Trinity Consultants
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trinityconsultants.com

August 24, 2023

Permit Programs Manager
NMED Air Quality Bureau
525 Camino de los Marquez Suite 1
Santa Fe, NM 87505-1816

RE: Title V Renewal and Significant Modification of Permit No. P066-R3M1
Freeport-McMoran Chino Mines Company – Chino Mine

Permit Programs Manager:

On behalf of Freeport-McMoRan Chino Mines Company, we are submitting this Title V Operating Permit Renewal and Significant Modification application for the Chino Mine Facility. Pursuant to 20.2.70.300.B.2 NMAC, this application is being submitted at least twelve months prior to the August 10, 2023 expiration of current Title Operating Permit No. P-0660-R3M1. The requested Significant Modification includes the changes to NSR Permit No. 0298-M10R1, 0298-M10R3, 0298-M10R4, 0298-M11R1, No. 0298-M11R2, No. 0298-M11R3, and No. 0298-M11R4. Those requested changes included authorization for blasting and material handling activities necessary for the construction of a borrow pit near the Cobre Haul Road and maintenance of the facility haul roads, retirement of Mase 1 from the facility, construction of baghouse to control SAG mill tunnel, removal of LmSIk and ENG-1 units, replacement of Fire Emergency Pump, and addition of two emergency standby generators.

The format and content of this application are consistent with the Bureau's current policy regarding Title V Operating Permit applications. Enclosed are two hard copies of the application, including an original certification, files for application will be sent via secure website link. Please feel free to contact either myself at (505) 266-6611 or aerenstein@trinityconsultants.com, or Sherry Burt-Kested, Manager of Environmental Services with Freeport McMoRan Chino Mines Company, at (575) 912-5927 or at sburtkested@fmi.com if you have any questions regarding this application.
Sincerely,

Adam Erenstein
Manager of Consulting Services

Cc: Sherry Burt-Kested – sburtkested@fmi.com

Trinity Project File: 223201.0121

Mail Application To:		For Department use only:
New Mexico Environment Department Air Quality Bureau Permits Section 525 Camino de los Marquez, Suite 1 Santa Fe, New Mexico, 87505 Phone: (505) 476-4300 Fax: (505) 476-4375 www.env.nm.gov/aqb		AIRS No.:

Universal Air Quality Permit Application

Use this application for NOI, NSR, or Title V sources.

Use this application for: the initial application, modifications, technical revisions, and renewals. For technical revisions, complete Sections, 1-A, 1-B, 2-E, 3, 9 and any other sections that are relevant to the requested action; coordination with the Air Quality Bureau permit staff prior to submittal is encouraged to clarify submittal requirements and to determine if more or less than these sections of the application are needed. Use this application for streamline permits as well. See Section 1-I for submittal instructions for other permits.

This application is submitted as (check all that apply)**:** ☐ Request for a No Permit Required Determination (no fee)
☐ **Updating** an application currently under NMED review. Include this page and all pages that are being updated (no fee required).
Construction Status: ☐ Not Constructed ☑ Existing Permitted (or NOI) Facility ☐ Existing Non-permitted (or NOI) Facility
Minor Source: ☐ a NOI 20.2.73 NMAC ☐ 20.2.72 NMAC application or revision ☐ 20.2.72.300 NMAC Streamline application
Title V Source: ☐ Title V (new) ☑ Title V renewal ☐ TV minor mod. ☑ TV significant mod. TV Acid Rain: ☐ New ☐ Renewal
PSD Major Source: ☐ PSD major source (new) ☐ minor modification to a PSD source ☐ a PSD major modification

Acknowledgements:
☑ I acknowledge that a pre-application meeting is available to me upon request. ☑ Title V Operating, Title IV Acid Rain, and NPR applications have no fees.
☐ $500 NSR application Filing Fee enclosed OR ☐ The full permit fee associated with 10 fee points (required w/ streamline applications).
☐ Check No.: **N/A** in the amount of $500
☑ I acknowledge the required submittal format for the hard copy application is printed double sided 'head-to-toe', 2-hole punched (except the Sect. 2 landscape tables is printed 'head-to-head'), numbered tab separators. Incl. a copy of the check on a separate page.
☑ I acknowledge there is an annual fee for permits in addition to the permit review fee: www.env.nm.gov/air-quality/permit-fees-2/.
☑ This facility qualifies for the small business fee reduction per 20.2.75.11.C. NMAC. The full $500.00 filing fee is included with this application and I understand the fee reduction will be calculated in the balance due invoice. The Small Business Certification Form has been previously submitted or is included with this application. (Small Business Environmental Assistance Program Information: www.env.nm.gov/air-quality/small-biz-eap-2/.)

Citation: Please provide the **low level citation** under which this application is being submitted: **20.2.70.300.B.(2) NMAC** and **20.2.70.404.C.(1)(a) NMAC**
(e.g. application for a new minor source would be 20.2.72.200.A NMAC, one example for a Technical Permit Revision is 20.2.72.219.B.1.b NMAC, a Title V acid rain application would be: 20.2.70.200.C NMAC)

Section 1 – Facility Information

Section 1-A: Company Information

		AI # if known (see 1st 3 to 5 #s of permit IDEA ID No.):526	Updating Permit/NOI #: P-066-R3M1
1	Facility Name: Chino Mine	Plant primary SIC Code (4 digits): 1021	
		Plant NAIC code (6 digits): 212234	
a	Facility Street Address (If no facility street address, provide directions from a prominent landmark): 99 Santa Rita Mine Road, Vanadium, NM 88023		
2	Plant Operator Company Name: Freeport-McMoRan Chino Mines Company	Phone/Fax: (575) 912-5000 / (575) 537-8012	

a	Plant Operator Address: 99 Santa Rita Mine Road, Vanadium, NM 88023	
b	Plant Operator's New Mexico Corporate ID or Tax ID: Unknown	
3	Plant Owner(s) name(s): Freeport-McMoRan Chino Mines Company	Phone/Fax: (575) 912-5000 / (575) 537-8012
a	Plant Owner(s) Mailing Address(s): P.O. Box 10, Bayard, NM 88023	
4	Bill To (Company): Freeport-McMoRan Chino Mines Company	Phone/Fax: (575) 912-5000 / (575) 537-8012
a	Mailing Address: P.O. Box 10, Bayard, NM 88023	E-mail: sburtkes@fmi.com
5	☑ Preparer: Adam Erenstein ☑ Consultant: Trinity Consultants	Phone/Fax: (505) 266-6611 / N/A
a	Mailing Address: 9400 Holly Blvd NE, Building 3, Suite 300 Albuquerque, NM 87122	E-mail: aerenstein@trinityconsultants.com
6	Plant Operator Contact: Randy Ellison	Phone/Fax: (575) 912-5640/ (575) 912-5035
a	Address: P.O. Box 10, Bayard, NM 88023	E-mail: rellison@fmi.com
7	Air Permit Contact: Sherry Burt-Kested	Title: Manager, Environmental Services
a	E-mail: sburtkes@fmi.com	Phone/Fax: (575) 912-5927 /N/A
b	Mailing Address: 99 Santa Rita Mine Rd., Vanadium, NM 88023	
c	The designated Air permit Contact will receive all official correspondence (i.e. letters, permits) from the Air Quality Bureau.	

Section 1-B: Current Facility Status

1.a	Has this facility already been constructed? ☑ Yes ☐ No	1.b If yes to question 1.a, is it currently operating in New Mexico? ☑ Yes ☐ No
2	If yes to question 1.a, was the existing facility subject to a Notice of Intent (NOI) (20.2.73 NMAC) before submittal of this application? ☐ Yes ☑ No	If yes to question 1.a, was the existing facility subject to a construction permit (20.2.72 NMAC) before submittal of this application? ☐ Yes ☐ No ☑N/A
3	Is the facility currently shut down? ☐ Yes ☑ No	If yes, give month and year of shut down (MM/YY): N/A
4	Was this facility constructed before 8/31/1972 and continuously operated since 1972? ☐ Yes ☑ No	
5	If Yes to question 3, has this facility been modified (see 20.2.72.7.P NMAC) or the capacity increased since 8/31/1972? ☐Yes ☐No ☑N/A	
6	Does this facility have a Title V operating permit (20.2.70 NMAC)? ☑ Yes ☐ No	If yes, the permit No. is: P-066-R3M1
7	Has this facility been issued a No Permit Required (NPR)? ☐ Yes ☑ No	If yes, the NPR No. is: N/A
8	Has this facility been issued a Notice of Intent (NOI)? ☐ Yes ☑ No	If yes, the NOI No. is: N/A
9	Does this facility have a construction permit (20.2.72/20.2.74 NMAC)? ☑ Yes ☐ No	If yes, the permit No. is: 0298-M10R1
10	Is this facility registered under a General permit (GCP-1, GCP-2, etc.)? ☐ Yes ☑ No	If yes, the register No. is: N/A

Section 1-C: Facility Input Capacity & Production Rate

1	What is the facility's maximum input capacity, specify units (reference here and list capacities in Section 20, if more room is required)			
a	Current	**Hourly:** 41,666 tons (Santa Rita Pit) 5,250 (Hanover Mountain)	**Daily:** 1,000,000 tons (Santa Rita Pit) 126,000 tons (Hanover Mountain)	**Annually:** 365,000,000 tons (Santa Rita Pit) 45,990,000 (Hanover Mountain)
b	Proposed	**Hourly:** 41,666 tons (Santa Rita Pit) 5,250 (Hanover Mountain)	**Daily:** 1,000,000 tons (Santa Rita Pit) 126,000 tons (Hanover Mountain)	**Annually:** 365,000,000 tons (Santa Rita Pit) 45,990,000 (Hanover Mountain)
2	What is the facility's maximum production rate, specify units (reference here and list capacities in Section 20, if more room is required)			

a	Current	**Hourly:** 41,666 tons (Santa Rita Pit) 5,250 (Hanover Mountain)	**Daily:** 1,000,000 tons (Santa Rita Pit) 126,000 tons (Hanover Mountain)	**Annually:** 365,000,000 tons (Santa Rita Pit) 45,990,000 (Hanover Mountain)
b	Proposed	**Hourly:** 41,666 tons (Santa Rita Pit) 5,250 (Hanover Mountain)	**Daily:** 1,000,000 tons (Santa Rita Pit) 126,000 tons (Hanover Mountain)	**Annually:** 365,000,000 tons (Santa Rita Pit) 45,990,000 (Hanover Mountain)

Section 1-D: Facility Location Information

1	Section: Various	Range: 11W, 12W, 13W	Township: 17S, 18S, 19S	County: Grant	Elevation (ft): 5,630
2	UTM Zone: ☑ 12 or ☐ 13			Datum: ☐ NAD 27 ☐ NAD 83 ☑ WGS 84	
a	UTM E (in meters, to nearest 10 meters): 774,500 m E			UTM N (in meters, to nearest 10 meters): 3,631,100 m N	
b	**AND** Latitude (deg., min., sec.): 32°47'0.94"N			Longitude (deg., min., sec.): 103°4'9.10"W	
3	Name and zip code of nearest New Mexico town: Bayard, NM 88023				
4	Detailed Driving Instructions from nearest NM town (attach a road map if necessary): From Bayard, NM head north on NM-356N/Central Avenue toward Coffey Street. Follow NM-356 N for 1.7 miles and then turn right onto Santa Rita Mine Rd. Continue on Santa Rita Mine Rd for 2.3 miles. Destination will be on the right.				
5	The facility is 3.89 miles northeast of Bayard, NM.				
6	Status of land at facility (check one): ☐ Private ☐ Indian/Pueblo ☑Federal BLM ☐ Federal Forest Service ☐ Other (specify): The majority of the land is privately owned. Some of the land is owned by BLM, but leased to Freeport-McMoRan.				
7	List all municipalities, Indian tribes, and counties within a ten (10) mile radius (20.2.72.203.B.2 NMAC) of the property on which the facility is proposed to be constructed or operated: **Municipalities**: Bayard, Santa Clara, Silver City, and Hurley. **Indian Tribes:** None. **Counties:** Grant and Luna.				
8	**20.2.72** NMAC applications **only**: Will the property on which the facility is proposed to be constructed or operated be closer than 50 km (31 miles) to other states, Bernalillo County, or a Class I area (see www.env.nm.gov/aqb/modeling/class1areas.html)? ☑ Yes ☐ No (20.2.72.206.A.7 NMAC) If yes, list all with corresponding distances in kilometers: Gila Wilderness Area (16.7 km north)				
9	Name nearest Class I area: Gila Wilderness Area				
10	Shortest distance (in km) from facility boundary to the boundary of the nearest Class I area (to the nearest 10 meters): 16.7 km				
11	Distance (meters) from the perimeter of the Area of Operations (AO is defined as the plant site inclusive of all disturbed lands, including mining overburden removal areas) to nearest residence, school or occupied structure: 60 m				
12	Method(s) used to delineate the Restricted Area: Controlled ownership of area with security gates at access points. "**Restricted Area**" is an area to which public entry is effectively precluded. Effective barriers include continuous fencing, continuous walls, or other continuous barriers approved by the Department, such as rugged physical terrain with steep grade that would require special equipment to traverse. If a large property is completely enclosed by fencing, a restricted area within the property may be identified with signage only. Public roads cannot be part of a Restricted Area.				
13	Does the owner/operator intend to operate this source as a portable stationary source as defined in 20.2.72.7.X NMAC? ☐ Yes ☑ No A portable stationary source is not a mobile source, such as an automobile, but a source that can be installed permanently at one location or that can be re-installed at various locations, such as a hot mix asphalt plant that is moved to different job sites.				
14	Will this facility operate in conjunction with other air regulated parties on the same property? ☒ No ☐ Yes If yes, what is the name and permit number (if known) of the other facility?				

Section 1-E: Proposed Operating Schedule (The 1-E.1 & 1-E.2 operating schedules may become conditions in the permit.)

1	Facility **maximum** operating ($\frac{hours}{day}$): 24	($\frac{days}{week}$): 7		($\frac{weeks}{year}$): 52	($\frac{hours}{year}$): 8,760	
2	Facility's maximum daily operating schedule (if less than 24 $\frac{hours}{day}$)?	Start: N/A	☐AM ☐PM		End: N/A	☐AM ☐PM
3	Month and year of anticipated start of construction: N/A					
4	Month and year of anticipated construction completion: N/A					
5	Month and year of anticipated startup of new or modified facility: N/A					

6	Will this facility operate at this site for more than one year? ☑ Yes ☐ No

Section 1-F: Other Facility Information

1	Are there any current Notice of Violations (NOV), compliance orders, or any other compliance or enforcement issues related to this facility? ☐ Yes ☑ No If yes, specify:		
a	If yes, NOV date or description of issue: N/A		NOV Tracking No: N/A
b	Is this application in response to any issue listed in 1-F, 1 or 1a above? ☐ Yes ☑No If Yes, provide the 1c & 1d info below:		
c	Document Title: N/A	Date: N/A	Requirement # (or page # and paragraph #): N/A
d	Provide the required text to be inserted in this permit: N/A		
2	Is air quality dispersion modeling or modeling waiver being submitted with this application? ☐ Yes ☑ No		
3	Does this facility require an "Air Toxics" permit under 20.2.72.400 NMAC & 20.2.72.502, Tables A and/or B? ☐ Yes ☑ No		
4	Will this facility be a source of federal Hazardous Air Pollutants (HAP)? ☑ Yes ☐ No		
a	If Yes, what type of source? ☐ **Major** (☐ ≥10 tpy of any single HAP **OR** ☐ ≥25 tpy of any combination of HAPS) **OR** ☑ **Minor** (☑<10 tpy of any single HAP **AND** ☑ <25 tpy of any combination of HAPS)		
5	Is any unit exempt under 20.2.72.202.B.3 NMAC? ☑ Yes ☐ No		
a	If yes, include the name of company providing commercial electric power to the facility: PNM Commercial power is purchased from a commercial utility company, which specifically does not include power generated on site for the sole purpose of the user.		

Section 1-G: Streamline Application **(This section applies to 20.2.72.300 NMAC Streamline applications only)**

1	☐ I have filled out Section 18, "Addendum for Streamline Applications." ☑ N/A (This is not a Streamline application.)

Section 1-H: Current Title V Information - Required for all applications from TV Sources

(Title V-source required information for all applications submitted pursuant to 20.2.72 NMAC (Minor Construction Permits), or 20.2.74/20.2.79 NMAC (Major PSD/NNSR applications), and/or 20.2.70 NMAC (Title V))

1	Responsible Official (R.O.) (20.2.70.300.D.2 NMAC): TBD	Phone: TBD
a	R.O. Title: TBD	R.O. e-mail: TBD
b	R. O. Address: TBD	
2	Alternate Responsible Official (20.2.70.300.D.2 NMAC): Randy Ellison	Phone: (575) 912-5640
a	A. R.O. Title: Plant Operator	A. R.O. e-mail: rellison@fmi.com
b	A. R. O. Address: P.O. Box 10 Bayard, NM 88023	
3	Company's Corporate or Partnership Relationship to any other Air Quality Permittee (List the names of any companies that have operating (20.2.70 NMAC) permits and with whom the applicant for this permit has a corporate or partnership relationship): Freeport-McMoRan Tyrone Inc.	
4	Name of Parent Company ("Parent Company" means the primary name of the organization that owns the company to be permitted wholly or in part.): Freeport-McMoRan, Inc.	
a	Address of Parent Company: 333 North Central Avenue, Phoenix, Arizona, 85004	
5	Names of Subsidiary Companies ("Subsidiary Companies" means organizations, branches, divisions or subsidiaries, which are owned, wholly or in part, by the company to be permitted.): N/A	
6	Telephone numbers & names of the owners' agents and site contacts familiar with plant operations: N/A	

7	Affected Programs to include Other States, local air pollution control programs (i.e. Bernalillo) and Indian tribes: Will the property on which the facility is proposed to be constructed or operated be closer than 80 km (50 miles) from other states, local pollution control programs, and Indian tribes and pueblos (20.2.70.402.A.2 and 20.2.70.7.B)? If yes, state which ones and provide the distances in kilometers:

Section 1-I – Submittal Requirements

Each 20.2.73 NMAC (**NOI**), a 20.2.70 NMAC (**Title V**), a 20.2.72 NMAC (**NSR** minor source), or 20.2.74 NMAC (**PSD**) application package shall consist of the following:

Hard Copy Submittal Requirements:

1) One hard copy **original signed and notarized application package** **printed double sided** **'head-to-toe'** **2-hole punched** as we bind the document on top, not on the side; except Section 2 (landscape tables), which should be head-to-head. Please use **numbered tab separators** in the hard copy submittal(s) as this facilitates the review process. For NOI submittals only, hard copies of UA1, Tables 2A, 2D & 2F, Section 3 and the signed Certification Page are required. Please include a copy of the check on a separate page.

2) If the application is for a minor NSR, PSD, NNSR, or Title V application, include one working hard **copy** for Department use. This copy should be printed in book form, 3-hole punched, and **must be double sided**. Note that this is in addition to the head-to-to 2-hole punched copy required in 1) above. Minor NSR Technical Permit revisions (20.2.72.219.B NMAC) only need to fill out Sections 1-A, 1-B, 3, and should fill out those portions of other Section(s) relevant to the technical permit revision. TV Minor Modifications need only fill out Sections 1-A, 1-B, 1-H, 3, and those portions of other Section(s) relevant to the minor modification. NMED may require additional portions of the application to be submitted, as needed.

3) The entire NOI or Permit application package, including the full modeling study, should be submitted electronically. Electronic files for applications for NOIs, any type of General Construction Permit (GCP), or technical revisions to NSRs must be submitted with compact disk (CD) or digital versatile disc (DVD). For these permit application submittals, two CD copies are required (in sleeves, not crystal cases, please), with additional CD copies as specified below. NOI applications require only a single CD submittal. Electronic files for other New Source Review (construction) permits/permit modifications or Title V permits/permit modifications can be submitted on CD/DVD or sent through AQB's secure file transfer service.

Electronic files sent by (check one):

☐ CD/DVD attached to paper application

☑ secure electronic transfer. Air Permit Contact Name Adam Erenstein

Email aerenstein@trinityconsultants.com

Phone number 505-266-6611

a. If the file transfer service is chosen by the applicant, after receipt of the application, the Bureau will email the applicant with instructions for submitting the electronic files through a secure file transfer service. Submission of the electronic files through the file transfer service needs to be completed within 3 business days after the invitation is received, so the applicant should ensure that the files are ready when sending the hard copy of the application. The applicant will not need a password to complete the transfer. **Do not use the file transfer service for NOIs, any type of GCP, or technical revisions to NSR permits.**

4) Optionally, the applicant may submit the files with the application on compact disk (CD) or digital versatile disc (DVD) following the instructions above and the instructions in 5 for applications subject to PSD review.

5) If **air dispersion modeling** is required by the application type, include the **NMED Modeling Waiver** and/or electronic air dispersion modeling report, input, and output files. The dispersion modeling ***summary report only*** should be submitted as hard copy(ies) unless otherwise indicated by the Bureau.

6) If the applicant submits the electronic files on CD and the application is subject to PSD review under 20.2.74 NMAC (PSD) or NNSR under 20.2.79 NMC include,
   a. one additional CD copy for US EPA,
   b. one additional CD copy for each federal land manager affected (NPS, USFS, FWS, USDI) and,
   c. one additional CD copy for each affected regulatory agency other than the Air Quality Bureau.

   If the application is submitted electronically through the secure file transfer service, these extra CDs do not need to be submitted.

Electronic Submittal Requirements [in addition to the required hard copy(ies)]:

1) All required electronic documents shall be submitted as 2 separate CDs or submitted through the AQB secure file transfer service. Submit a single PDF document of the entire application as submitted and the individual documents comprising the application.

2) The documents should also be submitted in Microsoft Office compatible file format (Word, Excel, etc.) allowing us to access the text and formulas in the documents (copy & paste). Any documents that cannot be submitted in a Microsoft Office compatible

format shall be saved as a PDF file from within the electronic document that created the file. If you are unable to provide Microsoft office compatible electronic files or internally generated PDF files of files (items that were not created electronically: i.e. brochures, maps, graphics, etc,), submit these items in hard copy format. We must be able to review the formulas and inputs that calculated the emissions.

3) It is preferred that this application form be submitted as 4 electronic files (3 MSWord docs: Universal Application section 1 [UA1], Universal Application section 3-19 [UA3], and Universal Application 4, the modeling report [UA4]) and 1 Excel file of the tables (Universal Application section 2 [UA2]). Please include as many of the 3-19 Sections as practical in a single MS Word electronic document. Create separate electronic file(s) if a single file becomes too large or if portions must be saved in a file format other than MS Word.

4) The electronic file names shall be a maximum of 25 characters long (including spaces, if any). The format of the electronic Universal Application shall be in the format: "A-3423-FacilityName". The "A" distinguishes the file as an application submittal, as opposed to other documents the Department itself puts into the database. Thus, all electronic application submittals should begin with "A-". Modifications to existing facilities should use the core permit number (i.e. '3423') the Department assigned to the facility as the next 4 digits. Use 'XXXX' for new facility applications. The format of any separate electronic submittals (additional submittals such as non-Word attachments, re-submittals, application updates) and Section document shall be in the format: "A-3423-9-description", where "9" stands for the section # (in this case Section 9-Public Notice). Please refrain, as much as possible, from submitting any scanned documents as this file format is extremely large, which uses up too much storage capacity in our database. Please take the time to fill out the header information throughout all submittals as this will identify any loose pages, including the Application Date (date submitted) & Revision number (0 for original, 1, 2, etc.; which will help keep track of subsequent partial update(s) to the original submittal. Do not use special symbols (#, @, etc.) in file names. The footer information should not be modified by the applicant.

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Table 2-A: Regulated Emission Sources

Unit and stack numbering must correspond throughout the application package. If applying for a NOI under 20.2.73 NMAC, equipment exemptions under 2.72.202 NMAC do not apply.

Unit Number[1]	Source Description	Make	Model #	Serial #	Manufact-urer's Rated Capacity[3] (Specify Units)	Requested Permitted Capacity[3] (Specify Units)	Date of Manufacture[2] Date of Construction/ Reconstruction[2]	Controlled by Unit # Emissions vented to Stack #	Source Classi-fication Code (SCC)	For Each Piece of Equipment, Check One	RICE Ignition Type (CI, SI, 4SLB, 4SRB, 2SLB)[4]	Replacing Unit No.
CB TLNGS	Cobre Mine Tailings Impoundment	N/A	N/A	N/A	N/A	N/A	N/A N/A	N/A N/A	30302408	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
CBM HR	Cobre Mine Hauling (Magnetite and Hanover Hauling)	N/A	N/A	N/A	N/A	N/A	N/A N/A	N/A N/A	30388801	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
CBM MH	Cobre Mine Material Handling (Magnetite and Hanover Handling)	N/A	N/A	N/A	N/A	N/A	N/A N/A	N/A N/A	30302404	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
CBM BLST	Cobre Mine Hanover Blasting	N/A	N/A	N/A	N/A	N/A	N/A N/A	N/A N/A	30388801	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
BORR_BLST	Cobre Haul Road Borrow Pit Blasting	N/A	N/A	N/A	N/A	N/A	N/A N/A	N/A N/A	30388801	☐ Existing (unchanged) ☐ To be Removed ☑ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
BORR_MH	Cobre Haul Road Borrow Pit Material Handling	N/A	N/A	N/A	N/A	N/A	N/A N/A	N/A N/A	30302408	☐ Existing (unchanged) ☐ To be Removed ☑ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
CM BLST	Chino Mine Blasting	N/A	N/A	N/A	N/A	N/A	N/A N/A	N/A N/A	30388801	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
CM HR	Chino Mine Hauling	N/A	N/A	N/A	N/A	N/A	N/A N/A	N/A N/A	30388801	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
CM MH	Chino Mine Material Handling	N/A	N/A	N/A	N/A	N/A	N/A N/A	N/A N/A	30302408	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
CM TLNGS	Chino Mine Tailings Impoundment	N/A	N/A	N/A	N/A	N/A	N/A N/A	N/A N/A	30302408	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
CTS-01	Conveyor Transfer (Beneath PC-01)	N/A	N/A	N/A	3,360 tons/hr	3,360 tons/hr	N/A N/A	N/A N/A	30510198	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
CV-01A	Coarse Ore Conveyor Transfer (Flight #1)	N/A	N/A	N/A	3,360 tons/hr	3,360 tons/hr	6/13/1981 N/A	N/A N/A	30510198	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
CV-01B	Coarse Ore Conveyor Transfer (Flight #1)	N/A	N/A	N/A	3,360 tons/hr	3,360 tons/hr	N/A N/A	N/A N/A	30510198	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
CV-01C	Coarse Ore Conveyor Transfer (between CV-01A and CV-01B)	N/A	N/A	N/A	3,360 tons/hr	3,360 tons/hr	N/A N/A	N/A N/A	30510198	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
F-2-1-1.4	Turbine	Westing-house	W251B12	4658139	455 MMBtu.hr	455 MMBtu.hr	2000 2000	N/A 009-A & 009-B	20200201	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
F-2-1-1.5	Heat Recovery Steam Generator with Duct Burner	HRSG	N/A	N/A	48.8 MMBtu.hr	48.8 MMBtu.hr	2000 2000	N/A 009-A	20100201	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
FLTR/ BLND	Filter/Blending Plant	N/A	N/A	N/A	N/A	N/A	N/A N/A	N/A N/A	30302408	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A

Unit Number[1]	Source Description	Make	Model #	Serial #	Manufact-urer's Rated Capacity[3] (Specify Units)	Requested Permitted Capacity[3] (Specify Units)	Date of Manufacture[2] Date of Construction/ Reconstruction[2]	Controlled by Unit # Emissions vented to Stack #	Source Classi-fication Code (SCC)	For Each Piece of Equipment, Check One	RICE Ignition Type (CI, SI, 4SLB, 4SRB, 2SLB)[4]	Replacing Unit No.
GDF	Gasoline Dispensing Facilities	N/A	N/A	N/A	Each tank is <10,000 gal/yr	Each tank is <10,000 gal/yr	Unknown Unknown	N/A N/A	40301008	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
IC-01	Molybdenum Plant	N/A	N/A	N/A	N/A	N/A	Aug-01 Unknown	MP SCRB S3	30301199	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
LHS-01 (IC-06)	Lime Handling System	Ivanhoe Concentrator	N/A	N/A	N/A	N/A	6/6/1980 Unknown	CSLH-01 SCSLH-02	30501615	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
LUS-01	Lime Unloading System	Ivanhoe Concentrator	N/A	N/A	N/A	N/A	6/13/1981 6/13/1981	CSLU-01 SCSLU-02	30501615	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
PC Dump	Primary Crusher Dump Pocket	N/A	N/A	N/A	3,360 tons/hr	3,360 tons/hr	N/A N/A	N/A N/A	30302404	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
PC-01	Primary Crusher	N/A	N/A	N/A	3,360 tons/hr	3,360 tons/hr	6/13/1981 6/13/1981	PCBH-01 SPCBH-01	30501060	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
SAG-F1 (IC-04)	SAG Mill Feeders	N/A	N/A	N/A	3,360 tons/hr	3,360 tons/hr	6/13/1981 6/13/1981	N/A N/A	30302404	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
SCDP	Stack Conveyor	N/A	N/A	N/A	3,360 tons/hr	3,360 tons/hr	6/13/1981 6/13/1981	N/A N/A	30510198	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
CH SCRN	Screening Material Handling	PORTEC Kolberg	Unknown	Unknown	1,000 TPH	1,000 TPH	Mar-12 Unknown	N/A N/A	30302404	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
CB SCRN	Screening Material Handling	Chieftain Powerscreen	2100X	PID00124TDGC3 4711-2012	450 TPH	450 TPH	Mar-12 Unknown	N/A N/A	30302404	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
CH SCRN ENG	Screening Plant Diesel Engine	Deutz	BF4M2012	010106/04	96.5 HP	96.5 HP	Aug-06 Aug-06	N/A S9	20200102	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	CI	N/A
CB SCRN ENG	Screening Plant Diesel Engine	Caterpillar	C4.4 ATAAC-4 cylinder	BPKXL04.4NM1	111 HP	111 HP	Feb-12 After 6/12/2006	N/A S10	20200102	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	CI	N/A
SXEW 10MST	SX/EW Plant Ten Mixer/ Settler Tanks	N/A	N/A	N/A	6-39,000 sqft & 4-39,400 sqft (±10%)	6-39,000 sqft & 4-39,400 sqft (±10%)	8/15/2000 Unknown	N/A N/A	30388801	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A

Unit Number[1]	Source Description	Make	Model #	Serial #	Manufact-urer's Rated Capacity[3] (Specify Units)	Requested Permitted Capacity[3] (Specify Units)	Date of Manufacture[2] Date of Construction/ Reconstruction[2]	Controlled by Unit # Emissions vented to Stack #	Source Classi-fication Code (SCC)	For Each Piece of Equipment, Check One	RICE Ignition Type (CI, SI, 4SLB, 4SRB, 2SLB)[4]	Replacing Unit No.
SXEW Boiler No. 1	SXEW Plant Water Boiler No. 1	Lochinvar	CBL1257	H12H00242605	1.255 MMBtu/hr	1.255 MMBtu/hr	1996 Unknown	N/A S5	10201002	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
SXEW Boiler No. 2	SXEW Plant Water Boiler No. 2	Lochinvar	CBL1257	H12H00242604	1.255 MMBtu/hr	1.255 MMBtu/hr	1996 Unknown	N/A S6	10201002	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
SXEW Boiler No. 3	SXEW Plant Water Boiler No. 3	Weben-Jarco, Inc.	AJH140	AJH140.1067	1.4 MMBtu/hr	1.4 MMBtu/hr	Jan-96 Unknown	N/A S7	10201002	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
SXEW RT	SX/EW Plant Raffinate Tank	N/A	N/A	N/A	5,024 sqft (±10%)	5,024 sqft (±10%)	8/15/2000 Unknown	N/A N/A	30388801	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
SXEW SAT	SXEW Plant Acid Tankhouse	N/A	N/A	N/A	N/A	N/A	Unknown Unknown	N/A SXEW SAT	30388801	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
ENG-1	Diesel Engine for Lime Slaking	Caterpillar	G3056	7MS00581	173 hp	173 hp	1999 TBD	N/A S32	20200102	☐ Existing (unchanged) ☑ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	CI	N/A
LmSlk	QuickLime Slaking Mill	Unknown	Unknown	Unknown	100 TPD	100 TPD	2019 1999	N/A N/A	30388801	☐ Existing (unchanged) ☑ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
WH Crush	White House Crushing Plant	Unknown	Unknown	Unknown	500 TPH	500 TPH	TBD TBD	N/A N/A	30501060	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A
GENERAC1	MIS Building	Generac	QT04524	5578228	60 hp	60 hp	2009 2009	N/A N/A	20200102	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	SI	N/A
GENERAC2	SX-EW Tankhouse	Generac	QT03624	6460608	50 hp	50 hp	2011 2011	N/A N/A	20200102	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	SI	N/A
GENERAC4	Mine Pit Slope Monitoring Station - Slope 2	Generac	G0064383	3000668968	15 hp	15 hp	Jul-16 Jul-16	N/A N/A	20200102	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	SI	N/A
GENERAC5	Santa Rita Tower	Generac	G0070330	3001383173	15 hp	15 hp	Jan-14 Jan-14	N/A N/A	20200102	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	SI	N/A
GENERAC6	Nun Complex Communication Station	Generac	G00703090	3002190256	15 hp	15 hp	TBD TBD	N/A N/A	20200102	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	SI	N/A
GENERAC7	Mine Warehouse	Generac	G007033	TBD	15 hp	15 hp	TBD TBD	N/A N/A	20200102	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	SI	N/A
GENERAC8	Emergency Generator	Generac	SG035	3009845286	47 hp	47 hp	TBD Aug-22	N/A N/A	20200102	☐ Existing (unchanged) ☐ To be Removed ☑ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	CI	N/A
ATT Gen	Emergency Generator	Yamnar	3TNV88-BNSA	TBD	36 hp	36 hp	TBD TBD	N/A N/A	20200102	☐ Existing (unchanged) ☐ To be Removed ☑ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	CI	N/A
Elliot Magnetek	Mine Warehouse	Elliot Magnetek	MPSG12	90871	16 hp	16 hp	TBD TBD	N/A N/A	20200102	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	SI	N/A
Sxlpwrprm8	20 Dam Hanover	Caterpillar	CAT/3126B	BEJ38448	275 hp	275 hp	2005 2005	N/A N/A	20200102	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	CI	N/A
Sxlpwrprm5	Far East	Caterpillar	CAT/3126B/IND	BEJ10891	225 hp	225 hp	2010 2010	N/A N/A	20200102	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	CI	N/A

Unit Number[1]	Source Description	Make	Model #	Serial #	Manufact-urer's Rated Capacity[3] (Specify Units)	Requested Permitted Capacity[3] (Specify Units)	Date of Manufacture[2]	Date of Construction/ Reconstruction[2]	Controlled by Unit #	Emissions vented to Stack #	Source Classi-fication Code (SCC)	For Each Piece of Equipment, Check One	RICE Ignition Type (CI, SI, 4SLB, 4SRB, 2SLB)[4]	Replacing Unit No.
Sxlpwrprm3	11 Dam Hanover	Perkins	APKXL06.6PJ1	PJ38861NT1818989	174 hp	174 hp	TBD	TBD	N/A	N/A	20200102	☐ Existing (unchanged) ☐ To be Removed ☑ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	CI	
Sxlgdwn1	10 Dam Hanover	Caterpillar	CAT/3126	BEJ09668	309 hp	309 hp	2005	2005	N/A	N/A	20200102	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	CI	N/A
Sxlpwrprm4	14 Dam Hanover	Caterpillar	CAT/3126B	BEJ10895	225 hp	225 hp	2005	2005	N/A	N/A	20200102	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	CI	N/A
Sxlpwrprm2	Sump #3	Caterpillar	CAT/3126	BEJ09674	309 hp	309 hp	2005	2005	N/A	N/A	20200102	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	CI	N/A
Sxlpwrprm7	13 Dam Hanover	Perkins	APKXL06.6J2	PJ38448	175 hp	175 hp	2004	TBD	N/A	N/A	20200102	☐ Existing (unchanged) ☐ To be Removed ☑ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	CI	N/A
Cummins Generator/1823	South Side Tailing office	Cummins 4BT-3.9	Cummins 4BT-3.9	Unknown	32 hp	32 hp	1984	1984	N/A	N/A	20200102	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	CI	N/A
Mase 1	Slope 1	Mase	PD 50 YS	G101753	4.5 hp	4.5 hp	2010	2010	N/A	N/A	20200102	☐ Existing (unchanged) ☑ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	CI	N/A
CB EGEN2	Cobre Mine Generator Set #2 Diesel Engine	Caterpillar	D399 PCTA	36Z01236	1300 hp	1300 hp	1979	1979	N/A	N/A	20200102	☐ Existing (unchanged) ☑ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	CI	N/A
CB EGEN3	Cobre Mine Generator Set #3 Diesel Engine	Caterpillar	D399 PCTA	36Z01234	1300 hp	1300 hp	1979	1979	N/A	N/A	20200102	☐ Existing (unchanged) ☑ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	CI	N/A
DEUTZ	Sump Pump	DEUTZ	F6L914	CE84/1	114 hp	114 hp	TBD	TBD	N/A	N/A	20200102	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	CI	N/A
EE5	SXEW Fire Emergency Pump	Detroit Diesel	Detroit Diesel	08GR109034	195 hp	195 hp	Feb-88	Jan-96	N/A	N/A	20200102	☐ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☑ To be Replaced	CI	N/A
EE5	SXEW Fire Emergency Pump	John Deere	6068HF285K	PE6068N025875	197 hp	197 hp	TBD	TBD	N/A	N/A	20200102	☐ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☑ Replacement Unit ☐ To Be Modified ☐ To be Replaced	CI	N/A
FWP01	Concentrator Fire Emergency Pump	Detroit Diesel	10447312	4A0252067	185 hp	185 hp	Aug-81	Aug-81	N/A	N/A	20200102	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	CI	N/A
RT-1	West Stockpile Radio Tower	Caterpillar	DG50-2	Unknown	67 hp	67 hp	N/A	N/A	N/A	N/A	20200102	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	SI	N/A
RT-2	Cobre Radio Tower	Caterpillar	DG50-2	Unknown	67 hp	67 hp	N/A	N/A	N/A	N/A	20200102	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	SI	N/A
SAG	Underground SAG Mill Tunnel	N/A	N/A	N/A	N/A	N/A	N/A	N/A	SAG BH	N/A	30399999	☐ Existing (unchanged) ☐ To be Removed ☑ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced	N/A	N/A

[1] Unit numbers must correspond to unit numbers in the previous permit unless a complete cross reference table of all units in both permits is provided.

[2] Specify dates required to determine regulatory applicability.

[3] To properly account for power conversion efficiencies, generator set rated capacity shall be reported as the rated capacity of the engine in horsepower, not the kilowatt capacity of the generator set.

[4] "4SLB" means four stroke lean burn engine, "4SRB" means four stroke rich burn engine, "2SLB" means two stroke lean burn engine, "CI" means compression ignition, and "SI" means spark ignition

Table 2-B: Insignificant Activities[1] (20.2.70 NMAC) OR Exempted Equipment (20.2.72 NMAC)

All 20.2.70 NMAC (Title V) applications must list all Insignificant Activities in this table. All 20.2.72 NMAC applications must list Exempted Equipment in this table. If equipment listed on this table is exempt under 20.2.72.202.B.5, include emissions calculations and emissions totals for 202.B.5 "similar functions" units, operations, and activities in Section 6, Calculations. Equipment and activities exempted under 20.2.72.202 NMAC may not necessarily be Insignificant under 20.2.70 NMAC (and vice versa). Unit & stack numbering must be consistent throughout the application package. Per Exemptions Policy 02-012.00 (see http://www.env.nm.gov/aqb/permit/aqb_pol.html), 20.2.72.202.B NMAC Exemptions do not apply, but 20.2.72.202.A NMAC exemptions do apply to NOI facilities under 20.2.73 NMAC. List 20.2.72.301.D.4 NMAC Auxiliary Equipment for Streamline applications in Table 2-A. The List of Insignificant Activities (for TV) can be found online at http://www.env.nm.gov/aqb/forms/InsignificantListTitleV.pdf . TV sources may elect to enter both TV Insignificant Activities and Part 72 Exemptions on this form.

Unit Number	Source Description	Manufacturer	Model No. / Serial No.	Max Capacity / Capacity Units	List Specific 20.2.72.202 NMAC Exemption (e.g. 20.2.72.202.B.5) / Insignificant Activity citation (e.g. IA List Item #1.a)	Date of Manufacture /Reconstruction[2] / Date of Installation /Construction[2]	For Each Piece of Equipment, Check Once
LABORATORY EQUIPMENT							
Lab 001	Laboratory Flotation test kits	N/A	N/A	-	20.2.72.202.A2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			Unknown	-	Insignificant Activity #5	N/A	
Lab 002	Laboratory Test sample dryer	N/A	N/A	8 samples/hr	20.2.72.202.A2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			Unknown	ppd	Insignificant Activity #5	N/A	
Lab 003	Laboratory Test sample dryer	N/A	N/A	8 samples/hr	20.2.72.202.A2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			Unknown	ppd	Insignificant Activity #5	N/A	
Lab 004	Laboratory Test sample dryer	N/A	N/A	8 samples/hr	20.2.72.202.A2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			Unknown	ppd	Insignificant Activity #5	N/A	

Unit Number	Source Description	Manufacturer	Model No. / Serial No.	Max Capacity / Capacity Units	List Specific 20.2.72.202 NMAC Exemption (e.g. 20.2.72.202.B.5) / Insignificant Activity citation (e.g. IA List Item #1.a)	Date of Manufacture /Reconstruction[2] / Date of Installation /Construction[2]	For Each Piece of Equipment, Check Once
Lab 008	Laboratory Dryer concentrate pulverizer/manual grind	N/A	N/A	50	20.2.72.202.B5	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			Unknown	ppd	Insignificant Activity #1a	N/A	
Lab 009	Jaw Crusher/Cone Crusher	N/A	N/A	240	20.2.72.202.B5	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			Unknown	ppd	Insignificant Activity #1a	N/A	
Lab 010	Laboratory Dry concentrate manual grind (2 hoods)	N/A	N/A	120	20.2.72.202.B5	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			Unknown	ppd	Insignificant Activity #1a	N/A	
Lab 011	Laboratory Moly Grind	N/A	N/A	50	20.2.72.202.B5	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			Unknown	ppd	Insignificant Activity #1a	N/A	
Lab 012	Laboratory Sample splitter	N/A	N/A	240	20.2.72.202.B5	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			Unknown	ppd	Insignificant Activity #1a	N/A	
MISCELLANEOUS EQUIPMENT							
ABE-001	Clemco Abrasive Industries, BNP 210-600P&DF 3 PH	N/A	N/A	270	20.2.72.202.B7	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			47425	pph	Insignificant Activity #2	N/A	
ABE-002	Empire Abrasive, EF- 2248	N/A	N/A	270	20.2.72.202.B7	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			C-24355	pph	Insignificant Activity #2	N/A	
ABE-003	Titan Abrasive, 4040 SDC	N/A	N/A	270	20.2.72.202.B5	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			4942 89	pph	Insignificant Activity #1a	N/A	
ANP	Ammonium Nitrate Pill Delivery	N/A	N/A	300,000	20.2.72.202.B5	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			Unknown	ppd	Insignificant Activity #1a	N/A	
Sioux-H	Sioux Corporation heater 360-H (Pressure washer)	N/A	N/A	0.36	20.2.72.202.B5	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			29087	MMBtu/hr	Insignificant Activity #1a	N/A	
Raff Pond	SX Raffinate Pond	N/A	N/A	67	20.2.72.202.B5	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	hp	N/A	N/A	
ERP-001	Electrolyte Recovery Pump	Caterpillar	DG50-2	29,098	20.2.72.202.B5	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			Unknown	ft^2	N/A	N/A	
FUEL STORAGE TANKS							
001	Used Oil	N/A	N/A	10500	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	

Unit Number	Source Description	Manufacturer	Model No.	Max Capacity	List Specific 20.2.72.202 NMAC Exemption (e.g. 20.2.72.202.B.5)	Date of Manufacture /Reconstruction[2]	For Each Piece of Equipment, Check Once
			Serial No.	Capacity Units	Insignificant Activity citation (e.g. IA List Item #1.a)	Date of Installation /Construction[2]	
006	Gasoline	N/A	N/A	2000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
007	Red-dyed diesel	N/A	N/A	10000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
008	ISO- 150 NL Gear	N/A	N/A	1300	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
009	ISO- 150 NL Gear	N/A	N/A	1300	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
012	Hydraulic Oil 32	N/A	N/A	1500	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
013	Used Oil	N/A	N/A	6250	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
014	Power-D Engine Oil SAE 15W-40	N/A	N/A	1000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
015	Powerdrive Fluid SAE 60	N/A	N/A	1000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
016	Powerdrive Fluid SAE 10W	N/A	N/A	1000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
017	Powerdrive 10W	N/A	N/A	1000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
018	Powerdrive Fluid SAE 30	N/A	N/A	1000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
019	Super All Season Oil SAE SW-30	N/A	N/A	1000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
020	ATF	N/A	N/A	1500	20.2.72.202.B2	N/A	☐ Existing (unchanged) ☑ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
021	Powerdrive Oil	N/A	N/A	15600	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	

Unit Number	Source Description	Manufacturer	Model No. / Serial No.	Max Capacity / Capacity Units	List Specific 20.2.72.202 NMAC Exemption (e.g. 20.2.72.202.B.5) / Insignificant Activity citation (e.g. IA List Item #1.a)	Date of Manufacture /Reconstruction[2] / Date of Installation /Construction[2]	For Each Piece of Equipment, Check Once
022	Powerdrive Oil	N/A	N/A	10000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
023	Used Oil (Ploy Tank)	N/A	N/A	4100	20.2.72.202.B2	N/A	☐ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☑ Replacement Unit ☐ To Be Modified ☐ To be Replaced
024	Used Oil	N/A	N/A	1550	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
025	Used Oil for Blasting	N/A	N/A	3500	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
026	Used Oil for Blasting	N/A	N/A	3500	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
027	Powerdrive Fluid SAE 60	N/A	N/A	1000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
028	Powerdrive Fluid SAE 10W	N/A	N/A	1000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
029	Powerdrive Fluid SAE 30	N/A	N/A	1000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
030	M5 Grease No. 2	N/A	N/A	850	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
031	15W-40 Oil	N/A	N/A	1000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
032	15W-40 Oil	N/A	N/A	1000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
033	SAE 30	N/A	N/A	11650	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
034	SAE 15W-40 Oil	N/A	N/A	10100	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
037	Diesel	N/A	N/A	1000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced

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038	Gear Lube 85W-140	N/A	N/A	650	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
039-A	Diesel	N/A	N/A	6110	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
040-A	Diesel	N/A	N/A	8209	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
042	Red-dyed Diesel	N/A	N/A	300788	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
043	Red-dyed Diesel	N/A	N/A	300788	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
046	Red-dyed Diesel	N/A	N/A	50750	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
047	Used Oil	N/A	N/A	1000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
048-A	Diesel	N/A	N/A	5264	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
049	Diesel	N/A	N/A	10869	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
049-A	Diesel	N/A	N/A	1000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
049-B	Diesel	N/A	N/A	10000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
050-A	Diesel	N/A	N/A	6000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
051-A	On-Road Diesel	N/A	N/A	20000	20.2.72.202.B2	N/A	☐ Existing (unchanged) ☑ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
052	Used Oil	N/A	N/A	750	20.2.72.202.B2	N/A	☐ Existing (unchanged) ☑ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	

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053-A	Gasoline	N/A	N/A	4000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
054	Diesel	N/A	N/A	50500	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
055	SAE 10W	N/A	N/A	8650	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
056	Used Oil	N/A	N/A	1450	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
057	Diesel	N/A	N/A	550	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
063	Diesel	N/A	N/A	265	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
065	Used Oil	N/A	N/A	1150	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
067	Diesel	N/A	N/A	3000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
069	Used Oil	N/A	N/A	1300	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
071	Used Oil	N/A	N/A	5000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
072	Turbine Oil	N/A	N/A	800	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
077	Diesel	N/A	N/A	3950	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
081	Transformer Oil	N/A	N/A	1300	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
084	Gear lube	N/A	N/A	500	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	

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086	Used Oil	N/A	N/A	400	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
101	Unleaded and Diesel	N/A	N/A	8000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
102	Diesel	N/A	N/A	20000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
103	Oily Water	N/A	N/A	2200	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
104	DEF	N/A	N/A	300	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
105	Oil	N/A	N/A	500	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
106	Magaplex-Grease	N/A	N/A	300	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
109	Diesel	N/A	N/A	150	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
117	Diesel	N/A	N/A	265	20.2.72.202.B2	N/A	☐ Existing (unchanged) ☑ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
119	Diesel	N/A	N/A	12000	20.2.72.202.B2	N/A	☐ Existing (unchanged) ☑ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
120-A	Used Oil & Lubricants	N/A	N/A	2300	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
121-A	Diesel	N/A	N/A	300	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
122	Diesel	N/A	N/A	300	20.2.72.202.B2	N/A	☐ Existing (unchanged) ☑ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
124-Wagner	Diesel	N/A	N/A	1500	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	

Unit Number	Source Description	Manufacturer	Model No. / Serial No.	Max Capacity / Capacity Units	List Specific 20.2.72.202 NMAC Exemption (e.g. 20.2.72.202.B.5) / Insignificant Activity citation (e.g. IA List Item #1.a)	Date of Manufacture /Reconstruction[2] / Date of Installation /Construction[2]	For Each Piece of Equipment, Check Once
125	Diesel	N/A	N/A	1000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
126	Gasoline	N/A	N/A	1000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
AA	New and Used Oils, Diesel	N/A	N/A	220	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
AB	New and Used Oils and Greases	N/A	N/A	55	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
AC	New and Used Oils and Greases	N/A	N/A	100	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
AD	Lubricants	N/A	N/A	220	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
AE	Used Oil	N/A	N/A	250	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
AF	New and Used Oils and Greases	N/A	N/A	275	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
AG	Transformer Oil	N/A	N/A	1500	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
AH	Transformer Oil	N/A	N/A	1500	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
AI	Transformer Oil	N/A	N/A	1200	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
AJ	New and Used oil products	N/A	N/A	55	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
AM	Transformer Oil	N/A	N/A	300	20.2.72.202.B2	N/A	☐ Existing (unchanged) ☐ To be Removed ☑ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
A	Used Oils (Oil Pad)	N/A	N/A	200	20.2.72.202.B2	N/A	☐ Existing (unchanged) ☐ To be Removed ☑ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	

Unit Number	Source Description	Manufacturer	Model No.	Max Capacity	List Specific 20.2.72.202 NMAC Exemption (e.g. 20.2.72.202.B.5)	Date of Manufacture /Reconstruction[2]	For Each Piece of Equipment, Check Once
			Serial No.	Capacity Units	Insignificant Activity citation (e.g. IA List Item #1.a)	Date of Installation /Construction[2]	
C	Diesel, Oil	N/A	N/A	200	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
D	New and Used Oils and Greases	N/A	N/A	500	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
D2	Lubricants	N/A	N/A	220	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
E	Product: Oils and Greases	N/A	N/A	55	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
F	Various oils and greases	N/A	N/A	55	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
G	Used Oils & Gear Lube	N/A	N/A	55	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
H	New and Used Oils and Greases	N/A	N/A	55	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
I	New and Used Oils and Greases	N/A	N/A	55	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
K	Oil	N/A	N/A	550	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
L	New and Used Oils and Greases	N/A	N/A	55	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
M	New and Used Oils and Greases	N/A	N/A	275	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
N	New and Used Oils and Greases	N/A	N/A	180	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
O	New and Used Oils and Greases	N/A	N/A	180	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
P	New and Used Oils and Greases	N/A	N/A	1000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	

Unit Number	Source Description	Manufacturer	Model No.	Max Capacity	List Specific 20.2.72.202 NMAC Exemption (e.g. 20.2.72.202.B.5)	Date of Manufacture /Reconstruction[2]	For Each Piece of Equipment, Check Once
			Serial No.	Capacity Units	Insignificant Activity citation (e.g. IA List Item #1.a)	Date of Installation /Construction[2]	
Q	New and Used Oils and Greases	N/A	N/A	110	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
R	Oils and Greases	N/A	N/A	800	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
TS	Oil and Diesel	N/A	N/A	250	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
U	New and Used Oils and Greases	N/A	N/A	55	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
V	New and Used Oils and Greases	N/A	N/A	55	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
V2	Diesel	N/A	N/A	495	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
V3	Diesel (SX mobile pumps)	N/A	N/A	275	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
WI	Diesel	N/A	N/A	0	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
X	New and Used Oils and Greases	N/A	N/A	55	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
Y	New and Used Oils and Greases	N/A	N/A	550	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
ZA	Diesel	N/A	N/A	500	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
ZB	Diesel (Mill mobile pumps)	N/A	N/A	55	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
OF-001	Diesel	N/A	N/A	10500	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	
OF-002	Unleaded	N/A	N/A	1000	20.2.72.202.B5	N/A	☑ Existing (unchanged) ☐ To be Removed ☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	

Unit Number	Source Description	Manufacturer	Model No. / Serial No.	Max Capacity / Capacity Units	List Specific 20.2.72.202 NMAC Exemption (e.g. 20.2.72.202.B.5) / Insignificant Activity citation (e.g. IA List Item #1.a)	Date of Manufacture /Reconstruction[2] / Date of Installation /Construction[2]	For Each Piece of Equipment, Check Once
OF-003	Diesel	N/A	N/A	550	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
M2-001	Lube Oil	N/A	N/A	300	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
M2-002	Lube Oil	N/A	N/A	300	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
M2-003	Lube Oil	N/A	N/A	300	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
M2-004	Lube Oil	N/A	N/A	360	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
M2-005	Diesel	N/A	N/A	10000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
M2-006	Used Oil	N/A	N/A	1000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
M2-007	Lube Oil	N/A	N/A	605	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
Tank 123	Cobre Diesel Tank	N/A	N/A	2000	20.2.72.202.B2	N/A	☑ Existing (unchanged) ☐ To be Removed
			N/A	Gallons	Insignificant Activity #5 & #8/ SDS	N/A	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
NON ROAD ENGINES[3]							
NR 1	Compressors	N/A	N/A	Variable	40 CFR 89	Variable	☑ Existing (unchanged) ☐ To be Removed
			N/A	hp	Insignificant Activity #1a and #6	Variable	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
NR 2	Pumps	N/A	N/A	Variable	40 CFR 89	Variable	☑ Existing (unchanged) ☐ To be Removed
			N/A	hp	Insignificant Activity #1a and #6	Variable	☐ New/Additional ☐ Replacement Unit ☐ To Be Modified ☐ To be Replaced
NR 3	Maintenance Equipment (Small Generators and Engines)	N/A	N/A	Variable	40 CFR 89	Variable	☐ Existing (unchanged) ☐ To be Removed
			N/A	hp	Insignificant Activity #1a and #6	Variable	☐ New/Additional ☐ Replacement Unit ☑ To Be Modified ☐ To be Replaced

[1] Insignificant activities exempted due to size or production rate are defined in 20.2.70.300.D.6, 20.2.70.7.Q NMAC, and the NMED/AQB List of Insignificant Activities, dated September 15, 2008. Emissions from these insignificant activities do not need to be reported, unless specifically requested.

[2] Specify date(s) required to determine regulatory applicability.

[3] For information purposes only. These engines satisfy the federal definition of "nonroad engine" under 40 CFR §§ 89.2 and 90.3 (for compression and spark-ignition engines, respectively) and are therefore regulated by EPA as mobile sources and not subject to state NSR and Title V permitting for stationary sources.

Table 2-C: Emissions Control Equipment

Unit and stack numbering must correspond throughout the application package. Only list control equipment for TAPs if the TAP's maximum uncontrolled emissions rate is over its respective threshold as listed in 20.2.72 NMAC, Subpart V, Tables A and B. In accordance with 20.2.72.203.A(3) and (8) NMAC, 20.2.70.300.D(5)(b) and (e) NMAC, and 20.2.73.200.B(7) NMAC, the permittee shall report all control devices and list each pollutant controlled by the control device regardless if the applicant takes credit for the reduction in emissions.

Control Equipment Unit No.	Control Equipment Description	Date Installed	Controlled Pollutant(s)	Controlling Emissions for Unit Number(s)[1]	Efficiency (% Control by Weight)	Method used to Estimate Efficiency
MP SCRB	Molybdenum Plant Wet Scrubber	Pre-2008	TSP/PM/PM10/PM2.5	IC-01	98.0%	Manufacturer Specifications
PCB H-01	Primary Crusher Baghouse	Pre-1983	TSP/PM/PM10/PM2.5	PC-01	99.7%	Bechtel Specifications
CSLU-01	Lime Unloading System Wet Scrubber	Pre-1983	TSP/PM/PM10/PM2.5	LUH-01	99.8%	Manufacturer Specifications
CSLH-01	Lime Handling System Wet Scrubber	Pre-1983	TSP/PM/PM10/PM2.5	LHS-01	99.8%	Manufacturer Specifications
RCB-01	Recycle Crusher Baghouse (no emissions to atmosphere; vents back into building)	Unknown	TSP/PM/PM10/PM2.5	Recycle Crusher	99.0%	Manufacturer Specifications
SAG-BH	SAG Tunnel Baghouse	TBD	TSP/PM/PM10/PM2.5	SAG Tunnel	99.99%	Manufacturer Specifications

[1] List each control device on a separate line. For each control device, list all emission units controlled by the control device.

Table 2-D: Maximum Emissions (under normal operating conditions)

☐ **This Table was intentionally left blank because it would be identical to Table 2-E.**

Maximum Emissions are the emissions at maximum capacity and prior to (in the absence of) pollution control, emission-reducing process equipment, or any other emission reduction. Calculate the hourly emissions using the worst case hourly emissions for each pollutant. For each pollutant, calculate the annual emissions as if the facility were operating at maximum plant capacity without pollution controls for 8760 hours per year, unless otherwise approved by the Department. List Hazardous Air Pollutants (HAP) & Toxic Air Pollutants (TAPs) in Table 2-I. Unit & stack numbering must be consistent throughout the application package. Fill all cells in this table with the emission numbers or a "-" symbol. A "-" symbol indicates that emissions of this pollutant are not expected. Numbers shall be expressed to at least 2 decimal points (e.g. 0.41, 1.41, or 1.41E-4).

Unit No.	NOx		CO		VOC		SOx		PM[1]		PM10[1]		PM2.5[1]		H_2S		Lead	
	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
CB TLNGS	--	--	--	--	--	--	--	--	0.27	1.17	0.13	0.00	0.020	0.088	--	--	--	--
CBM HR	--	--	--	--	--	--	--	--	3385.64	16087.84	862.87	4100.20	86.29	410.02	--	--	--	--
CBM MH	--	--	--	--	--	--	--	--	0.63	2.27	0.24	0.87	0.036	0.13	--	--	9.05E-06	3.44E-05
CBM BLST	*	12.87	*	290.58	--	--	*	0.026	*	33.20	*	17.26	*	1.00	--	--	--	--
CM BLST	*	46.80	*	1056.64	--	--	*	0.094	*	134.83	*	70.11	*	4.04	--	--	--	--
BORR_BLST	*	0.054	*	1.22	--	--	*	1.08E-04	*	0.058	*	0.058	*	0.0033	--	--	--	--
BORR_MH	--	--	--	--	--	--	--	--	2.67E-02	5.60E-03	2.67E-02	5.60E-03	4.00E-03	8.40E-04	--	--	--	--
CM HR	--	--	--	--	--	--	--	--	9906.36	143239.65	2524.77	36506.52	252.48	3650.65	--	--	--	--
CM MH	--	--	--	--	--	--	--	--	2.30	10.07	0.88	3.85	0.13	0.58	--	--	8.09E-06	3.02E-05
CM TLNGS	--	--	--	--	--	--	--	--	31.37	340.30	38.85	170.15	5.83	25.52	--	--	--	--
CTS-01	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CV-01A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CV-01B	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CV-01C	--	--	--	--	--	--	--	--	1.49	6.58	0.54	2.41	0.082	0.36	--	--	4.01E-05	1.78E-04
F-2-1-1.4	39.90	174.76	20.00	87.60	2.80	12.26	0.40	1.75	2.30	10.07	2.30	10.07	2.30	10.07	--	--	--	--
F-2-1-1.5	2.40	10.51	1.30	5.69	0.60	2.63	0.030	0.13	0.30	1.31	0.30	1.31	0.30	1.31	--	--	2.39E-05	1.05E-04
FLTR/BLND	--	--	--	--	--	--	--	--	5.91	5.29	2.34	2.06	2.34	2.06	--	--	--	--
GDF	--	--	--	--	0.62	2.72	--	--	--	--	--	--	--	--	--	--	--	--
IC-01	--	--	--	--	--	--	--	--	0.31	1.36	0.31	1.36	0.31	1.36	--	--	1.55E-05	6.79E-05
LHS-01 (IC-06)	--	--	--	--	--	--	--	--	0.044	0.10	0.044	0.10	6.6E-03	0.015	--	--	--	--
LUS-01	--	--	--	--	--	--	--	--	0.24	0.10	0.24	0.10	0.036	0.015	--	--	--	--
PC Dump	--	--	--	--	--	--	--	--	0.14	0.62	0.054	0.24	8.1E-03	0.035	--	--	3.79E-06	1.66E-05
PC-01	--	--	--	--	--	--	--	--	2.16	9.46	2.16	9.46	2.16	9.46	--	--	5.83E-05	2.55E-04
SAG-F1 (IC-04)	--	--	--	--	--	--	--	--	0.74	3.29	0.54	2.41	0.082	0.36	--	--	4.01E-05	1.78E-04
SCDP	--	--	--	--	--	--	--	--	0.74	3.29	0.15	0.67	0.043	0.19	--	--	1.25E-05	5.52E-05
CH SCRN	--	--	--	--	--	--	--	--	82.53	180.75	30.87	67.61	4.64	10.16	--	--	2.23E-03	4.88E-03
CB SCRN	--	--	--	--	--	--	--	--	13.73	30.06	5.09	11.14	0.76	1.67	--	--	3.71E-04	8.12E-04
CH SCRN ENG	0.81	3.56	0.10	0.45	0.018	0.077	0.19	0.82	0.20	0.88	0.20	0.88	0.20	0.88	--	--	--	--
CB SCRN ENG	1.16	2.53	1.02	2.22	0.50	1.10	0.42	0.91	0.45	0.98	0.45	0.98	0.45	0.98	--	--	--	--
SXEW 10MST	--	--	--	--	0.29	1.26	--	--	--	--	--	--	--	--	--	--	--	--

Unit No.	NOx		CO		VOC		SOx		PM[1]		PM10[1]		PM2.5[1]		H_2S		Lead	
	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
SXEW Boiler No. 1	0.18	0.78	0.10	0.45	0.014	0.060	7.27E-03	0.032	0.010	0.042	0.010	0.042	0.010	0.042	--	--	--	--
SXEW Boiler No. 2	0.18	0.78	0.10	0.45	0.014	0.060	7.27E-03	0.032	0.010	0.042	0.010	0.042	0.010	0.042	--	--	--	--
SXEW Boiler No. 3	0.20	0.87	0.11	0.50	0.015	0.067	8.11E-03	0.036	0.011	0.047	0.011	0.047	0.011	0.047	--	--	--	--
SXEW RT	--	--	--	--	0.019	0.083	--	--	--	--	--	--	--	--	--	--	--	--
SXEW SAT	--	--	--	--	--	--	--	--	--	--	2.28	10.00	--	--	--	--	--	--
WH Crush	--	--	--	--	--	--	--	--	78.53	171.99	34.48	75.51	6.20	13.57	--	--	2.11E-03	4.64E-03
GENERAC1	3.04	0.76	0.24	0.059	0.088	0.022	4.38E-04	1.09E-04	0.0074	0.0018	5.74E-05	1.44E-05	5.74E-05	1.44E-05	--	--	--	--
GENERAC2	2.05	0.51	0.16	0.040	0.059	0.015	2.96E-04	7.39E-05	0.0050	0.0012	3.88E-05	9.69E-06	3.88E-05	9.69E-06	--	--	--	--
GENERAC4	0.44	0.11	0.034	0.0085	0.013	0.0032	6.33E-05	1.58E-05	0.0011	2.67E-04	8.30E-06	2.07E-06	8.30E-06	2.07E-06	--	--	--	--
GENERAC5	0.73	0.18	0.057	0.014	0.021	0.0053	1.06E-04	2.65E-05	0.0018	4.46E-04	1.39E-05	3.47E-06	1.39E-05	3.47E-06	--	--	--	--
GENERAC6	0.73	0.18	0.057	0.014	0.021	0.0053	1.06E-04	2.65E-05	0.0018	4.46E-04	1.39E-05	3.47E-06	1.39E-05	3.47E-06	--	--	--	--
GENERAC7	0.73	0.18	0.057	0.014	0.021	0.0053	1.06E-04	2.65E-05	0.0018	4.46E-04	1.39E-05	3.47E-06	1.39E-05	3.47E-06	--	--	--	--
GENERAC8	1.75	0.44	0.14	0.034	0.051	0.013	2.53E-04	6.32E-05	0.0043	1.07E-03	3.32E-05	8.29E-06	3.32E-05	8.29E-06	--	--	--	--
ATT Gen	1.55	0.39	0.33	0.083	0.12	0.031	5.31E-04	1.33E-04	0.11	2.72E-02	1.09E-01	2.72E-02	1.09E-01	2.72E-02	--	--	--	--
Sxlpwrprm8	8.91	2.23	1.92	0.48	0.71	0.177	0.0031	7.65E-04	0.63	0.16	0.63	0.16	0.63	0.16	--	--	--	--
Sxlpwrprm5	7.37	1.84	1.59	0.40	0.58	0.15	0.0025	6.33E-04	0.52	0.13	0.52	0.13	0.52	0.13	--	--	--	--
Sxlpwrprm3	5.80	1.45	1.25	0.31	0.46	0.115	0.0020	4.98E-04	0.41	0.102	0.41	0.102	0.41	0.10	--	--	--	--
Sxlgdwn1	9.96	2.49	2.15	0.54	0.79	0.20	0.0034	8.55E-04	0.70	0.18	0.70	0.18	0.70	0.18	--	--	--	--
Sxlpwrprm4	7.37	1.84	1.59	0.40	0.58	0.146	0.0025	6.33E-04	0.52	0.130	0.52	0.130	0.52	0.13	--	--	--	--
Sxlpwrprm2	9.96	2.49	2.15	0.54	0.79	0.20	0.0034	8.55E-04	0.70	0.18	0.70	0.18	0.70	0.18	--	--	--	--
Sxlpwrprm7	5.83	1.46	1.26	0.31	0.46	0.116	0.0020	5.01E-04	0.41	0.102	0.41	0.102	0.41	0.10	--	--	--	--
Cummins Generator/1823	1.42	0.36	0.31	0.077	0.11	0.028	0.00049	1.22E-04	0.10	0.025	0.10	0.025	0.10	0.025	--	--	--	--
DEUTZ	3.95	0.99	0.85	0.21	0.313	0.078	0.0014	0.00034	0.28	0.069	0.28	0.069	0.28	0.069	--	--	--	--
EE5	6.51	1.63	1.40	0.35	0.52	0.13	0.0022	0.00056	0.46	0.11	0.46	0.11	0.46	0.11	--	--	--	--
FWP01	6.14	1.53	1.32	0.33	0.49	0.12	0.0021	0.00053	0.43	1.08E-01	4.31E-01	1.08E-01	4.31E-01	1.08E-01	--	--	--	--
RT-1	0.15	0.037	0.30	0.074	0.10	0.026	0.00043	0.00011	0.0072	1.79E-03	5.58E-05	1.40E-05	5.58E-05	1.40E-05	--	--	--	--
RT-2	0.15	0.037	0.30	0.074	0.10	0.026	0.00043	0.00011	0.0072	1.79E-03	5.58E-05	1.40E-05	5.58E-05	1.40E-05	--	--	--	--
SAG[3]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Totals	129.37	274.66	40.17	1,450.17	11.31	21.93	1.08	3.84	13,521.73	160,276.97	3,515.41	41,066.80	369.98	4,145.99	--	--	0.0049	0.011

[1] **Significant Figures Examples:** One significant figure – 0.03, 3, 0.3. Two significant figures – 0.34, 34, 3400, 3.4

[2] **Condensables:** Include condensable particulate matter emissions in particulate matter calculations.

[3] The SAG Tunnel is not a source of emissions in an uncontrolled scenario because it is an enclosed process. The pollution control device is present for industrial hygiene purposes.

"*" Indicates that an hourly limit is not appropriate for this operating situation and is not being requested

"-" Indicates emissions of this pollutant are not expected

Table 2-E: Requested Allowable Emissions

Unit & stack numbering must be consistent throughout the application package. Fill all cells in this table with the emission numbers or a "-" symbol. A "-" symbol indicates that emissions of this pollutant are not expected. Numbers shall be expressed to at least 2 decimal points (e.g. 0.41, 1.41, or $1.41E^{-4}$).

Unit No.	NOx		CO		VOC		SOx		PM[1]		PM10[1]		PM2.5[1]		H_2S		Lead	
	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
CB TLNGS	--	--	--	--	--	--	--	--	0.27	1.2	0.13	0.00	0.020	0.088	--	--	--	--
CBM HR	--	--	--	--	--	--	--	--	173.36	814.31	44.18	207.54	4.42	20.75	--	--	--	--
CBM MH	--	--	--	--	--	--	--	--	0.63	2.27	0.24	0.87	0.036	0.13	--	--	9.05E-06	3.44E-05
CBM BLST	*	12.87	*	290.58	--	--	*	0.026	*	33.20	*	17.26	*	1.00	--	--	--	--
CM BLST	*	46.80	*	1056.64	--	--	*	0.094	*	134.83	*	70.11	*	4.04	--	--	--	--
BORR_BLST	*	0.054	*	1.22	--	--	*	1.08E-04	*	0.058	*	0.058	*	0.0033	--	--	--	--
BORR_MH	--	--	--	--	--	--	--	--	2.67E-02	5.60E-03	2.67E-02	5.60E-03	4.00E-03	8.40E-04	--	--	--	--
CM HR	--	--	--	--	--	--	--	--	1109.51	16042.84	282.77	4088.73	28.28	408.87	--	--	--	--
CM MH	--	--	--	--	--	--	--	--	2.30	10.07	0.88	3.85	0.13	0.58	--	--	8.09E-06	3.02E-05
CM TLNGS	--	--	--	--	--	--	--	--	31.37	340.30	38.85	170.15	5.83	25.52	--	--	--	--
CTS-01	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CV-01A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CV-01B	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CV-01C	--	--	--	--	--	--	--	--	1.49	6.58	0.54	2.41	0.082	0.36	--	--	4.01E-05	1.79E-04
F-2-1-1.4	39.90	174.76	20.00	87.60	2.80	12.26	0.40	1.75	2.30	10.07	2.30	10.07	2.30	10.07	--	--	--	--
F-2-1-1.5	2.40	10.51	1.30	5.69	0.60	2.63	0.030	0.13	0.30	1.31	0.30	1.31	0.30	1.31	--	--	2.39E-05	1.05E-04
FLTR/ BLND	--	--	--	--	--	--	--	--	0.89	0.79	0.35	0.31	0.35	0.31	--	--	--	--
GDF	--	--	--	--	0.62	2.7	--	--	--	--	--	--	--	--	--	--	--	--
IC-01	--	--	--	--	--	--	--	--	0.31	1.36	0.31	1.36	0.31	1.36	--	--	3.10E-06	1.36E-05
LHS-01 (IC-06)	--	--	--	--	--	--	--	--	0.044	0.10	0.24	0.10	0.036	0.015	--	--	--	--
LUS-01	--	--	--	--	--	--	--	--	0.24	0.10	0.044	0.10	6.60E-03	0.015	--	--	--	--
PC Dump	--	--	--	--	--	--	--	--	0.14	0.62	0.016	0.071	2.4E-03	0.011	--	--	1.14E-06	4.98E-06
PC-01	--	--	--	--	--	--	--	--	2.16	9.46	2.16	9.46	2.16	9.46	--	--	5.83E-05	2.55E-04
SAG-F1 (IC-04)	--	--	--	--	--	--	--	--	0.74	3.29	0.54	2.41	0.082	0.36	--	--	4.01E-05	1.78E-04
SCDP	--	--	--	--	--	--	--	--	0.74	3.29	0.15	0.67	0.043	0.19	--	--	1.25E-05	5.52E-05
CH SCRN	--	--	--	--	--	--	--	--	19.77	43.30	8.63	18.90	1.22	2.67	--	--	5.34E-04	1.17E-03
CB SCRN	--	--	--	--	--	--	--	--	3.47	7.60	1.51	3.30	0.20	0.44	--	--	9.36E-05	2.05E-04
CH SCRN ENG	0.81	3.6	0.10	0.45	0.018	0.077	0.19	0.82	0.20	0.88	0.20	0.88	0.20	0.88	--	--	--	--
CB SCRN ENG	1.16	2.53	1.02	2.22	0.50	1.10	0.42	0.91	0.45	0.98	0.45	0.98	0.45	0.98	--	--	--	--
SXEW 10MST	--	--	--	--	0.29	1.26	--	--	--	--	--	--	--	--	--	--	--	--

Unit No.	NOx		CO		VOC		SOx		PM[1]		PM10[1]		PM2.5[1]		H_2S		Lead	
	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
SXEW Boiler No. 1	0.18	0.78	0.10	0.45	0.014	0.060	7.27E-03	0.032	0.010	0.042	0.010	0.042	0.010	0.042	--	--	--	--
SXEW Boiler No. 2	0.18	0.78	0.10	0.45	0.014	0.060	7.27E-03	0.032	0.010	0.042	0.010	0.042	0.010	0.042	--	--	--	--
SXEW Boiler No. 3	0.20	0.87	0.11	0.50	0.015	0.067	8.11E-03	0.036	0.011	0.047	0.011	0.047	0.011	0.047	--	--	--	--
SXEW RT	--	--	--	--	0.019	0.083	--	--	--	--	--	--	--	--	--	--	--	--
SXEW SAT	--	--	--	--	--	--	--	--	--	--	2.28	10.00	--	--	--	--	--	--
WH Crush	--	--	--	--	--	--	--	--	78.53	171.99	34.48	75.51	6.20	13.569	--	--	0.0021	0.0046
GENERAC1	3.04	0.76	0.24	0.059	0.088	0.022	4.38E-04	1.09E-04	0.0074	0.0018	5.74E-05	1.44E-05	5.74E-05	1.44E-05	--	--	--	--
GENERAC2	2.1	0.51	0.16	0.040	0.059	0.015	2.96E-04	7.39E-05	0.0050	0.0012	3.88E-05	9.69E-06	3.88E-05	9.69E-06	--	--	--	--
GENERAC4	0.44	0.11	0.034	0.0085	0.013	0.0032	6.33E-05	1.58E-05	0.0011	2.67E-04	8.30E-06	2.07E-06	8.30E-06	2.07E-06	--	--	--	--
GENERAC5	0.73	0.18	0.057	0.014	0.021	0.0053	1.06E-04	2.65E-05	0.0018	4.46E-04	1.39E-05	3.47E-06	1.39E-05	3.47E-06	--	--	--	--
GENERAC6	0.73	0.18	0.057	0.014	0.021	0.0053	1.06E-04	2.65E-05	0.0018	4.46E-04	1.39E-05	3.47E-06	1.39E-05	3.47E-06	--	--	--	--
GENERAC7	0.73	0.18	0.057	0.014	0.021	0.0053	1.06E-04	2.65E-05	0.0018	4.46E-04	1.39E-05	3.47E-06	1.39E-05	3.47E-06	--	--	--	--
GENERAC8	1.75	0.44	0.14	0.034	0.051	0.013	2.53E-04	6.32E-05	0.0043	1.07E-03	3.32E-05	8.29E-06	3.32E-05	8.29E-06				
ATT Gen	1.55	0.39	0.33	0.083	0.12	0.031	5.31E-04	1.33E-04	0.11	2.72E-02	1.09E-01	2.72E-02	1.09E-01	2.72E-02				
Sxlpwrprm8	8.91	2.23	1.92	0.48	0.71	0.177	0.0031	7.65E-04	0.63	0.16	0.63	0.16	0.63	0.16	--	--	--	--
Sxlpwrprm5	7.37	1.84	1.59	0.40	0.58	0.15	2.53E-03	6.33E-04	0.52	0.13	0.52	0.13	0.52	0.13	--	--	--	--
Sxlpwrprm3	5.80	1.45	1.25	0.31	0.46	0.115	0.0020	4.98E-04	0.41	0.10	0.41	0.10	0.41	0.10	--	--	--	--
Sxlgdwn1	9.96	2.49	2.15	0.54	0.79	0.198	0.0034	8.55E-04	0.70	0.18	0.70	0.18	0.70	0.18	--	--	--	--
Sxlpwrprm4	7.37	1.84	1.59	0.40	0.58	0.146	0.0025	6.33E-04	0.52	0.13	0.52	0.13	0.52	0.13	--	--	--	--
Sxlpwrprm2	9.96	2.49	2.15	0.54	0.79	0.198	0.0034	8.55E-04	0.70	0.18	0.70	0.18	0.70	0.18	--	--	--	--
Sxlpwrprm7	5.83	1.46	1.26	0.31	0.46	0.116	0.0020	5.01E-04	0.41	0.10	0.41	0.10	0.41	0.10	--	--	--	--
Cummins Generator/1823	1.42	0.36	0.31	0.08	0.11	0.0282	4.89E-04	1.22E-04	0.10	0.025	0.10	0.025	0.10	0.025	--	--	--	--
DEUTZ	3.95	0.99	0.85	0.21	0.31	0.078	0.0014	3.39E-04	0.28	0.069	0.28	0.069	0.28	0.069	--	--	--	--
EE5	6.51	1.63	1.40	0.35	0.52	0.13	0.0022	5.59E-04	0.46	0.11	0.46	0.11	0.46	0.11	--	--	--	--
FWP01	6.14	1.53	1.32	0.33	0.49	0.12	0.0021	5.27E-04	0.43	0.11	0.43	0.11	0.43	0.11	--	--	--	--
RT-1	0.15	0.037	0.30	0.074	0.10	0.026	4.26E-04	1.06E-04	0.0072	1.79E-03	5.58E-05	1.40E-05	5.58E-05	1.40E-05	--	--	--	--
RT-2	0.15	0.037	0.30	0.074	0.10	0.026	4.26E-04	1.06E-04	0.0072	1.79E-03	5.58E-05	1.40E-05	5.58E-05	1.40E-05	--	--	--	--
SAG	--	--	--	--	--	--	--	--	1.03	4.51	0.97	4.25	0.46	2.03	--	--	--	--
Totals	129.37	274.66	40.17	1,450.17	11.31	21.93	1.08	3.84	1,435.59	17,646.73	427.85	4,702.12	58.40	506.46	--	--	2.94E-03	6.87E-03

[1] **Significant Figures Examples**: One significant figure – 0.03, 3, 0.3. Two significant figures – 0.34, 34, 3400, 3.4

[2] **Condensables:** Include condensable particulate matter emissions in particulate matter calculations.

"*" Indicates that an hourly limit is not appropriate for this operating situation and is not being requested

"-" Indicates emissions of this pollutant are not expected

Table 2-F: Additional Emissions during Startup, Shutdown, and Routine Maintenance (SSM)

☑ This table is intentionally left blank since all emissions at this facility due to routine or predictable startup, shutdown, or scehduled maintenance are no higher than those listed in Table 2-E and a malfunction emission limit is not already permitted or requested. If you are required to report GHG emissions as described in Section 6a, include any GHG emissions during Startup, Shutdown, and/or Scheduled Maintenance (SSM) in Table 2-P. Provide an explanations of SSM emissions in Section 6 and 6a.

All applications for facilities that have emissions during routine our predictable startup, shutdown or scheduled maintenance (SSM)[1], including NOI applications, must include in this table the Maximum Emissions during routine or predictable startup, shutdown and scheduled maintenance (20.2.7 NMAC, 20.2.72.203.A.3 NMAC, 20.2.73.200.D.2 NMAC). In Section 6 and 6a, provide emissions calculations for all SSM emissions reported in this table. Refer to "Guidance for Submittal of Startup, Shutdown, Maintenance Emissions in Permit Applications (https://www.env.nm.gov/aqb/permit/aqb_pol.html) for more detailed instructions. Numbers shall be expressed to at least 2 decimal points (e.g. 0.41, 1.41, or 1.41E-4).

Unit No.	NOx		CO		VOC		SOx		PM[2]		PM10[2]		PM2.5[2]		H_2S		Lead	
	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
Totals																		

[1] **For instance**, if the short term steady-state Table 2-E emissions are 5 lb/hr and the SSM rate is 12 lb/hr, enter 7 lb/hr in this table. If the annual steady-state Table 2-E emissions are 21.9 TPY, and the number of scheduled SSM events result in annual emissions of 31.9 TPY, enter 10.0 TPY in the table below.

[2] **Condensable Particulate Matter:** Include condensable particulate matter emissions for PM10 and PM2.5 if the source is a combustion source. Do not include condensable particulate matter for PM unless PM is set equal to PM10 and PM2.5. Particulate matter (PM) is not subject to an ambient air quality standard, but it is a regulated air pollutant under PSD (20.2.74 NMAC) and Title V (20.2.70 NMAC).

Table 2-G: Stack Exit and Fugitive Emission Rates for Special Stacks

☑ I have elected to leave this table blank because this facility does not have any stacks/vents that split emissions from a single source or combine emissions from more than one source listed in table 2-A. Additionally, the emission rates of all stacks match the Requested allowable emission rates stated in Table 2-E.

