions from resuspended road surface material²⁸. The particulate emissions from vehicle exhaust, brake wear, and tire wear are now estimated separately using EPA's MOVES²⁹ model. This approach eliminates the possibility of double counting emissions. Double counting results when employing the previous version of the emission factor equation in this section and MOVES to estimate particulate emissions from vehicle traffic on paved roads. It also incorporates the decrease in exhaust emissions that has occurred since the paved road emission factor equation was developed. Earlier versions of the paved road emission factor equation includes estimates of emissions from exhaust, brake wear, and tire wear based on emission rates for vehicles in the 1980 calendar year fleet. The amount of PM released from vehicle exhaust has decreased since 1980 due to lower new vehicle emission standards and changes in fuel characteristics.

13.2.1.2 Emissions And Correction Parameters

Dust emissions from paved roads have been found to vary with what is termed the "silt loading" present on the road surface. In addition, the average weight and speed of vehicles traveling the road influence road dust emissions. The term silt loading (sL) refers to the mass of silt-size material (equal to or less than 75 micrometers [μm] in physical diameter) per unit area of the travel surface. The total road surface dust loading consists of loose material that can be collected by broom sweeping and vacuuming of the traveled portion of the paved road. The silt fraction is determined by measuring the proportion of the loose dry surface dust that passes through a 200-mesh screen, using the ASTM-C-136 method. Silt loading is the product of the silt fraction and the total loading, and is abbreviated "sL". Additional details on the sampling and analysis of such material are provided in AP-42 Appendices C.1 and C.2.

The surface sL provides a reasonable means of characterizing seasonal variability in a paved road emission inventory. In many areas of the country, road surface loadings¹¹⁻²¹ are heaviest during the late winter and early spring months when the residual loading from snow/ice controls is greatest. As noted earlier, once replenishment of fresh material is eliminated, the road surface loading can be expected to reach an equilibrium value, which is substantially lower than the late winter/early spring values.

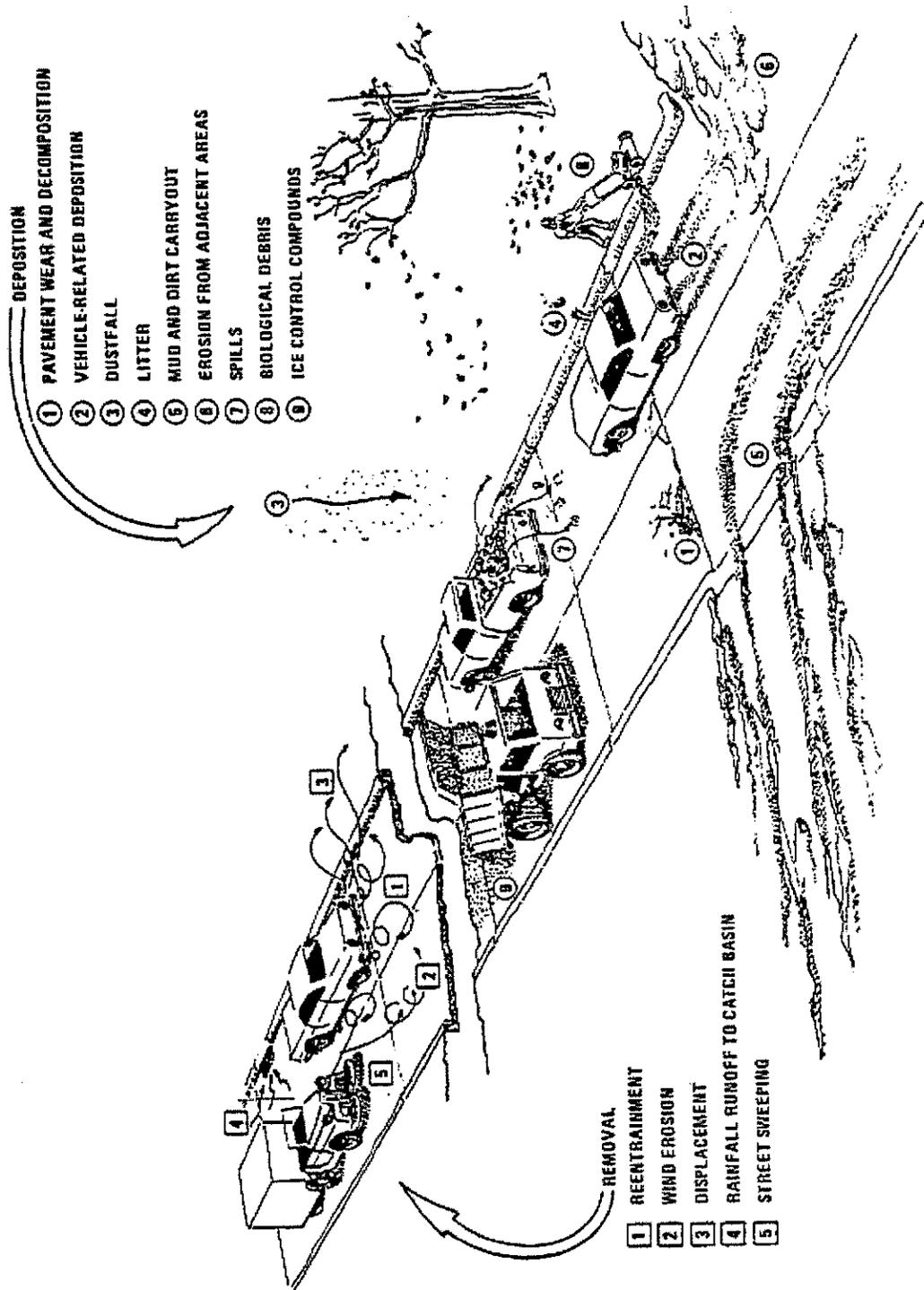


Figure 13.2.1-1. Deposition and removal processes.

13.2.1.3 Predictive Emission Factor Equations^{10,29}

The quantity of particulate emissions from resuspension of loose material on the road surface due to vehicle travel on a dry paved road may be estimated using the following empirical expression:

$$E = k (sL)^{0.91} \times (W)^{1.02} \quad (1)$$

where: E = particulate emission factor (having units matching the units of k),
 k = particle size multiplier for particle size range and units of interest (see below),
 sL = road surface silt loading (grams per square meter) (g/m²), and
 W = average weight (tons) of the vehicles traveling the road.

It is important to note that Equation 1 calls for the average weight of all vehicles traveling the road. For example, if 99 percent of traffic on the road are 2 ton cars/trucks while the remaining 1 percent consists of 20 ton trucks, then the mean weight "W" is 2.2 tons. More specifically, Equation 1 is *not* intended to be used to calculate a separate emission factor for each vehicle weight class. Instead, only one emission factor should be calculated to represent the "fleet" average weight of all vehicles traveling the road.

The particle size multiplier (k) above varies with aerodynamic size range as shown in Table 13.2.1-1. To determine particulate emissions for a specific particle size range, use the appropriate value of k shown in Table 13.2.1-1.

To obtain the total emissions factor, the emissions factors for the exhaust, brake wear and tire wear obtained from either EPA's MOBILE6.2²⁷ or most recent MOVES²⁹ software model should be added to the emissions factor calculated from the empirical equation.

Table 13.2.1-1. PARTICLE SIZE MULTIPLIERS FOR PAVED ROAD EQUATION

Size range ^a	Particle Size Multiplier k ^b		
	g/VKT	g/VMT	lb/VMT
PM-2.5 ^c	0.15	0.25	0.00054
PM-10	0.62	1.00	0.0022
PM-15	0.77	1.23	0.0027
PM-30 ^d	3.23	5.24	0.011

^a Refers to airborne particulate matter (PM-x) with an aerodynamic diameter equal to or less than x micrometers.