Use this table to list stack emissions (requested allowable) from split and combined stacks. List Toxic Air Pollutants (TAPs) and Hazardous Air Pollutants (HAPs) in Table 2-I. List all fugitives that are associated with the normal, routine, and non-emergency operation of the facility. Unit and stack numbering must correspond throughout the application package. Refer to Table 2-E for instructions on use of the "-" symbol and on significant figures.

Stack No.	Serving Unit Number(s) from Table 2-A	NOx		CO		VOC		SOx		PM		PM10		PM2.5		☐ H_2S or ☐ Lead	
		lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
Totals:																	

Table 2-H: Stack Exit Conditions

Unit and stack numbering must correspond throughout the application package. Include the stack exit conditions for each unit that emits from a stack, including blowdown venting parameters and tank emissions. If the facility has multiple operating scenarios, complete a separate Table 2-H for each scenario and, for each, type scenario name here:

Stack Number	Serving Unit Number(s) from Table 2-A	Orientation (H-Horizontal V=Vertical)	Rain Caps	Height Above	Temp.	Flow Rate		Moisture by	Velocity	Inside Diameter (ft)
			(Yes or No)	Ground (ft)	(F)	(acfs)	(dscfs)	Volume (%)	(ft/sec)	
009-B	F-2-1-1.4	Vertical	No	80	965.0	11,161.9	-	16%	128.9	10.5
009-A	F-2-1-1.4 and F-2-1-1.5	Vertical	No	130.9	377.3	8,804.5	-	16%	101.7	10.5
S3	IC-01	Vertical	No	80	92.9	229.2	-	-	33.5	3.0
SCSLH-02	LHS-01	Vertical	No	60	Ambient	82.5	-	-	39.0	1.6
SCSLU-02	LUS-01	Vertical	No	60	Ambient	20.0	-	-	59.1	0.66
SPCBH-01	PC-01	Vertical	No	27.9	Ambient	225.7	-	-	74.2	2.0
S9	CH SCRN ENG	Vertical	No	6	Unknown	Unknown	-	-	Unknown	0.25
S10	CB SCRN ENG	Vertical	No	6.6	1,130	20.6	-	-	53.5	0.7
S5	SXEW Boiler No. 1	Vertical	Yes	30.8	479.9	0.73	-	-	2.2	0.66
S6	SXEW Boiler No. 2	Vertical	Yes	30.8	479.9	0.73	-	-	2.2	0.66
S7	SXEW Boiler No. 3	Vertical	Yes	30.8	479.9	0.73	-	-	2.2	0.66
SXEW SAT	SXEW SAT	Horizontal	No	35.1	Ambient + 4˚	6,556.5	-	-	3.7	47.2
EE5	SXEW Fire Emergency Pump	Vertical	No	14.8 [1]	800 [1]	20.0	-	-	45.9 [1]	0.66 [1]
S13	Sxlpwrprm8	Vertical	No	14.8 [1]	800 [1]	20.0	-	-	45.9 [1]	0.66 [1]
S14	Sxlpwrprm3	Vertical	No	14.8 [1]	800 [1]	20.0	-	-	45.9 [1]	0.66 [1]
S15	Sxlgdwn1	Vertical	No	14.8 [1]	800 [1]	20.0	-	-	45.9 [1]	0.66 [1]
S16	Sxlpwrprm4	Vertical	No	14.8 [1]	800 [1]	20.0	-	-	45.9 [1]	0.66 [1]
S17	Sxlpwrprm2	Vertical	No	14.8 [1]	800 [1]	20.0	-	-	45.9 [1]	0.66 [1]
S18	Cummins Generator/1823	Vertical	No	14.8 [1]	800 [1]	20.0	-	-	45.9 [1]	0.66 [1]
S23	DEUTZ	Vertical	No	14.8 [1]	800 [1]	20.0	-	-	45.9 [1]	0.66 [1]
S24	FWP01	Vertical	No	14.8 [1]	800 [1]	20.0	-	-	45.9 [1]	0.66 [1]
S25	GENERAC1	Vertical	No	14.8 [1]	800 [1]	20.0	-	-	45.9 [1]	0.66 [1]
S26	GENERAC2	Vertical	No	14.8 [1]	800 [1]	20.0	-	-	45.9 [1]	0.66 [1]
S28	GENERAC4	Vertical	No	14.8 [1]	800 [1]	20.0	-	-	45.9 [1]	0.66 [1]
S29	GENERAC5	Vertical	No	14.8 [1]	800 [1]	20.0	-	-	45.9 [1]	0.66 [1]
S30	GENERAC6	Vertical	No	14.8 [1]	800 [1]	20.0	-	-	45.9 [1]	0.66 [1]
S31	GENERAC7	Vertical	No	14.8 [1]	800 [1]	20.0	-	-	45.9 [1]	0.66 [1]
GENERAC8	GENERAC8	Vertical	No	4.8	1330.0	3.4	-	-	45.9 [1]	0.66 [1]
ATT Gen	ATT Gen	Vertical	No	4.9	900.0	1.5	-	-	45.9 [1]	0.66 [1]
S34	RT-1	Vertical	No	14.8 [1]	1369.0	9.2	-	-	187.8	0.25
S33	RT-2	Vertical	No	14.8 [1]	1369.0	9.2	-	-	187.8	0.25

[1] Stack parameters are estimated based on unit Sxlgdwn1 because it has the highest emission rate of engines with unknown stack parameters. Table 26: Missing Stack Parameter Substitutions for Other Point Sources from NM AQB Air Dispersion Modeling Guidelines was used to supply the estimates for this missing data. The data supplied here does not represent actual stack parameters as they vary based on the size of the unit and are unknown at this time.

Table 2-I: Stack Exit and Fugitive Emission Rates for HAPs and TAPs

In the table below, report the Potential to Emit for each HAP from each regulated emission unit listed in Table 2-A, only if the entire facility emits the HAP at a rate greater than or equal to one (1) ton per year For each such emission unit, HAPs shall be reported to the nearest 0.1 tpy. Each facility-wide Individual HAP total and the facility-wide Total HAPs shall be the sum of all HAP sources calculated to the nearest 0.1 ton per year. Per 20.2.72.403.A.1 NMAC, facilities not exempt [see 20.2.72.402.C NMAC] from TAP permitting shall report each TAP that has an uncontrolled emission rate in excess of its pounds per hour screening level specified in 20.2.72.502 NMAC. TAPs shall be reported using one more significant figure than the number of significant figures shown in the pound per hour threshold corresponding to the substance. Use the HAP nomenclature as it appears in Section 112 (b) of the 1990 CAAA and the TAP nomenclature as it listed in 20.2.72.502 NMAC. Include tank-flashing emissions estimates of HAPs in this table. For each HAP or TAP listed, fill all cells in this table with the emission numbers or a "-" symbol. A "-" symbol indicates that emissions of this pollutant are not expected or the pollutant is emitted in a quantity less than the threshold amounts described above.

Stack No.	Unit No.(s)	Total HAPs		Benzene ☑ HAP or ☐ TAP		Acetaldehyde ☑ HAP or ☐ TAP		Acrolein ☑ HAP or ☐ TAP		Formaldehyde ☑ HAP or ☐ TAP		Naphthalene ☑ HAP or ☐ TAP		Toluene ☑ HAP or ☐ TAP		Xylenes ☑ HAP or ☐ TAP		Sulfuric Acid ☐ HAP or ☑ TAP	
		lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
N/A	CB TLNGS	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N/A	CBM HR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N/A	CBM MH	6.01E-04	1.69E-03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N/A	CBM BLST	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N/A	CM BLST	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N/A	BORR_BLST	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N/A	BORR_MH	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N/A	CM HR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N/A	CM MH	5.95E-04	2.43E-03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N/A	CM TLNGS	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N/A	CTS-01	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N/A	CV-01A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N/A	CV-01B	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N/A	CV-01C	1.13E-03	1.67E-03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
009-B	F-2-1-1.4	0.47	2.05	5.46E-03	2.39E-02	0.018	0.080	2.91E-03	0.013	0.32	1.41	5.92E-04	2.59E-03	0.059	0.26	0.029	0.13	0.020	0.088
009-A	F-2-1-1.5	0.090	0.39	1.00E-04	4.40E-04	--	--	--	--	3.59E-03	1.57E-02	2.92E-05	1.28E-04	1.63E-04	7.12E-04	--	--	--	--
N/A	FLTR/ BLND	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N/A	GDF	0.32	1.41	0.030	0.13	--	--	--	--	--	--	--	--	0.16	0.68	0.093	0.41	--	--
S-3	IC-01	1.32E-04	5.77E-04	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SCSLH-02	LHS-01 (IC-06)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SCSLU-02	LUS-01	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N/A	PC Dump	3.20E-05	1.40E-04	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SPCBH-01	PC-01	1.64E-03	7.18E-03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N/A	SAG-F1 (IC-04)	1.11E-03	4.99E-03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N/A	SCDP	3.51E-04	1.55E-03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N/A	CH SCRN	0.015	0.033	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N/A	CB SCRN	2.63E-03	5.76E-03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Stack No.	Unit No.(s)	Total HAPs		Benzene ☑ HAP or ☐ TAP		Acetaldehyde ☑ HAP or ☐ TAP		Acrolein ☑ HAP or ☐ TAP		Formaldehyde ☑ HAP or ☐ TAP	
		lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
N/A	CH SCRN ENG	2.42E-03	0.011	6.02E-04	2.64E-03	4.95E-04	2.17E-03	5.97E-05	2.61E-04	7.62E-04	3.34E-03
N/A	CB SCRN ENG	5.40E-03	0.012	1.34E-03	2.94E-03	1.10E-03	2.42E-03	1.33E-04	2.91E-04	1.70E-03	3.72E-03
N/A	SXEW 10MST	0.29	1.26	0.064	0.28	--	--	--	--	--	--
S5	SXEW Boiler No. 1	--	--	--	--	--	--	--	--	--	--
S6	SXEW Boiler No. 2	--	--	--	--	--	--	--	--	--	--
S7	SXEW Boiler No. 3	--	--	--	--	--	--	--	--	--	--
N/A	SXEW RT	0.019	0.083	4.24E-03	0.019	--	--	--	--	--	--
SXEW SAT	SXEW SAT	--	--	--	--	--	--	--	--	--	--
N/A	WH Crush	0.060	0.13	--	--	--	--	--	--	--	--
S12	EE5	5.54E-03	1.38E-03	1.38E-03	3.44E-04	1.13E-03	2.83E-04	1.36E-04	3.41E-05	1.74E-03	4.35E-04
S13	Sxlpwrprm8	7.58E-03	1.89E-03	1.89E-03	4.71E-04	1.55E-03	3.87E-04	1.87E-04	4.67E-05	2.38E-03	5.96E-04
S35	Sxlpwrprm5	6.27E-03	1.57E-03	1.56E-03	3.90E-04	1.28E-03	3.20E-04	1.55E-04	3.86E-05	1.97E-03	4.93E-04
S14	Sxlpwrprm3	4.93E-03	1.23E-03	1.23E-03	3.07E-04	1.01E-03	2.52E-04	1.22E-04	3.04E-05	1.55E-03	3.88E-04
S15	Sxlgdwn1	8.47E-03	2.12E-03	2.11E-03	5.27E-04	1.73E-03	4.33E-04	2.09E-04	5.22E-05	2.66E-03	6.66E-04
S16	Sxlpwrprm4	6.27E-03	1.57E-03	1.56E-03	3.90E-04	1.28E-03	3.20E-04	1.55E-04	3.86E-05	1.97E-03	4.93E-04
S17	Sxlpwrprm2	8.47E-03	2.12E-03	2.11E-03	5.27E-04	1.73E-03	4.33E-04	2.09E-04	5.22E-05	2.66E-03	6.66E-04
S36	Sxlpwrprm7	4.96E-03	1.24E-03	1.23E-03	3.08E-04	1.01E-03	2.53E-04	1.22E-04	3.06E-05	1.56E-03	3.90E-04
S18	Cummins Generator/1823	1.21E-03	3.03E-04	3.01E-04	7.53E-05	2.48E-04	6.19E-05	2.99E-05	7.46E-06	3.81E-04	9.52E-05
S23	DEUTZ	3.36E-03	8.40E-04	8.36E-04	2.09E-04	6.87E-04	1.72E-04	8.28E-05	2.07E-05	1.06E-03	2.64E-04
S24	FWP01	5.22E-03	1.31E-03	1.30E-03	3.25E-04	1.07E-03	2.67E-04	1.29E-04	3.22E-05	1.64E-03	4.11E-04
S25	GENERAC1	5.02E-02	1.25E-02	3.28E-04	8.19E-05	6.22E-03	1.56E-03	3.83E-03	9.57E-04	3.93E-02	9.83E-03
S26	GENERAC2	3.39E-02	8.47E-03	2.21E-04	5.53E-05	4.20E-03	1.05E-03	2.58E-03	6.46E-04	2.65E-02	2.12E-03
S28	GENERAC4	7.25E-03	1.81E-03	4.73E-05	1.18E-05	9.00E-04	2.25E-04	5.53E-04	1.38E-04	5.68E-03	4.53E-04
S29	GENERAC5	1.21E-02	3.03E-03	7.92E-05	1.98E-05	1.50E-03	3.76E-04	9.25E-04	2.31E-04	9.50E-03	7.58E-04
S30	GENERAC6	1.21E-02	3.03E-03	7.92E-05	1.98E-05	1.50E-03	3.76E-04	9.25E-04	2.31E-04	9.50E-03	7.58E-04
S31	GENERAC7	1.21E-02	3.03E-03	7.92E-05	1.98E-05	1.50E-03	3.76E-04	9.25E-04	2.31E-04	9.50E-03	7.58E-04
GENERAC8	GENERAC8	2.90E-02	7.25E-03	1.89E-04	4.73E-05	3.59E-03	8.99E-04	2.21E-03	5.53E-04	2.27E-02	1.81E-03
ATT Gen	ATT Gen	1.32E-03	3.29E-04	3.27E-04	8.18E-05	2.69E-04	6.72E-05	3.24E-05	8.11E-06	4.14E-04	1.03E-04
S34	RT-1	4.88E-02	1.22E-02	3.19E-04	7.96E-05	6.05E-03	1.51E-03	3.72E-03	9.30E-04	3.82E-02	3.05E-03
S33	RT-2	4.88E-02	1.22E-02	3.19E-04	7.96E-05	6.05E-03	1.51E-03	3.72E-03	9.30E-04	3.82E-02	3.05E-03
	Totals:	1.59	5.49	0.12	0.47	0.064	0.095	0.024	0.019	0.55	1.47

Stack No.	Unit No.(s)	Naphthalene ☑ HAP or ☐ TAP		Toluene ☑ HAP or ☐ TAP		Xylenes ☑ HAP or ☐ TAP		Sulfuric Acid ☐ HAP or ☑ TAP	
		lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
N/A	CH SCRN ENG	5.47E-05	2.40E-04	2.64E-04	1.16E-03	1.84E-04	8.06E-04	--	--
N/A	CB SCRN ENG	1.22E-04	2.67E-04	5.88E-04	1.29E-03	4.10E-04	8.98E-04	--	--
N/A	SXEW 10MST	--	--	0.070	0.31	0.078	0.34	--	--
S5	SXEW Boiler No. 1	--	--	--	--	--	--	--	--
S6	SXEW Boiler No. 2	--	--	--	--	--	--	--	--
S7	SXEW Boiler No. 3	--	--	--	--	--	--	--	--
N/A	SXEW RT	--	--	4.63E-03	0.020	5.13E-03	0.022	--	--
SXEW SAT	SXEW SAT	--	--	--	--	--	--	2.28	10.00
N/A	WH Crush	--	--	--	--	--	--	--	--
S12	EE5	1.25E-04	3.13E-05	6.04E-04	1.51E-04	4.21E-04	1.05E-04	--	--
S13	Sxlpwrprm8	1.71E-04	4.28E-05	8.26E-04	2.07E-04	5.76E-04	1.44E-04	--	--
S35	Sxlpwrprm5	1.42E-04	3.54E-05	6.84E-04	1.71E-04	4.76E-04	1.19E-04	--	--
S14	Sxlpwrprm3	1.12E-04	2.79E-05	5.38E-04	1.34E-04	3.75E-04	9.37E-05	--	--
S15	Sxlgdwn1	1.91E-04	4.79E-05	9.24E-04	2.31E-04	6.44E-04	1.61E-04	--	--
S16	Sxlpwrprm4	1.42E-04	3.54E-05	6.84E-04	1.71E-04	4.76E-04	1.19E-04	--	--
S17	Sxlpwrprm2	1.91E-04	4.79E-05	9.24E-04	2.31E-04	6.44E-04	1.61E-04	--	--
S36	Sxlpwrprm7	1.12E-04	2.80E-05	5.41E-04	1.35E-04	3.77E-04	9.42E-05	--	--
S18	Cummins Generator/1823	2.74E-05	6.84E-06	1.32E-04	3.30E-05	9.20E-05	2.30E-05	--	--
S23	DEUTZ	7.60E-05	1.90E-05	3.66E-04	9.16E-05	2.55E-04	6.38E-05	--	--
S24	FWP01	1.18E-04	2.95E-05	5.69E-04	1.42E-04	3.97E-04	9.92E-05	--	--
S25	GENERAC1	5.54E-05	1.38E-05	3.04E-04	7.59E-05	1.37E-04	3.43E-05	--	--
S26	GENERAC2	3.74E-05	9.35E-06	2.05E-04	5.13E-05	9.25E-05	2.31E-05	--	--
S28	GENERAC4	8.01E-06	2.00E-06	4.39E-05	1.10E-05	1.98E-05	4.95E-06	--	--
S29	GENERAC5	1.34E-05	3.35E-06	7.34E-05	1.84E-05	3.31E-05	8.28E-06	--	--
S30	GENERAC6	1.34E-05	3.35E-06	7.34E-05	1.84E-05	3.31E-05	8.28E-06	--	--
S31	GENERAC7	1.34E-05	3.35E-06	7.34E-05	1.84E-05	3.31E-05	8.28E-06	--	--
GENERAC8	GENERAC8	3.20E-05	8.00E-06	1.75E-04	4.39E-05	7.91E-05	1.98E-05	--	--
ATT Gen	ATT Gen	2.97E-05	7.43E-06	1.43E-04	3.59E-05	9.99E-05	2.50E-05	--	--
S34	RT-1	5.39E-05	1.35E-05	2.95E-04	7.39E-05	1.33E-04	3.33E-05	--	--
S33	RT-2	5.39E-05	1.35E-05	2.95E-04	7.39E-05	1.33E-04	3.33E-05	--	--
	Totals:	2.52E-03	3.66E-03	0.30	1.27	0.21	0.90	2.30	10.08

Table 2-J: Fuel

Specify fuel characteristics and usage. Unit and stack numbering must correspond throughout the application package.

Unit No.	Fuel Type (low sulfur Diesel, ultra low sulfur diesel, Natural Gas, Coal, …)	Fuel Source: purchased commercial, pipeline quality natural gas, residue gas, raw/field natural gas, process gas (e.g. SRU tail gas) or other	Specify Units				
			Lower Heating Value	Hourly Usage	Annual Usage	% Sulfur	% Ash
F-2-1-1.4	Natural Gas	Pipeline quality natural gas	1,020 Btu/scf	493,921.6 scf	4326.8 MMscf	<0.01	-
F-2-1-1.5	Natural Gas	Pipeline quality natural gas	1,020 Btu/scf	47,843.1 scf	419.1 MMscf	<0.01	-
CB SCRN ENG	Diesel Fuel	Purchased commercial	137,000 Btu/gal	10.5 gal	92.0 Mgal	<0.05%	-
CH SCRN ENG	Diesel Fuel	Purchased commercial	137,000 Btu/gal	4.7 gal	4.7 Mgal	<0.05%	-
SXEW Boiler No. 1	Liquid petroleum gas (LPG)	Purchased commercial	91,500 Btu/gal	13.7 gal	0.12 MMgal	5.3 lb/10^3 gal	-
SXEW Boiler No. 2	Liquid petroleum gas (LPG)	Purchased commercial	91,500 Btu/gal	13.7 gal	0.12 MMgal	5.3 lb/10^3 gal	-
SXEW Boiler No. 3	Liquid petroleum gas (LPG)	Purchased commercial	91,500 Btu/gal	15.3 gal	0.13 MMgal	5.3 lb/10^3 gal	-
EE5	Diesel Fuel	Varies					-
Sxlpwrprm8	Diesel Fuel	Varies					-
Sxlpwrprm5	Diesel Fuel	Varies					-
Sxlpwrprm3	Diesel Fuel	Varies					-
Sxlgdwn1	Diesel Fuel	Varies					-
Sxlpwrprm4	Diesel Fuel	Varies					-
Sxlpwrprm2	Diesel Fuel	Varies					-
Sxlpwrprm7	Diesel Fuel	Varies					-

Unit No.	Fuel Type (low sulfur Diesel, ultra low sulfur diesel, Natural Gas, Coal, …)	Fuel Source: purchased commercial, pipeline quality natural gas, residue gas, raw/field natural gas, process gas (e.g. SRU tail gas) or other	Specify Units				
			Lower Heating Value	Hourly Usage	Annual Usage	% Sulfur	% Ash
Cummins Generator/1823	Diesel Fuel	Varies					-
CB EGEN2	Diesel Fuel	Varies					-
CB EGEN3	Diesel Fuel	Varies					-
DEUTZ	Diesel Fuel	Varies					-
FWP01	Natural Gas	Varies					-
GENERAC1	Liquid petroleum gas (LPG)	Varies					-
GENERAC2	Liquid petroleum gas (LPG)	Varies					-
GENERAC4	Liquid petroleum gas (LPG)	Varies					-
GENERAC5	Liquid petroleum gas (LPG)	Varies					-
GENERAC6	Liquid petroleum gas (LPG)	Varies					-
GENERAC7	Liquid petroleum gas (LPG)	Varies					-
GENERAC8	Liquid petroleum gas (LPG)	Varies					-
ATT Gen	Diesel Fuel	Varies					-
RT-1	Liquid petroleum gas (LPG)	Varies					-
RT-2	Liquid petroleum gas (LPG)	Varies					-

Table 2-K: Liquid Data for Tanks Listed in Table 2-L

For each tank, list the liquid(s) to be stored in each tank. If it is expected that a tank may store a variety of hydrocarbon liquids, enter "mixed hydrocarbons" in the Composition column for that tank and enter the corresponding data of the most volatile liquid to be stored in the tank. If tank is to be used for storage of different materials, list all the materials in the "All Calculations" attachment, run the newest version of TANKS on each, and use the material with the highest emission rate to determine maximum uncontrolled and requested allowable emissions rate. The permit will specify the most volatile category of liquids that may be stored in each tank. Include appropriate tank-flashing modeling input data. Use additional sheets if necessary. Unit and stack numbering must correspond throughout the application package.

Tank No.	SCC Code	Material Name	Composition	Liquid Density (lb/gal)	Vapor Molecular Weight (lb/lb*mol)	Average Storage Conditions		Max Storage Conditions	
						Temperature (°F)	True Vapor Pressure (psia)	Temperature (°F)	True Vapor Pressure (psia)
N/A- All tanks are considered insignificant activities and are listed on Table 2-B.									

Table 2-L: Tank Data

Include appropriate tank-flashing modeling input data. Use an addendum to this table for unlisted data categories. Unit and stack numbering must correspond throughout the application package. Use additional sheets if necessary. See reference Table 2-L2. Note: 1.00 bbl = 10.159 M3 = 42.0 gal

Tank No.	Date Installed	Materials Stored	Seal Type (refer to Table 2-LR below)	Roof Type (refer to Table 2-LR below)	Capacity		Diameter (M)	Vapor Space (M)	Color (from Table VI-C)		Paint Condition (from Table VI-C)	Annual Throughput (gal/yr)	Turn-overs (per year)
					(bbl)	(M^3)			Roof	Shell			
N/A- All tanks are considered insignificant activities and are listed on Table 2-B.													

Table 2-L2: Liquid Storage Tank Data Codes Reference Table

Roof Type	Seal Type, Welded Tank Seal Type		Seal Type, Riveted Tank Seal Type		Roof, Shell Color	Paint Condition
	Mechanical Shoe Seal	**Liquid-mounted resilient seal**	**Vapor-mounted resilient seal**	**Seal Type**		
FX: Fixed Roof	**A**: Primary only	**A**: Primary only	**A**: Primary only	**A**: Mechanical shoe, primary only	**WH**: White	Good
IF: Internal Floating Roof	**B**: Shoe-mounted secondary	**B**: Weather shield	**B**: Weather shield	**B**: Shoe-mounted secondary	**AS**: Aluminum (specular)	Poor
EF: External Floating Roof	**C**: Rim-mounted secondary	**C**: Rim-mounted secondary	**C**: Rim-mounted secondary	**C**: Rim-mounted secondary	**AD**: Aluminum (diffuse)	
P: Pressure					**LG**: Light Gray	
					MG: Medium Gray	
					BL: Black	
					OT: Other (specify)	

Note: 1.00 bbl = 0.159 M^3 = 42.0 gal

Table 2-M: Materials Processed and Produced (Use additional sheets as necessary.)

Material Processed				Material Produced			
Description	**Chemical Composition**	**Phase (Gas, Liquid, or Solid)**	**Quantity (specify units)**	**Description**	**Chemical Composition**	**Phase**	**Quantity (specify units)**
Chino Mined Material	Copper, minerals, and trace metals	Solid	1,000,000 tons/day	Chino & Cobre Copper Cathode	High Purity Copper	Solid	215 tons/day
Cobre Mined Material	Copper, minerals, and trace metals	Solid	126,000 tons/day	Chino & Cobre Copper Cathode	High Purity Copper	Solid	215 tons/day
Magnetite	Iron, Copper, Manganese, and trace metals	Solid	4,500 tons/day	Magnetite	Magnetite	Solid	4,500 tons/day
Copper Ore for Concentrator (mined)	Copper, minerals, and trace metals	Solid	80,640 tons/day	Concentrate	30% Copper Concentrate Cake	Solid	360,800 tons/yr

Table 2-N: CEM Equipment

Enter Continuous Emissions Measurement (CEM) Data in this table. If CEM data will be used as part of a federally enforceable permit condition, or used to satisfy the requirements of a state or federal regulation, include a copy of the CEM's manufacturer specification sheet in the Information Used to Determine Emissions attachment. Unit and stack numbering must correspond throughout the application package. Use additional sheets if necessary.

Stack No.	Pollutant(s)	Manufacturer	Model No.	Serial No.	Sample Frequency	Averaging Time	Range	Sensitivity	Accuracy
N/A - This facility does not have any CEM equipment present.									

Table 2-O: Parametric Emissions Measurement Equipment

Unit and stack numbering must correspond throughout the application package. Use additional sheets if necessary.

Unit No.	Parameter/Pollutant Measured	Location of Measurement	Unit of Measure	Acceptable Range	Frequency of Maintenance	Nature of Maintenance	Method of Recording	Averaging Time
N/A - This facility does not have any PEM equipment present.								

Table 2-P: Greenhouse Gas Emissions

Applications submitted under 20.2.70, 20.2.72, & 20.2.74 NMAC are required to complete this Table. Power plants, Title V major sources, and PSD major sources must report and calculate all GHG emissions for each unit. Applicants must report potential emission rates in short tons per year (see Section 6.a for assistance). Include GHG emissions during Startup, Shutdown, and Scheduled Maintenance in this table. For minor source facilities that are not power plants, are not Title V, or are not PSD, there are three options for reporting GHGs 1) report GHGs for each individual piece of equipment; 2) report all GHGs from a group of unit types, for example report all combustion source GHGs as a single unit and all venting GHG as a second separate unit; OR 3) check the following box ☐ By checking this box, the applicant acknowledges the total CO2e emissions are less than 75,000 tons per year.

		CO_2 ton/yr	N_2O ton/yr	CH_4 ton/yr	SF_6 ton/yr	PFC/HFC ton/yr[2]									Total GHG Mass Basis ton/yr[4]	Total CO_2e ton/yr[5]
Unit No.	**GWPs [1]**	1	298	25	22,800	footnote 3										
CB TLNGS	mass GHG	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
CBM HR	mass GHG	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
CBM MH	mass GHG	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
CBM BLST	mass GHG	2,610.54	0.021	0.11	--	--									2,610.66	
	CO_2e	2,610.54	6.31	2.65	--	--										2,619.49
CM BLST	mass GHG	9,492.86	0.077	0.39	--	--									9,493.32	
	CO_2e	9,492.86	22.95	9.63	--	--										9,525.43
BORR_BLST	mass GHG	10.93	8.86E-05	4.43E-04	--	--									10.93	
	CO_2e	10.93	2.64E-02	1.11E-02	--	--										10.96
BORR_MH	mass GHG	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
CM HR	mass GHG	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
CM MH	mass GHG	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
CM TLNGS	mass GHG	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
CTS-01	mass GHG	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
CV-01A	mass GHG	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
CV-01B	mass GHG	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
CV-01C	mass GHG	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
F-2-1-1.4	mass GHG	314,047.46	0.44	4.39	--	--									314,052.29	
	CO_2e	314,047.46	130.93	109.84	--	--										314,288.23
F-2-1-1.5	mass GHG	24,984.31	0.047	0.47	--	--									24,984.83	
	CO_2e	24,984.31	14.04	11.78	--	--										25,010.14
FLTR/ BLND	mass GHG	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
GDF	mass GHG	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
IC-01	mass GHG	--	--	--	--	--										
	CO2e	--	--	--	--	--										
LHS-01 (IC-06)	mass GHG	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
LUS-01	mass GHG	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
PC DUMP	mass GHG	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
PC-01	mass GHG	--	--	--	--	--										
	CO_2e	--	--	--	--	--										

SAG-F1	**mass GHG**	--	--	--	--	--										
(IC-04)	**CO_2e**	--	--	--	--	--										
SCDP	**mass GHG**	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
CH SCRN	**mass GHG**	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
CB SCRN	**mass GHG**	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
CH SCRN ENG	**mass GHG**	464.31	0.00	0.02	--	--									464.33	
	CO_2e	464.31	1.12	0.47	--	--										465.90
CB SCRN ENG	**mass GHG**	517.42	0.00	0.02	--	--									517.45	
	CO_2e	517.42	1.25	0.52	--	--										519.20
SXEW 10MST	**mass GHG**	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
SXEW Boiler No. 1	**mass GHG**	763.23	0.01	0.04	--	--									763.27	
	CO_2e	763.23	2.17	0.91	--	--										766.30
SXEW Boiler No. 2	**mass GHG**	763.23	0.01	0.04	--	--									763.27	
	CO_2e	763.23	2.17	0.91	--	--										766.30
SXEW Boiler No. 3	**mass GHG**	851.41	0.01	0.04	--	--									851.46	
	CO_2e	851.41	2.42	1.01	--	--										854.84
SXEW RT	**mass GHG**	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
SXEW SAT	**mass GHG**	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
WH Crush	**mass GHG**	--	--	--	--	--										
	CO_2e	--	--	--	--	--										
EE5	**mass GHG**	54.75	4.43E-04	0.0022											54.76	
	CO_2e	54.57	0.13	0.055												54.75
Sxlpwrprm8	**mass GHG**	74.72	6.06E-04	0.0030	--	--									74.72	
	CO_2e	74.72	0.18	0.076	--	--										74.98
Sxlpwrprm3	**mass GHG**	48.62	3.94E-04	0.0020	--	--										
	CO_2e	48.62	0.12	0.049	--	--										
Sxlgdwn1	**mass GHG**	83.51	6.77E-04	0.0034	--	--									83.51	
	CO_2e	83.51	0.20	0.085	--	--										83.79
Sxlpwrprm4	**mass GHG**	61.80	5.01E-04	0.0025	--	--									61.80	
	CO_2e	61.80	0.15	0.063	--	--										62.01
Sxlpwrprm2	**mass GHG**	83.51	6.77E-04	0.0034	--	--									83.51	
	CO_2e	83.51	0.20	0.085	--	--										83.79
Cummins	**mass GHG**	11.93	9.68E-05	0.0005	--	--									11.93	
Generator/1823	**CO_2e**	11.93	0.029	0.012	--	--										11.98
DEUTZ	**mass GHG**	33.12	2.69E-04	0.0013	--	--									33.12	
	CO_2e	33.12	0.080	0.034	--	--										33.23
FWP01	**mass GHG**	51.47	4.20E-04	0.0021	--	--									51.47	
	CO_2e	51.47	0.13	0.053	--	--										51.64
GENERAC1	**mass GHG**	19.75	3.72E-05	3.72E-04	--	--									19.75	
	CO_2e	19.75	0.011	0.0093	--	--										19.77
GENERAC2	**mass GHG**	15.51	1.51E-04	7.54E-04	--	--									15.51	
	CO_2e	15.51	0.045	0.019	--	--										15.58
GENERAC4	**mass GHG**	3.32	3.23E-05	1.61E-04	--	--									3.32	
	CO_2e	3.32	0.010	0.0040	--	--										3.33
GENERAC5	**mass GHG**	5.55	5.40E-05	2.70E-04	--	--									5.55	
	CO_2e	5.55	0.016	0.0068	--	--										5.58
GENERAC6	**mass GHG**	5.55	5.40E-05	2.70E-04	--	--									5.55	
	CO_2e	5.55	0.016	0.0068	--	--										5.58
GENERAC7	**mass GHG**	5.55	5.40E-05	2.70E-04	--	--									5.55	
	CO_2e	5.55	0.016	0.0068	--	--										5.58

GENERAC8	**mass GHG**	13.32	1.29E-04	6.45E-04											13.32	
	CO_2e	13.32	0.038	0.016												13.38
ATT Gen	**mass GHG**	13.01	1.05E-04	5.26E-04											13.01	
	CO_2e	13.01	0.031	0.013												13.06
RT-1	**mass GHG**	22.34	2.17E-04	0.0011	--	--									22.34	
	CO_2e	22.34	0.065	0.027	--	--										22.43
RT-2	**mass GHG**	22.34	2.17E-04	0.0011	--	--									22.34	
	CO_2e	22.34	0.065	0.027	--	--										22.43
Total	**mass GHG**	355,135.38	0.62	5.54	--	--									355,141.54	
	CO_2e	355,135.19	184.91	138.38	--	--										355,458.48

[1] **GWP** (Global Warming Potential): Applicants must use the most current GWPs codified in Table A-1 of 40 CFR part 98. GWPs are subject to change, therefore, applicants need to check 40 CFR 98 to confirm GWP values.

[2] For **HFCs** or **PFCs** describe the specific HFC or PFC compound and use a separate column for each individual compound.

[3] For each new compound, enter the appropriate GWP for each HFC or PFC compound from Table A-1 in 40 CFR 98.

[4] Green house gas emissions on a **mass basis** is the ton per year green house gas emission before adjustment with its GWP.

[5] **CO_2e** means Carbon Dioxide Equivalent and is calculated by multiplying the TPY mass emissions of the green house gas by its GWP.

Section 3

Application Summary

The **Application Summary** shall include a brief description of the facility and its process, the type of permit application, the applicable regulation (i.e. 20.2.72.200.A.X, or 20.2.73 NMAC) under which the application is being submitted, and any air quality permit numbers associated with this site. If this facility is to be collocated with another facility, provide details of the other facility including permit number(s). In case of a revision or modification to a facility, provide the lowest level regulatory citation (i.e. 20.2.72.219.B.1.d NMAC) under which the revision or modification is being requested. Also describe the proposed changes from the original permit, how the proposed modification will affect the facility's operations and emissions, de-bottlenecking impacts, and changes to the facility's major/minor status (both PSD & Title V).

The **Process Summary** shall include a brief description of the facility and its processes.

Startup, Shutdown, and Maintenance (SSM) routine or predictable emissions: Provide an overview of how SSM emissions are accounted for in this application. Refer to "Guidance for Submittal of Startup, Shutdown, Maintenance Emissions in Permit Applications (http://www.env.nm.gov/aqb/permit/app_form.html) for more detailed instructions on SSM emissions.

Freeport-McMoRan Chino Mines Company is submitting this application for a renewal and Significant Modification of Title V Operating Permit No. P-066-R3M1 for the Chino Mine. The Significant Modification will reflect recent changes to NSR 0298M10R1, 0298M10R3, 0298M10R4, 0298M11R1, 0298M11R2, 0298M11R3, and 0298M11R4 requested in the NSR Revision applications that were submitted to the NMED. Those changes include requested (1) authorization for the construction of a material borrow pit near the Cobre Haul road to provide material for maintenance of the facility haul roads; (2) authorization of 119,700 lb/day for borrow pit blasting; (3) retirement of Mase 1 from the facility; (4) construction of baghouse to control SAG mill tunnel; (5) removal of LmSIk and ENG-1 units; (6) replacement of Fire Emergency Pump; and (7) addition of two emergency standby generators.

Freeport-McMoRan Chino Mines Company (Freeport) owns and operates the Chino Mine (Chino). The Chino mine is an open-pit copper mining operation located approximately 15 miles east of Silver City in Grant County, New Mexico (UTM Zone 12 and Air Quality Control Region 12). The primary purpose of the facility is to produce copper cathode using the Solvent Extraction/Electrowinning (SXEW) process and copper concentrate using a wet flotation process. Chino is a minor source under the Prevention of Significant Deterioration (PSD) rules as currently permitted and will remain a minor source after the proposed significant revision. Chino will also remain a major source for Title V Operating Permit purposes under 20.2.70 NMAC.

Chino includes two open pits, the Santa Rita open pit and the Continental open pit (formally known as the Cobre Mine or herein as "Cobre") located approximately 3 miles north of the Santa Rita open pit. Chino consists of unpaved haul roads and storage stockpiles. Ore mined from Cobre is transported via the Cobre Haul Road for future processing. Additional operations include a mill, which includes a primary crusher, conveyor belts and concentrator, two screening plants, loading of magnetite into over-the road trucks, a power plant, and a solution extraction and electrowinning plant.

Significant Modification of Title V Operating Permit No. P-066-R3M1:

1. Freeport-McMoRan requests four blasts that are to occur separately (only for this single construction event) and not during any other blasting events at the facility. With this application, emissions from blasting and material handling at this borrow pit are included in facility-wide emissions.

   The following changes are included below:
   - New Unit BORR_BLST for the Cobre Haul Road Borrow Pit Blasting
   - New Unit BORR_MH for Cobre Haul Road Borrow Pit Material Handling

2. Freeport-McMoRan is requesting an update to the language associated with permit condition A605.B, which states that 40 CFR 60, Subpart LL applies to units LUS-041 and LHS-01, however as documented in Table 103.A, Subpart LL does not apply to these units. These units are associated with the lime unloading and handling systems and are not

affected facilities as defined by Subpart LL. The units that are subject to this subpart are PC-01, PC DUMP, CV-01A, CTS-01, CV-01B, CV-01C, SAG-F1, IC-01, and SCDP which does not include LUH-041 and LSH-01.

B. 40 CFR 60, Subpart LL Compliance (Units PC-01, PC DUMP, CV-01A, CTS-01, CV-01B, CV-01C, SAG-F1, IC-01, and SCDP) (NSR Permit 0298M10, Condition A605.A and revised by this permit)

Requirement: Compliance with the allowable emissions limits in Table 106.A shall be demonstrated by complying with the requirements of 40 CFR 60, Subpart LL. 40 CFR 60, Subpart LL applies only to the specified Ivanhoe Concentrator affected facilities listed above. For an affected facility using a wet scrubber (Units IC-01, LUH-01, and LHS-01), the scrubber shall be equipped with pressure gauges to measure pressure drop across the control device. Wet scrubbing systems shall be equipped with a continuous monitoring device to measure the scrubbing liquid flow rate. Pressure gauges and monitoring devices shall be installed, calibrated, maintained, and operated in accordance with the manufacturer specifications. Compliance with this will be based on Department inspections of the facility to verify that instruments have been installed and of the records as set forth in 40CFR60, Subpart LL.

3. Additionally, Freeport-McMoRan is requesting the removal of the requirement under permit condition A602.B of the current Title V Operating Permit No. P-066-R3M1. A602.B is specific to periodic emissions testing for units CH SCRN ENG and CB SCRN ENG. Based on historical testing, Freeport-McMoRan believes that these units have been shown meet the required permitted emission rates within this permit, and therefore additional testing should not be required for these units.

4. 0298M11R1: Freeport-McMoRan is requesting a maximum amount of blasting agent per day of 119,700 lb/day for Borrow Pit blasting. Freeport-McMoRan is also seeking to increase the Borrow pit material handling limit to 20,000 tons/day while retaining the annual material handling (unit BORR_MH) at 350,000 tons/year.

5. 0298M11R2: Freeport-McMoRan is requesting to retire Mase 1 from the facility.

6. 0298M11R3: Freeport-McMoRan is requesting the construction of a baghouse to control the SAG mill tunnel. Freeport-McMoRan is requesting the baghouse flow capacity of 24,000 acfm for the underground SAG mill tunnel (Unit SAG).

7. 0298M11R4: Freeport-McMoRan seeks the removal of two units (QuickLime Slaking Mill, unit LmSlk, and Diesel Engine for Lime Slaking, unit ENG-1).

8. Freeport-McMoRan seeks to replace Unit EE5, SXEW Fire Emergency Pump from Detroit Diesel pump (195 hp) to John Deere pump (197 hp).

9. 0298M10R3 & 0298M10R4: Freeport-McMoRan seeks to add two emergency standby generators, GENERAC8 and ATT Gen.

These modifications do not modify any other preexisting sources or scenarios.

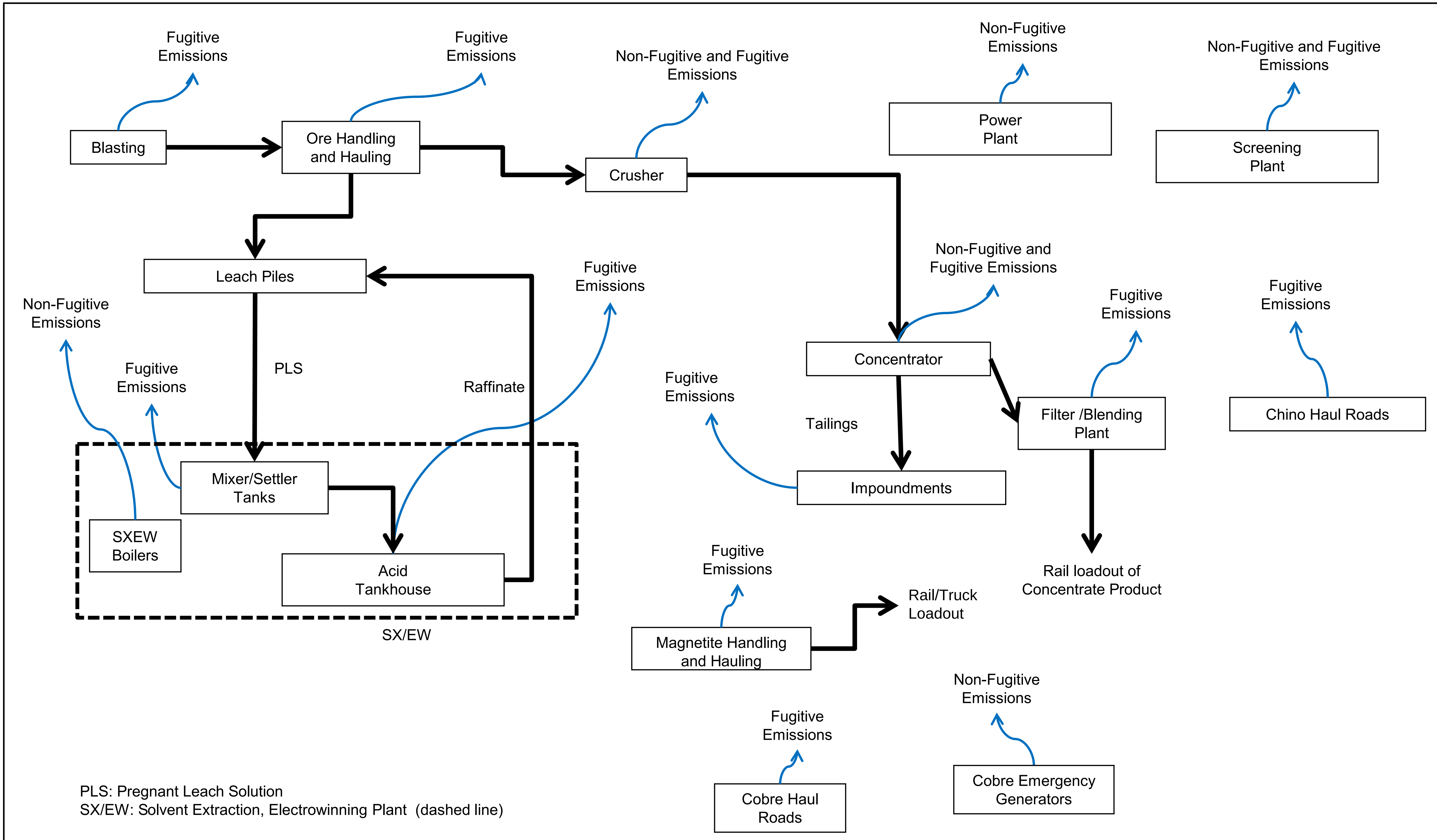
Section 4

Process Flow Sheet

A **process flow sheet** and/or block diagram indicating the individual equipment, all emission points and types of control applied to those points. The unit numbering system should be consistent throughout this application.

A process flow diagram for the facility is attached.

Freeport McMoRan Chino Mines Company
Process Flow Diagram

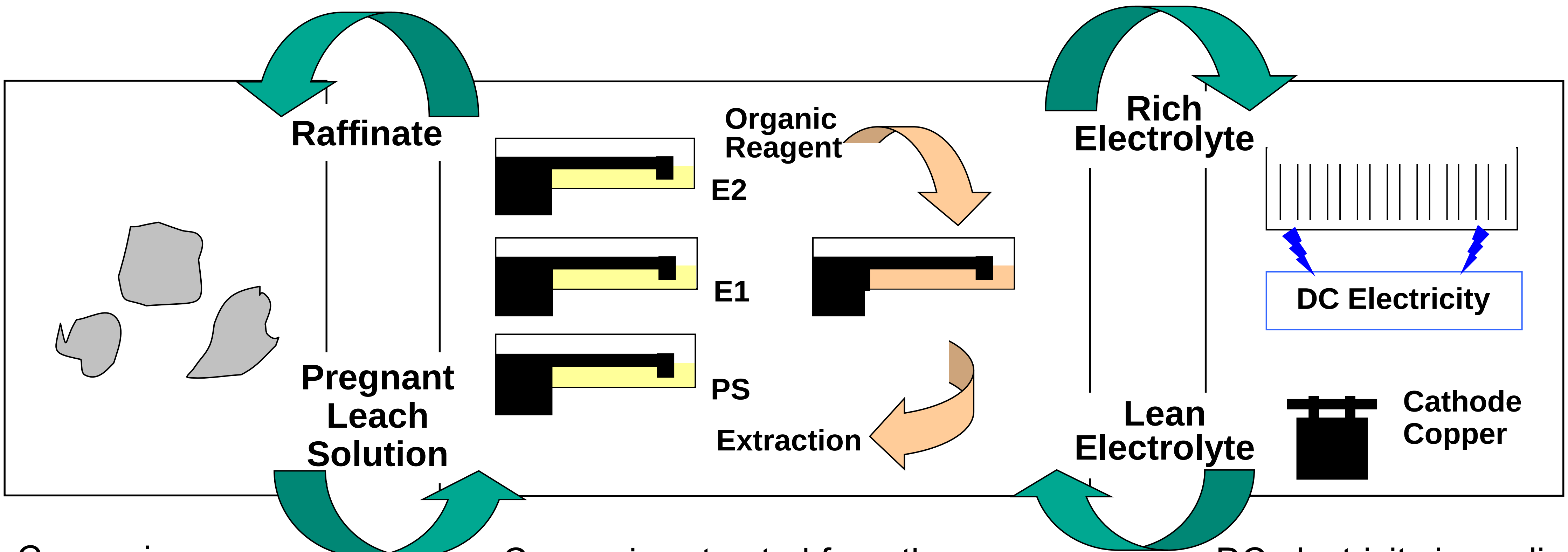


Freeport McMoRan Chino Mines Company
Process Diagram

Leaching

Extraction

Electrowinning



Copper ions are leached from the ore by the leach solution sprayed on the stockpiles.

Copper is extracted from the leach solution by an organic ion-exchange reagent. The copper is then stripped from the organic by the acidic electrolyte in the stripping stage.

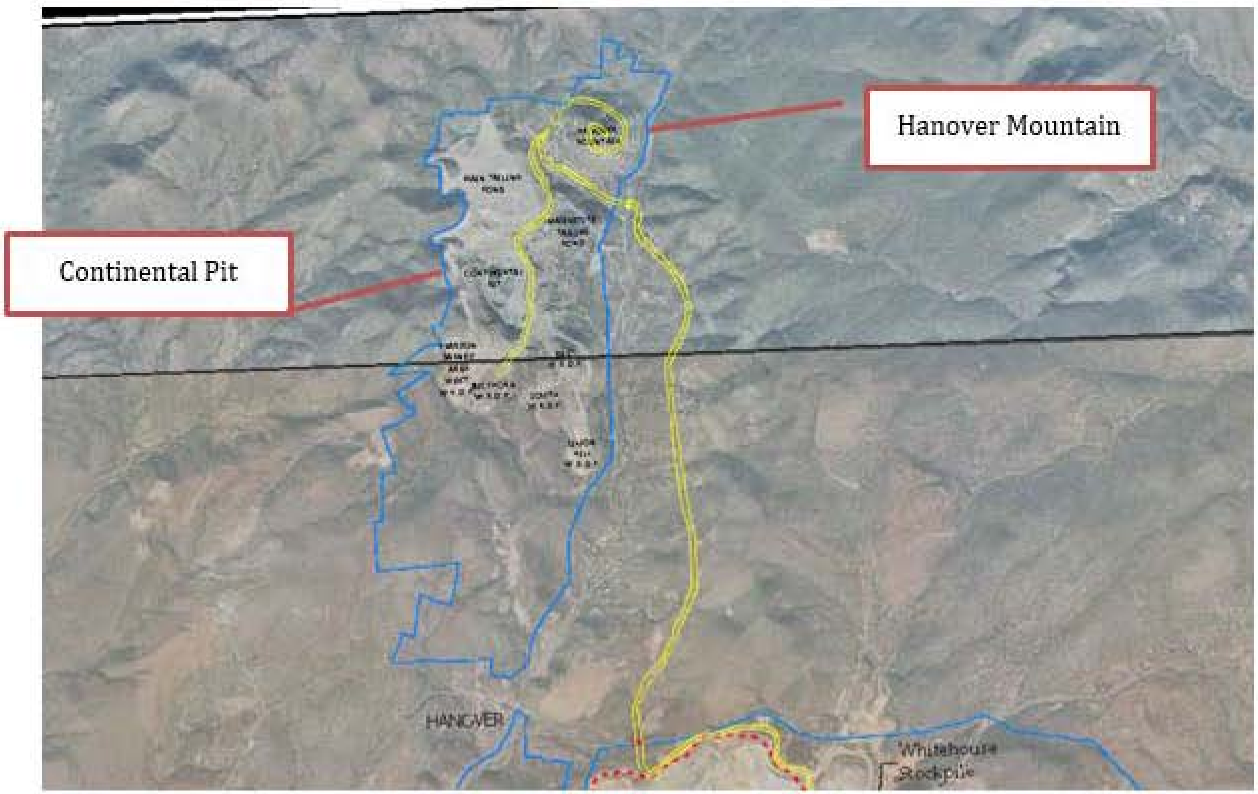
DC electricity is applied to the electrolyte, reducing the copper ions to copper metal, which is deposited on the cathode.

Section 5

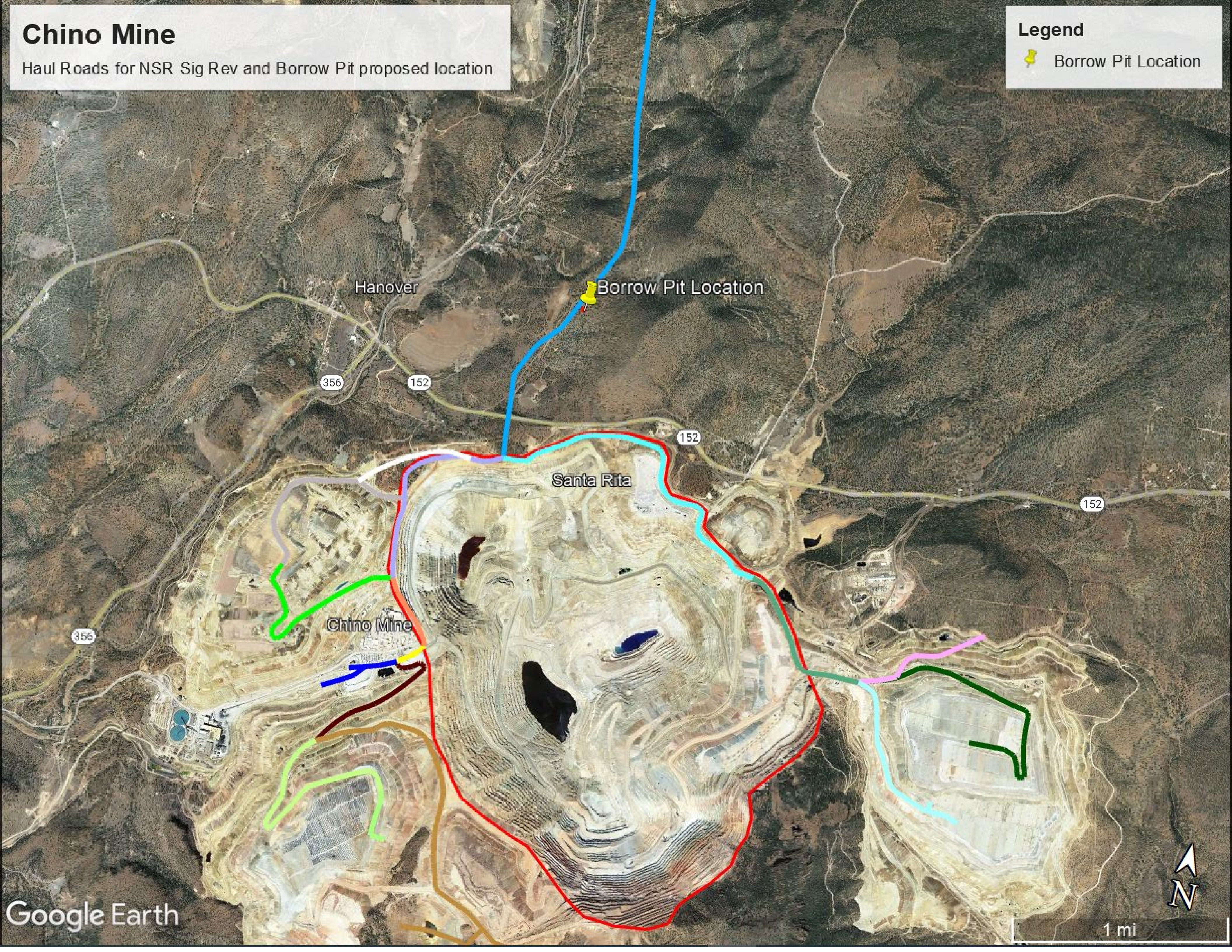
Plot Plan Drawn To Scale

A **plot plan drawn to scale** showing emissions points, roads, structures, tanks, and fences of property owned, leased, or under direct control of the applicant. This plot plan must clearly designate the restricted area as defined in UA1, Section 1-D.12. The unit numbering system should be consistent throughout this application.

A plot plan of the facility is attached on the following pages.



Hanover Mountain
Continental Pit
HANOVER
Whitehouse
Stockpile



Chino Mine
Haul Roads for NSR Sig Rev and Borrow Pit proposed location
Legend
Borrow Pit Location
Hanover
Borrow Pit Location
356
152
152
152
Santa Rita
Chino Mine
356
Google Earth
N
1 mi

FREEPORT-McMoRAN
CHINO MINES COMPANY

South Mine Area Sources

Scale: As Noted	Date: 10-10-2018	Notes: Drawing No. Air-002.000	
Dept. Environmental Services			
Drawn By: SMG	Checked By: DV		

Section 6

All Calculations

Show all calculations used to determine both the hourly and annual controlled and uncontrolled emission rates. All calculations shall be performed keeping a minimum of three significant figures. Document the source of each emission factor used (if an emission rate is carried forward and not revised, then a statement to that effect is required). If identical units are being permitted and will be subject to the same operating conditions, submit calculations for only one unit and a note specifying what other units to which the calculations apply. All formulas and calculations used to calculate emissions must be submitted. The "Calculations" tab in the UA2 has been provided to allow calculations to be linked to the emissions tables. Add additional "Calc" tabs as needed. If the UA2 or other spread sheets are used, all calculation spread sheet(s) shall be submitted electronically in Microsoft Excel compatible format so that formulas and input values can be checked. Format all spread sheets and calculations such that the reviewer can follow the logic and verify the input values. Define all variables. If calculation spread sheets are not used, provide the original formulas with defined variables. Additionally, provide subsequent formulas showing the input values for each variable in the formula. All calculations, including those calculations are imbedded in the Calc tab of the UA2 portion of the application, the printed Calc tab(s), should be submitted under this section.

Tank Flashing Calculations: The information provided to the AQB shall include a discussion of the method used to estimate tank-flashing emissions, relative thresholds (i.e., NOI, permit, or major source (NSPS, PSD or Title V)), accuracy of the model, the input and output from simulation models and software, all calculations, documentation of any assumptions used, descriptions of sampling methods and conditions, copies of any lab sample analysis. If Hysis is used, all relevant input parameters shall be reported, including separator pressure, gas throughput, and all other relevant parameters necessary for flashing calculation.

SSM Calculations: It is the applicant's responsibility to provide an estimate of SSM emissions or to provide justification for not doing so. In this Section, provide emissions calculations for Startup, Shutdown, and Routine Maintenance (SSM) emissions listed in the Section 2 SSM and/or Section 22 GHG Tables and the rational for why the others are reported as zero (or left blank in the SSM/GHG Tables). Refer to "Guidance for Submittal of Startup, Shutdown, Maintenance Emissions in Permit Applications (http://www.env.nm.gov/aqb/permit/app_form.html) for more detailed instructions on calculating SSM emissions. If SSM emissions are greater than those reported in the Section 2, Requested Allowables Table, modeling may be required to ensure compliance with the standards whether the application is NSR or Title V. Refer to the Modeling Section of this application for more guidance on modeling requirements.

Glycol Dehydrator Calculations: The information provided to the AQB shall include the manufacturer's maximum design recirculation rate for the glycol pump. If GRI-Glycalc is used, the full input summary report shall be included as well as a copy of the gas analysis that was used.

Road Calculations: Calculate fugitive particulate emissions and enter haul road fugitives in Tables 2-A, 2-D and 2-E for:

1. If you transport raw material, process material and/or product into or out of or within the facility and have PER emissions greater than 0.5 tpy.
2. If you transport raw material, process material and/or product into or out of the facility more frequently than one round trip per day.

Significant Figures:

A. All emissions standards are deemed to have at least two significant figures, but not more than three significant figures.
B. At least 5 significant figures shall be retained in all intermediate calculations.
C. In calculating emissions to determine compliance with an emission standard, the following rounding off procedures shall be used:

- **(1)** If the first digit to be discarded is less than the number 5, the last digit retained shall not be changed;
- **(2)** If the first digit discarded is greater than the number 5, or if it is the number 5 followed by at least one digit other than the number zero, the last figure retained shall be increased by one unit; **and**
- **(3)** If the first digit discarded is exactly the number 5, followed only by zeros, the last digit retained shall be rounded upward if it is an odd number, but no adjustment shall be made if it is an even number.
- **(4)** The final result of the calculation shall be expressed in the units of the standard.

Control Devices: In accordance with 20.2.72.203.A(3) and (8) NMAC, 20.2.70.300.D(5)(b) and (e) NMAC, and 20.2.73.200.B(7) NMAC, the permittee shall report all control devices and list each pollutant controlled by the control device regardless if the applicant takes credit for the reduction in emissions. The applicant can indicate in this section of the application if they chose to not take credit for the reduction in emission rates. For notices of intent submitted under 20.2.73 NMAC, only uncontrolled emission rates can be considered to determine applicability unless the state or federal Acts require the control. This information is necessary to determine if federally enforceable conditions are necessary for the control device, and/or if the control device produces its own regulated pollutants or increases emission rates of other pollutants.

Tailings Impoundment (Not changing as a result of this application)

Tailings Impoundment (Units CB TLNGS & CM TLNGS)

Wind erosion emissions for the tailings impoundment are based on AP-42, Section 13.2.5, Industrial Wind Erosion (11/06). These emissions on based on the availability of erodible material, the wind speed threshold required to cause the material to become airborne, and how often new material is deposited on the area. Calculated emissions represent intermittent events that only occur when wind speeds are great enough to transport available materials. The emission rate is not a steady state event and decays rapidly to zero when erodible material is no longer available or when wind speeds are no longer great enough to transport material. Freeport is requesting to increase the tailing pond impoundment to incorporate an area that was previously used for reclamation borrow material with this permit application. By extending the tailings into the 7 West area, it will extend the life of tailings dam 7 by several years.

Haul Roads (Not changing as a result of this application)

Haul Roads (Units CBM HR & CM HR)

Haul road emissions were calculated using Equations 1a and 2 of AP-42 Section 13.2.2. The haul road inputs were based on projected production rates and estimated vehicle miles traveled required to move the ore and magnetite material. The haul road distances were estimated from google earth satellite images. Additionally, the calculations were based on the assumption that the haul roads will be operating at 24 hours a day, 7 days a week, and 365 days a year. The controlled emissions include emission reductions of 80%, 88.8%, and 96.8% based on the control factor used on each segment of the road. The emission reduction methods include blading, watering, speed limit reduction, and application of dust suppressants/dust binders. These control efficiencies are based on factors from the Western Regional Air Partnership (WRAP) Fugitive Dust Handbook, published September 7, 2006. The modeling report in Section 16 contains detailed information on which portions of the roads are controlled and by what control efficiency. The haul roads were redrawn to account for the mine proposed operations. Additionally, the haul roads throughputs were increased to account for the increase in ore production and operations.

Material Handling: To be modified

Material Handling (Unit CBM MH)

Particulate emissions from magnetite handling, material handling, and unloading are all based on emission factors in AP-42, Chapter 11.19.2, Table 11.19.2-2 Crushed Stone Processing and Pulverized Mineral Processing (August 2004) for Truck Unloading - Fragmented Stone. The basis for these emission factors is the PM_{10} emission factor for truck unloading of fragmented stone in Table 11.19.2-2. This table provides a PM_{10} emission factor but does not provide $PM_{2.5}$ or TSP emission factors. A $PM_{2.5}$ emission factor was calculated from the available PM_{10} emission factor using the ratio of 0.15 $PM_{2.5}$ / PM_{10} as recommended in the Background Document for AP-42, Chapter 13.2.4, Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006. An uncontrolled TSP emission factor was calculated from the available uncontrolled PM_{10} emission factor using the TSP/ PM_{10} ratio calculated from the following uncontrolled TSP and PM_{10} emission factors in Table 11.19.2-2: Tertiary Crushing (0.0054/0.0024 = 2.25); Fines Crushing (0.0390/0.0150 = 2.60); Screening (0.025/0.0087 = 2.87; and Conveyor Transfer Point 0.0030/0.00110 = 2.73).

TAP emissions from material handling and loading operations of waste rock and leach rock were calculated by multiplying the TSP emissions by the TAP content (%) in waste rock or leach rock. For conservative TAPs emission estimations for material handling are based on the higher TAP % available for waste rock or leach rock. For example, antimony emissions from material handling are based on antimony % in leach rock and barium emissions from material handling in the pit are based on barium % in waste rock.

Cobre Haul Road Borrow Pit Material Handling (Unit BORR_MH)
This application seeks to increase the borrow pit material handling limit to 20,000 tons/day while retaining the annual material handling at 350,000 tons/year.

Particulate emissions from material handling and unloading are all based on emission factors in AP-42, Chapter 11.19.2, Table 11.19.2-2 Crushed Stone Processing and Pulverized Mineral Processing (August 2004) for Truck Unloading - Fragmented Stone. The basis for these emission factors is the PM_{10} emission factor for truck unloading of fragmented stone in Table 11.19.2-2. This table provides a PM_{10} emission factor but does not provide $PM_{2.5}$ or TSP emission factors. A $PM_{2.5}$ emission factor was calculated from the available PM_{10} emission factor using the ratio of 0.15 $PM_{2.5}$ / PM_{10} as recommended in the Background Document for AP-42, Chapter 13.2.4, Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006. An uncontrolled TSP emission factor was calculated from the available uncontrolled PM_{10} emission factor using the TSP/ PM_{10} ratio calculated from the following uncontrolled TSP and PM_{10} emission factors in Table 11.19.2-2: Tertiary Crushing (0.0054/0.0024 = 2.25); Fines Crushing (0.0390/0.0150 = 2.60); Screening (0.025/0.0087 = 2.87; and Conveyor Transfer Point 0.0030/0.00110 = 2.73).

TAP emissions from material handling and loading operations of waste rock and leach rock were calculated by multiplying the TSP emissions by the TAP content (%) in waste rock or leach rock. For conservative TAPs emission estimations for material handling are based on the higher TAP % available for waste rock or leach rock. For example, antimony emissions from material handling are based on antimony % in leach rock and barium emissions from material handling in the pit are based on barium % in waste rock.

Blasting: To be modified

Hanover Mountain Blasting (Unit CBM BLST)
Particulate emissions resulting from blasting at Hanover Mountain were calculated using emissions factors from AP-42 Section 11, Table 11.9-1. NO_X emission factors is the average measurements from a "*NO_X Emissions from Blasting Operations in Open-Cut Coal Mining*" by Moetaz I. Attalla, Stuart J. Day, Tony Lange, William Lilley, and Scott Morgan (2008). CO emission factors is the average measurements from "*Factors Affecting Anfo Fumes Production" by James H. Rowland III and Richard Mainiero (2001)*. SO_2 emissions are based on a diesel sulfur content of 15 ppm, assuming a complete conversion of SO_2.

The calculation methodology used: The emission factor (lb/blast) is multiplied by the amount of blasting agent per day. This provides the total lb/day emission rate which is divided by the number of blasts per day. The lb/event emission rate is equal to the lb/hr emission rate since it is assumed only one blast would occur per hour. The maximum amount of blasting agent used at Cobre Mine is 110,000 pounds per day. The blasting emissions will not change from the previous application.

Chino Mine Blasting (Unit CM BLST)
Particulate emissions resulting from blasting at Santa Rita Pit were calculated using emissions factors from AP-42 Section 11, Table 11.9-1. NO_X emission factors is the average measurements from a "*NO_X Emissions from Blasting Operations in Open-Cut Coal Mining*" by Moetaz I. Attalla, Stuart J. Day, Tony Lange, William Lilley, and Scott Morgan (2008). CO emission factors is the average measurements from "*Factors Affecting Anfo Fumes Production" by James H. Rowland III and Richard Mainiero (2001)*. SO_2 emissions are based on a diesel sulfur content of 15 ppm, assuming a complete conversion of SO_2.

The calculation methodology used: The emission factor (lb/blast) is multiplied by the amount of blasting agent per day. This provides the total lb/day emission rate which is divided by the number of blasts per day. The lb/event emission rate is equal to the lb/hr emission rate since it is assumed only one blast would occur per hour. The maximum amount of blasting agent used at Chino Mine is 400,000 pounds per day. The blasting emissions will not change from the last permitted application.

Cobre Haul Road Borrow Pit Blasting (Unit BORR_BLST)
Particulate emissions resulting from blasting at Cobre Haul Road Borrow Pit were calculated using emissions factors from AP-42 Section 11, Table 11.9-1. NO_X emission factors is the average measurements from a "*NO_X Emissions from Blasting Operations in Open-Cut Coal Mining*" by Moetaz I. Attalla, Stuart J. Day, Tony Lange, William Lilley, and Scott Morgan (2008). CO emission factors is the average measurements from "*Factors Affecting Anfo Fumes Production" by James H. Rowland III and Richard Mainiero (2001)*. SO_2 emissions are based on a diesel sulfur content of 15 ppm, assuming a complete conversion of SO_2.

The calculation methodology used: The emission factor (lb/blast) is multiplied by the amount of blasting agent per day. This provides the total lb/day emission rate which is divided by the number of blasts per day. The lb/event emission rate is equal to the lb/hr emission rate since it is assumed only one blast would occur per hour. The maximum amount of blasting agent used at the proposed Borrow Pit is 119,700 pounds per this construction event. The total amount of blasting agent is to be distributed into four smaller blasts consisting of 29,925 pounds of blasting agent per blast. The division of blasting agent is to be applied to the particulate emissions as well, which will result in four 25,000 ft^2 blasting areas.

Hurly Power Plant (Not changing as a result of this application)

Gas Turbine (Unit F-2-1-1.4)
HAP emissions were calculated using AP-42 Chapter 3.1 Table 3.1-3 emission factors. The maximum hourly emissions rates for NO_x, CO, SO_2, VOC and PM were based on the allowed rates in air permits 376-M4 and P066-R3M1. The annual emissions rates are based on 8,760 annual operating hours. Greenhouse gas emissions are based on 40CFR 98 Table C-1, C-2, and Subpart A, Table A-1. The gas turbine emissions will not change from the last permitted application.

Steam Generator (Unit F-2-1-1.5)
HAP emissions were calculated using AP-42 Chapter 1.4 Tables 1.4-2 and 1.4-3 emission factors. The maximum hourly emissions rates for NO_x, CO, SO_2, VOC and PM were based on the allowed rates in air permits 376-M4 and P066-R3M1. The annual emissions rates are based on 8,760 annual operating hours. Greenhouse gas emissions are based on 40CFR 98 Table C-1, C-2, and Subpart A, Table A-1. The steam generator emissions will not change from the last permitted application.

Filter/Blending Plant (Not changing as a result of this application)

Filter/Blending Plant (Unit FLTR/BLND)
Emissions from the filter/blending plant were calculated using Conveyor Drop Point Emission Factors from AP-42 Table 11.19.2-2 in "Crushed Stone Processing and Pulverized Mineral Processing" for uncontrolled Conveyor Transfer Point (08/2004). Emissions for front-end loaders were calculated using Front End Loader Emission Factors from AP-42 Table 11.24-2 in "Metallic Minerals Processing" for Material handling and transfer--all minerals except bauxite (01/1995). The throughput data used in the calculations was provided by Carlos Silva and Gary Brown of the Ivanhoe Concentrator and covered conveyor to Filter/Blending Plant. Filter/blending plant operations consist of 6 conveyor drops (CV-01 through CV-06) plus one material handling step using a Cat 966 to load material from the Concentrate Storage pile into a rail car for shipping offsite. The Filter/Blending Plant will not change from the last permitted application.

Gasoline Dispensing Facility (Not changing as a result of this application)

Gasoline Dispensing Facility (Unit GDF)
Emission estimates for VOC losses from gasoline dispensing are based on petroleum loading loss equation in USEPA publication AP-42, Table 5.2-7, Evaporative Emissions from Gasoline Service Station Operations (7/08). HAP emissions were estimated based on typical gasoline percent HAP constituents per MSDS. The Gasoline Dispensing Facility will not change from the last permitted application.

Ivanhoe Concentrator (Not changing as a result of this application)

Enclosed Ore Transfer Point (Unit CV-01C)
Emission factors for Enclosed Ore Transfer Point were obtained from Table 11.19.2-2 of USEPA AP-42, conveyor transfer point emission factors for Crushed Stone Processing and Pulverized Mineral Processing (8/04). A $PM_{2.5}$ emission factor was calculated from the available PM_{10} emission factor using the ratio of 0.15 $PM_{2.5}/PM_{10}$ as recommended in the Background Document for AP-42, Chapter 13.2.4: Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006. The percent content of HAP and TAP in molybdenum concentrate from Chino TRI data was used to calculate HAP and TAP emissions. The enclosed Ore Transfer Point emissions will not change from the last permitted application.

SAG Mill Conveyor No.1 & SAG Mill Conveyor No.2 (Units SAF F1 & SAG F2)
Emission factors for the SAG Mill Conveyors were obtained from Table 11.19.2-2 of USEPA AP-42, conveyor transfer point emission factors for Crushed Stone Processing and Pulverized Mineral Processing (8/04). A $PM_{2.5}$ emission factor was calculated from the available PM_{10} emission factor using the ratio of 0.15 $PM_{2.5}/PM_{10}$ as recommended in the Background Document for AP-42, Chapter 13.2.4, Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006. The percent content of HAP and TAP in molybdenum concentrate from Chino TRI data was used to calculate HAP and TAP emissions. The SAG Mill Conveyor emissions will not change from the last permitted application.

Stacker Conveyor Drop Point (Unit SCDP)
Emission factors for the Stacker Conveyor Drop Point were obtained from Table 11.19.2-2 of USEPA AP-42, conveyor transfer point emission factors for Crushed Stone Processing and Pulverized Mineral Processing (8/04). A $PM_{2.5}$ emission

factor was calculated from the available PM_{10} emission factor using the ratio of 0.15 $PM_{2.5}/PM_{10}$ as recommended in the Background Document for AP-42, Chapter 13.2.4: Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006. The percent content of HAP and TAP in molybdenum concentrate from Chino TRI data was used to calculate HAP and TAP emissions. The Stacker Conveyor Drop Point emissions will not change from the last permitted application.

Molybdenum Plant Wet Scrubber (Unit IC-01)
Scrubber particulate emissions are form stack test data conducted in October 2008. The molybdenum plant wet scrubber remain unchanged from the last permit application. The percent content of HAP and TAP in molybdenum concentrate from Chino TRI data was used to calculate HAP and TAP emissions. The Molybdenum Plant Wet Scrubber will not change from the last permitted application.

Ivanhoe Concentrators (Units LHS-01 and LUS-01)
Emissions were calculated using emission factors from Table 11.17-4 of AP-42 Section 11.17, emission factors for lime handling raw material and product processing and handling, product transfer and conveying (2/98). Assumes all PM_{10} is equivalent to PM. A $PM_{2.5}$ emission factor was calculated from the available PM_{10} emission factor using the ratio of 0.15 $PM_{2.5}/PM_{10}$ as recommended in the Background Document for AP-42: Chapter 13.2.4, Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006. The Ivanhoe Concentrators will not change from the last permitted application.

Ivanhoe Concentrator Crusher Dump (Unit PC DUMP)
PM emissions were calculated using emission factors obtained from AP-42 Chapter 11, Table 11.19-2.2. The emission factor used for $PM_{2.5}$ emissions was established using the ratio of $PM_{2.5}$ to PM_{10} as recommended in the Background Document for AP-42 Chapter 13.2.4, Revisions to Fine Fraction Ratios used for AP-42 Fugitive Dust Emission Factors – November 2006. The percent content of HAP and TAP in molybdenum concentrate from Chino TRI data was used to calculate HAP and TAP emissions. The Ivanhoe Concentration Crusher Dump will not change from the last permitted application.

Ivanhoe Concentrator Primary Crusher Baghouse Emissions (Unit PC-01)
PM emissions were taken from Chino TRI data. The percent content of HAP and TAP in molybdenum concentrate from Chino TRI data was used to calculate HAP and TAP emissions. Emissions from the primary crusher are controlled by a dust collector with a 99.7% vendor guarantee and a 6.0 gr/cf inlet loading. The Ivanhoe Concentrator Primary Crusher Baghouse will not change from the last permitted application

Screening Plant (Not changing as a result of this application)

Screen Plants (Units CH SCRN & CB SCRN)
Aggregate handling emission factors based on USEPA AP-42 USEPA's Drop Equation in AP-42, Section 13.2.4. TSP, PM_{10}, and controlled $PM_{2.5}$ emission factors are taken from AP-42, Chapter 11.19: Crushed Stone Processing and Pulverized Mineral Processing, Table 11.19.2-2: Screening. Uncontrolled $PM_{2.5}$ emission factor was calculated from uncontrolled PM_{10} emission factor using the ratio of 0.15 $PM_{2.5}/PM_{10}$ as recommended in Background Document for AP-42, Chapter 13.2.4: Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006. The TAP emissions for screening operations were calculated by multiplying the TSP emissions by the Ore TAP content (%). The Screen Plant emissions will not change from the last permitted application.

Screening Engine (Unit CH SCRN ENG)
PM and SO_2 emission factors obtained from uncontrolled diesel industrial engines present in Table 3.3-1, USEPA AP-42 Section 3.3 "Gasoline and Diesel Industrial Engines" (10/96). CO, VOC, NOx, emission factors are based on manufacturer information. HAP/Air Toxics emission factors obtained from Table 3.3-2 in USEPA AP-42 Section 3.3 "Gasoline and Diesel Industrial Engines" (10/96). The engine emissions will remain unchanged with this permit application.

Screening Engine (Unit CB SCRN ENG)
CO and NO_x emission factors were obtained from NSPS, Tier 3 emission standards for stationary compression ignition (CI) internal combustion engines (ICE) (40 CFR 60.4202-ref. 89.112, Table 1). VOC, $TSP/PM_{10}/PM_{2.5}$, and SO_2 emission factors were obtained from uncontrolled diesel industrial engines present in Table 3.3-1, USEPA AP-42 Section 3.3 “Gasoline and Diesel Industrial Engines” (10/96). The engine emissions will remain unchanged with this permit application.

SXEW Plant (Not changing as a result of this application)

SXEW Plant Ten Mixer/Settler Tanks (Unit SXEW 10MST)
The calculations were based on the BHP Copper VOC study which was conducted in 1997. The total HAPs molecular weight was obtained by determining the average of total HAP constituents within the product. The constituent diffusivity comes from EPA reference link for Estimated Diffusion Coefficients in Air and Water. The constituent concentration at liquid surface comes from the manufacturer data. The constituent concentration at 0.61 meter, ppm is assumed to be the same as BHP's measured concentrations. Based on the number of tanks and the area of each tank the emissions were calculated for each chemical product. The Ten Mixer/Settler Tank emissions will remain unchanged with this permit application.

SXEW Boilers (Units SXEW Boiler No. 1, SXEW Boiler No. 2, & SXEW Boiler No. 3)
Emissions were calculated based on the emission factors for commercial boilers presented in AP-42 Section 1.5, Table 1.5-1. There is no guidance in AP-42 Section 1.5 for HAP/TAP emissions from liquefied petroleum gas combustion. Filterable PM is the PM collected on or prior to the filter of an EPA Method 5 sampling train. For liquefied petroleum gas combustion, all PM is less than 10 micrograms. The emissions from the SXEW Boilers will remain unchanged with this permit application.

SXEW Plant Raffinate Tank (Units SXEW RT)
The calculations were based on the BHP Copper VOC study which was conducted in 1997. The total HAPs molecular weight was obtained by determining the average of total HAP constituents within the product. The constituent diffusivity comes from EPA reference link for Estimated Diffusion Coefficients in Air and Water. The constituent concentration at liquid surface comes from the manufacturer data. The constituent concentration at 0.61-meter, ppm is assumed to be the same as BHP's measured concentrations. Based on the number of tanks and the area of each tank the emissions were calculated for each chemical product. The Plant Raffinate Tank will not change with this permit application.

SXEW Plant Acid Tank House (Units SXEW SAT)
The calculation methodology for emissions from the Solvent extraction and electrowinning (SXEW) Plant Acid Tank House is as previously permitted. Emissions are estimated based on methodology in the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) 2001 Fundamentals Handbook. The wind speed is parameter is estimated at 10 mph based on recent on-site meteorological data gathered by Chino Mine. The Plant Acid Tank House will not change with this permit application.

White House Crusher and Screening Plant (Not changing as a result of this application)

White House Crushing and Screening Plant (Unit WH Crush)

The White House Crusher Plant will be added to facilitate the production of aggregate and road based material. The White House Crusher Plant consists of two (2) stone crushers, nine (9) conveyor systems, and two (2) screens.

The screening emission factors for TSP and PM_{10} are based on USEPA AP-42 11.19-2.2 Emission factors for Crushed Stone Processing. The $PM_{2.5}$ emission factor was calculated from the PM_{10} emission factor using the ratio of 0.15 $PM_{2.5}/PM_{10}$ as recommended in Background Document for AP-42, Chapter 13.2.4 Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006. The TAP emissions for screening operations were calculated by multiplying the TSP emissions by the Ore TAP content (%).

Emission factors for the nine (9) conveyor systems are based from Table 11.19.2-2 of USEPA AP-42, conveyor transfer point emission factors for Crushed Stone Processing and Pulverized Mineral Processing (8/04). A $PM_{2.5}$ emission factor was calculated from the available PM_{10} emission factor using the ratio of 0.15 $PM_{2.5}/PM_{10}$ as recommended in the Background Document for AP-42, Chapter 13.2.4, Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006. The TAP emissions for screening operations were calculated by multiplying the TSP emissions by the Ore TAP content (%).

Emission factors for the Conveyor Drop Point were obtained from Table 11.19.2-2 of USEPA AP-42, conveyor transfer point emission factors for Crushed Stone Processing and Pulverized Mineral Processing (8/04). A $PM_{2.5}$ emission factor was calculated from the available PM_{10} emission factor using the ratio of 0.15 $PM_{2.5}/PM_{10}$ as recommended in the Background Document for AP-42, Chapter 13.2.4: Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006. The TAP emissions for screening operations were calculated by multiplying the TSP emissions by the Ore TAP content (%).

Emission factors for the two stone crushers are based from AP-42 Table 11.19-2.2. of USEPA AP-42 Emission factors for Crushed Stone Processing and Pulverized Mineral Processing (8/04). According to AP-42 Table 11.19.2-2 sub note "n" Emission factors for PM_{10} for tertiary crushers equals $PM_{2.5}$ for tertiary crushers, according to AP-42 Table 11.19.2-2 sub note "n". The TAP emissions for screening operations were calculated by multiplying the TSP emissions by the Ore TAP content (%).