^b Units shown are grams per vehicle kilometer traveled (g/VKT), grams per vehicle mile traveled (g/VMT), and pounds per vehicle mile traveled (lb/VMT). The multiplier k includes unit conversions to produce emission factors in the units shown for the indicated size range from the mixed units required in Equation 1.

^c The k-factors for PM_{2.5} were based on the average PM_{2.5}:PM₁₀ ratio of test runs in Reference 30.

^d PM-30 is sometimes termed "suspensible particulate" (SP) and is often used as a surrogate for TSP.

Equation 1 is based on a regression analysis of 83 tests for PM-10.^{3, 5-6, 8, 27-29, 31-36} Sources tested include public paved roads, as well as controlled and uncontrolled industrial paved roads. The majority of tests involved freely flowing vehicles traveling at constant speed on relatively level roads. However, 22 tests of slow moving or "stop-and-go" traffic or vehicles under load were available for inclusion in the data base.³²⁻³⁶ Engine exhaust, tire wear and break wear were subtracted from the emissions measured in the test programs prior to stepwise regression to determine Equation 1.^{37, 39} The equations retain the quality rating of A (D for PM-2.5), if applied within the range of source conditions that were tested in developing the equation as follows:

Silt loading:	0.03 - 400 g/m ² 0.04 - 570 grains/square foot (ft ²)
Mean vehicle weight:	1.8 - 38 megagrams (Mg) 2.0 - 42 tons
Mean vehicle speed:	1 - 88 kilometers per hour (kph) 1 - 55 miles per hour (mph)

The upper and lower 95% confidence levels of equation 1 for PM₁₀ is best described with equations using an exponents of 1.14 and 0.677 for silt loading and an exponents of 1.19 and 0.85 for weight. Users are cautioned that application of equation 1 outside of the range of variables and operating conditions specified above, e.g., application to roadways or road networks with speeds above 55 mph and average vehicle weights of 42 tons, will result in emission estimates with a higher level of uncertainty. In these situations, users are encouraged to consider an assessment of the impacts of the influence of extrapolation to the overall emissions and alternative methods that are equally or more plausible in light of local emissions data and/or ambient concentration or compositional data.

To retain the quality rating for the emission factor equation when it is applied to a specific paved road, it is necessary that reliable correction parameter values for the specific road in question be determined. With the exception of limited access roadways, which are difficult to sample, the collection and use of site-specific silt loading (sL) data for public paved road emission inventories are strongly recommended. The field and laboratory procedures for determining surface material silt content and surface dust loading are summarized in Appendices C.1 and C.2. In the event that site-specific values cannot be obtained, an appropriate value for a paved public road may be selected from the values in Table 13.2.1-2, but the quality rating of the equation should be reduced by 2 levels.

Equation 1 may be extrapolated to average uncontrolled conditions (but including natural mitigation) under the simplifying assumption that annual (or other long-term) average emissions are inversely proportional to the frequency of measurable (> 0.254 mm [0.01 inch]) precipitation by application of a precipitation correction term. The precipitation correction term can be applied on a daily or an hourly basis^{26, 38}.

For the daily basis, Equation 1 becomes:

$$E_{ext} = [k (sL)^{0.91} \times (W)^{1.02}] (1 - P/4N) \quad (2)$$

where k , sL , W , and S are as defined in Equation 1 and

E_{ext} = annual or other long-term average emission factor in the same units as k ,

P = number of "wet" days with at least 0.254 mm (0.01 in) of precipitation during the averaging period, and

N = number of days in the averaging period (e.g., 365 for annual, 91 for seasonal, 30 for monthly).

Note that the assumption leading to Equation 2 is based on analogy with the approach used to develop long-term average unpaved road emission factors in Section 13.2.2. However, Equation 2 above incorporates an additional factor of "4" in the denominator to account for the fact that paved roads dry more quickly than unpaved roads and that the precipitation may not occur over the complete 24-hour day.

For the hourly basis, equation 1 becomes:

$$E_{ext} = [k (sL)^{0.91} \times (W)^{1.02}] (1 - 1.2P/N) \quad (3)$$

where k , sL , W , and S are as defined in Equation 1 and

- E_{ext} = annual or other long-term average emission factor in the same units as k ,
- P = number of hours with at least 0.254 mm (0.01 in) of precipitation during the averaging period, and
- N = number of hours in the averaging period (e.g., 8760 for annual, 2124 for season 720 for monthly)

Note: In the hourly moisture correction term $(1 - 1.2P/N)$ for equation 3, the 1.2 multiplier is applied to account for the residual mitigative effect of moisture. For most applications, this equation will produce satisfactory results. Users should select a time interval to include sufficient "dry" hours such that a reasonable emissions averaging period is evaluated. For the special case where this equation is used to calculate emissions on an hour by hour basis, such as would be done in some emissions modeling situations, the moisture correction term should be modified so that the moisture correction "credit" is applied to the first hours following cessation of precipitation. In this special case, it is suggested that this 20% "credit" be applied on a basis of one hour credit for each hour of precipitation up to a maximum of 12 hours.

Note that the assumption leading to Equation 3 is based on analogy with the approach used to develop long-term average unpaved road emission factors in Section 13.2.2.

Figure 13.2.1-2 presents the geographical distribution of "wet" days on an annual basis for the United States. Maps showing this information on a monthly basis are available in the *Climatic Atlas of the United States*²³. Alternative sources include other Department of Commerce publications (such as local climatological data summaries). The National Climatic Data Center (NCDC) offers several products that provide hourly precipitation data. In particular, NCDC offers *Solar and Meteorological Surface Observation Network 1961-1990* (SAMSON) CD-ROM, which contains 30 years worth of hourly meteorological data for first-order National Weather Service locations. Whatever meteorological data are used, the source of that data and the averaging period should be clearly specified.

It is emphasized that the simple assumption underlying Equations 2 and 3 has not been verified in any rigorous manner. For that reason, the quality ratings for Equations 2 and 3 should be downgraded one letter from the rating that would be applied to Equation 1.