Emergency Generators: To be modified

Diesel Emergency Generators
To calculate the emissions from the diesel emergency generators AP-42 Section 3.4 factors were used for calculating the emissions of CO, NO_X, SO_2, VOC, and PM. The HAP emissions were calculated using the diesel fuel usage. Since the units are considered emergency, the emissions are based on 500 hours per year. Greenhouse gas emissions were calculated using emission factors from Table C-1 and Table C-2 from Subpart C of 40 CFR 98. The global warming potentials used in the calculations came from 40 CFR Part 98, Subpart A, Table A-1.

Natural Gas Emergency Generator
To calculate the emissions from the natural gas emergency generator AP-42 Section 3.2 factors for 4-stroke lean burn engines were used for calculating the emissions of CO, NO_X, SO_2, VOC, and PM. The HAP emissions were calculated using the natural gas fuel usage. Since the units are considered emergency, the emissions are based on 500 hours per year. Greenhouse gas emissions were calculated using emission factors from Table C-1 and Table C-2 from Subpart C of 40 CFR 98. The global warming potentials used in the calculations came from 40 CFR Part 98, Subpart A, Table A-1.

LPG Emergency Generators
To calculate the emissions from the LPG emergency generators AP-42 Section 3.2 factors for 4-stroke lean burn engines were used for calculating the emissions of CO, NO_X, SO_2, VOC, and PM. For units WestTower and CobreTower, NO_X, CO, and VOC emission factors were taken from an EPA certificate of conformity. The HAP emissions were calculated using the natural gas fuel usage. Since the units are considered emergency, the emissions are based on 500 hours per year. Greenhouse gas emissions were calculated using emission factors from Table C-1 and Table C-2 from Subpart C of 40 CFR 98. The global warming potentials used in the calculations came from 40 CFR Part 98, Subpart A, Table A-1.

SAG Tunnel: To be modified

Underground SAG Tunnel Baghouse (Unit SAG)
Controlled particulate matter (PM) emissions at the outlet of the baghouse are calculated using the manufacturer guaranteed exit grain loading (gr/dscf) and minimum design exit flow rate. Filtered PM_{10} to filtered PM and filtered $PM_{2.5}$ to filtered PM rations were obtained using AP-42 Appendix B.2 Generalized Particle Size Distributions Table B.2.2. Category 3. The SAG Tunnel has no emissions in an uncontrolled scenario due to it being a enclosed process. The pollution control device is present for industrial hygiene purposes.

Section 6.a

Green House Gas Emissions

(Submitting under 20.2.70, 20.2.72 20.2.74 NMAC)

Title V (20.2.70 NMAC), Minor NSR (20.2.72 NMAC), and PSD (20.2.74 NMAC) applicants must estimate and report greenhouse gas (GHG) emissions to verify the emission rates reported in the public notice, determine applicability to 40 CFR 60 Subparts, and to evaluate Prevention of Significant Deterioration (PSD) applicability. GHG emissions that are subject to air permit regulations consist of the sum of an aggregate group of these six greenhouse gases: carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).

Calculating GHG Emissions:

1. Calculate the ton per year (tpy) GHG mass emissions and GHG CO_2e emissions from your facility.
2. GHG mass emissions are the sum of the total annual tons of greenhouse gases without adjusting with the global warming potentials (GWPs). GHG CO_2e emissions are the sum of the mass emissions of each individual GHG multiplied by its GWP found in Table A-1 in 40 CFR 98 Mandatory Greenhouse Gas Reporting.
3. Emissions from routine or predictable start up, shut down, and maintenance must be included.
4. Report GHG mass and GHG CO_2e emissions in Table 2-P of this application. Emissions are reported in **short** tons per year and represent each emission unit's Potential to Emit (PTE).
5. All Title V major sources, PSD major sources, and all power plants, whether major or not, must calculate and report GHG mass and CO2e emissions for each unit in Table 2-P.
6. For minor source facilities that are not power plants, are not Title V, and are not PSD there are three options for reporting GHGs in Table 2-P: 1) report GHGs for each individual piece of equipment; 2) report all GHGs from a group of unit types, for example report all combustion source GHGs as a single unit and all venting GHGs as a second separate unit; 3) or check the following ☐ By checking this box, the applicant acknowledges the total CO2e emissions are less than 75,000 tons per year.

Sources for Calculating GHG Emissions:

- Manufacturer's Data
- AP-42 Compilation of Air Pollutant Emission Factors at http://www.epa.gov/ttn/chief/ap42/index.html
- EPA's Internet emission factor database WebFIRE at http://cfpub.epa.gov/webfire/
- 40 CFR 98 Mandatory Green House Gas Reporting except that tons should be reported in short tons rather than in metric tons for the purpose of PSD applicability.
- API Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Natural Gas Industry. August 2009 or most recent version.
- Sources listed on EPA's NSR Resources for Estimating GHG Emissions at http://www.epa.gov/nsr/clean-air-act-permitting-greenhouse-gases:

Global Warming Potentials (GWP):
Applicants must use the Global Warming Potentials codified in Table A-1 of the most recent version of 40 CFR 98 Mandatory Greenhouse Gas Reporting. The GWP for a particular GHG is the ratio of heat trapped by one unit mass of the GHG to that of one unit mass of CO_2 over a specified time period.

"Greenhouse gas" for the purpose of air permit regulations is defined as the aggregate group of the following six gases: carbon dioxide, nitrous oxide, methane, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. **(20.2.70.7 NMAC, 20.2.74.7 NMAC).** You may also find GHGs defined in 40 CFR 86.1818-12(a).

Metric to Short Ton Conversion:
Short tons for GHGs and other regulated pollutants are the standard unit of measure for PSD and title V permitting programs. 40 CFR 98 Mandatory Greenhouse Reporting requires metric tons.
1 metric ton = 1.10231 short tons (per Table A-2 to Subpart A of Part 98 – Units of Measure Conversions)

Freeport-McMoRan Chino Mines Company

SAG Tunnel Dust Collector

Item	Value	Unit	Notes
Outlet Grain Loading:	0.005	gr/dscf	Golder Conceptual Design , pg.11
Inlet Grain Loading:	10	gr/dscf	Golder Conceptual Design, pg.11
Baghouse Flow Capacity:	24000	acfm	Golder Conceptual Design, pg.13
Baghouse Flow Capacity:	24000.00	dscfm	Assumed to operate at STP
Baghouse Control Efficiency:	99.99%	-	Golder Conceptual Design, pg.11
Filt. PM_{10} to Filt. PM Ratio	0.51	-	AP-42 Appendix B.2 Generalized Particle Size Distributions Table B.2.2 Category 3
Filt. $PM_{2.5}$ to Filt. PM Ratio	0.15	-	AP-42 Appendix B.2 Generalized Particle Size Distributions Table B.2.2 Category 3

PM_{10} Safety Factor:	85%
$PM_{2.5}$ Safety Factor:	200%

Controlled Emissions per Baghouse					
	PM	PM_{10}	$PM_{2.5}$	Units	Notes
Emission Factors	1.03			lb/hr	Grain loading (gr/dscf) * baghouse flow rate (dscfm) * 60 min/hr * 1lb / 7000 gr
		0.97	0.46	lb/hr	Filt. PM Ratio * Filterable PM Emission Factor
Total Emissions	1.03	0.97	0.46	lb/hr	
	4.51	4.25	2.03	tpy	lb/ hr * annual operating hours (8760 hrs/yr) / 2000 lbs / ton

Freeport-McMoRan Chino Mines Company
Revised: May 2023

Aggregate and Material Handling - Cobre Haul Road Borrow Pit
Unit: Cobre Haul Road Borrow Pit

Basis			
Maximum daily amount handled:	20,000	tons	Based on forecasted maximum production rates
Maximum annual amount handled:	350,000	tons	
Maximum daily amount unloaded to repair Haul roads:	20,000	tons	
Maximum annual amount unloaded to repair Haul roads:	350,000	tons	
Annual operating days:	365	(7 days/week x 52 weeks/year)	
Daily operating hours:	24		

Criteria Pollutant	Emission Factors (lb/ton)		
	PM	PM10	PM2.5
Truck Unloading - Fragmented Stone (1)	4.18E-05	1.60E-05	2.40E-06

Emissions Activity	Maximum Mine Material Throughput(2)			TSP Emissions		PM_{10} Emissions		$PM_{2.5}$ Emissions	
	tons/hr	tons/day	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr
Loading - Cobre Haul Road Borrow Pit	833	20,000	350,000	3.48E-02	7.32E-03	1.33E-02	2.80E-03	2.00E-03	4.20E-04
Unloading - Haul Road Repairs	833	20,000	350,000	3.48E-02	7.32E-03	1.33E-02	2.80E-03	2.00E-03	4.20E-04
TOTAL				**6.97E-02**	**1.46E-02**	**2.67E-02**	**5.60E-03**	**4.00E-03**	**8.40E-04**

(1) The emission factors for material handling are based on AP-42, Chapter 11.19.2, Table 11.19.2-2 Crushed Stone Processing and Pulverized Mineral Processing (August 2004) for Truck Unloading - Fragmented Stone. The basis for these emission factors is the PM_{10} emission factor for truck unloading of fragmented stone in Table 11.19.2-2. This table provides a PM_{10} emission factor, but does not provide $PM_{2.5}$ or TSP emission factors. A $PM_{2.5}$ emission factor was calculated from the available PM_{10} emission factor using the ratio of 0.15 $PM_{2.5}/PM_{10}$ as recommended in the Background Document for AP-42, Chapter 13.2.4, *Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors* - November 2006. An uncontrolled TSP emission factor was calculated from the available uncontrolled PM_{10} emission factor using the TSP/PM_{10} ratio calculated from the following uncontrolled TSP and PM_{10} emission factors in Table 11.19.2-2: Tertiary Crushing (0.0054/0.0024 = 2.25); Fines Crushing (0.0390/0.0150 = 2.60); Screening (0.025/0.0087 = 2.87; and Conveyor Transfer Point (0.0030/0.00110 = 2.73). See sample calculation below.

(2) Maximum Material Throughput is based on maximum annual throughput provided by Freeport's estimated material production

Freeport-McMoRan Chino Mines Company
Revised: June 2022

Blasting Emissions - Cobre Haul Road Borrow Pit
Unit: Cobre Haul Road Borrow Pit BLST

	Basis	
Pounds of ANFO per hole:	570	lbs
Number of Holes:	210	
Burden Area per Hole:	528	ft^2
Maximum amount of blasting agent/day:	119,700	lbs
Maximum number of blasts/day:	4	blasts/day
Maximum amount of blasting agent/event:	29,925	lbs
Maximum amount of blasting agent/year:	60	tons
X Dimension:	500	ft
Y Dimension:	200	ft
Maximum horizontal area per blast:	25,000	ft^2
Diesel fuel usage:	47	gal/day
Diesel fuel usage:	973	gal/yr
Diesel fuel oil to ammonium nitrate blasting products ratio:	6%	
Diesel Fuel Density:	7.38	lb/gal
Event Duration:	2	seconds

Criteria Pollutant	Emission Factor (lb/ton blasting agent)[1]	Emission Rate [2]			
		(lb/event)	(lb/day)	(lb/hr)[3]	(ton/yr)
Nitrogen Oxides (NO_x)	1.80	26.93	107.73	26.93	0.054
Carbon Monoxide (CO)	40.64	608.08	2,432.30	608.08	1.22
Sulfur Dioxide (SO_2)	3.60E-03	0.05	0.22	0.054	1.08E-04

Criteria Pollutant	Emission Rate [4]			
	(lb/event)	(lb/day)	(lb/hr)[3]	(ton/yr)
TSP	55.34	221.36	55.34	0.11
PM_{10}	28.78	115.11	28.78	0.06
$PM_{2.5}$	1.66	6.64	1.66	0.003

Pollutant	Emission Factor (lb/MMBtu)[5]	Emission Rate [6]	
		(lb/day)	(ton/yr)
CO_2	162.71	1055.35	10.93
N_2O	1.32E-03	0.01	8.86E-05
CH_4	6.60E-03	0.04	4.43E-04
CO_2e			**10.96**

Notes:

[1]NOx emission factor is the average of measurements from "NOx Emissions from Blasting Operations in Open-Cut Coal Mining" by Moetaz I. Attalla, Stuart J. Day, Tony Lange, William Lilley, and Scott Morgan (2008).

[1]CO emission factor is the average of the measurements in "Factors Affecting Anfo Fumes Production" by James H. Rowland III and Richard Mainiero (2001).

[1]SO_2 emissions are based on a diesel sulfur content of 15 ppm assuming complete conversion to SO_2.

[2]Pound per event emission rates are based on a maximum use of 29,295 lbs of blasting agent per event. Annual emission rates are based on a maximum annual use of 60 tons of blasting agent.

$$E\left(\frac{lb}{year}\right)=EF\left(\frac{lb}{ton\,of\,blasting\,agent}\right)\times\left(blasting\,agent\frac{ton}{year}\right)$$

[3]Pound per hour modeling rate is based the daily emission rates (lb/day) which is converted to a pound per hour rate.

[4]Particulate blasting emissions are based on emission factors from AP-42 Table 11.9-1.

[5]CO_2, N_2O, and CH_4 emission factor per 40 CFR 98 Subpart C, Table C–1, and Table C–2.

[6]CO_2, N_2O, and CH_4 emissions calculated based on emission factors, diesel fuel usage, and diesel fuel HHV of 0.138 MMBtu/gal per 40 CFR 98 Subpart C Table C–1

FEDERAL HAP/NM TOXIC AIR POLLUTANT EMISSIONS ESTIMATION

Emissions Activity	TAP Emissions(4)													
	Antimony		Arsenic		Barium		Cadmium		Chromium		Cobalt		Copper	
	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
Loading - Cobre Haul Road Borrow Pit	8.02E-09	3.51E-08	6.68E-09	2.93E-08	1.85E-07	8.12E-07	2.17E-09	9.51E-09	1.52E-07	6.66E-07	6.51E-08	2.85E-07	4.87E-06	2.13E-05
Unloading - Haul Road Repairs	8.02E-09	3.51E-08	6.68E-09	2.93E-08	1.85E-07	8.12E-07	2.17E-09	9.51E-09	1.52E-07	6.66E-07	6.51E-08	2.85E-07	4.87E-06	2.13E-05
TOTAL	**1.60E-08**	**7.02E-08**	**6.68E-09**	**2.93E-08**	**1.85E-07**	**8.12E-07**	**2.17E-09**	**9.51E-09**	**1.52E-07**	**6.66E-07**	**6.51E-08**	**2.85E-07**	**4.87E-06**	**2.13E-05**

Emissions Activity	TAP Emissions(4)											
	Lead		Manganese		Nickel		Silver		Vanadium		Zinc	
	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
Loading - Cobre Haul Road Borrow Pit	2.62E-08	1.15E-07	8.23E-07	3.61E-06	3.51E-08	1.54E-07	6.68E-09	2.93E-08	6.18E-08	2.71E-07	1.57E-07	6.88E-07
Unloading - Haul Road Repairs	2.62E-08	1.15E-07	8.23E-07	3.61E-06	3.51E-08	1.54E-07	6.68E-09	2.93E-08	6.18E-08	2.71E-07	1.57E-07	6.88E-07
TOTAL	**5.24E-08**	**2.30E-07**	**1.65E-06**	**7.21E-06**	**7.01E-08**	**3.07E-07**	**1.34E-08**	**5.85E-08**	**1.24E-07**	**5.41E-07**	**3.14E-07**	**1.38E-06**

Notes:

(1) Process parameters provided by Tyler Solem Cobre Haul Road Blasting emails, 11/15/2021. Metal content data from Chino TRI Assay data provided by Clyde Durham 1/28/11 email to R. Felty (ARCADIS-US). The mine plan is constantly in flux, and the forecast tonnages can change month to month. Daily overall tonnage and daily Lampbright tonnages fluctuate the most. Therefore, daily tonnages are slightly increased to allow for a buffer and are not directly calculated from annual tonnages and operating schedule.

(2) The emission factors for material handling are based on AP-42, Chapter 11.19.2, Table 11.19.2-2 Crushed Stone Processing and Pulverized Mineral Processing (August 2004) for Truck Unloading - Fragmented Stone. The basis for these emission factors is the PM_{10} emission factor for truck unloading of fragmented stone in Table 11.19.2-2. This table provides a PM_{10} emission factor, but does not provide $PM_{2.5}$ or TSP emission factors. A $PM_{2.5}$ emission factor was calculated from the available PM_{10} emission factor using the ratio of 0.15 $PM_{2.5}/PM_{10}$ as recommended in the Background Document for AP-42, Chapter 13.2.4, *Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors* - November 2006. An uncontrolled TSP emission factor was calculated from the available uncontrolled PM_{10} emission factor using the TSP/PM_{10} ratio calculated from the following uncontrolled TSP and PM_{10} emission factors in Table 11.19.2-2: Tertiary Crushing (0.0054/0.0024 = 2.25); Fines Crushing (0.0390/0.0150 = 2.60); Screening (0.025/0.0087 = 2.87; and Conveyor Transfer Point (0.0030/0.00110 = 2.73). See sample calculation below.

(3)Maximum Material Throughput is based on maximum annual throughput provided by Freeport's estimated material production

(4) TAP emissions for waste rock and leach rock calculated by multiplying the TSP/PM Emissions by the TAP content (%) in waste rock or in leach rock, respectively. Material handling at Hanover will occur with waste rock and leach rock, so conservative TAPs emissions for material handling are based on the higher TAP % available for waste rock or leach rock. For example, antimony emissions from material handling are based on antimony % in leach rock and barium emissions from material handling in the pit are based on barium % in waste rock.

Sample Calculations:

Unloading - Haul Road Repairs:

PM Emission Factor (lb/ton) = [2.25 tertiary crushing + 2.60 fines crushing + 2.87 screening + 2.73 conveyor transfer point]/4 x 0.000016 lb/ton PM-10 emission factor =0.000042 lb/ton

Freeport-McMoRan Chino Mines Company
8/23/2023 Revised

ID	Description	Hp	Max fuel use, gal/hr	Diesel heat value, Btu/gal[1]	Max heat input, MMBtu/hr	Annual operating hours[2]	NOx		CO		VOC		SO_2		PM		PM_{10}		$PM_{2.5}$	
							lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr
ATT Gen	Emergency Generator	36	2.56	137,000	0.35	500	1.55	0.39	0.33	0.083	0.12	0.031	5.31E-04	1.33E-04	0.11	0.027	0.11	0.027	0.11	0.027
ID	**Description**	**Hp**	**Max fuel use, cu.ft/hr[3]**	**LPG heat value, Btu/scf[4]**	**Max heat input, MMBtu/hr**	**Annual operating hours[2]**	**NOx**		**CO**		**VOC**		**SO_2**		**TSP/PM**		**PM_{10}**		**$PM_{2.5}$**	
							lb/hr	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**
GENERAC8	Emergency Generator	47	N/A	N/A	0.43	500	1.75	0.44	0.14	0.034	0.051	0.013	2.53E-04	6.32E-05	4.26E-03	1.07E-03	3.32E-05	8.29E-06	3.32E-05	8.29E-06

Units	AP-42 Emission Factors for Diesel Fuel Combustion[5]						
	CO	NO_x	VOC	TSP/PM	PM_{10}	$PM_{2.5}$	SO_2
lb/MMBtu	0.95	4.41	0.350	0.310	0.310	0.310	0.0015

Units	AP-42 Emission Factors Natural Gas Combustion[6]						
	CO	NO_x	VOC	TSP/PM	PM_{10}	$PM_{2.5}$	SO_2
lb/MMBtu	0.32	4.1	0.12	0.0099	0.000077	0.000077	0.00059

FEDERAL HAP/NM TOXIC AIR POLLUTANT EMISSIONS ESTIMATION for Emergency Generators

Compound		Diesel Emission Factor (lb/MMBtu)[7]	LPG/NG Emission Factor (lb/MMBtu)[8]
Pollutant	**Species**		
Hazardous Air Pollutants	Benzene	9.33E-04	4.40E-04
	Acetaldehyde	7.67E-04	8.36E-03
	Acrolein	9.25E-05	5.14E-03
	Formaldehyde	1.18E-03	5.28E-02
	Naphthalene	8.48E-05	7.44E-05
	Toluene	4.09E-04	4.08E-04
	Xylenes	2.85E-04	1.84E-04

Certificate of Conformity[9]				
	CO	NO_x	VOC	Unit
CAT DG50-2	2	1	0.7	g/hp-hr

Notes:

[1]Diesel fuel usage was based on estimated diesel usage via trending analysis. Annual usage is based on a limit of 500 hour/year for emergency equipment. Heat input value in MMBtu is based on 137,000 Btu/gallon conversion.

[2]Operating hours are limited to less than 500 hours/year per rolling 12-month period and operated only during the unavoidable loss of commercial utility power.

[3]The maximum fuel usage for unit "GENERAC4" and "Elliot Magnetek" were based on the manufacture fuel usage for "GENERAC3" which is a unit of similar capacity.

[4]LPG heat value is based on heating value for Propane. LPG fuel is primarily composed of Propane.

[5]Based on emission factors for uncontrolled diesel industrial engines present in USEPA AP-42 Section 3.3 "Gasoline and Diesel Industrial Engines" (10/96). NOx emission factor is uncontrolled. TSP=PM10=PM2.5. PM-10 = particulate matter less than or equal to 10 µm aerodynamic diameter. All particulate is assumed to be ≤ 1 µm in size. Criteria pollutant emission factors were obtained from Table 3.3-1. SO_2 emission factor = 1.01S, where S = % sulfur.

[6]Based on emission factors for uncontrolled 4-stroke lean-burn engines present in USEPA AP-42 Section 3.2 "Natural Gas-Fired Reciprocal Engines" (7/00). NOx and CO emission factor is uncontrolled with 90-105 % load . Criteria pollutant emission factors were obtained from Table 3.2-1 and 3.2-2. SO2 emission factor = 1.01S, where S = % sulfur.

[7]HAP emissions are based on USEPA AP-42 Section 3.3 "Gasoline and Diesel Industrial Engines" (10/96) Table 3.3-2.

[7]HAP emissions are based on USEPA AP-42 Section 3.2 "Natural Gas-fired Reciprocating Industrial Engines" (10/96) Table 3.2-2.

[9]Emission factors for NOX, CO, and VOC from CAT DG50-2 engines are based on EPA Certificate of Conformity NSPS JJJJ limits.

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ID	Description	Hp	Max fuel use, gal/hr	Diesel heat value, Btu/gal[1]	Max heat input, MMBtu/hr	Annual operating hours[2]	HAPs[2,7]		Benzene		Acetaldehyde		Acrolein		Formaldehyde		Naphthalene		Toluene		Xylene		CO_2e	CO_2	N_2O	CH_4
							lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
ATT Gen	Emergency Generator	36	2.56	137,000	0.35	500	1.32E-03	3.29E-04	3.27E-04	8.18E-05	2.69E-04	6.72E-05	3.24E-05	8.11E-06	4.14E-04	1.03E-04	2.97E-05	7.43E-06	1.43E-04	3.59E-05	9.99E-05	2.50E-05	13.01	12.97	1.05E-04	5.26E-04
ID	**Description**	**Hp**	**Max fuel use, cu.ft/hr[3]**	**LPG heat value, Btu/scf[4]**	**Max heat input, MMBtu/hr**	**Annual operating hours[2]**	**HAPs[8]**		**Benzene**		**Acetaldehyde**		**Acrolein**		**Formaldehyde**		**Naphthalene**		**Toluene**		**Xylene**		**CO_2e**	**CO_2**	**N_2O**	**CH_4**
							lb/hr	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**tons/yr**	**tons/yr**	**tons/yr**	**tons/yr**
GENERAC8	Emergency Generator	47	N/A	N/A	0.43	500	0.029	0.0072	1.89E-04	4.73E-05	3.59E-03	8.99E-04	2.21E-03	5.53E-04	0.023	0.0018	3.20E-05	8.00E-06	1.75E-04	4.39E-05	7.91E-05	1.98E-05	13.32	13.27	1.29E-04	6.45E-04

Units	AP-42 Emission Factors for Diesel Fuel Combustion[5]					Certificate of Conformity [9]		
	CO	NO_x	VOC	TSP/PM	PM_{10}	NO_x	VOC	Unit
lb/MMBtu	0.95	4.41	0.350	0.310	0.310	1	0.7	g/hp-hr

FEDERAL HAP/NM TOXIC AIR POLLUTANT EMISSIONS ESTIMATION for Emergency Generators

Compound		Diesel Emission Factor (lb/MMBtu)[7]	LPG/NG Emission Factor (lb/MMBtu)[8]
Pollutant	Species		
Hazardous Air Pollutants	Benzene	9.33E-04	4.40E-04
	Acetaldehyde	7.67E-04	8.36E-03
	Acrolein	9.25E-05	5.14E-03
	Formaldehyde	1.18E-03	5.28E-02
	Naphthalene	8.48E-05	7.44E-05
	Toluene	4.09E-04	4.08E-04
	Xylenes	2.85E-04	1.84E-04

Notes:

[1]Diesel fuel usage was based on estimated diesel usage via trending analysis. Annual usage is based on a limit of 500 hour/year for emergency equipment. Heat input value in MMBtu is based on 137,000 Btu/gallon conversion.

[2]Operating hours are limited to less than 500 hours/year per rolling 12-month period and operated only during the unavoidable loss of commercial utility power.

[3]The maximum fuel usage for unit "GENERAC4" and "Elliot Magnetek" were based on the manufacture fuel usage for "GENERAC3" which is a unit of similar capacity.

[4]LPG heat value is based on heating value for Propane. LPG fuel is primarily composed of Propane.

[5]Based on emission factors for uncontrolled diesel industrial engines present in USEPA AP-42 Section 3.3 "Gasoline and Diesel Industrial Engines" (10/96). NOx emission factor is uncontrolled. TSP=PM10=PM2.5. PM-10 = particulate matter less than or equal to 10 µm aerodynamic diameter. All particulate is assumed to be ≤ 1 µm in size. Criteria pollutant emission factors were obtained from Table 3.3-1. SO_2 emission factor = 1.01S, where S = % sulfur.

[6]Based on emission factors for uncontrolled 4-stroke lean-burn engines present in USEPA AP-42 Section 3.2 "Natural Gas-Fired Reciprocal Engines" (7/00). NOx and CO emission factor is uncontrolled with 90-105 % load . Criteria pollutant emission factors were obtained from Table 3.2-1 and 3.2-2. SO2 emission factor = 1.01S, where S = % sulfur.

[7]HAP emissions are based on USEPA AP-42 Section 3.3 "Gasoline and Diesel Industrial Engines" (10/96) Table 3.3-2.

[7]HAP emissions are based on USEPA AP-42 Section 3.2 "Natural Gas-fired Reciprocating Industrial Engines" (10/96) Table 3.2-2.

[9]Emission factors for NOX, CO, and VOC from CAT DG50-2 engines are based on EPA Certificate of Conformity NSPS JJJJ limits.

Freeport-McMoRan Chino Mines Company
Revised: 08/10/2023

Chino Mine - Emergency Generator Engine Emissions

ID	Description	Hp	Max fuel use, gal/hr	Diesel heat value, Btu/gal[1]	Heat input, MMBtu/hr	Annual operating hours[2]	NOx		CO		VOC		SO_2		PM		PM_{10}		$PM_{2.5}$		CO_2e	CO_2	N_2O	CH_4
							lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	tons/yr	tons/yr	tons/yr	tons/yr
Emergency Fire Pump	SXEW Fire Emergency Pump	197	10.77	137,000	1.48	500	6.51	1.63	1.40	0.35	0.52	0.13	2.24E-03	5.59E-04	4.57E-01	1.14E-01	4.57E-01	1.14E-01	4.57E-01	1.14E-01	54.75	54.57	4.4E-04	2.2E-03
Sxlpwrprm8	20 Dam Hanover	275	14.75	137,000	2.02	500	8.91	2.23	1.92	0.48	0.71	0.18	3.06E-03	7.65E-04	6.26E-01	1.57E-01	6.26E-01	1.57E-01	6.26E-01	1.57E-01	74.98	74.72	6.1E-04	3.0E-03
Sxlpwrprm5	Far East Containment	225	12.20	137,000	1.67	500	7.37	1.84	1.59	0.40	0.58	0.15	2.53E-03	6.33E-04	5.18E-01	1.30E-01	5.18E-01	1.30E-01	5.18E-01	1.30E-01	62.01	61.80	5.0E-04	2.5E-03
Sxlpwrprm3	11 Dam Hanover	174	9.60	137,000	1.31	500	5.80	1.45	1.25	0.31	0.46	0.12	1.99E-03	4.98E-04	4.08E-01	1.02E-01	4.08E-01	1.02E-01	4.08E-01	1.02E-01	48.79	48.62	3.9E-04	2.0E-03
Sxlgdwn1	10 Dam Hanover	309	16.48	137,000	2.26	500	9.96	2.49	2.15	0.54	0.79	0.20	3.42E-03	8.55E-04	7.00E-01	1.75E-01	7.00E-01	1.75E-01	7.00E-01	1.75E-01	83.79	83.51	6.8E-04	3.4E-03
Sxlpwrprm4	14 Dam Hanover	225	12.20	137,000	1.67	500	7.37	1.84	1.59	0.40	0.58	0.15	2.53E-03	6.33E-04	5.18E-01	1.30E-01	5.18E-01	1.30E-01	5.18E-01	1.30E-01	62.01	61.80	5.0E-04	2.5E-03
Sxlpwrprm2	Sump #3	309	16.48	137,000	2.26	500	9.96	2.49	2.15	0.54	0.79	0.20	3.42E-03	8.55E-04	7.00E-01	1.75E-01	7.00E-01	1.75E-01	7.00E-01	1.75E-01	83.79	83.51	6.8E-04	3.4E-03
Sxlpwrprm7	13 Dam Hanover	175	9.65	137,000	1.32	500	5.83	1.46	1.26	0.31	0.46	0.12	2.00E-03	5.01E-04	4.10E-01	1.02E-01	4.10E-01	1.02E-01	4.10E-01	1.02E-01	49.05	48.88	4.0E-04	2.0E-03
Cummins 1823	South Side Tailing office	32	2.36	137,000	0.32	500	1.42	0.36	0.31	0.08	0.11	0.03	4.89E-04	1.22E-04	1.00E-01	2.50E-02	1.00E-01	2.50E-02	1.00E-01	2.50E-02	11.98	11.93	9.7E-05	4.8E-04
DEUTZ	Sump Pump	114	6.54	137,000	0.90	500	3.95	0.99	0.85	0.21	0.31	0.08	1.36E-03	3.39E-04	2.78E-01	6.94E-02	2.78E-01	6.94E-02	2.78E-01	6.94E-02	33.23	33.12	2.7E-04	1.3E-03
FWP01	Concentrator Fire Emergency Pump	185	10.16	137,000	1.39	500	6.14	1.53	1.32	0.33	0.49	0.12	2.11E-03	5.27E-04	4.31E-01	1.08E-01	4.31E-01	1.08E-01	4.31E-01	1.08E-01	51.64	51.47	4.2E-04	2.1E-03
ID	**Description**	**Hp**	**Max fuel use, cu.ft/hr**	**Natural Gas heat value, Btu/scf**	**Heat input, MMBtu/hr**	**Annual operating hours[2]**	**NOx**		**CO**		**VOC**		**SO_2**		**PM**		**PM_{10}**		**$PM_{2.5}$**		**CO_2e**	**CO_2**	**N_2O**	**CH_4**
							lb/hr	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**tons/yr**	**tons/yr**	**tons/yr**	**tons/yr**
GENERAC1	MIS Building	60	730.00	1,020	0.74	500	3.0	0.76	0.24	0.059	0.088	0.022	0.00044	0.00011	0.0074	0.0018	5.74E-05	1.44E-05	5.74E-05	1.44E-05	19.8	19.8	3.7E-05	3.7E-04
ID	**Description**	**Hp**	**Max fuel use, cu.ft/hr[3]**	**LPG heat value, Btu/scf[4]**	**Heat input, MMBtu/hr**	**Annual operating hours[2]**	**NOx**		**CO**		**VOC**		**SO_2**		**PM**		**PM_{10}**		**$PM_{2.5}$**		**CO_2e**	**CO_2**	**N_2O**	**CH_4**
							lb/hr	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**tons/yr**	**tons/yr**	**tons/yr**	**tons/yr**
GENERAC2	SX-EW Tank house	50	200.00	2,514	0.50	500	2.1	0.51	0.16	0.040	0.059	0.015	2.96E-04	7.39E-05	4.98E-03	1.25E-03	3.88E-05	9.69E-06	3.88E-05	9.69E-06	15.6	15.5	1.51E-04	7.54E-04
GENERAC4	Mine Pit Slope Monitoring Station - Slope 2	15	42.80	2,514	0.11	500	0.44	0.11	0.034	0.0085	0.013	0.0032	6.33E-05	1.58E-05	1.07E-03	2.67E-04	8.30E-06	2.07E-06	8.30E-06	2.07E-06	3.3	3.3	3.23E-05	1.61E-04
GENERAC5	Santa Rita Tower	15	71.60	2,514	0.18	500	0.73	0.18	0.057	0.0143	0.021	0.0053	1.06E-04	2.65E-05	1.78E-03	4.46E-04	1.39E-05	3.47E-06	1.39E-05	3.47E-06	5.6	5.6	5.40E-05	2.70E-04
GENERAC6	Nun Complex Communication Station	15	71.60	2,514	0.18	500	0.73	0.18	0.057	0.0143	0.021	0.0053	1.06E-04	2.65E-05	1.78E-03	4.46E-04	1.39E-05	3.47E-06	1.39E-05	3.47E-06	5.6	5.6	5.40E-05	2.70E-04
GENERAC7	Mine Warehouse	15	71.60	2,514	0.18	500	0.73	0.18	0.057	0.0143	0.021	0.0053	1.06E-04	2.65E-05	1.78E-03	4.46E-04	1.39E-05	3.47E-06	1.39E-05	3.47E-06	5.6	5.6	5.40E-05	2.70E-04
West Tower	Radio Tower Emergency Engine CAT DG50-2 [9]	67.1	288.00	2,514	0.72	500	0.15	0.037	0.30	0.074	0.10	0.026	4.26E-04	1.06E-04	0.0072	0.0018	5.58E-05	1.40E-05	5.58E-05	1.40E-05	22.4	22.3	2.17E-04	1.09E-03
Cobre Tower	Radio Tower Emergency Engine CAT DG50-2 [9]	67.1	288.00	2,514	0.72	500	0.15	0.037	0.30	0.074	0.10	0.026	4.26E-04	1.06E-04	0.0072	0.0018	5.58E-05	1.40E-05	5.58E-05	1.40E-05	22.4	22.3	2.17E-04	1.09E-03
TOTAL							**81.2**	**20.3**	**17.0**	**4.2**	**6.2**	**1.56**	**0.027**	**0.007**	**5.2**	**1.29**	**5.1**	**1.29**	**5.1**	**1.29**	**716.3**	**713.9**	**0.006**	**0.029**

Units	AP-42 Emission Factors for Diesel Fuel Combustion[5]						
	CO	NO_x	VOC	PM	PM_{10}	$PM_{2.5}$	SO_2
lb/MMBtu	0.95	4.41	0.350	0.310	0.310	0.310	0.0015

Units	AP-42 Emission Factors Natural Gas Combustion[6]						
	CO	NO_x	VOC	PM	PM_{10}	$PM_{2.5}$	SO_2
lb/MMBtu	0.32	4.1	0.12	0.0099	7.71E-05	7.71E-05	0.00059

CAT DG50-2 Certificate of Conformity [9]			
Units	**CO**	**NO_x**	**VOC**
g/hp-hr	2	1	0.7

Freeport-McMoRan Chino Mines Company
Revised: 08/10/2023

Chino Mine - Emergency Generator Engine Emissions

ID	Description	Hp	Max fuel use, gal/hr	Diesel heat value, Btu/gal[1]	Max heat input, MMBtu/hr	Annual operating hours[2]	HAPs[2,7]		Benzene		Acetaldehyde		Acrolein		Formaldehyde		Napththalene		Toulene		Xylene	
							lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr
Emergency Fire Pump	SXEW Fire Emergency Pump	197	10.77	137,000	1.48	500	5.54E-03	1.38E-03	1.38E-03	3.44E-04	1.13E-03	2.83E-04	1.36E-04	3.41E-05	1.74E-03	4.35E-04	1.25E-04	3.13E-05	6.04E-04	1.51E-04	4.21E-04	1.05E-04
Sxlpwrprm8	20 Dam Hanover	275	14.75	137,000	2.02	500	7.58E-03	1.89E-03	1.89E-03	4.71E-04	1.55E-03	3.87E-04	1.87E-04	4.67E-05	2.38E-03	5.96E-04	1.71E-04	4.28E-05	8.26E-04	2.07E-04	5.76E-04	1.44E-04
Sxlpwrprm5	Far East Containment	225	12.20	137,000	1.67	500	6.27E-03	1.57E-03	1.56E-03	3.90E-04	1.28E-03	3.20E-04	1.55E-04	3.86E-05	1.97E-03	4.93E-04	1.42E-04	3.54E-05	6.84E-04	1.71E-04	4.76E-04	1.19E-04
Sxlpwrprm3	11 Dam Hanover	174	9.60	137,000	1.31	500	4.93E-03	1.23E-03	1.23E-03	3.07E-04	1.01E-03	2.52E-04	1.22E-04	3.04E-05	1.55E-03	3.88E-04	1.12E-04	2.79E-05	5.38E-04	1.34E-04	3.75E-04	9.37E-05
Sxlgdwn1	10 Dam Hanover	309	16.48	137,000	2.26	500	8.47E-03	2.12E-03	2.11E-03	5.27E-04	1.73E-03	4.33E-04	2.09E-04	5.22E-05	2.66E-03	6.66E-04	1.91E-04	4.79E-05	9.24E-04	2.31E-04	6.44E-04	1.61E-04
Sxlpwrprm4	14 Dam Hanover	225	12.20	137,000	1.67	500	6.27E-03	1.57E-03	1.56E-03	3.90E-04	1.28E-03	3.20E-04	1.55E-04	3.86E-05	1.97E-03	4.93E-04	1.42E-04	3.54E-05	6.84E-04	1.71E-04	4.76E-04	1.19E-04
Sxlpwrprm2	Sump #3	309	16.48	137,000	2.26	500	8.47E-03	2.12E-03	2.11E-03	5.27E-04	1.73E-03	4.33E-04	2.09E-04	5.22E-05	2.66E-03	6.66E-04	1.91E-04	4.79E-05	9.24E-04	2.31E-04	6.44E-04	1.61E-04
Sxlpwrprm7	13 Dam Hanover	175	9.65	137,000	1.32	500	4.96E-03	1.24E-03	1.23E-03	3.08E-04	1.01E-03	2.53E-04	1.22E-04	3.06E-05	1.56E-03	3.90E-04	1.12E-04	2.80E-05	5.41E-04	1.35E-04	3.77E-04	9.42E-05
Cummins 1823	South Side Tailing office	32	2.36	137,000	0.32	500	1.21E-03	3.03E-04	3.01E-04	7.53E-05	2.48E-04	6.19E-05	2.99E-05	7.46E-06	3.81E-04	9.52E-05	2.74E-05	6.84E-06	1.32E-04	3.30E-05	9.20E-05	2.30E-05
DEUTZ	Sump Pump	114	6.54	137,000	0.90	500	3.36E-03	8.40E-04	8.36E-04	2.09E-04	6.87E-04	1.72E-04	8.28E-05	2.07E-05	1.06E-03	2.64E-04	7.60E-05	1.90E-05	3.66E-04	9.16E-05	2.55E-04	6.38E-05
FWP01	Concentrator Fire Emergency Pump	185	10.16	137,000	1.39	500	5.22E-03	1.31E-03	1.30E-03	3.25E-04	1.07E-03	2.67E-04	1.29E-04	3.22E-05	1.64E-03	4.11E-04	1.18E-04	2.95E-05	5.69E-04	1.42E-04	3.97E-04	9.92E-05
ID	**Description**	**Hp**	**Max fuel use, cu.ft/hr**	**Natural Gas heat value, Btu/scf**	**Heat input, MMBtu/hr**	**Annual operating hours[2]**	**HAPs[8]**		**Benzene**		**Acetaldehyde**		**Acrolein**		**Formaldehyde**		**Napththalene**		**Toulene**		**Xylene**	
							lb/hr	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**
GENERAC1	MIS Building	60	730.00	1,020	0.74	500	5.02E-02	1.25E-02	3.28E-04	8.19E-05	6.22E-03	1.56E-03	3.83E-03	9.57E-04	3.93E-02	9.83E-03	5.54E-05	1.38E-05	3.04E-04	7.59E-05	1.37E-04	3.43E-05
ID	**Description**	**Hp**	**Max fuel use, cu.ft/hr[3]**	**LPG heat value, Btu/scf[4]**	**Heat input, MMBtu/hr**	**Annual operating hours[2]**	**HAPs[8]**		**Benzene**		**Acetaldehyde**		**Acrolein**		**Formaldehyde**		**Napththalene**		**Toulene**		**Xylene**	
							lb/hr	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**	**lb/hr**	**tons/yr**
GENERAC2	SX-EW Tank house	50	200.00	2,514	0.50	500	3.39E-02	8.47E-03	2.21E-04	5.53E-05	4.20E-03	1.05E-03	2.58E-03	6.46E-04	2.65E-02	2.12E-03	3.74E-05	9.35E-06	2.05E-04	5.13E-05	9.25E-05	2.31E-05
GENERAC4	Mine Pit Slope Monitoring Station - Slope 2	15	42.80	2,514	0.11	500	7.25E-03	1.81E-03	4.73E-05	1.18E-05	9.00E-04	2.25E-04	5.53E-04	1.38E-04	5.68E-03	4.53E-04	8.01E-06	2.00E-06	4.39E-05	1.10E-05	1.98E-05	4.95E-06
GENERAC5	Santa Rita Tower	15	71.60	2,514	0.18	500	1.21E-02	3.03E-03	7.92E-05	1.98E-05	1.50E-03	3.76E-04	9.25E-04	2.31E-04	9.50E-03	7.58E-04	1.34E-05	3.35E-06	7.34E-05	1.84E-05	3.31E-05	8.28E-06
GENERAC6	Nun Complex Communication Station	15	71.60	2,514	0.18	500	1.21E-02	3.03E-03	7.92E-05	1.98E-05	1.50E-03	3.76E-04	9.25E-04	2.31E-04	9.50E-03	7.58E-04	1.34E-05	3.35E-06	7.34E-05	1.84E-05	3.31E-05	8.28E-06
GENERAC7	Mine Warehouse	15	71.60	2,514	0.18	500	1.21E-02	3.03E-03	7.92E-05	1.98E-05	1.50E-03	3.76E-04	9.25E-04	2.31E-04	9.50E-03	7.58E-04	1.34E-05	3.35E-06	7.34E-05	1.84E-05	3.31E-05	8.28E-06
West Tower	Radio Tower Emergency Engine CAT DG50-2 [9]	67.1	288.00	2,514	0.72	500	4.88E-02	1.22E-02	3.19E-04	7.96E-05	6.05E-03	1.51E-03	3.72E-03	9.30E-04	3.82E-02	3.05E-03	5.39E-05	1.35E-05	2.95E-04	7.39E-05	1.33E-04	3.33E-05
Cobre Tower	Radio Tower Emergency Engine CAT DG50-2 [9]	67.1	288.00	2,514	0.72	500	4.88E-02	1.22E-02	3.19E-04	7.96E-05	6.05E-03	1.51E-03	3.72E-03	9.30E-04	3.82E-02	3.05E-03	5.39E-05	1.35E-05	2.95E-04	7.39E-05	1.33E-04	3.33E-05

FEDERAL HAP/NM TOXIC AIR POLLUTANT EMISSIONS ESTIMATION for Emergency Generators

Compound		Diesel Emission Factor (lb/MMBtu)[7]	LPG/NG Emission Factor (lb/MMBtu)[8]
Pollutant	**Species**		
Hazardous Air Pollutants	Benzene	9.33E-04	4.40E-04
	Acetaldehyde	7.67E-04	8.36E-03
	Acrolein	9.25E-05	5.14E-03
	Formaldehyde	1.18E-03	5.28E-02
	Naphthalene	8.48E-05	7.44E-05
	Toluene	4.09E-04	4.08E-04
	Xylenes	2.85E-04	1.84E-04

Notes:

[1]Diesel fuel usage was based on estimated diesel usage via trending analysis. Annual usage is based on a limit of 500 hour/year for emergency equipment. Heat input value in MMBtu is based on 137,000 Btu/gallon conversion.

[2]Operating hours are limited to less than 500 hours/year per rolling 12-month period and operated only during the unavoidable loss of commercial utility power.

[3]The maximum fuel usage for unit "GENERAC4" and "Elliot Magnetek" were based on the manufacture fuel usage for "GENERAC3" which is a unit of similar capacity.

[4]LPG heat value is based on heating value for Propane. LPG fuel is primarily composed of Propane.

[5]Based on emission factors for uncontrolled diesel industrial engines present in USEPA AP-42 Section 3.3 "Gasoline and Diesel Industrial Engines" (10/96). NOx

[6]Based on emission factors for uncontrolled 4-stroke lean-burn engines present in USEPA AP-42 Section 3.2 "Natural Gas-Fired Reciprocal Engines" (7/00). NOx and

[7]HAP emissions are based on USEPA AP-42 Section 3.3 "Gasoline and Diesel Industrial Engines" (10/96) Table 3.3-2

[7]HAP emissions are based on USEPA AP-42 Section 3.2 "Natural Gas-fired Reciprocating Industrial Engines" (10/96) Table 3.2-2

[9]Emission factors for NOX, CO, and VOC from CAT DG50-2 engines are based on EPA Certificate of Conformity NSPS JJJJ limits.

Freeport-McMoRan Chino Mines Company
Revised: August 2023

HAP & TAP Emissions Summary

Legend	
	HAP
	Tap & HAP
	TAP
	Neither HAP or TAP

Controlled HAP & TAP Emissions Summary

Grouping	SOURCE		HAP's		TAP's		Copper		Manganese		Vanadium		Zinc		Benzene		Ethylbenzene		Hexane		Toluene		Xylene		Sulfuric acid		Acetaldehyde		Acrolein		Formaldehyde	
			lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
Tailing Summary	CB TLNGS	Cobre Mine Tailings	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CM TLNGS	Chino Mine Tailings	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HR Summary	CBM HR	Cobre Mine Haul Roads (Hanover Hauling & Magnetite Hauling)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CM HR	Chino Mine Haul Roads	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SAG Mill Tunnel Summary	SAG	Underground SAG Mill Tunnel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Material Handling Summary	BORR_MH	Borrow Pit Material Handling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CBM MH	Cobre Mine Material Handling (Hanover Mining & Magnetite Handling)	6.01E-04	1.6925E-03	1.51E-03	5.13E-03	7.02E-04	2.90E-03	5.36E-04	1.46E-03	2.13E-05	8.10E-05	5.42E-05	2.06E-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CM MH	Chino Mine Material Handling	6.27E-04	2.57E-03	7.65E-03	0.033	6.71E-03	0.029	2.84E-04	1.08E-03	2.13E-05	8.10E-05	5.42E-05	2.06E-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Blasting Summary	BORR_BLST	Borrow Pit Blasting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CBM BLST	Cobre Mine Hanover Blasting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CM BLST	Chino Mine Blasting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ivanhoe Summary	CV-01C	Coarse Ore Conveyor Transfer	1.13E-03	1.67E-03	0.010	0.014	8.76E-03	0.012	9.83E-04	1.35E-03	6.39E-05	8.80E-05	1.63E-04	2.25E-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hurley Summary	F-2-1-1.4	Westinghouse Gas Turbine - Hurley Power Plant	0.47	2.05	0.020	0.088	-	-	-	-	-	-	-	-	5.46E-03	0.024	0.015	0.064	-	-	0.059	0.26	0.029	0.13	0.020	0.088	0.018	0.080	2.91E-03	0.013	0.32	1.41
	F-2-1-1.5	Heat Recovery Steam Generator - Hurley Power Plant	0.090	0.39	5.74E-05	2.51E-04	-	-	-	-	-	-	-	-	1.00E-04	4.40E-04	-	-	0.086	0.377	1.63E-04	7.12E-04	-	-	-	-	-	-	-	-	3.59E-03	0.016
	FLTR/BLND[1]	Filter/Blending Plant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GDF Summary	GDF	Gasoline Dispensing Facilities	0.32	1.41	-	-	-	-	-	-	-	-	-	-	0.030	0.13	0.019	0.082	0.025	0.11	0.16	0.68	0.093	0.408	-	-	-	-	-	-	-	-
Ivanhoe Summary	IC-01	Molybdenum Plant Wet Scrubber	1.32E-04	5.77E-04	1.71E-04	7.47E-04	1.55E-05	6.79E-05	3.10E-05	1.36E-04	1.55E-06	6.79E-06	2.48E-05	1.09E-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LHS-01	Ivanhoe Concentrator Lime Handling System	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LUS-01	Ivanhoe Concentrator Lime Unloading System	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	PC DUMP	Primary Crusher Dump Pocket	3.20E-05	1.40E-04	2.87E-04	1.26E-03	2.49E-04	1.09E-03	2.79E-05	1.22E-04	1.81E-06	7.94E-06	4.63E-06	2.03E-05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	PC-01	Primary Crusher	1.64E-03	7.18E-03	0.015	0.064	1.27E-02	0.056	1.43E-03	6.26E-03	9.29E-05	4.07E-04	2.38E-04	1.04E-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SAG-F1	SAG Mill Feeders No. 1 and No. 2	1.11E-03	4.99E-03	0.010	0.045	8.76E-03	0.039	9.83E-04	4.35E-03	6.39E-05	2.83E-04	1.63E-04	7.23E-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SCDP	Stacker Conveyor	3.51E-04	1.55E-03	3.14E-03	0.014	2.73E-03	0.012	3.06E-04	1.35E-03	1.99E-05	8.80E-05	5.08E-05	2.25E-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCRN Summary	CH SCRN	Chino Screening Plant Material Handling	0.015	0.033	0.134	0.29	0.12	0.26	0.013	0.029	8.50E-04	1.86E-03	2.18E-03	4.76E-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CB SCRN	Cobre Screening Plant Material Handling	2.63E-03	5.76E-03	0.024	0.052	0.020	0.045	2.30E-03	5.03E-03	1.49E-04	3.27E-04	3.81E-04	8.35E-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CH SCRN ENG	Chino Screening Plant Engine	2.42E-03	0.011	-	-	-	-	-	-	-	-	-	-	6.02E-04	2.64E-03	-	-	-	-	2.64E-04	1.16E-03	1.84E-04	8.06E-04	-	-	4.95E-04	2.17E-03	5.97E-05	2.61E-04	7.62E-04	3.34E-03
	CB SCRN ENG	Cobre Screening Plant Engine	5.40E-03	0.012	-	-	-	-	-	-	-	-	-	-	1.34E-03	2.94E-03	-	-	-	-	5.88E-04	1.29E-03	4.10E-04	8.98E-04	-	-	1.10E-03	2.42E-03	1.33E-04	2.91E-04	1.70E-03	3.72E-03
SXEW Summary	SXEW 10MST	SXEW Plant Ten Mixer/Settler Tanks	0.29	1.26	2.18E-03	0.010	-	-	-	-	-	-	-	-	0.064	0.28	0.075	0.33	-	-	0.070	0.31	0.078	0.34	-	-	-	-	-	-	-	-
	SXEW Boiler No. 1	SXEW Plant Boiler No. 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SXEW Boiler No. 2	SXEW Plant Boiler No. 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SXEW Boiler No. 3	SXEW Plant Boiler No. 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SXEW RT	SXEW Plant Raffinate Tank	0.019	0.083	1.54E-04	6.74E-04	-	-	-	-	-	-	-	-	4.24E-03	0.019	4.96E-03	0.022	-	-	4.63E-03	0.020	5.13E-03	0.022	-	-	-	-	-	-	-	-
	SXEW SAT	SXEW Plant Acid Tankhouse	-	-	2.28	10.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.28	10.00	-	-	-	-	-	-
WH Crusher Summary	WH Crush	White House Crushing Plant	0.060	0.13	0.53	1.17	0.46	1.01	0.052	0.11	3.38E-03	7.40E-03	8.64E-03	0.019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Totals			**1.28**	**5.41**	**3.04**	**11.79**	**0.64**	**1.47**	**0.072**	**0.16**	**4.66E-03**	**0.011**	**0.012**	**0.027**	**0.11**	**0.46**	**0.11**	**0.50**	**0.11**	**0.49**	**0.29**	**1.27**	**0.21**	**0.90**	**2.30**	**10.08**	**0.020**	**0.084**	**3.10E-03**	**0.013**	**0.33**	**1.44**

*Polycyclic Organic Matter (compounds with more than one benzene ring, and which have a boiling point greater than or equal to 100 C

[1] Emergency Engines are not included in the Emissions Total since they are exempt under 20.2.72.202.B(3).

Uncontrolled HAP & TAP Emissions Summary

Grouping	SOURCE		HAP's		TAP's		Copper		Manganese		Vanadium		Zinc		Benzene		Ethylbenzene		Hexane		Toluene		Xylene		Sulfuric acid		Acetaldehyde		Acrolein		Formaldehyde	
			lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
Tailing Summary	CB TLNGS	Cobre Mine Tailings	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CM TLNGS	Chino Mine Tailings	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HR Summary	CBM HR	Cobre Mine Haul Roads (Hanover Hauling & Magnetite Hauling)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CM HR	Chino Mine Haul Roads	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SAG Mill Tunnel Summary	SAG	Underground SAG Mill Tunnel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Material Handling Summary	BORR_MH	Borrow Pit Material Handling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CBM MH	Cobre Mine Material Handling (Hanover Mining & Magnetite Handling)	6.01E-04	1.69E-03	1.51E-03	5.13E-03	7.02E-04	2.90E-03	5.36E-04	1.46E-03	2.13E-05	8.10E-05	5.42E-05	2.06E-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CM MH	Chino Mine Material Handling	6.27E-04	2.57E-03	7.65E-03	0.033	6.71E-03	0.029	2.84E-04	1.08E-03	2.13E-05	8.10E-05	5.42E-05	2.06E-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Blasting Summary	BORR_BLST	Borrow Pit Blasting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CBM BLST	Cobre Mine Hanover Blasting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CM BLST	Chino Mine Blasting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ivanhoe Summary	CV-01C	Coarse Ore Conveyor Transfer	1.13E-03	1.67E-03	0.010	0.014	8.76E-03	0.012	9.83E-04	1.35E-03	6.39E-05	8.80E-05	1.63E-04	2.25E-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hurley Summary	F-2-1-1.4	Westinghouse Gas Turbine - Hurley Power Plant	0.47	2.05	0.020	0.088	-	-	-	-	-	-	-	-	5.46E-03	0.024	0.015	0.064	-	-	0.059	0.26	0.029	0.13	0.020	0.088	0.018	0.080	0.003	0.013	0.32	1.41
	F-2-1-1.5	Heat Recovery Steam Generator - Hurley Power Plant	0.090	0.39	5.74E-05	2.51E-04	-	-	-	-	-	-	-	-	1.00E-04	4.40E-04	-	-	0.086	0.38	1.63E-04	7.12E-04	-	-	-	-	-	-	-	-	3.59E-03	0.016
	FLTR/BLND[1]	Filter/Blending Plant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GDF Summary	GDF	Gasoline Dispensing Facilities	0.32	1.41	-	-	-	-	-	-	-	-	-	-	0.030	0.13	0.019	0.082	0.025	0.11	0.16	0.68	0.093	0.41	-	-	-	-	-	-	-	-
Ivanhoe Summary	IC-01	Molybdenum Plant Wet Scrubber	31.00	135.80	15.51	67.92	7.75E-04	3.39E-03	7.75E-04	3.39E-03	7.75E-04	3.39E-03	1.55E-04	6.79E-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LHS-01	Ivanhoe Concentrator Lime Handling System	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	LUS-01	Ivanhoe Concentrator Lime Unloading System	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	PC DUMP	Primary Crusher Dump Pocket	1.07E-04	4.67E-04	9.55E-04	4.18E-03	8.29E-04	3.63E-03	9.30E-05	4.07E-04	6.04E-06	2.65E-05	1.54E-05	6.77E-05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	PC-01	Primary Crusher	1.64E-03	7.18E-03	0.015	0.064	0.013	0.056	1.43E-03	6.26E-03	9.29E-05	4.07E-04	2.38E-04	1.04E-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SAG-F1	SAG Mill Feeders No. 1 and No. 2	1.11E-03	4.99E-03	0.010	0.045	8.76E-03	3.88E-02	9.83E-04	4.35E-03	6.39E-05	2.83E-04	1.63E-04	7.23E-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SCDP	Stacker Conveyor	3.51E-04	1.55E-03	3.14E-03	0.014	2.73E-03	0.012	3.06E-04	1.35E-03	1.99E-05	8.80E-05	5.08E-05	2.25E-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCRN Summary	CH SCRN	Chino Screening Plant Material Handling	0.063	0.137	0.56	1.23	0.49	1.07	0.055	0.12	3.55E-03	7.77E-03	9.08E-03	0.020	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CB SCRN	Cobre Screening Plant Material Handling	0.010	0.023	0.093	0.20	0.081	0.18	9.09E-03	0.020	5.90E-04	1.29E-03	1.51E-03	3.31E-03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	CH SCRN ENG	Chino Screening Plant Engine	2.42E-03	0.011	-	-	-	-	-	-	-	-	-	-	6.02E-04	2.64E-03	-	-	-	-	2.64E-04	1.16E-03	1.84E-04	8.06E-04	-	-	4.95E-04	2.17E-03	5.97E-05	2.61E-04	7.62E-04	3.34E-03
	CB SCRN ENG	Cobre Screening Plant Engine	5.40E-03	0.012	-	-	-	-	-	-	-	-	-	-	1.34E-03	2.94E-03	-	-	-	-	5.88E-04	1.29E-03	4.10E-04	8.98E-04	-	-	1.10E-03	2.42E-03	1.33E-04	2.91E-04	1.70E-03	3.72E-03
SXEW Summary	SXEW 10MST	SXEW Plant Ten Mixer/Settler Tanks	1.26	0.29	9.53E-03	2.18E-03	-	-	-	-	-	-	-	-	0.28	0.064	0.33	0.075	-	-	0.31	0.070	0.34	0.078	-	-	-	-	-	-	-	-
	SXEW Boiler No. 1	SXEW Plant Boiler No. 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SXEW Boiler No. 2	SXEW Plant Boiler No. 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SXEW Boiler No. 3	SXEW Plant Boiler No. 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SXEW RT	SXEW Plant Raffinate Tank	0.083	0.019	6.74E-04	1.54E-04	-	-	-	-	-	-	-	-	0.019	4.24E-03	0.022	4.96E-03	-	-	0.020	4.63E-03	0.022	5.13E-03	-	-	-	-	-	-	-	-
	SXEW SAT	SXEW Plant Acid Tankhouse	-	-	2.28	10.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.28	10.00	-	-	-	-	-	-
WH Crusher Summary	WH Crush	White House Crushing Plant	0.060	0.13	0.53	1.17	0.46	1.01	0.052	0.11	3.38E-03	7.40E-03	8.64E-03	0.019	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Totals			**33.37**	**140.29**	**19.06**	**80.79**	**1.07**	**2.42**	**0.12**	**0.27**	**8.58E-03**	**0.021**	**0.020**	**0.045**	**0.34**	**0.23**	**0.38**	**0.23**	**0.11**	**0.49**	**0.54**	**1.02**	**0.49**	**0.62**	**2.30**	**10.08**	**0.020**	**0.084**	**3.10E-03**	**0.013**	**0.33**	**1.44**

[1] Emergency Engines are not included in the Emissions Total since they

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GDF - Calculations
Units: GDF

GASOLINE DISPENSING FACILITY (Unit GDF) VOC EMISSIONS

Emission Unit	Actual Usage Rate gals/day (average)	gals/month	gals/yr[1]	Emission Factor (lbs/$10^{(3)}$gal)	VOC Emissions lb/hr	lb/day	tons/yr
GDF Chino (facility)	100	3,042	36,500	11.3	0.047	1.13	0.21
GDF Chino (contractor)	1144	34,797	417,560	11.3	0.54	12.89	2.35
GDF Cobre	80	2,433	29,200	11.3	0.038	0.90	0.16
Total					**0.62**	**14.92**	**2.72**

Notes:
[1]Based on weekly Gasoline Usage, provided by James Ford from Jacobs (8/16/2013 email).
[2]Emission factor for gasoline is based on petroleum loading loss equation in USEPA publication AP-42, Table 5.2-7, Evaporative Emissions from Gasoline Service Station Operations (7/08). The loading loss equation is :

Loading Loss (lb/1000 gal) = 12.46 x SPM/T

where,

S= saturation factor (assume 1.00 for submerged loading),
P = true vapor pressure of liquid loaded, pounds per square inch absolute (assume 7.4 psia for Gasoline RVP 10 @ 80°F),
M = molecular weight of vapors, pounds per pound-mole (assume 66 lb/lb-mole),
T = temperature of bulk liquid loaded, °R (80°F + 460 = 540°R),

(Note that average annual liquid surface temperature for El Paso, TX as estimated by the USEPA TANKS software is 74°F, therefore the emission factor is conservatively determined based on 80°F).

Sample Calculations
GDF Cobre
VOC emissions (lb/hr) = 80 gal/day x 11.3 lb/1,000 gal x 1.0 day/24 hours = 0.04 lb/hr
VOC emissions (ton/yr) = 29200 gal/yr x 11.3 lb/1,000 gal x 1.0 ton/2,000 lbs = 0.16 ton/yr

GASOLINE DISPENSING FACILITY (GDF) HAP EMISSIONS

Unit	Source Description	VOC Emissions[1] lbs/hr	ton/yr	HAP Emissions: Benzene lbs/hr	Benzene TPY	Hexane lbs/hr	Hexane TPY	Toluene lbs/hr	Toluene TPY	Xylene lbs/hr	Xylene TPY	Ethylbenzene lbs/hr	Ethylbenzene TPY
GDF	GDF	0.62	2.72	0.030	0.13	0.02	0.11	0.16	0.68	0.093	0.41	0.019	0.08
			Total HAPs (TPY)	**1.41**									

Storage Tank Content	HAP Mass fraction [2] Benzene	Hexane	Toluene	Xylene	Ethylbenzene
Gasoline	0.049	0.040	0.25	0.15	0.030

Notes:
[1]Based on emission calculations in Table "GASOLINE DISPENSING FACILITY (GDF) POTENTIAL VOC EMISSIONS"
[2]Mass fraction is based on the average percent content of the HAP constituent in gasoline. Data obtained from typical material MSDS for gasoline

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Hurley Power Plant - Filter/Blending Plant Emissions
Unit: FLTR/BLND

Hurley Power Plant - Filter/Blending Plant Emissions (Fugitive) - Scenario #1
Unit FLTR/BLND

Basis			
Annual throughput of concentrate[(1)]:	365,000	dry tons	
Hourly throughput of concentrate for conveyance[(1)]:	79	tons	
Hourly front end loader loading rate[(1)]:	260	tons	
Building Enclosure Efficiency:	85	%	[industry experience]
Maximum annual operating days:	365		
Maximum daily operating hours:	24		

Filter/Blending Plant

Source	Unit Number	TSP/PM Emissions (lb/ton processed)	$PM_{10}/PM_{2.5}$ Emissions (lb/ton processed)[(2)]	Uncontrolled				Controlled			
				$PM_{10}/PM_{2.5}$ Emissions (lb/hr)	$PM_{10}/PM_{2.5}$ Emissions (tons/yr)	TSP Emissions (lb/hr)	TSP Emissions (tons/yr)	$PM_{10}/PM_{2.5}$ Emissions (lb/hr)	$PM_{10}/PM_{2.5}$ Emissions (tons/yr)	TSP Emissions (lb/hr)	TSP Emissions (tons/yr)
Conveyor Belt Drop Point #1 *(Filter Plant)*	53-CV-01	0.0030	0.0011	0.087	0.20	0.24	0.55	0.013	0.030	0.036	0.082
Conveyor Belt Drop Point #2 *(Filter Plant)*	53-CV-02	0.0030	0.0011	0.087	0.20	0.24	0.55	0.013	0.030	0.036	0.082
Conveyor Belt Drop Point #3 *(Filter Plant)*	CV-03	0.0030	0.0011	0.087	0.20	0.24	0.55	0.013	0.030	0.036	0.082
Conveyor Belt Drop Point #4 *(Blending Plant)*	CV-04	0.0030	0.0011	0.087	0.20	0.24	0.55	0.013	0.030	0.036	0.082
Conveyor Belt Drop Point #5 *(Blending Plant)*	CV-05	0.0030	0.0011	0.087	0.20	0.24	0.55	0.013	0.030	0.036	0.082
Conveyor Belt Drop Point #6 *(Blending Plant)*	CV-06	0.0030	0.0011	0.087	0.20	0.24	0.55	0.013	0.030	0.036	0.082
CAT966 Front End Loader (Concentrate Storage pile into a rail car for shipping offsite)[(3)]	F-1-3-2	0.010	0.0040	1.04	0.73	2.60	1.83	0.16	0.11	0.39	0.27
TOTAL				**1.56**	**1.93**	**4.02**	**5.11**	**0.23**	**0.29**	**0.60**	**0.77**

Notes:

[1]Throughput data provided by Carlos Silva and Gary Brown of the Ivanhoe Concentrator and covered conveyor to Filter/Blending Plant. Concentrate produced = Filter Plant throughput. (Reference email to Roger Felty 03/25/2011). Operations consist of 6 conveyor drops (CV-01 through CV-06) plus one material handling step using a Cat 966 to load material from the Concentrate Storage pile into a rail car for shipping offsite. (6 conveyor drops + one handling step).

[2]Conveyor Drop Point Emission Factors from AP-42 Table 11.19.2-2 in "Crushed Stone Processing and Pulverized Mineral Processing" for uncontrolled Conveyor Transfer Point (08/2004)

[2]Front End Loader Emission Factors from AP-42 Table 11.24-2 in "Metallic Minerals Processing" for Material handling and transfer--all minerals except bauxite (01/1995).

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Hurley Power Plant - Stationary Gas Turbine Emissions
Unit: F-2-1-1.4

Basis

Fuel parameters

Natural Gas Heat Content	1,020	Btu/scf

Fuel Usage

Firing Rate:	455	MMBtu/hr
Maximum daily operating hours:	24	hr/day
Potential Annual Operation:	365	days/yr
Maximum hourly operating hours:	8760	hr/yr

Pollutant		Emission Factor[1]	UNCONTROLLED PTE EMISSIONS	
		lb/MMscf	(lb/hr)[2]	(ton/yr)[3]
NOx		-	39.90	174.76
CO		-	20.00	87.60
SO_2		-	0.40	1.75
VOC		-	2.80	12.26
TSP		-	2.30	10.07
PM_{10}		-	2.30	10.07
$PM_{2.5}$		-	2.30	10.07
Federal Hazardous Air Pollutants (HAPs) & NM Toxic Air Pollutants	Lead	No Data	-	-
	1-3 Butadiene	4.30E-07	1.96E-04	0.00086
	Acetaldehyde	4.00E-05	1.82E-02	0.080
	Acrolein	6.40E-06	2.91E-03	0.013
	Benzene	1.20E-05	5.46E-03	0.024
	Ethylbenzene	3.20E-05	1.46E-02	0.064
	Formaldehyde	7.10E-04	3.23E-01	1.41
	Naphthalene	1.30E-06	5.92E-04	0.0026
	PAH	2.20E-06	1.00E-03	0.0044
	Propylene Oxide	2.90E-05	1.32E-02	0.058
	Toluene	1.30E-04	5.92E-02	0.26
	Xylenes	6.40E-05	2.91E-02	0.13
	Sulfuric Acid[4]	-	2.00E-02	0.09
TOTAL HAPs			**0.49**	**2.13**

Notes:

[1]HAP emission factors provided from Table 3.1-3 provided in AP-42 Chapter 3.1 Stationary Gas Turbine (4/00).

[2]Maximum hourly emission rates allowed by air permits 376-M4 and P066R1.

[3]Based on 8,760 annual operating hours.

[4] A nominal estimate of the sulfur oxides emissions is calculated by assuming that all fuel sulfur is converted to SO_2. However, sulfur oxide emissions are in the form of both SO_2 and SO_3. Measurements show that the ratio of SO_3 to SO_2 varies. For emissions reporting, a 95% of the sulfur into the turbine is converted to SO_2 in the exhaust. The remaining sulfur (5%) is converted into SO_3. SO_3 combines with water vapor in the exhaust to form sulfuric acid.

SO_2 emissions (lb/hr) = 0.40
SO_2 emissions (tpy) = 1.75

SO_3 emissions (lb/hr) = 0.02
SO_3 emissions (tpy) = 0.09

H_2SO_4 emissions are calculated based on 100% stoichiometric conversion of sulfur as SO_3 to H_2SO_4, i.e.,

$SO_3 + H_20 \Rightarrow H_2SO_4$
1 mole of SO_3 => 1 mole of H_2SO_4
1 lb/hr SO_3 => 1 lb/hr H_2SO_4

Therefore, 0.02 lb/hr of SO_3 => 0.02 lb/hr of H_2SO_4
Therefore, 0.09 tpy of SO3 => 0.09 tpy of H_2SO_4

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Hurley Power Plant - Natural Gas-Fired Heat Recovery Steam Generator (HRSG) Duct Burner Emissions
Unit: F-2-1-1.5

Basis

Fuel parameters

Natural Gas Heat Content	1,020	Btu/scf

Fuel Usage

Firing Rate:	48.8	MMBtu/hr
Maximum daily operating hours:	24.0	hr/day
Potential Annual Operation:	365.0	days/yr
Maximum hourly operating hours:	8760.0	hr/yr

Pollutant		AP-42 Emission Factor[(1)]	UNCONTROLLED PTE EMISSIONS	
		lb/MMscf	(lb/hr)[(2)]	(ton/yr)[(3)]
NOx		--	2.40	10.51
CO		--	1.30	5.69
SO_2		--	0.03	0.13
VOC		--	0.60	2.63
TSP		--	0.30	1.31
PM_{10}		--	0.30	1.31
$PM_{2.5}$		--	0.30	1.31
Federal Hazardous Air Pollutants (HAPs) & NM Toxic Air Pollutants	Lead	0.0005	2.39E-05	1.05E-04
	2-Methylnapthalene	2.40E-05	1.15E-06	5.03E-06
	Benzene	2.10E-03	1.00E-04	4.40E-04
	Dichlorobenzene	1.20E-03	5.74E-05	2.51E-04
	Fluoranthene	3.00E-06	1.44E-07	6.29E-07
	Fluorene	2.80E-06	1.34E-07	5.87E-07
	Formaldehyde	7.50E-02	3.59E-03	1.57E-02
	Hexane	1.80E+00	8.61E-02	3.77E-01
	Naphthalene	6.10E-04	2.92E-05	1.28E-04
	Phenanthrene	1.70E-05	8.13E-07	3.56E-06
	Pyrene	5.00E-06	2.39E-07	1.05E-06
	Toluene	3.40E-03	1.63E-04	7.12E-04
TOTAL HAPs			**0.090**	**0.395**

Notes:
[1]Emissions for the Hurley HRSG duct burner are estimated from emission factors for boilers combusting natural gas. The rationale for this is that the duct burner combustion process is better represented by boilers firing natural gas than by combustion turbines firing natural gas. Lead and HAP emissions are based on emission factors from Tables 1.4-2 and 1.4-3 provided in AP-42, Chapter 1.4, Natural Gas Combustion (7/98).
[2]Maximum hourly emission rates allowed by air permits 376-M4 and P066R1.
[3]Based on 8,760 annual operating hours

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Blasting Emissions - Hanover
Unit: CBM BLST

	Basis	
Maximum amount of blasting agent/day:	110,000	lbs
Maximum number of blasts/day:	4	blasts/day
Maximum amount of blasting agent/event:	27,500	lbs
Maximum amount of blasting agent/year:	14,300	tons
Maximum horizontal area per blast:	27,500	ft^2
Diesel fuel usage:	894	gal/day
Diesel fuel usage:	232,520	gal/yr
Diesel fuel oil to ammonium nitrate blasting products ratio:	6%	
Diesel Fuel Density:	7.38	lb/gal
Event Duration:	2	seconds

Criteria Pollutant	Emission Factor (lb/ton blasting agent)[1]	Emission Rate [2]			
		(lb/event)	(lb/day)	(ton/yr)	(lb/hr)[3]
Nitrogen Oxides (NO_x)	1.80	24.75	99.00	12.87	24.75
Carbon Monoxide (CO)	40.64	558.80	2,235.20	290.58	558.80
Sulfur Dioxide (SO_2)	3.60E-03	0.05	0.20	0.026	0.050

Criteria Pollutant	Emission Rate [4]			
	(lb/event)	(lb/day)	(ton/yr)	(lb/hr)[3]
TSP	63.85	255.38	33.20	63.85
PM_{10}	33.20	132.80	17.26	33.20
$PM_{2.5}$	1.92	7.66	1.00	1.92

Pollutant	Emission Factor (lb/MMBtu)[5]	Emission Rate [6]	
		(lb/day)	(ton/yr)
CO_2	162.71	20081.04	2610.54
N_2O	1.32E-03	0.16	0.021
CH_4	6.60E-03	0.81	0.11
CO_2e			**2619.49**

Notes:

[1]NOx emission factor is the average of measurements from "NOx Emissions from Blasting Operations in Open-Cut Coal Mining" by Moetaz I. Attalla, Stuart J. Day, Tony Lange, William Lilley, and Scott Morgan (2008).

[1]CO emission factor is the average of the measurements in "Factors Affecting Anfo Fumes Production" by James H. Rowland III and Richard Mainiero (2001).

[1]SO_2 emissions are based on a diesel sulfur content of 15 ppm assuming complete conversion to SO_2.

[2]Pound per event emission rates are based on a maximum use of 55,000 lbs of blasting agent per event. Annual emission rates are based on a maximum annual use of 14,300 tons of blasting agent.

$$E\left(\frac{lb}{year}\right) = EF\left(\frac{lb}{ton\, of\ blasting\ agent}\right) \times \left(blasting\ agent\, \frac{ton}{year}\right)$$

[3]Pound per hour modeling rate is based the daily emission rates (lb/day) which is converted to a pound per hour rate.

[4]Particulate blasting emissions are based on emission factors from AP-42 Table 11.9-1.

[5]CO_2, N_2O, and CH_4 emission factor per 40 CFR 98 Subpart C, Table C–1, and Table C–2.

[6]CO_2, N_2O, and CH_4 emissions calculated based on emission factors, diesel fuel usage, and diesel fuel HHV of 0.138 MMBtu/gal per 40 CFR 98 Subpart C Table C–1

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Blasting Emissions - Chino Mine
Unit: CM BLST

Basis

Maximum amount of blasting agent/day:	400,000	lbs
Maximum number of blasts/day:	4	blasts/day
Maximum number of blasts/year:	1,040	blasts/year
Maximum amount of blasting agent/event:	100,000	lbs
Maximum amount of blasting agent/year:	52,000	tons
Horizontal area per blast:	70,000	ft^2
Diesel fuel usage:	3,252	gal/day
Diesel fuel usage:	845,528	gal/yr
Diesel fuel oil to ammonium nitrate blasting products ratio:	6%	
Diesel Fuel Density =	7.38	lb/gal
Event Duration:	2	seconds

Criteria Pollutant	Emission Factor (lb/ton blasting agent)(1)	Emission Rate 2			
		(lb/event)	(lb/day)	(ton/yr)	(lb/hr)3
Nitrogen Oxides (NO_x)	1.80	90.00	360.00	46.80	90.00
Carbon Monoxide (CO)	40.64	2,032.00	8,128.00	1,056.64	2,032.00
Sulfur Dioxide (SO_2)	3.60E-03	0.18	0.72	0.094	0.18

Criteria Pollutant	Emission Rate 4			
	(lb/event)	lb/day	(ton/yr)	(lb/hr)3
TSP	259.28	1037.13	134.83	259.28
PM_{10}	134.83	539.31	70.11	134.83
$PM_{2.5}$	7.78	31.11	4.04	7.78

Pollutant	Emission Factor (lb/MMBtu)5	Emission Rate 6	
		(lb/day)	(ton/yr)
CO_2	162.71	73021.97	9492.86
N_2O	0.0013	0.59	0.077
CH_4	0.0066	2.96	0.39
CO_2e			**9525.43**

Notes:

[1]NO_x emission factor is the average of measurements from "NO_x Emissions from Blasting Operations in Open-Cut Coal Mining" by Moetaz I. Attalla,

[1]CO emission factor is the average of the measurements in "Factors Affecting Anfo Fumes Production" by James H. Rowland III and Richard Mainiero

[1]SO_2 emissions are based on a diesel sulfur content of 15 ppm assuming complete conversion to SO_2.

[2]Pound per event emission rates are based on a maximum use of 200,000 lbs of blasting agent per event. Annual emission rates are based on a maximum annual use of 52,000 tons of blasting agent.

$$E\left(\frac{lb}{year}\right)=EF\left(\frac{lb}{ton\,of\ blasting\ agent}\right)\times\left(blasting\ agent\,\frac{ton}{year}\right)$$

[3]Pound per hour modeling rate is based the daily emission rates (lb/day) which is converted to a pound per hour rate.

[4]Particulate blasting emissions are based on emission factors from AP-42 Table 11.9-1.

[5]CO_2, N_2O, and CH_4 emission factor per 40 CFR 98 Subpart C, Table C–1, and Table C–2.

[6]CO_2, N_2O, and CH_4 emissions calculated based on emission factors, diesel fuel usage, and diesel fuel HHV of 0.138 MMBtu/gal per 40 CFR 98 Subpart C Table C–1

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Ivanhoe Concentrator - SAG Mill Feeder Emissions
Units CV-01 C, SCDP, SAG-F1

Basis			
Annual Throughput of Ore to Mill:	29,223,360	tons	
Daily Throughput of Ore to Mill:	80,064	tons	Annual average basis per Condition A601 A. of NSR Permit 0298M5
Hourly Throughput of Ore to Mill:	3,300	tons	Maximum single hourly rate per Condition A601 A. of NSR Permit 0298M5
Building Enclosure Efficiency:	85	%	Industry experience; used in controlled emission calculations for Ore Transfer Point and SAG Mill Conveyors only.
Annual operating days:*	365		
Daily operating hours:*	24		

Federal Hazardous Air Pollutants and New Mexico Toxic Air Pollutants Content of Ore for Mill (%)[1]

Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
7.00E-04	4.00E-04	1.90E-03	2.00E-04	2.50E-03	2.00E-03	5.90E-01	2.70E-03	6.62E-02	1.20E-03	1.00E-04	4.30E-03	1.10E-02

Criteria Pollutant	TSP	PM_{10}	$PM_{2.5}$
Uncontrolled Emission Factors, lb/ton[2]	3.00E-03	1.10E-03	1.65E-04

Criteria Pollutant	TSP	PM_{10}	$PM_{2.5}$
Controlled Emission Factors, lb/ton[3]	1.40E-04	4.60E-05	1.30E-05

Emission Unit Name	Controlled Pollutant Emissions, lb/hr														
	TSP	PM_{10}	$PM_{2.5}$	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
CV-01C- Ore Transfer Point (enclosed)	1.49	0.54	0.082	1.04E-05	5.94E-06	2.82E-05	2.97E-06	3.71E-05	2.97E-05	8.76E-03	4.01E-05	9.83E-04	1.78E-05	1.49E-06	6.39E-05	1.63E-04
SCDP - Stacker Conveyor Drop Point	0.46	0.15	0.043	3.23E-06	1.85E-06	8.78E-06	9.24E-07	1.16E-05	9.24E-06	2.73E-03	1.25E-05	3.06E-04	5.54E-06	4.62E-07	1.99E-05	5.08E-05
SAG-F1 - SAG Mill Conveyor No.1	0.74	0.27	0.041	5.20E-06	2.97E-06	1.41E-05	1.49E-06	1.86E-05	1.49E-05	4.38E-03	2.00E-05	4.92E-04	8.91E-06	7.43E-07	3.19E-05	8.17E-05
SAG-F1 - SAG Mill Conveyor No.2	0.74	0.27	0.041	5.20E-06	2.97E-06	1.41E-05	1.49E-06	1.86E-05	1.49E-05	4.38E-03	2.00E-05	4.92E-04	8.91E-06	7.43E-07	3.19E-05	8.17E-05
TOTALS	**3.43**	**1.24**	**0.21**	**2.40E-05**	**1.37E-05**	**6.52E-05**	**6.86E-06**	**8.58E-05**	**6.86E-05**	**2.02E-02**	**9.27E-05**	**2.27E-03**	**4.12E-05**	**3.43E-06**	**1.48E-04**	**3.78E-04**

Emission Unit Name	Controlled Pollutant Emissions, tpy														
	TSP	PM_{10}	$PM_{2.5}$	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver		Zinc
CV-01C- Ore Transfer Point (enclosed)	6.58	2.41	0.36	1.43E-05	8.18E-06	3.89E-05	4.09E-06	5.11E-05	4.09E-05	1.21E-02	1.78E-04	1.35E-03	2.45E-05	2.05E-06	8.80E-05	2.25E-04
SCDP - Stacker Conveyor Drop Point	2.05	0.67	0.19	1.43E-05	8.18E-06	3.89E-05	4.09E-06	5.11E-05	4.09E-05	1.21E-02	5.52E-05	1.35E-03	2.45E-05	2.05E-06	8.80E-05	2.25E-04
SAG-F1 - SAG Mill Conveyor No.1	3.29	1.21	0.18	2.30E-05	1.32E-05	6.25E-05	6.58E-06	8.22E-05	6.58E-05	1.94E-02	8.88E-05	2.18E-03	3.95E-05	3.29E-06	1.41E-04	3.62E-04
SAG-F1 - SAG Mill Conveyor No.2	3.29	1.21	0.18	2.30E-05	1.32E-05	6.25E-05	6.58E-06	8.22E-05	6.58E-05	1.94E-02	8.88E-05	2.18E-03	3.95E-05	3.29E-06	1.41E-04	3.62E-04
TOTALS	**15.20**	**5.49**	**0.91**	**7.47E-05**	**4.27E-05**	**2.03E-04**	**2.13E-05**	**2.67E-04**	**2.13E-04**	**6.29E-02**	**4.10E-04**	**7.06E-03**	**1.28E-04**	**1.07E-05**	**4.59E-04**	**1.17E-03**

Notes:

[1]Data taken from Chino TRI data received from Clyde Durham 1/28/11 email.

[2]Emission factors for the SAG Mill Conveyors and Ore Transfer Point were obtained from Table 11.19.2-2 of USEPA AP-42, conveyor transfer point emission factors for Crushed Stone Processing and Pulverized Mineral Processing (8/04). A $PM_{2.5}$ emission factor was calculated from the available PM_{10} emission factor using the ratio of 0.15 $PM_{2.5}/PM_{10}$ as recommended in the Background Document for AP-42, Chapter 13.2.4, Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006.

[3]Controlled emission factors for the Stacker Conveyor Drop Point were obtained from Table 11.19.2-2 of USEPA AP-42, conveyor transfer point (wet suppression controls) emission factors for Crushed Stone Processing and Pulverized Mineral Processing (8/04).

*Daily and annual operating schedule provided by E P Bock, Chino Mines Company, Mine Engineering.

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Ivanhoe Concentrator - Lime System Wet Scrubber Emissions

Units LHS-01 and LUS-01

Basis			
Annual Throughput of lime unloading system:	46,428	tons	
Daily Throughput of lime unloading system:	127	tons	
Hourly Throughput of lime unloading system:	55	tons	
Annual Throughput of lime handling system:	46,428	tons	
Daily Throughput of lime handling system:	127	tons	
Hourly Throughput of lime handling system:	10	tons	
Control Efficiency of Wet Scrubber for Lime Handling:	100	%	[Manufacturer specs]
Control Efficiency of Wet Scrubber for Lime Unloading:	100	%	[Manufacturer specs]
Lime unloading annual operating days:	365		
Lime unloading daily operating hours:	2		
Lime handling annual operating days:	365		
Lime handling daily operating hours:	13		

Criteria Pollutant	TSP	PM_{10}	$PM_{2.5}$
Uncontrolled Emission Factors, lb/ton[1]	2.20	2.20	0.33

Emission Unit Name	Controlled Pollutant Emissions, lb/hr[2]			Controlled Pollutant Emissions, tpy[2]		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
LUS-01 - Lime Unloading System	0.24	0.24	0.036	0.102	0.102	0.015
LHS-01 - Lime Handling System	0.044	0.044	0.0066	0.102	0.102	0.015
TOTALS	**0.28**	**0.28**	**0.043**	**0.204**	**0.204**	**0.031**

Notes:

[1]Emission factors obtained from Table 11.17-4 of AP-42 Section 11.17, emission factors for lime handling raw material and product processing and handling, product transfer and conveying (2/98). Assumes all PM_{10} is equivalent to PM. A $PM_{2.5}$ emission factor was calculated from the available PM_{10} emission factor using the ratio of 0.15 $PM_{2.5}/PM_{10}$ as recommended in the Background Document for AP-42, Chapter 13.2.4, Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006.

[2]Process operations and daily and annual operating schedule provided by Roger Magnuson, Chino Mines Company in 3/18/2011 email.

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Ivanhoe Concentrator - Molybdenum Plant Wet Scrubber Emissions
Unit IC-01

Basis	
Annual operating days:	365
Daily operating hours:	24

Federal Hazardous Air Pollutants and New Mexico Toxic Air Pollutants Content of Moly Concentrate (%)[1]

Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead
5.00E-03	4.00E-03	8.00E-03	1.00E-03	2.00E-03	5.00E-03	5.00E-03	5.00E-03	1.00E-03

Mercury	Manganese	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
5.00E-04	1.00E-02	5.00E-03	4.00E-03	1.00E-03	5.00E-04	5.00E-04	8.00E-03

Emission Unit Name	Controlled Pollutant Emissions, lb/hr									
	TSP	PM_{10}	$PM_{2.5}$	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt
Moly Plant Scrubber [2]	0.31	0.31	0.31	1.55E-05	1.24E-05	2.48E-05	3.10E-06	6.20E-06	1.55E-05	1.55E-05
	Copper	Lead	Mercury	Manganese	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
	1.55E-05	3.10E-06	1.55E-06	3.10E-05	1.55E-05	1.24E-05	3.10E-06	1.55E-06	1.55E-06	2.48E-05

Emission Unit Name	Controlled Pollutant Emissions, tpy									
	TSP	PM_{10}	$PM_{2.5}$	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt
Moly Plant Scrubber[3]	1.36	1.36	1.36	6.79E-05	5.43E-05	1.09E-04	1.36E-05	2.72E-05	6.79E-05	6.79E-05
	Copper	Lead	Mercury	Manganese	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
	6.79E-05	1.36E-05	6.79E-06	1.36E-04	6.79E-05	5.43E-05	1.36E-05	6.79E-06	6.79E-06	1.09E-04

Notes:

[1]Data taken from Chino TRI data received from Clyde Durham 1/28/11 email.

[2]Scrubber PM emissions from moly scrubber stack test data conducted in October 2008. Assume that PM_{10} and $PM_{2.5}$ same as PM.

[3]Annual emissions based on conservative assumption that process operates 8,760 hr/yr.

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Ivanhoe Concentrator - Crusher Dump Emissions
Unit PC DUMP

Basis			
Annual Throughput of Ore to Crusher:	29,433,600	tons	[Based on daily max X 365 day/yr]
Daily Throughput of Ore to Crusher:	80,640	tons	[Permit limit, NSR 298M5]
Hourly Throughput of Ore to Crusher:	3,360	tons	[Permit limit, NSR 298M5]
Control Efficiency of Dump Pocket Fogging System:	70	%	[Minimum, based on design of typical system]
Annual operating days:	365		
Daily operating hours:	24		

Federal Hazardous Air Pollutants and New Mexico Toxic Air Pollutants Content of Ore for Mill (%)[1]

Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
7.00E-04	4.00E-04	1.90E-03	2.00E-04	2.50E-03	2.00E-03	5.90E-01	2.70E-03	6.62E-02	1.20E-03	1.00E-04	4.30E-03	1.10E-02

Criteria Pollutant	PM	PM_{10}	$PM_{2.5}$
Uncontrolled Emission Factors, lb/ton[2]	4.18E-05	1.60E-05	2.40E-06

Emission Unit Name	Controlled Pollutant Emissions, lb/hr[3]															
	TSP	PM_{10}	$PM_{2.5}$	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
Primary Crusher Dump Pocket (Controlled	0.042	0.016	0.0024	2.95E-07	1.69E-07	8.01E-07	8.43E-08	1.05E-06	8.43E-07	2.49E-04	1.14E-06	2.79E-05	5.06E-07	4.21E-08	1.81E-06	4.63E-06
(Uncontrolled)	0.140	0.054	0.0081	9.83E-07	5.62E-07	2.67E-06	2.81E-07	3.51E-06	2.81E-06	8.29E-04	3.79E-06	9.30E-05	1.69E-06	1.40E-07	6.04E-06	1.54E-05
Emission Unit Name	Controlled Pollutant Emissions, tpy[3]															
	PM	PM_{10}	$PM_{2.5}$	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
Primary Crusher Dump Pocket (Controlled)	0.18	0.071	0.011	1.29E-06	7.38E-07	3.51E-06	3.69E-07	4.61E-06	3.69E-06	1.09E-03	4.98E-06	1.22E-04	2.21E-06	1.85E-07	7.94E-06	2.03E-05
(Uncontrolled)	0.62	0.24	0.035	4.31E-06	2.46E-06	1.17E-05	1.23E-06	1.54E-05	1.23E-05	3.63E-03	1.66E-05	4.07E-04	7.38E-06	6.15E-07	2.65E-05	6.77E-05

Notes:

[1]Data taken from Chino TRI data received from Clyde Durham 1/28/11 email.

[2]Emission factors obtained from Table 11.19-2.2, the AP-42, truck unloading emission factors for Crushed Stone Processing and Pulverized Mineral Processing (8/04). A $PM_{2.5}$ emission factor was calculated from the available PM_{10} emission factor using the ratio of 0.15 $PM_{2.5}/PM_{10}$ as recommended in the Background Document for AP-42, Chapter 13.2.4, Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006.

[3]Daily and annual operating schedule and process parameters provided by E P Bock, Chino Mines Company, Mine Engineering

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Ivanhoe Concentrator - Primary Crusher Baghouse Emissions
Unit PC-01

Basis			
Design/Nominal Baghouse Capacity:	14,000	CFM	[Bechtel Specifications]
Control Efficiency of Dust Collector:	100	%	[Bechtel Specifications]
Grain Inlet Loading:	6	gr/scf	[Bechtel Specifications]
Annual operating days:	365		
Daily operating hours:	24		

Federal Hazardous Air Pollutants and New Mexico Toxic Air Pollutants Content of Ore for Mill (%)[1]

Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
7.00E-04	4.00E-04	1.90E-03	2.00E-04	2.50E-03	2.00E-03	5.90E-01	2.70E-03	6.62E-02	1.20E-03	1.00E-04	4.30E-03	1.10E-02

Emission Unit Name	Controlled Pollutant Emissions, lb/hr[3]															
	TSP	PM_{10}	$PM_{2.5}$	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
Primary Crusher Baghouse	2.16	2.16	2.16	1.51E-05	8.64E-06	4.10E-05	4.32E-06	5.40E-05	4.32E-05	1.27E-02	5.83E-05	1.43E-03	2.59E-05	2.16E-06	9.29E-05	2.38E-04

Emission Unit Name	Controlled Pollutant Emissions, tpy[3]															
	TSP	PM_{10}	$PM_{2.5}$	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
Primary Crusher Baghouse	9.46	9.46	9.46	6.62E-05	3.78E-05	1.80E-04	1.89E-05	2.37E-04	1.89E-04	5.58E-02	2.55E-04	6.26E-03	1.14E-04	9.46E-06	4.07E-04	1.04E-03

Notes:
[1]Data taken from Chino TRI data received from Clyde Durham 1/28/11 email.
[2]Emissions from Primary Crusher and Crusher drop Point are controlled by a dust collector with a 99.7% vendor guarantee and a 6.0 gr/cf inlet loading

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Wind Erosion Emissions for Cobre Tailings Impoundment
Unit CB TLNGS

Wind erosion emissions for the tailings impoundment are based on AP-42, Section 13.2.5, Industrial Wind Erosion (11/06).
Emissions are based on the availability of erodible material, the wind speed threshold required to cause the material to become airborne, and how often new material is deposited on the area. Calculated emissions represent intermittent events that only occur when wind speeds are great enough to transport available materials. The emission rate is not a steady state event and decays rapidly to zero when erodible material is no longer available or when wind speeds are no longer great enough to transport material.

The entire Cobre Tailings Impoundment covers approximately 142 acres including the 25-acre Reclaim Pond. Of the 117 acres of the impoundment not covered by the Reclaim Pond, approximately 108 acres have been covered with a six-inch thick rock cover to alleviate wind-blown tailings. No new tailings have been placed in the tailings impoundment since 1999.

Cobre Tailings Impoundment (Inactive)	Acres
Total Impoundment Area	142
area covered by pond water	25
area with rock cover	108
Total Remaining Area of Erodible Material	9

All acreages are approximate.

Summary of Total Erodible Area Emissions - Cobre Tailings		
Pollutant	**Inactive Area**	**TOTALS**
TSP (lb/hr)	0.27	**0.27**
TSP (tons/yr)	1.17	**1.17**
PM10 (lb/hr)	0.13	**0.13**
PM10 (tons/yr)	0.00	**0.00**
PM2.5 (lb/hr)	0.02	**0.02**
PM2.5 (tons/yr)	0.09	**0.09**

See detailed calculations below.

Annual Emissions from Inactive Areas
Erodible Area: **9** acres
Emissions from inactive areas are based on one disturbance or one event that placed erodible material on the area.

Source: AP-42, 13.2.5 (11/06)														Erodible Area Emissions		
Area	**Pollutant**	**# of Times/Yr for New Erodible Material, N [1]**	**Particle Size Multiplier, k [2]**	**Threshold friction velocity, U_t [3]**	**Particle Roughness height[4]**	**Fastest Mile [5]**	**Fastest Mile**	**Height wind Measurement was taken[6]**	**U_{10}^{+}[7]**	**Friction velocity, U [8]**	**Erosion Potential, P_i [9]**	**Emission Factor[10]**	**Erodible Surface Area**	**Annual Emissions**		**Hourly Emissions, based on 8,760 hr/yr**
				(m/s)	**(m)**	**(mph)**	**(m/s)**	**(m)**	**(m/s)**	**(m/s)**	**(g/m^2)**	**(g/m^2/yr)**	**(m^2)**	**(lb/yr)**	**(tons/yr)**	**(lb/hr)**
Cobre (Inactive)	TSP	1	1	0.54	0.002	45	20.12	10.00	20.12	1.07	29.21	29.21	36,422	2,346	1.17	0.27
	PM10	1	0.5	0.54	0.002	45	20.12	10.00	20.12	1.07	29.21	14.61	36,422	1,173		0.13
	PM2.5	1	0.075	0.54	0.002	45	20.12	10.00	20.12	1.07	29.21	2.19	36,422	176	0.09	0.02

Notes:
[1]For inactive areas, no new erodible material is placed. For purposes of providing a conservative estimate of emissions, N is set equal to 1.
[2]k is a particle size multiplier: TSP (30 um), k=1.0; PM10 (<10 um), k=0.5; PM2.5 (<2.5 um), k = 0.075. [AP-42, page 13.2.5-3]
[3]Threshold friction velocity is based on fine coal dust on a concrete pad. [Ap-42, Table 13.2.5-2]
[4]Particle Roughness height is abased on the fine coal dust on a concreate pad. [AP-42 Table 13.2.5-5]
[5]The fastest mile (maximum 2-minute wind data from the 2007-2010) obtained from the Silver City station.
[6]Height of the wind measurement was taken.
[7]Standardization of wind measurement based on height: U_{10}^{+} = wind measurement * (ln(10/particle height))/(ln(height wind measurement was taken/ particle height)).
[8]Friction Velocity equals the U_{10}^{+} * 0.053
[9]Friction Potential function for a dry, exposed surface is:

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

$$P = 0 \text{ for } U<U_t$$

where U = friction velocity
U_t = threshold friction velocity (m/s)

[10]Emission Factor = Erosion Potential * Particle Size Multiplier

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Wind Erosion Emissions for Chino Tailings Impoundment
Unit CM TLNGS

Wind erosion emissions for the tailings impoundment are based on AP-42, Section 13.2.5, Industrial Wind Erosion (11/06).
Emissions are based on the availability of erodible material, the wind speed threshold required to cause the material to become airborne, and how often new material is deposited on the area. Calculated emissions represent intermittent events that only occur when wind speeds are great enough to transport available materials. The emission rate is not a steady state event and decays rapidly to zero when erodible material is no longer available or when wind speeds are no longer great enough to transport material.

The entire Chino Tailings Impoundment covers approximately 3,750 acres of which approximately 2,400 acres have been reclaimed, revegetated, crimped with straw, covered by water, or regularly wetted from the application of tailings slurry from the Ivanhoe Concentrator. Of the remaining approximately 1,350 acres available for erodible material, approximately 930 acres are not actively used. Only Tailings Pond 7 is actively used for deposition of tailings slurry.

Annual Emissions from Active Areas*	
Area	**Acres**
Pond 7 Area	1557.00
Pond 7 Expansion	484.00
Total Area	2041.00
Area covered by pond water	548.70
Area wetted by slurry	437.97
Total Active Area	**1054.33**

*Total Inactive area includes Pond 7 and Pond 7 Expansion.

Annual Emissions from Inactive Areas**	
Area	**Acres**
Total Inactive Area	**1,557**

**Total Inactive area includes the following areas: Pond 6 West, Pond 6 East, Pond 4, Pond C, and Pond B

Summary of Total Erodible Area Emissions - Chino Tailings			
Pollutant	**Inactive Areas**	**Active Area**	**TOTALS**
TSP (lb/hr)	0.00	31.37	**31.37**
TSP (tons/yr)	202.90	137.40	**340.3**
PM10 (lb/hr)	23.16	15.68	**38.85**
PM10 (tons/yr)	101.45	68.70	**170.15**
PM2.5 (lb/hr)	3.47	2.35	**5.83**
PM2.5 (tons/yr)	15.22	10.30	**25.52**

See detailed calculations below.

Source: AP-42, 13.2.5 (11/06)													Erodible Area Emissions		
Area	**Pollutant**	**Fastest Mile [1]**	**Fastest Mile**	**# of Times/Yr for New Erodible Material, N [2]**	**Particle Size Multiplier, k [3]**	**Roughness height**	**u10+**	**Friction velocity, u*[4]**	**Threshold friction velocity, u_t [5]**	**Erosion Potential, P_i**	**Emission Factor**	**Erodible Surface Area**	**Annual Emissions**		**Hourly Emissions, based on 8,760 hr/yr**
		(mph)	**(m/s)**			**(m)**	**(m/s)**	**(m/s)**	**(m/s)**	**(g/m^2)**	**(g/m^2/yr)**	**(m^2)**	**(lb/yr)**	**(tons/yr)**	**(lb/hr)**
Chino Inactive	TSP	45	20.12	1	1	0.0001	20.12	1.07	0.54	29.21	29.21	6,300,955	405,808	202.90	
	PM10	45	20.12	1	0.5	0.0001	20.12	1.07	0.54	29.21	14.61	6,300,955	202,904	101.45	23.16
	PM2.5	45	20.12	1	0.075	0.0001	20.12	1.07	0.54	29.21	2.19	6,300,955	30,436	15.22	3.47

Annual Emissions from Active Area - Pond 7
Erodible Area: **1,054 acres**
Emissions for the active area of Pond 7 are conservatively based on placement of new erodible material over the entire available area once every year.
See note 2 below for additional information.

Source: AP-42, 13.2.5 (11/06)													Erodible Area Emissions		
Area	**Pollutant**	**Fastest Mile [1]**	**Fastest Mile**	**# of Times/Yr for New Erodible Material, N [2]**	**Particle Size Multiplier, k [3]**	**Roughness height**	**u10+**	**Friction velocity, u*[4]**	**Threshold friction velocity, u_t [5]**	**Erosion Potential, P_i**	**Emission Factor**	**Erodible Surface Area**	**Annual Emissions**		**Hourly Emissions, based on 8,760 hr/yr**
		(mph)	**(m/s)**			**(m)**	**(m/s)**	**(m/s)**	**(m/s)**	**(g/m^2)**	**(g/m^2/yr)**	**(m^2)**	**(lb/yr)**	**(tons/yr)**	**(lb/hr)**
Pond 7	PM	45	20.12	**1**	1	**0.0001**	20.12	1.07	0.54	29.21	29.21	4,266,730	274,796	137.40	31.37
	PM10	45	20.12	1	0.5	0.0001	20.12	1.07	0.54	29.21	14.61	4,266,730	137,398	68.70	15.68
	PM2.5	45	20.12	1	0.075	0.0001	20.12	1.07	0.54	29.21	2.19	4,266,730	20,610	10.30	2.35

Notes:
[1] The fastest mile (maximum 2-minute wind data from the 2007-2010) obtained from the Silver City station.

[2] For inactive areas, no new erodible material is placed. For purposes of providing a conservative estimate of emissions, N is set equal to 1. For the active area, new material is placed over the entire surface every two years (G. Andazola, 5/6/11 phone call w/ R. Felty) and N is set equal to 1 to represent the new erodible material.
[3] k is a particle size multiplier: TSP (30 um), k=1.0; PM10 (<10 um), k=0.5; PM2.5 (<2.5 um), k = 0.075. [AP-42, page 13.2.5-3]
[4] Friction velocity assumes a typical roughness height of 0.5cm for open terrain. [AP-42, page 13.2.5-5]
[5] Due to a lack of site-specific data, the threshold friction velocity is based on fine coal dust on a concrete pad. [AP-42, Table 13.2.5-2]

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Cobre Mine Screening Plant Material Handling Emissions - Magnetite
CB SCRN

	Basis		
Maximum Annual Throughput of Screened Material	1,971,000	tons	[Annual throughput based on projected Cobre Mine material shipments.]
Maximum Annual Throughput of Material Handling	1,971,000	tons	
Maximum Hourly Throughput of Material	450	tons	
Annual Operating Hours	4,380	hrs	**Note: screening plant will only operate during daylight hours.**
Annual Operating Days	365	days	For reference only, not used in calculations.

Federal Hazardous Air Pollutants and New Mexico Toxic Air Pollutants Content of Ore for Mill (%)

Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
7.00E-04	4.00E-04	1.90E-03	2.00E-04	2.50E-03	2.00E-03	5.90E-01	2.70E-03	6.62E-02	1.20E-03	1.00E-04	4.30E-03	1.10E-02

Magnetite	Operating Parameters[1]			Uncontrolled Emission Factors[2,3]			Uncontrolled Emissions[4]																					
	Annual Throughput	Hourly Throughput	Number of Transfer Points	$PM_{2.5}$ (lb/ton)	PM_{10} (lb/ton)	TSP (lb/ton)	$PM_{2.5}$		PM_{10}		TSP		Antimony		Arsenic		Barium		Cadmium		Chromium		Cobalt		Copper			
	tons	tons					lb/hr	TPY	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY		
Screening	1,971,000	450	1	1.31E-03	8.70E-03	2.50E-02	0.59	1.29	3.92	8.57	11.25	24.64	7.88E-05	1.72E-04	4.50E-05	9.86E-05	2.14E-04	4.68E-04	2.25E-05	4.93E-05	2.81E-04	6.16E-04	2.25E-04	4.93E-04	6.64E-02	1.45E-01		
Material Handling	1,971,000	450	4	9.86E-05	6.51E-04	1.38E-03	0.18	0.39	1.17	2.57	2.48	5.43	1.73E-05	3.80E-05	9.91E-06	2.17E-05	4.71E-05	1.03E-04	4.96E-06	1.09E-05	6.20E-05	1.36E-04	4.96E-05	1.09E-04	1.46E-02	3.20E-02		
TOTAL							0.76	1.67	5.09	11.14	13.73	30.06	9.61E-05	2.10E-04	5.49E-05	1.20E-04	2.61E-04	5.71E-04	2.75E-05	6.01E-05	3.43E-04	7.52E-04	2.75E-04	6.01E-04	8.10E-02	1.77E-01		

Magnetite	Operating Parameters[1]			Controlled Emission Factors[2,3]			Controlled Emissions[4]																			
	Annual Throughput	Hourly Throughput	Number of Transfer Points	$PM_{2.5}$ (lb/ton)	PM_{10} (lb/ton)	TSP (lb/ton)	$PM_{2.5}$		PM_{10}		TSP		Antimony		Arsenic		Barium		Cadmium		Chromium		Cobalt		Copper	
	tons	tons					lb/hr	TPY	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY
Screening	1,971,000	450	1	5.00E-05	7.40E-04	2.20E-03	0.02	0.05	0.33	0.73	0.99	2.17	6.93E-06	1.52E-05	3.96E-06	8.67E-06	1.88E-05	4.12E-05	1.98E-06	4.34E-06	2.48E-05	5.42E-05	1.98E-05	4.34E-05	5.84E-03	1.28E-02
Material Handling	1,971,000	450	4	9.86E-05	6.51E-04	1.38E-03	0.18	0.39	1.17	2.57	2.48	5.43	1.73E-05	3.80E-05	9.91E-06	2.17E-05	4.71E-05	1.03E-04	4.96E-06	1.09E-05	6.20E-05	1.36E-04	4.96E-05	1.09E-04	1.46E-02	3.20E-02
TOTAL							0.20	0.438	1.51	3.30	3.47	7.60	2.43E-05	5.32E-05	1.39E-05	3.04E-05	6.59E-05	1.44E-04	6.94E-06	1.52E-05	8.67E-05	1.90E-04	6.94E-05	1.52E-04	2.05E-02	4.48E-02

Notes:

[1]Throughputs and equipment specifications taken from Southern Materials Group (SMG), Cobre Magnetite Dam Mine Plan, Magnetite Screening Operation and Dust Management Plan (May 2011).

[2] Material handling uncontrolled emission factors based on USEPA AP-42 USEPA's Drop Equation in AP-42, Section 13.2.4. Drop equation is as follows:

$$E\left(\frac{lb}{ton}\right) = k \cdot 0.0032 \cdot \frac{\left(\frac{U}{5}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

E = Emission Factor (lbs/ton)
k = Particle Size Multiplier, dimensionless ($PM_{2.5}$= 0.053, PM_{10}= 0.35, PM=0.74)
U = Mean Wind Speed = 6.95 mph (Bayard, NM)
M = Moisture Content = 4% (Based on actual magnetite data from average moisture content)

[3] TSP, PM_{10}, and controlled $PM_{2.5}$ emission factors from AP-42, Chapter 11.19.2, Crushed Stone Processing and Pulverized Mineral Processing, Table 11.19.2-2, Screening; uncontrolled $PM_{2.5}$ emission factor calculated from uncontrolled PM_{10} emission factor using the ratio of 0.15 $PM_{2.5}/PM_{10}$ as recommended in Background Document for AP-42, Chapter 13.2.4, Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006. Total Controlled Emissions include emissions from uncontrolled aggregate handling.

[4] Hourly emissions are based on maximum hourly rate in calculation tables. Annual emissions are based on maximum annual rate in calculation tables.

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Chino Mine Screen Plant Material Handling Emissions
Unit: CH SCRN

Basis			
um Annual Throughput of Screened Material	4,380,000	tons	[Annual throughput based on projected Cobre Mine material shipments.]
ıum Annual Throughput of Material Handling	4,380,000	tons	
Maximum Hourly Throughput of Material	1,000	tons	
Annual Operating Hours	4,380	hrs	**Note: screening plant will only operate during daylight hours.**
Annual Operating Days	365	days	For reference only, not used in calculations.

Federal Hazardous Air Pollutants and New Mexico Toxic Air Pollutants Content of Ore for Mill (%)

Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
7.00E-04	4.00E-04	1.90E-03	2.00E-04	2.50E-03	2.00E-03	5.90E-01	2.70E-03	6.62E-02	1.20E-03	1.00E-04	4.30E-03	1.10E-02

Storage Pile Material	Parameters[1]			Uncontrolled Emission Factors[2,3]			Uncontrolled Emissions					
	Annual Throughput	Hourly Throughput	Number of Transfer Points	$PM_{2.5}$ Loading (lb/ton)	PM_{10} Loading (lb/ton)	TSP Loading (lb/ton)	$PM_{2.5}$		PM_{10}		TSP	
	tons	tons					lb/hr	TPY	lb/hr	TPY	lb/hr	TPY
Screening	4,380,000	1,000	2	1.31E-03	8.70E-03	2.50E-02	2.61	5.72	17.40	38.11	50.00	109.50
Conveyor Transfer Point	4,380,000	1,000	6	1.65E-04	1.10E-03	3.00E-03	0.99	2.17	6.60	14.45	18.00	39.42
Aggregate Handling	4,380,000	1,000	4	2.60E-04	1.72E-03	3.63E-03	1.04	2.28	6.87	15.05	14.53	31.83
TOTAL							4.64	10.16	30.87	67.61	82.53	180.75

Storage Pile Material	Antimony		Arsenic		Barium		Cadmium		Chromium		Cobalt		Copper	
	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY
Screening	3.50E-04	7.67E-04	2.00E-04	4.38E-04	9.50E-04	2.08E-03	1.00E-04	2.19E-04	1.25E-03	2.74E-03	1.00E-03	2.19E-03	2.95E-01	6.46E-01
Conveyor Transfer Point	1.26E-04	2.76E-04	7.20E-05	1.58E-04	3.42E-04	7.49E-04	3.60E-05	7.88E-05	4.50E-04	9.86E-04	3.60E-04	7.88E-04	1.06E-01	2.33E-01
Aggregate Handling	1.02E-04	2.23E-04	5.81E-05	1.27E-04	2.76E-04	6.05E-04	2.91E-05	6.37E-05	3.63E-04	7.96E-04	2.91E-04	6.37E-04	8.57E-02	1.88E-01
TOTAL	5.78E-04	1.27E-03	3.30E-04	7.23E-04	1.57E-03	3.43E-03	1.65E-04	3.61E-04	2.06E-03	4.52E-03	1.65E-03	3.61E-03	4.87E-01	1.07E+00

Storage Pile Material	Parameters[1]			Controlled Emission Factors[2,3]			Controlled Emissions					
	Annual Throughput	Hourly Throughput	Number of Transfer Points	$PM_{2.5}$ Loading (lb/ton)	PM_{10} Loading (lb/ton)	TSP Loading (lb/ton)	$PM_{2.5}$		PM_{10}		TSP	
	tons	tons					lb/hr	TPY	lb/hr	TPY	lb/hr	TPY
Screening	4,380,000	1,000	2	5.00E-05	7.40E-04	2.20E-03	0.10	0.22	1.48	3.24	4.40	9.64
Conveyor Transfer Point	4,380,000	1,000	6	1.30E-05	4.60E-05	1.40E-04	0.08	0.17	0.28	0.60	0.84	1.84
Aggregate Handling	4,380,000	1,000	4	2.60E-04	1.72E-03	3.63E-03	1.04	2.28	6.87	15.05	14.53	31.83
TOTAL							**1.22**	**2.67**	**8.63**	**18.90**	**19.77**	**43.30**

Storage Pile Material	Antimony		Arsenic		Barium		Cadmium		Chromium		Cobalt		Copper	
	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY	lb/hr	TPY
Screening	3.08E-05	6.75E-05	1.76E-05	3.85E-05	8.36E-05	1.83E-04	8.80E-06	1.93E-05	1.10E-04	2.41E-04	8.80E-05	1.93E-04	2.60E-02	5.69E-02
Conveyor Transfer Point	5.88E-06	1.29E-05	3.36E-06	7.36E-06	1.60E-05	3.50E-05	1.68E-06	3.68E-06	2.10E-05	4.60E-05	1.68E-05	3.68E-05	4.96E-03	1.09E-02
Aggregate Handling	1.02E-04	2.23E-04	5.81E-05	1.27E-04	2.76E-04	6.05E-04	2.91E-05	6.37E-05	3.63E-04	7.96E-04	2.91E-04	6.37E-04	8.57E-02	1.88E-01
TOTAL	1.38E-04	3.03E-04	7.91E-05	1.73E-04	3.76E-04	8.23E-04	3.95E-05	8.66E-05	4.94E-04	1.08E-03	3.95E-04	8.66E-04	1.17E-01	2.55E-01

Notes:

[1]Throughputs provided by Sherry Burt-Kested email on 5/17/2012. Hourly emissions are based on maximum hourly rating of 1,000 tons/hour. Annual emissions are based on annual throughput of 1,404,000 tons.

[2]Aggregate handling emission factors based on USEPA AP-42 USEPA's Drop Equation in AP-42, Section 13.2.4. Drop equation is as follows:
where,

$$E\left(\frac{lb}{ton}\right) = k \cdot 0.0032 \cdot \frac{\left(\frac{U}{5}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

	TSP	PM_{10}	$PM_{2.5}$	
E	3.63E-03	1.72E-03	2.60E-04	lbs/ton
k	0.74	0.35	0.053	unitless
U	6.95	6.95	6.95	mph
M	2	2	2	%

E = Emission Factor (lbs/ton)
k = Particle Size Multiplier, dimensionless ($PM_{2.5}$= 0.053, PM_{10}= 0.35, PM=0.74)
U = Mean Wind Speed = 6.95 mph (Bayard, NM)
M = Moisture Content = 2% (NMED default value for crushing plants per Feb 2006 spreadsheet by Sam Speaker of NMED)

[3]TSP, PM_{10}, and controlled $PM_{2.5}$ emission factors from AP-42, Chapter 11.19.2, Crushed Stone Processing and Pulverized Mineral Processing, Table 11.19.2-2, Screening; uncontrolled $PM_{2.5}$ emission factor calculated from uncontrolled PM_{10} emission factor using the ratio of 0.15 $PM_{2.5}/PM_{10}$ as recommended in Background Document for AP-42, Chapter 13.2.4, Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006. Controlled emissions are controlled by water spray bars. Total Controlled Emissions include emissions from uncontrolled aggregate handling. Aggregate handling does not include water spray bars.

Freeport-McMoRan Chino Mines Company
Revised: December 2019

Cobre Mine Screening Plant Engine Emissions
Unit CB SCRN ENG

Basis

Engine Size [1]:	175	HP
Fuel Usage:	10.5	gal/hr
Diesel heat value:	137,000	Btu/gallon
Annual Operating Hours[1]:	4,380	

ID	Description	Max fuel use, gal/hr	Diesel heat value, Btu/gal	Max heat input, MMBtu/hr	Annual operating hours	CO		NOx		VOC		PM		PM_{10}		$PM_{2.5}$		SO_2	
						lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr
Screening Plant - CAT C6.6 ACERT Tier 3 Diesel Engine	Diesel Engine	10.5	137,000	1.44	4,380	1.02	2.22	1.16	2.53	0.50	1.10	0.45	0.98	0.45	0.98	0.45	0.98	0.42	0.91

Units	Emission Factors for Diesel Fuel Combustion[3,4]						
	CO	NO_x	VOC	TSP/PM	PM_{10}	$PM_{2.5}$	SO_2
lb/hp-hr	0.0058	0.0066	-	-	-	-	-
lb/MMBtu	-	-	0.35	0.31	0.31	0.31	0.29

FEDERAL HAP/NM TOXIC AIR POLLUTANT EMISSIONS ESTIMATION

Compound		Emission Factor (lb/MMBtu)[5]	Air Emissions	
Pollutant	Species		(lb/hr)	(tpy)
Hazardous Air Pollutants	Benzene	9.33E-04	1.34E-03	2.94E-03
	Acetaldehyde	7.67E-04	1.10E-03	2.42E-03
	Acrolein	9.25E-05	1.33E-04	2.91E-04
	Formaldehyde	1.18E-03	1.70E-03	3.72E-03
	Naphthalene	8.48E-05	1.22E-04	2.67E-04
	Toluene	4.09E-04	5.88E-04	1.29E-03
	Xylenes	2.85E-04	4.10E-04	8.98E-04
TOTAL			**5.40E-03**	**1.18E-02**

Notes:

[1]Engine horsepower and fuel usage based on CAT specification sheet for C6.6 ACERT industrial open power unit. Annual operating hours based on anticipated operation of screening plant.

[2] Fuel usage based on standard conversion factors, engine size, and diesel fuel density of 0.845-0.850 kg/L at 15°C and fuel inlet temperature of 40°C.

[3]CO and NOx emission factors were obtained from NSPS, Tier 3 emission standards for stationary compression ignition (CI) internal combustion engines (ICE) (40 CFR 60.4202- ref. 89.112, Table 1)

[4] VOC, TSP/PM/PM_{10}/$PM_{2.5}$, and SO_2 emission factors were obtained from uncontrolled diesel industrial engines present in Table 3.3-1, USEPA AP-42 Section 3.3 "Gasoline And Diesel Industrial Engines" (10/96).

[5]HAP/Air Toxics emission factors were obtained from Table 3.3-2 in USEPA AP-42 Section 3.3 "Gasoline And Diesel Industrial Engines" (10/96).

Freeport-McMoRan Chino Mines Company
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Chino Mine, Screening Plant - Internal Combustion Engine Emissions
CH SCRN ENG

Basis		
Engine Size [1]:	96	hp
Specific fuel consumption[1]:	208	grams/kWh
Diesel heat value:	137000	Btu/gallon
Annual Operating Hours[1]:	8760	

ID	Description	Max fuel use[2], gal/hr	Diesel heat value, Btu/gal	Max heat input, MMBtu/hr	Annual operating hours	CO		NOx		VOC		PM		PM_{10}		$PM_{2.5}$		SO_2	
						lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr
Screening Plant - 2007 Deutz Diesel Engine (BF4M2012)	Diesel Engine	4.71	137,000	0.65	8,760	0.10	0.45	0.813	3.56	0.018	0.077	0.200	0.876	0.200	0.876	0.200	0.88	0.19	0.82

Units	Emission Factors for Diesel Fuel Combustion[3,4]						
	CO	NO_x	VOC	TSP/PM	PM_{10}	$PM_{2.5}$	SO_2
lb/MMBtu	--	--	--	0.31	0.31	0.31	0.29
grams/hr	47.1	369	8	--	--	--	--

FEDERAL HAP/NM TOXIC AIR POLLUTANT EMISSIONS ESTIMATION

Compound		Emission Factor (lb/MMBtu)[5]	Air Emissions	
Pollutant	Species		(lb/hr)	(tpy)
Hazardous Air Pollutants	Benzene	9.33E-04	6.02E-04	2.64E-03
	Acetaldehyde	7.67E-04	4.95E-04	2.17E-03
	Acrolein	9.25E-05	5.97E-05	2.61E-04
	Formaldehyde	1.18E-03	7.62E-04	3.34E-03
	Naphthalene	8.48E-05	5.47E-05	2.40E-04
	Toluene	4.09E-04	2.64E-04	1.16E-03
	Xylenes	2.85E-04	1.84E-04	8.06E-04
TOTAL			**2.42E-03**	**1.06E-02**

Notes:

[1]Engine horsepower from 1/30/2009 GCP-2 screening plant relocation application. Engine fuel usage rate from Deutz Model BF4M2012 data sheet. Maximum annual operating hours for engine used for modeling purposes.

[2]Fuel usage converted from grams/kilowatt-hour to gallons/hour based on standard conversion factors, engine size, and diesel fuel specific gravity of 0.835 kg/dm^3 at 15°C or density of 6.968 lb/gal. See calculation below.

[3]PM and SO_2 emission factors obtained from uncontrolled diesel industrial engines present in Table 3.3-1, USEPA AP-42 Section 3.3 "Gasoline And Diesel Industrial Engines" (10/96).

[4] CO, VOC, NOx, emission factors are based on manufacturer information (CO = 47.1 g/hr, VOC = 8 g/hr, and NOx = 369 g/hr) submitted with 1/30/2009 GCP-2 relocation application.

[5]HAP/Air Toxics emission factors obtained from Table 3.3-2 in USEPA AP-42 Section 3.3 "Gasoline And Diesel Industrial Engines" (10/96).

Freeport-McMoRan Chino Mines Company
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SXEW - Sulfuric Acid Emission Estimates for the Chino SX/EW Tank House

Units: SXEW SAT

Parameter[(1)]	Value	Units	Notes
A1 (Inlet Area)	6,515	sqft	Based on measurements taken at Chino facility
A2 (Outlet Area)	1,760	sqft	Based on measurements taken at Chino facility
H (Height separating inlet from outlet)	30	ft	Based on measurements taken at Chino facility
Ti (Inside Temperature)	523	deg R (63°F)	Based on measurements taken at Chino facility
To (Outside Temperature)	515	deg R (55.2°F)	Based on measurements taken at Chino facility
h (Natural plane calculation)	**2.01**	ft	Equation 8
Cv (effectiveness of openings)	0.55	-	Page 26.11 of ASHRAE HVAC Handbook 2001
Aw (Area of openings)	1,260	sqft	Based on measurements taken at Chino facility
V (Wind speed)[(3)]	10.00	MPH	Based on meteorological data at Chino facility
Qw (Wind effect calc.)	**609,840**	cfm	Equation 1
A (Area)	1,760	sqft	Based on measurements taken at Chino facility
Cs (Stack effect coefficient)	0.0449	-	26.22 Table 7 of of ASHRAE HVAC Handbook 2001
h (Natural plane calculation)	2.01	ft	Equation 8
Ti (Inside Temperature)	523	deg R	Based on measurements taken at Chino facility
dT (Temperature difference)	7.47	deg R	Ti - To
Fc (Correction Factor)	1.37	-	Figure 7 on Page 26.11 of ASHRAE HVAC Handbook 2001
Qs (Thermal effect calc.)	**8,837**	cfm	Equation 9
Q_{Total} (combined wind & thermal)	**609,904**	**cfm**	Equation 10
H_2SO_4 Concentration	1.00	mg/m^3	Maximum OEL for an 8 hour work shift
H_2SO_4 Concentration	6.24E-08	lb/cf	Unit conversion
ACID MIST EMISSIONS (classified as PM_{10})	2.282	lb/hr	(lb/year) / (8,760 hours/year)
	19,994	lb/yr	Equation 12
	10.00	**TPY**	(lb/year) / (2,000 lbs/ton)

Notes:

[1] Equipment information and specs provided by Clyde Durham, Sr. Environmental Engineer Chino, ELWD, Air Compliance Programs. Data taken from 1997 Notice of Intent submitted to NMED.

[2] Calculation method based on American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) 2001 Fundamentals Handbook.

[3]Average wind speed obtained from on-site MET station data.

[4] H_2SO_4 concentration is the OEL for an 8 hour work shift

Conversions:
1 lb = 454 grams
1 ft = 0.3048 m
cf = cubic foot
cm = cubic meter
cfm = cubic feet per minute

Freeport-McMoRan Chino Mines Company
Revised: December 2019

SXEW - Sulfuric Acid Emission Estimates for the Chino SX/EW Tank House
Units: SXEW SAT

EMISSIONS BASED ON THE FOLLOWING ASHRAE EQUATIONS:
See Section 7 for additional details.

Flow due to wind effect: $Q_w = (88)C_w A_w V$ (Eqn. 1)

where,
Q_W = wind effect air flow (ft^3/min)
C_V= effectiveness of openings (orifice coefficient)
A_W = area of windward inlet openings (ft^2)
V = wind velocity (MPH)
88 = conversion factor (MPH to ft/min)

Flow due to stack effect: $h_{th} = h(1 - s_h)$ (Eqn. 2)

where,
h_{Th}= thermostatic head (ft of air)
h = height of feet of hot air in an enclosure
s_h = specific gravity of hot air relative to cold air

Since the specific gravity of the cooler air is equal to unity (as point of reference), becomes: $s_h = \frac{s_c T_o}{T_i} = \frac{T_o}{T_i}$ (Eqn. 3)

where,
s_c = specific gravity of cool air in an enclosure
T_i = absolute temperature of the hot interior air
T_o = absolute temperature of the cooler air

Combining Eqns. 2 & 3: $h_{th} = h(1 - \frac{T_o}{T_i}) = h\frac{(T_i - T_o)}{T_i} = h\frac{\Delta T}{T_i}$ (Eqn. 4)

Since the value of h_{Th} is in feet of air, it can be used directly in the following equation to ascertain velocity through an orifice: $v = C_s\sqrt{2gh_{th}}$ (Eqn. 5)

where,
v = orifice velocity (ft/s)
Cs = effectiveness of openings (orifice coefficient)
g = gravitational constant (32.2 ft/s^2)
h_{Th}= thermostatic head (ft)

Combining Eqns. 4 & 5: $v = C_s\sqrt{(2)(32.2)h\frac{\Delta T}{T_i}} = 8.02C_s\sqrt{h\frac{\Delta T}{T_i}}$ (Eqn. 6)

Orifice flowrates can be calculated by multiplying the orifice velocity by the orifice cross sectional area: $Q_s = (8.02)(60)C_s A\sqrt{h\frac{\Delta T}{T_i}}$ (Eqn. 7)

where,
Q_s = stack effect air flow (ft_3/min)
A = flow area (ft^2)
60 = conversion factor (ft/s to ft/min)

SXEW - Sulfuric Acid Emission Estimates for the Chino SX/EW Tank House

Units: SXEW SAT

According to the ASHRAE Fundamentals Handbook, the thermal effect flowrate is greatest when the inlet and outlet openings are equal. In the case of unequal openings, the smaller area should be used in the equation and the flowrate corrected using a correction factor, F_c, that accounts for the increase in flow (percent). This correction is determined from the ratio of inlet to outlet areas and Figure 7 located on page 26.11 of the 2001 Fundamentals Handbook.

To calculate h, the following equation can be used:

$$h = \frac{H}{1 + \frac{A_1^2 T_i}{A_2^2 T_o}} \qquad \text{(Eqn. 8)}$$

where,

A_1 = area of lower openings (ft^2)

A_2 = area of upper openings (ft^2)

H = distance from lower to upper openings (ft)

Combining Eqns. 7 & 8, taking into account F_c, correction factor:

$$Q_s = (481.2)F_c C_s A \sqrt{\frac{\frac{H\Delta T}{T_i}}{1 + \frac{A_1^2 T_i}{A_2^2 T_o}}} \qquad \text{(Eqn. 9)}$$

Combining wind effect and stack effect flowrates:

$$Q_{Total} = \sqrt{Q_w^2 + Q_s^2} \qquad \text{(Eqn. 10)}$$

Substituting equations (1) and (9) into (10) yields the final equation:

$$Q = \sqrt{(7{,}744)C_w^2 A_w^2 V^2 + (231{,}533.44)F_c^2 C_s^2 A^2 \frac{\frac{H\Delta T}{T_i}}{1 + \frac{A_1^2 T_i}{A_2^2 T_o}}} \qquad (11)$$

Calculation of acid mist emission

When the ventilation rate and acid mist concentration are known, the acid mist emissions can be determined from the following equation:

$$E_A = kQZ \qquad (12)$$

where E_A = Acid mist emission rate (ton/yr)

k = Conversion factor

Z = Acid mist concentration (mg/m^3)

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SX/EW - Propane-fired Boiler Emissions

Units SXEW Boiler No. 1, SXEW Boiler No. 2, SXEW Boiler No. 3

Basis		
Boiler No.1 Max Rating	1.255	MMBtu/hr
Boiler No.2 Max Rating	1.255	MMBtu/hr
Boiler No.3 Max Rating	1.4	MMBtu/hr
LPG Heating Value	91,500	Btu/gallon
Fuel Sulfur content, S	5.3	gr/100 ft^3
Annual Operating Hours	8,760	

ID	Description	Max fuel use, gal/hr[1]	Max heat input,	Annual operating	NOx		CO		VOC		SO_2		TSP		PM_{10}		$PM_{2.5}$	
					lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr
SXEW Boiler No.1	SX/EW Water Heater East	13.72	1.255	8,760	0.18	0.78	0.10	0.45	0.014	0.060	7.27E-03	3.18E-02	0.010	0.042	0.010	0.042	0.010	0.042
SXEW Boiler No.2	SX/EW Water Heater	13.72	1.255	8,760	0.18	0.78	0.10	0.45	0.014	0.060	7.27E-03	3.18E-02	0.010	0.042	0.010	0.042	0.010	0.042
SXEW Boiler No.3	SX/EW Water Heater West	15.30	1.40	8,760	0.20	0.87	0.11	0.50	0.015	0.067	8.11E-03	3.55E-02	0.011	0.047	0.011	0.047	0.011	0.047
TOTAL					**0.56**	**2.43**	**0.320**	**1.40**	**0.043**	**0.187**	**0.0226**	**0.0992**	**0.0299**	**0.131**	**0.0299**	**0.131**	**0.0299**	**0.131**

Units	AP-42 Emission Factors for LPG Combustion[2]						
	CO	NO_x	VOC	TSP/PM	PM_{10}	$PM_{2.5}$	SO_2
lb/10^3gal	7.5	13	1.0	0.7	0.7	0.7	0.530

FEDERAL HAP/NM TOXIC AIR POLLUTANT EMISSIONS ESTIMATION[3]

Notes:

[1] Propane fuel usage, gal/hr, is calculated from heat input (MMBtu/hr) given a natural gas heating value, 91.5 MMBtu/10^3gal.

[2] Based on emission factors for commercial boilers presented in USEPA AP-42 Section 1.5 "Liquefied Petroleum Gas Combustion" (7/08), Table 1.5-1. SO_2 emission factor = 0.10S where S = grains Sulfur/100 ft^3 gas vapor.

[2]Filterable particulate matter (PM) is that PM collected on or prior to the filter of an EPA Method 5 (or equivalent) sampling train. For natural gas, a fuel with similar combustion characteristics, all PM is less than 10 µm in aerodynamic equivalent diameter (PM-

[3] No HAP/TAP emission factors available in USEPA AP-42 Section 1.5 "Liquefied Petroleum Gas Combustion" (7/08).

[4] 2.6 grams SO_2/GJ LPG x 32.064 grams S/64.06 grams SO_2 x 15.43 grains/gram x 1.055 GJ/MMBtu x 0.002516 MMBtu/ft^3 x 100 = 5.3 grains/100ft^3

[4] average national sulfur content of LPG is 0.012% by mass (approximately 2.6 g of SO_2/GJ of heat input) per Appendix K-2 of undated document at US Department of Energy website:
http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/k-2.pdf

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SX/EW -Chemical Summary

Please note that the information provided in the table below is considered CONFIDENTIAL BUSINESS INFORMATION by the chemical suppliers that provided the information.

	Chemical Concentration [ppm]							
Reagent Name	**Benzene**	**Toluene**	**Ethylbenzene**	**Total Xylene**	**1,2,4 - TMB**	**1,3,5 - TMB**	**Total HAPs**	**Other VOCs**
Extractants								
ACORGA M5910	3.35	7.25	3.40	8.60	6.35	3.35		
ACORGA M5640	5.00	17.90	23.30	34.80				
ACORGA OR25	3.35	7.25	3.40	8.60	6.35	3.35		
COGNIS LIX 684N-LV							43.5	60.0
Diluents								
Penreco 170ES	25.0	25.0	25.0	25.0				
Escaid 110							10.0	
Escaid 115							10.0	
ORFOM SX-80	5.00	5.0	5.0	5.0	0.0	0.0	0.0	0.00

Data for ACORGA extractants provided by Cytec.
Data for Penreco 170ES provided by Calumet Specialty Products.
Data for SX-80 provided by Chevron Phillips.
Data for Escaid provided by ExonnMobil.
Data for LIX provided by Cognis.
Blank cells indicate that data for this chemical was not available from the chemical supplier.
1,2,4 - TMB = 1,2,4-trimethylbenzene
1,3,5 - TMB = 1,3,5-trimethylbenzene
Other VOCs represented by octane, heptane, hexane, and pentane.

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SX/EW - Plant Mixer/ Settler Tank Emissions
Unit: SXEW 10MST

Note: The highest emissions from any combination of tank contents is used in the facility-wide emissions summary table.

MAXIMUM SX/EW Plant Mixer/Settler Tank Emissions - Penreco 170ES and ACORGA M5640

The following calculations are based on the BHP Copper VOC study conducted in 1997. A summary and copy of the report is included in Section 7.

number of tanks	6	area of each tank	6,150	ft^2	total area	36,900	ft^2
number of tanks	4	area of each tank	9,776	ft^2	total area	39,104	ft^2

Chemical Product	Percent
Penreco 170ES	92%
ACORGA M5640	8%

Component	D cm^2/sec	MW g/gmole	Ci ppm	Ci g/m^3	Ch ppm	Ch g/m^3	Diff F g/m^2-s	Emission Rate ton/yr-ft^2	Emission Rate tons/year	Emission Rate lb/hr
Benzene	0.0933	78.11	23.5	7.48E-02	0.0018	5.73E-06	1.14E-06	3.69E-06	0.281	0.064
Toluene	0.0833	92.13	24.5	9.19E-02	0.067	2.51E-04	1.25E-06	4.04E-06	0.307	0.070
Ethylbenzene	0.0760	106.16	24.9	1.08E-01	0.057	2.46E-04	1.34E-06	4.32E-06	0.328	0.075
Total Xylene	0.0760	106.16	25.7	1.11E-01	0.037	1.61E-04	1.39E-06	4.48E-06	0.340	0.078
1,2,4 - trimethylbenzene	0.066	120.2	0.00	0.000	0.00	0.00E+00	0.00E+00	0.00E+00	0.000	0.000
1,3,5 - trimethylbenzene	0.066	120.2	0.00	0.000	0.000	0.00E+00	0.00E+00	0.00E+00	0.000	0.000
Other VOCs (non-HAPs)	0.066	112.1	0.00	0.000	0.000	0.00E+00	0.00E+00	0.00E+00	0.000	0.000
Total HAPs									**1.26**	**0.29**
Total VOCs									**1.26**	**0.29**

Where: D = constituent diffusivity (from EPA Reference Link for Estimated Diffusion Coefficients in Air and Water; Assumed Pressure of 1 atm, and Temperature of 25.84 deg. C per 1995 met. data)
MW = constituent molecular weight
Ci = constituent concentration at liquid surface, ppm. (from manufacturer data)
Ci, g/m^3, calculated from ideal gas law. Conservative temperature of 25.84 deg. C used based on 1995 meteorological data (Average plus Standard Deviation).

Ch = constituent concentration at 0.61 meter, ppm. Assumed same as BHP's measured concentrations at H=1 m
H = distance above liquid surface = 0.61 m

Chemical	Concentration in ppm							Notes
	Benzene	Toluene	Ethyl-benzene	Xylene	1,2,4 - tmb	1,3,5 - tmb	Other	
Penreco 170ES	25.00	25.00	25.00	25.00	0.00	0.00	0.00	confidential information supplied by Calumet Specialty Products
ACORGA M5640	5.00	17.90	23.30	34.80	0.00	0.00	0.00	confidential information supplied by Cytec
Organic in ppm	23.48	24.46	24.87	25.74	0.00	0.00	0.00	composite concentration, Ci

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SX/EW - Plant Mixer/ Settler Tank Emissions

SX/EW Plant Mixer/Settler Tank Emissions - Penreco 170ES and ACORGA M5910

The following calculations are based on the BHP Copper VOC study conducted in 1997. A summary and copy of the report is included in Section 7

Emissions from the use of ACORGA M5910 also represent emissions from the use of ACORGA OR25 since the chemical constituents are the same

number of tanks	6	area of each tank	6,150	ft^2	total area	36,900	ft^2
number of tanks	4	area of each tank	9,776	ft^2	total area	39,104	ft^2

Chemical Product	Percent
Penreco 170ES	92%
ACORGA M5910	8%

Component	D cm^2/sec	MW g/gmole	Ci ppm	Ci g/m^3	Ch ppm	Ch g/m^3	Diff F g/m^2-s	Emission Rate ton/yr-ft^2	Emission Rate tons/year	Emission Rate lb/hr
Benzene	0.0933	78.11	23.4	7.44E-02	0.0018	5.73E-06	1.14E-06	3.67E-06	0.28	0.06
Toluene	0.0833	92.13	23.7	8.88E-02	0.067	2.51E-04	1.21E-06	3.91E-06	0.30	0.07
Ethylbenzene	0.0760	106.16	23.4	1.01E-01	0.057	2.46E-04	1.26E-06	4.06E-06	0.31	0.07
Total Xylene	0.0760	106.16	23.8	1.03E-01	0.037	1.61E-04	1.28E-06	4.13E-06	0.31	0.07
1,2,4 - trimethylbenzene	0.066	120.2	0.48	0.002	0.00	0.00E+00	2.54E-08	8.21E-08	6.24E-03	1.42E-03
1,3,5 - trimethylbenzene	0.066	120.2	0.25	0.001	0.000	0.00E+00	1.34E-08	4.33E-08	3.29E-03	7.52E-04
Other VOCs (non-HAPs)	0.066	112.1	0.00	0.000	0.000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total HAPs									1.20	0.27
Total VOCs									1.21	0.28

Where: D = constituent diffusivity (from EPA Reference Link for Estimated Diffusion Coefficients in Air and Water; Assumed Pressure of 1 atm, and Temperature of 25.84 deg. C per 1995 met. data)
MW = constituent molecular weight
Ci = constituent concentration at liquid surface, ppm. (from manufacturer data)
Ci, g/m^3, calculated from ideal gas law. Conservative temperature of 25.84 deg. C used based on 1995 meteorological data (Average plus Standard Deviation).
Ch = constituent concentration at 0.61 meter, ppm. Assumed same as BHP's measured concentrations at H=1 r
H = distance above liquid surface = 0.61 m

Chemical	Concentration in ppm							Notes
	Benzene	Toluene	Ethyl-benzene	Xylene	1,2,4 - tmb	1,3,5 - tmb	Other	
Penreco 170ES	25.00	25.00	25.00	25.00	0.00	0.00	0.00	confidential information supplied by Calumet Specialty Products
ACORGA M5910	3.35	7.25	3.40	8.60	6.35	3.35	0.00	confidential information supplied by Cytec
Organic in ppm	23.35	23.65	23.36	23.75	0.48	0.25	0.00	composite concentration, Ci

SX/EW - Plant Mixer/ Settler Tank Emissions

SX/EW Plant Mixer/Settler Tank Emissions - Penreco 170ES and COGNIS LIX 684N-LV

The following calculations are based on the BHP Copper VOC study conducted in 1997. A summary and copy of the report is included in Section 7.

number of tanks	6	area of each tank	6,150	ft^2	total area	36,900	ft^2
number of tanks	4	area of each tank	9,776	ft^2	total area	39,104	ft^2

Chemical Product	Percent
Penreco 170ES	92%
COGNIS LIX 684N-LV	8%

Component	D cm^2/sec	MW g/gmole	Ci ppm	Ci g/m^3	Ch ppm	Ch g/m^3	Diff F g/m^2-s	Emission Rate ton/yr-ft^2	Emission Rate tons/year	Emission Rate lb/hr
Benzene	0.0933	78.11	23.1	7.35E-02	0.0018	5.73E-06	1.12E-06	3.63E-06	0.276	0.063
Toluene	0.0833	92.13	23.1	8.67E-02	0.067	2.51E-04	1.18E-06	3.81E-06	0.290	0.066
Ethylbenzene	0.0760	106.16	23.1	1.00E-01	0.057	2.46E-04	1.24E-06	4.01E-06	0.305	0.070
Total Xylene	0.0760	106.16	23.1	1.00E-01	0.037	1.61E-04	1.24E-06	4.02E-06	0.305	0.070
Total HAPs(1)	0.082	103.94	3.31	0.014	0.60	2.54E-03	1.54E-07	4.99E-07	0.019	0.004
1,2,4 - trimethylbenzene	0.066	120.2	0.00	0.000	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,3,5 - trimethylbenzene	0.066	120.2	0.00	0.000	0.000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Other VOCs (non-HAPs)	0.066	112.1	4.56	0.021	0.000	0.00E+00	2.24E-07	7.23E-07	5.50E-02	1.26E-02
Total HAPs									1.20	0.27
Total VOCs									1.25	0.29

(1) Total HAPs Molecular weight and Ch, ppm is obtained by determining the average of total HAP constituents within the product.

Where: D = constituent diffusivity (from EPA Reference Link for Estimated Diffusion Coefficients in Air and Water; Assumed Pressure of 1 atm, anc Temperature of 25.84 deg. C per 1995 met. data)
MW = constituent molecular weight
Ci = constituent concentration at liquid surface, ppm. (from manufacturer data)
Ci, g/m^3, calculated from ideal gas law. Conservative temperature of 25.84 deg. C used based on 1995 meteorological data (Average plus Standard Deviation).
Ch = constituent concentration at 0.61 meter, ppm. Assumed same as BHP's measured concentrations at H=1 m
H = distance above liquid surface = 0.61 m

Chemical	Concentration in ppm								Notes
	Benzene	Toluene	Ethylbenzene	Total Xylene	Total HAPs	1,2,4 - TMB	1,3,5 - TMB	Other VOCs	
Penreco 170ES	25.00	25.00	25.00	25.00	0.00	0.00	0.00	0.00	confidential information supplied by Calumet Specialty Products
COGNIS LIX 684N-LV	0.00	0.00	0.00	0.00	43.50	0.00	0.00	60.00	confidential information supplied by Cytec
Organic in ppm	23.10	23.10	23.10	23.10	3.31	0.00	0.00	4.56	composite concentration, Ci

SX/EW - Plant Mixer/ Settler Tank Emissions

SX/EW Plant Mixer/Settler Tank Emissions - Escaid 110 and ACORGA M5910

The following calculations are based on the BHP Copper VOC study conducted in 1997. A summary and copy of the report is included in Section 7.

Emissions from the use of Escaid 110 also represent emissions from the use of Escaid 115 since the chemical constituents are the same
Emissions from the use of ACORGA M5910 also represent emissions from the use of ACORGA OR25 since the chemical constituents are the same

number of tanks	6	area of each tank	6,150	ft^2	total area	36,900	ft^2
number of tanks	4	area of each tank	9,776	ft^2	total area	39,104	ft^2

Chemical Product	Percent
Escaid 110	92%
ACORGA M5910	8%

Component	D cm^2/sec	MW g/gmole	Ci ppm	Ci g/m^3	Ch ppm	Ch g/m^3	Diff F g/m^2-s	Emission Rate ton/yr-ft^2	Emission Rate tons/year	Emission Rate lb/hr
Benzene	0.0933	78.11	0.25	8.11E-04	0.0018	5.73E-06	1.23E-08	3.98E-08	3.02E-03	6.90E-04
Toluene	0.0833	92.13	0.55	2.07E-03	0.067	2.51E-04	2.48E-08	8.02E-08	6.09E-03	1.39E-03
Ethylbenzene	0.0760	106.16	0.26	1.12E-03	0.057	2.46E-04	1.09E-08	3.51E-08	2.67E-03	6.09E-04
Total Xylene	0.0760	106.16	0.65	2.83E-03	0.037	1.61E-04	3.32E-08	1.07E-07	8.16E-03	1.86E-03
Total HAPs(1)	0.082	103.94	9.24	0.039	0.60	2.54E-03	4.93E-07	1.59E-06	1.21E-01	2.76E-02
1,2,4 - trimethylbenzene	0.066	120.19	0.48	0.002	0.00	0.00E+00	2.54E-08	8.21E-08	6.24E-03	1.42E-03
1,3,5 - trimethylbenzene	0.066	120.19	0.25	0.001	0.000	0.00E+00	1.34E-08	4.33E-08	3.29E-03	7.52E-04
Other VOCs (non-HAPs)	0.066	112.06	0.00	0.000	0.000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total HAPs									0.141	0.032
Total VOCs									0.150	0.034

(1) Total HAPs Molecular weight and Ch, ppm is obtained by determining the average of total HAP constituents within the product.

Where: D = constituent diffusivity (from EPA Reference Link for Estimated Diffusion Coefficients in Air and Water; Assumed Pressure of 1 atm, anc
Temperature of 25.84 deg. C per 1995 met. data)
MW = constituent molecular weight
Ci = constituent concentration at liquid surface, ppm. (from manufacturer data)
Ci, g/m^3, calculated from ideal gas law. Conservative temperature of 25.84 deg. C used based on 1995 meteorological data (Average plus Standard Deviation).
Ch = constituent concentration at 0.61 meter, ppm. Assumed same as BHP's measured concentrations at H=1 r
H = distance above liquid surface = 0.61 m

Chemical	Concentration in ppm								Notes
	Benzene	Toluene	Ethylbenzene	Total Xylene	Total HAPs	1,2,4 - TMB	1,3,5 - TMB	Other VOCs	
Escaid 110	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	confidential information supplied by ExxonMobil
ACORGA M5910	3.35	7.25	3.40	8.60	0.00	6.35	3.35	0.00	confidential information supplied by Cytec
Organic in ppm	0.25	0.55	0.26	0.65	9.24	0.48	0.25	0.00	composite concentration, Ci

Freeport-McMoRan Chino Mines Company
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SX/EW - Plant Mixer/ Settler Tank Emissions

SX/EW Plant Mixer/Settler Tank Emissions - Escaid 110 and Cognis LIX 684N-LV

The following calculations are based on the BHP Copper VOC study conducted in 1997. A summary and copy of the report is included in Section 7.

Emissions from the use of Escaid 110 also represent emissions from the use of Escaid 115 since the chemical constituents are the same.

number of tanks	6	area of each tank	6,150	ft^2	total area	36,900	ft^2
number of tanks	4	area of each tank	9,776	ft^2	total area	39,104	ft^2

Chemical Product	Percent
Escaid 110	92%
COGNIS LIX 684N-LV	8%

Component	D cm^2/sec	MW g/gmole	Ci ppm	Ci g/m^3	Ch ppm	Ch g/m^3	Diff F g/m^2-s	Emission Rate ton/yr-ft^2	Emission Rate tons/year	Emission Rate lb/hr
Benzene	0.0933	78.11	0.00	0.00E+00	0.0018	5.73E-06	-8.77E-11	-2.83E-10	-2.15E-05	-4.91E-06
Toluene	0.0833	92.13	0.00	0.00E+00	0.067	2.51E-04	-3.43E-09	-1.11E-08	-8.41E-04	-1.92E-04
Ethylbenzene	0.0760	106.16	0.00	0.00E+00	0.057	2.46E-04	-3.06E-09	-9.89E-09	-7.52E-04	-1.72E-04
Total Xylene	0.0760	106.16	0.00	0.00E+00	0.037	1.61E-04	-2.00E-09	-6.46E-09	-4.91E-04	-1.12E-04
Total HAPs(1)	0.082	103.9	9.24	0.039	0.60	2.54E-03	4.93E-07	1.59E-06	1.21E-01	2.76E-02
1,2,4 - trimethylbenzene	0.066	120.2	0.00	0.000	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,3,5 - trimethylbenzene	0.066	120.2	3.31	0.016	0.000	0.00E+00	1.74E-07	5.63E-07	4.28E-02	9.76E-03
Other VOCs (non-HAPs)	0.066	112.1	4.56	0.021	0.000	0.00E+00	2.24E-07	7.23E-07	5.50E-02	1.26E-02
Total HAPs									0.119	0.027
Total VOCs									0.217	0.049

(1) Total HAPs Molecular weight and Ch, ppm is obtained by determining the average of total HAP constituents within the product.

Where: D = constituent diffusivity (from EPA Reference Link for Estimated Diffusion Coefficients in Air and Water; Assumed Pressure of 1 atm, anc
Temperature of 25.84 deg. C per 1995 met. data)
MW = constituent molecular weight
Ci = constituent concentration at liquid surface, ppm. (from manufacturer data)
Ci, g/m^3, calculated from ideal gas law. Conservative temperature of 25.84 deg. C used based on 1995 meteorological data (Average plus Standard Deviation).
Ch = constituent concentration at 0.61 meter, ppm. Assumed same as BHP's measured concentrations at H=1 r
H = distance above liquid surface = 0.61 m

Chemical	Concentration in ppm								Notes
	Benzene	Toluene	Ethylbenzene	Total Xylene	Total HAPs	1,2,4 - TMB	1,3,5 - TMB	Other VOCs	
Escaid 110	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	confidential information supplied by ExxonMobil
COGNIS LIX 684N-LV	0.00	0.00	0.00	0.00	0.00	0.00	43.50	60.00	confidential information supplied by Cytec
Organic in ppm	0.00	0.00	0.00	0.00	9.24	0.00	3.31	4.56	composite concentration, Ci

SX/EW Plant Mixer/Settler Tank Emissions - Escaid 110 and ACORGA M5640

The following calculations are based on the BHP Copper VOC study conducted in 1997. A summary and copy of the report is included in Section 7.

Emissions from the use of Escaid 110 also represent emissions from the use of Escaid 115 since the chemical constituents are the same.

number of tanks	6	area of each tank	6,150	ft^2	total area	36,900	ft^2
number of tanks	4	area of each tank	9,776	ft^2	total area	39,104	ft^2

Chemical Product	Percent
Escaid 110	92%
ACORGA M5640	8%

Component	D cm^2/sec	MW g/gmole	Ci ppm	Ci g/m^3	Ch ppm	Ch g/m^3	Diff F g/m^2-s	Emission Rate ton/yr-ft^2	Emission Rate tons/year	Emission Rate lb/hr
Benzene	0.0933	78.11	0.38	1.21E-03	0.0018	5.73E-06	1.84E-08	5.95E-08	4.52E-03	1.03E-03
Toluene	0.0833	92.13	1.36	5.11E-03	0.067	2.51E-04	6.63E-08	2.14E-07	1.63E-02	3.72E-03
Ethylbenzene	0.0760	106.16	1.77	7.66E-03	0.057	2.46E-04	9.24E-08	2.98E-07	2.27E-02	5.18E-03
Total Xylene	0.0760	106.16	2.64	1.14E-02	0.037	1.61E-04	1.41E-07	4.54E-07	3.45E-02	7.88E-03
Total HAPs(1)	0.082	103.9	9.24	0.039	0.600	2.54E-03	4.93E-07	1.59E-06	1.21E-01	2.76E-02
1,2,4 - trimethylbenzene	0.066	120.2	0.00	0.000	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,3,5 - trimethylbenzene	0.066	120.2	0.00	0.000	0.000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Other VOCs (non-HAPs)	0.066	112.1	0.00	0.000	0.000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total HAPs									0.199	0.045
Total VOCs									0.199	0.045

(1) Total HAPs Molecular weight and Ch, ppm is obtained by determining the average of total HAP constituents within the product.

Where: D = constituent diffusivity (from EPA Reference Link for Estimated Diffusion Coefficients in Air and Water; Assumed Pressure of 1 atm, anc
Temperature of 25.84 deg. C per 1995 met. data)
MW = constituent molecular weight
Ci = constituent concentration at liquid surface, ppm. (from manufacturer data)
Ci, g/m^3, calculated from ideal gas law. Conservative temperature of 25.84 deg. C used based on 1995 meteorological data (Average plus Standard Deviation).
Ch = constituent concentration at 0.61 meter, ppm. Assumed same as BHP's measured concentrations at H=1 r
H = distance above liquid surface = 0.61 m

Chemical	Concentration in ppm								Notes
	Benzene	Toluene	Ethylbenzene	Total Xylene	Total HAPs	1,2,4 - TMB	1,3,5 - TMB	Other VOCs	
Escaid 110	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	confidential information supplied by ExxonMobil
ACORGA M5640	5.00	17.90	23.30	34.80	0.00	0.00	0.00	0.00	confidential information supplied by Cytec
Organic in ppm	0.38	1.36	1.77	2.64	9.24	0.00	0.00	0.00	composite concentration, Ci

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SX/EW - Plant Mixer/ Settler Tank Emissions

SX/EW Plant Mixer/Settler Tank Emissions - ORFOM SX-80 and ACORGA M5910

The following calculations are based on the BHP Copper VOC study conducted in 1997. A summary and copy of the report is included in Section 7.

Emissions from the use of ACORGA M5910 also represent emissions from the use of ACORGA OR25 since the chemical constituents are the same

number of tanks	6	area of each tank	6,150	ft^2	total area	36,900	ft^2
number of tanks	4	area of each tank	9,776	ft^2	total area	39,104	ft^2

Chemical Product	Percent
ORFOM SX-80	92%
ACORGA M5910	8%

Component	D cm^2/sec	MW g/gmole	Ci ppm	Ci g/m^3	Ch ppm	Ch g/m^3	Diff F g/m^2-s	Emission Rate ton/yr-ft^2	Emission Rate tons/year	Emission Rate lb/hr
Benzene	0.0933	78.11	4.87	1.55E-02	0.0018	5.73E-06	2.37E-07	7.66E-07	0.06	0.01
Toluene	0.0833	92.13	5.17	1.94E-02	0.067	2.51E-04	2.62E-07	8.45E-07	0.06	0.01
Ethylbenzene	0.0760	106.16	4.88	2.11E-02	0.057	2.46E-04	2.60E-07	8.40E-07	0.06	0.01
Total Xylene	0.0760	106.16	5.27	2.28E-02	0.037	1.61E-04	2.82E-07	9.12E-07	0.07	0.02
Total HAPs(1)	0.082	103.94	0.00	0.000	0.60	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
1,2,4 - trimethylbenzene	0.066	120.19	0.48	0.002	0.00	0.00E+00	2.54E-08	8.21E-08	0.01	0.00
1,3,5 - trimethylbenzene	0.066	120.19	0.25	0.001	0.000	0.00E+00	1.34E-08	4.33E-08	0.00	0.00
Other VOCs (non-HAPs)	0.066	112.06	0.00	0.000	0.000	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
Total HAPs									0.256	0.058
Total VOCs									0.265	0.061

(1) Total HAPs Molecular weight and Ch, ppm is obtained by determining the average of total HAP constituents within the product.

Where: D = constituent diffusivity (from EPA Reference Link for Estimated Diffusion Coefficients in Air and Water; Assumed Pressure of 1 atm, anc Temperature of 25.84 deg. C per 1995 met. data)
MW = constituent molecular weight
Ci = constituent concentration at liquid surface, ppm. (from manufacturer data)
Ci, g/m^3, calculated from ideal gas law. Conservative temperature of 25.84 deg. C used based on 1995 meteorological data (Average plus Standard Deviation).
Ch = constituent concentration at 0.61 meter, ppm. Assumed same as BHP's measured concentrations at H=1 r
H = distance above liquid surface = 0.61 m

Chemical	Concentration in ppm								Notes
	Benzene	Toluene	Ethylbenzene	Total Xylene	Total HAPs	1,2,4 - TMB	1,3,5 - TMB	Other VOCs	
ORFOM SX-80	5.00	5.00	5.00	5.00	0.00	0.00	0.00	0.00	confidential information supplied by Chevron Phillips
ACORGA M5910	3.35	7.25	3.40	8.60	0.00	6.35	3.35	0.00	confidential information supplied by Cytec
Organic in ppm	4.87	5.17	4.88	5.27	0.00	0.48	0.25	0.00	composite concentration, Ci

Freeport-McMoRan Chino Mines Company
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SX/EW - Plant Mixer/ Settler Tank Emissions

SX/EW Plant Mixer/Settler Tank Emissions - ORFOM SX-80 and Cognis LIX 684N-LV

The following calculations are based on the BHP Copper VOC study conducted in 1997. A summary and copy of the report is included in Section 7.

number of tanks	6	area of each tank	6,150	ft^2	total area	36,900	ft^2
number of tanks	4	area of each tank	9,776	ft^2	total area	39,104	ft^2

Chemical Product	Percent
ORFOM SX-80	92%
COGNIS LIX 684N-LV	8%

Component	D cm^2/sec	MW g/gmole	Ci ppm	Ci g/m^3	Ch ppm	Ch g/m^3	Diff F g/m^2-s	Emission Rate ton/yr-ft^2	Emission Rate tons/year	Emission Rate lb/hr
Benzene	0.0933	78.11	4.62	1.47E-02	0.0018	5.73E-06	2.25E-07	7.26E-07	0.06	0.01
Toluene	0.0833	92.13	4.62	1.73E-02	0.067	2.51E-04	2.33E-07	7.54E-07	0.06	0.01
Ethylbenzene	0.0760	106.16	4.62	2.00E-02	0.057	2.46E-04	2.46E-07	7.95E-07	0.06	0.01
Total Xylene	0.0760	106.16	4.62	2.00E-02	0.037	1.61E-04	2.47E-07	7.98E-07	0.06	0.01
Total HAPs[(1)]	0.082	103.9	3.31	0.014	0.60	2.54E-03	1.54E-07	4.99E-07	0.04	0.01
1,2,4 - trimethylbenzene	0.066	120.2	0.00	0.000	0.00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
1,3,5 - trimethylbenzene	0.066	120.2	0.00	0.000	0.000	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
Other VOCs (non-HAPs)	0.066	112.1	4.56	0.021	0.000	0.00E+00	2.24E-07	7.23E-07	0.05	0.01
Total HAPs									0.27	0.06
Total VOCs									0.33	0.07

(1) Total HAPs Molecular weight and Ch, ppm is obtained by determining the average of total HAP constituents within the product.

Where: D = constituent diffusivity (from EPA Reference Link for Estimated Diffusion Coefficients in Air and Water; Assumed Pressure of 1 atm, anc
Temperature of 25.84 deg. C per 1995 met. data)
MW = constituent molecular weight
Ci = constituent concentration at liquid surface, ppm. (from manufacturer data)
Ci, g/m^3, calculated from ideal gas law. Conservative temperature of 25.84 deg. C used based on 1995 meteorological data (Average plus Standard Deviation).
Ch = constituent concentration at 0.61 meter, ppm. Assumed same as BHP's measured concentrations at H=1 r
H = distance above liquid surface = 0.61 m

Chemical	Concentration in ppm								Notes
	Benzene	Toluene	Ethylbenzene	Total Xylene	Total HAPs	1,2,4 - TMB	1,3,5 - TMB	Other VOCs	
ORFOM SX-80	5.00	5.00	5.00	5.00	0.00	0.00	0.00	0.00	confidential information supplied by Chevron Phillips
COGNIS LIX 684N-LV	0.00	0.00	0.00	0.00	43.50	0.00	0.00	60.00	confidential information supplied by Cytec
Organic in ppm	4.62	4.62	4.62	4.62	3.31	0.00	0.00	4.56	composite concentration, Ci

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SX/EW - Plant Mixer/ Settler Tank Emissions

SX/EW Plant Mixer/Settler Tank Emissions - ORFOM SX-80 and ACORGA M5640

The following calculations are based on the BHP Copper VOC study conducted in 1997. A summary and copy of the report is included in Section 7.

number of tanks	6	area of each tank	6,150	ft^2	total area	36,900	ft^2
number of tanks	4	area of each tank	9,776	ft^2	total area	39,104	ft^2

Chemical Product	Percent
ORFOM SX-80	92%
ACORGA M5640	8%

Component	D cm^2/sec	MW g/gmole	Ci ppm	Ci g/m^3	Ch ppm	Ch g/m^3	Diff F g/m^2-s	Emission Rate ton/yr-ft^2	Emission Rate tons/year	Emission Rate lb/hr
Benzene	0.0933	78.11	5.00	1.59E-02	0.0018	5.73E-06	2.43E-07	7.86E-07	0.06	0.01
Toluene	0.0833	92.13	5.98	2.25E-02	0.067	2.51E-04	3.03E-07	9.79E-07	0.07	0.02
Ethylbenzene	0.0760	106.16	6.39	2.77E-02	0.057	2.46E-04	3.41E-07	1.10E-06	0.08	0.02
Total Xylene	0.0760	106.16	7.26	3.14E-02	0.037	1.61E-04	3.90E-07	1.26E-06	0.10	0.02
Total HAPs(1)	0.082	103.9	0.00	0.000	0.600	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
1,2,4 - trimethylbenzene	0.066	120.2	0.00	0.000	0.00	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
1,3,5 - trimethylbenzene	0.066	120.2	0.00	0.000	0.000	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
Other VOCs (non-HAPs)	0.066	112.1	0.00	0.000	0.000	0.00E+00	0.00E+00	0.00E+00	0.00	0.00
Total HAPs									0.314	0.072
Total VOCs									0.314	0.072

(1) Total HAPs Molecular weight and Ch, ppm is obtained by determining the average of total HAP constituents within the product.

Where: D = constituent diffusivity (from EPA Reference Link for Estimated Diffusion Coefficients in Air and Water; Assumed Pressure of 1 atm, anc
Temperature of 25.84 deg. C per 1995 met. data)
MW = constituent molecular weight
Ci = constituent concentration at liquid surface, ppm. (from manufacturer data)
Ci, g/m^3, calculated from ideal gas law. Conservative temperature of 25.84 deg. C used based on 1995 meteorological data (Average plus Standard Deviation).
Ch = constituent concentration at 0.61 meter, ppm. Assumed same as BHP's measured concentrations at H=1 r
H = distance above liquid surface = 0.61 m

Chemical	Concentration in ppm								Notes
	Benzene	Toluene	Ethylbenzene	Total Xylene	Total HAPs	1,2,4 - TMB	1,3,5 - TMB	Other VOCs	
ORFOM SX-80	5.00	5.00	5.00	5.00	0.00	0.00	0.00	0.00	confidential information supplied by Chevron Phillips
ACORGA M5640	5.00	17.90	23.30	34.80	0.00	0.00	0.00	0.00	confidential information supplied by Cytec
Organic in ppm	5.00	5.98	6.39	7.26	0.00	0.00	0.00	0.00	composite concentration, Ci

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SXEW - Raffinate Tank Emissions
Units: SXEW RT

Note: The highest emissions from any combination of tank contents is used in the facility-wide emissions summary table.

MAXIMUM SX/EW Plant 900,000 Gallon Raffinate Tank Emissions - Penreco 170ES and ACORGA M5640

The following calculations are based on the BHP Copper VOC study conducted in 1997. A summary and copy of the report is included in Appendix F, References.

number of tanks	1	area of each tank	5,024 ft^2	total area	5,024 ft^2

Chemical Product	Percent
Penreco 170ES	92%
ACORGA M5640	8%

Component	D cm^2/sec	MW g/gmole	Ci ppm	Ci g/m^3	Ch ppm	Ch g/m^3	Diff F g/m^2-s	Emission Rate ton/yr-ft^2	Emission Rate tons/year	Emission Rate lb/hr
Benzene	0.0933	78.11	23.48	0.0748	0.0018	5.73E-06	1.14E-06	3.69E-06	1.86E-02	4.24E-03
Toluene	0.0833	92.14	24.46	0.092	0.067	2.51E-04	1.25E-06	4.04E-06	2.03E-02	4.63E-03
Ethylbenzene	0.0760	106.17	24.87	0.108	0.057	2.46E-04	1.34E-06	4.32E-06	2.17E-02	4.96E-03
Total Xylene	0.0760	106.16	25.74	0.111	0.037	1.61E-04	1.39E-06	4.48E-06	2.25E-02	5.13E-03
1,2,4 - trimethylbenzene	0.070	120.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1,3,5 - trimethylbenzene	0.070	120.2	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
Other VOCs (non-HAPs)	0.066	112.1	0.00	0.0000	0.00	0.00	0.00	0.00	0.00	0.00
								Total HAPs	**0.083**	**0.019**
								Total VOCs	**0.083**	**0.019**

Where: D = constituent diffusivity (from EPA Reference Link for Estimated Diffusion Coefficients in Air and Water; Assumed Pressure of 1 atm, and Temperature of 25.84 deg. C per 1995 met. data)
MW = constituent molecular weight
Ci = constituent concentration at liquid surface, ppm. (from manufacturer data)
Ci, g/m^3, calculated from ideal gas law. Conservative temperature of 25.84 deg. C used based on 1995 meteorological data (Average plus Standard Deviation).
Ch = constituent concentration at 0.61 meter, ppm. Assumed same as BHP's measured concentrations at H=1 m
H = distance above liquid surface = 0.61 m

Chemical	Concentration in ppm								Notes
	Benzene	Toluene	Ethylbenzene	Total Xylene	1,2,4 - TMB	1,3,5 - TMB	Total HAPs	Other VOCs	
Penreco 170ES	25.00	25.00	25.00	25.00	0.00	0.00	0.00	0.00	confidential information supplied by Calumet Specialty Products
ACORGA M5640	5.00	17.90	23.30	34.80	0.00	0.00	0.00	0.00	confidential information supplied by Cytec
Organic in ppm	23.48	24.46	24.87	25.74	0.00	0.00	0.00	0.00	composite concentration, Ci

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SXEW - Raffinate Tank Emissions
Units: SXEW RT

Note: The highest emissions from any combination of tank contents is used in the facility-wide emissions summary table.