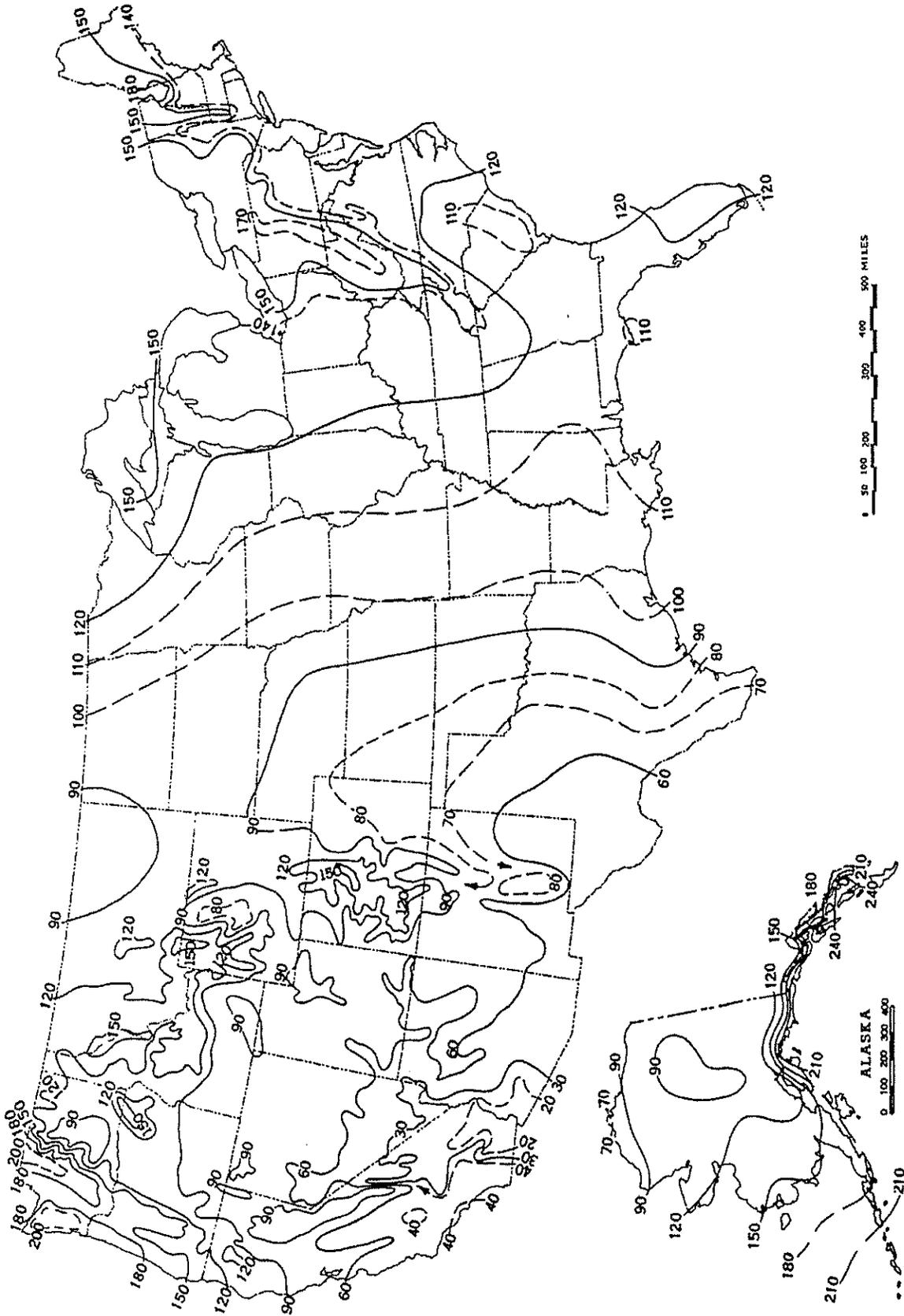


Figure 13.2.1-2. Mean number of days with 0.01 inch or more of precipitation in the United States.

Table 13.2.1-2 presents recommended default silt loadings for normal baseline conditions and for wintertime baseline conditions in areas that experience frozen precipitation with periodic application of antiskid material²⁴. The winter baseline is represented as a multiple of the non-winter baseline, depending on the ADT value for the road in question. As shown, a multiplier of 4 is applied for low volume roads (< 500 ADT) to obtain a wintertime baseline silt loading of $4 \times 0.6 = 2.4 \text{ g/m}^2$.

Table 13.2.1-2. Ubiquitous Silt Loading Default Values with Hot Spot Contributions from Anti-Skid Abrasives (g/m^2)

ADT Category	< 500	500-5,000	5,000-10,000	> 10,000
Ubiquitous Baseline g/m^2	0.6	0.2	0.06	0.03 0.015 limited access
Ubiquitous Winter Baseline Multiplier during months with frozen precipitation	X4	X3	X2	X1
Initial peak additive contribution from application of antiskid abrasive (g/m^2)	2	2	2	2
Days to return to baseline conditions (assume linear decay)	7	3	1	0.5

It is suggested that an additional (but temporary) silt loading contribution of 2 g/m^2 occurs with each application of antiskid abrasive for snow/ice control. This was determined based on a typical application rate of 500 lb per lane mile and an initial silt content of 1 % silt content. Ordinary rock salt and other chemical deicers add little to the silt loading, because most of the chemical dissolves during the snow/ice melting process.

To adjust the baseline silt loadings for mud/dirt trackout, the number of trackout points is required. It is recommended that in calculating PM_{10} emissions, six additional miles of road be added for each active trackout point from an active construction site, to the paved road mileage of the specified category within the county. In calculating $\text{PM}_{2.5}$ emissions, it is recommended that three additional miles of road be added for each trackout point from an active construction site.

It is suggested the number of trackout points for activities other than road and building construction areas be related to land use. For example, in rural farming areas, each mile of paved road would have a specified number of trackout points at intersections with unpaved roads. This value could be estimated from the unpaved road density (mi/sq. mi.).

The use of a default value from Table 13.2.1-2 should be expected to yield only an order-of-magnitude estimate of the emission factor. Public paved road silt loadings are dependent

upon: traffic characteristics (speed, ADT, and fraction of heavy vehicles); road characteristics (curbs, number of lanes, parking lanes); local land use (agriculture, new residential construction) and regional/seasonal factors (snow/ice controls, wind blow: dust). As a result, the collection and use of site-specific silt loading data is highly recommended. In the event that default silt loading values are used, the quality ratings for the equation should be downgraded 2 levels.

Limited access roadways pose severe logistical difficulties in terms of surface sampling, and few silt loading data are available for such roads. Nevertheless, the available data do not suggest great variation in silt loading for limited access roadways from one part of the country to another. For annual conditions, a default value of 0.015 g/m^2 is recommended for limited access roadways.^{9,22} Even fewer of the available data correspond to worst-case situations, and elevated loadings are observed to be quickly depleted because of high traffic speeds and high ADT rates. A default value of 0.2 g/m^2 is recommended for short periods of time following application of snow/ice controls to limited access roads.²²

The limited data on silt loading values for industrial roads have shown as much variability as public roads. Because of the variations of traffic conditions and the use of preventive mitigative controls, the data probably do not reflect the full extent of the potential variation in silt loading on industrial roads. However, the collection of site specific silt loading data from industrial roads is easier and safer than for public roads. Therefore, the collection and use of site-specific silt loading data is preferred and is highly recommended. In the event that site-specific values cannot be obtained, an appropriate value for an industrial road may be selected from the mean values given in Table 13.2.1-3, but the quality rating of the equation should be reduced by 2 levels.

The predictive accuracy of Equation 1 requires thorough on-site characterization of road silt loading. Road surface sampling is time-consuming and potentially hazardous because of the need to block traffic lanes. In addition, large number of samples is required to represent spatial and temporal variations across roadway networks. Mobile monitoring is a new alternative silt loading or road dust emission characterization method for either paved or unpaved roads. It utilizes a test vehicle that generates and monitors its own dust plume concentration (mass basis) at a fixed sampling probe location. A calibration factor is needed for each mobile monitoring configuration (test vehicle and sampling system), to convert the relative dust emission intensity to an equivalent silt loading or emission factor. Typically, portable continuous particle concentration monitors do not comply with Federal Reference Method (FRM) standards. Therefore, a controlled study must be performed to correlate the portable monitor response to the road silt loading or size specific particle concentration measured with an approved FRM sampling system. In the calibration tests, multiple test conditions should be performed to provide an average correlation with known precision and to accommodate variations in road silt loading, vehicle speed, road dust characteristics and other road conditions that may influence mobile monitoring measurements or emissions characteristics. Because the paved road dust emissions are also dependent on the average vehicle weight for the road segment, it is important that the weight of the test vehicle correspond closely to the average vehicle weight for the road segment or be adjusted using the average vehicle weight relationship in Equation 1. In summary, it is believed that the Mobile Monitoring Method will provide improved capabilities to provide reliable temporally and spatially resolved silt loading or emissions factors with increased coverage, improved safety, reduced traffic interference and decreased cost.^{40, 41, 42}