SX/EW Plant 900,000 Gallon Raffinate Tank Emissions - Penreco 170ES and ACORGA M5910

The following calculations are based on the BHP Copper VOC study conducted in 1997. A summary and copy of the report is included in Appendix F, References.

Emissions from the use of ACORGA M5910 also represent emissions from the use of ACORGA OR25 since the chemical constituents are the same.

number of tanks	1	area of each tank	5,024 ft^2	total area	5,024 ft^2

Chemical Product	Percent
Penreco 170ES	92%
ACORGA M5910	8%

Component	D cm^2/sec	MW g/gmole	Ci ppm	Ci g/m^3	Ch ppm	Ch g/m^3	Diff F g/m^2-s	Emission Rate ton/yr-ft^2	Emission Rate tons/year	Emission Rate lb/hr
Benzene	0.0933	78.11	23.35	0.0744	0.0018	5.73E-06	1.14E-06	3.67E-06	1.85E-02	4.21E-03
Toluene	0.0833	92.14	23.65	0.089	0.067	2.51E-04	1.21E-06	3.91E-06	1.96E-02	4.48E-03
Ethylbenzene	0.0760	106.17	23.36	0.101	0.057	2.46E-04	1.26E-06	4.06E-06	2.04E-02	4.65E-03
Total Xylene	0.0760	106.16	23.75	0.103	0.037	1.61E-04	1.28E-06	4.13E-06	2.07E-02	4.74E-03
1,2,4 - trimethylbenzene	0.070	120.2	0.48	0.00	0.0000	0.00E+00	2.72E-08	8.77E-08	4.41E-04	1.01E-04
1,3,5 - trimethylbenzene	0.070	120.2	0.25	0.0012	0.0000	0.00E+00	1.44E-08	4.64E-08	2.33E-04	5.32E-05
Other VOCs (non-HAPs)	0.066	112.1	0.00	0.0000	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Total HAPs	0.079	0.018
								Total VOCs	0.080	0.018

Where: D = constituent diffusivity (from EPA Reference Link for Estimated Diffusion Coefficients in Air and Water; Assumed Pressure of 1 atm, and Temperature of 25.84 deg. C per 1995 met. data)
MW = constituent molecular weight
Ci = constituent concentration at liquid surface, ppm. (from manufacturer data)
Ci, g/m^3, calculated from ideal gas law. Conservative temperature of 25.84 deg. C used based on 1995 meteorological data (Average plus Standard Deviation).
Ch = constituent concentration at 0.61 meter, ppm. Assumed same as BHP's measured concentrations at H=1 m
H = distance above liquid surface = 0.61 m

Chemical	Concentration in ppm							Notes
	Benzene	Toluene	Ethyl-benzene	Xylene	1,2,4 - tmb	1,3,5 - tmb	Other	
Penreco 170ES	25.00	25.00	25.00	25.00	0.00	0.00	0.00	confidential information supplied by Calumet Specialty Products
ACORGA M5910	3.35	7.25	3.40	8.60	6.35	3.35	0.00	confidential information supplied by Cytec
Organic in ppm	23.35	23.65	23.36	23.75	0.48	0.25	0.00	composite concentration, Ci

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SXEW - Raffinate Tank Emissions
Units: SXEW RT

Note: The highest emissions from any combination of tank contents is used in the facility-wide emissions summary table.

SX/EW Plant 900,000 Gallon Raffinate Tank Emissions - Penreco 170ES and COGNIS LIX 684N-LV

The following calculations are based on the BHP Copper VOC study conducted in 1997. A summary and copy of the report is included in Appendix F, References.

number of tanks	1	area of each tank	5,024 ft^2	total area	5,024 ft^2

Chemical Product	Percent
Penreco 170ES	92%
COGNIS LIX 684N-LV	8%

Component	D cm^2/sec	MW g/gmole	Ci ppm	Ci g/m^3	Ch ppm	Ch g/m^3	Diff F g/m^2-s	Emission Rate ton/yr-ft^2	Emission Rate tons/year	Emission Rate lb/hr
Benzene	0.0933	78.11	23.10	0.0735	0.0018	5.73E-06	1.12E-06	3.63E-06	1.83E-02	4.17E-03
Toluene	0.0833	92.14	23.10	0.087	0.067	2.51E-04	1.18E-06	3.82E-06	1.92E-02	4.38E-03
Ethylbenzene	0.0760	106.17	23.10	0.100	0.057	2.46E-04	1.24E-06	4.01E-06	2.02E-02	4.60E-03
Total Xylene	0.0760	106.16	23.10	0.100	0.037	1.61E-04	1.24E-06	4.02E-06	2.02E-02	4.61E-03
Total HAPs(1)	0.082	103.94	3.31	0.014	0.60	2.54E-03	1.54E-07	4.99E-07	2.51E-03	5.72E-04
1,2,4 - trimethylbenzene	0.070	120.2	0.00	0.00	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,3,5 - trimethylbenzene	0.070	120.2	0.00	0.0000	0.0000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Other VOCs (non-HAPs)	0.066	112.1	4.56	0.0208	0.0000	0.00E+00	2.24E-07	7.23E-07	3.63E-03	8.30E-04
								Total HAPs	0.078	0.018
								Total VOCs	0.081	0.019

(1) Total HAPs Molecular weight and Ch, ppm is obtained by determining the average of total HAP constituents within the product.

Where: D = constituent diffusivity (from EPA Reference Link for Estimated Diffusion Coefficients in Air and Water; Assumed Pressure of 1 atm, and Temperature of 25.84 deg. C per 1995 met. data)
MW = constituent molecular weight
Ci = constituent concentration at liquid surface, ppm. (from manufacturer data)
Ci, g/m^3, calculated from ideal gas law. Conservative temperature of 25.84 deg. C used based on 1995 meteorological data (Average plus Standard Deviation).
Ch = constituent concentration at 0.61 meter, ppm. Assumed same as BHP's measured concentrations at H=1 m
H = distance above liquid surface = 0.61 m

Chemical	Concentration in ppm								Notes
	Benzene	Toluene	Ethylbenzene	Total Xylene	1,2,4 - TMB	1,3,5 - TMB	Total HAPs	Other VOCs	
Penreco 170ES	25.00	25.00	25.00	25.00	0.00	0.00	0.00	0.00	confidential information supplied by Calumet Specialty Products
COGNIS LIX 684N-LV	0.00	0.00	0.00	0.00	0.00	0.00	43.50	60.00	confidential information supplied by Cytec
Organic in ppm	23.10	23.10	23.10	23.10	0.00	0.00	3.31	4.56	composite concentration, Ci

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SXEW - Raffinate Tank Emissions
Units: SXEW RT

Note: The highest emissions from any combination of tank contents is used in the facility-wide emissions summary table.

SX/EW Plant 900,000 Gallon Raffinate Tank Emissions - Escaid 110 and ACORGA M5910

The following calculations are based on the BHP Copper VOC study conducted in 1997. A summary and copy of the report is included in Section 7.
Emissions from the use of Escaid 110 also represent emissions from the use of Escaid 115 since the chemical constituents are the same.
Emissions from the use of ACORGA M5910 also represent emissions from the use of ACORGA OR25 since the chemical constituents are the same.

number of tanks	1	area of each tank	5,024 ft^2	total area	5,024 ft^2

Chemical Product	Percent
Escaid 110	92%
ACORGA M5910	8%

Component	D cm^2/sec	MW g/gmole	Ci ppm	Ci g/m^3	Ch ppm	Ch g/m^3	Diff F g/m^2-s	Emission Rate ton/yr-ft^2	Emission Rate tons/year	Emission Rate lb/hr
Benzene	0.0933	78.11	0.25	8.11E-04	0.0018	5.73E-06	1.23E-08	3.98E-08	2.00E-04	4.56E-05
Toluene	0.0833	92.13	0.55	2.07E-03	0.067	2.51E-04	2.48E-08	8.02E-08	4.03E-04	9.20E-05
Ethylbenzene	0.0760	106.16	0.26	1.12E-03	0.057	2.46E-04	1.09E-08	3.51E-08	1.76E-04	4.03E-05
Total Xylene	0.0760	106.16	0.65	2.83E-03	0.037	1.61E-04	3.32E-08	1.07E-07	5.39E-04	1.23E-04
Total HAPs(1)	0.082	103.94	9.24	0.039	0.60	2.54E-03	4.93E-07	1.59E-06	8.00E-03	1.83E-03
1,2,4 - trimethylbenzene	0.066	120.19	0.48	0.002	0.00	0.00E+00	2.54E-08	8.21E-08	4.13E-04	9.42E-05
1,3,5 - trimethylbenzene	0.066	120.19	0.25	0.001	0.000	0.00E+00	1.34E-08	4.33E-08	2.18E-04	4.97E-05
Other VOCs (non-HAPs)	0.066	112.06	0.00	0.000	0.000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Total HAPs	0.009	0.002
								Total VOCs	0.010	0.002

(1) Total HAPs Molecular weight and Ch, ppm is obtained by determining the average of total HAP constituents within the product.

Where: D = constituent diffusivity (from EPA Reference Link for Estimated Diffusion Coefficients in Air and Water; Assumed Pressure of 1 atm, and Temperature of 25.84 deg. C per 1995 met. data)
MW = constituent molecular weight
Ci = constituent concentration at liquid surface, ppm. (from manufacturer data)
Ci, g/m^3, calculated from ideal gas law. Conservative temperature of 25.84 deg. C used based on 1995 meteorological data (Average plus Standard Deviation).
Ch = constituent concentration at 0.61 meter, ppm. Assumed same as BHP's measured concentrations at H=1 m
H = distance above liquid surface = 0.61 m

Chemical	Concentration in ppm								Notes
	Benzene	Toluene	Ethylbenzene	Total Xylene	Total HAPs	1,2,4 - TMB	1,3,5 - TMB	Other VOCs	
Escaid 110	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	confidential information supplied by ExxonMobil
ACORGA M5910	3.35	7.25	3.40	8.60	0.00	6.35	3.35	0.00	confidential information supplied by Cytec
Organic in ppm	0.25	0.55	0.26	0.65	9.24	0.48	0.25	0.00	composite concentration, Ci

Freeport-McMoRan Chino Mines Company
Revised: December 2019

SXEW - Raffinate Tank Emissions
Units: SXEW RT

Note: The highest emissions from any combination of tank contents is used in the facility-wide emissions summary table.

SX/EW Plant 900,000 Gallon Raffinate Tank Emissions - Escaid 110 and COGNIS LIX 684N-LV

The following calculations are based on the BHP Copper VOC study conducted in 1997. A summary and copy of the report is included in Section 7.
Emissions from the use of Escaid 110 also represent emissions from the use of Escaid 115 since the chemical constituents are the same.

number of tanks	1	area of each tank	5,024 ft^2	total area	5,024 ft^2

Chemical Product	Percent
Escaid 110	92%
COGNIS LIX 684N-LV	8%

Component	D cm^2/sec	MW g/gmole	Ci ppm	Ci g/m^3	Ch ppm	Ch g/m^3	Diff F g/m^2-s	Emission Rate ton/yr-ft^2	Emission Rate tons/year	Emission Rate lb/hr
Benzene	0.0933	78.11	0.00	0.00	0.0018	5.73E-06	-8.77E-11	-2.83E-10	-1.42E-06	-3.25E-07
Toluene	0.0833	92.13	0.00	0.00	0.067	2.51E-04	-3.43E-09	-1.11E-08	-5.56E-05	-1.27E-05
Ethylbenzene	0.0760	106.16	0.00	0.00	0.057	2.46E-04	-3.06E-09	-9.89E-09	-4.97E-05	-1.13E-05
Total Xylene	0.0760	106.16	0.00	0.00	0.037	1.61E-04	-2.00E-09	-6.46E-09	-3.25E-05	-7.41E-06
Total HAPs(1)	0.082	103.9	9.24	0.039	0.600	2.54E-03	4.93E-07	1.59E-06	8.00E-03	1.83E-03
1,2,4 - trimethylbenzene	0.066	120.2	0.00	0.000	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,3,5 - trimethylbenzene	0.066	120.2	3.31	0.016	0.000	0.00E+00	1.74E-07	5.63E-07	2.83E-03	6.45E-04
Other VOCs (non-HAPs)	0.066	112.1	4.56	0.021	0.000	0.00E+00	2.24E-07	7.23E-07	3.63E-03	8.30E-04
								Total HAPs	0.008	0.002
								Total VOCs	0.014	0.003

(1) Total HAPs Molecular weight and Ch, ppm is obtained by determining the average of total HAP constituents within the product.

Where: D = constituent diffusivity (from EPA Reference Link for Estimated Diffusion Coefficients in Air and Water; Assumed Pressure of 1 atm, and Temperature of 25.84 deg. C per 1995 met. data)
MW = constituent molecular weight
Ci = constituent concentration at liquid surface, ppm. (from manufacturer data)
Ci, g/m^3, calculated from ideal gas law. Conservative temperature of 25.84 deg. C used based on 1995 meteorological data (Average plus Standard Deviation).
Ch = constituent concentration at 0.61 meter, ppm. Assumed same as BHP's measured concentrations at H=1 m
H = distance above liquid surface = 0.61 m

Chemical	Concentration in ppm								Notes
	Benzene	Toluene	Ethylbenzene	Total Xylene	Total HAPs	1,2,4 - TMB	1,3,5 - TMB	Other VOCs	
Escaid 110	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	confidential information supplied by ExxonMobil
COGNIS LIX 684N-LV	0.00	0.00	0.00	0.00	0.00	0.00	43.50	60.00	confidential information supplied by Cytec
Organic in ppm	0.00	0.00	0.00	0.00	9.24	0.00	3.31	4.56	composite concentration, Ci

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SXEW - Raffinate Tank Emissions
Units: SXEW RT

Note: The highest emissions from any combination of tank contents is used in the facility-wide emissions summary table.

SX/EW Plant 900,000 Gallon Raffinate Tank Emissions - Escaid 110 and ACORGA M5640

The following calculations are based on the BHP Copper VOC study conducted in 1997. A summary and copy of the report is included in Section 7.
Emissions from the use of Escaid 110 also represent emissions from the use of Escaid 115 since the chemical constituents are the same.

number of tanks	1	area of each tank	5,024 ft^2	total area	5,024 ft^2

Chemical Product	Percent
Escaid 110	92%
ACORGA M5640	8%

Component	D cm^2/sec	MW g/gmole	Ci ppm	Ci g/m^3	Ch ppm	Ch g/m^3	Diff F g/m^2-s	Emission Rate ton/yr-ft^2	Emission Rate tons/year	Emission Rate lb/hr
Benzene	0.0933	78.11	0.38	1.21E-03	0.0018	5.73E-06	1.84E-08	5.95E-08	2.99E-04	6.82E-05
Toluene	0.0833	92.13	1.36	5.11E-03	0.067	2.51E-04	6.63E-08	2.14E-07	1.08E-03	2.46E-04
Ethylbenzene	0.0760	106.16	1.77	7.66E-03	0.057	2.46E-04	9.24E-08	2.98E-07	1.50E-03	3.42E-04
Total Xylene	0.0760	106.16	2.64	1.14E-02	0.037	1.61E-04	1.41E-07	4.54E-07	2.28E-03	5.21E-04
Total HAPs(1)	0.082	103.9	9.24	0.039	0.600	2.54E-03	4.93E-07	1.59E-06	8.00E-03	1.83E-03
1,2,4 - trimethylbenzene	0.066	120.2	0.00	0.000	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,3,5 - trimethylbenzene	0.066	120.2	0.00	0.000	0.000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Other VOCs (non-HAPs)	0.066	112.1	0.00	0.000	0.000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Total HAPs	0.013	0.003
								Total VOCs	0.013	0.003

(1) Total HAPs Molecular weight and Ch, ppm is obtained by determining the average of total HAP constituents within the product.

Where: D = constituent diffusivity (from EPA Reference Link for Estimated Diffusion Coefficients in Air and Water; Assumed Pressure of 1 atm, and Temperature of 25.84 deg. C per 1995 met. data)
MW = constituent molecular weight
Ci = constituent concentration at liquid surface, ppm. (from manufacturer data)
Ci, g/m^3, calculated from ideal gas law. Conservative temperature of 25.84 deg. C used based on 1995 meteorological data (Average plus Standard Deviation).
Ch = constituent concentration at 0.61 meter, ppm. Assumed same as BHP's measured concentrations at H=1 m
H = distance above liquid surface = 0.61 m

Chemical	Concentration in ppm								Notes
	Benzene	Toluene	Ethylbenzene	Total Xylene	Total HAPs	1,2,4 - TMB	1,3,5 - TMB	Other VOCs	
Escaid 110	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	confidential information supplied by ExxonMobil
ACORGA M5640	5.00	17.90	23.30	34.80	0.00	0.00	0.00	0.00	confidential information supplied by Cytec
Organic in ppm	0.38	1.36	1.77	2.64	9.24	0.00	0.00	0.00	composite concentration, Ci

Freeport-McMoRan Chino Mines Company
Revised: December 2019

SXEW - Raffinate Tank Emissions
Units: SXEW RT

Note: The highest emissions from any combination of tank contents is used in the facility-wide emissions summary table.

SX/EW Plant 900,000 Gallon Raffinate Tank Emissions - ORFOM SX-80 and ACORGA M5910

The following calculations are based on the BHP Copper VOC study conducted in 1997. A summary and copy of the report is included in Section 7.
Emissions from the use of ACORGA M5910 also represent emissions from the use of ACORGA OR25 since the chemical constituents are the same.

number of tanks	1	area of each tank	5,024 ft^2	total area	5,024 ft^2

Chemical Product	Percent
ORFOM SX-80	92%
ACORGA M5910	8%

Component	D cm^2/sec	MW g/gmole	Ci ppm	Ci g/m^3	Ch ppm	Ch g/m^3	Diff F g/m^2-s	Emission Rate ton/yr-ft^2	Emission Rate tons/year	Emission Rate lb/hr
Benzene	0.0933	78.11	4.87	1.55E-02	0.0018	5.73E-06	2.37E-07	7.66E-07	3.85E-03	8.79E-04
Toluene	0.0833	92.13	5.17	1.94E-02	0.067	2.51E-04	2.62E-07	8.45E-07	4.25E-03	9.70E-04
Ethylbenzene	0.0760	106.16	4.88	2.11E-02	0.057	2.46E-04	2.60E-07	8.40E-07	4.22E-03	9.63E-04
Total Xylene	0.0760	106.16	5.27	2.28E-02	0.037	1.61E-04	2.82E-07	9.12E-07	4.58E-03	1.05E-03
Total HAPs(1)	0.082	103.94	0.00	0.000	0.60	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2,4 - trimethylbenzene	0.066	120.19	0.48	0.002	0.00	0.00E+00	2.54E-08	8.21E-08	4.13E-04	9.42E-05
1,3,5 - trimethylbenzene	0.066	120.19	0.25	0.001	0.000	0.00E+00	1.34E-08	4.33E-08	2.18E-04	4.97E-05
Other VOCs (non-HAPs)	0.066	112.06	0.00	0.000	0.000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Total HAPs	0.017	0.004
								Total VOCs	0.018	0.004

(1) Total HAPs Molecular weight and Ch, ppm is obtained by determining the average of total HAP constituents within the product.

Where: D = constituent diffusivity (from EPA Reference Link for Estimated Diffusion Coefficients in Air and Water; Assumed Pressure of 1 atm, and Temperature of 25.84 deg. C per 1995 met. data)
MW = constituent molecular weight
Ci = constituent concentration at liquid surface, ppm. (from manufacturer data)
Ci, g/m^3, calculated from ideal gas law. Conservative temperature of 25.84 deg. C used based on 1995 meteorological data (Average plus Standard Deviation).
Ch = constituent concentration at 0.61 meter, ppm. Assumed same as BHP's measured concentrations at H=1 m
H = distance above liquid surface = 0.61 m

Chemical	Concentration in ppm								Notes
	Benzene	Toluene	Ethylbenzene	Total Xylene	Total HAPs	1,2,4 - TMB	1,3,5 - TMB	Other VOCs	
ORFOM SX-80	5.00	5.00	5.00	5.00	0.00	0.00	0.00	0.00	confidential information supplied by Chevron Phillips
ACORGA M5910	3.35	7.25	3.40	8.60	0.00	6.35	3.35	0.00	confidential information supplied by Cytec
Organic in ppm	4.87	5.17	4.88	5.27	0.00	0.48	0.25	0.00	composite concentration, Ci

Freeport-McMoRan Chino Mines Company
Revised: December 2019

SXEW - Raffinate Tank Emissions
Units: SXEW RT

Note: The highest emissions from any combination of tank contents is used in the facility-wide emissions summary table.

SX/EW Plant 900,000 Gallon Raffinate Tank Emissions - ORFOM SX-80 and COGNIS LIX 684N-LV

The following calculations are based on the BHP Copper VOC study conducted in 1997. A summary and copy of the report is included in Section 7.

number of tanks	1	area of each tank	5,024 ft^2	total area	5,024 ft^2

Chemical Product	Percent
ORFOM SX-80	92%
COGNIS LIX 684N-LV	8%

Component	D cm^2/sec	MW g/gmole	Ci ppm	Ci g/m^3	Ch ppm	Ch g/m^3	Diff F g/m^2-s	Emission Rate ton/yr-ft^2	Emission Rate tons/year	Emission Rate lb/hr
Benzene	0.0933	78.11	4.62	0.01	0.0018	5.73E-06	2.25E-07	7.26E-07	3.65E-03	8.33E-04
Toluene	0.0833	92.13	4.62	0.02	0.067	2.51E-04	2.33E-07	7.54E-07	3.79E-03	8.65E-04
Ethylbenzene	0.0760	106.16	4.62	0.02	0.057	2.46E-04	2.46E-07	7.95E-07	3.99E-03	9.11E-04
Total Xylene	0.0760	106.16	4.62	0.02	0.037	1.61E-04	2.47E-07	7.98E-07	4.01E-03	9.15E-04
Total HAPs(1)	0.082	103.9	3.31	0.014	0.600	2.54E-03	1.54E-07	4.99E-07	2.51E-03	5.72E-04
1,2,4 - trimethylbenzene	0.066	120.2	0.00	0.000	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,3,5 - trimethylbenzene	0.066	120.2	0.00	0.000	0.000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Other VOCs (non-HAPs)	0.066	112.1	4.56	0.021	0.000	0.00E+00	2.24E-07	7.23E-07	3.63E-03	8.30E-04
								Total HAPs	0.018	0.004
								Total VOCs	0.022	0.005

(1) Total HAPs Molecular weight and Ch, ppm is obtained by determining the average of total HAP constituents within the product.

Where: D = constituent diffusivity (from EPA Reference Link for Estimated Diffusion Coefficients in Air and Water; Assumed Pressure of 1 atm, and Temperature of 25.84 deg. C per 1995 met. data)
MW = constituent molecular weight
Ci = constituent concentration at liquid surface, ppm. (from manufacturer data)
Ci, g/m^3, calculated from ideal gas law. Conservative temperature of 25.84 deg. C used based on 1995 meteorological data (Average plus Standard Deviation).
Ch = constituent concentration at 0.61 meter, ppm. Assumed same as BHP's measured concentrations at H=1 m
H = distance above liquid surface = 0.61 m

Chemical	Concentration in ppm								Notes
	Benzene	Toluene	Ethylbenzene	Total Xylene	Total HAPs	1,2,4 - TMB	1,3,5 - TMB	Other VOCs	
ORFOM SX-80	5.00	5.00	5.00	5.00	0.00	0.00	0.00	0.00	confidential information supplied by Chevron Phillips
COGNIS LIX 684N-LV	0.00	0.00	0.00	0.00	43.50	0.00	0.00	60.00	confidential information supplied by Cytec
Organic in ppm	4.62	4.62	4.62	4.62	3.31	0.00	0.00	4.56	composite concentration, Ci

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SXEW - Raffinate Tank Emissions
Units: SXEW RT

Note: The highest emissions from any combination of tank contents is used in the facility-wide emissions summary table.

SX/EW Plant 900,000 Gallon Raffinate Tank Emissions - ORFOM SX-80 and ACORGA M5640

The following calculations are based on the BHP Copper VOC study conducted in 1997. A summary and copy of the report is included in Section 7.

number of tanks	1	area of each tank	5,024 ft^2	total area	5,024 ft^2

Chemical Product	Percent
ORFOM SX-80	92%
ACORGA M5640	8%

Component	D cm^2/sec	MW g/gmole	Ci ppm	Ci g/m^3	Ch ppm	Ch g/m^3	Diff F g/m^2-s	Emission Rate ton/yr-ft^2	Emission Rate tons/year	Emission Rate lb/hr
Benzene	0.0933	78.11	5.00	1.59E-02	0.0018	5.73E-06	2.43E-07	7.86E-07	3.95E-03	9.02E-04
Toluene	0.0833	92.13	5.98	2.25E-02	0.067	2.51E-04	3.03E-07	9.79E-07	4.92E-03	1.12E-03
Ethylbenzene	0.0760	106.16	6.39	2.77E-02	0.057	2.46E-04	3.41E-07	1.10E-06	5.54E-03	1.27E-03
Total Xylene	0.0760	106.16	7.26	3.14E-02	0.037	1.61E-04	3.90E-07	1.26E-06	6.32E-03	1.44E-03
Total HAPs(1)	0.082	103.9	0.00	0.000	0.600	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2,4 - trimethylbenzene	0.066	120.2	0.00	0.000	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,3,5 - trimethylbenzene	0.066	120.2	0.00	0.000	0.000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Other VOCs (non-HAPs)	0.066	112.1	0.00	0.000	0.000	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
								Total HAPs	0.021	0.005
								Total VOCs	0.021	0.005

(1) Total HAPs Molecular weight and Ch, ppm is obtained by determining the average of total HAP constituents within the product.

Where: D = constituent diffusivity (from EPA Reference Link for Estimated Diffusion Coefficients in Air and Water; Assumed Pressure of 1 atm, and Temperature of 25.84 deg. C per 1995 met. data)
MW = constituent molecular weight
Ci = constituent concentration at liquid surface, ppm. (from manufacturer data)
Ci, g/m^3, calculated from ideal gas law. Conservative temperature of 25.84 deg. C used based on 1995 meteorological data (Average plus Standard Deviation).
Ch = constituent concentration at 0.61 meter, ppm. Assumed same as BHP's measured concentrations at H=1 m
H = distance above liquid surface = 0.61 m

Chemical	Concentration in ppm								Notes
	Benzene	Toluene	Ethylbenzene	Total Xylene	Total HAPs	1,2,4 - TMB	1,3,5 - TMB	Other VOCs	
ORFOM SX-80	5.00	5.00	5.00	5.00	0.00	0.00	0.00	0.00	confidential information supplied by Chevron Phillips
ACORGA M5640	5.00	17.90	23.30	34.80	0.00	0.00	0.00	0.00	confidential information supplied by Cytec
Organic in ppm	5.00	5.98	6.39	7.26	0.00	0.00	0.00	0.00	composite concentration, Ci

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White House Crushing and Screening Plant
Unit: WH Crush (Loading & Unloading)

Basis		
Annual throughput of material to plant	4,380,000.00	US tons/yr
Daily throughput of material to plant	12000	US tons/day
Hourly throughput of material to plant	500	US tons/hr
Annual Operating Days	365	days
Daily Operating Hours	12	hours
White House Cusher - Conveyor		

Conversions		
1 US ton =	2000	lb

	Emission Factors (lb/ton)		
White House Cusher - Screens	TSP	PM10	PM2.5
Truck Unloading - Fragmented Stone [1]	4.18E-05	1.60E-05	2.40E-06
Truck Loading (Drop Equation) [2]	0.067	3.16E-02	0.0048

Federal Hazardous Air Pollutants and New Mexico Toxic Air Pollutants Content of Ore for Mill (%)[1]

Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
7.00E-04	4.00E-04	1.90E-03	2.00E-04	2.50E-03	2.00E-03	5.90E-01	2.70E-03	6.62E-02	1.20E-03	1.00E-04	4.30E-03	1.10E-02

Load ID Number	Hourly Throughput (tons/hr)	Operating Efficiency	Controlled or Uncontrolled	Pollutant Emissions lb/hr															
				TSP	PM_{10}	$PM_{2.5}$	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
Unload	312.48	0.00%	uncontrolled	0.01	0.0050	7.50E-04	9.14E-08	5.22E-08	2.48E-07	2.61E-08	3.27E-07	2.61E-07	7.71E-05	3.53E-07	8.65E-06	1.57E-07	1.31E-08	5.62E-07	1.44E-06
Load	312.48	0.00%	uncontrolled	20.87	9.87	1.49E+00	1.46E-04	8.35E-05	3.96E-04	4.17E-05	5.22E-04	4.17E-04	1.23E-01	5.63E-04	1.38E-02	2.50E-04	2.09E-05	8.97E-04	2.30E-03
Totals				**20.88**	**9.87**	**1.50**	**1.46E-04**	**8.35E-05**	**3.97E-04**	**4.18E-05**	**5.22E-04**	**4.18E-04**	**1.23E-01**	**5.64E-04**	**1.38E-02**	**2.51E-04**	**2.09E-05**	**8.98E-04**	**2.30E-03**

Load ID Number	Hourly Throughput (tons/hr)	Operating Efficiency	Controlled or Uncontrolled	Pollutant Emissions ton/yr															
				TSP	PM_{10}	$PM_{2.5}$	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
Unload	312.48	0.00%	uncontrolled	0.03	0.011	0.0016	2.00E-07	1.14E-07	5.43E-07	5.72E-08	7.15E-07	5.72E-07	1.69E-04	7.72E-07	1.89E-05	3.43E-07	2.86E-08	1.23E-06	3.15E-06
Load	312.48	0.00%	uncontrolled	45.70	21.61	3.27	3.20E-04	1.83E-04	8.68E-04	9.14E-05	1.14E-03	9.14E-04	2.70E-01	1.23E-03	3.03E-02	5.48E-04	4.57E-05	1.96E-03	5.03E-03
Totals				**45.73**	**21.62**	**3.27**	**3.20E-04**	**1.83E-04**	**8.69E-04**	**9.15E-05**	**1.14E-03**	**9.15E-04**	**2.70E-01**	**1.23E-03**	**3.03E-02**	**5.49E-04**	**4.57E-05**	**1.97E-03**	**5.03E-03**

Notes

[1]The emission factors for material handling are based on AP-42, Chapter 11.19.2, Table 11.19.2-2 Crushed Stone Processing and Pulverized Mineral Processing (August 2004) for Truck Unloading - Fragmented Stone. The basis for these emission factors is the PM10 emission factor for truck unloading of fragmented stone in Table 11.19.2-2. This table provides a PM10 emission factor, but does not provide PM2.5 or TSP emission factors. A PM2.5 emission factor was calculated from the available PM10 emission factor using the ratio of 0.15 PM2.5/PM10 as recommended in the Background Document for AP-42, Chapter 13.2.4, Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006. An uncontrolled TSP emission factor was calculated from the available uncontrolled PM10 emission factor using the TSP/PM10 ratio calculated from the following uncontrolled TSP and PM10 emission factors in Table 11.19.2-2: Tertiary Crushing (0.0054/0.0024 = 2.25); Fines Crushing (0.0390/0.0150 = 2.60); Screening (0.025/0.0087 = 2.87; and Conveyor Transfer Point 0.0030/0.00110 = 2.73).

[2] Material handling uncontrolled emission factors based on USEPA AP-42 USEPA's Drop Equation in AP-42, Section 13.2.4. Drop equation is as follows:
where,

$$E\left(\frac{lb}{ton}\right) = k \cdot 0.0032 \cdot \frac{\left(\frac{U}{5}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

	TSP	PM_{10}	$PM_{2.5}$	
E	0.067	0.032	0.0048	lbs/ton
k	0.74	0.35	0.053	unitless
U	6.95	6.95	6.95	mph
M	0.25	0.25	0.25	%

E = Emission Factor (lbs/ton)
k = Particle Size Multiplier, dimensionless ($PM_{2.5}$= 0.053, PM_{10}= 0.35, PM=0.74)
U = Mean Wind Speed = 6.95 mph (Bayard, NM)
M = Moisture Content = 0.25% Assuming the lowest possible moisture content to be conservative.

Freeport-McMoRan Chino Mines Company
Revised: December 2019

White House Crushing and Screening Plant
Unit: WH Crush (Conveyor Transfer Points)

Basis		
Annual throguhput of material to plant	4,380,000.00	US tons/yr
Daily throughput of material to plant	12000	US tons/day
Hourly throughput of material to plant	500	US tons/hr
Annual Operating Days	365	days
Daily Operating Hours	12	hours

Conversions		
1 US ton =	2000	lb

	Emission Factors		
	TSP (lb/ton)	PM_{10} (lb/ton)	$PM_{2.5}$ (lb/ton)
Conveyor Transfer Point (uncontrolled)[1,2]	0.003	0.0011	0.000165
Conveyor Transfer Point (controlled)[1,3]	0.00014	0.000046	0.000013
Coveyor Drop Point (aggregate handling- uncontrolled) [4,5,6,7]	0.067	0.032	0.005

Federal Hazardous Air Pollutants and New Mexico Toxic Air Pollutants Content of Ore for Mill (%)

Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
7.00E-04	4.00E-04	1.90E-03	2.00E-04	2.50E-03	2.00E-03	5.90E-01	2.70E-03	6.62E-02	1.20E-03	1.00E-04	4.30E-03	1.10E-02

Conveyor ID Number	Transfer Point[4]	Hourly Throughput (tons/hr)	Operating efficiency	Controlled or Uncontrolled	Pollutant Emissions lb/hr															
					TSP	PM_{10}	$PM_{2.5}$	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
Conv-1	a	38.08	0.00%	uncontrolled	0.11	0.04	0.01	8.00E-07	4.57E-07	2.17E-06	2.28E-07	2.86E-06	2.28E-06	6.74E-04	3.08E-06	7.56E-05	1.37E-06	1.14E-07	4.91E-06	1.26E-05
	c	100.00	0.00%	uncontrolled	6.68	3.16	0.48	4.67E-05	2.67E-05	1.27E-04	1.34E-05	1.67E-04	1.34E-04	3.94E-02	1.80E-04	4.42E-03	8.01E-05	6.68E-06	2.87E-04	7.35E-04
Conv-2	a	274.40	0.00%	uncontrolled	0.82	0.30	0.05	5.76E-06	3.29E-06	1.56E-05	1.65E-06	2.06E-05	1.65E-05	4.86E-03	2.22E-05	5.45E-04	9.88E-06	8.23E-07	3.54E-05	9.06E-05
	b	274.40	0.00%	uncontrolled	0.82	0.30	0.05	5.76E-06	3.29E-06	1.56E-05	1.65E-06	2.06E-05	1.65E-05	4.86E-03	2.22E-05	5.45E-04	9.88E-06	8.23E-07	3.54E-05	9.06E-05
Conv-3	a	300.16	0.00%	uncontrolled	0.90	0.33	0.05	6.30E-06	3.60E-06	1.71E-05	1.80E-06	2.25E-05	1.80E-05	5.31E-03	2.43E-05	5.96E-04	1.08E-05	9.00E-07	3.87E-05	9.91E-05
	b	300.16	0.00%	uncontrolled	0.90	0.33	0.05	6.30E-06	3.60E-06	1.71E-05	1.80E-06	2.25E-05	1.80E-05	5.31E-03	2.43E-05	5.96E-04	1.08E-05	9.00E-07	3.87E-05	9.91E-05
Conv-4	a	300.16	0.00%	uncontrolled	0.90	0.33	0.05	6.30E-06	3.60E-06	1.71E-05	1.80E-06	2.25E-05	1.80E-05	5.31E-03	2.43E-05	5.96E-04	1.08E-05	9.00E-07	3.87E-05	9.91E-05
	b	300.16	0.00%	uncontrolled	0.90	0.33	0.05	6.30E-06	3.60E-06	1.71E-05	1.80E-06	2.25E-05	1.80E-05	5.31E-03	2.43E-05	5.96E-04	1.08E-05	9.00E-07	3.87E-05	9.91E-05
Conv-5	a	67.20	0.00%	uncontrolled	0.20	0.07	0.01	1.41E-06	8.06E-07	3.83E-06	4.03E-07	5.04E-06	4.03E-06	1.19E-03	5.44E-06	1.33E-04	2.42E-06	2.02E-07	8.67E-06	2.22E-05
	c	100.00	0.00%	uncontrolled	6.68	3.16	0.48	4.67E-05	2.67E-05	1.27E-04	1.34E-05	1.67E-04	1.34E-04	3.94E-02	1.80E-04	4.42E-03	8.01E-05	6.68E-06	2.87E-04	7.35E-04
Conv-6	a	81.76	0.00%	uncontrolled	0.25	0.09	0.01	1.72E-06	9.81E-07	4.66E-06	4.91E-07	6.13E-06	4.91E-06	1.45E-03		1.62E-04	2.94E-06	2.45E-07	1.05E-05	2.70E-05
	c	100.00	0.00%	uncontrolled	6.68	3.16	0.48	4.67E-05	2.67E-05	1.27E-04	1.34E-05	1.67E-04	1.34E-04	3.94E-02	1.80E-04	4.42E-03	8.01E-05	6.68E-06	2.87E-04	7.35E-04
Conv-7	a	62.72	0.00%	uncontrolled	0.19	0.07	0.01	1.32E-06	7.53E-07	3.58E-06	3.76E-07	4.70E-06	3.76E-06	1.11E-03	5.08E-06	1.25E-04	2.26E-06	1.88E-07	8.09E-06	2.07E-05
	c	100.00	0.00%	uncontrolled	6.68	3.16	0.48	4.67E-05	2.67E-05	1.27E-04	1.34E-05	1.67E-04	1.34E-04	3.94E-02	1.80E-04	4.42E-03	8.01E-05	6.68E-06	2.87E-04	7.35E-04
Conv-8	a	61.60	0.00%	uncontrolled	0.18	0.07	0.01	1.29E-06	7.39E-07	3.51E-06	3.70E-07	4.62E-06	3.70E-06	1.09E-03	4.99E-06	1.22E-04	2.22E-06	1.85E-07	7.95E-06	2.03E-05
	c	100.00	0.00%	uncontrolled	6.68	3.16	0.48	4.67E-05	2.67E-05	1.27E-04	1.34E-05	1.67E-04	1.34E-04	3.94E-02	1.80E-04	4.42E-03	8.01E-05	6.68E-06	2.87E-04	7.35E-04
Conv-9	a	25.76	0.00%	uncontrolled	0.08	0.03	0.00	5.41E-07	3.09E-07	1.47E-06	1.55E-07	1.93E-06	1.55E-06	4.56E-04	2.09E-06	5.12E-05	9.27E-07	7.73E-08	3.32E-06	8.50E-06
	b	25.76	0.00%	uncontrolled	0.08	0.03	0.00	5.41E-07	3.09E-07	1.47E-06	1.55E-07	1.93E-06	1.55E-06	4.56E-04	2.09E-06	5.12E-05	9.27E-07	7.73E-08	3.32E-06	8.50E-06
Total					**39.73**	**18.12**	**2.74**	**2.78E-04**	**1.59E-04**	**7.55E-04**	**7.95E-05**	**9.93E-04**	**7.95E-04**	**2.34E-01**	**1.07E-03**	**2.63E-02**	**4.77E-04**	**3.97E-05**	**1.71E-03**	**4.37E-03**

Conveyor ID Number	Transfer Point	Hourly Throughput (tons/hr)	Operating efficiency	Controlled or Uncontrolled	Pollutant Emissions ton/yr															
					TSP	PM_{10}	$PM_{2.5}$	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
Conv-1	a	38.08	0.00%	uncontrolled	0.25	0.09	0.01	1.75E-06	1.00E-06	4.75E-06	5.00E-07	6.25E-06	5.00E-06	1.48E-03	6.76E-06	1.66E-04	3.00E-06	2.50E-07	1.08E-05	2.75E-05
	c	100.00	0.00%	uncontrolled	14.62	6.92	1.05	1.02E-04	5.85E-05	2.78E-04	2.92E-05	3.66E-04	2.92E-04	8.63E-02	3.95E-04	9.68E-03	1.75E-04	1.46E-05	6.29E-04	1.61E-03
Conv-2	a	274.40	0.00%	uncontrolled	1.80	0.66	0.10	1.26E-05	7.21E-06	3.43E-05	3.61E-06	4.51E-05	3.61E-05	1.06E-02	4.87E-05	1.19E-03	2.16E-05	1.80E-06	7.75E-05	1.98E-04
	b	274.40	0.00%	uncontrolled	1.80	0.66	0.10	1.26E-05	7.21E-06	3.43E-05	3.61E-06	4.51E-05	3.61E-05	1.06E-02	4.87E-05	1.19E-03	2.16E-05	1.80E-06	7.75E-05	1.98E-04
Conv-3	a	300.16	0.00%	uncontrolled	1.97	0.72	0.11	1.38E-05	7.89E-06	3.75E-05	3.94E-06	4.93E-05	3.94E-05	1.16E-02	5.32E-05	1.31E-03	2.37E-05	1.97E-06	8.48E-05	2.17E-04
	b	300.16	0.00%	uncontrolled	1.97	0.72	0.11	1.38E-05	7.89E-06	3.75E-05	3.94E-06	4.93E-05	3.94E-05	1.16E-02	5.32E-05	1.31E-03	2.37E-05	1.97E-06	8.48E-05	2.17E-04
Conv-4	a	300.16	0.00%	uncontrolled	1.97	0.72	0.11	1.38E-05	7.89E-06	3.75E-05	3.94E-06	4.93E-05	3.94E-05	1.16E-02	5.32E-05	1.31E-03	2.37E-05	1.97E-06	8.48E-05	2.17E-04
	b	300.16	0.00%	uncontrolled	1.97	0.72	0.11	1.38E-05	7.89E-06	3.75E-05	3.94E-06	4.93E-05	3.94E-05	1.16E-02	5.32E-05	1.31E-03	2.37E-05	1.97E-06	8.48E-05	2.17E-04
Conv-5	a	67.20	0.00%	uncontrolled	0.44	0.16	0.02	3.09E-06	1.77E-06	8.39E-06	8.83E-07	1.10E-05	8.83E-06	2.60E-03	1.19E-05	2.92E-04	5.30E-06	4.42E-07	1.90E-05	4.86E-05
	c	100.00	0.00%	uncontrolled	14.62	6.92	1.05	1.02E-04	5.85E-05	2.78E-04	2.92E-05	3.66E-04	2.92E-04	8.63E-02	3.95E-04	9.68E-03	1.75E-04	1.46E-05	6.29E-04	1.61E-03
Conv-6	a	81.76	0.00%	uncontrolled	0.54	0.20	0.03	3.76E-06	2.15E-06	1.02E-05	1.07E-06	1.34E-05	1.07E-05	3.17E-03	1.45E-05	3.56E-04	6.45E-06	5.37E-07	2.31E-05	5.91E-05
	c	100.00	0.00%	uncontrolled	14.62	6.92	1.05	1.02E-04	5.85E-05	2.78E-04	2.92E-05	3.66E-04	2.92E-04	8.63E-02	3.95E-04	9.68E-03	1.75E-04	1.46E-05	6.29E-04	1.61E-03
Conv-7	a	62.72	0.00%	uncontrolled	0.41	0.15	0.02	2.88E-06	1.65E-06	7.83E-06	8.24E-07	1.03E-05	8.24E-06	2.43E-03	1.11E-05	2.73E-04	4.94E-06	4.12E-07	1.77E-05	4.53E-05
	c	100.00	0.00%	uncontrolled	14.62	6.92	1.05	1.02E-04	5.85E-05	2.78E-04	2.92E-05	3.66E-04	2.92E-04	8.63E-02	3.95E-04	9.68E-03	1.75E-04	1.46E-05	6.29E-04	1.61E-03
Conv-8	a	61.60	0.00%	uncontrolled	0.40	0.15	0.02	2.83E-06	1.62E-06	7.69E-06	8.09E-07	1.01E-05	8.09E-06	2.39E-03	1.09E-05	2.68E-04	4.86E-06	4.05E-07	1.74E-05	4.45E-05
	c	100.00	0.00%	uncontrolled	14.62	6.92	1.05	1.02E-04	5.85E-05	2.78E-04	2.92E-05	3.66E-04	2.92E-04	8.63E-02	3.95E-04	9.68E-03	1.75E-04	1.46E-05	6.29E-04	1.61E-03
Conv-9	a	25.76	0.00%	uncontrolled	0.17	0.06	0.01	1.18E-06	6.77E-07	3.22E-06	3.38E-07	4.23E-06	3.38E-06	9.99E-04	4.57E-06	1.12E-04	2.03E-06	1.69E-07	7.28E-06	1.86E-05
	b	25.76	0.00%	uncontrolled	0.17	0.06	0.01	1.18E-06	6.77E-07	3.22E-06	3.38E-07	4.23E-06	3.38E-06	9.99E-04	4.57E-06	1.12E-04	2.03E-06	1.69E-07	7.28E-06	1.86E-05
Total					**87.00**	**39.67**	**6.00**	**6.09E-04**	**3.48E-04**	**1.65E-03**	**1.74E-04**	**2.17E-03**	**1.74E-03**	**5.13E-01**	**2.35E-03**	**5.76E-02**	**1.04E-03**	**8.70E-05**	**3.74E-03**	**9.57E-03**

Notes

[1]Emission factors obtained from AP-42 Table 11.19-2.2

[2] PM2.5 emission factor was calculated from the available PM10 emission factor using the ratio of 0.15 PM2.5/PM10 as recommended in the Background Document for AP-42, Chapter 13.2.4, Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006.

[3] Controlled sources (with wet suppression) are those that are part of the processing plant that employs current wet suppression technology similar to the study group. The moisture content of the study group without wet suppression systems operating (uncontrolled) ranged from 0.21 to 1.3 percent, and the same facilities operating wet suppression systems (controlled) ranged from 0.55 to 2.88 percent. Due to carry over of the small amount of moisture required, it has been shown that each source, with the exception of crushers, does not need to employ direct water sprays. Although the moisture content was the only variable measured, other process features may have as much influence on emissions from a given source. Visual observations from each source under normal operating conditions are probably the best indicator of which emission factor is most appropriate. Plants that employ substandard control measures as indicated by visual observations should use the uncontrolled factor with appropriate control efficiency that best reflects the effectiveness of

[4] There will be 5 piles and associated drop points. However, each pile has a fraction of the total mass, so the total throughput of 500 tph divided by 5 drop points equals 100 tph per each drop point

[5] Conveyor drop point uncontrolled emission factors based on USEPA AP-42 USEPA's Drop Equation in AP-42, Section 13.2.4. Drop equation is as follows:

where,

$$E\left(\frac{lb}{ton}\right) = k \cdot 0.0032 \cdot \frac{\left(\frac{U}{5}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

	TSP	PM_{10}	$PM_{2.5}$	
E	0.067	0.032	0.0048	lbs/ton
k	0.74	0.35	0.053	unitless
U	6.95	6.95	6.95	mph
M	0.25	0.25	0.25	%

E = Emission Factor (lbs/ton)

k = Particle Size Multiplier, dimensionless ($PM_{2.5}$= 0.053, PM_{10}= 0.35, PM=0.74)

U = Mean Wind Speed = 6.95 mph (Bayard, NM)

M = Moisture Content = 0.25% Assuming the lowest possible moisture content to be conservative.

[6] The conveyor drop point (aggregate handling) AP-42 emission factors takes into account the following activities: 1) loading of aggregate onto the storage pile; 2) wind erosion associated with the pile; 3) load out of aggregate for shipment or for return to the process.

[7] TSP, PM_{10}, and controlled $PM_{2.5}$ emission factors from AP-42, Chapter 11.19.2, Crushed Stone Processing and Pulverized Mineral Processing, Table 11.19.2-2, Screening; uncontrolled $PM_{2.5}$ emission factor calculated from uncontrolled PM_{10} emission factor using the ratio of 0.15 $PM_{2.5}/PM_{10}$ as recommended in Background Document for AP-42, Chapter 13.2.4, Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006. Total Controlled Emissions include emissions from uncontrolled aggregate handling.

[8] a = the load point conveyor belt; b = the release point of the conveyor belt; c = conveyor drop point into aggregate pile

Freeport-McMoRan Chino Mines Company
Revised: December 2019

White House Crushing and Screening Plant
Unit: WH Crush (Crushers)

Basis		
Annual throughput of material to plant	4380000	US tons/yr
Daily throughput of material to plant	12000	US tons/day
Hourly throughput of material to plant	500	US tons/hr
Annual Operating Days	365	days
	12	hours

Conversions		
1 US ton =	2000	lb

	Emission Factors (lb/ton)		
	TSP	PM10	PM2.5
Primary Crushing (uncontrolled)[1,2,3]	0.0054	0.0024	0.0024
Primary Crushing (controlled)[1,2,3]	0.0012	0.00054	0.00054
Tertiary Crushing (uncontrolled)[1,4]	0.0054	0.0024	0.0024
Tertiary Crushing (controlled)[1]	0.0012	0.00054	0.00010

Federal Hazardous Air Pollutants and New Mexico Toxic Air Pollutants Content of Ore for Mill (%)

Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
7.00E-04	4.00E-04	1.90E-03	2.00E-04	2.50E-03	2.00E-03	5.90E-01	2.70E-03	6.62E-02	1.20E-03	1.00E-04	4.30E-03	1.10E-02

Crusher ID Number	Hourly Throughput (tons/hr)	Operating efficiency	Material handling Size	Controlled or Uncontrolled	Pollutant Emissions lb/hr															
					TSP	PM_{10}	$PM_{2.5}$	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
Crush-1	183.68	0.00%	Primary	uncontrolled	0.99	0.44	0.44	6.94E-06	3.97E-06	1.88E-05	1.98E-06	2.48E-05	1.98E-05	5.85E-03	2.68E-05	6.57E-04	1.19E-05	9.92E-07	4.27E-05	1.09E-04
Crush-2	300.16	0.00%	Tertiary	uncontrolled	1.62	0.72	0.72	1.13E-05	6.48E-06	3.08E-05	3.24E-06	4.05E-05	3.24E-05	9.56E-03	4.38E-05	1.07E-03	1.95E-05	1.62E-06	6.97E-05	1.78E-04
Totals					**2.61**	**1.16**	**1.16**	**1.83E-05**	**1.05E-05**	**4.96E-05**	**5.23E-06**	**6.53E-05**	**5.23E-05**	**1.54E-02**	**7.05E-05**	**1.73E-03**	**3.14E-05**	**2.61E-06**	**1.12E-04**	**2.87E-04**

Crusher ID Number	Hourly Throughput (tons/hr)	Operating efficiency	Material handling Size	Controlled or Uncontrolled	Pollutant Emissions ton/yr															
					TSP	PM_{10}	$PM_{2.5}$	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
Crush-1	183.68	0.00%	Primary	uncontrolled	2.17	0.97	0.97	1.52E-05	8.69E-06	4.13E-05	4.34E-06	5.43E-05	4.34E-05	1.28E-02	5.86E-05	1.44E-03	2.61E-05	2.17E-06	9.34E-05	2.39E-04
Crush-2	300.16	0.00%	Tertiary	uncontrolled	3.55	1.58	1.58	2.48E-05	1.42E-05	6.74E-05	7.10E-06	8.87E-05	7.10E-05	2.09E-02	9.58E-05	2.35E-03	4.26E-05	3.55E-06	1.53E-04	3.90E-04
Totals					**5.72**	**2.54**	**2.54**	**4.01E-05**	**2.29E-05**	**1.09E-04**	**1.14E-05**	**1.43E-04**	**1.14E-04**	**3.38E-02**	**1.54E-04**	**3.79E-03**	**6.87E-05**	**5.72E-06**	**2.46E-04**	**6.29E-04**

Notes

[1] Emission factors obtained from AP-42 Table 11.19-2.2.

[2] PM Primary emission factors equals PM Tertiary Crushing emission factors.

[3] According to AP-42 Table 11.19.2-2 sub note "n": emission factors for PM_{10} for tertiary crushers can be used as an upper limit for primary or secondary crushing, because there is no data available.

[4] According to AP-42 Table 11.19.2-2 sub note "n": emission factors for PM_{10} for uncontrolled tertiary crushers equals $PM_{2.5}$ for uncontrolled tertiary crushers.

Freeport-McMoRan Chino Mines Company
Revised: December 2019

White House Crushing and Screening Plant
Unit: WH Crush (Crushers)

Basis		
Annual throughput of material to plant	4380000	US tons/yr
Daily throughput of material to plant	12000	US tons/day
Hourly throughput of material to plant	500	US tons/hr
Annual Operating Days	365	days
Daily Operating Hours	12	hours

Conversions		
1 US ton =	2000	lb

	Emission Factors (lb/ton)		
	TSP	PM10	PM2.5
Fine Screening (uncontrolled)[1,2]	0.300	0.072	0.011
Fine Screening (controlled)[1]	0.0036	0.0022	0.00033
Screening (uncontrolled)[1,2]	0.025	0.0087	0.0013
Screening (controlled)[1]	0.0022	0.00074	0.0005

Federal Hazardous Air Pollutants and New Mexico Toxic Air Pollutants Content of Ore for Mill (%)

Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
7.00E-04	4.00E-04	1.90E-03	2.00E-04	2.50E-03	2.00E-03	5.90E-01	2.70E-03	6.62E-02	1.20E-03	1.00E-04	4.30E-03	1.10E-02

Screen ID Number	Hourly Throughput (tons/hr)	Operating Efficiency	Material Handling Size	Controlled or Uncontrolled	Pollutant Emissions lb/hr															
					TSP	PM_{10}	$PM_{2.5}$	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
Screen-1	312.48	0.00%	Normal	uncontrolled	7.81	2.72	0.41	5.47E-05	3.12E-05	1.48E-04	1.56E-05	1.95E-04	1.56E-04	4.61E-02	2.11E-04	5.17E-03	9.37E-05	7.81E-06	3.36E-04	8.59E-04
Screen-2	300.16	0.00%	Normal	uncontrolled	7.50	2.61	0.39	5.25E-05	3.00E-05	1.43E-04	1.50E-05	1.88E-04	1.50E-04	4.43E-02	2.03E-04	4.97E-03	9.00E-05	7.50E-06	3.23E-04	8.25E-04
Totals					**15.32**	**5.33**	**0.80**	**1.07E-04**	**6.13E-05**	**2.91E-04**	**3.06E-05**	**3.83E-04**	**3.06E-04**	**9.04E-02**	**4.14E-04**	**1.01E-02**	**1.84E-04**	**1.53E-05**	**6.59E-04**	**1.68E-03**

Screen ID Number	Hourly Throughput (tons/hr)	Operating Efficiency	Material Handling Size	Controlled or Uncontrolled	Pollutant Emissions ton/yr															
					TSP	PM_{10}	$PM_{2.5}$	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
Screen-1	312.48	0.00%	Normal	uncontrolled	17.11	5.95	0.89	1.20E-04	6.84E-05	3.25E-04	3.42E-05	4.28E-04	3.42E-04	1.01E-01	4.62E-04	1.13E-02	2.05E-04	1.71E-05	7.36E-04	1.88E-03
Screen-2	300.16	0.00%	Normal	uncontrolled	16.43	5.72	0.86	1.15E-04	6.57E-05	3.12E-04	3.29E-05	4.11E-04	3.29E-04	9.70E-02	4.44E-04	1.09E-02	1.97E-04	1.64E-05	7.07E-04	1.81E-03
Totals					**33.54**	**11.67**	**1.75**	**2.35E-04**	**1.34E-04**	**6.37E-04**	**6.71E-05**	**8.39E-04**	**6.71E-04**	**1.98E-01**	**9.06E-04**	**2.22E-02**	**4.03E-04**	**3.35E-05**	**1.44E-03**	**3.69E-03**

Notes

[1] Emission factors obtained from AP-42 Table 11.19-2.2

[2] PM2.5 emission factor was calculated from the available PM10 emission factor using the ratio of 0.15 PM2.5/PM10 as recommended in

Freeport-McMoRan Chino Mines Company
Revised: December 2019

Aggregate and Material Handling - Magnetite Stockpile
Unit: CBM MH Mag

Basis		
Maximum daily amount from material handling:	4,500	tons
Maximum annual amount from material handling:	1,346,800	tons
Annual operating days:	365	(7 days/week x 52 weeks/year)
Estimated Average Daily operating hours:	10	

Note: operating basis information provided by Bruce Taylor, Cobre Operations Manager

Composite Assay of Samples [mass fraction]	Measured Magnetite Analysis[1]				
	Copper	Chromium	Nickel	Aluminum	Manganese
Magnetite	0.0011	0.00014	0.000060	0.0021	0.0045

Criteria Pollutant	Emission Factors (lb/ton)		
	PM	PM10	PM2.5
Truck Unloading - Fragmented Stone [2]	4.18E-05	1.60E-05	2.40E-06

Emissions Activity [3]	Maximum Mine Material Throughput[4]			TSP Emissions		PM_{10} Emissions		$PM_{2.5}$ Emissions	
	tons/hr	tons/day	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr
Unloading - Magnetite Pit to Storage	450	4,500	1,346,800	1.88E-02	2.81E-02	7.20E-03	1.08E-02	1.08E-03	1.62E-03
Unloading - Haul Truck	450	4,500	1,346,800	1.88E-02	2.81E-02	7.20E-03	1.08E-02	1.08E-03	1.62E-03
Loading - Rail Car	450	4,500	1,346,800	1.88E-02	2.81E-02	7.20E-03	1.08E-02	1.08E-03	1.62E-03
TOTAL				**0.056**	**0.084**	**0.022**	**0.032**	**0.0032**	**0.0048**

FEDERAL HAP/NM TOXIC AIR POLLUTANT EMISSIONS ESTIMATION

Emissions Activity	TAP Emissions (as % PM)									
	Copper		Chromium		Nickel		Aluminum		Manganese	
	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
Magnetite Pit to Storage (Unloading)	2.07E-05	3.10E-05	2.63E-06	3.94E-06	1.13E-06	1.69E-06	3.97E-05	5.94E-05	8.39E-05	1.26E-04
Haul Truck (Unloading)	2.07E-05	3.10E-05	2.63E-06	3.94E-06	1.13E-06	1.69E-06	3.97E-05	5.94E-05	8.39E-05	1.26E-04
Rail Car Loading	2.07E-05	3.10E-05	2.63E-06	3.94E-06	1.13E-06	1.69E-06	3.97E-05	5.94E-05	8.39E-05	1.26E-04
TOTAL	**6.21E-05**	**9.29E-05**	**7.90E-06**	**1.18E-05**	**3.39E-06**	**5.07E-06**	**1.19E-04**	**1.78E-04**	**2.52E-04**	**3.77E-04**

Notes:

(1). Mass fraction is based on the average content of the constituent within magnetite. Data obtained from Typical Magnetite Analysis, Phelps Dodge mining Company, Cobre Mining Division.

(2) The emission factors for material handling are based on AP-42, Chapter 11.19.2, Table 11.19.2-2 Crushed Stone Processing and Pulverized Mineral Processing (August 2004) for Truck Unloading - Fragmented Stone & Truck Loading - Conveyor crushed stone . The basis for these emission factors is the PM_{10} emission factor for truck unloading of fragmented stone & Truck Loading - Conveyor, crushed stone in Table 11.19.2-2. This table provides a PM_{10} emission factor, but does not provide $PM_{2.5}$ or TSP emission factors. A $PM_{2.5}$ emission factor was calculated from the available PM_{10} emission factor using the ratio of 0.15 $PM_{2.5}/PM_{10}$ as recommended in the Background Document for AP-42, Chapter 13.2.4, *Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors* - November 2006. An uncontrolled TSP emission factor was calculated from the available uncontrolled PM_{10} emission factor using the TSP/PM_{10} ratio calculated from the following uncontrolled TSP and PM_{10} emission factors in Table 11.19.2-2: Tertiary Crushing (0.0054/0.0024 = 2.25); Fines Crushing (0.0390/0.0150 = 2.60); Screening (0.025/0.0087 = 2.87; and Conveyor Transfer Point 0.0030/0.00110 = 2.73). See sample calculation below.

(3) Material handling in the magnetite pit consists of one handling step: front-end loader pickup/loading into haul truck. Material handling at the loadout consists of two handling steps: haul truck dumping at load out (one step) and front-end loader pickup/loading into rail car or over-the-road truck (one step) for a total of two handling steps.

(4) Provided by Cobre Mining Company, Senior Environmental Engineer. Rail/truck loading occurs during daylight hours, 7 days/week. Average annual daylight hours estimated to be 10 hours/day over the course of a year.

Freeport-McMoRan Chino Mines Company
Revised: December 2020

Aggregate and Material Handling - Mining Hanover Mountain
Unit: CBM MH

Basis

Maximum daily amount handled:	126,000	tons	Based on forecasted maximum production rates
Maximum annual amount handled:	45,990,000	tons	
Maximum daily amount unloaded to SWRDF stockpile:	75,000	tons	
Maximum annual amount unloaded to SWRDF stockpile:	27,375,000	tons	
Maximum daily amount unloaded to North Overburden stockpile:	90,000	tons	
Maximum annual amount unloaded to North Overburden stockpile:	16,790,000	tons	
Maximum daily amount unloaded to Lampbright:	40,000	tons	
Maximum annual amount unloaded to Lampbright:	14,600,000	tons	
Annual operating days:	365	(7 days/week x 52 weeks/year)	
Daily operating hours:	24		

Federal Hazardous Air Pollutants and New Mexico Toxic Air Pollutants Content of Waste Rock (%)[1]

	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
Composite Assay of Samples [mass fraction]	3.00E-04	*4.00E-04*	*1.11E-02*	1.00E-04	5.69E-03	1.45E-03	5.33E-02	9.00E-04	4.40E-02	1.10E-03	*4.00E-04*	*3.70E-03*	7.90E-03

Federal Hazardous Air Pollutants and New Mexico Toxic Air Pollutants Content of Ore for Leach (%)[1]

	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
Composite Assay of Samples [mass fraction]	*4.80E-04*	3.70E-04	6.80E-03	*1.30E-04*	*9.10E-03*	*3.90E-03*	*2.92E-01*	*1.57E-03*	*4.93E-02*	*2.10E-03*	8.00E-05	2.70E-03	*9.40E-03*

Criteria Pollutant	Emission Factors (lb/ton)		
	PM	PM10	PM2.5
Truck Unloading - Fragmented Stone [2]	4.18E-05	1.60E-05	2.40E-06

Emissions Activity	Maximum Mine Material Throughput[3]			TSP Emissions		PM_{10} Emissions		$PM_{2.5}$ Emissions	
	tons/hr	tons/day	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr
Loading - Hanover Mountain	5,250	126,000	45,990,000	0.22	0.96	0.084	0.37	0.013	0.06
Unloading - SWRDF Stockpile	3,125	75,000	27,375,000	0.13	0.57	0.050	0.22	0.008	0.033
Unloading - North Overburden	3,750	90,000	16,790,000	0.16	0.35	0.060	0.13	0.009	0.020
Unloading - Hanover/Cobre to Lampbright	1,667	40,000	14,600,000	0.07	0.31	0.027	0.12	0.004	0.018
TOTAL				**0.58**	**2.19**	**0.22**	**0.84**	**0.033**	**0.13**

FEDERAL HAP/NM TOXIC AIR POLLUTANT EMISSIONS ESTIMATION

Emissions Activity	TAP Emissions[4]													
	Antimony		Arsenic		Barium		Cadmium		Chromium		Cobalt		Copper	
	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
Loading - Hanover Mountain	1.05E-06	4.61E-06	8.78E-07	3.84E-06	2.44E-05	1.07E-04	2.85E-07	1.25E-06	2.00E-05	8.75E-05	8.56E-06	3.75E-05	6.40E-04	2.80E-03
Unloading - SWRDF Stockpile	6.27E-07	2.75E-06	5.23E-07	2.29E-06	1.45E-05	6.35E-05	1.70E-07	7.44E-07	1.19E-05	5.21E-05	5.09E-06	2.23E-05	3.81E-04	1.67E-03
Unloading - North Overburden	7.52E-07	1.68E-06	6.27E-07	1.40E-06	1.74E-05	3.90E-05	2.04E-07	4.56E-07	1.43E-05	3.19E-05	6.11E-06	1.37E-05	4.57E-04	1.02E-03
Unloading - Hanover/Cobre to Lampbright	3.34E-07	1.46E-06	2.79E-07	1.22E-06	7.73E-06	3.39E-05	9.06E-08	3.97E-07	6.34E-06	2.78E-05	2.72E-06	1.19E-05	2.03E-04	8.90E-04
TOTAL	**2.77E-06**	**1.05E-05**	**8.78E-07**	**3.84E-06**	**2.44E-05**	**1.07E-04**	**2.85E-07**	**1.25E-06**	**2.00E-05**	**8.75E-05**	**8.56E-06**	**3.75E-05**	**6.40E-04**	**2.80E-03**

Emissions Activity	TAP Emissions[4]											
	Lead		Manganese		Nickel		Silver		Vanadium		Zinc	
	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
Loading - Hanover Mountain	3.45E-06	1.51E-05	1.08E-04	4.74E-04	4.61E-06	2.02E-05	8.78E-07	3.84E-06	8.12E-06	3.56E-05	2.06E-05	9.04E-05
Unloading - SWRDF Stockpile	2.05E-06	8.98E-06	6.44E-05	2.82E-04	2.74E-06	1.20E-05	5.23E-07	2.29E-06	4.83E-06	2.12E-05	1.23E-05	5.38E-05
Unloading - North Overburden	2.46E-06	5.51E-06	7.73E-05	1.73E-04	3.29E-06	7.37E-06	6.27E-07	1.40E-06	5.80E-06	1.30E-05	1.47E-05	3.30E-05
Unloading - Hanover/Cobre to Lampbright	1.09E-06	4.79E-06	3.43E-05	1.50E-04	1.46E-06	6.41E-06	2.79E-07	1.22E-06	2.58E-06	1.13E-05	6.55E-06	2.87E-05
TOTAL	**9.05E-06**	**3.44E-05**	**2.84E-04**	**1.08E-03**	**1.21E-05**	**4.60E-05**	**2.31E-06**	**8.76E-06**	**2.13E-05**	**8.10E-05**	**5.42E-05**	**2.06E-04**

Notes:

(1) Process parameters provided by E.P. Bock and Mikel Lindley emails, Chino Mine Engineering, 1/25/11, 3/9/11, and 3/18/2011. Metal content data from Chino TRI Assay data provided by Clyde Durham 1/28/11 email to R. Felty (ARCADIS-US). The mine plan is constantly in flux, and the forecast tonnages can change month to month. Daily overall tonnage and daily Lampbright tonnages fluctuate the most. Therefore, daily tonnages are slightly increased to allow for a buffer and are not directly calculated from annual tonnages and operating schedule.

(2) The emission factors for material handling are based on AP-42, Chapter 11.19.2, Table 11.19.2-2 Crushed Stone Processing and Pulverized Mineral Processing (August 2004) for Truck Unloading - Fragmented Stone. The basis for these emission factors is the PM_{10} emission factor for truck unloading of fragmented stone in Table 11.19.2-2. This table provides a PM_{10} emission factor, but does not provide $PM_{2.5}$ or TSP emission factors. A $PM_{2.5}$ emission factor was calculated from the available PM_{10} emission factor using the ratio of 0.15 $PM_{2.5}/PM_{10}$ as recommended in the Background Document for AP-42, Chapter 13.2.4, *Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors* - November 2006. An uncontrolled TSP emission factor was calculated from the available uncontrolled PM_{10} emission factor using the TSP/PM_{10} ratio calculated from the following uncontrolled TSP and PM_{10} emission factors in Table 11.19.2-2: Tertiary Crushing (0.0054/0.0024 = 2.25); Fines Crushing (0.0390/0.0150 = 2.60); Screening (0.025/0.0087 = 2.87; and Conveyor Transfer Point (0.0030/0.00110 = 2.73). See sample calculation below.

(3)Maximum Material Throughput is based on maximum annual throughput provided by Freeport

(4) TAP emissions for waste rock and leach rock calculated by multiplying the TSP/PM Emissions by the TAP content (%) in waste rock or in leach rock, respectively. Material handling at Hanover will occur with waste rock and leach rock, so conservative TAPs emissions for material handling are based on the higher TAP % available for waste rock or leach rock. For example, antimony emissions from material handling are based on antimony % in leach rock and barium emissions from material handling in the pit are based on barium % in waste rock.

Freeport-McMoRan Chino Mines Company
Revised: December 2020

Aggregate and Material Handling - Mining Hanover Mountain
Unit: CBM MH

Basis

Maximum daily amount handled:	126,000	tons	Based on forecasted maximum production rates
Maximum annual amount handled:	45,990,000	tons	
Maximum daily amount unloaded to SWRDF stockpile:	75,000	tons	
Maximum annual amount unloaded to SWRDF stockpile:	27,375,000	tons	
Maximum daily amount unloaded to North Overburden stockpile:	90,000	tons	
Maximum annual amount unloaded to North Overburden stockpile:	16,790,000	tons	
Maximum daily amount unloaded to Lampbright:	40,000	tons	
Maximum annual amount unloaded to Lampbright:	14,600,000	tons	
Annual operating days:	365	(7 days/week x 52 weeks/year)	
Daily operating hours:	24		

Federal Hazardous Air Pollutants and New Mexico Toxic Air Pollutants Content of Waste Rock (%)[1]

Composite Assay of Samples [mass fraction]	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
	3.00E-04	*4.00E-04*	*1.11E-02*	1.00E-04	5.69E-03	1.45E-03	5.33E-02	9.00E-04	4.40E-02	1.10E-03	*4.00E-04*	*3.70E-03*	7.90E-03

Federal Hazardous Air Pollutants and New Mexico Toxic Air Pollutants Content of Ore for Leach (%)[1]

Composite Assay of Samples [mass fraction]	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
	4.80E-04	3.70E-04	6.80E-03	*1.30E-04*	*9.10E-03*	*3.90E-03*	*2.92E-01*	*1.57E-03*	*4.93E-02*	*2.10E-03*	8.00E-05	2.70E-03	*9.40E-03*

Criteria Pollutant	Emission Factors (lb/ton)		
	PM	PM10	PM2.5
Truck Unloading - Fragmented Stone [2]	4.18E-05	1.60E-05	2.40E-06

Emissions Activity	Maximum Mine Material Throughput[3]			TSP Emissions		PM_{10} Emissions		$PM_{2.5}$ Emissions	
	tons/hr	tons/day	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr
Loading - Hanover Mountain	5,250	126,000	45,990,000	0.22	0.96	0.084	0.37	0.013	0.06
Unloading - SWRDF Stockpile	3,125	75,000	27,375,000	0.13	0.57	0.050	0.22	0.008	0.033
Unloading - North Overburden	3,750	90,000	16,790,000	0.16	0.35	0.060	0.13	0.009	0.020
Unloading - Hanover/Cobre to Lampbright	1,667	40,000	14,600,000	0.07	0.31	0.027	0.12	0.004	0.018
TOTAL				**0.58**	**2.19**	**0.22**	**0.84**	**0.033**	**0.13**

FEDERAL HAP/NM TOXIC AIR POLLUTANT EMISSIONS ESTIMATION

Emissions Activity	TAP Emissions[4]													
	Antimony		Arsenic		Barium		Cadmium		Chromium		Cobalt		Copper	
	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
Loading - Hanover Mountain	1.05E-06	4.61E-06	8.78E-07	3.84E-06	2.44E-05	1.07E-04	2.85E-07	1.25E-06	2.00E-05	8.75E-05	8.56E-06	3.75E-05	6.40E-04	2.80E-03
Unloading - SWRDF Stockpile	6.27E-07	2.75E-06	5.23E-07	2.29E-06	1.45E-05	6.35E-05	1.70E-07	7.44E-07	1.19E-05	5.21E-05	5.09E-06	2.23E-05	3.81E-04	1.67E-03
Unloading - North Overburden	7.52E-07	1.68E-06	6.27E-07	1.40E-06	1.74E-05	3.90E-05	2.04E-07	4.56E-07	1.43E-05	3.19E-05	6.11E-06	1.37E-05	4.57E-04	1.02E-03
Unloading - Hanover/Cobre to Lampbright	3.34E-07	1.46E-06	2.79E-07	1.22E-06	7.73E-06	3.39E-05	9.06E-08	3.97E-07	6.34E-06	2.78E-05	2.72E-06	1.19E-05	2.03E-04	8.90E-04
TOTAL	**2.77E-06**	**1.05E-05**	**8.78E-07**	**3.84E-06**	**2.44E-05**	**1.07E-04**	**2.85E-07**	**1.25E-06**	**2.00E-05**	**8.75E-05**	**8.56E-06**	**3.75E-05**	**6.40E-04**	**2.80E-03**

Emissions Activity	TAP Emissions[4]											
	Lead		Manganese		Nickel		Silver		Vanadium		Zinc	
	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
Loading - Hanover Mountain	3.45E-06	1.51E-05	1.08E-04	4.74E-04	4.61E-06	2.02E-05	8.78E-07	3.84E-06	8.12E-06	3.56E-05	2.06E-05	9.04E-05
Unloading - SWRDF Stockpile	2.05E-06	8.98E-06	6.44E-05	2.82E-04	2.74E-06	1.20E-05	5.23E-07	2.29E-06	4.83E-06	2.12E-05	1.23E-05	5.38E-05
Unloading - North Overburden	2.46E-06	5.51E-06	7.73E-05	1.73E-04	3.29E-06	7.37E-06	6.27E-07	1.40E-06	5.80E-06	1.30E-05	1.47E-05	3.30E-05
Unloading - Hanover/Cobre to Lampbright	1.09E-06	4.79E-06	3.43E-05	1.50E-04	1.46E-06	6.41E-06	2.79E-07	1.22E-06	2.58E-06	1.13E-05	6.55E-06	2.87E-05
TOTAL	**9.05E-06**	**3.44E-05**	**2.84E-04**	**1.08E-03**	**1.21E-05**	**4.60E-05**	**2.31E-06**	**8.76E-06**	**2.13E-05**	**8.10E-05**	**5.42E-05**	**2.06E-04**

Notes:

(1) Process parameters provided by E.P. Bock and Mikel Lindley emails, Chino Mine Engineering, 1/25/11, 3/9/11, and 3/18/2011. Metal content data from Chino TRI Assay data provided by Clyde Durham 1/28/11 email to R. Felty (ARCADIS-US). The mine plan is constantly in flux, and the forecast tonnages can change month to month. Daily overall tonnage and daily Lampbright tonnages fluctuate the most. Therefore, daily tonnages are slightly increased to allow for a buffer and are not directly calculated from annual tonnages and operating schedule.

(2) The emission factors for material handling are based on AP-42, Chapter 11.19.2, Table 11.19.2-2 Crushed Stone Processing and Pulverized Mineral Processing (August 2004) for Truck Unloading - Fragmented Stone. The basis for these emission factors is the PM_{10} emission factor for truck unloading of fragmented stone in Table 11.19.2-2. This table provides a PM_{10} emission factor, but does not provide $PM_{2.5}$ or TSP emission factors. A $PM_{2.5}$ emission factor was calculated from the available PM_{10} emission factor using the ratio of 0.15 $PM_{2.5}/PM_{10}$ as recommended in the Background Document for AP-42, Chapter 13.2.4, *Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors* - November 2006. An uncontrolled TSP emission factor was calculated from the available uncontrolled PM_{10} emission factor using the TSP/PM_{10} ratio calculated from the following uncontrolled TSP and PM_{10} emission factors in Table 11.19.2-2: Tertiary Crushing (0.0054/0.0024 = 2.25); Fines Crushing (0.0390/0.0150 = 2.60); Screening (0.025/0.0087 = 2.87; and Conveyor Transfer Point (0.0030/0.00110 = 2.73). See sample calculation below.

(3)Maximum Material Throughput is based on maximum annual throughput provided by Freeport

(4) TAP emissions for waste rock and leach rock calculated by multiplying the TSP/PM Emissions by the TAP content (%) in waste rock or in leach rock, respectively. Material handling at Hanover will occur with waste rock and leach rock, so conservative TAPs emissions for material handling are based on the higher TAP % available for waste rock or leach rock. For example, antimony emissions from material handling are based on antimony % in leach rock and barium emissions from material handling in the pit are based on barium % in waste rock.

Freeport-McMoRan Chino Mines Company
Revised: December 2019

Aggregate and Material Handling - Chino Mine Material Handling
Unit: CM MH

	Basis	
Maximum daily amount handled at Pit and unloaded at Stockpiles:	400,000	tons
Maximum annual amount handled at Pit and unloaded at Stockpiles:	146,000,000	tons
Maximum daily amount unloaded to Lampbright North leach stockpile:	350,000	tons
Maximum annual amount unloaded to Lampbright North leach stockpile:	127,750,000	tons
Maximum daily amount unloaded to South waste stockpile:	300,000	tons
Maximum annual amount unloaded to South waste stockpile:	109,500,000	tons
Maximum daily amount unloaded to West waste stockpile:	100,000	tons
Maximum annual amount unloaded to West waste stockpile:	36,500,000	tons
Maximum daily amount unloaded to NSPE waste stockpile:	0	tons
Maximum annual amount unloaded to NSPE waste stockpile:	0	tons
Maximum daily amount handled to Crusher/Hill Stockpile	170,000	
Maximum annual amount unloaded to Crusher/Hill Stockpile	62,050,000	
Annual operating days:	365	(7 days/week x 52 weeks/year)
Daily operating hours:	24	

Federal Hazardous Air Pollutants and New Mexico Toxic Air Pollutants Content of Waste Rock (%)[1]

Composite Assay of Samples [mass fraction]	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
	3.00E-04	4.00E-04	1.11E-02	1.00E-04	5.69E-03	1.45E-03	5.33E-02	9.00E-04	4.40E-02	1.10E-03	*4.00E-04*	*3.70E-03*	7.90E-03

Federal Hazardous Air Pollutants and New Mexico Toxic Air Pollutants Content of Ore for Leach (%)[1]

Composite Assay of Samples [mass fraction]	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Lead	Manganese	Nickel	Silver	Vanadium	Zinc
	4.80E-04	3.70E-04	6.80E-03	1.30E-04	9.10E-03	3.90E-03	2.92E-01	1.57E-03	4.93E-02	2.10E-03	*8.00E-05*	*2.70E-03*	9.40E-03

Criteria Pollutant	Emission Factors (lb/ton)		
	PM	PM10	PM2.5
Truck Unloading - Fragmented Stone [2]	4.18E-05	1.60E-05	2.40E-06

Emissions Activity	Maximum Mine Material Throughput [3]			TSP Emissions		PM_{10} Emissions		$PM_{2.5}$ Emissions	
	tons/hr	tons/day	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr
Loading - Santa Rita Pit	16,667	400,000	146,000,000	0.70	3.05	0.27	1.17	0.04	0.18
Unloading - Lampbright North Leach Stockpile	14,583	350,000	127,750,000	0.61	2.67	0.23	1.02	0.035	0.15
Unloading - South Waste + Leach Stockpile	12,500	300,000	109,500,000	0.52	2.29	0.20	0.88	0.03	0.13
Unloading - West Waste Stockpile	4,167	100,000	36,500,000	0.17	0.76	0.07	0.29	0.010	0.04
Unloading - NSPE Waste Stockpile	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
Unloading - Crusher/Hill Stockpile	7,083	170,000	62,050,000	0.30	1.30	0.11	0.50	0.02	0.07
TOTAL				**2.30**	**10.07**	**0.88**	**3.85**	**0.13**	**0.58**

FEDERAL HAP/NM TOXIC AIR POLLUTANT EMISSIONS ESTIMATION

Emissions Activity	TAP Emissions[4]													
	Antimony		Arsenic		Barium		Cadmium		Chromium		Cobalt		Copper	
	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
Material Handling at Santa Rita Pit	3.34E-06	1.46E-05	2.79E-06	1.22E-05	7.73E-05	3.39E-04	9.06E-07	3.97E-06	6.34E-05	2.78E-04	2.72E-05	1.19E-04	2.03E-03	8.90E-03
Unloading - Lampbright North Leach Stockpile	2.93E-06	1.28E-05	2.44E-06	1.07E-05	6.77E-05	2.96E-04	7.92E-07	3.47E-06	5.55E-05	2.43E-04	2.38E-05	1.04E-04	1.78E-03	7.79E-03
Unloading - South Waste + Leach Stockpile	2.51E-06	1.10E-05	2.09E-06	9.15E-06	5.80E-05	2.54E-04	6.79E-07	2.98E-06	4.75E-05	2.08E-04	2.04E-05	8.93E-05	1.52E-03	6.68E-03
Unloading - West Waste Stockpile	8.36E-07	3.66E-06	6.97E-07	3.05E-06	1.93E-05	8.47E-05	2.26E-07	9.92E-07	1.58E-05	6.94E-05	6.79E-06	2.98E-05	5.08E-04	2.23E-03
Unloading - NSPE Waste Stockpile	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Unloading - Crusher/Hill Stockpile	1.42E-06	6.22E-06	1.18E-06	5.19E-06	3.29E-05	1.44E-04	3.85E-07	1.69E-06	2.69E-05	1.18E-04	1.15E-05	5.06E-05	8.64E-04	3.78E-03
TOTAL	**1.10E-05**	**4.83E-05**	**9.20E-06**	**4.03E-05**	**2.55E-04**	**1.12E-03**	**2.99E-06**	**1.31E-05**	**2.09E-04**	**9.16E-04**	**8.97E-05**	**3.93E-04**	**6.71E-03**	**2.94E-02**

Emissions Activity	TAP Emissions[4]											
	Lead		Manganese		Nickel		Silver		Vanadium		Zinc	
	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
Material Handling at Santa Rita Pit	1.09E-05	4.79E-05	3.43E-04	1.50E-03	1.46E-05	6.41E-05	2.79E-06	1.22E-05	2.58E-05	1.13E-04	6.55E-05	2.87E-04
Unloading - Lampbright North Leach Stockpile	9.57E-06	4.19E-05	3.01E-04	1.32E-03	1.28E-05	5.61E-05	2.44E-06	1.07E-05	2.26E-05	9.88E-05	5.73E-05	2.51E-04
Unloading - South Waste + Leach Stockpile	8.20E-06	3.59E-05	2.58E-04	1.13E-03	1.10E-05	4.81E-05	2.09E-06	9.15E-06	1.93E-05	8.47E-05	4.91E-05	2.15E-04
Unloading - West Waste Stockpile	2.73E-06	1.20E-05	8.59E-05	3.76E-04	3.66E-06	1.60E-05	6.97E-07	3.05E-06	6.44E-06	2.82E-05	1.64E-05	7.17E-05
Unloading - NSPE Waste Stockpile	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Unloading - Crusher Hill Stockpile	4.65E-06	2.04E-05	1.46E-04	6.39E-04	6.22E-06	2.72E-05	1.18E-06	5.19E-06	1.10E-05	4.80E-05	2.78E-05	1.22E-04
TOTAL	**3.61E-05**	**1.58E-04**	**1.13E-03**	**4.96E-03**	**4.83E-05**	**2.11E-04**	**9.20E-06**	**4.03E-05**	**8.51E-05**	**3.73E-04**	**2.16E-04**	**9.47E-04**

Notes:

(1) Process parameters provided by E.P. Bock and Mikel Lindley emails, Chino Mine Engineering, 1/25/11, 3/9/11, and 3/18/2011. Metal content data from Chino TRI Assay data provided by Clyde Durham 1/28/11 email to R. Felty (ARCADIS-US). The mine plan is constantly in flux, and the forecast tonnages can change month to month. Daily overall tonnage and daily Lampbright tonnages fluctuate the most. Therefore, daily tonnages are slightly increased to allow for a buffer and are not directly calculated from annual tonnages and operating schedule.