Table 13.2.1-3 (Metric And English Units). TYPICAL SILT CONTENT AND LOADING VALUES FOR PAVED ROADS AT INDUSTRIAL FACILITIES^a

Industry	No. of Sites	No. Of Samples	Silt Content (%)		No. of Travel Lanes	Total Loading x 10 ⁻³			Silt Loading (g/m ²)	
			Range	Mean		Range	Mean	Units ^b	Range	Mean
Copper smelting	1	3	15.4-21.7	19.0	2	12.9 - 19.5	15.9	kg/km	188-400	292
Iron and steel production	9	48	1.1-35.7	12.5	2	0.006 - 4.77	0.495	kg/km	0.09-79	9.7
Asphalt batching	1	3	2.6 - 4.6	3.3	1	12.1 - 18.0	14.9	kg/km	76-193	120
Concrete batching	1	3	5.2 - 6.0	5.5	2	43.0 - 64.0	52.8	lb/mi	11-12	12
Sand and gravel processing	1	3	6.4 - 7.9	7.1	1	1.4 - 1.8	1.7	kg/km	53-95	70
Municipal solid waste landfill	2	7	-	-	2	5.0 - 6.4	5.9	lb/mi	1.1-32.0	7.4
Quarry	1	6	-	-	2	-	-	-	2.4-14	8.2
Corn wet mills	3	15	-	-	2	-	-	-	0.05 - 2.9	1.1

^a References 1-2,5-6,11-13. Values represent samples collected from *industrial* roads. Public road silt loading values are presented in Table-13.2.1-2. Dashes indicate information not available.^b Multiply entries by 1000 to obtain stated units; kilograms per kilometer (kg/km) and pounds per mile (lb/mi).

13.2.1.4 Controls^{6,25}

Because of the importance of the silt loading, control techniques for paved roads attempt either to prevent material from being deposited onto the surface (preventive controls) or to remove from the travel lanes any material that has been deposited (mitigative controls). Covering of loads in trucks, and the paving of access areas to unpaved lots or construction sites, are examples of preventive measures. Examples of mitigative controls include vacuum sweeping, water flushing, and broom sweeping and flushing. Actual control efficiencies for any - of these techniques can be highly variable. Locally measured silt loadings before and after the application of controls is the preferred method to evaluate controls. It is particularly important to note that street sweeping of gutters and curb areas may actually increase the silt loading on the traveled portion of the road. Redistribution of loose material onto the travel lanes will actually produce a short-term increase in the emissions.

In general, preventive controls are usually more cost effective than mitigative controls. The cost-effectiveness of mitigative controls falls off dramatically as the size of an area to be treated increases. The cost-effectiveness of mitigative measures is also unfavorable if only a short period of time is required for the road to return to equilibrium silt loading condition. That is to say, the number and length of public roads within most areas of interest preclude any widespread and routine use of mitigative controls. On the other hand, because of the more limited scope of roads at an industrial site, mitigative measures may be used quite successfully (especially in situations where truck spillage occurs). Note, however, that public agencies could make effective use of mitigative controls to remove sand/salt from roads after the winter ends.

Because available controls will affect the silt loading, controlled emission factors may be obtained by substituting controlled silt loading values into the equation. (Emission factors from controlled industrial roads were used in the development of the equation.) The collection of surface loading samples from treated, as well as baseline (untreated), roads provides a means to track effectiveness of the controls over time. The use of Mobile Monitoring Methodologies provide an improved means to track progress in controlling silt loading values.

13.2.1.5 Changes since Fifth Edition

The following changes were made since the publication of the Fifth Edition of AP-42:

October 2002

- 1) The particle size multiplier for $PM_{2.5}$ was revised to 25% of PM_{10} . The approximately 55% reduction was a result of emission testing using FRM monitors. The monitoring was specifically intended to evaluate the $PM_{2.5}$ component of the emissions.
- 2) Default silt loading values were included in Table 13.2.1-2 replacing the Tables and Figures containing silt loading statistical information.
- 3) Editorial changes within the text were made indicating the possible causes of variations in the silt loading between roads within and among different locations. The uncertainty of using the default silt loading value was discussed.

- 4) Section 13.2.1.1 was revised to clarify the role of dust loading in resuspension. Additional minor text changes were made.
- 5) Equations 2 and 3, Figure 13.2.1-2, and text were added to incorporate natural mitigation into annual or other long-term average emission factors.

December 2003

- 1) The emission factor equation was adjusted to remove the component of particulate emissions- from exhaust, brake wear, and tire wear. A parameter C representing these emissions was included in the predictive equation. The parameter C varied with aerodynamic size range of the particulate matter. Table 13.2.1-2 was added to present the new coefficients.
- 2) The default silt loading values in Table 13.2.1-3 were revised to incorporate the results from a recent analysis of silt loading data.

November 2006

- 1) The $PM_{2.5}$ particle size multiplier was revised to 15% of PM_{10} as the result of wind tunnel studies of a variety of dust emitting surface materials.
- 2) References were rearranged and renumbered.

January 2011

- 1) The empirical predictive equation was revised. The revision is based upon stepwise regression of 83 profile emissions tests and an adjustment of individual test data for the exhaust; break wear and tire wear emissions prior to regression of the data.
- 2) The C term is removed from the empirical predictive equation and Table 13.2.1-2 with the C term values is removed since the exhaust; break wear and tire wear emissions were no longer part of the regressed data.
- 3) The $PM_{2.5}$ particle size multiplier was revised to 25% of PM_{10} since the PM_{10} test data used to develop the equation did not meet the necessary PM_{10} concentrations for a ratio of 15%.
- 4) The lower speed of the vehicle speed range supported by the empirical predictive equation was revised to 1 mph.
- 5) Information was added on an improved methodology to develop spatially and temporally resolved silt loadings or emissions factors by Mobile Monitoring Methodologies.

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13.2.5 Industrial Wind Erosion

13.2.5.1 General¹⁻³

Dust emissions may be generated by wind erosion of open aggregate storage piles and exposed areas within an industrial facility. These sources typically are characterized by nonhomogeneous surfaces impregnated with nonerodible elements (particles larger than approximately 1 centimeter [cm] in diameter). Field testing of coal piles and other exposed materials using a portable wind tunnel has shown that (a) threshold wind speeds exceed 5 meters per second (m/s) (11 miles per hour [mph]) at 15 cm above the surface or 10 m/s (22 mph) at 7 m above the surface, and (b) particulate emission rates tend to decay rapidly (half-life of a few minutes) during an erosion event. In other words, these aggregate material surfaces are characterized by finite availability of erodible material (mass/area) referred to as the erosion potential. Any natural crusting of the surface binds the erodible material, thereby reducing the erosion potential.

13.2.5.2 Emissions And Correction Parameters

If typical values for threshold wind speed at 15 cm are corrected to typical wind sensor height (7 - 10 m), the resulting values exceed the upper extremes of hourly mean wind speeds observed in most areas of the country. In other words, mean atmospheric wind speeds are not sufficient to sustain wind erosion from flat surfaces of the type tested. However, wind gusts may quickly deplete a substantial portion of the erosion potential. Because erosion potential has been found to increase rapidly with increasing wind speed, estimated emissions should be related to the gusts of highest magnitude.