(2) The emission factors for material handling are based on AP-42, Chapter 11.19.2, Table 11.19.2-2 Crushed Stone Processing and Pulverized Mineral Processing (August 2004) for Truck Unloading - Fragmented Stone. The basis for these emission factors is the PM_{10} emission factor for truck unloading of fragmented stone in Table 11.19.2-2. This table provides a PM_{10} emission factor, but does not provide $PM_{2.5}$ or TSP emission factors. A $PM_{2.5}$ emission factor was calculated from the available PM_{10} emission factor using the ratio of 0.15 $PM_{2.5}/PM_{10}$ as recommended in the Background Document for AP-42, Chapter 13.2.4, *Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors* - November 2006. An uncontrolled TSP emission factor was calculated from the available uncontrolled PM_{10} emission factor using the TSP/PM_{10} ratio calculated from the following uncontrolled TSP and PM_{10} emission factors in Table 11.19.2-2: Tertiary Crushing (0.0054/0.0024 = 2.25); Fines Crushing (0.0390/0.0150 = 2.60); Screening (0.025/0.0087 = 2.87; and Conveyor Transfer Point (0.0030/0.00110 = 2.73). See sample calculation below.

(3) Maximum Material Throughput is based on maximum annual throughput provided by Freeport

(4) TAP emissions for waste rock and leach rock calculated by multiplying the TSP/PM Emissions by the TAP content (%) in waste rock or in leach rock, respectively. Material handling at Hanover will occur with waste rock and leach rock, so conservative TAPs emissions for material handling are based on the higher TAP % available for waste rock or leach rock. For example, antimony emissions from material handling are based on antimony % in leach rock and barium emissions from material handling in the pit are based on barium % in waste rock.

Freeport-McMoRan Chino Mines Company
Revised: December 2019
Road Name Maintenance Entrance Road
Road Number 2

Truck type	Caterpillar 793							
Average Truck Weight [tons]	303							
Hourly VMT [miles/hour][1]	10.88							
Annual VMT [miles/year][2]	462378.73							
Control Efficiency [%][3]	88.80%							
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]			
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled		
Particulate Matter (PM 2.5)	0.42	0.52	98.04	10.98	5.71	0.64		
Particulate Matter (PM 10)	4.24	5.25	980.36	109.80	57.10	6.40		
Particulate Matter (TSP)	16.64	20.59	3846.62	430.82	224.04	25.09		

Truck type	-					
Average Truck Weight [tons]	0					
Hourly VMT [miles/hour][1]	0.00					
Annual VMT [miles/year][2]	0.00					
Control Efficiency [%][3]	88.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	0.000	0.00	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	0.00	0.00	0.00	0.00	0.00	0.00

Truck type	-					
Average Truck Weight [tons]	0					
Hourly VMT [miles/hour][1]	0.00					
Annual VMT [miles/year][2]	0.00					
Control Efficiency [%][3]	88.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Annual Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	0.00	0.00	0.00	0.00	0.00	0.00

Emission Factor Constants	Maintenance Entrance Road		
Parameter	$PM_{2.5}$	PM_{10}	TSP
k*	0.15	1.50	4.90
a*	0.90	0.90	0.70
b*	0.45	0.45	0.45
silt content	4.8		
P [days]	70		

	Total Maximum Fugitive Emissions[6]				Number of volume sources	Emissions per Volume Source[7]			
	Controlled		Uncontrolled			Controlled		Uncontrolled	
	[tons/year]	[lb/hr]	[tons/year]	[lb/hr]		[tons/year]	[lb/hr]	[tons/year]	[lb/hr]
Particulate Matter (PM 2.5)	10.98	0.64	98.04	5.71	6	1.83	0.11	16.34	0.95
Particulate Matter (PM 10)	109.80	6.40	980.36	57.10	6	18.30	1.07	163.39	9.52
Particulate Matter (TSP)	430.82	25.09	3846.62	224.04	6	71.80	4.18	641.10	37.34

Fugitive emissions from traffic on unpaved surfaces by vehicles such as haul trucks and maintenance vehicles were estimated using EPA AP-42 emission factors, Section 13.2.2, Unpaved Roads (November 2006). The following equations are recommended for industrial sites:

(AP-42, Chapter 13.2.2, Equation 1a)

$$E\left(\frac{lb}{VMT}\right) = k\left(\frac{s}{12}\right)^{a}\left(\frac{W}{3}\right)^{b}$$

Where: E = emission factor in lb/VMT
lb = pounds of pollutant
VMT = vehicle miles traveled
k = particle size multiplier (lb/VMT)
a = empirical constant (unit less)
b = empirical constant (unit less)
s = surface silt content, (%)
W = mean vehicle weight, full vs. empty (tons)

Hourly Emission Factor:

$$E_h\left(\frac{lb}{hr}\right) = E \cdot d \cdot L$$

Where: E_h = hourly emission factor (lb/hr)
E = emission factor (lb/VMT)
d = average hourly daytime traffic rate, roundtrips per hour (h^{-1})
L = longest haul road length in miles (roundtrip)

By considering annual natural mitigation from rainfall, the annual emission factor is affected:

(AP-42, Chapter 13.2.2, Equation 1a)

$$E_{ext}\left(\frac{lb}{VMT}\right) = E \cdot \left[{(365 - P)}/{365}\right]$$

Where: E_{ext} = annual emission factor extrapolated for annual natural mitigation (lb/VMT)
E = hourly emission factor (lb/VMT)
P = number of days in a year with at least 0.01 inches of precipitation

Notes:
[1] Hourly Vehicle Miles Traveled = d (trips/hour) * L (mile/trip)
[2] Annual Vehicle Miles Traveled = Hourly Vehicle Miles Traveled (miles/hour) * Annual Operating Hours (hours/year)
[3]Control Efficiency is set at 88.8%; see control efficiency page for more info.
[4] Emission factors are from AP-42, Chapter 13.2.2, Unpaved Roads, vehicles traveling on unpaved surfaces at industrial sites.
[5] Annual Emission Rate = Annual Uncontrolled Emission Factor * Annual VMT ÷ 2000
[5]Hourly Emission Rate = Hourly Uncontrolled Emission Factor * Hourly VMT
6 Total Emission are the sum of all truck emissions operating on that road
7 Emission per Volume source = Total Emissions ÷ Number of Volume Sources
* Values for k, a, and b obtained from AP-42, Chapter 13.2.2, Unpaved Roads, Table 13.2.2-2 (November 2006)

Freeport-McMoRan Chino Mines Company
Revised: December 2019
Road Name Cobre Haul Road
Road Number 3

Truck type	Caterpillar 793							
Average Truck Weight [tons]	303							
Hourly VMT [miles/hour][1]	86.19							
Annual VMT [miles/year][2]	1144029.85							
Control Efficiency [%][3]	96.80%							
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]			
	[lb./VMT]	[lb./VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled		
Particulate Matter (PM 2.5)	0.42	0.52	242.56	7.76	45.22	1.45		
Particulate Matter (PM 10)	4.24	5.25	2425.64	77.62	452.24	14.47		
Particulate Matter (TSP)	16.64	20.59	9517.42	304.56	1774.43	56.78		

Truck type	-					
Average Truck Weight [tons]	0					
Hourly VMT [miles/hour][1]	0.00					
Annual VMT [miles/year][2]	0.00					
Control Efficiency [%][3]	96.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	0.000	0.00	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	0.00	0.00	0.00	0.00	0.00	0.00

Truck type	-					
Average Truck Weight [tons]	0					
Hourly VMT [miles/hour][1]	0.00					
Annual VMT [miles/year][2]	0.00					
Control Efficiency [%][3]	96.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Annual Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	0.00	0.00	0.00	0.00	0.00	0.00

Emission Factor Constants	Cobre Haul Road		
Parameter	$PM_{2.5}$	PM_{10}	TSP
k*	0.15	1.50	4.90
a*	0.90	0.90	0.70
b*	0.45	0.45	0.45
silt content	4.8		
P [days]	70		

	Total Maximum Fugitive Emissions[6]				Number of volume sources	Emissions per Volume Source[7]			
	Controlled		Uncontrolled			Controlled		Uncontrolled	
	[tons/year]	[lb/hr]	[tons/year]	[lb/hr]		[tons/year]	[lb/hr]	[tons/year]	[lb/hr]
Particulate Matter (PM 2.5)	7.76	1.45	242.56	45.22	109	0.07	0.01	2.23	0.41
Particulate Matter (PM 10)	77.62	14.47	2425.64	452.24	109	0.71	0.13	22.25	4.15
Particulate Matter (TSP)	304.56	56.78	9517.42	1774.43	109	2.79	0.52	87.32	16.28

Fugitive emissions from traffic on unpaved surfaces by vehicles such as haul trucks and maintenance vehicles were estimated using EPA AP-42 emission factors, Section 13.2.2, Unpaved Roads (November 2006). The following equations are recommended for industrial sites:

(AP-42, Chapter 13.2.2, Equation 1a)

$$E\left(\frac{lb}{VMT}\right) = k\left(\frac{s}{12}\right)^a\left(\frac{W}{3}\right)^b$$

Where: E = emission factor in lb/VMT
lb = pounds of pollutant
VMT = vehicle miles traveled
k = particle size multiplier (lb/VMT)
a = empirical constant (unit less)
b = empirical constant (unit less)
s = surface silt content, (%)
W = mean vehicle weight, full vs. empty (tons)

Hourly Emission Factor:

$$E_h\left(\frac{lb}{hr}\right) = E \cdot d \cdot L$$

Where: E_h = hourly emission factor (lb/hr)
E = emission factor (lb/VMT)
d = average hourly daytime traffic rate, roundtrips per hour (h^{-1})
L = longest haul road length in miles (roundtrip)

By considering annual natural mitigation from rainfall, the annual emission factor is affected:

(AP-42, Chapter 13.2.2, Equation 1a)

$$E_{ext}\left(\frac{lb}{VMT}\right) = E \cdot \left[(365-P)/365\right]$$

Where: E_{ext} = annual emission factor extrapolated for annual natural mitigation (lb/VMT)
E = hourly emission factor (lb/VMT)
P = number of days in a year with at least 0.01 inches of precipitation

Notes:
[1] Hourly Vehicle Miles Traveled = d (trips/hour) * L (mile/trip)
[2] Annual Vehicle Miles Traveled = Hourly Vehicle Miles Traveled (miles/hour) * Annual Operating Hours (hours/year)
[3] Control Efficiency is set at 88.8%; see control efficiency page for more info.
[4] Emission factors are from AP-42, Chapter 13.2.2, Unpaved Roads, vehicles traveling on unpaved surfaces at industrial sites.
[5] Annual Emission Rate = Annual Uncontrolled Emission Factor * Annual VMT ÷ 2000
[5] Hourly Emission Rate = Hourly Uncontrolled Emission Factor * Hourly VMT
6 Total Emission are the sum of all truck emissions operating on that road
7 Emission per Volume source = Total Emissions ÷ Number of Volume Sources
* Values for k, a, and b obtained from AP-42, Chapter 13.2.2, Unpaved Roads, Table 13.2.2-2 (November 2006)

Freeport-McMoRan Chino Mines Company
Revised: December 2019
Road Name SWRDF Road
Road Number 4

Truck type	Caterpillar 793							
Average Truck Weight [tons]	303							
Hourly VMT [miles/hour][1]	35.68							
Annual VMT [miles/year][2]	416753.73							
Control Efficiency [%][3]	88.80%							
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]			
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled		
Particulate Matter (PM 2.5)	0.42	0.52	88.36	9.90	18.72	2.10		
Particulate Matter (PM 10)	4.24	5.25	883.63	98.97	187.21	20.97		
Particulate Matter (TSP)	16.64	20.59	3467.06	388.31	734.55	82.27		

Truck type	-					
Average Truck Weight [tons]	0					
Hourly VMT [miles/hour][1]	0.00					
Annual VMT [miles/year][2]	0.00					
Control Efficiency [%][3]	88.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	0.000	0.00	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	0.00	0.00	0.00	0.00	0.00	0.00

Truck type	-					
Average Truck Weight [tons]	0					
Hourly VMT [miles/hour][1]	0.00					
Annual VMT [miles/year][2]	0.00					
Control Efficiency [%][3]	88.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Annual Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	0.00	0.00	0.00	0.00	0.00	0.00

Emission Factor Constants	SWRDF Road		
Parameter	$PM_{2.5}$	PM_{10}	TSP
k*	0.15	1.50	4.90
a*	0.90	0.90	0.70
b*	0.45	0.45	0.45
silt content	4.8		
P [days]	70		

	Total Maximum Fugitive Emissions[6]				Number of volume sources	Emissions per Volume Source[7]			
	Controlled		Uncontrolled			Controlled		Uncontrolled	
	[tons/year]	[lb/hr]	[tons/year]	[lb/hr]		[tons/year]	[lb/hr]	[tons/year]	[lb/hr]
Particulate Matter (PM 2.5)	9.90	2.10	88.36	18.72	40	0.25	0.052	2.21	0.47
Particulate Matter (PM 10)	98.97	20.97	883.63	187.21	40	2.47	0.52	22.09	4.68
Particulate Matter (TSP)	388.31	82.27	3467.06	734.55	40	9.71	2.06	86.68	18.36

Fugitive emissions from traffic on unpaved surfaces by vehicles such as haul trucks and maintenance vehicles were estimated using EPA AP-42 emission factors, Section 13.2.2, Unpaved Roads (November 2006). The following equations are recommended for industrial sites:

(AP-42, Chapter 13.2.2, Equation

$$E\left(\frac{lb}{VMT}\right) = k\left(\frac{s}{12}\right)^a\left(\frac{W}{3}\right)^b$$

Where: E = emission factor in lb/VMT
lb = pounds of pollutant
VMT = vehicle miles traveled
k = particle size multiplier (lb/VMT)
a = empirical constant (unit less)
b = empirical constant (unit less)
s = surface silt content, (%)
W = mean vehicle weight, full vs. empty (tons)

Hourly Emission Factor:

$$E_h\left(\frac{lb}{hr}\right) = E \cdot d \cdot L$$

Where: E_h = hourly emission factor (lb/hr)
E = emission factor (lb/VMT)
d = average hourly daytime traffic rate, roundtrips per hour (h^{-1})
L = longest haul road length in miles (roundtrip)

By considering annual natural mitigation from rainfall, the annual emission factor is affected:

(AP-42, Chapter 13.2.2, Equation

$$E_{ext}\left(\frac{lb}{VMT}\right) = E \cdot \left[(365-P)/365\right]$$

Where: E_{ext} = annual emission factor extrapolated for annual natural mitigation (lb/VMT)
E = hourly emission factor (lb/VMT)
P = number of days in a year with at least 0.01 inches of precipitation

Notes:
[1] Hourly Vehicle Miles Traveled = d (trips/hour) * L (mile/trip)
[2] Annual Vehicle Miles Traveled = Hourly Vehicle Miles Traveled (miles/hour) * Annual Operating Hours (hours/year)
[3]Control Efficiency is set at 88.8%; see control efficiency page for more info.
[4] Emission factors are from AP-42, Chapter 13.2.2, Unpaved Roads, vehicles traveling on unpaved surfaces at industrial sites.
[5] Annual Emission Rate = Annual Uncontrolled Emission Factor * Annual VMT ÷ 2000
[5]Hourly Emission Rate = Hourly Uncontrolled Emission Factor * Hourly VMT
6 Total Emission are the sum of all truck emissions operating on that road
7 Emission per Volume source = Total Emissions ÷ Number of Volume Sources
* Values for k, a, and b obtained from AP-42, Chapter 13.2.2, Unpaved Roads, Table 13.2.2-2 (November 2006)

Freeport-McMoRan Chino Mines Company
Revised: December 2019
Road Name **Hanover Mountain Road**
Road Number **5 North 1**

Truck type	Caterpillar 793						-						-					
Average Truck Weight [tons]	303						0						0					
Hourly VMT [miles/hour][1]	38.79						0.00						0.00					
Annual VMT [miles/year][2]	339776.87						0.00						0.00					
Control Efficiency [%][3]	96.80%						96.80%						96.80%					
Criteria Pollutant	**Annual Uncontrolled Emission Factor**[4]	**Hourly Controlled Emission Factor**[4]	**Annual Emission Rate**[5] **[tons/year]**		**Hourly Emission Rate**[5] **[lb/yr]**		**Annual Uncontrolled Emission Factor**[4]	**Hourly Controlled Emission Factor**[4]	**Annual Emission Rate**[5] **[tons/year]**		**Hourly Emission Rate**[5] **[lb/yr]**		**Annual Uncontrolled Emission Factor**[4]	**Hourly Controlled Emission Factor**[4]	**Annual Emission Rate**[5] **[tons/year]**		**Annual Emission Rate**[5] **[lb/yr]**	
	[lb/VMT]	**[lb/VMT]**	**Uncontrolled**	**Controlled**	**Uncontrolled**	**Controlled**	**[lb/VMT]**	**[lb/VMT]**	**Uncontrolled**	**Controlled**	**Uncontrolled**	**Controlled**	**[lb/VMT]**	**[lb/VMT]**	**Uncontrolled**	**Controlled**	**Uncontrolled**	**Controlled**
Particulate Matter (PM 2.5)	0.42	0.52	72.04	2.31	20.35	0.65	0.000	0.000	0.00	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	4.24	5.25	720.42	23.05	203.51	6.51	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	16.64	20.59	2826.67	90.45	798.50	25.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Emission Factor Constants	**Hanover Mountain Road**		
Parameter	**$PM_{2.5}$**	**PM_{10}**	**TSP**
k*	0.15	1.50	4.90
a*	0.90	0.90	0.70
b*	0.45	0.45	0.45
silt content	4.8		
P [days]	70		

	Total Maximum Fugitive Emissions[6]				**Number of volume sources**	**Emissions per Volume Source**[7]			
	Controlled		**Uncontrolled**			**Controlled**		**Uncontrolled**	
	[tons/year]	**[lb/hr]**	**[tons/year]**	**[lb/hr]**		**[tons/year]**	**[lb/hr]**	**[tons/year]**	**[lb/hr]**
Particulate Matter (PM 2.5)	2.305	0.65	72.04	20.35	5	0.46	0.13	14.41	4.07
Particulate Matter (PM 10)	23.05	6.51	720.42	203.51	5	4.61	1.30	144.08	40.70
Particulate Matter (TSP)	90.45	25.55	2826.67	798.50	5	18.09	5.11	565.33	159.70

Fugitive emissions from traffic on unpaved surfaces by vehicles such as haul trucks and maintenance vehicles were estimated using EPA AP-42 emission factors, Section 13.2.2, Unpaved Roads (November 2006). The following equations are recommended for industrial sites:

(AP-42, Chapter 13.2.2, Equatior

$$E\left(\frac{lb}{VMT}\right) = k\left(\frac{s}{12}\right)^a\left(\frac{W}{3}\right)^b$$

Where: E = emission factor in lb/VMT
lb = pounds of pollutant
VMT = vehicle miles traveled
k = particle size multiplier (lb/VMT)
a = empirical constant (unit less)
b = empirical constant (unit less)
s = surface silt content, (%)
W = mean vehicle weight, full vs. empty (tons)

Hourly Emission Factor:

$$E_h\left(\frac{lb}{hr}\right) = E \cdot d \cdot L$$

Where: E_h = hourly emission factor (lb/hr)
E = emission factor (lb/VMT)
d = average hourly daytime traffic rate, roundtrips per hour (h^{-1})
L = longest haul road length in miles (roundtrip)

By considering annual natural mitigation from rainfall, the annual emission factor is affected:

(AP-42, Chapter 13.2.2, Equatior

$$E_{ext}\left(\frac{lb}{VMT}\right) = E \cdot \left[\frac{(365-P)}{365}\right]$$

Where: E_{ext} = annual emission factor extrapolated for annual natural mitigation (lb/VMT)
E = hourly emission factor (lb/VMT)
P = number of days in a year with at least 0.01 inches of precipitation

Notes:
1 Hourly Vehicle Miles Traveled = d (trips/hour) * L (mile/trip)
2 Annual Vehicle Miles Traveled = Hourly Vehicle Miles Traveled (miles/hour) * Annual Operating Hours
3 Control Efficiency is set at 88.8%; see control efficiency page for more info.
4 Emission factors are from AP-42, Chapter 13.2.2, Unpaved Roads, vehicles traveling on unpaved surfaces at industrial sites.
5 Annual Emission Rate = Annual Uncontrolled Emission Factor * Annual VMT ÷ 2000
5 Hourly Emission Rate = Hourly Uncontrolled Emission Factor * Hourly VMT
6 Total Emission are the sum of all truck emissions operating on that road
7 Emission per Volume source = Total Emissions ÷ Number of Volume Sources
* Values for k, a, and b obtained from AP-42, Chapter 13.2.2, Unpaved Roads, Table 13.2.2-2 (November 2006)

Freeport-McMoRan Chino Mines Company
Revised: December 2019
Road Name Muffler
Road Number 5 South 1

Truck type	Caterpillar 793						-						-					
Average Truck Weight [tons]	303						0						0					
Hourly VMT [miles/hour][1]	23.63						0.00						0.00					
Annual VMT [miles/year][2]	1004022.39						0.00						0.00					
Control Efficiency [%][3]	88.80%						88.80%						88.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]		Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]		Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Annual Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.42	0.52	212.88	23.84	12.40	1.39	0.000	0.000	0.00	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	4.24	5.25	2128.79	238.42	123.99	13.89	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	16.64	20.59	8352.67	935.50	486.50	54.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Emission Factor Constants	Muffler		
Parameter	$PM_{2.5}$	PM_{10}	TSP
k*	0.15	1.50	4.90
a*	0.90	0.90	0.70
b*	0.45	0.45	0.45
silt content	4.8		
P [days]	70		

	Total Maximum Fugitive Emissions[6]				Number of volume sources	Emissions per Volume Source[7]			
	Controlled		Uncontrolled			Controlled		Uncontrolled	
	[tons/year]	[lb/hr]	[tons/year]	[lb/hr]		[tons/year]	[lb/hr]	[tons/year]	[lb/hr]
Particulate Matter (PM 2.5)	23.842	1.39	212.88	12.40	12	1.987	0.12	17.74	1.03
Particulate Matter (PM 10)	238.42	13.89	2128.79	123.99	12	19.87	1.16	177.40	10.33
Particulate Matter (TSP)	935.50	54.49	8352.67	486.50	12	77.96	4.54	696.06	40.54

Fugitive emissions from traffic on unpaved surfaces by vehicles such as haul trucks and maintenance vehicles were estimated using EPA AP-42 emission factors, Section 13.2.2, Unpaved Roads (November 2006). The following equations are recommended for industrial sites:

(AP-42, Chapter 13.2.2, Equatioı

$$E\left(\frac{lb}{VMT}\right) = k\left(\frac{s}{12}\right)^a \left(\frac{W}{3}\right)^b$$

Where: E = emission factor in lb/VMT
lb = pounds of pollutant
VMT = vehicle miles traveled
k = particle size multiplier (lb/VMT)
a = empirical constant (unitless)
b = empirical constant (unitless)
s = surface silt content, (%)
W = mean vehicle weight, full vs. empty (tons)

Hourly Emission Factor:

$$E_h\left(\frac{lb}{hr}\right) = E \cdot d \cdot L$$

Where: E_h = hourly emission factor (lb/hr)
E = emission factor (lb/VMT)
d = average hourly daytime traffic rate, roundtrips per hour (h^{-1})
L = longest haul road length in miles (roundtrip)

By considering annual natural mitigation from rainfall, the annual emission factor is affected:

(AP-42, Chapter 13.2.2, Equatioı

$$E_{ext}\left(\frac{lb}{VMT}\right) = E \cdot \left[(365-P)/365\right]$$

Where: E_{ext} = annual emission factor extrapolated for annual natural mitigation (lb/VMT)
E = hourly emission factor (lb/VMT)
P = number of days in a year with at least 0.01 inches of precipitation

Notes:
[1] Hourly Vehicle Miles Traveled = d (trips/hour) * L (mile/trip)
[2] Annual Vehicle Miles Traveled = Hourly Vehicle Miles Traveled (miles/hour) * Annual Operating Hours
[3]Control Efficiency is set at 88.8%; see control effieciency page for more info.
[4] Emission factors are from AP-42, Chapter 13.2.2, Unpaved Roads, vehicles traveling on unpaved surfaces at industrial sites.
[5] Annual Emission Rate = Annual Uncontrolled Emission Factor * Annual VMT ÷ 2000
[5]Hourly Emission Rate = Hourly Uncontrolled E,ission Factor * Hourly VMT
6 Total Emission are the sum of all truck emissions operating on that road
7 Emission per Volume source = Total Emissions ÷ Number of Volume Sources
* Values for k, a, and b obtained from AP-42, Chapter 13.2.2, Unpaved Roads, Table 13.2.2-2 (November 2006)

Freeport-McMoRan Chino Mines Company
Revised: December 2019
Road Name South Stockpile Road
Road Number 6

Truck type	Caterpillar 793					
Average Truck Weight [tons]	303					
Hourly VMT [miles/hour][1]	43.53233831					
Annual VMT [miles/year][2]	1849514.925					
Control Efficiency [%][3]	88.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.42	0.52	392.15	43.92	22.84	2.56
Particulate Matter (PM 10)	4.24	5.25	3921.45	439.20	228.40	25.58
Particulate Matter (TSP)	16.64	20.59	15386.49	1723.29	896.18	100.37

Truck type	-					
Average Truck Weight [tons]	0					
Hourly VMT [miles/hour][1]	0					
Annual VMT [miles/year][2]	0					
Control Efficiency [%][3]	88.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	0.000	0.00	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	0.00	0.00	0.00	0.00	0.00	0.00

Truck type	-					
Average Truck Weight [tons]	0					
Hourly VMT [miles/hour][1]	0					
Annual VMT [miles/year][2]	0					
Control Efficiency [%][3]	88.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Annual Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	0.00	0.00	0.00	0.00	0.00	0.00

Emission Factor Constants	South Stockpile Road		
Parameter	$PM_{2.5}$	PM_{10}	TSP
k*	0.15	1.50	4.90
a*	1	0.90	0.70
b*	0.45	0.45	0.45
silt content	4.8		
P [days]	70		

	Total Maximum Fugitive Emissions[6]				Number of volume sources	Emissions per Volume Source[7]			
	Controlled		Uncontrolled			Controlled		Uncontrolled	
	[tons/year]	[lb/hr]	[tons/year]	[lb/hr]		[tons/year]	[lb/hr]	[tons/year]	[lb/hr]
Particulate Matter (PM 2.5)	43.92	2.56	392.15	22.84	37	1.19	0.07	10.60	0.62
Particulate Matter (PM 10)	439.20	25.58	3921.45	228.40	37	11.87	0.69	105.99	6.17
Particulate Matter (TSP)	1723.29	100.37	15386.49	896.18	37	46.58	2.71	415.85	24.22

Fugitive emissions from traffic on unpaved surfaces by vehicles such as haul trucks and maintenance vehicles were estimated using EPA AP-42 emission factors, Section 13.2.2, Unpaved Roads (November 2006). The following equations are recommended for industrial sites:

(AP-42, Chapter 13.2.2, Equation

$$E\left(\frac{lb}{VMT}\right) = k\left(\frac{s}{12}\right)^{a}\left(\frac{W}{3}\right)^{b}$$

Where: E = emission factor in lb/VMT
lb = pounds of pollutant
VMT = vehicle miles traveled
k = particle size multiplier (lb/VMT)
a = empirical constant (unit less)
b = empirical constant (unit less)
s = surface silt content, (%)
W = mean vehicle weight, full vs. empty (tons)

Hourly Emission Factor:

$$E_h\left(\frac{lb}{hr}\right) = E \cdot d \cdot L$$

Where: E_h = hourly emission factor (lb/hr)
E = emission factor (lb/VMT)
d = average hourly daytime traffic rate, roundtrips per hour (h^{-1})
L = longest haul road length in miles (roundtrip)

By considering annual natural mitigation from rainfall, the annual emission factor is affected:

(AP-42, Chapter 13.2.2, Equation

$$E_{ext}\left(\frac{lb}{VMT}\right) = E \cdot \left[{(365-P)}/{365}\right]$$

Where: E_{ext} = annual emission factor extrapolated for annual natural mitigation (lb/VMT)
E = hourly emission factor (lb/VMT)
P = number of days in a year with at least 0.01 inches of precipitation

Notes:
[1] Hourly Vehicle Miles Traveled = d (trips/hour) * L (mile/trip)
[2] Annual Vehicle Miles Traveled = Hourly Vehicle Miles Traveled (miles/hour) * Annual Operating Hours (hours/year)
[3] Control Efficiency is set at 88.8%; see control efficiency page for more info.
[4] Emission factors are from AP-42, Chapter 13.2.2, Unpaved Roads, vehicles traveling on unpaved surfaces at industrial sites.
[5] Annual Emission Rate = Annual Uncontrolled Emission Factor * Annual VMT ÷ 2000
[5] Hourly Emission Rate = Hourly Uncontrolled Emission Factor * Hourly VMT
6 Total Emission are the sum of all truck emissions operating on that road
7 Emission per Volume source = Total Emissions ÷ Number of Volume Sources
* Values for k, a, and b obtained from AP-42, Chapter 13.2.2, Unpaved Roads, Table 13.2.2-2 (November 2006)

Freeport-McMoRan Chino Mines Company
Revised: December 2019
Road Name **3A / 9 Dam**
Road Number **7**

Truck type	Caterpillar 793						-						-					
Average Truck Weight [tons]	303						0						0					
Hourly VMT [miles/hour][1]	72.45						0.00						0.00					
Annual VMT [miles/year][2]	3078121.27						0.00						0.00					
Control Efficiency [%][3]	88.80%						88.80%						88.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]		Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]		Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Annual Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.42	0.52	652.64	73.10	38.01	4.26	0.000	0.000	0.00	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	4.24	5.25	6526.42	730.96	380.13	42.57	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	16.64	20.59	25607.52	2868.04	1491.50	167.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Emission Factor Constants	**3A / 9 Dam**		
Parameter	**$PM_{2.5}$**	**PM_{10}**	**TSP**
k*	0.15	1.50	4.90
a*	0.90	0.90	0.70
b*	0.45	0.45	0.45
silt content	4.8		
P [days]	70		

	Total Maximum Fugitive Emissions[6]				**Number of volume sources**	**Emissions per Volume Source[7]**			
	Controlled		**Uncontrolled**			**Controlled**		**Uncontrolled**	
	[tons/year]	**[lb/hr]**	**[tons/year]**	**[lb/hr]**		**[tons/year]**	**[lb/hr]**	**[tons/year]**	**[lb/hr]**
Particulate Matter (PM 2.5)	73.10	4.26	652.64	38.01	58	1.26	0.07	11.25	0.66
Particulate Matter (PM 10)	730.96	42.57	6526.42	380.13	58	12.60	0.73	112.52	6.55
Particulate Matter (TSP)	2868.04	167.05	25607.52	1491.50	58	49.45	2.88	441.51	25.72

Fugitive emissions from traffic on unpaved surfaces by vehicles such as haul trucks and maintenance vehicles were estimated using EPA AP-42 emission factors, Section 13.2.2, Unpaved Roads (November 2006). The following equations are recommended for industrial sites:

(AP-42, Chapter 13.2.2, Equation 1a

$$E\left(\frac{lb}{VMT}\right) = k\left(\frac{s}{12}\right)^a \left(\frac{W}{3}\right)^b$$

Where: E = emission factor in lb/VMT
lb = pounds of pollutant
VMT = vehicle miles traveled
k = particle size multiplier (lb/VMT)
a = empirical constant (unit less)
b = empirical constant (unit less)
s = surface silt content, (%)
W = mean vehicle weight, full vs. empty (tons)

Hourly Emission Factor:

$$E_h\left(\frac{lb}{hr}\right) = E \cdot d \cdot L$$

Where: E_h = hourly emission factor (lb/hr)
E = emission factor (lb/VMT)
d = average hourly daytime traffic rate, roundtrips per hour (h^{-1})
L = longest haul road length in miles (roundtrip)

By considering annual natural mitigation from rainfall, the annual emission factor is affected:

(AP-42, Chapter 13.2.2, Equation 1a

$$E_{ext}\left(\frac{lb}{VMT}\right) = E \cdot \left[{(365-P)}/{365}\right]$$

Where: E_{ext} = annual emission factor extrapolated for annual natural mitigation (lb/VMT)
E = hourly emission factor (lb/VMT)
P = number of days in a year with at least 0.01 inches of precipitation

Notes:
1 Hourly Vehicle Miles Traveled = d (trips/hour) * L (mile/trip)
2 Annual Vehicle Miles Traveled = Hourly Vehicle Miles Traveled (miles/hour) * Annual Operating Hours (hours/year)
3 Control Efficiency is set at 88.8%; see control efficiency page for more info.
4 Emission factors are from AP-42, Chapter 13.2.2, Unpaved Roads, vehicles traveling on unpaved surfaces at industrial sites.
5 Annual Emission Rate = Annual Uncontrolled Emission Factor * Annual VMT ÷ 2000
5 Hourly Emission Rate = Hourly Uncontrolled Emission Factor * Hourly VMT
6 Total Emission are the sum of all truck emissions operating on that road
7 Emission per Volume source = Total Emissions ÷ Number of Volume Sources
* Values for k, a, and b obtained from AP-42, Chapter 13.2.2, Unpaved Roads, Table 13.2.2-2 (November 2006)

Freeport-McMoRan Chino Mines Company
Revised: December 2019
Road Name **West Stockpile**
Road Number **8**

Truck type	Caterpillar 793								-								-							
Average Truck Weight [tons]	303								0								0							
Hourly VMT [miles/hour][1]	60.63								0.00								0.00							
Annual VMT [miles/year][2]	2124626.87								0.00								0.00							
Control Efficiency [%][3]	88.80%								88.80%								88.80%							
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]				Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]				Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Annual Emission Rate[5] [lb/yr]			
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled			[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled			[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled		
Particulate Matter (PM 2.5)	0.42	0.52	450.48	50.45	31.81	3.56			0.000	0.000	0.00	0.00	0.00	0.00			0.000	0.000	0.00	0.00	0.00	0.00		
Particulate Matter (PM 10)	4.24	5.25	4504.76	504.53	318.13	35.63			0.000	0.00	0.00	0.00	0.00	0.00			0.000	0.000	0.00	0.00	0.00	0.00		
Particulate Matter (TSP)	16.64	20.59	17675.21	1979.62	1248.25	139.80			0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00		

Emission Factor Constants	West Stockpile		
Parameter	$PM_{2.5}$	PM_{10}	TSP
k*	0.15	1.50	4.90
a*	0.90	0.90	0.70
b*	0.45	0.45	0.45
silt content	4.8		
P [days]	70		

	Total Maximum Fugitive Emissions[6]				Number of volume sources	Emissions per Volume Source[7]			
	Controlled		Uncontrolled			Controlled		Uncontrolled	
	[tons/year]	[lb/hr]	[tons/year]	[lb/hr]		[tons/year]	[lb/hr]	[tons/year]	[lb/hr]
Particulate Matter (PM 2.5)	50.45	3.56	450.48	31.81	45	1.12	0.08	10.01	0.71
Particulate Matter (PM 10)	504.53	35.63	4504.76	318.13	45	11.21	0.79	100.11	7.07
Particulate Matter (TSP)	1979.62	139.80	17675.21	1248.25	45	43.99	3.11	392.78	27.74

Fugitive emissions from traffic on unpaved surfaces by vehicles such as haul trucks and maintenance vehicles were estimated using EPA AP-42 emission factors, Section 13.2.2, Unpaved Roads (November 2006). The following equations are recommended for industrial sites:

(AP-42, Chapter 13.2.2, Equation 1a)

$$E\left(\frac{lb}{VMT}\right) = k\left(\frac{s}{12}\right)^a\left(\frac{W}{3}\right)^b$$

Where: E = emission factor in lb/VMT
lb = pounds of pollutant
VMT = vehicle miles traveled
k = particle size multiplier (lb/VMT)
a = empirical constant (unit less)
b = empirical constant (unit less)
s = surface silt content, (%)
W = mean vehicle weight, full vs. empty (tons)

Hourly Emission Factor:

$$E_h\left(\frac{lb}{hr}\right) = E \cdot d \cdot L$$

Where: E_h = hourly emission factor (lb/hr)
E = emission factor (lb/VMT)
d = average hourly daytime traffic rate, roundtrips per hour (h^{-1})
L = longest haul road length in miles (roundtrip)

By considering annual natural mitigation from rainfall, the annual emission factor is affected:

(AP-42, Chapter 13.2.2, Equation 1a)

$$E_{ext}\left(\frac{lb}{VMT}\right) = E \cdot \left[{(365-P)}/{365}\right]$$

Where: E_{xt} = annual emission factor extrapolated for annual natural mitigation (lb/VMT)
E = hourly emission factor (lb/VMT)
P = number of days in a year with at least 0.01 inches of precipitation

Notes:
[1] Hourly Vehicle Miles Traveled = d (trips/hour) * L (mile/trip)
[2] Annual Vehicle Miles Traveled = Hourly Vehicle Miles Traveled (miles/hour) * Annual Operating Hours (hours/year)
[3]Control Efficiency is set at 88.8%; see control efficiency page for more info.
[4] Emission factors are from AP-42, Chapter 13.2.2, Unpaved Roads, vehicles traveling on unpaved surfaces at industrial sites.
[5] Annual Emission Rate = Annual Uncontrolled Emission Factor * Annual VMT ÷ 2000
[5]Hourly Emission Rate = Hourly Uncontrolled Emission Factor * Hourly VMT
6 Total Emission are the sum of all truck emissions operating on that road
7 Emission per Volume source = Total Emissions ÷ Number of Volume Sources
* Values for k, a, and b obtained from AP-42, Chapter 13.2.2, Unpaved Roads, Table 13.2.2-2 (November 2006)

Freeport-McMoRan Chino Mines Company
Revised: December 2019
Road Name Café to Lampbright
Road Number 11

Truck type	Caterpillar 793							
Average Truck Weight [tons]	303							
Hourly VMT [miles/hour][1]	37.31							
Annual VMT [miles/year][2]	1123600.75							
Control Efficiency [%][3]	88.80%							
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]			
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled		
Particulate Matter (PM 2.5)	0.42	0.52	238.23	26.68	19.58	2.19		
Particulate Matter (PM 10)	4.24	5.25	2382.33	266.82	195.77	21.93		
Particulate Matter (TSP)	16.64	20.59	9347.47	1046.92	768.15	86.03		

Truck type	-					
Average Truck Weight [tons]	0					
Hourly VMT [miles/hour][1]	0.00					
Annual VMT [miles/year][2]	0.00					
Control Efficiency [%][3]	88.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	0.000	0.00	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	0.00	0.00	0.00	0.00	0.00	0.00

Truck type	-					
Average Truck Weight [tons]	0					
Hourly VMT [miles/hour][1]	0.00					
Annual VMT [miles/year][2]	0.00					
Control Efficiency [%][3]	88.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	0.00	0.00	0.00	0.00	0.00	0.00

Emission Factor Constants	Café to Lampbright		
Parameter	$PM_{2.5}$	PM_{10}	TSP
k*	0.15	1.50	4.90
a*	0.90	0.90	0.70
b*	0.45	0.45	0.45
silt content	4.8		
P [days]	70		

	Total Maximum Fugitive Emissions[6]				Number of volume sources	Emissions per Volume Source[7]			
	Controlled		Uncontrolled			Controlled		Uncontrolled	
	[tons/year]	[lb/hr]	[tons/year]	[lb/hr]		[tons/year]	[lb/hr]	[tons/year]	[lb/hr]
Particulate Matter (PM 2.5)	26.68	2.19	238.23	19.58	24	1.11	0.09	9.93	0.82
Particulate Matter (PM 10)	266.82	21.93	2382.33	195.77	24	11.12	0.91	99.26	8.16
Particulate Matter (TSP)	1046.92	86.03	9347.47	768.15	24	43.62	3.58	389.48	32.01

Fugitive emissions from traffic on unpaved surfaces by vehicles such as haul trucks and maintenance vehicles were estimated using EPA AP-42 emission factors, Section 13.2.2, Unpaved Roads (November 2006). The following equations are recommended for industrial sites:

(AP-42, Chapter 13.2.2, Equation

$$E\left(\frac{lb}{VMT}\right) = k\left(\frac{s}{12}\right)^a\left(\frac{W}{3}\right)^b$$

Where: E = emission factor in lb/VMT
lb = pounds of pollutant
VMT = vehicle miles traveled
k = particle size multiplier (lb/VMT)
a = empirical constant (unit less)
b = empirical constant (unit less)
s = surface silt content, (%)
W = mean vehicle weight, full vs. empty (tons)

Hourly Emission Factor:

$$E_h\left(\frac{lb}{hr}\right) = E \cdot d \cdot L$$

Where: E_h = hourly emission factor (lb/hr)
E = emission factor (lb/VMT)
d = average hourly daytime traffic rate, roundtrips per hour (h^{-1})
L = longest haul road length in miles (roundtrip)

By considering annual natural mitigation from rainfall, the annual emission factor is affected:

(AP-42, Chapter 13.2.2, Equation

$$E_{ext}\left(\frac{lb}{VMT}\right) = E \cdot \left[\frac{(365-P)}{365}\right]$$

Where: E_{xt} = annual emission factor extrapolated for annual natural mitigation (lb/VMT)
E = hourly emission factor (lb/VMT)
P = number of days in a year with at least 0.01 inches of precipitation

Notes:
[1] Hourly Vehicle Miles Traveled = d (trips/hour) * L (mile/trip)
[2] Annual Vehicle Miles Traveled = Hourly Vehicle Miles Traveled (miles/hour) * Annual Operating Hours (hours/year)
[3] Control Efficiency is set at 88.8%; see control efficiency page for more info.
[4] Emission factors are from AP-42, Chapter 13.2.2, Unpaved Roads, vehicles traveling on unpaved surfaces at industrial sites.
[5] Annual Emission Rate = Annual Uncontrolled Emission Factor * Annual VMT ÷ 2000
[5] Hourly Emission Rate = Hourly Uncontrolled Emission Factor * Hourly VMT
6 Total Emission are the sum of all truck emissions operating on that road
7 Emission per Volume source = Total Emissions ÷ Number of Volume Sources
* Values for k, a, and b obtained from AP-42, Chapter 13.2.2, Unpaved Roads, Table 13.2.2-2 (November 2006)

Freeport-McMoRan Chino Mines Company
Revised: December 2019
Road Name LBX
Road Number 12

Truck type	Caterpillar 793								-								-							
Average Truck Weight [tons]	303								0								0							
Hourly VMT [miles/hour][1]	32.34								0.00								0.00							
Annual VMT [miles/year][2]	973787.31								0.00								0.00							
Control Efficiency [%][3]	88.80%								88.80%								88.80%							
Criteria Pollutant	**Annual Uncontrolled Emission Factor[4]**	**Hourly Controlled Emission Factor[4]**	**Annual Emission Rate[5] [tons/year]**		**Hourly Emission Rate[5] [lb/yr]**				**Annual Uncontrolled Emission Factor[4]**	**Hourly Controlled Emission Factor[4]**	**Annual Emission Rate[5] [tons/year]**		**Hourly Emission Rate[5] [lb/yr]**		**Annual Uncontrolled Emission Factor[4]**	**Hourly Controlled Emission Factor[4]**	**Annual Emission Rate[5] [tons/year]**		**Annual Emission Rate[5] [lb/yr]**					
	[lb/VMT]	**[lb/VMT]**	**Uncontrolled**	**Controlled**	**Uncontrolled**	**Controlled**			**[lb/VMT]**	**[lb/VMT]**	**Uncontrolled**	**Controlled**	**Uncontrolled**	**Controlled**	**[lb/VMT]**	**[lb/VMT]**	**Uncontrolled**	**Controlled**	**Uncontrolled**	**Controlled**				
Particulate Matter (PM 2.5)	0.42	0.52	206.47	23.12	16.97	1.90			0.000	0.000	0.00	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00	0.00				
Particulate Matter (PM 10)	4.24	5.25	2064.68	231.24	169.67	19.00			0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00	0.00				
Particulate Matter (TSP)	16.64	20.59	8101.14	907.33	665.73	74.56			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				

Emission Factor Constants	**LBX**		
Parameter	**$PM_{2.5}$**	**PM_{10}**	**TSP**
k*	0.15	1.50	4.90
a*	0.90	0.90	0.70
b*	0.45	0.45	0.45
silt content	4.8		
P [days]	70		

	Total Maximum Fugitive Emissions[6]				**Number of volume sources**	**Emissions per Volume Source[7]**			
	Controlled		**Uncontrolled**			**Controlled**		**Uncontrolled**	
	[tons/year]	**[lb/hr]**	**[tons/year]**	**[lb/hr]**		**[tons/year]**	**[lb/hr]**	**[tons/year]**	**[lb/hr]**
Particulate Matter (PM 2.5)	23.12	1.90	206.47	16.97	11	2.10	0.17	18.77	1.54
Particulate Matter (PM 10)	231.24	19.00	2064.68	169.67	11	21.02	1.73	187.70	15.42
Particulate Matter (TSP)	907.33	74.56	8101.14	665.73	11	82.48	6.78	736.47	60.52

Fugitive emissions from traffic on unpaved surfaces by vehicles such as haul trucks and maintenance vehicles were estimated using EPA AP-42 emission factors, Section 13.2.2, Unpaved Roads (November 2006). The following equations are recommended for industrial sites:

(AP-42, Chapter 13.2.2, Equati

$$E\left(\frac{lb}{VMT}\right) = k\left(\frac{s}{12}\right)^a \left(\frac{W}{3}\right)^b$$

Where: E = emission factor in lb/VMT
lb = pounds of pollutant
VMT = vehicle miles traveled
k = particle size multiplier (lb/VMT)
a = empirical constant (unit less)
b = empirical constant (unit less)
s = surface silt content, (%)
W = mean vehicle weight, full vs. empty (tons)

Hourly Emission Factor:

$$E_h\left(\frac{lb}{hr}\right) = E \cdot d \cdot L$$

Where: E_h = hourly emission factor (lb/hr)
E = emission factor (lb/VMT)
d = average hourly daytime traffic rate, roundtrips per hour (h^{-1})
L = longest haul road length in miles (roundtrip)

By considering annual natural mitigation from rainfall, the annual emission factor is affected:

(AP-42, Chapter 13.2.2, Equati

$$E_{ext}\left(\frac{lb}{VMT}\right) = E \cdot \left[(365-P)/365\right]$$

Where: E_{ext} = annual emission factor extrapolated for annual natural mitigation (lb/VMT)
E = hourly emission factor (lb/VMT)
P = number of days in a year with at least 0.01 inches of precipitation

Notes:
1 Hourly Vehicle Miles Traveled = d (trips/hour) * L (mile/trip)
2 Annual Vehicle Miles Traveled = Hourly Vehicle Miles Traveled (miles/hour) * Annual Operating Hours (hours/year)
3 Control Efficiency is set at 88.8%; see control efficiency page for more info.
4 Emission factors are from AP-42, Chapter 13.2.2, Unpaved Roads, vehicles traveling on unpaved surfaces at industrial sites.
5 Annual Emission Rate = Annual Uncontrolled Emission Factor * Annual VMT ÷ 2000
5 Hourly Emission Rate = Hourly Uncontrolled Emission Factor * Hourly VMT
6 Total Emission are the sum of all truck emissions operating on that road
7 Emission per Volume source = Total Emissions ÷ Number of Volume Sources
* Values for k, a, and b obtained from AP-42, Chapter 13.2.2, Unpaved Roads, Table 13.2.2-2 (November 2006)

Freeport-McMoRan Chino Mines Company
Revised: December 2019
Road Name Upper Lampbright
Road Number 13

Truck type	Caterpillar 793							
Average Truck Weight [tons]	303							
Hourly VMT [miles/hour][1]	72.14							
Annual VMT [miles/year][2]	2172294.78							
Control Efficiency [%][3]	88.80%							
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]			
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled		
Particulate Matter (PM 2.5)	0.42	0.52	460.58	51.59	37.85	4.24		
Particulate Matter (PM 10)	4.24	5.25	4605.83	515.85	378.50	42.39		
Particulate Matter (TSP)	16.64	20.59	18071.77	2024.04	1485.10	166.33		

Truck type	-					
Average Truck Weight [tons]	0					
Hourly VMT [miles/hour][1]	0.00					
Annual VMT [miles/year][2]	0.00					
Control Efficiency [%][3]	88.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	0.000	0.00	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	0.00	0.00	0.00	0.00	0.00	0.00

Truck type	-					
Average Truck Weight [tons]	0					
Hourly VMT [miles/hour][1]	0.00					
Annual VMT [miles/year][2]	0.00					
Control Efficiency [%][3]	88.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Annual Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	0.00	0.00	0.00	0.00	0.00	0.00

Emission Factor Constants	Upper Lampbright		
Parameter	$PM_{2.5}$	PM_{10}	TSP
k*	0.15	1.50	4.90
a*	0.90	0.90	0.70
b*	0.45	0.45	0.45
silt content	4.8		
P [days]	70		

	Total Maximum Fugitive Emissions[6]				Number of volume sources	Emissions per Volume Source[7]			
	Controlled		Uncontrolled			Controlled		Uncontrolled	
	[tons/year]	[lb/hr]	[tons/year]	[lb/hr]		[tons/year]	[lb/hr]	[tons/year]	[lb/hr]
Particulate Matter (PM 2.5)	51.59	4.24	460.58	37.85	25	2.06	0.170	18.42	1.51
Particulate Matter (PM 10)	515.85	42.39	4605.83	378.50	25	20.63	1.70	184.23	15.14
Particulate Matter (TSP)	2024.04	166.33	18071.77	1485.10	25	80.96	6.65	722.87	59.40

Fugitive emissions from traffic on unpaved surfaces by vehicles such as haul trucks and maintenance vehicles were estimated using EPA AP-42 emission factors, Section 13.2.2, Unpaved Roads (November 2006). The following equations are recommended for industrial sites:

(AP-42, Chapter 13.2.2, Equa

$$E\left(\frac{lb}{VMT}\right) = k\left(\frac{s}{12}\right)^a \left(\frac{W}{3}\right)^b$$

Where: E = emission factor in lb/VMT
lb = pounds of pollutant
VMT = vehicle miles traveled
k = particle size multiplier (lb/VMT)
a = empirical constant (unit less)
b = empirical constant (unit less)
s = surface silt content, (%)
W = mean vehicle weight, full vs. empty (tons)

Hourly Emission Factor:

$$E_h\left(\frac{lb}{hr}\right) = E \cdot d \cdot L$$

Where: E_h = hourly emission factor (lb/hr)
E = emission factor (lb/VMT)
d = average hourly daytime traffic rate, roundtrips per hour (h^{-1})
L = longest haul road length in miles (roundtrip)

By considering annual natural mitigation from rainfall, the annual emission factor is affected:

(AP-42, Chapter 13.2.2, Equa

$$E_{ext}\left(\frac{lb}{VMT}\right) = E \cdot \left[(365 - P) / 365 \right]$$

Where: E_{ext} = annual emission factor extrapolated for annual natural mitigation (lb/VMT)
E = hourly emission factor (lb/VMT)
P = number of days in a year with at least 0.01 inches of precipitation

Notes:
[1] Hourly Vehicle Miles Traveled = d (trips/hour) * L (mile/trip)
[2] Annual Vehicle Miles Traveled = Hourly Vehicle Miles Traveled (miles/hour) * Annual Operating Hours (hours/year)
[3] Control Efficiency is set at 88.8%; see control efficiency page for more info.
[4] Emission factors are from AP-42, Chapter 13.2.2, Unpaved Roads, vehicles traveling on unpaved surfaces at industrial sites.
[5] Annual Emission Rate = Annual Uncontrolled Emission Factor * Annual VMT ÷ 2000
[5] Hourly Emission Rate = Hourly Uncontrolled Emission Factor * Hourly VMT
6 Total Emission are the sum of all truck emissions operating on that road
7 Emission per Volume source = Total Emissions ÷ Number of Volume Sources
* Values for k, a, and b obtained from AP-42, Chapter 13.2.2, Unpaved Roads, Table 13.2.2-2 (November 2006)

Freeport-McMoRan Chino Mines Company
Revised: December 2019
Road Name Lower Lampbright
Road Number 14

Truck type	Caterpillar 793						-						-					
Average Truck Weight [tons]	303						0						0					
Hourly VMT [miles/hour][1]	42.79						0.00						0.00					
Annual VMT [miles/year][2]	1288395.52						0.00						0.00					
Control Efficiency [%][3]	88.80%						88.80%						88.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]		Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]		Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Annual Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.42	0.52	273.17	30.60	22.45	2.51	0.000	0.000	0.00	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	4.24	5.25	2731.73	305.95	224.49	25.14	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	16.64	20.59	10718.43	1200.46	880.82	98.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Emission Factor Constants	Lower Lampbright		
Parameter	$PM_{2.5}$	PM_{10}	TSP
k*	0.15	1.50	4.90
a*	0.90	0.90	0.70
b*	0.45	0.45	0.45
silt content	4.8		
P [days]	70		

	Total Maximum Fugitive Emissions[6]				Number of volume sources	Emissions per Volume Source[7]			
	Controlled		Uncontrolled			Controlled		Uncontrolled	
	[tons/year]	[lb/hr]	[tons/year]	[lb/hr]		[tons/year]	[lb/hr]	[tons/year]	[lb/hr]
Particulate Matter (PM 2.5)	30.60	2.51	273.17	22.45	16	1.91	0.16	17.07	1.40
Particulate Matter (PM 10)	305.95	25.14	2731.73	224.49	16	19.12	1.57	170.73	14.03
Particulate Matter (TSP)	1200.46	98.65	10718.43	880.82	16	75.03	6.17	669.90	55.05

Fugitive emissions from traffic on unpaved surfaces by vehicles such as haul trucks and maintenance vehicles were estimated using EPA AP-42 emission factors, Section 13.2.2, Unpaved Roads (November 2006). The following equations are recommended for industrial sites:

(AP-42, Chapter 13.2.2, Equation

$$E\left(\frac{lb}{VMT}\right) = k\left(\frac{s}{12}\right)^a \left(\frac{W}{3}\right)^b$$

Where: E = emission factor in lb/VMT
lb = pounds of pollutant
VMT = vehicle miles traveled
k = particle size multiplier (lb/VMT)
a = empirical constant (unit less)
b = empirical constant (unit less)
s = surface silt content, (%)
W = mean vehicle weight, full vs. empty (tons)

<u>Hourly Emission Factor:</u>

$$E_h\left(\frac{lb}{hr}\right) = E \cdot d \cdot L$$

Where: E_h = hourly emission factor (lb/hr)
E = emission factor (lb/VMT)
d = average hourly daytime traffic rate, roundtrips per hour (h^{-1})
L = longest haul road length in miles (roundtrip)

By considering annual natural mitigation from rainfall, the annual emission factor is affected:

(AP-42, Chapter 13.2.2, Equation

$$E_{ext}\left(\frac{lb}{VMT}\right) = E \cdot \left[(365-P)/365\right]$$

Where: E_{ext} = annual emission factor extrapolated for annual natural mitigation (lb/VMT)
E = hourly emission factor (lb/VMT)
P = number of days in a year with at least 0.01 inches of precipitation

Notes:
1 Hourly Vehicle Miles Traveled = d (trips/hour) * L (mile/trip)
2 Annual Vehicle Miles Traveled = Hourly Vehicle Miles Traveled (miles/hour) * Annual Operating Hours (hours/year)
3 Control Efficiency is set at 88.8%; see control efficiency page for more info.
4 Emission factors are from AP-42, Chapter 13.2.2, Unpaved Roads, vehicles traveling on unpaved surfaces at industrial sites.
5 Annual Emission Rate = Annual Uncontrolled Emission Factor * Annual VMT ÷ 2000
5 Hourly Emission Rate = Hourly Uncontrolled Emission Factor * Hourly VMT
6 Total Emission are the sum of all truck emissions operating on that road
7 Emission per Volume source = Total Emissions ÷ Number of Volume Sources
* Values for k, a, and b obtained from AP-42, Chapter 13.2.2, Unpaved Roads, Table 13.2.2-2 (November 2006)

Freeport-McMoRan Chino Mines Company
Revised: December 2019
Road Name Crusher / Stockpiles / Rehandle
Road Number 15

Truck type	Caterpillar 793						-						-					
Average Truck Weight [tons]	303						0						0					
Hourly VMT [miles/hour][1]	18.97						0.00						0.00					
Annual VMT [miles/year][2]	415391.79						0.00						0.00					
Control Efficiency [%][3]	88.80%						88.80%						88.80%					
Criteria Pollutant	**Annual Uncontrolled Emission Factor**[4]	**Hourly Controlled Emission Factor**[4]	**Annual Emission Rate**[5] **[tons/year]**		**Hourly Emission Rate**[5] **[lb/yr]**		**Annual Uncontrolled Emission Factor**[4]	**Hourly Controlled Emission Factor**[4]	**Annual Emission Rate**[5] **[tons/year]**		**Hourly Emission Rate**[5] **[lb/yr]**		**Annual Uncontrolled Emission Factor**[4]	**Hourly Controlled Emission Factor**[4]	**Annual Emission Rate**[5] **[tons/year]**		**Annual Emission Rate**[5] **[lb/yr]**	
	[lb/VMT]	**[lb/VMT]**	**Uncontrolled**	**Controlled**	**Uncontrolled**	**Controlled**	**[lb/VMT]**	**[lb/VMT]**	**Uncontrolled**	**Controlled**	**Uncontrolled**	**Controlled**	**[lb/VMT]**	**[lb/VMT]**	**Uncontrolled**	**Controlled**	**Uncontrolled**	**Controlled**
Particulate Matter (PM 2.5)	0.42	0.52	88.07	9.86	9.95	1.11	0.000	0.000	0.00	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	4.24	5.25	880.74	98.64	99.52	11.15	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	16.64	20.59	3455.73	387.04	390.48	43.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Emission Factor Constants	**Crusher / Stockpiles / Rehandle**		
Parameter	**$PM_{2.5}$**	**PM_{10}**	**TSP**
k*	0.15	1.50	4.90
a*	0.90	0.90	0.70
b*	0.45	0.45	0.45
silt content	4.8		
P [days]	70		

	Total Maximum Fugitive Emissions[6]				**Number of volume sources**	**Emissions per Volume Source**[7]			
	Controlled		**Uncontrolled**			**Controlled**		**Uncontrolled**	
	[tons/year]	**[lb/hr]**	**[tons/year]**	**[lb/hr]**		**[tons/year]**	**[lb/hr]**	**[tons/year]**	**[lb/hr]**
Particulate Matter (PM 2.5)	9.86	1.11	88.07	9.95	11	0.90	0.10	8.01	0.90
Particulate Matter (PM 10)	98.64	11.15	880.74	99.52	11	8.97	1.01	80.07	9.05
Particulate Matter (TSP)	387.04	43.73	3455.73	390.48	11	35.19	3.98	314.16	35.50

Fugitive emissions from traffic on unpaved surfaces by vehicles such as haul trucks and maintenance vehicles were estimated using EPA AP-42 emission factors, Section 13.2.2, Unpaved Roads (November 2006). The following equations are recommended for industrial sites:

(AP-42, Chapter 13.2.2, Equatic

$$E\left(\frac{lb}{VMT}\right) = k\left(\frac{s}{12}\right)^a \left(\frac{W}{3}\right)^b$$

Where: E = emission factor in lb/VMT
lb = pounds of pollutant
VMT = vehicle miles traveled
k = particle size multiplier (lb/VMT)
a = empirical constant (unit less)
b = empirical constant (unit less)
s = surface silt content, (%)
W = mean vehicle weight, full vs. empty (tons)

Hourly Emission Factor:

$$E_h\left(\frac{lb}{hr}\right) = E \cdot d \cdot L$$

Where: E_h = hourly emission factor (lb/hr)
E = emission factor (lb/VMT)
d = average hourly daytime traffic rate, roundtrips per hour (h^{-1})
L = longest haul road length in miles (roundtrip)

By considering annual natural mitigation from rainfall, the annual emission factor is affected:

(AP-42, Chapter 13.2.2, Equatic

$$E_{ext}\left(\frac{lb}{VMT}\right) = E \cdot \left[{(365-P)}/{365}\right]$$

Where: E_{ext} = annual emission factor extrapolated for annual natural mitigation (lb/VMT)
E = hourly emission factor (lb/VMT)
P = number of days in a year with at least 0.01 inches of precipitation

Notes:
[1] Hourly Vehicle Miles Traveled = d (trips/hour) * L (mile/trip)
[2] Annual Vehicle Miles Traveled = Hourly Vehicle Miles Traveled (miles/hour) * Annual Operating Hours (hours/year)
[3] Control Efficiency is set at 88.8%; see control efficiency page for more info.
[4] Emission factors are from AP-42, Chapter 13.2.2, Unpaved Roads, vehicles traveling on unpaved surfaces at industrial sites.
[5] Annual Emission Rate = Annual Uncontrolled Emission Factor * Annual VMT ÷ 2000
[5] Hourly Emission Rate = Hourly Uncontrolled Emission Factor * Hourly VMT
6 Total Emission are the sum of all truck emissions operating on that road
7 Emission per Volume source = Total Emissions ÷ Number of Volume Sources
* Values for k, a, and b obtained from AP-42, Chapter 13.2.2, Unpaved Roads, Table 13.2.2-2 (November 2006)

Freeport-McMoRan Chino Mines Company
Revised: December 2019
Road Name Roundabout
Road Number 16

Truck type	Caterpillar 793							
Average Truck Weight [tons]	303							
Hourly VMT [miles/hour][1]	4.66							
Annual VMT [miles/year][2]	198162.31							
Control Efficiency [%][3]	88.80%							
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]			
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled		
Particulate Matter (PM 2.5)	0.42	0.52	42.02	4.71	2.45	0.27		
Particulate Matter (PM 10)	4.24	5.25	420.16	47.06	24.47	2.74		
Particulate Matter (TSP)	16.64	20.59	1648.55	184.64	96.02	10.75		

Truck type	-					
Average Truck Weight [tons]	0					
Hourly VMT [miles/hour][1]	0.00					
Annual VMT [miles/year][2]	0.00					
Control Efficiency [%][3]	88.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	0.000	0.00	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	0.00	0.00	0.00	0.00	0.00	0.00

Truck type	-					
Average Truck Weight [tons]	0					
Hourly VMT [miles/hour][1]	0.00					
Annual VMT [miles/year][2]	0.00					
Control Efficiency [%][3]	88.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Annual Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	0.00	0.00	0.00	0.00	0.00	0.00

Emission Factor Constants	Roundabout		
Parameter	$PM_{2.5}$	PM_{10}	TSP
k*	0.15	1.50	4.90
a*	0.90	0.90	0.70
b*	0.45	0.45	0.45
silt content	4.8		
P [days]	70		

	Total Maximum Fugitive Emissions[6]				Number of volume sources	Emissions per Volume Source[7]			
	Controlled		Uncontrolled			Controlled		Uncontrolled	
	[tons/year]	[lb/hr]	[tons/year]	[lb/hr]		[tons/year]	[lb/hr]	[tons/year]	[lb/hr]
Particulate Matter (PM 2.5)	4.71	0.27	42.02	2.45	3	1.57	0.09	14.01	0.82
Particulate Matter (PM 10)	47.06	2.74	420.16	24.47	3	15.69	0.91	140.05	8.16
Particulate Matter (PM 10)	184.64	10.75	1648.55	96.02	3	61.55	3.58	549.52	32.01

Fugitive emissions from traffic on unpaved surfaces by vehicles such as haul trucks and maintenance vehicles were estimated using EPA AP-42 emission factors, Section 13.2.2, Unpaved Roads (November 2006). The following equations are recommended for industrial sites:

(AP-42, Chapter 13.2.2, Equation 1a

$$E\left(\frac{lb}{VMT}\right) = k\left(\frac{s}{12}\right)^a \left(\frac{W}{3}\right)^b$$

Where: E = emission factor in lb/VMT
lb = pounds of pollutant
VMT = vehicle miles traveled
k = particle size multiplier (lb/VMT)
a = empirical constant (unit less)
b = empirical constant (unit less)
s = surface silt content, (%)
W = mean vehicle weight, full vs. empty (tons)

Hourly Emission Factor:

$$E_h\left(\frac{lb}{hr}\right) = E \cdot d \cdot L$$

Where: E_h = hourly emission factor (lb/hr)
E = emission factor (lb/VMT)
d = average hourly daytime traffic rate, roundtrips per hour (h^{-1})
L = longest haul road length in miles (roundtrip)

By considering annual natural mitigation from rainfall, the annual emission factor is affected:

(AP-42, Chapter 13.2.2, Equation 1a

$$E_{ext}\left(\frac{lb}{VMT}\right) = E \cdot \left[{(365-P)}/{365} \right]$$

Where: E_{ext} = annual emission factor extrapolated for annual natural mitigation (lb/VMT)
E = hourly emission factor (lb/VMT)
P = number of days in a year with at least 0.01 inches of precipitation

Notes:
[1] Hourly Vehicle Miles Traveled = d (trips/hour) * L (mile/trip)
[2] Annual Vehicle Miles Traveled = Hourly Vehicle Miles Traveled (miles/hour) * Annual Operating Hours (hours/year)
[3] Control Efficiency is set at 88.8%; see control efficiency page for more info.
[4] Emission factors are from AP-42, Chapter 13.2.2, Unpaved Roads, vehicles traveling on unpaved surfaces at industrial sites.
[5] Annual Emission Rate = Annual Uncontrolled Emission Factor * Annual VMT ÷ 2000
[5] Hourly Emission Rate = Hourly Uncontrolled Emission Factor * Hourly VMT
6 Total Emission are the sum of all truck emissions operating on that road
7 Emission per Volume source = Total Emissions ÷ Number of Volume Sources
* Values for k, a, and b obtained from AP-42, Chapter 13.2.2, Unpaved Roads, Table 13.2.2-2 (November 2006)

Freeport-McMoRan Chino Mines Company
Revised: December 2019
Road Name **Princess Ramp**
Road Number **17**

Truck type	Caterpillar 793							
Average Truck Weight [tons]	303							
Hourly VMT [miles/hour][1]	11.49							
Annual VMT [miles/year][2]	100674.63							
Control Efficiency [%][3]	88.80%							
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]			
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled		
Particulate Matter (PM 2.5)	0.42	0.52	21.35	2.39	6.03	0.68		
Particulate Matter (PM 10)	4.24	5.25	213.46	23.91	60.30	6.75		
Particulate Matter (TSP)	16.64	20.59	837.53	93.80	236.59	26.50		

Truck type	-					
Average Truck Weight [tons]	0					
Hourly VMT [miles/hour][1]	0.00					
Annual VMT [miles/year][2]	0.00					
Control Efficiency [%][3]	88.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	0.000	0.00	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	0.00	0.00	0.00	0.00	0.00	0.00

Truck type	-					
Average Truck Weight [tons]	0					
Hourly VMT [miles/hour][1]	0.00					
Annual VMT [miles/year][2]	0.00					
Control Efficiency [%][3]	88.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Annual Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	0.00	0.00	0.00	0.00	0.00	0.00

Emission Factor Constants	Princess Ramp		
Parameter	$PM_{2.5}$	PM_{10}	TSP
k*	0.15	1.50	4.90
a*	0.90	0.90	0.70
b*	0.45	0.45	0.45
silt content	4.8		
P [days]	70		

	Total Maximum Fugitive Emissions[6]				Number of volume sources	Emissions per Volume Source[7]			
	Controlled		Uncontrolled			Controlled		Uncontrolled	
	[tons/year]	[lb/hr]	[tons/year]	[lb/hr]		[tons/year]	[lb/hr]	[tons/year]	[lb/hr]
Particulate Matter (PM 2.5)	2.39	0.68	21.35	6.03	12	0.20	0.06	1.78	0.50
Particulate Matter (TSP)	23.91	6.75	213.46	60.30	12	1.99	0.56	17.79	5.02
Particulate Matter (PM 10)	93.80	26.50	837.53	236.59	12	7.82	2.21	69.79	19.72

Fugitive emissions from traffic on unpaved surfaces by vehicles such as haul trucks and maintenance vehicles were estimated using EPA AP-42 emission factors, Section 13.2.2, Unpaved Roads (November 2006). The following equations are recommended for industrial sites:

(AP-42, Chapter 13.2.2, Equation 1a)

$$E\left(\frac{lb}{VMT}\right) = k\left(\frac{s}{12}\right)^a\left(\frac{W}{3}\right)^b$$

Where: E = emission factor in lb/VMT
lb = pounds of pollutant
VMT = vehicle miles traveled
k = particle size multiplier (lb/VMT)
a = empirical constant (unit less)
b = empirical constant (unit less)
s = surface silt content, (%)
W = mean vehicle weight, full vs. empty (tons)

Hourly Emission Factor:

$$E_h\left(\frac{lb}{hr}\right) = E \cdot d \cdot L$$

Where: E_h = hourly emission factor (lb/hr)
E = emission factor (lb/VMT)
d = average hourly daytime traffic rate, roundtrips per hour (h^{-1})
L = longest haul road length in miles (roundtrip)

By considering annual natural mitigation from rainfall, the annual emission factor is affected:

(AP-42, Chapter 13.2.2, Equation 1a

$$E_{ext}\left(\frac{lb}{VMT}\right) = E \cdot \left[\frac{(365-P)}{365}\right]$$

Where: E_{ext} = annual emission factor extrapolated for annual natural mitigation (lb/VMT)
E = hourly emission factor (lb/VMT)
P = number of days in a year with at least 0.01 inches of precipitation

Notes:
[1] Hourly Vehicle Miles Traveled = d (trips/hour) * L (mile/trip)
[2] Annual Vehicle Miles Traveled = Hourly Vehicle Miles Traveled (miles/hour) * Annual Operating Hours (hours/year)
[3] Control Efficiency is set at 88.8%; see control efficiency page for more info.
[4] Emission factors are from AP-42, Chapter 13.2.2, Unpaved Roads, vehicles traveling on unpaved surfaces at industrial sites.
[5] Annual Emission Rate = Annual Uncontrolled Emission Factor * Annual VMT ÷ 2000
[5] Hourly Emission Rate = Hourly Uncontrolled Emission Factor * Hourly VMT
6 Total Emission are the sum of all truck emissions operating on that road
7 Emission per Volume source = Total Emissions ÷ Number of Volume Sources
* Values for k, a, and b obtained from AP-42, Chapter 13.2.2, Unpaved Roads, Table 13.2.2-2 (November 2006)

Freeport-McMoRan Chino Mines Company
Revised: December 2019
Road Name NOBS
Road Number 18

Truck type	Caterpillar 793					
Average Truck Weight [tons]	303					
Hourly VMT [miles/hour][1]	3.43					
Annual VMT [miles/year][2]	30071.64					
Control Efficiency [%][3]	88.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.42	0.52	6.38	0.71	1.80	0.20
Particulate Matter (PM 10)	4.24	5.25	63.76	7.14	18.01	2.02
Particulate Matter (TSP)	16.64	20.59	250.17	28.02	70.67	7.92

Truck type	-					
Average Truck Weight [tons]	0					
Hourly VMT [miles/hour][1]	0.00					
Annual VMT [miles/year][2]	0.00					
Control Efficiency [%][3]	88.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Hourly Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	0.000	0.00	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	0.00	0.00	0.00	0.00	0.00	0.00

Truck type	-					
Average Truck Weight [tons]	0					
Hourly VMT [miles/hour][1]	0.00					
Annual VMT [miles/year][2]	0.00					
Control Efficiency [%][3]	88.80%					
Criteria Pollutant	Annual Uncontrolled Emission Factor[4]	Hourly Controlled Emission Factor[4]	Annual Emission Rate[5] [tons/year]		Annual Emission Rate[5] [lb/yr]	
	[lb/VMT]	[lb/VMT]	Uncontrolled	Controlled	Uncontrolled	Controlled
Particulate Matter (PM 2.5)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	0.000	0.000	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	0.00	0.00	0.00	0.00	0.00	0.00

Emission Factor Constants	NOBS		
Parameter	$PM_{2.5}$	PM_{10}	TSP
k*	0.15	1.50	4.90
a*	0.90	0.90	0.70
b*	0.45	0.45	0.45
silt content	4.8		
P [days]	70		

	Total Maximum Fugitive Emissions[6]				Number of volume sources	Emissions per Volume Source[7]			
	Controlled		Uncontrolled			Controlled		Uncontrolled	
	[tons/year]	[lb/hr]	[tons/year]	[lb/hr]		[tons/year]	[lb/hr]	[tons/year]	[lb/hr]
Particulate Matter (PM 2.5)	0.71	0.20	6.38	1.80	12	0.06	0.017	0.53	0.15
Particulate Matter (PM 10)	7.14	2.02	63.76	18.01	12	0.60	0.17	5.31	1.50
Particulate Matter (TSP)	28.02	7.92	250.17	70.67	12	2.33	0.66	20.85	5.89

Fugitive emissions from traffic on unpaved surfaces by vehicles such as haul trucks and maintenance vehicles were estimated using EPA AP-42 emission factors, Section 13.2.2, Unpaved Roads (November 2006). The following equations are recommended for industrial sites:

(AP-42, Chapter 13.2.2, Equation 1a

$$E\left(\frac{lb}{VMT}\right) = k\left(\frac{s}{12}\right)^a\left(\frac{W}{3}\right)^b$$

Where: E = emission factor in lb/VMT
lb = pounds of pollutant
VMT = vehicle miles traveled
k = particle size multiplier (lb/VMT)
a = empirical constant (unit less)
b = empirical constant (unit less)
s = surface silt content, (%)
W = mean vehicle weight, full vs. empty (tons)

Hourly Emission Factor:

$$E_h\left(\frac{lb}{hr}\right) = E \cdot d \cdot L$$

Where: E_h = hourly emission factor (lb/hr)
E = emission factor (lb/VMT)
d = average hourly daytime traffic rate, roundtrips per hour (h^{-1})
L = longest haul road length in miles (roundtrip)

By considering annual natural mitigation from rainfall, the annual emission factor is affected:

(AP-42, Chapter 13.2.2, Equation 1a

$$E_{ext}\left(\frac{lb}{VMT}\right) = E \cdot \left[{(365-P)}/{365}\right]$$

Where: E_{ext} = annual emission factor extrapolated for annual natural mitigation (lb/VMT)
E = hourly emission factor (lb/VMT)
P = number of days in a year with at least 0.01 inches of precipitation

Notes:
[1] Hourly Vehicle Miles Traveled = d (trips/hour) * L (mile/trip)
[2] Annual Vehicle Miles Traveled = Hourly Vehicle Miles Traveled (miles/hour) * Annual Operating Hours (hours/year)
[3] Control Efficiency is set at 88.8%; see control efficiency page for more info.
[4] Emission factors are from AP-42, Chapter 13.2.2, Unpaved Roads, vehicles traveling on unpaved surfaces at industrial sites.
[5] Annual Emission Rate = Annual Uncontrolled Emission Factor * Annual VMT ÷ 2000
[5] Hourly Emission Rate = Hourly Uncontrolled Emission Factor * Hourly VMT
6 Total Emission are the sum of all truck emissions operating on that road
7 Emission per Volume source = Total Emissions ÷ Number of Volume Sources
* Values for k, a, and b obtained from AP-42, Chapter 13.2.2, Unpaved Roads, Table 13.2.2-2 (November 2006)

Freeport-McMoRan Chino Mines Company
Revised: December 2019
Road Name **Magnetite**
Road Number **19**

Truck type	Caterpillar 793						-						-					
Average Truck Weight [tons]	303						0						0					
Hourly VMT [miles/hour][1]	0.36						0.00						0.00					
Annual VMT [miles/year][2]	3186.94						0.00						0.00					
Control Efficiency [%][3]	88.80%						88.80%						88.80%					
Criteria Pollutant	**Annual Uncontrolled Emission Factor[4]**	**Hourly Controlled Emission Factor[4]**	**Annual Emission Rate[5] [tons/year]**		**Hourly Emission Rate[5] [lb/yr]**		**Annual Uncontrolled Emission Factor[4]**	**Hourly Controlled Emission Factor[4]**	**Annual Emission Rate[5] [tons/year]**		**Hourly Emission Rate[5] [lb/yr]**		**Annual Uncontrolled Emission Factor[4]**	**Hourly Controlled Emission Factor[4]**	**Annual Emission Rate[5] [tons/year]**		**Annual Emission Rate[5] [lb/yr]**	
	[lb/VMT]	**[lb/VMT]**	**Uncontrolled**	**Controlled**	**Uncontrolled**	**Controlled**	**[lb/VMT]**	**[lb/VMT]**	**Uncontrolled**	**Controlled**	**Uncontrolled**	**Controlled**	**[lb/VMT]**	**[lb/VMT]**	**Uncontrolled**	**Controlled**	**Uncontrolled**	**Controlled**
Particulate Matter (PM 2.5)	0.42	0.52	0.68	0.076	0.19	0.021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Particulate Matter (PM 10)	4.24	5.25	6.76	0.76	1.91	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Particulate Matter (TSP)	16.64	20.59	26.51	2.97	7.49	0.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Emission Factor Constants	**Magnetite**		
Parameter	**$PM_{2.5}$**	**PM_{10}**	**TSP**
k*	0.15	1.50	4.90
a*	0.90	0.90	0.70
b*	0.45	0.45	0.45
silt content	4.8		
P [days]	70		

	Total Maximum Fugitive Emissions[6]				**Number of volume sources**	**Emissions per Volume Source[7]**			
	Controlled		**Uncontrolled**			**Controlled**		**Uncontrolled**	
	[tons/year]	**[lb/hr]**	**[tons/year]**	**[lb/hr]**		**[tons/year]**	**[lb/hr]**	**[tons/year]**	**[lb/hr]**
Particulate Matter (PM 2.5)	0.076	0.02	0.68	0.19	12	0.0063	0.0018	0.056	0.016
Particulate Matter (PM 10)	0.76	0.21	6.76	1.91	12	0.063	0.018	0.56	0.16
Particulate Matter (TSP)	2.97	0.84	26.51	7.49	12	0.25	0.070	2.21	0.62

Fugitive emissions from traffic on unpaved surfaces by vehicles such as haul trucks and maintenance vehicles were estimated using EPA AP-42 emission factors, Section 13.2.2, Unpaved Roads (November 2006). The following equations are recommended for industrial sites:

(AP-42, Chapter 13.2.2, Equation 1a

$$E\left(\frac{lb}{VMT}\right) = k\left(\frac{s}{12}\right)^a \left(\frac{W}{3}\right)^b$$

Where: E = emission factor in lb/VMT
lb = pounds of pollutant
VMT = vehicle miles traveled
k = particle size multiplier (lb/VMT)
a = empirical constant (unit less)
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Hourly Emission Factor:

$$E_h\left(\frac{lb}{hr}\right) = E \cdot d \cdot L$$

Where: E_h = hourly emission factor (lb/hr)
E = emission factor (lb/VMT)
d = average hourly daytime traffic rate, roundtrips per hour (h^{-1})
L = longest haul road length in miles (roundtrip)

By considering annual natural mitigation from rainfall, the annual emission factor is affected:

(AP-42, Chapter 13.2.2, Equation 1a

$$E_{ext}\left(\frac{lb}{VMT}\right) = E \cdot \left[(365 - P) \big/ 365 \right]$$

Where: E_{ext} = annual emission factor extrapolated for annual natural mitigation (lb/VMT)
E = hourly emission factor (lb/VMT)
P = number of days in a year with at least 0.01 inches of precipitation

Notes:
[1] Hourly Vehicle Miles Traveled = d (trips/hour) * L (mile/trip)
[2] Annual Vehicle Miles Traveled = Hourly Vehicle Miles Traveled (miles/hour) * Annual Operating Hours (hours/year)
[3] Control Efficiency is set at 88.8%; see control efficiency page for more info.
[4] Emission factors are from AP-42, Chapter 13.2.2, Unpaved Roads, vehicles traveling on unpaved surfaces at industrial sites.
[5] Annual Emission Rate = Annual Uncontrolled Emission Factor * Annual VMT ÷ 2000
[5] Hourly Emission Rate = Hourly Uncontrolled Emission Factor * Hourly VMT
6 Total Emission are the sum of all truck emissions operating on that road
7 Emission per Volume source = Total Emissions ÷ Number of Volume Sources
* Values for k, a, and b obtained from AP-42, Chapter 13.2.2, Unpaved Roads, Table 13.2.2-2 (November 2006)

Section 7

Information Used To Determine Emissions

<u>Information Used to Determine Emissions</u> shall include the following:

- ☑ If manufacturer data are used, include specifications for emissions units <u>and</u> control equipment, including control efficiencies specifications and sufficient engineering data for verification of control equipment operation, including design drawings, test reports, and design parameters that affect normal operation.
- ☐ If test data are used, include a copy of the complete test report. If the test data are for an emissions unit other than the one being permitted, the emission units must be identical. Test data may not be used if any difference in operating conditions of the unit being permitted and the unit represented in the test report significantly effect emission rates.
- ☑ If the most current copy of AP-42 is used, reference the section and date located at the bottom of the page. Include a copy of the page containing the emissions factors, and clearly mark the factors used in the calculations.
- ☐ If an older version of AP-42 is used, include a complete copy of the section.
- ☑ If an EPA document or other material is referenced, include a complete copy.
- ☐ Fuel specifications sheet.
- ☐ If computer models are used to estimate emissions, include an input summary (if available) and a detailed report, and a disk containing the input file(s) used to run the model. For tank-flashing emissions, include a discussion of the method used to estimate tank-flashing emissions, relative thresholds (i.e., permit or major source (NSPS, PSD or Title V)), accuracy of the model, the input and output from simulation models and software, all calculations, documentation of any assumptions used, descriptions of sampling methods and conditions, copies of any lab sample analysis.

Diesel Emergency Generators (To be modified – addition of emergency standby generators)

- AP-42 Section 3.4 "Natural Gas-Fired Reciprocal Engines" (07/00) Tables 3.4-1, 3.4-2, and 3.4-4
- 40 CFR 98 Table C-1, C-2
- 40 CFR 98 Subpart A, Table A-1

Natural Gas Emergency Generators (Not changing as a result of this application)

- AP-42 Section 3.2 "Large Stationary Diesel and All Stationary Dual-fuel Engines" (10/96) Tables 3.2-1 and 3.2-2
- 40 CFR 98 Table C-1, C-2
- 40 CFR 98 Subpart A, Table A-1
- Manufacturer Data

LPG Emergency Generators (To be modified)

- AP-42 Section 3.2 "Large Stationary Diesel and All Stationary Dual-fuel Engines" (10/96) Tables 3.2-1 and 3.2-2
- 40 CFR 98 Table C-1, C-2
- 40 CFR 98 Subpart A, Table A-1
- Manufacture Data

Tailings Impoundment (Not changing as a result of this application)

Tailings Impoundment (Units CB TLNGS & CM TLNGS)

- AP-42, Section 13.2.5, Industrial Wind Erosion (11/06).

Haul Roads (Not changing as a result of this application)

Haul Roads (Units CBM HR & CM HR)

- AP-42 Section 13.2.2.2, Unpaved Roads
- Western Regional Air Partnership (WRAP) Fugitive Dust Handbook, published September 7, 2006
- Value for s based on NMED default value from http://www.epa.gov/ttn/chief/ap42/ch13/related/r13s0202_dec03.xls

Material Handling

Material Handling (Unit CBM MH)

- AP-42, Chapter 11.19.2, Table 11.19.2-2 Crushed Stone Processing and Pulverized Mineral Processing (August 2004) for Truck Unloading - Fragmented Stone.
- Background Document for AP-42, Chapter 13.2.4, Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006.
- Chino TRI Assay data provided by Clyde Durham 1/28/11

Cobre Haul Road Borrow Pit Material Handling (Unit BORR_MH)

- AP-42, Chapter 11.19.2, Table 11.19.2-2 Crushed Stone Processing and Pulverized Mineral Processing (August 2004) for Truck Unloading - Fragmented Stone.
- Background Document for AP-42, Chapter 13.2.4, Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006.
- Chino TRI Assay data provided by Clyde Durham 1/28/11

Blasting

Hanover Mountain Blasting (Unit CBM BLST)

- "*NO_x Emissions from Blasting Operations in Open-Cut Coal Mining*" by Moetaz I. Attalla, Stuart J. Day, Tony Lange, William Lilley, and Scott Morgan (2008).
- "*Factors Affecting Anfo Fumes Production*" by James H. Rowland III and Richard Mainiero (2001).
- AP-42 Section 11, Table 11.9-1.

Chino Mine Blasting (Unit CM BLST)

- "*NO_x Emissions from Blasting Operations in Open-Cut Coal Mining*" by Moetaz I. Attalla, Stuart J. Day, Tony Lange, William Lilley, and Scott Morgan (2008).
- "*Factors Affecting Anfo Fumes Production*" by James H. Rowland III and Richard Mainiero (2001).
- AP-42 Section 11, Table 11.9-1.

Cobre Haul Road Borrow Pit Blasting (Unit BORR_BLST)

- "*NO_x Emissions from Blasting Operations in Open-Cut Coal Mining*" by Moetaz I. Attalla, Stuart J. Day, Tony Lange, William Lilley, and Scott Morgan (2008).
- "*Factors Affecting Anfo Fumes Production*" by James H. Rowland III and Richard Mainiero (2001).
- AP-42 Section 11, Table 11.9-1.

Hurly Power Plant (Not changing as a result of this application)

Gas Turbine (Unit F-2-1-1.4)

- AP-42 Chapter 3.1 Stationary Gas Turbine Table 3.1-3
- 40 CFR 98 Table C-1, C-2
- 40 CFR 98 Subpart A, Table A-1

Steam Generator (Unit F-2-1-1.5)

- AP-42, Chapter 1.4, Natural Gas Combustion Tables 1.4-2 and 1.4-3
- 40 CFR 98 Table C-1, C-2

- 40 CFR 98 Subpart A, Table A-1

Filter/Blending Plant (Not changing as a result of this application)

Filter/Blending Plant (Unit FLTR/BLND)

- AP-42 Table 11.19.2-2 in "Crushed Stone Processing and Pulverized Mineral Processing" for uncontrolled Conveyor Transfer Point (08/2004)
- AP-42 Table 11.24-2 in "Metallic Minerals Processing" for Material handling and transfer--all minerals except bauxite (01/1995).

Gasoline Dispensing Facility (Not changing as a result of this application)

Gasoline Dispensing Facility (Unit GDF)

- AP-42, Table 5.2-7

Ivanhoe Concentrator (Not changing as a result of this application)

Enclosed Ore Transfer Point (Unit CV-01C)

- Chino TRI data received from Clyde Durham 1/28/11 email
- Table 11.19.2-2 of USEPA AP-42
- Background Document for AP-42, Chapter 13.2.4, Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006.

SAG Mill Conveyor No.1 & SAG Mill Conveyor No.2 (Units SAF F1 & SAG F2)

- Chino TRI data received from Clyde Durham 1/28/11 email
- Table 11.19.2-2 of USEPA AP-42
- Background Document for AP-42, Chapter 13.2.4, Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006.

Stacker Conveyor Drop Point (Unit SCDP)

- Chino TRI data received from Clyde Durham 1/28/11 email
- Table 11.19.2-2 of USEPA AP-42
- Background Document for AP-42, Chapter 13.2.4, Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006.

Molybdenum Plant Wet Scrubber (Unit IC-01)

- Chino TRI data received from Clyde Durham 1/28/11 email
- Stack test data conducted in October 2008

Ivanhoe Concentrators (Units LHS-01 and LUS-01)

- Table 11.17-4 of AP-42 Section 11.17 – Lime Manufacturing
- Background Document for AP-42, Chapter 13.2.4, Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006

Ivanhoe Concentrator Crusher Dump (Unit PC DUMP)

- Chino TRI data received from Clyde Durham 1/28/11 email
- Table 11.19.2-2, of AP-42 Section 11.19.2 Crushed Stone Processing and Pulverized Mineral Processing
- Background Document for AP-42, Chapter 13.2.4, Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006

Ivanhoe Concentrator Primary Crusher Baghouse Emissions (Unit PC-01)

- Chino TRI data received from Clyde Durham 1/28/11 email

Screening Plant (Not changing as a result of this application)

Screen Plants (Units CH SCRN & CB SCRN)

- AP-42 Section 13.2.4 Drop Equation
- AP-42, Chapter 11.19.2, Crushed Stone Processing and Pulverized Mineral Processing, Table 11.19.2-2
- Background Document for AP-42, Chapter 13.2.4, Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors - November 2006

Screening Engine (Unit CH SCRN ENG)

- Deutz Model BF4M2012 data sheet
- AP-42 Section 3.3 "Gasoline And Diesel Industrial Engines", Table 3.3-1, Table 3.3-2
- 40 CFR 98 Table C-1, C-2
- 40 CFR 98 Subpart A, Table A-1

Screening Engine (Unit CB SCRN ENG)

- CAT specification sheet for C6.6 ACERT industrial open power unit
- AP-42 Section 3.3 "Gasoline And Diesel Industrial Engines", Table 3.3-1, Table 3.3-2
- 40 CFR 98 Table C-1, C-2
- 40 CFR 98 Subpart A, Table A-1

SXEW Plant (Not changing as a result of this application)

SXEW Plant Ten Mixer/Settler Tanks (Unit SXEW 10MST)

- BHP Copper VOC study conducted in 1997
- MSDS for the following chemicals:
  - Acorga OR25 solvent extraction reagent
  - Acorga M5910 extraction reagent
  - Acorga M5640 solvent extraction reagent
  - LIX 684 N-LV
  - Escaid 115
  - Escaid 110
  - Gasoline, all grades
  - ShellSol D70
  - Penreco 170ES
  - ORFOM SX 80 solvent extraction diluent

SXEW Boilers (Units SXEW Boiler No. 1, SXEW Boiler No. 2, & SXEW Boiler No. 3)

- AP-42 Section 1.5 "Liquefied Petroleum Gas Combustion" (7/08), Table 1.5-1
- 40 CFR 98 Table C-1, C-2
- 40 CFR 98 Subpart A, Table A-1
- Boiler Derating Manufacture Data

SXEW Plant Raffinate Tank (Units SXEW RT)

- BHP Copper VOC study conducted in 1997
- MSDS for the following chemicals:
  - Acorga OR25 solvent extraction reagent
  - Acorga M5910 extraction reagent
  - Acorga M5640 solvent extraction reagent
  - LIX 684 N-LV
  - Escaid 115
  - Escaid 110
  - Gasoline, all grades
  - ShellSol D70
  - Penreco 170ES

- ORFOM SX 80 solvent extraction diluent

SXEW Plant Acid Tank House (Units SXEW SAT)

- Equations from the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) 2001 Fundamentals Handbook

White House Crusher and Screening Plant (Not changing as a result of this application)

White House Crushing and Screening Plant (Unit WH Crush)

- AP-42 Section 11.19-2.2

SAG Tunnel Baghouse (Unit SAG)

- Golder Conceptual Design Document
- AP-42 Appendix B.2 Table B.2.2 Category 3

SG035 | 4.5L | 35 kW

INDUSTRIAL SPARK-IGNITED GENERATOR SET

EPA Certified Stationary

GENERAC INDUSTRIAL POWER

DEMAND RESPONSE READY

Standby Power Rating
35 kW, 44 kVA, 60 Hz

Demand Response Rating
35 kW, 44 kVA, 60 Hz

Prime Power Rating
32 kW, 39 kVA, 60 Hz

ISO 9001: 2008

USA ENGINEERED & BUILT*

*Assembled in the USA using domestic and foreign parts

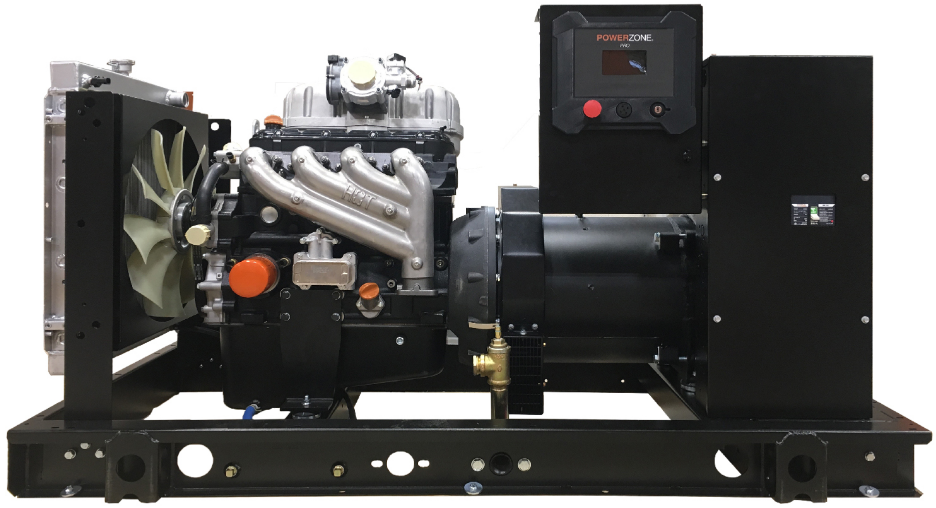


Image used for illustration purposes only

Codes and Standards

Not all codes and standards apply to all configurations. Contact factory for details.

UL2200, UL6200, UL1236, UL489

CSA C22.2

BS5514 and DIN 6271

SAE J1349

NFPA 37, 70, 99, 110

NEC700, 701, 702, 708

ISO 3046, 7637, 8528, 9001

NEMA ICS10, MG1, 250, ICS6, AB1

ANSI C62.41

IBC 2009, CBC 2010, IBC 2012,
ASCE 7-05, ASCE 7-10,
ICC-ES AC-156 (2012)

Powering Ahead

Generac ensures superior quality by designing and manufacturing most of its generator components, such as alternators, enclosures, control systems and communications software. Generac also makes its own spark-ignited engines, and you'll find them on every Generac gaseous-fueled generator. We engineer and manufacture them from the block up — all at our facilities throughout Wisconsin. Applying natural gas and LP-fueled engines to generators requires advanced engineering expertise to ensure reliability, durability and necessary performance. By designing specifically for these dry, hotter-burning fuels, the engines last longer and require less maintenance. Building our own engines also means we control every step of the supply chain and delivery process, so you benefit from single-source responsibility.

Plus, Generac Industrial Power's distribution network provides all parts and service so you don't have to deal with third-party suppliers. It all leads to a positive owner experience and higher confidence level. Generac spark-ignited engines give you more options in commercial and industrial generator applications as well as extended run time from utility-supplied natural gas.

SG035 | 4.5L | 35 kW

INDUSTRIAL SPARK-IGNITED GENERATOR SET

EPA Certified Stationary

GENERAC® | INDUSTRIAL POWER

STANDARD FEATURES

DEMAND RESPONSE READY

ENGINE SYSTEM

- Oil Drain Extension
- Air Cleaner
- Level 1 Fan and Belt Guards (Open Set Only)
- Stainless Steel Flexible Exhaust Connection
- Factory Filled Oil and Coolant
- Critical Silencer
- Oil Temperature Sender with Alarm
- Air Filter Restriction Indicator

Fuel System

- Fuel Line - NPT Connection
- Primary and Secondary Fuel Shutoff

Cooling System

- Closed Coolant Recovery System
- UV/Ozone Resistant Hoses
- Factory-Installed Radiator
- 50/50 Ethylene Glycol Antifreeze
- Radiator Drain Extension

Electrical System

- Battery Charging Alternator
- Battery Cables
- Battery Tray
- Rubber-Booted Engine Electrical Connections
- Solenoid Activated Starter Motor

ALTERNATOR SYSTEM

- UL2200 GENprotect™
- Class H Insulation Material
- 2/3 Pitch
- Skewed Stator
- Brushless Excitation
- Sealed Bearing
- Full Load Capacity Alternator

GENERATOR SET

- Internal Genset Vibration Isolation
- Separation of Circuits - High/Low Voltage
- Separation of Circuits - Multiple Breakers
- Wrapped Exhaust Piping
- Standard Factory Testing
- 2 Year Limited Warranty (Standby and Demand Response Rated Units)
- 1 Year Limited Warranty (Prime Rated Units)

ENCLOSURE (If Selected)

- Rust-Proof Fasteners with Nylon Washers to Protect Finish
- High Performance Sound-Absorbing Material (Sound Attenuated Enclosures)
- Gasketed Doors
- Upward Facing Discharge Hoods (Radiator and Exhaust)
- Stainless Steel Lift Off Door Hinges
- Stainless Steel Lockable Handles
- RhinoCoat™ - Textured Polyester Powder Coat Paint

CONTROL SYSTEM

Power Zone® Pro Controller

- NFPA 110 Level 1 Compliant
- Engine Protective Functions
- Alternator Protective Functions
- Digital Engine Governor Control
- Digital Voltage Regulator
- Multiple Programmable Inputs and Outputs
- Remote Display Capability
- Remote Communication via Modbus® RTU, Modbus TCP/IP, and Ethernet 10/100
- Alarm and Event Logging with Real Time Stamping
- Expandable Analog and Digital Inputs and Outputs
- Remote Wireless Software Update Capable
- Wi-Fi®, Bluetooth®, BMS, and Remote Telemetry
- Built-In Programmable Logic Eliminates the Need for External Controllers Under Most Conditions
- Programmable I/O Channel Properties
- Built-In Diagnostics

Alarms and Warnings

- High/Low Oil Pressure
- High/Low Coolant Level
- High/Low Coolant Temperature
- Sender/Sensor Failure
- High/Low Oil Temperature
- Over Total kW
- Over/Under Speed
- Over/Under Voltage
- Over/Under Frequency
- Over Current
- High/Low Battery Voltage
- Battery Charger Current
- Phase to Phase and Phase to Neutral Short Circuits (I^2T Algorithm)

4.3 Inch Color Touch Screen Display

- Resistive Color Touch Screen
- Easily Identifiable Icons
- Multi-Lingual
- On Screen Editable Parameters
- Key Function Monitoring
- Three Phase Voltage, Amperage, kW, kVA, and kVAr
- Selectable Line to Line or Line to Neutral Measurements
- Frequency
- Engine Speed
- Engine Coolant Temperature
- Engine Oil Pressure
- Engine Oil Temperature
- Battery Voltage
- Hourmeter
- Warning and Alarm Indication
- Diagnostics
- Maintenance Events/Information

GENERAC | INDUSTRIAL POWER

CONFIGURABLE OPTIONS

DEMAND RESPONSE READY

ENGINE SYSTEM

- Engine Coolant Heater
- Level 1 Fan and Belt Guards (Enclosed Units Only)
- Baseframe Cover/Rodent Guard
- Radiator Duct Adapter (Open Set Only)

FUEL SYSTEM

- Stainless Steel Flexible Fuel Lines

ELECTRICAL SYSTEM

- 10A UL Listed Battery Charger
- Battery Warmer

ALTERNATOR SYSTEM

- Alternator Upsizing
- Anti-Condensation Heater
- Tropical Coating

CIRCUIT BREAKER OPTIONS

- Main Line Circuit Breaker
- 2nd Main Line Circuit Breaker
- 3rd Main Line Circuit Breaker
- Shunt Trip and Auxiliary Contact
- Electronic Trip Breakers

GENERATOR SET

- Extended Factory Testing (3-Phase Only)
- 8 Position Load Center
- Spring Vibration Isolators
- Pad Vibration Isolators

ENCLOSURE

- Weather Protected Enclosure
- Level 1 Sound Attenuated
- Level 2 Sound Attenuated
- Level 2 Sound Attenuated with Motorized Dampers
- Steel Enclosure
- Aluminum Enclosure
- Up to 200 MPH Wind Load Rating (Contact Factory for Availability)
- AC/DC Enclosure Lighting Kit
- Enclosure Heaters (with Motorized Dampers Only)

CONTROL SYSTEM

- NFPA 110 Compliant 21-Light Remote Annunciator
- Remote Relay Assembly (8 or 16)
- Remote E-Stop (Break Glass-Type, Surface Mount)
- Remote E-Stop (Red Mushroom-Type, Surface Mount)
- Remote E-Stop (Red Mushroom-Type, Flush Mount)
- 10A Engine Run Relay
- Ground Fault Indication and Protection Functions
- 120V GFCI and 240V Outlets
- 100 dB Alarm Horn

WARRANTY (Standby Gensets Only)

- 2 Year Extended Limited Warranty
- 5 Year Limited Warranty
- 5 Year Extended Limited Warranty
- 7 Year Extended Limited Warranty
- 10 Year Extended Limited Warranty

ENGINEERED OPTIONS

CONTROL SYSTEM

- Spare Inputs (x4) / Outputs (x4)
- Battery Disconnect Switch

GENERATOR SET

- Special Testing
- Battery Box

SG035 | 4.5L | 35 kW

INDUSTRIAL SPARK-IGNITED GENERATOR SET

EPA Certified Stationary

GENERAC | INDUSTRIAL POWER

APPLICATION AND ENGINEERING DATA

DEMAND RESPONSE READY

ENGINE SPECIFICATIONS

General

Make	Generac
Cylinder #	4
Type	In-Line
Displacement - in^3 (L)	275.0 (4.5)
Bore - in (mm)	4.5 (114.3)
Stroke - in (mm)	4.25 (107.95)
Compression Ratio	9.94:1
Intake Air Method	Naturally Aspirated
Number of Main Bearings	5
Connecting Rods	Forged Steel, Fractured Split, Bushingless
Cylinder Head	Cast Iron
Cylinder Liners	Cast Iron
Ignition	Coil Near Plug Solid State Inductive
Piston Type	Cast Aluminum Flat Top
Crankshaft Type	Forged Steel
Lifter Type	Hydraulic
Intake Valve Material	Stainless Steel
Exhaust Valve Material	Stainless Steel
Hardened Valve Seats	High Steel Iron Alloy

Engine Governing

Governor	Electronic
Frequency Regulation (Steady State)	±0.25%

Lubrication System

Oil Pump Type	Gear Driving
Oil Filter Type	Full-Flow Spin-On Cartridge
Crankcase Capacity - qt (L)	21 (20)

Cooling System

Cooling System Type	Pressurized Closed
Fan Type	Pusher
Fan Speed - RPM	2,100
Fan Diameter - in (mm)	20 (508)

Fuel System

Fuel Type	Natural Gas, Propane
Fuel Injection	Electronic
Fuel Shut Off	Generac
NG Operating Fuel Pressure - in H_2O (kPa)	5 - 14 (1.2 - 3.5)
LP Operating Fuel Pressure - in H_2O (kPa)	7 - 14 (1.7 - 3.5)

Engine Electrical System

System Voltage	12 VDC
Battery Charger Alternator	35 A
Battery Size	See Battery Index 0161970SBY
Battery Voltage	12 VDC
Ground Polarity	Negative

ALTERNATOR SPECIFICATIONS

Standard Model	K0035124Y21
Poles	4
Field Type	Revolving
Insulation Class - Rotor	H
Insulation Class - Stator	H
Total Harmonic Distortion	<5% (3-Phase Only)
Telephone Interference Factor (TIF)	<50

Standard Excitation	Synchronous Brushless
Bearings	Sealed Ball
Coupling	Direct via Flexible Disc
Prototype Short Circuit Test	Yes
Voltage Regulator Type	Full Digital
Number of Sensed Phases	All
Regulation Accuracy (Steady State)	±0.25%

GENERAC | INDUSTRIAL POWER

OPERATING DATA

DEMAND RESPONSE READY

POWER RATINGS

	Standby		Prime	
Single-Phase 120/240 VAC @1.0pf	35 kW/35 kVA	Amps: 146	32 kW/32 kVA	Amps: 131
Three-Phase 120/208 VAC @0.8pf	35 kW/44 kVA	Amps: 122	32 kW/39 kVA	Amps: 109
Three-Phase 120/240 VAC @0.8pf	35 kW/44 kVA	Amps: 105	32 kW/39 kVA	Amps: 95
Three-Phase 277/480 VAC @0.8pf	35 kW/44 kVA	Amps: 53	32 kW/39 kVA	Amps: 47
Three-Phase 346/600 VAC @0.8pf	35 kW/44 kVA	Amps: 42	32 kW/39 kVA	Amps: 38

MOTOR STARTING CAPABILITIES (skVA)

skVA vs. Voltage Dip

277/480 VAC	30%	208/240 VAC	30%
K0035124Y21	61	K0035124Y21	46
K0060124Y21	124	K0060124Y21	95

FUEL CONSUMPTION RATES*

Natural Gas – scfh (m³/hr)

Percent Load	Standby	Prime
25%	184 (5.2)	174 (4.9)
50%	273 (7.7)	248 (7.0)
75%	361 (10.2)	343 (9.7)
100%	446 (12.6)	427 (12.1)

LP Vapor – scfh (m³/hr)

Percent Load	Standby	Prime
25%	98 (2.8)	94 (2.7)
50%	129 (3.7)	120 (3.4)
75%	159 (4.5)	155 (4.4)
100%	191 (5.4)	184 (5.2)

* Fuel supply installation must accommodate fuel consumption rates at 100% load.

COOLING

		Standby	Prime
Air Flow (Fan Air Flow Across Radiator) - Open Set	scfm (m^3/min)	3,511 (99.4)	
Coolant Flow	gpm (Lpm)	37.7 (142.7)	
Coolant System Capacity	gal (L)	3 (11.4)	
Max. Operating Ambient Temperature	°F (°C)	122 (50)	
Maximum Operating Ambient Temperature (Before Derate)		See Bulletin No. 0199270SSD	
Maximum Additional Radiator Backpressure	in H_2O (kPa)	0.5 (0.12)	

COMBUSTION AIR REQUIREMENTS

	Standby	Prime
Flow at Rated Power - scfm (m^3/min)	74 (2.1)	66.3 (1.9)

ENGINE

		Standby	Prime
Rated Engine Speed	RPM	1,800	1,800
Horsepower at Rated kW**	hp	54	49
Piston Speed	ft/min (m/min)	1,275 (389)	1,275 (389)
BMEP	psi (kPa)	88 (606)	80 (554)

EXHAUST

		Standby	Prime
Exhaust Flow (Rated Output)	scfm (m^3/min)	214.2 (6.1)	201.5 (5.7)
Maximum Allowable Backpressure (Post Silencer)	inHg (kPa)	0.75 (2.54)	0.75 (2.54)
Exhaust Temperature (Rated Output)	°F (°C)	1,342 (728)	1,330 (721)

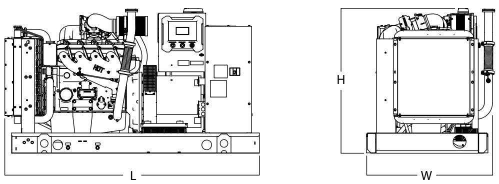
** Refer to "Emissions Data Sheet" for maximum bHP for EPA and SCAQMD permitting purposes.

Deration – Operational characteristics consider maximum ambient conditions. Derate factors may apply under atypical site conditions.
Please contact a Generac Power Systems Industrial Dealer for additional details. All performance ratings in accordance with ISO3046, BS5514, ISO8528, and DIN6271 standards.
Standby - See Bulletin 0187500SSB
Demand Response - See Bulletin 10000018250
Prime - See Bulletin 0187510SSB

GENERAC INDUSTRIAL POWER

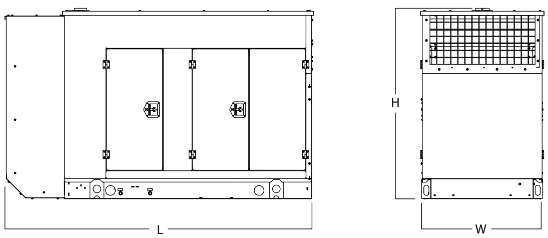
DIMENSIONS AND WEIGHTS*

DEMAND RESPONSE READY



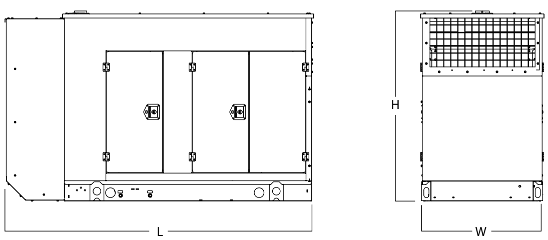
OPEN SET

L x W x H - in (mm)	78.1 (1,981) x 37.3 (946) x 44.4 (1,128)
Weight - lbs (kg)	1,675 - 1,748 (760 - 793)



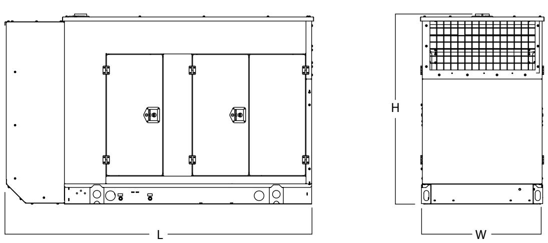
WEATHER PROTECTED ENCLOSURE

L x W x H - in (mm)	94.8 (2,409) x 38.0 (965) x 57.5 (1,461)
Weight - lbs (kg)	Steel: 2,160 - 2,233 (980 - 1,013) Aluminum: 1,894 - 1,965 (859 - 891)



LEVEL 1 SOUND ATTENUATED ENCLOSURE

L x W x H - in (mm)	94.8 (2,409) x 38.0 (965) x 57.5 (1,461)
Weight - lbs (kg)	Steel: 2,258 - 2,329 (1,024 - 1,056) Aluminum: 1,987 - 2,061 (901 - 935)



LEVEL 2 SOUND ATTENUATED ENCLOSURE

L x W x H - in (mm)	94.8 (2,409) x 38.0 (965) x 57.5 (1,461)
Weight - lbs (kg)	Steel: 2,341 - 2,414 (1,062 - 1,095) Aluminum: 2,071 - 2,144 (939 - 972)

* All measurements are approximate and for estimation purposes only.

YOUR FACTORY RECOGNIZED GENERAC INDUSTRIAL DEALER

Specification characteristics may change without notice. Please contact a Generac Power Systems Industrial Dealer for detailed installation drawings.

SPEC SHEET

Generac Power Systems, Inc. | P.O. Box 8 | Waukesha, WI 53189
P: (262) 544-4811

Part No. A0000310331
Rev. B 06/03/20

20 KW DIESEL DC GENERATOR
PART NUMBER 8220-100-D-20-03

All APUs include:

- Ethernet module with SNMP
- Powder coated aluminum enclosure
- V-belt driven radiator fan
- 5 Year Warranty

Options available:

- Electric radiator fans
- Level 2 sound enclosure
- 8-alarm relay board
- Oil refining kit

Standards:

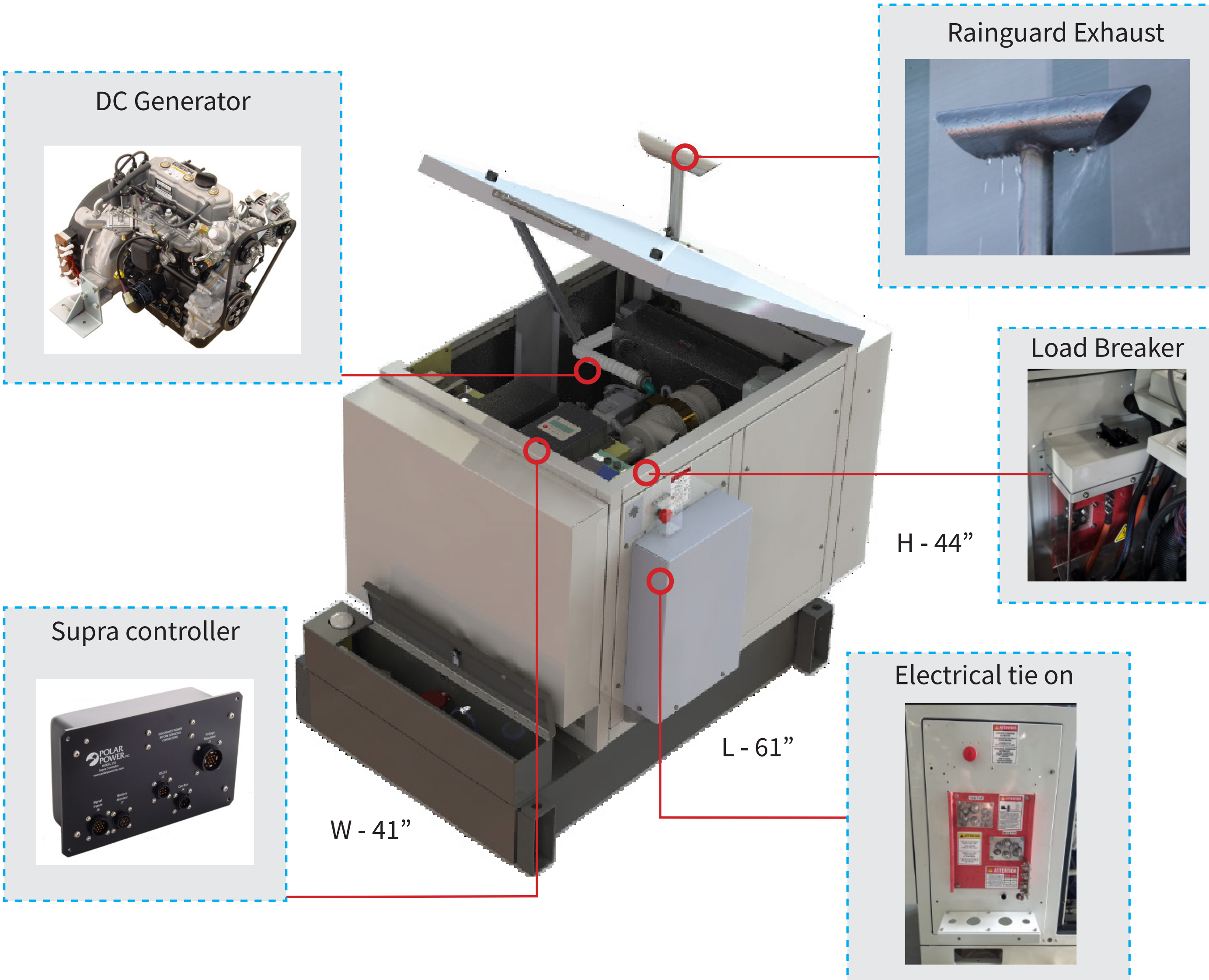
- *UL STD 2200*
- *EPA Compliant*

Made in USA

Founded in 1979 Polar Power specialized in solar photovoltaic systems, solar air conditioning and refrigeration. We developed and provided photovoltaic charging controls for telecommunications in the 1980s along with DC generators for the military. In 1994 we were first to provide DC generators with remote control and monitoring to the telecommunications industry.

Polar's success is based on engineering generators to meet the very specific needs of each application. Telecom site optimization is best met with the DC generator technology as the loads and batteries are DC. It makes no sense to install an AC generator and convert the output to DC. The AC generators are designed for a wide range of applications and they are not specifically produced for telecom applications so there are issues with reliability, space, and fuel efficiency.

Polar can save you considerable time and cost in permitting, installing, purchasing, and maintaining a backup generator. We reduce CAPEX and OPEX costs while improving backup reliability.



SMALL FOOTPRINT.
Polar’s DC generator is considerably smaller in size than an AC generator. You can now backup sites that could not accommodate an AC generator. Smaller also means less cost for space leasing.

LOW MAINTENANCE.

LOW ACOUSTIC NOISE. <67 dBA @ 7 meters, and low vibration so as not to disturb the local residents or building landlords.

CORROSION RESISTANT. All-aluminum enclosure with stainless hardware for low maintenance, and long service life.

FUEL EFFICIENT. Up to 85% fuel savings due to smaller engine displacement, high efficiency alternator, and variable speed operation.

ADVANCED MONITORING. Remote diagnostics, control, and monitoring. Ethernet and RS232 standard, with SNMP.

RODENT RESISTANT. Small animals can quickly destroy a generator set by gnawing on wires, fuel lines, radiator hoses, etc. Cooling air inlets and outlets have perforated aluminum screens to keep small rodents and large insects out. Stainless steel wire braid is placed over fuel and radiator lines to prevent damage.

LONG LIFE. Controls and wire harnesses are designed to exceed a 20 year life. Higher grade, longer life electrical wire (UL 3173), weather tight connectors, gold plated connector pins on signal circuits. No transfer switches are required.

SPECIFICATIONS PN 8220-100-D-20-03

Engine

Engine Model	Yanmar 3TNV88-BDSA
Cylinders	3 In-line
Displacement (L)	1.642
Bore (in./mm)	3.4/88
Stroke (in./mm)	3.5/90
Intake Air System	Naturally Aspirated
Engine HP	36
Emissions	U.S. EPA Tier 4 Interim
Emissions Compliance	EPA and CARB Certified
Variable RPM	2300 to 3000

Engine lubrication system

Oil Filter Type	Full flow spin-on canister
Oil Capacity (L)	6.7
Oil Pressure Switch	Yes
Oil Pressure Transducer	Optional

Fuel tank

UL Rated Capacity (gal/L)	54/204
Run Time (hrs)	50 to 60
Tank Alarms	Yes
Visual Gages	Yes
Catch Basin (gal/L)	5/19
Listings	UL 142 (double wall)

Fuel tank reserve time

Load (kW)	**Reserve Time (hrs.)**
3	99
6	72
9	56
10	55
11	48
12	46
13	44
14	40
15	38
20	30

Engine cooling system

Type	Pressurized Aluminum Radiator
Water Pump	Belt-driven, Pre-lubed, self-sealing
Fan Type	Electric Fans
Airflow CFM	1300
Fan Mode	Pusher
Temperature Sensor	Yes

Environmental

Operating Temperature (°C/°F)	-40 to 72 / -40 to 162
Operating Humidity %	100
Cold Start Aids	Glow Plugs

Optional: manifold heater available for temperatures < -40 ºF

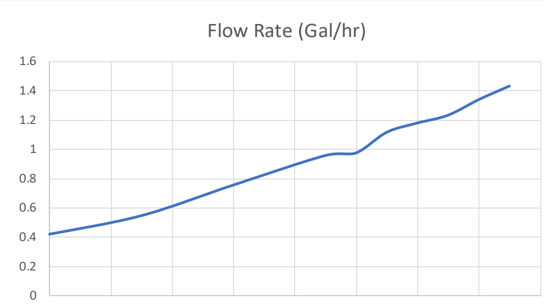
Power adjustment for conditions

Temperature Deration	2% derate for every 5.6 ºC (10 ºF) above 25 ºC (77 ºF)
Altitude Deration	4% derate for every 300 m (1000 ft) above 91 m (300 ft)

Diesel Fuel system

Type	Diesel
Fuel Pump Type	Electrical
Injector Type	Mechanical
Fuel Filtering	Paper Element

Diesel fuel consumption



Engine cooling

System coolant capacity (gal/L)	2.2/8.3
Maximum operation air temperature on radiator (°C/°F)	54/129
Maximum ambient temperature (°C/°F)	49/120

Exhaust

Exhaust flow at rated output (cfm/cmm)	90/2.55
Exhaust temperature at rated output (°C/°F)	480/900

Alternator

Alternator Model	8220
Type	Permanent Magnets, NdFeB
Weight (lb/kg)	46.5/21
Regulation Type	Variable engine speed
Stator	3 phase/32 poles
Overcurrent Protection (A)	20 kW - 500
Disconnect Means	Pull fuse block or Circuit breaker
Voltage Range (VDC)	44 to 60
Alternator Exhaust Flow (cfm/cmm)	130 to 180 / 3.68 to 5.1
MTBF (hr)	100,000+

Enclosure

Model	88-25-0100
Type	Weather Protective
Materials	Powder coated aluminum
Door Hardware	Three Point with Padlock Hasp, and Removable Side Panels
Mounting	Secure Mounting Tabs
Dims.	L 61” x W 41” x H 44” *(Height 59” including Exhaust)*

Optional: L2 option

Weight

Dry Weight (lb/kg)	837.4/380

Starter Supercapacitor

Model	20-16-0001
Storage Rating (Ah)	500
Voltage (VDC)	13-14.4
Weight (lb/kg)	12.1/5.5
Operating Temperature (°C/°F)	-40 to 65 / -40 to 149
Service Life (year)	10 to 15

Charger

Model	00-10-0015
Input Voltage (VDC)	37 to 62
Output Voltage (VDC)	14 to 14.4
Recharge time from 0 VDC (min)	10
Recharge time from 8 VDC (min)	2
Weight (lb/kg)	2.2/1

Standards

Certification	Intertek 400376
UL Listing	UL STD 2200
Standards	CSA STD C22.2 No. 100

Controller features

Controller Type......Supra Model 250
4-Line Plain Text OLED Display......Simple user interface for ease of operation
Engine Run Hours Indication......Standard
Programmable Start Delay......Standard
Run/Alarm/Maintenance Logs......Standard
Engine Start Sequence......Cyclic cranking: 5 sec on, 45 sec rest (3 attempts maximum)
Starter Supercapacitor Charger......Standard
Automatic Voltage Regulation with Over and Under Voltage Protection......Standard
Automatic Low Oil Pressure/High Oil Temperature Shutdown......Standard
Overcrank/Overspeed......Standard
Automatic High Engine Temperature Shutdown......Standard
Field Upgradeable Firmware......Standard
Glow Plug Delay......Automatic With Temperature
Engine Start Delay......Adjustable, Set at 60 sec
Return to Utility Delay......Adjustable, Set at 60 sec
Engine Cool-down......Adjustable, Set at 60 sec
Exerciser......Programmable

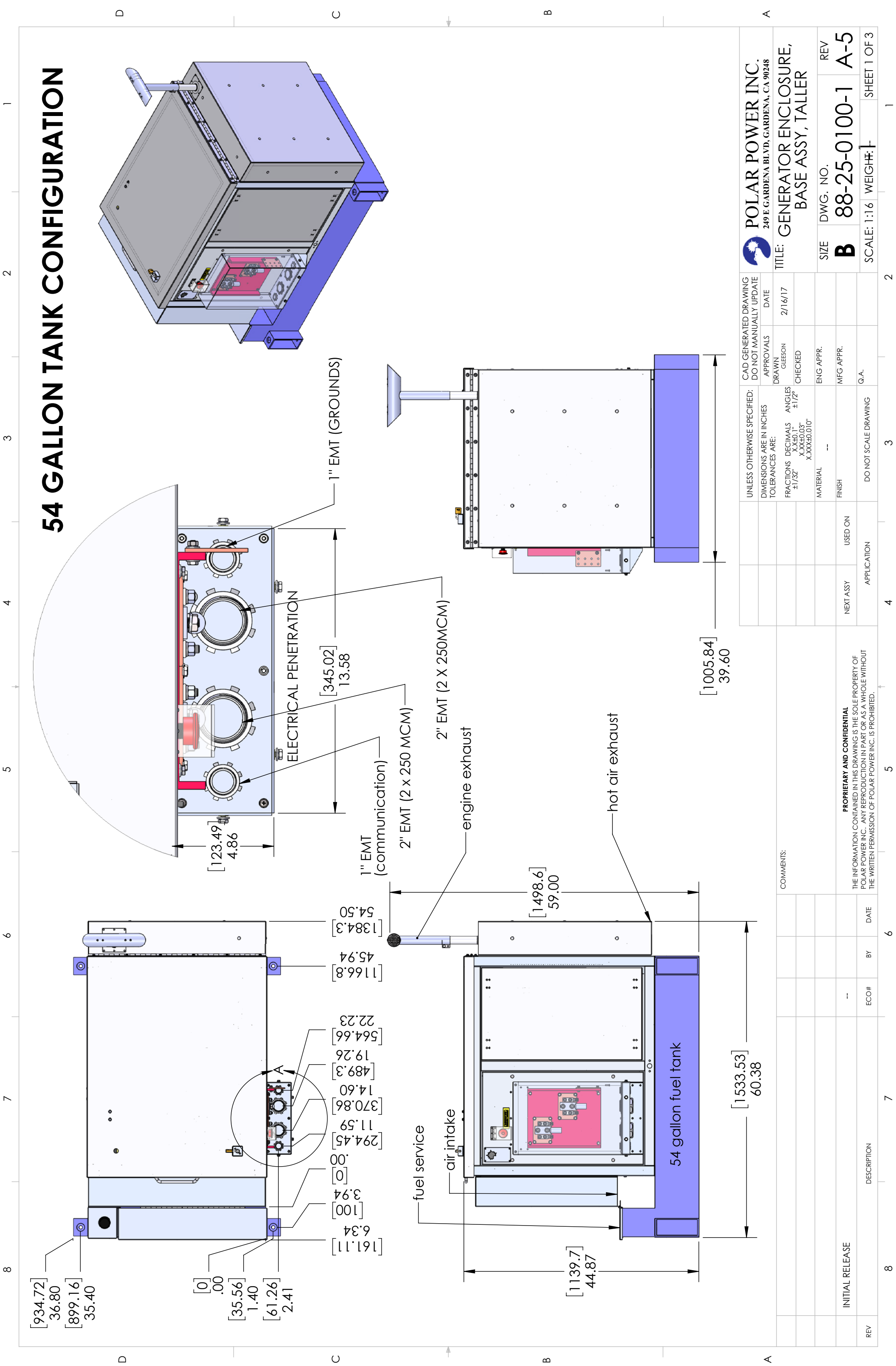
Monitoring

Alarm monitoring and remote control through Ethernet.

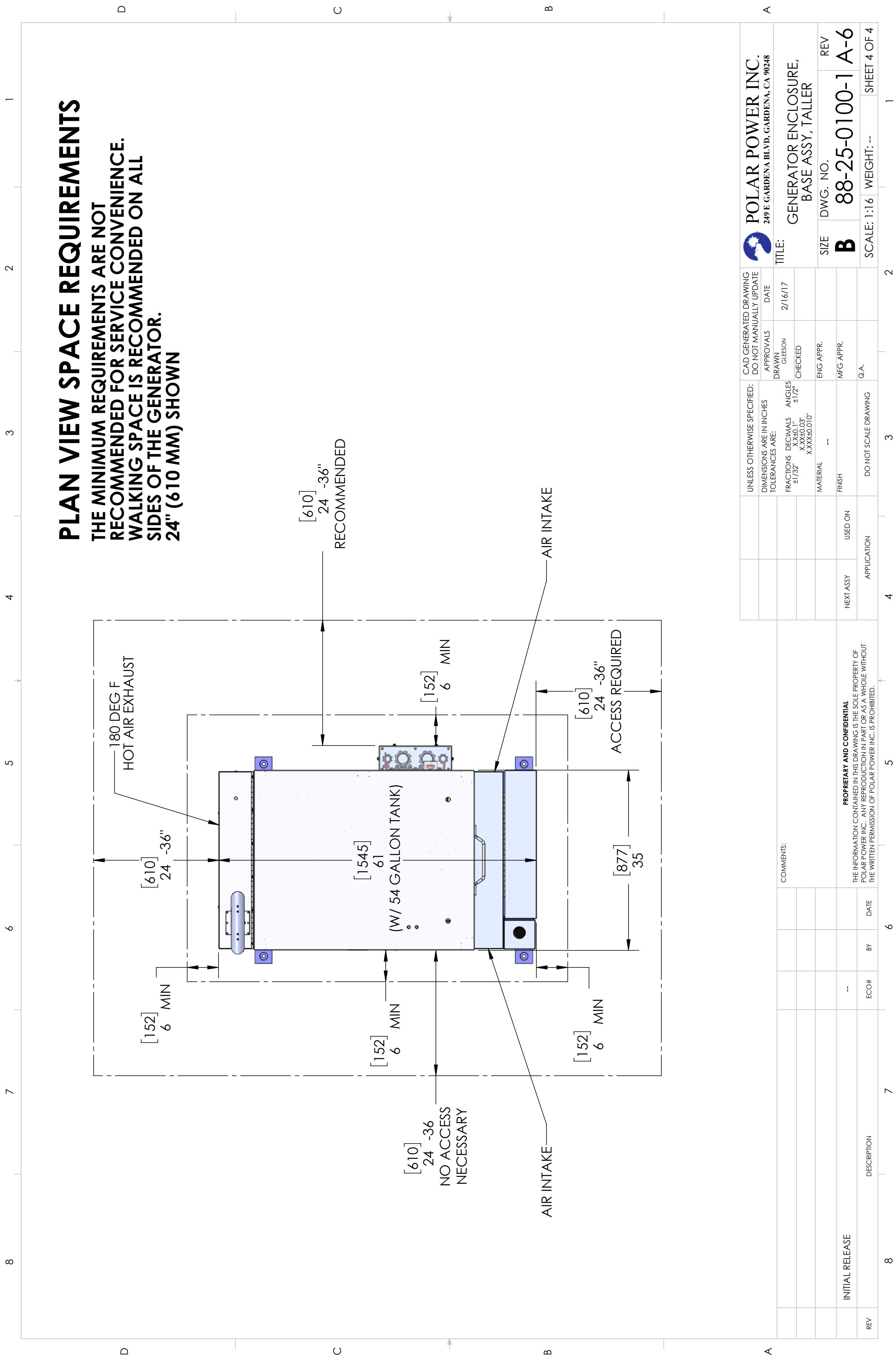
Contact closure alarm board

Shutdown Alarm......Standard
Warning Alarm......Standard
Engine Run......Standard
E-Stop Depressed......Standard

DRAWING FOR PN 8220-100-D-20-03



PLANNING FOR PN 8220-100-D-20-03



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APPENDIX B.2

GENERALIZED PARTICLE SIZE DISTRIBUTIONS

CONTENTS

Appendix B.2

Generalized Particle Size Distributions

B.2.1 Rationale For Developing Generalized Particle Size Distributions

The preparation of size-specific particulate emission inventories requires size distribution information for each process. Particle size distributions for many processes are contained in appropriate industry sections of this document. Because particle size information for many processes of local impact and concern are unavailable, this appendix provides "generic" particle size distributions applicable to these processes. The concept of the "generic" particle size distribution is based on categorizing measured particle size data from similar processes generating emissions from similar materials. These generic distributions have been developed from sampled size distributions from about 200 sources.

Generic particle size distributions are approximations. They should be used only in the absence of source-specific particle size distributions for areawide emission inventories.

B.2.2 How To Use The Generalized Particle Size Distributions For Uncontrolled Processes

Figure B.2-1 provides an example calculation to assist the analyst in preparing particle size-specific emission estimates using generic size distributions.

The following instructions for the calculation apply to each particulate emission source for which a particle size distribution is desired and for which no source specific particle size information is given elsewhere in this document:

1. Identify and review the AP-42 section dealing with that process.
2. Obtain the uncontrolled particulate emission factor for the process from the main text of AP-42, and calculate uncontrolled total particulate emissions.
3. Obtain the category number of the appropriate generic particle size distribution from Table B.2-1.
4. Obtain the particle size distribution for the appropriate category from Table B.2-2. Apply the particle size distribution to the uncontrolled particulate emissions.

Instructions for calculating the controlled size-specific emissions are given in Table B.2-3 and illustrated in Figure B.2-1.

Figure B.2-1. Example calculation for determining uncontrolled and controlled particle size-specific emissions.

SOURCE IDENTIFICATION

Source name and address: ABC Brick Manufacturing
24 Dusty Way
Anywhere, USA

Process description: Dryers/Grinders
AP-42 Section: 8.3, Bricks And Related Clay Products
Uncontrolled AP-42 emission factor: 96 lbs/ton (units)
Activity parameter: 63,700 tons/year (units)
Uncontrolled emissions: 3057.6 tons/year (units)

UNCONTROLLED SIZE EMISSIONS

Category name: Mechanically Generated/Aggregated, Unprocessed Ores
Category number: 3

	Particle size (µm)		
	≤ 2.5	≤ 6	≤ 10
Generic distribution, Cumulative percent equal to or less than the size:	15	34	51
Cumulative mass ≤ particle size emissions (tons/year):	458.6	1039.6	1559.4

CONTROLLED SIZE EMISSIONS*

Type of control device: Fabric Filter

	Particle size (µm)		
	0 - 2.5	2.5 - 6	6 - 10
Collection efficiency (Table B.2-3):	99.0	99.5	99.5
Mass in size range** before control (tons/year):	458.6	581.0	519.8
Mass in size range after control (tons/year):	4.59	2.91	2.60
Cumulative mass (tons/year):	4.59	7.50	10.10

* These data do not include results for the greater than 10 µm particle size range.
** Uncontrolled size data are cumulative percent equal to or less than the size. Control efficiency data apply only to size range and are not cumulative.

Table B.2-1. PARTICLE SIZE CATEGORY BY AP-42 SECTION

AP-42 Section	Source Category	Category Number*
	External combustion	
1.1	Bituminous and subbituminous coal combustion	a
1.2	Anthracite coal combustion	a
1.3	Fuel oil combustion	
	Residual oil	
	Utility	a
	Commercial	a
	Distillate oil	
	Utility	a
	Commercial	a
	Residential	a
1.4	Natural gas combustion	a
1.5	Liquefied petroleum gas	a
1.6	Wood waste combustion in boilers	a
1.7	Lignite combustion	a
1.8	Bagasse combustion	b
1.9	Residential fireplaces	a
1.10	Residential wood stoves	a
1.11	Waste oil combustion	a
	Solid waste disposal	
2.1	Refuse combustion	a
2.2	Sewage sludge incineration	a
2.7	Conical burners (wood waste)	2
	Internal combustion engines	
	Highway vehicles	c
3.2	Off highway vehicles	1
	Organic chemical processes	
6.4	Paint and varnish	4
6.5	Phthalic anhydride	9
6.8	Soap and detergents	a
	Inorganic chemical processes	
8.2	Urea	a
8.3	Ammonium nitrate fertilizers	a
8.4	Ammonium sulfate	
	Rotary dryer	b
	Fluidized bed dryer	b
8.5	Phosphate fertilizers	3
8.5.3	Ammonium phosphates	
	Reactor/ammoniator-granulator	4
	Dryer/cooler	4
8.7	Hydrofluoric acid	
	Spar drying	3
	Spar handling	3
	Transfer	3
8.9	Phosphoric acid (thermal process)	a
8.10	Sulfuric acid	b
8.12	Sodium carbonate	a
	Food and agricultural	
9.3.1	Defoliation and harvesting of cotton	
	Trailer loading	6
	Transport	6
9.3.2	Harvesting of grain	
	Harvesting machine	6
	Truck loading	6
	Field transport	6
9.5.2	Meat smokehouses	9
9.7	Cotton ginning	b
9.9.1	Grain elevators and processing plants	a
9.9.4	Alfalfa dehydrating	
	Primary cyclone	b
	Meal collector cyclone	7
	Pellet cooler cyclone	7
	Pellet regrind cyclone	7
9.9.7	Starch manufacturing	7
9.12	Fermentation	6,7
9.13.2	Coffee roasting	6
	Wood products	
10.2	Chemical wood pulping	a
10.7	Charcoal	9
	Mineral products	
11.1	Hot mix asphalt plants	a
11.3	Bricks and related clay products	
	Raw materials handling	
	Dryers, grinders, etc.	b

Table B.2-1 (cont.).

AP-42 Section	Source Category	Category Number*
	Tunnel/periodic kilns	
	Gas fired	a
	Oil fired	a
	Coal fired	a
11.5	Refractory manufacturing	
	Raw material dryer	3
	Raw material crushing and screening	3
	Electric arc melting	8
	Curing oven	3
11.6	Portland cement manufacturing	
	Dry process	
	Kilns	a
	Dryers, grinders, etc.	4
	Wet process	
	Kilns	a
	Dryers, grinders, etc.	4
11.7	Ceramic clay manufacturing	
	Drying	3
	Grinding	4
	Storage	3
11.8	Clay and fly ash sintering	
	Fly ash sintering, crushing, screening, yard storage	5
	Clay mixed with coke	
	Crushing, screening, yard storage	3
11.9	Western surface coal mining	a
11.10	Coal cleaning	3
11.12	Concrete batching	3
11.13	Glass fiber manufacturing	
	Unloading and conveying	3
	Storage bins	3
	Mixing and weighing	3
	Glass furnace - wool	a
	Glass furnace - textile	a
11.15	Glass manufacturing	a
11.16	Gypsum manufacturing	
	Rotary ore dryer	a
	Roller mill	4
	Impact mill	4
	Flash calciner	a
	Continuous kettle calciner	a
11.17	Lime manufacturing	a
11.18	Mineral wool manufacturing	
	Cupola	8
	Reverberatory furnace	8
	Blow chamber	8
	Curing oven	9
	Cooler	9
11.19.1	Sand and gravel processing	
	Continuous drop	
	Transfer station	a
	Pile formation - stacker	a
	Batch drop	a
	Active storage piles	a
	Vehicle traffic on unpaved road	a
11.19.2	Crushed stone processing	
	Dry crushing	
	Primary crushing	a
	Secondary crushing and screening	a
	Tertiary crushing and screening	3
	Recrushing and screening	4
	Fines mill	4
	Screening, conveying, handling	a
11.21	Phosphate rock processing	
	Drying	a
	Calcining	a
	Grinding	b
	Transfer and storage	3
11.23	Taconite ore processing	
	Fine crushing	4

Table B.2-1 (cont.).

AP-42 Section	Source Category	Category Number*
	Waste gas	a
	Pellet handling	4
	Grate discharge	5
	Grate feed	4
	Bentonite blending	4
	Coarse crushing	3
	Ore transfer	3
	Bentonite transfer	4
	Unpaved roads	a
11.24	Metallic minerals processing	a
	Metallurgical	
12.1	Primary aluminum production	
	Bauxite grinding	4
	Aluminum hydroxide calcining	5
	Anode baking furnace	9
	Prebake cell	a
	Vertical Soderberg	8
	Horizontal Soderberg	a
12.2	Coke manufacturing	a
12.3	Primary copper smelting	a
12.4	Ferroalloy production	a
12.5	Iron and steel production	
	Blast furnace	
	Slips	a
	Cast house	a
	Sintering	
	Windbox	a
	Sinter discharge	a
	Basic oxygen furnace	a
	Electric arc furnace	a
12.6	Primary lead smelting	a
12.7	Zinc smelting	8
12.8	Secondary aluminum operations	
	Sweating furnace	8
	Smelting	
	Crucible furnace	8
	Reverberatory furnace	a
12.9	Secondary copper smelting and alloying	8
12.10	Gray iron foundries	a
12.11	Secondary lead processing	a
12.12	Secondary magnesium smelting	8
12.13	Steel foundries - melting	b
12.14	Secondary zinc processing	8
12.15	Storage battery production	b
12.18	Leadbearing ore crushing and grinding	4
	Miscellaneous sources	
13.1	Wildfires and prescribed burning	a
13.2	Fugitive dust	a

* Data for numbered categories are given Table B.2-2. Particle size data on "a" categories are found in the AP-42 text; for "b" categories, in Appendix B.1; and for "c" categories, in AP-42 *Volume II: Mobile Sources*.

Figure B.2-2. CALCULATION SHEET

SOURCE IDENTIFICATION

Source name and address: ____

____

____

Process description: ____

AP-42 Section: ____

Uncontrolled AP-42 emission factor: ____ (units)

Activity parameter: ____ (units)

Uncontrolled emissions: ____ (units)

UNCONTROLLED SIZE EMISSIONS

Category name: ____

Category number: _____

	Particle size (µm)		
	≤ 2.5	≤ 6	≤ 10
Generic distribution, Cumulative percent equal to or less than the size:			
Cumulative mass ≤ particle size emissions (tons/year):			

CONTROLLED SIZE EMISSIONS*

Type of control device: ____

	Particle size (µm)		
	0 - 2.5	2.5 - 6	6 - 10
Collection efficiency (Table B.2-3):			
Mass in size range** before control (tons/year):			
Mass in size range after control (tons/year):			
Cumulative mass (tons/year):			

* These data do not include results for the greater than 10 µm particle size range.

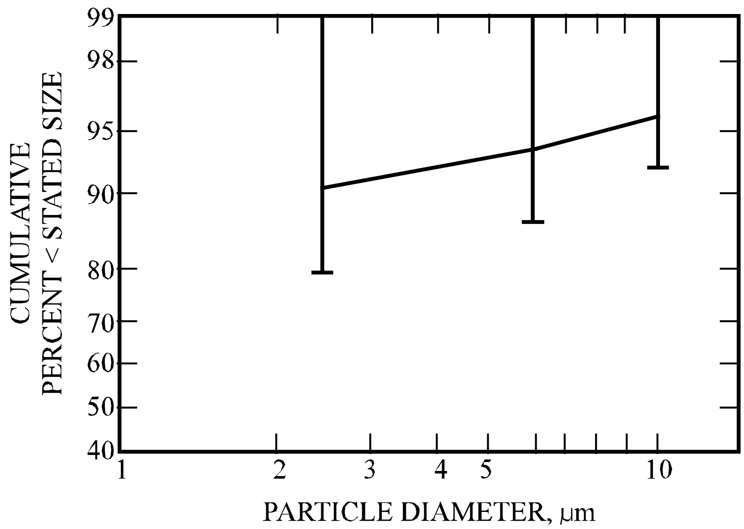
** Uncontrolled size data are cumulative percent equal to or less than the size. Control efficiency data apply only to size range and are not cumulative.

Table B.2-2. DESCRIPTION OF PARTICLE SIZE CATEGORIES

Category: 1
Process: Stationary Internal Combustion Engines
Material: Gasoline and Diesel Fuel

Category 1 covers size-specific emissions from stationary internal combustion engines. The particulate emissions are generated from fuel combustion.

REFERENCES: 1,9



Particle Size, μm	Cumulative % ≤ Stated Size (Uncontrolled)	Minimum Value	Maximum Value	Standard Deviation
1.0[a]	82			
2.0[a]	88			
2.5	90	78	99	11
3.0[a]	90			
4.0[a]	92			
5.0[a]	93			
6.0	93	86	99	7
10.0	96	92	99	4

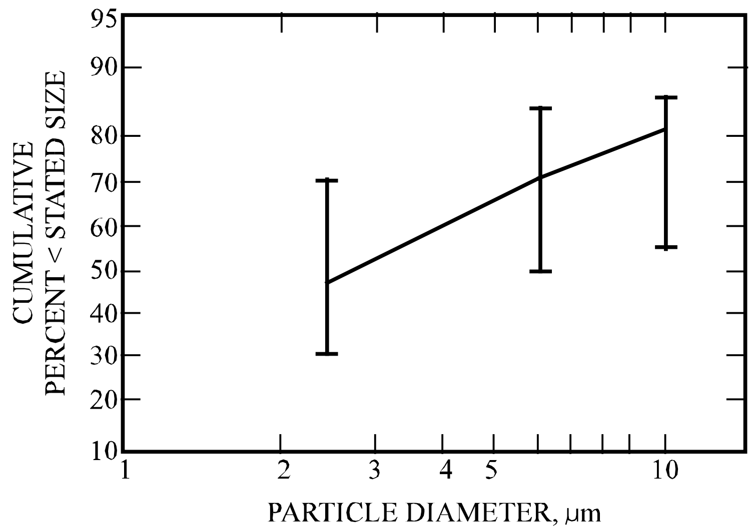
[a] Value calculated from data reported at 2.5, 6.0, and 10.0 μm. No statistical parameters are given for the calculated value.

Table B.2.2 (cont.).

Category: 2
Process: Combustion
Material: Mixed Fuels

Category 2 covers boilers firing a mixture of fuels, regardless of the fuel combination. The fuels include gas, coal, coke, and petroleum. Particulate emissions are generated by firing these miscellaneous fuels.

REFERENCE: 1



Particle Size, µm	Cumulative % ≤ Stated Size (Uncontrolled)	Minimum Value	Maximum Value	Standard Deviation
1.0[a]	23			
2.0[a]	40			
2.5	45	32	70	17
3.0[a]	50			
4.0[a]	58			
5.0[a]	64			
6.0	70	49	84	14
10.0	79	56	87	12

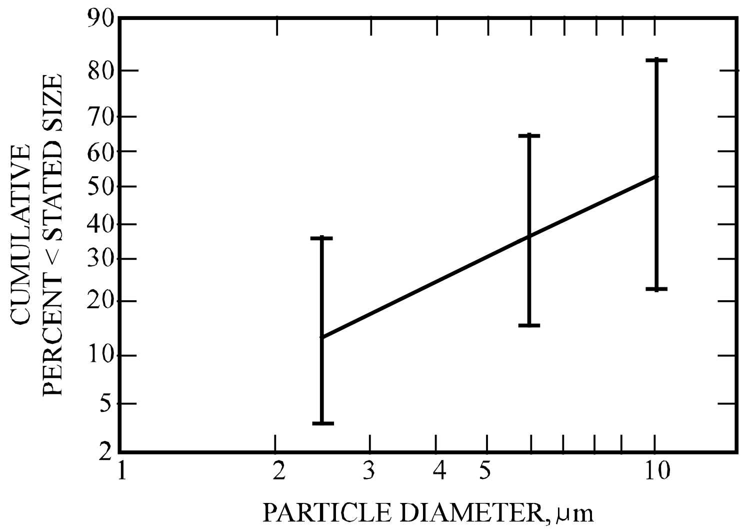
[a] Value calculated from data reported at 2.5, 6.0, and 10.0 µm. No statistical parameters are given for the calculated value.

Table B.2.2 (cont.).

Category: 3
Process: Mechanically Generated
Material: Aggregate, Unprocessed Ores

Category 3 covers material handling and processing of aggregate and unprocessed ore. This broad category includes emissions from milling, grinding, crushing, screening, conveying, cooling, and drying of material. Emissions are generated through either the movement of the material or the interaction of the material with mechanical devices.

REFERENCES: 1-2,4,7



Particle Size, μm	Cumulative % ≤ Stated Size (Uncontrolled)	Minimum Value	Maximum Value	Standard Deviation
1.0[a]	4			
2.0[a]	11			
2.5	15	3	35	7
3.0[a]	18			
4.0[a]	25			
5.0[a]	30			
6.0	34	15	65	13
10.0	51	23	81	14

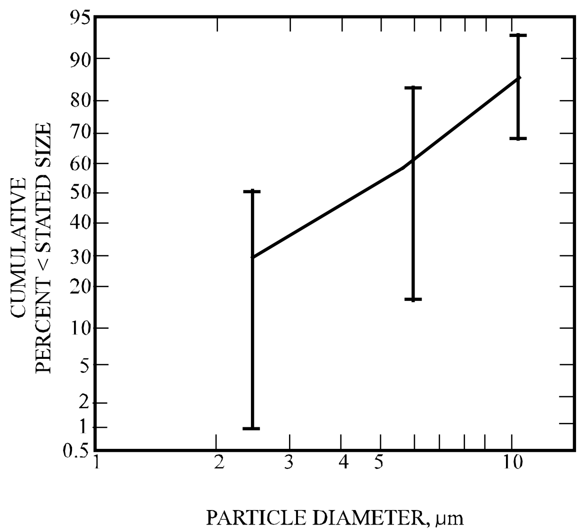
[a] Value calculated from data reported at 2.5, 6.0, and 10.0 μm. No statistical parameters are given for the calculated value.

Table B.2.2 (cont.).

Category: 4
Process: Mechanically Generated
Material: Processed Ores and Nonmetallic Minerals

Category 4 covers material handling and processing of processed ores and minerals. While similar to Category 3, processed ores can be expected to have a greater size consistency than unprocessed ores. Particulate emissions are a result of agitating the materials by screening or transfer during size reduction and beneficiation of the materials by grinding and fine milling and by drying.

REFERENCE: 1



Particle Size, µm	Cumulative % ≤ Stated Size (Uncontrolled)	Minimum Value	Maximum Value	Standard Deviation
1.0[a]	6			
2.0[a]	21			
2.5	30	1	51	19
3.0[a]	36			
4.0[a]	48			
5.0[a]	58			
6.0	62	17	83	17
10.0	85	70	93	7

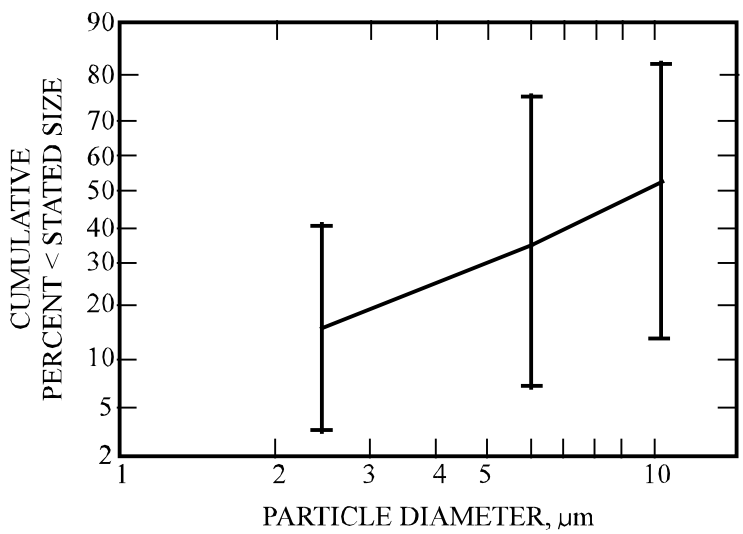
[a] Value calculated from data reported at 2.5, 6.0, and 10.0 µm. No statistical parameters are given for the calculated value.

Table B.2.2 (cont.).

Category: 5
Process: Calcining and Other Heat Reaction Processes
Material: Aggregate, Unprocessed Ores

Category 5 covers the use of calciners and kilns in processing a variety of aggregates and unprocessed ores. Emissions are a result of these high temperature operations.

REFERENCES: 1-2,8



Particle Size, μm	Cumulative % ≤ Stated Size (Uncontrolled)	Minimum Value	Maximum Value	Standard Deviation
1.0[a]	6			
2.0[a]	13			
2.5	18	3	42	11
3.0[a]	21			
4.0[a]	28			
5.0[a]	33			
6.0	37	13	74	19
10.0	53	25	84	19

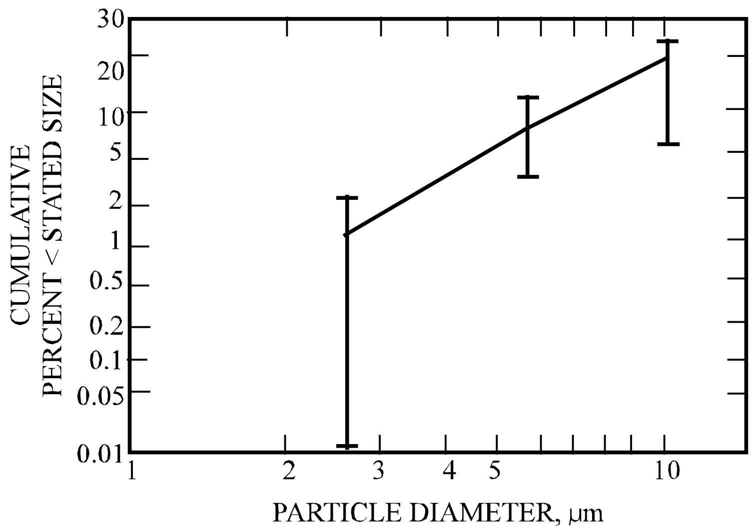
[a] Value calculated from data reported at 2.5, 6.0, and 10.0 μm. No statistical parameters are given for the calculated value.

Table B.2.2 (cont.).

Category: 6
Process: Grain Handling
Material: Grain

Category 6 covers various grain handling (versus grain processing) operations. These processes could include material transfer, ginning and other miscellaneous handling of grain. Emissions are generated by mechanical agitation of the material.

REFERENCES: 1,5



Particle Size, µm	Cumulative % ≤ Stated Size (Uncontrolled)	Minimum Value	Maximum Value	Standard Deviation
1.0[a]	0.07			
2.0[a]	0.60			
2.5	1	0	2	1
3.0[a]	2			
4.0[a]	3			
5.0[a]	5			
6.0	7	3	12	3
10.0	15	6	25	7

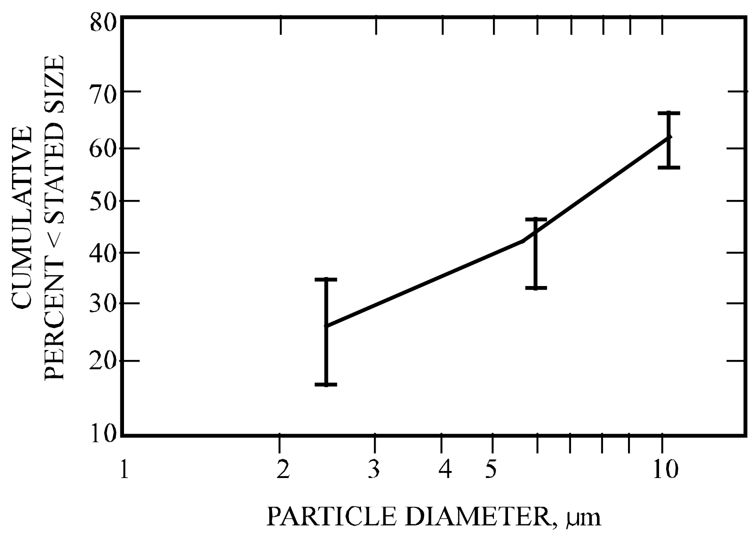
[a] Value calculated from data reported at 2.5, 6.0, and 10.0 µm. No statistical parameters are given for the calculated value.

Table B.2.2 (cont.).

Category: 7
Process: Grain Processing
Material: Grain

Category 7 covers grain processing operations such as drying, screening, grinding, and milling. The particulate emissions are generated during forced air flow, separation, or size reduction.

REFERENCES: 1-2



Particle Size, µm	Cumulative % ≤ Stated Size (Uncontrolled)	Minimum Value	Maximum Value	Standard Deviation
1.0[a]	8			
2.0[a]	18			
2.5	23	17	34	9
3.0[a]	27			
4.0[a]	34			
5.0[a]	40			
6.0	43	35	48	7
10.0	61	56	65	5

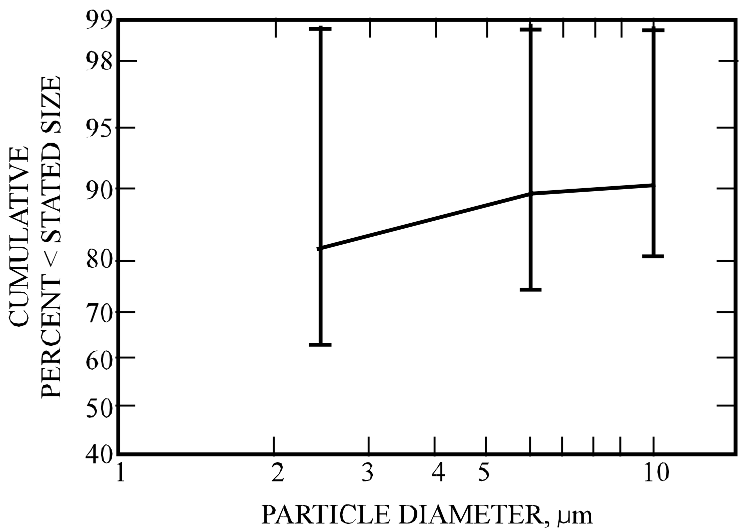
[a] Value calculated from data reported at 2.5, 6.0, and 10.0 µm. No statistical parameters are given for the calculated value.

Table B.2.2 (cont.).

Category: 8
Process: Melting, Smelting, Refining
Material: Metals, except Aluminum

Category 8 covers the melting, smelting, and refining of metals (including glass) other than aluminum. All primary and secondary production processes for these materials which involve a physical or chemical change are included in this category. Materials handling and transfer are not included. Particulate emissions are a result of high temperature melting, smelting, and refining.

REFERENCES: 1-2



Particle Size, µm	Cumulative % ≤ Stated Size (Uncontrolled)	Minimum Value	Maximum Value	Standard Deviation
1.0[a]	72			
2.0[a]	80			
2.5	82	63	99	12
3.0[a]	84			
4.0[a]	86			
5.0[a]	88			
6.0	89	75	99	9
10.0	92	80	99	7

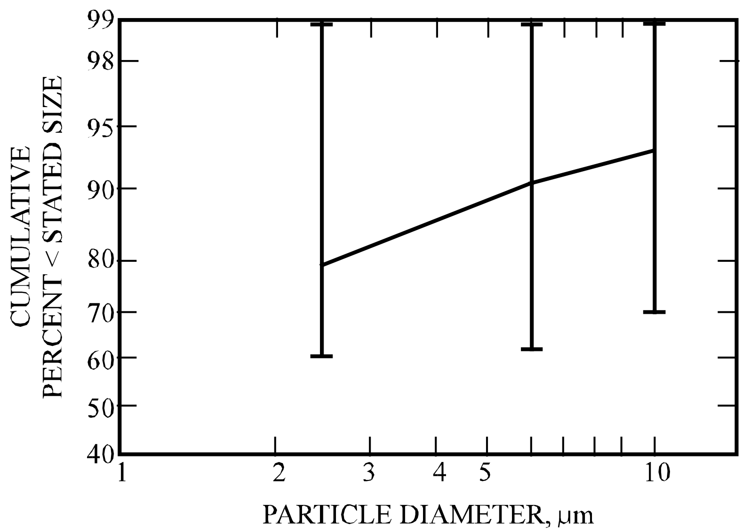
[a] Value calculated from data reported at 2.5, 6.0, and 10.0 µm. No statistical parameters are given for the calculated value.

Table B.2.2 (cont.).

Category: 9
Process: Condensation, Hydration, Absorption, Prilling, and Distillation
Material: All

Category 9 covers condensation, hydration, absorption, prilling, and distillation of all materials. These processes involve the physical separation or combination of a wide variety of materials such as sulfuric acid and ammonium nitrate fertilizer. (Coke ovens are included since they can be considered a distillation process which separates the volatile matter from coal to produce coke.)

REFERENCES: 1,3



Particle Size, µm	Cumulative % ≤ Stated Size (Uncontrolled)	Minimum Value	Maximum Value	Standard Deviation
1.0[a]	60			
2.0[a]	74			
2.5	78	59	99	17
3.0[a]	81			
4.0[a]	85			
5.0[a]	88			
6.0	91	61	99	12
10.0	94	71	99	9

[a] Value calculated from data reported at 2.5, 6.0, and 10.0 µm. No statistical parameters are given for the calculated value.

B.2.3 How To Use The Generalized Particle Size Distributions For Controlled Processes

To calculate the size distribution and the size-specific emissions for a source with a particulate control device, the user first calculates the uncontrolled size-specific emissions. Next, the fractional control efficiency for the control device is estimated using Table B.2-3. The Calculation Sheet provided (Figure B.2-2) allows the user to record the type of control device and the collection efficiencies from Table B.2-3, the mass in the size range before and after control, and the cumulative mass. The user will note that the uncontrolled size data are expressed in cumulative fraction less than the stated size. The control efficiency data apply only to the size range indicated and are not cumulative. These data do not include results for the greater than 10 µm particle size range. In order to account for the total controlled emissions, particles greater than 10 µm in size must be included.

B.2.4 Example Calculation

An example calculation of uncontrolled total particulate emissions, uncontrolled size-specific emissions, and controlled size specific emission is shown in Figure B.2-1. A blank Calculation Sheet is provided in Figure B.2-2.

Table B.2-3. TYPICAL COLLECTION EFFICIENCIES OF VARIOUS PARTICULATE CONTROL DEVICES[a]
(%)

AIRS Code[b]	Type Of Collector	Particle Size (µm)		
		0 - 2.5	2.5 - 6	6 - 10
001	Wet scrubber - hi-efficiency	90	95	99
002	Wet scrubber - med-efficiency	25	85	95
003	Wet scrubber - low-efficiency	20	80	90
004	Gravity collector - hi-efficiency	3.6	5	6
005	Gravity collector - med-efficiency	2.9	4	4.8
006	Gravity collector - low-efficiency	1.5	3.2	3.7
007	Centrifugal collector - hi-efficiency	80	95	95
008	Centrifugal collector - med-efficiency	50	75	85
009	Centrifugal collector - low-efficiency	10	35	50
010	Electrostatic precipitator - hi-efficiency	95	99	99.5
011	Electrostatic precipitator - med-efficiency			
	boilers	50	80	94
	other	80	90	97
012	Electrostatic precipitator - low-efficiency			
	boilers	40	70	90
	other	70	80	90
014	Mist eliminator - high velocity >250 FPM	10	75	90
015	Mist eliminator - low velocity <250 FPM	5	40	75

Table B.2-3 (cont.).