The routinely measured meteorological variable that best reflects the magnitude of wind gusts is the fastest mile. This quantity represents the wind speed corresponding to the whole mile of wind movement that has passed by the 1 mile contact anemometer in the least amount of time. Daily measurements of the fastest mile are presented in the monthly Local Climatological Data (LCD) summaries. The duration of the fastest mile, typically about 2 minutes (for a fastest mile of 30 mph), matches well with the half-life of the erosion process, which ranges between 1 and 4 minutes. It should be noted, however, that peak winds can significantly exceed the daily fastest mile.

The wind speed profile in the surface boundary layer is found to follow a logarithmic distribution:

$$u(z) = \frac{u^*}{0.4} \ln \frac{z}{z_0} \quad (z > z_0) \quad (1)$$

where:

- u = wind speed, cm/s
- u* = friction velocity, cm/s
- z = height above test surface, cm
- z₀ = roughness height, cm
- 0.4 = von Karman's constant, dimensionless

The friction velocity (u^*) is a measure of wind shear stress on the erodible surface, as determined from the slope of the logarithmic velocity profile. The roughness height (z_0) is a measure of the roughness of the exposed surface as determined from the y intercept of the velocity profile, i. e., the height at which the wind speed is zero. These parameters are illustrated in Figure 13.2.5-1 for a roughness height of 0.1 cm.

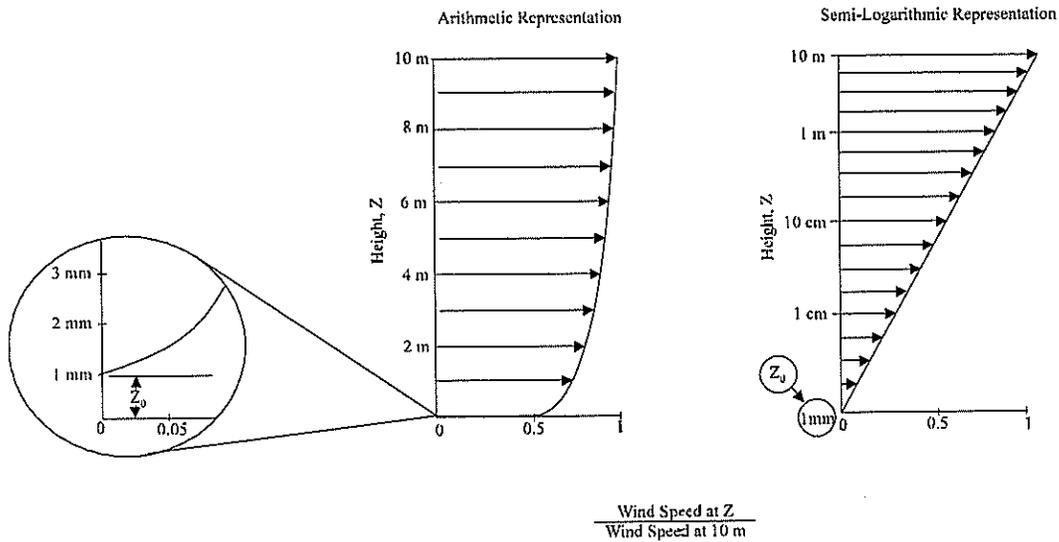


Figure 13.2.5-1. Illustration of logarithmic velocity profile.

Emissions generated by wind erosion are also dependent on the frequency of disturbance of the erodible surface because each time that a surface is disturbed, its erosion potential is restored. A disturbance is defined as an action that results in the exposure of fresh surface material. On a storage pile, this would occur whenever aggregate material is either added to or removed from the old surface. A disturbance of an exposed area may also result from the turning of surface material to a depth exceeding the size of the largest pieces of material present.

13.2.5.3 Predictive Emission Factor Equation⁴

The emission factor for wind-generated particulate emissions from mixtures of erodible and nonerodible surface material subject to disturbance may be expressed in units of grams per square meter (g/m^2) per year as follows:

$$\text{Emission factor} = k \sum_{i=1}^N P_i \quad (2)$$

where:

- k = particle size multiplier
- N = number of disturbances per year
- P_i = erosion potential corresponding to the observed (or probable) fastest mile of wind for the i th period between disturbances, g/m^2

The particle size multiplier (k) for Equation 2 varies with aerodynamic particle size, as follows:

Aerodynamic Particle Size Multipliers For Equation 2			
30 μm	<15 μm	<10 μm	<2.5 μm
1.0	0.6	0.5	0.075 ^a

^a Multiplier for < 2.5 μm taken from Reference 11.

This distribution of particle size within the under 30 micrometer (μm) fraction is comparable to the distributions reported for other fugitive dust sources where wind speed is a factor. This is illustrated, for example, in the distributions for batch and continuous drop operations encompassing a number of test aggregate materials (see Section 13.2.4).

In calculating emission factors, each area of an erodible surface that is subject to a different frequency of disturbance should be treated separately. For a surface disturbed daily, $N = 365$ per year, and for a surface disturbance once every 6 months, $N = 2$ per year.

The erosion potential function for a dry, exposed surface is:

$$P = 58 (u^* - u_t^*)^2 + 25 (u^* - u_t^*) \quad (3)$$

$$P = 0 \text{ for } u^* \leq u_t^*$$

where:

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

Because of the nonlinear form of the erosion potential function, each erosion event must be treated separately.

Equations 2 and 3 apply only to dry, exposed materials with limited erosion potential. The resulting calculation is valid only for a time period as long or longer than the period between disturbances. Calculated emissions represent intermittent events and should not be input directly into dispersion models that assume steady-state emission rates.

For uncrusted surfaces, the threshold friction velocity is best estimated from the dry aggregate structure of the soil. A simple hand sieving test of surface soil can be used to determine the mode of the surface aggregate size distribution by inspection of relative sieve catch amounts, following the procedure described below.

FIELD PROCEDURE FOR DETERMINATION OF THRESHOLD FRICTION VELOCITY
(from a 1952 laboratory procedure published by W. S. Chepil):

1. Prepare a nest of sieves with the following openings: 4 mm, 2 mm, 1 mm, 0.5 mm, and 0.25 mm. Place a collector pan below the bottom (0.25 mm) sieve.
2. Collect a sample representing the surface layer of loose particles (approximately 1 cm in depth, for an encrusted surface), removing any rocks larger than about 1 cm in average physical diameter. The area to be sampled should be not less than 30 cm by 30 cm.
3. Pour the sample into the top sieve (4-mm opening), and place a lid on the top.
4. Move the covered sieve/pan unit by hand, using a broad circular arm motion in the horizontal plane. Complete 20 circular movements at a speed just necessary to achieve some relative horizontal motion between the sieve and the particles.
5. Inspect the relative quantities of catch within each sieve, and determine where the mode in the aggregate size distribution lies, i. e., between the opening size of the sieve with the largest catch and the opening size of the next largest sieve.
6. Determine the threshold friction velocity from Table 13.2.5-1.

The results of the sieving can be interpreted using Table 13.2.5-1. Alternatively, the threshold friction velocity for erosion can be determined from the mode of the aggregate size distribution using the graphical relationship described by Gillette.⁵⁻⁶ If the surface material contains nonerodible elements that are too large to include in the sieving (i. e., greater than about 1 cm in diameter), the effect of the elements must be taken into account by increasing the threshold friction velocity.¹⁰

Table 13.2.5-1 (Metric Units). FIELD PROCEDURE FOR DETERMINATION OF THRESHOLD FRICTION VELOCITY

Tyler Sieve No.	Opening (mm)	Midpoint (mm)	u_t^* (cm/s)
5	4		
9	2	3	100
16	1	1.5	76
32	0.5	0.75	58
60	0.25	0.375	43

Threshold friction velocities for several surface types have been determined by field measurements with a portable wind tunnel. These values are presented in Table 13.2.5-2.

Table 13.2.5-2 (Metric Units). THRESHOLD FRICTION VELOCITIES

Material	Threshold Friction Velocity (m/s)	Roughness Height (cm)	Threshold Wind Velocity At 10 m (m/s)	
			$z_0 = \text{Act}$	$z_0 = 0.5 \text{ cm}$
Overburden ^a	1.02	0.3	21	19
Scoria (roadbed material) ^a	1.33	0.3	27	25
Ground coal (surrounding coal pile) ^a	0.55	0.01	16	10
Uncrusted coal pile ^a	1.12	0.3	23	21
Scraper tracks on coal pile ^{a,b}	0.62	0.06	15	12
Fine coal dust on concrete pad ^c	0.54	0.2	11	10

^a Western surface coal mine. Reference 2.

^b Lightly crusted.

^c Eastern power plant. Reference 3.

The fastest mile of wind for the periods between disturbances may be obtained from the monthly LCD summaries for the nearest reporting weather station that is representative of the site in question.⁷ These summaries report actual fastest mile values for each day of a given month. Because the erosion potential is a highly nonlinear function of the fastest mile, mean values of the fastest mile are inappropriate. The anemometer heights of reporting weather stations are found in Reference 8, and should be corrected to a 10-m reference height using Equation 1.

To convert the fastest mile of wind (u^+) from a reference anemometer height of 10 m to the equivalent friction velocity (u^*), the logarithmic wind speed profile may be used to yield the following equation:

$$u^* = 0.053 u_{10}^+ \quad (4)$$

where:

u^* = friction velocity (m/s)

u_{10}^+ = fastest mile of reference anemometer for period between disturbances (m/s)

This assumes a typical roughness height of 0.5 cm for open terrain. Equation 4 is restricted to large relatively flat piles or exposed areas with little penetration into the surface wind layer.

If the pile significantly penetrates the surface wind layer (i. e., with a height-to-base ratio exceeding 0.2), it is necessary to divide the pile area into subareas representing different degrees of exposure to wind. The results of physical modeling show that the frontal face of an elevated pile is exposed to wind speeds of the same order as the approach wind speed at the top of the pile.

For 2 representative pile shapes (conical and oval with flattop, 37-degree side slope), the ratios of surface wind speed (u_s) to approach wind speed (u_r) have been derived from wind tunnel studies.⁹ The results are shown in Figure 13.2.5-2 corresponding to an actual pile height of 11 m, a reference (upwind) anemometer height of 10 m, and a pile surface roughness height (z_0) of 0.5 cm. The measured surface winds correspond to a height of 25 cm above the surface. The area fraction within each contour pair is specified in Table 13.2.5-3.

Table 13.2.5-3. SUBAREA DISTRIBUTION FOR REGIMES OF u_s/u_r ^a

Pile Subarea	Percent Of Pile Surface Area			
	Pile A	Pile B1	Pile B2	Pile B3
0.2a	5	5	3	3
0.2b	35	2	28	25
0.2c	NA	29	NA	NA
0.6a	48	26	29	28
0.6b	NA	24	22	26
0.9	12	14	15	14
1.1	NA	NA	3	4

^a NA = not applicable.

The profiles of u_s/u_r in Figure 13.2.5-2 can be used to estimate the surface friction velocity distribution around similarly shaped piles, using the following procedure:

1. Correct the fastest mile value (u^+) for the period of interest from the anemometer height (z) to a reference height of 10 m u_{10}^+ using a variation of Equation 1:

$$u_{10}^+ = u^+ \frac{\ln(10/0.005)}{\ln(z/0.005)} \quad (5)$$

where a typical roughness height of 0.5 cm (0.005 m) has been assumed. If a site-specific roughness height is available, it should be used.

2. Use the appropriate part of Figure 13.2.5-2 based on the pile shape and orientation to the fastest mile of wind, to obtain the corresponding surface wind speed distribution (u_s^+)

$$u_s^+ = \frac{(u_s)}{u_r} u_{10}^+ \quad (6)$$

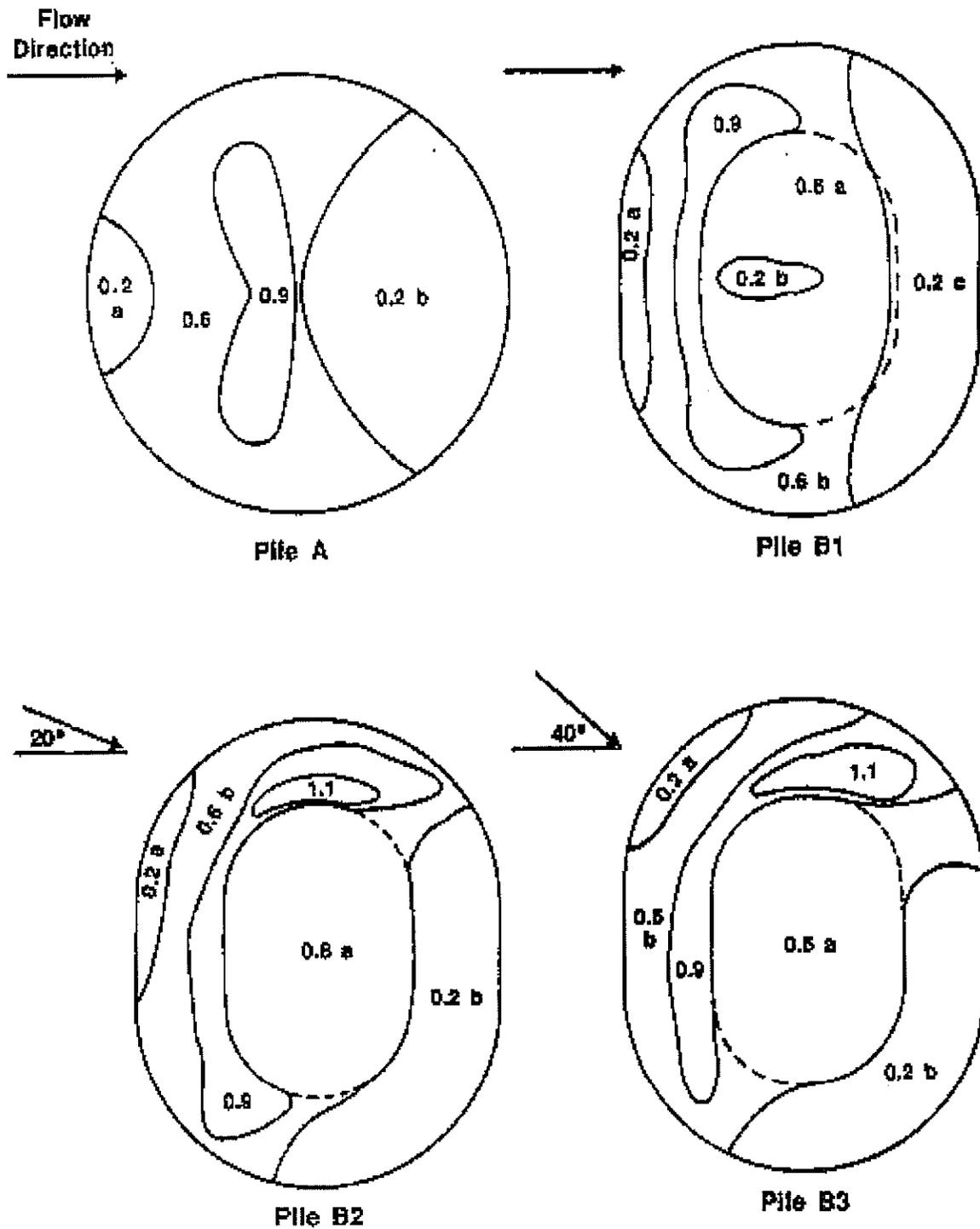


Figure 13.2.5-2. Contours of normalized surface windspeeds, u_s/u_r .

3. For any subarea of the pile surface having a narrow range of surface wind speed, use a variation of Equation 1 to calculate the equivalent friction velocity (u^*):

$$u^* = \frac{0.4u_s^+}{\frac{25}{\ln 0.5}} = 0.10u_s^- \quad (7)$$

From this point on, the procedure is identical to that used for a flat pile, as described above.

Implementation of the above procedure is carried out in the following steps:

1. Determine threshold friction velocity for erodible material of interest (see Table 13.2.5-2 or determine from mode of aggregate size distribution).
2. Divide the exposed surface area into subareas of constant frequency of disturbance (N).
3. Tabulate fastest mile values (u^+) for each frequency of disturbance and correct them to 10 m (u^+) using Equation 5.5
4. Convert fastest mile values (u_{10}) to equivalent friction velocities (u^*), taking into account (a) the uniform wind exposure of nonelevated surfaces, using Equation 4, or (b) the nonuniform wind exposure of elevated surfaces (piles), using Equations 6 and 7.
5. For elevated surfaces (piles), subdivide areas of constant N into subareas of constant u^* (i. e., within the isopleth values of u_s/u_r in Figure 13.2.5-2 and Table 13.2.5-3) and determine the size of each subarea.
6. Treating each subarea (of constant N and u^*) as a separate source, calculate the erosion potential (P_i) for each period between disturbances using Equation 3 and the emission factor using Equation 2.
7. Multiply the resulting emission factor for each subarea by the size of the subarea, and add the emission contributions of all subareas. Note that the highest 24-hour (hr) emissions would be expected to occur on the windiest day of the year. Maximum emissions are calculated assuming a single event with the highest fastest mile value for the annual period.

The recommended emission factor equation presented above assumes that all of the erosion potential corresponding to the fastest mile of wind is lost during the period between disturbances. Because the fastest mile event typically lasts only about 2 minutes, which corresponds roughly to the half-life for the decay of actual erosion potential, it could be argued that the emission factor overestimates particulate emissions. However, there are other aspects of the wind erosion process that offset this apparent conservatism:

1. The fastest mile event contains peak winds that substantially exceed the mean value for the event.
2. Whenever the fastest mile event occurs, there are usually a number of periods of

slightly lower mean wind speed that contain peak gusts of the same order as the fastest mile wind speed.

Of greater concern is the likelihood of overprediction of wind erosion emissions in the case of surfaces disturbed infrequently in comparison to the rate of crust formation.

13.2.5.4 Example 1: Calculation for wind erosion emissions from conically shaped coal pile

A coal burning facility maintains a conically shaped surge pile 11 m in height and 29.2 m in base diameter, containing about 2000 megagrams (Mg) of coal, with a bulk density of 800 kilograms per cubic meter (kg/m^3) (50 pounds per cubic foot [lb/ft^3]). The total exposed surface area of the pile is calculated as follows:

Coal is added to the pile by means of a fixed stacker and reclaimed by front-end loaders operating

$$\begin{aligned} S &= \pi r \sqrt{r^2 + h^2} \\ &= 3.14(14.6)\sqrt{(14.6)^2 + (11.0)^2} \\ &= 838 \text{ m}^2 \end{aligned}$$

at the base of the pile on the downwind side. In addition, every 3 days 250 Mg (12.5 percent of the stored capacity of coal) is added back to the pile by a topping off operation, thereby restoring the full capacity of the pile. It is assumed that (a) the reclaiming operation disturbs only a limited portion of the surface area where the daily activity is occurring, such that the remainder of the pile surface remains intact, and (b) the topping off operation creates a fresh surface on the entire pile while restoring its original shape in the area depleted by daily reclaiming activity.

Because of the high frequency of disturbance of the pile, a large number of calculations must be made to determine each contribution to the total annual wind erosion emissions. This illustration will use a single month as an example.

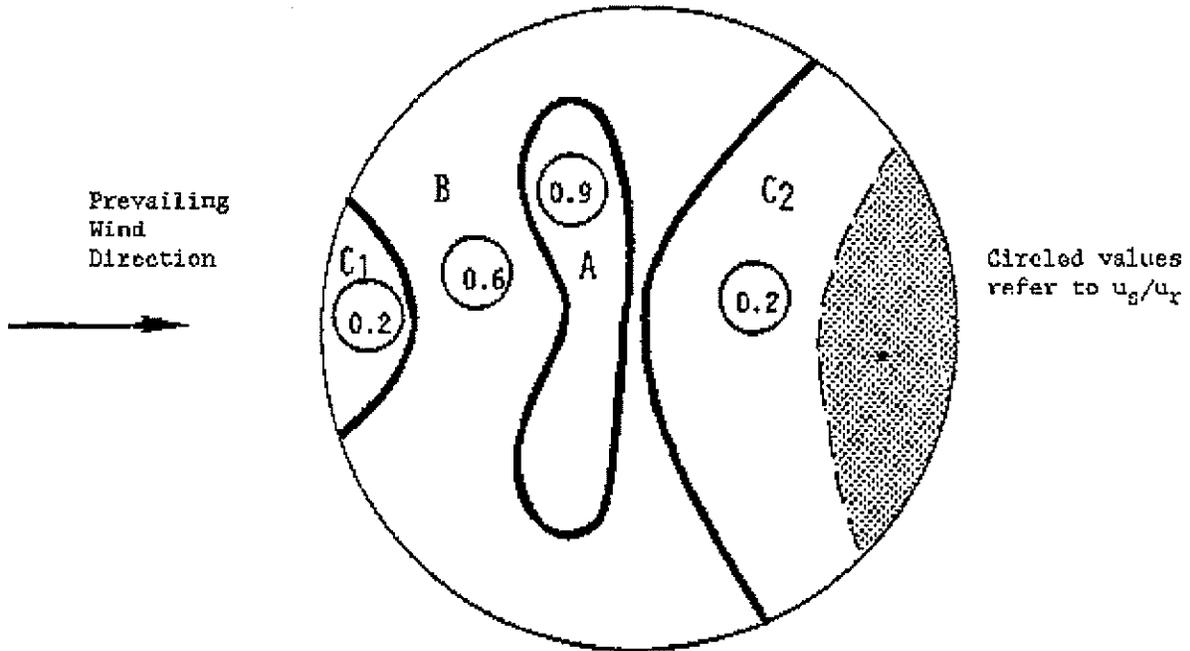
Step 1: In the absence of field data for estimating the threshold friction velocity, a value of 1.12 m/s is obtained from Table 13.2.5-2.

Step 2: Except for a small area near the base of the pile (see Figure 13.2.5-3), the entire pile surface is disturbed every 3 days, corresponding to a value of $N = 120$ per year. It will be shown that the contribution of the area where daily activity occurs is negligible so that it does not need to be treated separately in the calculations.

Step 3: The calculation procedure involves determination of the fastest mile for each period of disturbance. Figure 13.2.5-4 shows a representative set of values (for a 1-month period) that are assumed to be applicable to the geographic area of the pile location. The values have been separated into 3-day periods, and the highest value in each period is indicated. In this example, the anemometer height is 7 m, so that a height correction to 10 m is needed for the fastest mile values. From Equation 5,

$$\begin{aligned} u_{10}^+ &= u_7^+ \left(\frac{\ln(10/0.005)}{\ln(7/0.005)} \right) \\ u_{10}^+ &= 1.05 u_7^+ \end{aligned}$$

Step 4: The next step is to convert the fastest mile value for each 3-day period into



* A portion of C₂ is disturbed daily by reclaiming activities.

Area ID	$\frac{u_g}{u_r}$	Pile Surface	
		%	Area (m ²)
A	0.9	12	101
B	0.6	48	402
C ₁ + C ₂	0.2	40	335
		Total	838

Figure 13.2.5-3. Example 1: Pile surface areas within each wind speed regime.

Local Climatological Data
Monthly Summary



Wind					
Resultant Dir. 13	Resultant Speed M.P.H. 14	Average Speed M.P.H. 15	Fastest Mile		Date 22
			Speed M.P.H. 16	Direction 17	
30	5.3	6.9	9	36	1
01	10.5	10.6	(14)	01	2
10	2.4	6.0	10	02	3
13	11.0	11.4	16	13	4
12	11.3	11.9	15	11	5
20	11.1	19.0	(29)	30	6
29	19.6	19.8	(30)	30	7
29	10.9	11.2	17	30	8
22	3.0	8.1	15	13	9
14	14.6	15.1	23	12	10
29	22.3	23.3	(31)	29	11
17	7.9	13.5	23	17	12
21	7.7	15.5	18	18	13
10	4.5	9.6	(22)	13	14
10	6.7	8.8	13	11	15
01	13.7	13.8	(21)	36	16
33	11.2	11.5	15	34	17
27	4.3	5.8	12	31	18
32	9.3	10.2	14	35	19
24	7.5	7.8	(16)	24	20
22	10.3	10.6	16	20	21
32	17.1	17.3	(25)	32	22
29	2.4	8.5	14	13	23
07	5.9	8.8	15	02	24
34	11.3	11.7	(17)	32	25
31	12.1	12.2	16	32	26
30	8.3	8.5	16	26	27
30	8.2	8.3	(13)	32	28
33	5.0	6.6	10	32	29
34	3.1	5.2	9	31	30
29	4.9	5.5	8	25	31
For the Month:					
30	3.3	11.1	31	29	
			Date: 11		

Figure 13.2.5-4. Example daily fastest miles wind for periods of interest.

equivalent friction velocities for each surface wind regime (i. e., u_s/u_r ratio) of the pile, using Equations 6 and 7. Figure 13.2.5-3 shows the surface wind speed pattern (expressed as a fraction of the approach wind speed at a height of 10 m). The surface areas lying within each wind speed regime are tabulated below the figure.

The calculated friction velocities are presented in Table 13.2.5-4. As indicated, only 3 of the periods contain a friction velocity which exceeds the threshold value of 1.12 m/s for an uncrusted coal pile. These 3 values all occur within the $u_s/u_r = 0.9$ regime of the pile surface.

Table 13.2.5-4 (Metric And English Units). EXAMPLE 1:
CALCULATION OF FRICTION VELOCITIES

3-Day Period	u_7^+		u_{10}^+		$u^* = 0.1u^+ \text{ (m/s)}$		
	mph	m/s	mph	m/s	s		
					$u_s/u_r: 0.2$	$u_s/u_r: 0.6$	$u_s/u_r: 0.9$
1	14	6.3	15	6.6	0.13	0.40	0.59
2	29	13.0	31	13.7	0.27	0.82	1.23
3	30	13.4	32	14.1	0.28	0.84	1.27
4	31	13.9	33	14.6	0.29	0.88	1.31
5	22	9.8	23	10.3	0.21	0.62	0.93
6	21	9.4	22	9.9	0.20	0.59	0.89
7	16	7.2	17	7.6	0.15	0.46	0.68
8	25	11.2	26	11.8	0.24	0.71	1.06
9	17	7.6	18	8.0	0.16	0.48	0.72
10	13	5.8	14	6.1	0.12	0.37	0.55

Step 5: This step is not necessary because there is only 1 frequency of disturbance used in the calculations. It is clear that the small area of daily disturbance (which lies entirely within the $u_s/u_r = 0.2$ regime) is never subject to wind speeds exceeding the threshold value.

Steps 6 and 7: The final set of calculations (shown in Table 13.2.5-5) involves the tabulation and summation of emissions for each disturbance period and for the affected subarea. The erosion potential (P) is calculated from Equation 3.

For example, the calculation for the second 3-day period is:

$$P = 58(u^* - u_t^*)^2 + 25(u^* - u_t^*)$$

$$P_2 = 58(1.23 - 1.12)^2 + 25(1.23 - 1.12)$$

$$= 0.70 + 2.75 = 3.45 \text{ g/m}^2$$

Table 13.2.5-5 (Metric Units). EXAMPLE 1: CALCULATION OF PM-10 EMISSIONS^a

3-Day Period	u^* (m/s)	$u^* - u_t^*$ (m/s)	P (g/m ²)	ID	Pile Surface Area (m ²)	kPA (g)
2	1.23	0.11	3.45	A	101	170
3	1.27	0.15	5.06	A	101	260
4	1.31	0.19	6.84	A	101	350
TOTAL						780

^a Where $u_t^* = 1.12$ m/s for uncrusted coal and $k = 0.5$ for PM-10.

The emissions of particulate matter greater than 10 μm (PM-10) generated by each event are found as the product of the PM-10 multiplier ($k = 0.5$), the erosion potential (P), and the affected area of the pile (A).

As shown in Table 13.2.5-5, the results of these calculations indicate a monthly PM-10 emission total of 780 g.

13.2.5.5 Example 2: Calculation for wind erosion from flat area covered with coal dust

A flat circular area 29.2 m in diameter is covered with coal dust left over from the total reclaiming of a conical coal pile described in the example above. The total exposed surface area is calculated as follows:

$$s = \frac{\pi}{4} d^2 = 0.785 (29.2)^2 = 670 \text{ m}^2$$

This area will remain exposed for a period of 1 month when a new pile will be formed.

Step 1: In the absence of field data for estimating the threshold friction velocity, a value of 0.54 m/s is obtained from Table 13.2.5-2.

Step 2: The entire surface area is exposed for a period of 1 month after removal of a pile and $N = 1/\text{yr}$.

Step 3: From Figure 13.2.5-4, the highest value of fastest mile for the 30-day period (31 mph) occurs on the 11th day of the period. In this example, the reference anemometer height is 7 m, so that a height correction is needed for the fastest mile value. From Step 3 of the previous example, $u_{10}^+ = 1.05 u^+$, so that $u^+ \approx 33$ mph.

Step 4: Equation 4 is used to convert the fastest mile value of 14.6 m/s (33 mph) to an equivalent friction velocity of 0.77 m/s. This value exceeds the threshold friction velocity from Step 1 so that erosion does occur.

Step 5: This step is not necessary, because there is only 1 frequency of disturbance for the entire source area.

Steps 6 and 7: The PM-10 emissions generated by the erosion event are calculated as the product of the PM-10 multiplier ($k = 0.5$), the erosion potential (P) and the source area (A). The erosion potential is calculated from Equation 3 as follows:

$$\begin{aligned}
 P &= 58(u^* - u_t^*)^2 + 25(u^* - u_t^*) \\
 P &= 58(0.77 - 0.54)^2 + 25(0.77 - 0.54) \\
 &= 3.07 + 5.75 \\
 &= 8.82 \text{ g/m}^2
 \end{aligned}$$

Thus the PM-10 emissions for the 1-month period are found to be:

$$\begin{aligned}
 E &= (0.5)(8.82 \text{ g/m}^2)(670 \text{ m}^2) \\
 &= 3.0 \text{ kg}
 \end{aligned}$$

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