AIRS Code[b]	Type Of Collector	Particle Size (μm)		
		0 - 2.5	2.5 - 6	6 - 10
016	Fabric filter - high temperature	99	99.5	99.5
017	Fabric filter - med temperature	99	99.5	99.5
018	Fabric filter - low temperature	99	99.5	99.5
046	Process change	NA	NA	NA
049	Liquid filtration system	50	75	85
050	Packed-gas absorption column	90	95	99
051	Tray-type gas absorption column	25	85	95
052	Spray tower	20	80	90
053	Venturi scrubber	90	95	99
054	Process enclosed	1.5	3.2	3.7
055	Impingement plate scrubber	25	95	99
056	Dynamic separator (dry)	90	95	99
057	Dynamic separator (wet)	50	75	85
058	Mat or panel filter - mist collector	92	94	97
059	Metal fabric filter screen	10	15	20
061	Dust suppression by water sprays	40	65	90
062	Dust suppression by chemical stabilizer or wetting agents	40	65	90
063	Gravel bed filter	0	5	80
064	Annular ring filter	80	90	97
071	Fluid bed dry scrubber	10	20	90
075	Single cyclone	10	35	50
076	Multiple cyclone w/o fly ash reinjection	80	95	95
077	Multiple cyclone w/fly ash reinjection	50	75	85
085	Wet cyclonic separator	50	75	85
086	Water curtain	10	45	90

[a] Data represent an average of actual efficiencies. Efficiencies are representative of well designed and well operated control equipment. Site-specific factors (e. g., type of particulate being collected, varying pressure drops across scrubbers, maintenance of equipment, etc.) will affect collection efficiencies. Efficiencies shown are intended to provide guidance for estimating control equipment performance when source-specific data are not available. NA = not applicable.

[b] Control codes in Aerometric Information Retrieval System (AIRS), formerly National Emissions Data Systems.

References For Appendix B.2

1. Fine Particle Emission Inventory System, Office Of Research And Development, U. S. Environmental Protection Agency, Research Triangle Park, NC, 1985.

2. Confidential test data from various sources, PEI Associates, Inc., Cincinnati, OH, 1985.

3. *Final Guideline Document: Control Of Sulfuric Acid Production Units*, EPA-450/2-77-019, U. S. Environmental Protection Agency, Research Triangle Park, NC, 1977.

4. *Air Pollution Emission Test, Bunge Corp., Destrehan, LA*, EMB-74-GRN-7, U. S. Environmental Protection Agency, Research Triangle Park, NC, 1974.

5. I. W. Kirk, "Air Quality In Saw And Roller Gin Plants", *Transactions Of The ASAE*, 20:5, 1977.

6. *Emission Test Report, Lightweight Aggregate Industry. Galite Corp.*, EMB- 80-LWA-6, U. S. Environmental Protection Agency, Research Triangle Park, NC, 1982.

7. *Air Pollution Emission Test, Lightweight Aggregate Industry, Texas Industries, Inc.*, EMB-80-LWA-3, U. S. Environmental Protection Agency, Research Triangle Park, NC, 1975.

8. *Air Pollution Emission Test, Empire Mining Company, Palmer, Michigan*, EMB-76-IOB-2, U. S. Environmental Protection Agency, Research Triangle Park, NC, 1975.

9. H. J. Taback, *et al*., *Fine Particulate Emissions From Stationary Sources In The South Coast Air Basin*, KVB, Inc., Tustin, CA, 1979.

10. K. Rosbury, *Generalized Particle Size Distributions For Use In Preparing Particle Size-Specific Emission Inventories*, U. S. EPA Contract No. 68-02-3890, PEI Associates, Inc., Golden, CO, 1985.

13.2.2 Unpaved Roads

13.2.2.1 General

When a vehicle travels an unpaved road, the force of the wheels on the road surface causes pulverization of surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed.

The particulate emission factors presented in the previous draft version of this section of AP-42, dated October 2001, implicitly included the emissions from vehicles in the form of exhaust, brake wear, and tire wear as well as resuspended road surface material[25]. EPA included these sources in the emission factor equation for unpaved public roads (equation 1b in this section) 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 unpaved public road emission factor equation only estimates particulate emissions from resuspended road surface material [23, 26]. The particulate emissions from vehicle exhaust, brake wear, and tire wear are now estimated separately using EPA's MOBILE6.2 [24]. 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 MOBILE6.2 to estimate particulate emissions from vehicle traffic on unpaved public roads. It also incorporates the decrease in exhaust emissions that has occurred since the unpaved public road emission factor equation was developed. The previous version of the unpaved public 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.

13.2.2.2 Emissions Calculation And Correction Parameters[1-6]

The quantity of dust emissions from a given segment of unpaved road varies linearly with the volume of traffic. Field investigations also have shown that emissions depend on source parameters that characterize the condition of a particular road and the associated vehicle traffic. Characterization of these source parameters allow for "correction" of emission estimates to specific road and traffic conditions present on public and industrial roadways.

Dust emissions from unpaved roads have been found to vary directly with the fraction of silt (particles smaller than 75 micrometers [µm] in diameter) in the road surface materials.[1] The silt fraction is determined by measuring the proportion of loose dry surface dust that passes a 200-mesh screen, using the ASTM-C-136 method. A summary of this method is contained in Appendix C of AP-42. Table 13.2.2-1 summarizes measured silt values for industrial unpaved roads. Table 13.2.2-2 summarizes measured silt values for public unpaved roads. It should be noted that the ranges of silt content vary over two orders of magnitude. Therefore, the use of data from this table can potentially introduce considerable error. Use of this data is strongly discouraged when it is feasible to obtain locally gathered data.

Since the silt content of a rural dirt road will vary with geographic location, it should be measured for use in projecting emissions. As a conservative approximation, the silt content of the parent soil in the area can be used. Tests, however, show that road silt content is normally lower than in the surrounding parent soil, because the fines are continually removed by the vehicle traffic, leaving a higher percentage of coarse particles.

Other variables are important in addition to the silt content of the road surface material. For example, at industrial sites, where haul trucks and other heavy equipment are common, emissions are highly correlated with vehicle weight. On the other hand, there is far less variability in the weights of cars and pickup trucks that commonly travel publicly accessible unpaved roads throughout the United States. For those roads, the moisture content of the road surface material may be more dominant in determining differences in emission levels between, for example a hot, desert environment and a cool, moist location.

The PM-10 and TSP emission factors presented below are the outcomes from stepwise linear regressions of field emission test results of vehicles traveling over unpaved surfaces. Due to a limited amount of information available for PM-2.5, the expression for that particle size range has been scaled against the result for PM-10. Consequently, the quality rating for the PM-2.5 factor is lower than that for the PM-10 expression.

Table 13.2.2-1. TYPICAL SILT CONTENT VALUES OF SURFACE MATERIAL ON INDUSTRIAL UNPAVED ROADS[a]

Industry	Road Use Or Surface Material	Plant Sites	No. Of Samples	Silt Content (%)	
				Range	Mean
Copper smelting	Plant road	1	3	16 - 19	17
Iron and steel production	Plant road	19	135	0.2 - 19	6.0
Sand and gravel processing	Plant road	1	3	4.1 - 6.0	4.8
	Material storage area	1	1	-	7.1
Stone quarrying and processing	Plant road	2	10	2.4 - 16	10
	Haul road to/from pit	4	20	5.0-15	8.3
Taconite mining and processing	Service road	1	8	2.4 - 7.1	4.3
	Haul road to/from pit	1	12	3.9 - 9.7	5.8
Western surface coal mining	Haul road to/from pit	3	21	2.8 - 18	8.4
	Plant road	2	2	4.9 - 5.3	5.1
	Scraper route	3	10	7.2 - 25	17
	Haul road (freshly graded)	2	5	18 - 29	24
Construction sites	Scraper routes	7	20	0.56-23	8.5
Lumber sawmills	Log yards	2	2	4.8-12	8.4
Municipal solid waste landfills	Disposal routes	4	20	2.2 - 21	6.4

[a]References 1,5-15.

The following empirical expressions may be used to estimate the quantity in pounds (lb) of size-specific particulate emissions from an unpaved road, per vehicle mile traveled (VMT):

For vehicles traveling on unpaved surfaces at industrial sites, emissions are estimated from the following equation:

$$E = k\,(s/12)^a (W/3)^b \qquad (1a)$$

and, for vehicles traveling on publicly accessible roads, dominated by light duty vehicles, emissions may be estimated from the following:

$$E = \frac{k\,(s/12)^a (S/30)^d}{(M/0.5)^c} - C \qquad (1b)$$

where k, a, b, c and d are empirical constants (Reference 6) given below and

E = size-specific emission factor (lb/VMT)
s = surface material silt content (%)
W = mean vehicle weight (tons)
M = surface material moisture content (%)
S = mean vehicle speed (mph)
C = emission factor for 1980's vehicle fleet exhaust, brake wear and tire wear.

The source characteristics s, W and M are referred to as correction parameters for adjusting the emission estimates to local conditions. The metric conversion from lb/VMT to grams (g) per vehicle kilometer traveled (VKT) is as follows:

1 lb/VMT = 281.9 g/VKT

The constants for Equations 1a and 1b based on the stated aerodynamic particle sizes are shown in Tables 13.2.2-2 and 13.2.2-4. The PM-2.5 particle size multipliers (k-factors) are taken from Reference 27.

Table 13.2.2-2. CONSTANTS FOR EQUATIONS 1a AND 1b

Constant	Industrial Roads (Equation 1a)			Public Roads (Equation 1b)		
	PM-2.5	PM-10	PM-30*	PM-2.5	PM-10	PM-30*
k (lb/VMT)	0.15	1.5	4.9	0.18	1.8	6.0
a	0.9	0.9	0.7	1	1	1
b	0.45	0.45	0.45	-	-	-
c	-	-	-	0.2	0.2	0.3
d	-	-	-	0.5	0.5	0.3
Quality Rating	B	B	B	B	B	B

*Assumed equivalent to total suspended particulate matter (TSP)
"-" = not used in the emission factor equation

Table 13.2.2-2 also contains the quality ratings for the various size-specific versions of Equation 1a and 1b. The equation retains the assigned quality rating, if applied within the ranges of source conditions, shown in Table 13.2.2-3, that were tested in developing the equation:

Table 13.2.2-3. RANGE OF SOURCE CONDITIONS USED IN DEVELOPING EQUATION 1a AND 1b

Emission Factor	Surface Silt Content, %	Mean Vehicle Weight		Mean Vehicle Speed		Mean No. of Wheels	Surface Moisture Content, %
		Mg	ton	km/hr	mph		
Industrial Roads (Equation 1a)	1.8-25.2	1.8-260	2-290	8-69	5-43	4-17[a]	0.03-13
Public Roads (Equation 1b)	1.8-35	1.4-2.7	1.5-3	16-88	10-55	4-4.8	0.03-13

[a] See discussion in text.

As noted earlier, the models presented as Equations 1a and 1b were developed from tests of traffic on unpaved surfaces. Unpaved roads have a hard, generally nonporous surface that usually dries quickly after a rainfall or watering, because of traffic-enhanced natural evaporation. (Factors influencing how fast a road dries are discussed in Section 13.2.2.3, below.) The quality ratings given above pertain to the mid-range of the measured source conditions for the equation. A higher mean vehicle weight and a higher than normal traffic rate may be justified when performing a worst-case analysis of emissions from unpaved roads.

The emission factors for the exhaust, brake wear and tire wear of a 1980's vehicle fleet (*C*) was obtained from EPA's MOBILE6.2 model [23]. The emission factor also varies with aerodynamic size range as shown in Table 13.2.2-4

Table 13.2.2-4. EMISSION FACTOR FOR 1980'S VEHICLE FLEET EXHAUST, BRAKE WEAR AND TIRE WEAR

Particle Size Range[a]	*C*, Emission Factor for Exhaust, Brake Wear and Tire Wear[b] lb/VMT
$PM_{2.5}$	0.00036
PM_{10}	0.00047
PM_{30}[c]	0.00047

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

[b] Units shown are pounds per vehicle mile traveled (lb/VMT).

[c] PM-30 is sometimes termed "suspendable particulate" (SP) and is often used as a surrogate for TSP.

It is important to note that the vehicle-related source conditions refer to the average weight, speed, and number of wheels for all vehicles traveling the road. For example, if 98 percent of traffic on the road are 2-ton cars and trucks while the remaining 2 percent consists of 20-ton trucks, then the mean weight is 2.4 tons. More specifically, Equations 1a and 1b are *not* intended to be used to calculate a separate emission factor for each vehicle class within a mix of traffic on a given unpaved road. That is, in the example, one should *not* determine one factor for the 2-ton vehicles and a second factor for the 20-ton trucks. Instead, only one emission factor should be calculated that represents the "fleet" average of 2.4 tons for all vehicles traveling the road.

Moreover, to retain the quality ratings when addressing a group of unpaved roads, it is necessary that reliable correction parameter values be determined for the road in question. The field and laboratory procedures for determining road surface silt and moisture contents are given in AP-42 Appendices C.1 and C.2. Vehicle-related parameters should be developed by recording visual observations of traffic. In some cases, vehicle parameters for industrial unpaved roads can be determined by reviewing maintenance records or other information sources at the facility.

In the event that site-specific values for correction parameters cannot be obtained, then default values may be used.In the absence of site-specific silt content information, an appropriate mean value from Table 13.2.2-1 may be used as a default value, but the quality rating of the equation is reduced by two letters. Because of significant differences found between different types of road surfaces and between different areas of the country, use of the default moisture content value of 0.5 percent in Equation 1b is discouraged. The quality rating should be downgraded two letters when the default moisture content value is used. (It is assumed that readers addressing industrial roads have access to the information needed to develop average vehicle information in Equation 1a for their facility.)

The effect of routine watering to control emissions from unpaved roads is discussed below in Section 13.2.2.3, "Controls". However, all roads are subject to some natural mitigation because of rainfall and other precipitation. The Equation 1a and 1b emission factors can be extrapolated to annual average uncontrolled conditions (but including natural mitigation) under the simplifying assumption that annual average emissions are inversely proportional to the number of days with measurable (more than 0.254 mm [0.01 inch]) precipitation:

$$E_{ext} = E\ [(365 - P)/365] \qquad (2)$$

where:

E_{ext} = annual size-specific emission factor extrapolated for natural mitigation, lb/VMT

E = emission factor from Equation 1a or 1b

P = number of days in a year with at least 0.254 mm (0.01 in) of precipitation (see below)

Figure 13.2.2-1 gives the geographical distribution for the mean annual number of "wet" days for the United States.

Equation 2 provides an estimate that accounts for precipitation on an annual average basis for the purpose of inventorying emissions. It should be noted that Equation 2 does not account for differences in the temporal distributions of the rain events, the quantity of rain during any event, or the potential for the rain to evaporate from the road surface. In the event that a finer temporal and spatial resolution is desired for inventories of public unpaved roads, estimates can be based on a more complex set of assumptions. These assumptions include:

1. The moisture content of the road surface material is increased in proportion to the quantity of water added;
2. The moisture content of the road surface material is reduced in proportion to the Class A pan evaporation rate;
3. The moisture content of the road surface material is reduced in proportion to the traffic volume; and
4. The moisture content of the road surface material varies between the extremes observed in the area. The CHIEF Web site (http://www.epa.gov/ttn/chief/ap42/ch13/related/c13s02-2.html) has a file which contains a spreadsheet program for calculating emission factors which are temporally and spatially resolved. Information required for use of the spreadsheet program includes monthly Class A pan evaporation values, hourly meteorological data for precipitation, humidity and snow cover, vehicle traffic information, and road surface material information.

It is emphasized that <u>the simple assumption underlying Equation 2 and the more complex set of assumptions underlying the use of the procedure which produces a finer temporal and spatial resolution</u> have not been verified in any rigorous manner. For this reason, the quality ratings for either approach should be downgraded one letter from the rating that would be applied to Equation 1.

13.2.2.3 Controls[18-22]

A wide variety of options exist to control emissions from unpaved roads. Options fall into the following three groupings:

1. <u>Vehicle restrictions</u> that limit the speed, weight or number of vehicles on the road;

2. Surface improvement, by measures such as (a) paving or (b) adding gravel or slag to a dirt road; and

3. Surface treatment, such as watering or treatment with chemical dust suppressants.

Available control options span broad ranges in terms of cost, efficiency, and applicability. For example, traffic controls provide moderate emission reductions (often at little cost) but are difficult to enforce. Although paving is highly effective, its high initial cost is often prohibitive. Furthermore, paving is not feasible for industrial roads subject to very heavy vehicles and/or spillage of material in transport. Watering and chemical suppressants, on the other hand, are potentially applicable to most industrial roads at moderate to low costs. However, these require frequent reapplication to maintain an acceptable level of control. Chemical suppressants are generally more cost-effective than water but not in cases of temporary roads (which are common at mines, landfills, and construction sites). In summary, then, one needs to consider not only the type and volume of traffic on the road but also how long the road will be in service when developing control plans.

Vehicle restrictions. These measures seek to limit the amount and type of traffic present on the road or to lower the mean vehicle speed. For example, many industrial plants have restricted employees from driving on plant property and have instead instituted bussing programs. This eliminates emissions due to employees traveling to/from their worksites. Although the heavier average vehicle weight of the busses increases the base emission factor, the decrease in vehicle-miles-traveled results in a lower overall emission rate.

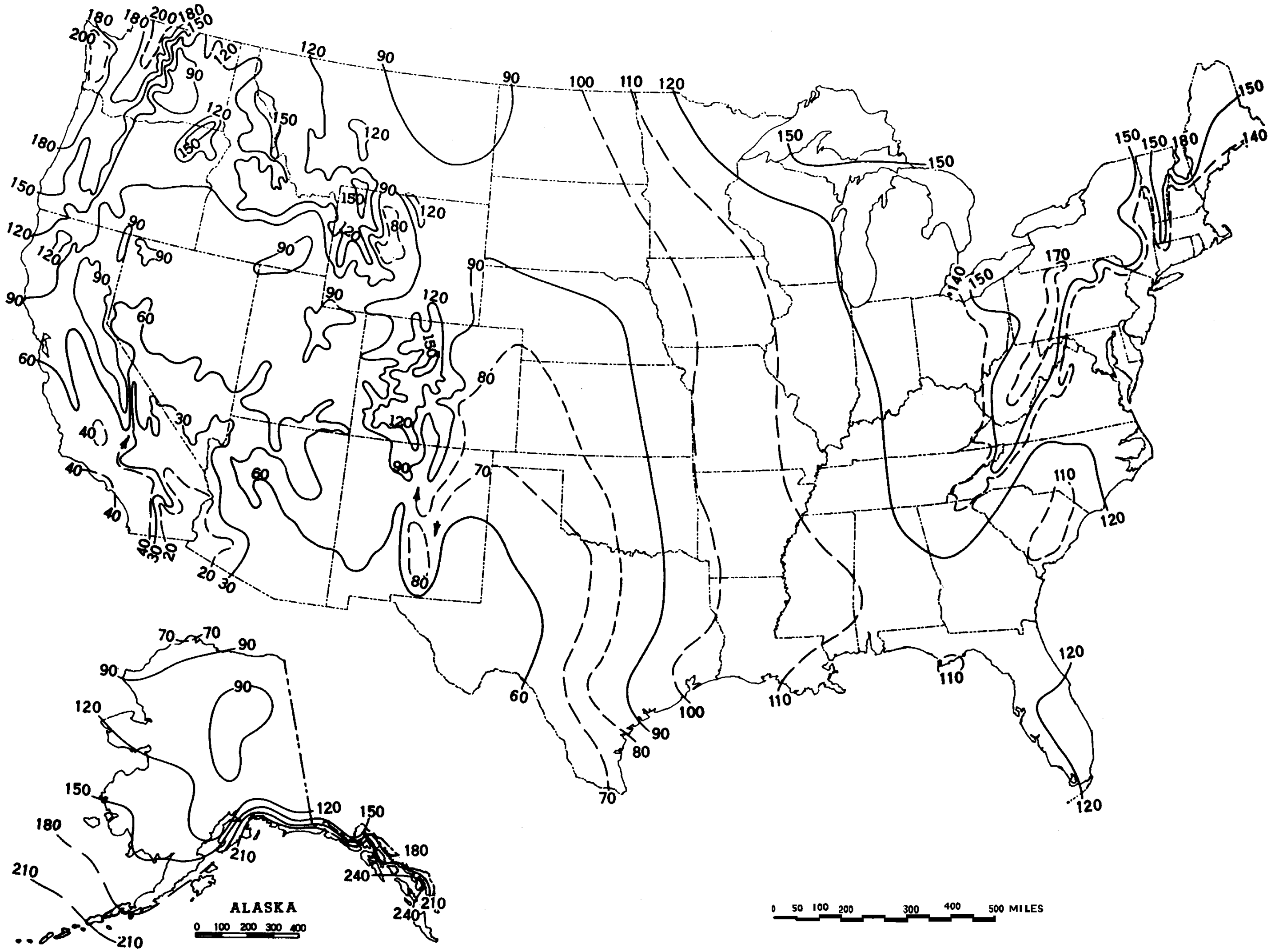


Figure 13.2.2-1. Mean number of days with 0.01 inch or more of precipitation in United States.

Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors

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MRI Project No. 110397

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Responses to Comments Received on Proposed AP-42 Revisions

Commenter and Date	Source Category	Comment	Response
John Hayden, National Stone, Sand and Gravel Association (NSSGA); June 14, 2006	Unpaved Roads	NSSGA-sponsored tests (report dated Oct. 15, 2004) at California aggregate producing plants support the proposed fine fractions.	This comment reference a test report prepared by Air Control Techniques for the National Stone, Sand & Gravel Association, dated October 4, 2004. The report gives the results of tests to determine unpaved road emissions factors for controlled (wet suppression only) haul roads at two aggregate processing plants. A variation of the plume profiling method using TEOM continuous monitors with PM-2.5 and PM-10 inlets was employed. Tests with road surface moisture content below 1.5 percent were considered to be uncontrolled. Based on the example PM-10 concentration profiles presented in the report, the maximum roadside PM-10 dust concentrations in the subject study were in the range of 300 micrograms per cubic meter. This is an order of magnitude lower than the concentrations typically found in other unpaved road emission factor studies. For the range of plume concentrations measured in the NSSGA-sponsored test program, an average fine fraction (PM-2.5/PM-10 ratio) of 0.15 was reported. This fine fraction value is consistent with the results of the MRI dust tunnel testing in the same concentration range. At plume concentrations more typical of unpaved road emission factor studies, the proposed value of 0.1 is applicable. There is no need for any revisions to the proposed changes to AP-42 as a result of the cited study.
Hao Quinn, Sacramento Metro AQMD; July 20, 2006	Paved vs. unpaved roads	For a particular industrial facility, the PM-10 emission factor equations show higher emissions from paved roads rather than unpaved roads.	***This comment does not relate to the proposed changes to the fine particle fractions***. It is possible that the emissions from a heavily loaded paved road can exceed emissions from an unpaved road with a low-to-moderate silt content at the same industrial facility, even if traveled by the same vehicles. This is the case in the cited example, for which the paved road silt loading is 70 g/m^2.

Commenter and Date	Source Category	Comment	Response
Brian Leahy, Horizon Environmental; July 26, 2006	Unpaved roads	The k value for PM-2.5 does not appear to have changed in the proposed revision.	The latest (2003) approved AP-42 k values for PM-2.5 in Table 13.2.2-2 are 0.23 and 0.27 lb/VMT for industrial and public roads, respectively. The proposed values are 0.15 and 0.18 lb/VMT, which are equivalent to 10 percent of the respective k values for PM-10. There is no need for revisions to the proposed changes to AP-42 as a result of this comment.
Shengxin Jin, NYSDOT Environmental Analysis Bureau; undated	Paved roads	The conversion of proposed k values from g/VMT to g/VKT does not appear correct	Regarding the revised k values for PM-2.5, when the k value of 0.66 g/VKT is multiplied by 1.6 km/mi, it becomes 1.06 g/VMT, which rounds to 1.1 g/VKT given in the proposed revision. Because the k values are given only to two significant figures, the converted values can vary by up to five digits in the second figure, depending on which direction the units conversion is made. For example, when k value of 1.1 g/VKT is divided by 1.6 km/mi, the resulting value rounds to 0.69 g/VKT, but if 1.06 g/VKT is divided by 1.6 km/mi, the resulting value rounds to 0.66 g/VKT. There is no need for revisions to the proposed changes to AP-42 as a result of this comment.
		The stated silt loading impact of antiskid abrasive does not appear correct	***This comment does not relate to the proposed changes to the fine particle fractions***. The commenter is correct in that 500 lb/mi of antiskid abrasive with a 1% silt content produces a silt loading in the range of 0.5 g/m^2 rather than 2 g/m^2. EPA may elect to make a separate modification to correct this discrepancy at a later time.

Proposed Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors

ABSTRACT

A number of fugitive dust studies have indicated that the $PM_{2.5}$ / PM_{10} ratios measured by US EPA federal reference method (FRM) samplers are significantly lower than predicted by AP-42 emission factors. As a result, the $PM_{2.5}$ emission estimates are biased high. The controlled exposure study described in this report was conducted to compare fine fraction ratios derived from FRM samplers to those derived from the cyclone/impactor method that had been used to develop AP-42 emission factors for fugitive dust sources. The study was conducted by the Midwest Research Institute using the same cyclone/impactor samplers and operating method that generated the original AP-42 emission factors and associated $PM_{2.5}$ / PM_{10} ratios. This study was sponsored by the Western Regional Air Partnership.

The study found that concentration measurements used to develop $PM_{2.5}$ emission factors in AP-42 were biased high by a factor of two, as compared to $PM_{2.5}$ measurements from FRM samplers. This factor-of-two bias helps to explain why researchers have often seen a discrepancy in the proportion of fugitive dust found in $PM_{2.5}$ emission inventories and modeled ambient air impacts, as compared to the proportion on ambient filter samples. This study also shows that the $PM_{2.5}$ / PM_{10} ratios for fugitive dust should be in the range of 0.1 to 0.15. Currently, the ratios in AP-42 range from 0.15 to 0.4 for most fugitive dust sources.

It is recommended that the results of this study be used to revise the AP-42 $PM_{2.5}$ emission factors for the following four fugitive dust source categories: paved roads, unpaved roads (public and industrial), aggregate handling and storage piles, and industrial wind erosion (AP-42 Sections 13.2.1, 13.2.2, 13.2.4, & 13.2.5, respectively). Emission estimates for other fugitive dust producing activities, such as construction and demolition will also be affected since they are based on these four source categories.

INTRODUCTION

The Dust Emissions Joint Forum (DEJF) of the Western Regional Air Partnership (WRAP) is engaged in gathering and improving data pertaining to the $PM_{2.5}$ and PM_{10} components of fugitive dust emissions. Most of the $PM_{2.5}$ emission factors in EPA's AP-42 guidance for fugitive dust sources (USEPA, 2005) were determined by using high-volume samplers, each fitted with a cyclone precollector and cascade impactor. Typically, AP-42 recommends that $PM_{2.5}$ emission factors for dust sources be calculated by using PM_{10} emission factor equations along with $PM_{2.5}/PM_{10}$ ratios that have been published by EPA in AP-42.

Beginning with the introduction of the cyclone/impactor method, it was realized particle bounce from the cascade impactor stages to the backup filter may have resulted in inflated $PM_{2.5}$ concentrations, even though steps were taken to minimize particle bounce. This led to an EPA-funded field study in the late 1990s (MRI, 1997) to gather comparative particle sizing data in dust plumes downwind of paved and unpaved roads around the country. The test results indicated that dichotomous samplers produced consistently lower $PM_{2.5}/PM_{10}$ ratios than generated with the cyclone/impactor system. Dichotomous samplers are federal reference method (FRM) samplers that are used to measure compliance with federal air quality standards for particulate matter measured as $PM_{2.5}$ and PM_{10}. Pending the eventual collection of additional data, the decision was made that the true ratios would best be represented by an averaging of the cyclone/impactor data with the dichotomous sampler data.

Based on the results of the EPA-funded field program, modifications were made to the appropriate sections of AP-42 for dust emissions from paved and unpaved roads. The $PM_{2.5}/PM_{10}$ ratio for emissions from unpaved roads (dominated by fugitive dust) was reduced from 0.26 to 0.15, and the $PM_{2.5}/PM_{10}$ ratio for the dust component of emissions from paved roads was reduced from 0.46 to 0.25. In the 2003 revision to AP-42, the non-dust component of paved road emissions was assigned a $PM_{2.5}/PM_{10}$ ratio of 0.76, accounting for vehicle exhaust and brake and tire wear.

Subsequent to the modifications of the $PM_{2.5}/PM_{10}$ ratios in AP-42, additional field test results (mostly from ambient air samplers) indicated that further reductions to the ratios were warranted (Pace, 2005). For example, ambient air monitoring data suggested that the fine fraction dust mass is of the order of 10 percent of the PM_{10} mass, based on chemical fingerprinting of the collected fine and coarse fractions of PM_{10} impacted by dust sources. It is important to note, however, that particle size data applicable to fugitive dust emission factors should be gathered either from the emissions plume or near the point where emissions are generated (within 10 m of the downwind edge of the source).

METHODOLOGY

This led DEJF to fund Midwest Research Institute (MRI) in conducting a controlled study of particle sizing in dust plumes. The objective of the study was to resolve the fine particle bias in the cyclone/impactor system, so that reliable $PM_{2.5}/PM_{10}$ ratios could be developed for as many dust source categories as possible. For this purpose, an air exposure chamber connected to a recirculating supply air stream was used in conjunction with a fluidization system for generating well-mixed dust plumes from a variety of western soils and road surface materials. R&P Model 2000 Partisol samplers were selected as the ground-truthing FRM samplers for PM_{10} and $PM_{2.5}$.

This study was performed in two phases (see below), as described in the attached test report (Cowherd and Donaldson, 2005). The test report serves as the background document to support the recommended revisions to AP-42, and it contains all the quality assurance procedures and results of the testing.

Phase I – Compare $PM_{2.5}$ Measured by Cyclone/Impactor to FRM Sampler

In the first testing phase of the project, $PM_{2.5}$ measurements using the high-volume cascade impactors were compared to simultaneous measurements obtained with EPA FRM samplers for $PM_{2.5}$. As stated above, these tests were conducted in a flow-through wind tunnel and exposure chamber, where the PM_{10} concentration level and uniformity were controlled. The results of the tests provided the basis for quantifying more effectively any sampling bias associated with the cascade impactor system.

Phase 2 – Compare $PM_{2.5}$ to PM_{10} Ratios for Different Geologic Soils

With the same test setup, a second phase of testing was performed with reference method samplers, for the purpose of measuring $PM_{2.5}$ to PM_{10} ratios for fugitive dust from different geologic sources in the West. This testing provided needed information on the magnitude and variability of this ratio, especially for source materials that are recognized as problematic with regard to application of mitigative dust control measures.

RESULTS

The tests that were performed are listed in Tables 6 and 7 of the attached report. The Phase I tests were performed in March and April of 2005. The Phase II tests were performed in June through August of 2005. A total of 100 individual tests were performed, including 17 blank runs (for quality assurance purposes). The raw and intermediate test data are summarized in the tables presented in Appendix A of the attached report.

Based on the 100 wind tunnel tests that were performed in the wind tunnel study, the findings support the following conclusions:

1. $PM_{2.5}$ concentrations measured by the high-volume cyclone/impactor system used to develop AP-42 emission factors for fugitive dust sources have a positive bias by a factor of 2, as compared to the $PM_{2.5}$ concentration measurements from reference-method samplers (see Figure 1). The geometric mean bias is 2.01 and the arithmetic mean bias is 2.15.
2. The $PM_{2.5}$ bias associated with the cyclone/impactor system, as measured under controlled laboratory conditions with dust concentrations held at nearly steady values, closely replicates the bias observed in the prior EPA-funded field study at distributed geographic locations across the country.

3. The $PM_{2.5}/PM_{10}$ ratios measured by the FRM samplers in the current study for a variety of western soils show a decrease in magnitude with increasing PM_{10} concentration (see Figure 2). Soils with a nominally spherical shape are observed to have somewhat lower ratios (at given PM_{10} concentrations) than soils with angular shape. A very similar dependence of $PM_{2.5}/PM_{10}$ ratio on PM_{10} concentration was also observed in the prior field study that used dichotomous samplers as FRM devices.
4. The test data from the current study support a $PM_{2.5}/PM_{10}$ ratio in the range of 0.1 to 0.15 for typical uncontrolled fugitive dust sources (see Figure 2). The $PM_{2.5}/PM_{10}$ ratio of 0.1 is also supported by numerous other studies including the prior EPA-funded field study that used dichotomous samplers as reference devices. It is possible that a ratio as low as 0.05 (as was found in the prior field tests of unpaved road emission factors) might be appropriate for very dusty sources, but this would require extrapolation of the current test data from the wind tunnel study.

DISCUSSION

Peer Review

The test report on the wind tunnel study (Cowherd and Donaldson, 2005) was issued first in draft form for external peer review. Three peer reviewers (having no prior contact with the study) were selected by the DEJF: Patrick Gaffney (California Air Resources Board), John Kinsey (U.S. Environmental Protection Agency), and Mel Zeldin (Private Consultant). In addition, peer review comments were provided by Duane Ono (Great Basin UAPCD) and Richard Countess (Countess Environmental) who helped to develop this study. After the review comments on the draft test report were received, comment/ response logs were prepared by MRI, listing each comment and the response to each comment. The next step was to modify the draft test report in accordance with the responses to the review comments. The final test report was issued on October 12, 2005.

Recommended Particle Size Ratios

Based on the results of the WRAP/DEJF study (see attached test report) and the prior EPA-funded field study, it is proposed that new $PM_{2.5}/PM_{10}$ ratios be adopted for several categories of (uncontrolled) fugitive dust sources, as addressed in AP-42. The proposed ratios (given to the nearest 0.05) are summarized in Table 1. It should be noted that these fine fraction ratios and the emission factors could change in the future if field studies show other differences than those identified through this study.

The proposed $PM_{2.5}/PM_{10}$ ratios in Table 1, apply to dry surface materials, having moisture contents in the range of 1% or less. Such materials when exposed to energetic disturbances produce dust plumes with core PM_{10} concentrations in the range of 5,000 micrograms per cubic meter, near the point of emissions generation. The wind tunnel test data show that dust plumes with lower core concentrations have higher $PM_{2.5}/PM_{10}$

ratios. This might occur, for example, at higher soil (or other surface material) moisture contents. However, the emissions from such sources typically are substantially lower with correspondingly less impact on the ambient environment.

Table 1. Proposed Particle Size Ratios for AP-42

Fugitive dust source category	AP-42 section	$PM_{2.5}/PM_{10}$ Ratio	
		Current	Proposed
Paved Roads	13.2.1	0.25	0.15
Unpaved Roads (Public & Industrial)	13.2.2	0.15	0.1
Construction & Demolition	–	0.208 [1]	0.1
Aggregate Handling & Storage Piles	13.2.4	0.314	0.1 (traffic) 0.15 (transfer)
Industrial Wind Erosion	13.2.5	0.40	0.15
Agricultural Tilling	–	0.222 [2]	0.2 (no change)
Open Area Wind Erosion	–	-	0.15

Notes:

[1] AP-42 Section 13.2.3 suggests using emission factors for individual dust producing activities, e.g., materials handling and unpaved roads. The WRAP Fugitive Dust Handbook recommends using a fine fraction ratio of 0.208 from a report prepared for the US EPA, Estimating Particulate Matter Emissions from Construction Operations (MRI, 1999).

[2] Agricultural tilling was dropped from the 5th edition of AP-42. The WRAP Fugitive Dust Handbook recommends using a fine fraction ratio of 0.222 from Section 7.4 of the California Air Resources Board's Emission Inventory Methodology (CARB, 2003).

The justification for each proposed ratio in Table 1 is provided by source category in the sections below. In each case, reference is made to test reports that contain supporting data.

Paved Roads

For the dust component of particulate emissions from paved roads, a $PM_{2.5}/PM_{10}$ ratio of 0.15 is recommended. The proposed ratio is based on the factor-of-two bias in the cyclone/impactor data for the wind tunnel study, which tested western soils and road surface materials. As shown in Table 1, the current AP-42 ratio is 0.25. It should be recalled that the nondust component of paved road particulate emissions has been assigned a much higher ratio of 0.76, based on inputs from the EPA's MOBILE 6 model.

Unpaved Roads

For the dust component of particulate emissions from unpaved roads, which dominates the total particulate emissions from this source category, a $PM_{2.5}/PM_{10}$ ratio of 0.1 is recommended. The proposed ratio is justified from the test results of the wind tunnel study for a variety of western surface materials. It is also consistent with the factor-of-two bias in the cyclone/impactor data from the wind tunnel study and with the results of the prior field study that used dichotomous samplers as FRM devices (MRI, 1997).

Construction and Demolition

The dust component of particulate emissions from construction and demolition dominate the total particulate emissions from this source category. A $PM_{2.5}/PM_{10}$ ratio of 0.1 is recommended for dust emissions from construction and demolition. The proposed ratio is justified by the fact that the dominant dust source associated with construction and demolition projects is emissions from vehicle travel over unpaved surfaces. This is shown by case studies that calculate particulate emissions from representative construction activities (road, building, and nonbuilding construction). For example, the fine fraction ratio for scraper travel averages about 0.2 (Muleski et al., 2005), before correcting for the factor-of- two bias in the cyclone/impactor system. Moreover this includes the diesel emissions that are contained within the fine fraction component.

It should be noted that if large open areas are disturbed (such as in land clearing) and left unprotected, and the areas are exposed to high winds, open area wind erosion can also be an important contributor to dust emissions from this source category. The recommended fine fraction ratio identified below should be used for the open area wind erosion component.

Aggregate Handling and Storage Piles

Although usually not a major source in comparison with traffic around storage piles, the transfer of aggregate associated with bucket loaders and unloaders or conveyor transfer points is addressed directly in this section of AP-42. A $PM_{2.5}/PM_{10}$ ratio of 0.15 is recommended for transfer operations. This is half the current value in AP-42 and reflects adjustment for the factor-of-two bias in the cyclone/impactor test results.

The dominant dust component of particulate emissions from aggregate handling and storage piles typically consists of loader and truck traffic around the storage piles. AP-42 refers the reader to the unpaved roads section to find appropriate emission factors. A $PM_{2.5}/PM_{10}$ ratio of 0.1 is recommended for this source. The proposed ratio is consistent with that recommended above for traffic on unpaved surfaces.

Industrial Wind Erosion

For the dust component of particulate emissions from industrial wind erosion, a $PM_{2.5}/PM_{10}$ ratio of 0.15 is recommended. Industrial wind erosion is associated with crushed aggregate materials, such as coal or metallic ore piles. Examples would include open storage piles at mining operations. The proposed ratio is justified by portable wind tunnel tests of industrial aggregate materials which produced $PM_{2.5}/PM_{10}$ ratios averaging 0.4, as indicated by the current AP-42 fine fraction ratio given in Table 1. When these results are corrected for the bias associated with the cyclone/impactor system at very high PM_{10} concentrations observed in the effluent from the portable wind tunnel (exceeding 10,000 $\mu g/m^3$), the result is 0.15.

Agricultural Tilling

For the dust component of particulate emissions from agricultural tilling and related land preparation activities, which dominates the total particulate emissions from this source category, no new $PM_{2.5}/PM_{10}$ ratio can be recommended at this time, because of the lack of published test data. However, the current factor of 0.2, as listed in Table 1, appears to be generally consistent with the results of the current wind tunnel tests. It was found that the agricultural soils tested in the wind tunnel produced slightly higher ratios than the other test materials. In addition, the dust plume core concentrations from agricultural operations are generally observed to be less intense because of the lower equipment speeds involved and the lack of repeated travel over the same routes.

Open Area Wind Erosion

For the dust component of particulate emissions from open area wind erosion (not currently addressed in AP-42), a $PM_{2.5}/PM_{10}$ ratio of 0.15 is recommended. Open area wind erosion is associated with exposed soils that have been disturbed, removing the protection afforded by natural crusting. Examples would include freshly tilled agricultural fields prior to planting of crops. The proposed ratio is justified by wind tunnel tests of exposed soils (MRI, 1994), which produced $PM_{2.5}/PM_{10}$ ratios averaging 0.3. When these results are corrected for the bias associated with the cyclone/impactor system, the ratio becomes 0.15. This is consistent with the $PM_{2.5}/PM_{10}$ ratios in the range of 0.12 measured during dust storms on Owens Dry Lake (Ono, 2005).

Specific Revisions to AP-42

This section presents a listing of specific revisions to AP-42, for the purpose of incorporating the proposed $PM_{2.5}/PM_{10}$ ratios. As shown in Table 2, five subsections of AP-42 Section 13.2, Fugitive Dust, are impacted by the proposed changes. However, one of the five sections (13.2.3, Heavy Construction Operations) is impacted only indirectly because it refers to other sections of AP-42 for fugitive dust emission factors.

In most cases, the change in the $PM_{2.5}/PM_{10}$ ratio is accomplished by changing the appropriate PM-2.5 particle size multiplier (k-factor) for the respective emission factor equation. In addition, the changes need to be referenced to the WRAP test report (Cowherd and Donaldson, 2005).

Table 2. Specific revisions to AP-42 that are incorporated into the AP-42 sections included in Attachment A.

Source category	Sub-section	Title	Revision	Comments
13.2.1 Paved Roads	13.2.1.3	*Predictive Emission Factor Equation*	In Table 13.2.1-1, reduce k values for PM-2.5 by 40 percent, e.g., the new value is 1.1 g/VMT (and equivalent values for the other units)	Add ref. number for WRAP test report
	13.2.1.5	*Changes since Fifth Edition*	Modify statement (1) to reflect change in fine fraction	
		References	Add WRAP test report as Ref. 22	
13.2.2 Unpaved Roads	13.2.2.2	*Emission Calculation and Correction Parameters*	In Table 13.2.2-2, reduce k values for PM-2.5 by 33%, e.g., the new value is 0.15 lb/VMT for industrial roads and 0.18 lb/VMT for public roads (and equivalent values for the other units)	Add ref. number for WRAP test report
	13.2.2.4	*Updates since Fifth Edition*	Add sentences describing change in fine fraction	
		References	Add WRAP test report	
13.2.3 Heavy Construction Operations	–	–	No changes required	Refers to other AP-42 sections for emission factors
13.2.4 Aggregate Handling and Storage Piles	13.2.4.3	*Predictive Emission Factor Equations*	In k-factor table for Equation 1 for transfer operations, change PM-2.5 multiplier to 0.053 (dimensionless)	Add ref. number for WRAP test report
		References	Add WRAP test report	
13.2.5 Industrial Wind Erosion	13.2.5.2	*Emissions and Correction Parameters*	In k-factor table for Equation 1, change PM-2.5 multiplier to 0.075 (dimensionless)	Add ref. number for WRAP test report
		References	Add WRAP test report	

CONCLUSION

This study found that concentration measurements used to develop $PM_{2.5}$ emission factors for AP-42 were biased high by a factor of two, as compared to $PM_{2.5}$ measurements from FRM samplers. This factor-of-two bias helps to explain why researchers have often seen a similar discrepancy in the proportion of fugitive dust found in $PM_{2.5}$ emission inventories and modeled ambient impacts, as compared to the proportion observed on ambient filter samples. This study also shows that the $PM_{2.5}$ / PM_{10} ratios for fugitive dust should be in the range of 0.1 to 0.15. Currently, the fine fraction ratios in AP-42 range from 0.15 to 0.4 for most fugitive dust sources.

It is recommended that the results of this study by used to revise the AP-42 $PM_{2.5}$ emission factors for the following four fugitive dust source categories: paved roads, unpaved roads (public and industrial), aggregate handling and storage piles, and industrial wind erosion (AP-42 Sections 13.2.1, 13.2.2, 13.2.4, & 13.2.5, respectively). Emission estimates for other fugitive dust producing activities, such as construction and demolition, will also be affected since they are based on these four source categories. It is recommended that revisions to the current AP-42 sections for these fugitive dust sources be adopted as shown in Attachment A to this report.

IMPLICATIONS

The proposed revisions to AP-42 are needed to ensure the most accurate $PM_{2.5}$ and PM_{10} fugitive dust emissions inventories that are possible for regional haze regulatory purposes, given the available resources and the significant contribution of fugitive dust to visibility impairment. In particular, the revisions will affect the quantity of dust apportioned to the fine ($PM_{2.5}$) versus coarse ($PM_{2.5\text{-}10}$) size modes, which have significantly different effects on visibility and long-range transport potentials. This will reduce $PM_{2.5}$ emission estimates for fugitive dust sources to about half their current level. It will also increase the coarse-mode size fraction for fugitive dust, which would be important in the event that a PM coarse standard is adopted by the US EPA and emission inventories are developed.

The revisions will be helpful in developing accurate emission inventories for PM nonattainment, maintenance, and action plan areas throughout the country. Finally, the proposed modifications to the fine fractions associated with EPA's AP-42 emission factors will ensure widespread availability of the most recent and accurate scientific information.

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Muleski, G. E., C. Cowherd, and J. S. Kinsey. 2005. "Particulate Emissions from Construction Activities," *J. Air & Waste Manage. Assoc.* **55:** 772-783. **[Summarizes field test results for emissions from major components of construction projects]**

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Figure 1. Phase I test results show that the Cyclone/ Impactor method measured $PM_{2.5}$ concentrations that were two times higher than those measured by Federal Reference Method samplers when simultaneously exposed to the well-mixed dust environment in the wind tunnel.

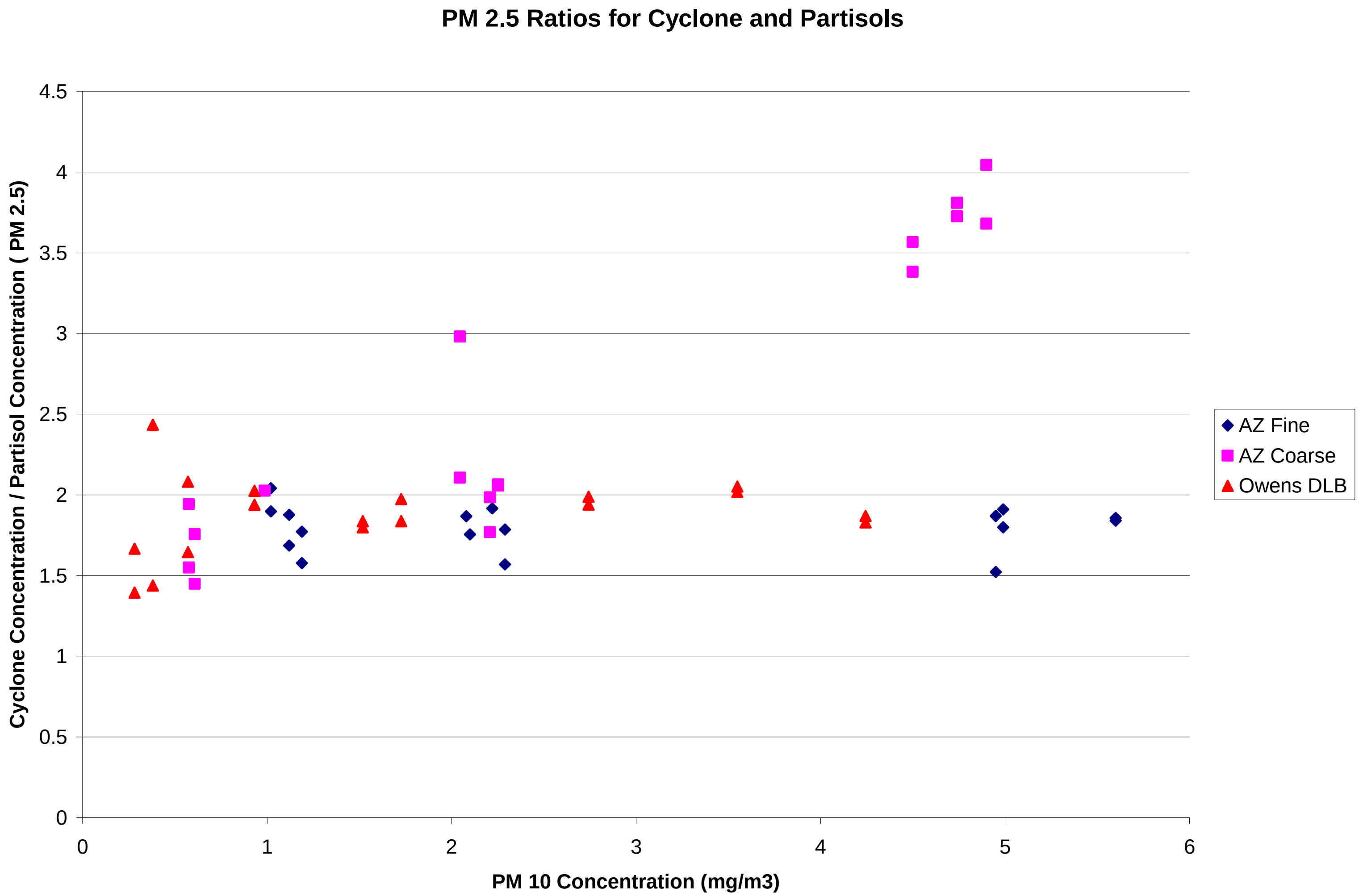
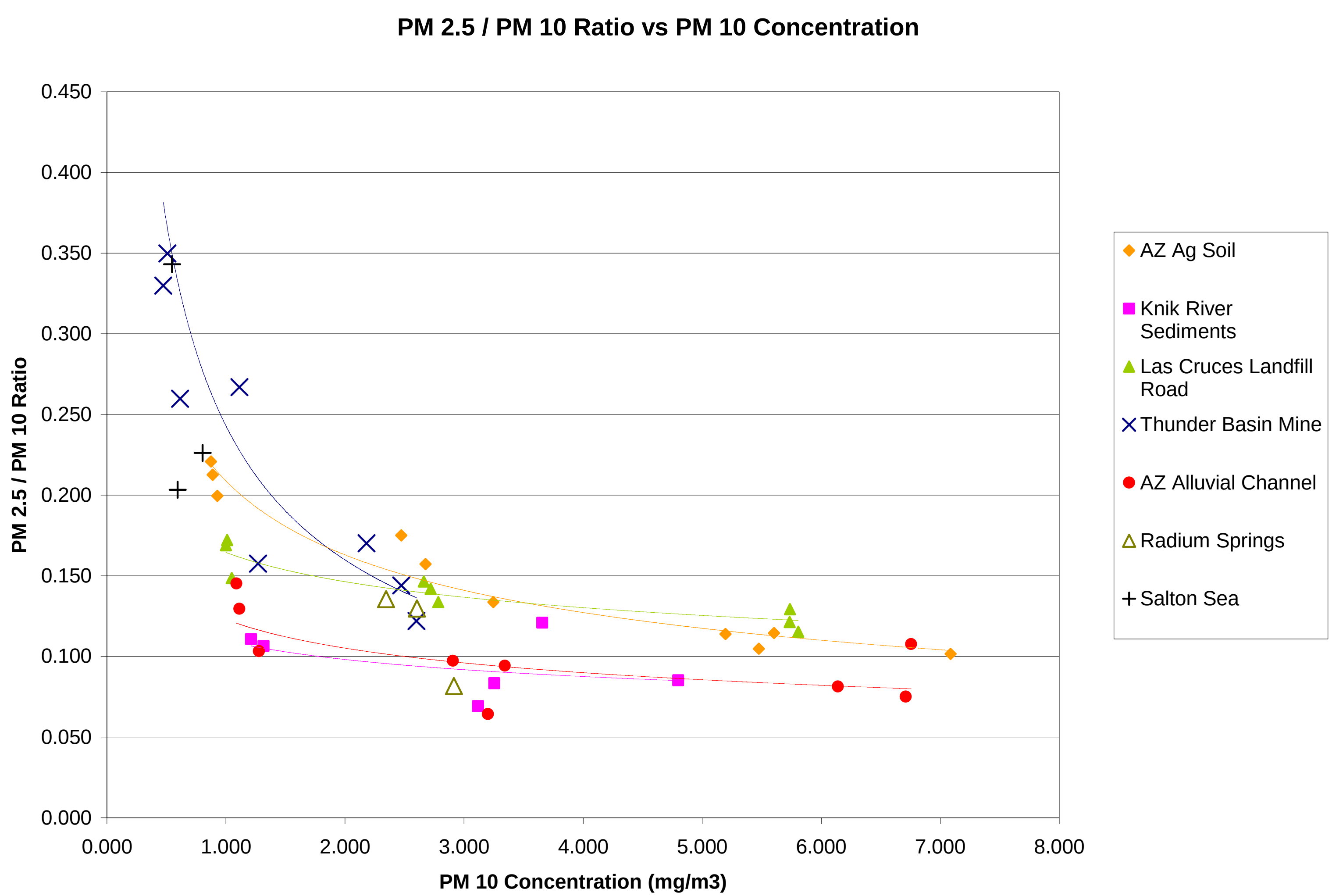


Figure 2. Phase II tests show that the $PM_{2.5}/PM_{10}$ ratio decreased with increasing PM concentrations, and could be expected to be in the range of 0.1 at concentrations that are typical of fugitive dust emission plumes.



Unpaved Road Surface Material Silt Content Values Used in the 1999 NEI

comment

State	Unpaved Road Surface Material Silt Content (%)
Alabama	
Alaska	3.9
Arizona	3.8
Arkansas	3.0
California	3.9
Colorado	2.6
Connecticut	1.5
Delaware	3.9
DC	3.9
Florida	0.0
Georgia	3.9
Hawaii	3.9
Idaho	3.8
Illinois	3.9
Indiana	2.6
Iowa	2.6
Kansas	2.5
Kentucky	3.9
Louisiana	3.9
Maine	3.9
Maryland	3.9
Massachusetts	3.9
Michigan	3.9
Minnesota	2.6
Mississippi	2.7
Missouri	3.9
Montana	6.5
Nebraska	6.6
Nevada	4.2
New Hampshire	1.7
New Jersey	3.9
New Mexico	3.9
New York	4.3
North Carolina	4.7
North Dakota	5.1
Ohio	3.9
Oklahoma	3.1
Oregon	4.4
Pennsylvania	7.2
Rhode Island	3.3
South Carolina	3.9
South Dakota	3.9
Tennessee	3.1
Texas	2.0
Utah	5.6
Vermont	3.9
Virginia	3.9
Washington	3.2
West Virginia	3.9
Wisconsin	3.9
Wyoming	4.2
	7.1
	3.8

TYPICAL MAGNETITE ANALYSIS
From FreePort McMorRan Mining Company
COBRE MINING DIVISION

	Ranges %
% Fe	65.39 - 67.84
% Fe_3O_4	90.37 - 92.54

Composite Assay of Samples 1a through 6A

% Acid Insoluble	4.38
% Ca	1.25
% Cu	0.11
% Cr	0.014
% Ni	0.006
% Mg	0.501
% Al	0.211
% Ba	0.077
% Na	0.015
% S	0.19
% Mn	0.446
% Zn	0.038
% Ti	0.024
% Sr	0.007
% C	0.18
% P_2O_5	0.004

MAGNETICS	95%
SPECIFIC GRAVITY	5.02
MOISTURE CONTENT	2.0-10%

TYPICAL MAGNETITE SCREEN ANALYSIS %

SCREEN SIZE	RANGE %
PLUS 65 MESH	.87-1.39
PLUS 100 MESH	2.18-4.56
PLUS 150 MESH	8.93-26.87
PLUS 200 MESH	14.30-19.87
PLUS 270 MESH	17.27-22.98
PLUS 400 MESH	7.02-11.41
MINUS 400 MESH	18.32-38.50

PRECIOUS METALS ANALYSIS

GOLD (AU)	NON-DETECTABLE
SILVER (AG)	NON-DETECTABLE
PLATINUM (PT)	NON-DETECTABLE
PALLADIUM (PD)	NON-DETECTABLE

Table 11.19.2-2 (English Units). EMISSION FACTORS FOR CRUSHED STONE PROCESSING OPERATIONS (lb/Ton)[a]

Source [b]	Total Particulate Matter [r,s]	EMISSION FACTOR RATING	Total PM-10	EMISSION FACTOR RATING	Total PM-2.5	EMISSION FACTOR RATING
Primary Crushing (SCC 3-05-020-01)	ND		ND[n]		ND[n]	
Primary Crushing (controlled) (SCC 3-05-020-01)	ND		ND[n]		ND[n]	
Secondary Crushing (SCC 3-05-020-02)	ND		ND[n]		ND[n]	
Secondary Crushing (controlled) (SCC 3-05-020-02)	ND		ND[n]		ND[n]	
Tertiary Crushing (SCC 3-050030-03)	0.0054[d]	E	0.0024[o]	C	ND[n]	
Tertiary Crushing (controlled) (SCC 3-05-020-03)	0.0012[d]	E	0.00054[p]	C	0.00010[q]	E
Fines Crushing (SCC 3-05-020-05)	0.0390[e]	E	0.0150[e]	E	ND	
Fines Crushing (controlled) (SCC 3-05-020-05)	0.0030[f]	E	0.0012[f]	E	0.000070[q]	E
Screening (SCC 3-05-020-02, 03)	0.025[c]	E	0.0087[l]	C	ND	
Screening (controlled) (SCC 3-05-020-02, 03)	0.0022[d]	E	0.00074[m]	C	0.000050[q]	E
Fines Screening (SCC 3-05-020-21)	0.30[g]	E	0.072[g]	E	ND	
Fines Screening (controlled) (SCC 3-05-020-21)	0.0036[g]	E	0.0022[g]	E	ND	
Conveyor Transfer Point (SCC 3-05-020-06)	0.0030[h]	E	0.00110[h]	D	ND	
Conveyor Transfer Point (controlled) (SCC 3-05-020-06)	0.00014[i]	E	4.6×10^{-5}[i]	D	1.3×10^{-5}[q]	E
Wet Drilling - Unfragmented Stone (SCC 3-05-020-10)	ND		8.0×10^{-5}[j]	E	ND	
Truck Unloading -Fragmented Stone (SCC 3-05-020-31)	ND		1.6×10^{-5}[j]	E	ND	
Truck Loading - Conveyor, crushed stone (SCC 3-05-020-32)	ND		0.00010[k]	E	ND	

a. Emission factors represent uncontrolled emissions unless noted. Emission factors in lb/Ton of material of throughput. SCC = Source Classification Code. ND = No data.

b. Controlled sources (with wet suppression) are those that are part of the processing plant that employs current wet suppression technology similar to the study group. The moisture content of the study group without wet suppression systems operating (uncontrolled) ranged from 0.21 to 1.3 percent, and the same facilities operating wet suppression systems (controlled) ranged from 0.55 to 2.88 percent. Due to carry over of the small amount of moisture required, it has been shown that each source, with the exception of crushers, does not need to employ direct water sprays. Although the moisture content was the only variable measured, other process features may have as much influence on emissions from a given source. Visual observations from each source under normal operating conditions are probably the best indicator of which emission factor is most appropriate. Plants that employ substandard control measures as indicated by visual observations should use the uncontrolled factor with an appropriate control efficiency that best reflects the effectiveness of the controls employed.

c. References 1, 3, 7, and 8

d. References 3, 7, and 8

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NO_x emissions from blasting operations in open-cut coal mining

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ABSTRACT

The Australian coal mining industry, as with other industries is coming under greater constraints with respect to their environmental impacts. Emissions of acid gases such as NO_x and SO_x to the atmosphere have been regulated for many years because of their adverse health effects. Although NO_x from blasting in open-cut coal mining may represent only a very small proportion of mining operations' total NO_x emissions, the rapid release and high concentration associated with such activities may pose a health risk. This paper presents the results of a new approach to measure these gas emissions by scanning the resulting plume from an open-cut mine blast with a miniaturised ultraviolet spectrometer. The work presented here was undertaken in the Hunter Valley, New South Wales, Australia during 2006. Overall this technique was found to be simpler, safer and more successful than other approaches that in the past have proved to be ineffective in monitoring these short lived plumes. The average emission flux of NO_x from the blasts studied was about 0.9 kt t^{-1} of explosive. Numerical modelling indicated that NO_x concentrations resulting from the blast would be indistinguishable from background levels at distances greater than about 5 km from the source.

1. Introduction

Open-cut coal mining is widespread in the upper Hunter Valley in New South Wales (NSW) with several large mines operating within close proximity to the towns of Muswellbrook and Singleton. Consequently, there is community concern about the potential environmental impacts of mining on nearby populations.

Blasting, in particular, has the potential to affect areas outside the mine boundary and accordingly, vibration and dust emission limits are set in each mine's environmental licence. However, gaseous emissions of environmental concern, such as nitrogen dioxide (NO_2) may also be released during blasting operations. Currently, there are very little quantitative data relating to the magnitude of these emissions and it is not yet possible to determine if they contribute significantly to ambient levels in the main population centres.

The explosive ammonium nitrate/fuel oil (ANFO) is used almost universally throughout the open-cut coal mining industry. Under ideal conditions, the only gaseous products from the explosion are carbon dioxide (CO_2), water (H_2O) and nitrogen (N_2).

$$3NH_4NO_3 + CH_2 \rightarrow 3N_2 + CO_2 + 7H_2O \quad (1)$$

However, even quite small changes in the stoichiometry (either in the bulk material or caused by localised conditions such as moisture in the blast hole, mineral matter or other factors) can lead to the formation of substantial amounts of the toxic gases carbon monoxide (CO) and nitric oxide (NO) as shown.

$$2NH_4NO_3 + CH_2 \rightarrow 2N_2 + CO + 5H_2O \quad (2)$$

$$5NH_4NO_3 + CH_2 \rightarrow 4N_2 + 2NO + CO_2 + 7H_2O \quad (3)$$

In addition, some of the NO formed may oxidise in the presence of oxygen (O_2) to produce NO_2.

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$$2NO + O_2 \rightarrow 2NO_2 \quad (4)$$

Often in practice, large quantities of NO_2 are released from blasts which are observed as intense orange plumes.

Although these gases are not considered in their environmental licences, each mine is required to estimate annual emissions of CO, NO_x and SO_2 for the National Pollutant Inventory (NPI), compiled each year by the Australian government. These estimates are made by multiplying the amount of explosive consumed by an emission factor which is currently 8 kg t^{-1} for NO_x, 34 kg t^{-1} for CO and 1 kg t^{-1} for SO_2 (National Pollutant Inventory, 1999). These emission factors, however, are based on limited overseas data and are subject to high uncertainty.

Most of the studies which have examined NO_x formation from blasting have used blast chambers. The results from these studies do not necessarily correlate with what is observed during actual blasts. Few studies have attempted to measure NO_x emissions under actual field conditions, presumably because of the practical difficulties involved. Plumes from blasting lack confinement, can be very large in size and are affected by prevailing weather conditions. There is also a large quantity of dust associated with the blast and these factors combine to make physical sampling of the plume very difficult. There are also the obvious safety implications which restrict access to blast sites. Consequently, quantitative measurements of plume characteristics are generally unavailable. Nevertheless, it is important for mine operators, particularly when their operations are close to residential areas, to have some method for assessing NO_x formation and more importantly, predicting the severity of the NO_x plume. At present predictions of NO_x formation are subjective and are based on the blast engineer's knowledge of the area to be blasted (e.g. rock type, area of the mine, presence of water in the holes, etc.) and the ratings obtained from blasts performed under similar conditions. Quantitative flux estimations of NO_x released from a blast require measurement of concentration through the plume in both the horizontal and vertical axes.

Some of the options available to make these measurements are given in the following sections.

1.1. Physical sampling

Sampling of blasting fumes involves taking a sample of gas from the plume for subsequent analysis, which could be either on site or in an off site laboratory. Although physical sampling could in principle provide sufficient information to characterise a plume, there are a number of serious logistical problems with this approach:

- The size of the plume means that a large number of sample points would be required to sample across the width and height of the plume.
- The force of the explosion and the resulting debris would restrict the proximity of any sampling packages to the initial gas release.
- The potential toxicity of the plume; personnel cannot move through it to take samples, hence sampling stations must be fixed prior to the blast. This means that the path of the plume must be anticipated before the blast.

1.2. Continuous analysis

Another option is to use portable analysers to measure NO_x concentrations in real time. There are, however, disadvantages with this approach since a sample of the plume must be presented to the instrument for analysis. Usually a pump draws air through a small diameter tube into the instrument, but to achieve the necessary spatial characterisation of the plume, sample tubes would need to be positioned at various points throughout the plume. Thus many of the problems identified for the physical sampling would also apply to the use of continuous analysers.

1.3. Optical methods

There are several optical methods of analysis currently available that may be applicable to field measurements of NO_x. These include open-path Fourier Transform Infra-Red Spectroscopy (FT-IR), Correlation Spectroscopy (COSPEC) and Differential Optical Absorption Spectroscopy (DOAS). FT-IR has often been used in air pollution studies (e.g. Levine and Russwurm, 1994). It has also been used in mine situations to measure fugitive methane emissions. Kirchgessner et al. (1993) used open-path FT-IR (op-FT-IR) to estimate methane emissions from open-cut coal mines in the United States. The technique relies on passing a collimated infrared beam through ambient air over a path length of up to several hundred metres. In the Kirchgessner et al. (1993) study, the concentration of methane across the plume was measured then wind speed data and a Gaussian plume dispersion model were used to estimate the methane emission rate from the mine. These authors subsequently developed a modification of their method which improved its accuracy (Piccot et al., 1994, 1996). The improved method was essentially the same as described above except that methane concentrations were measured at several elevations to better characterise the plume.

In principle, open-path FT-IR could be used to measure NO_x in blast plumes since it is sensitive to NO, NO_2, and CO along with other gases. Infrared radiation is also strongly absorbed in many parts of the spectrum by both CO_2 and water which are very likely to be present in high concentrations in blast plumes and this may tend to obscure the NO_x signal. High resolution instruments may resolve at least some of the NO_x absorption lines, however, a more serious drawback with op-FT-IR is that the infrared beam would be substantially attenuated by the dust thrown up by the blast. In the period immediately after the blast when the dust level is very high it is likely that the IR beam would be completely blocked thus making measurements impossible.

Another well established optical method is Correlation Spectroscopy (COSPEC). The system was first described by Moffat and Milan (1971) and was designed to measure point source emissions of SO_2 and NO_2 from industrial plants but found a niche application in the measurement of SO_2 fluxes from volcanoes (Galle et al., 2002). The COSPEC system utilises a "mask correlation" spectrometer and was designed to measure vertical or slant columns using sky-scattered sunlight. By traversing beneath plumes with the mobile instrument, the concentration of the column is calculated and, once multiplied by the plume velocity, produces a source emission rate. These instruments are limited to detecting only those species where masks are available. They also suffer from interferences from other atmospheric gases and light scattering from clouds or aerosols that can produce errors in column densities (Chalmers Radio and Space Science, website).

The DOAS technique is a relatively new technique that is gaining widespread acceptance as an air pollution monitoring method. Like the open-path FT-IR method, the DOAS can simultaneously measure concentrations of a number of species over path lengths which typically range from hundreds of metres to kilometres.

A DOAS, configured as an 'active system', Fig. 1, has three main parts – a light emitter, a light receiver and a spectrometer. The emitter sends a beam of light to the receiver (in some cases the emitter and receiver are contained in the same unit and the light beam is reflected off a remotely located passive reflector). The light beam contains a range of wavelengths, from ultraviolet to visible, although instruments are now available with an infrared source, which extends the range of compounds that can be detected. Different pollutant molecules absorb light at different wavelengths along the path between the emitter and receiver. The receiver is connected to the spectrometer which measures the intensity of the different wavelengths over the entire light path and through the data system converts this signal into concentrations for each of the species being monitored.

DOAS instruments are routinely used to measure SO_2, NO_2 and O_3.

More recently, advances in miniaturising UV–vis spectrometers has lead to the development of much more compact DOAS units, configured as a passive system (Fig. 1), which have come to be known as "mini-DOAS". The mini-DOAS system has so far been used mainly in the study of SO_2 fluxes in volcanic emissions (McGonigle et al., 2003).

2. Methodology

2.1. Field measurements

A portable DOAS (mini-DOAS) manufactured by Resonance Ltd was used in this study. The instrument covers a spectral range of 280–420 nm and can measure sub-part per million levels of NO_2 and SO_2. The unit, which comprises a telescope, scanning mirrors, calibration cells and a miniature CCD array spectrometer (Ocean Optics USB2000 spectrometer), is housed in a small package which is mounted on a tripod. Calibration of the instrument was carried out using the internal calibration cell. The concentration of the cell was equivalent 50 ppm m. No SO_x measurements were undertaken.

Data collection and processing were performed by Ocean Optics OOIBase32 software loaded in a laptop computer. This results in a more compact system that is easier to deploy at mine sites and provides greater flexibility in positioning the instrument in relation to the blast plume.

Prior to each monitored blast, a dark spectrum was collected by blocking light from entering the spectrometer and a scan was performed. To produce a reference spectrum, a further scan was performed in a clear sky background which contained background absorption from NO_2. The reference spectrum was required in order to determine the increase in concentration of NO_2 above ambient levels in the blast plumes.

The plume resulting from each blast was tracked with the spectrometer until the NO_2 concentration was indistinguishable from the surrounding sky. During each field measurement, the mini-DOAS and a video camera were positioned a safe operating distance from the blast at all times.

NO_2 concentrations in the plume were calculated by subtracting the dark spectrum from the measured spectrum and the reference spectrum using the supplied software.

The results obtained from the mini-DOAS are a path-averaged NO_2 concentration profile measured in units of parts per million metre (ppm m). The mini-DOAS results must be divided by the path length through the plume to yield a concentration. To estimate the amount of NO_2 released from each blast it was necessary to multiply the concentration by the volume of the plume. Hence it was necessary to estimate the dimensions of each plume.

All of the blasts monitored were video-taped using at least one, and sometimes two, video recorders. The distances between the cameras and the blast were measured by locating their positions with a handheld GPS receiver.

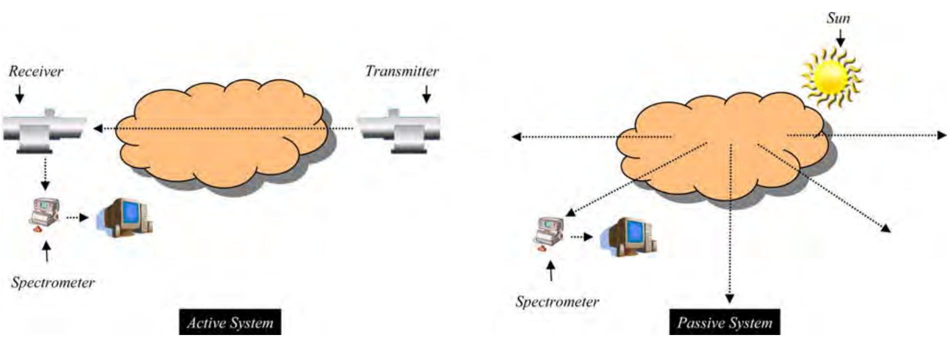

Fig. 1. Schematic diagram of DOAS systems operating in both active and passive modes.

Wind speed and directional data used to plot the directional path of the plume were obtained from a series of meteorological stations located around the mining lease. Simple trigonometry was employed to determine the distance from the video camera to the plume at the corresponding time intervals.

A rudimentary method of photogrammetry was then used to estimate the size of the plume based on still images extracted from the videos. Ratios of the plume to picture size in both the vertical and horizontal planes were made.

Once the plume to camera distance and the constraining angle for the plume is known, a crude three-dimensional estimate of the plume dimension was calculated using basic trigonometric functions. An example of the dimensions determined for a plume using this method is shown in Fig. 2.

Ground level measurements were carried out using a Greenline 8000 portable gas analyser. This instrument is capable of continuous, simultaneous analysis of O_2, CO_2, CO, SO_2, NO and NO_2. It is battery powered and can operate unattended for up to about 2 h. The instrument was calibrated against a standard gas mixture before each use. Data were logged on a laptop computer connected to the instrument.

For each experiment, the instrument was set up downwind of the blast in a location where the plume was expected to pass, but far enough away to avoid flying debris. The inlet probe was fixed at about 2 m above ground level.

It must be noted that selecting an appropriate location for the instrument was often difficult. In many cases, the wind conditions were quite variable, especially within the pit so it was not always possible to correctly anticipate the path of the blast plume. As well, the layout of the mine pit and safety considerations imposed constraints on where the instrument could be placed. Because of these problems, the plumes from many of the blasts did not pass over the analyser and data was not recorded.

2.2. Modelling

A simple modelling exercise was undertaken for this study to determine if the release of NO_2 from a blast could be of detriment to persons exposed to the plume within 5 km of the release. The results of this study are indicative and based on the assumption that the model used is appropriate. Modelling generally relies on local observational data to confirm the performance of the model. The difficulty in measuring emissions from mining blasts has meant that in this case the model is used as an indicator relying on the verifications used in the development of the chosen model. For this reason we have modelled concentrations directly downwind of theoretical blasts with AFTOX (Kunkel, 1991), a USEPA approved dispersion model (http://www.epa.gov/scram001/dispersion_alt.htm#aftox). The original DOS based QuickBasic code was transformed into Excel macros to enable many scenarios to be run.

AFTOX is a Gaussian Puff model developed for the United States Air Force to assess real time toxic chemical releases. The model uses information from US Air Weather Service (AWS) stations to calculate dispersion based on measured atmospheric conditions. As for all Gaussian models, the spread of pollutants is governed by dispersion coefficients in the horizontal (σ_y) and vertical (σ_z) directions. These coefficients depend on the atmospheric stability derived from the AWS data. In this study, the scenarios were modelled by predefining the wind speed and atmospheric stability classes. The wind speeds modelled ranged from very low ($0.5\ m\ s^{-1}$) to moderate ($10\ m\ s^{-1}$). Stability was modelled in six steps representing the standard Pasquill-Gifford stability classes, i.e. A–F, where A, B and C represent unstable conditions (where A is the most unstable), D is neutral and E and F are stable conditions. These stability classes are used to categorise the rate at which a plume will disperse. Unstable conditions might be found on a sunny day with light winds leading to rapid plume dispersion while the stable conditions may occur in clear skies with light winds and perhaps a temperature inversion present. Plume spread is slow in these circumstances.

AFTOX is operated by assuming an emission release from a single location. The emissions can be either continuous or instantaneous. In this study AFTOX was used to describe an area source by representing it as a large number of individual points. The area of the emission (i.e. the area over which the explosives were distributed) was

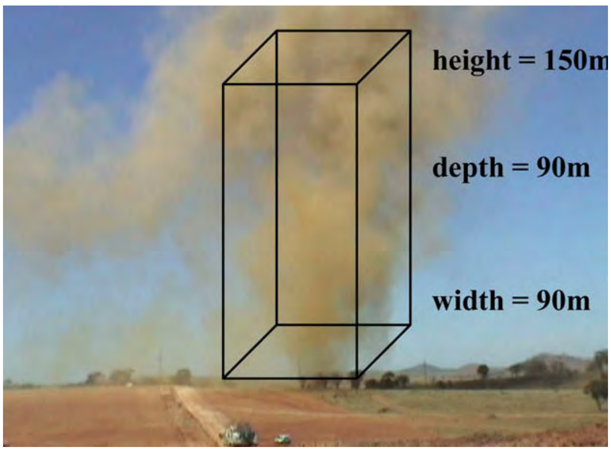

Fig. 2. Blast plume with estimated dimensions.

assumed to be 100 m × 200 m based upon sizes commonly observed during the field measurements. The area was subdivided into 10 m × 10 m units. Each square was represented by a point source with its source at the centre. In total, the area was modelled as 231 separate point sources (see Fig. 3). The total flux of emissions for the source was set at 100 kg. To estimate the maximum concentration and pollutant exposure values, the values should be multiplied by an appropriate scaling factor.

One hundred and twenty scenarios were modelled in which the 100 kg of emissions were spread randomly throughout the source area. A multi-stage process was employed for this task. In the first step, the total maximum number of points emitting was determined. This was defined by a random number between 20% and 80% of the maximum number of sources (in this case 231). The range chosen was an estimate from the portion of blasts that appeared to fume in conditions witnessed during this study. The total emission was then divided by this number. Each portion of the total emission was then placed randomly within the emission area. This process allowed certain points to receive multiple portions of the total emissions enabling the formation of hot spots. An example of one emission grid (Scenario 1 of 120) is displayed in Fig. 4.

Concentrations were determined for each of the 120 emission scenarios at distances of 200 m, 300 m, 400 m, 500 m, 750 m, 1 km, 1.25 km, 1.5 km, 2 km, 2.5 km, 3 km, 4 km and 5 km from the origin of the source. A concentration was determined for a number of discrete times that encompassed the complete plume travelling past the receptor. Further the concentrations were determined at 21 locations 10 m apart in a plane parallel and directly downwind of the source area (see Fig. 3). An average concentration from each of the receptors was determined; in this case with N equal to 21.

$$C^{*} = \frac{1}{N}\sum_{i=1}^{N} C_i \tag{5}$$

The average for each scenario was then used to create an ensemble average and standard deviation for the entire run (i.e. $N = 120$).

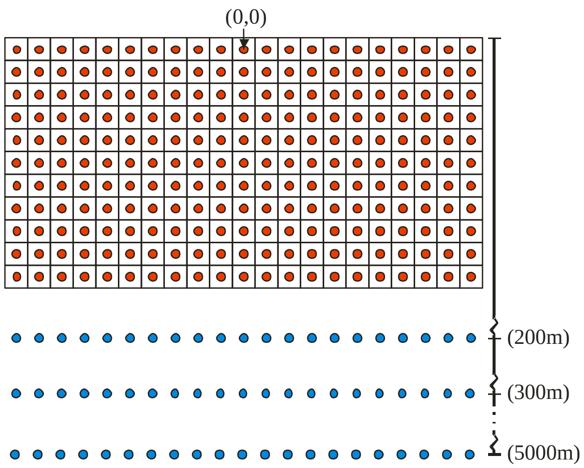

Fig. 3. Emission grid and receptor array setup.

$$\overline{C} = \frac{1}{N}\sum_{j=1}^{N} C_j^{*} \tag{6}$$

$$\sigma_{\overline{C}} = \frac{1}{N}\sum_{j=1}^{N}\left(C_j^{*} - \overline{C}\right)^2 \tag{7}$$

$$C_{\max} = \max_{k=1}^{N}[\overline{C}_k] \tag{8}$$

A dosage expressed in ppm s was determined from the times when the ensemble average plume travelled past the receptors located at each distance downwind of the source. Again N represents each discrete time step ($\mathrm{d}t$) where $C' \neq 0$.

$$C_{\text{dose}} = \sum_{k=1}^{N}(\overline{C}_k)\mathrm{d}t \tag{9}$$

The relative variation for the dosage is provided by similarly treating the ensemble standard deviation.

$$\sigma_{\text{dose}} = \sum_{k=1}^{N}(\sigma_{\overline{C}k})\mathrm{d}t \tag{10}$$

3. Results and discussion

3.1. Field measurements

Plume measurements were made using the mini-DOAS spectrometer at two open-cut mine sites located in the Hunter Valley. The combination of the spectral analysis and the plume estimation technique allowed for NO_2 concentration and mass flux estimates to be made remotely, totally eliminating the requirement of physical sampling.

An example of the spectral output produced by the mini-DOAS is shown in Fig. 5. The spectral output consists of the NO_2 concentration (ppm m) as a function of time. The figure also contains a series of photographs depicting the formation of a blast plume at time intervals of 70, 110, 163, 250 and 350 s post-blast initiation. It is worth noting the change in intensity of the colour of plume and size as a function of time.

Reliable concentration measurements with the mini-DOAS may only be made when the spectrometer is aimed into a sky background above the horizon from the point of observation. In this example, a peak concentration of 580 ppm m was achieved in 163 s post-blast initiation (third image from the left). At this time the plume has risen above the horizon from the point of observation. The plume to mini-DOAS distance at this stage is approximately 500 m, with an estimated plume depth of 105 m. This results in a NO_2 concentration of 5.6 ppm at that particular stage of the plumes' dispersion.

After 350 s, the plume is barely visible and is now estimated to be approximately 650 m from the mini-DOAS unit. The plume depth has increased to 125 m with

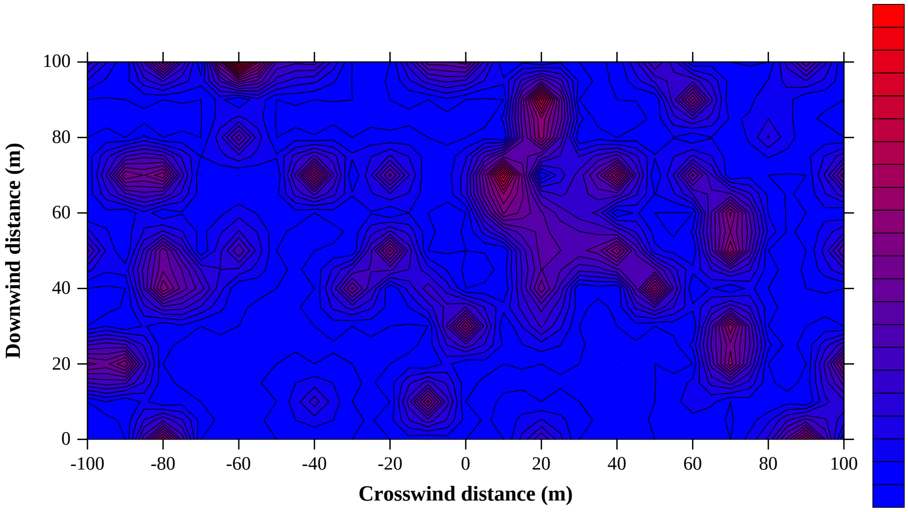

Fig. 4. Example of emission grid for 1 of the 120 scenarios modelled (the scale on the right hand side refers to NO_2 concentration in ppm).

a corresponding increase in plume volume by a factor of two. This expansion of the plume corresponds to a decrease in NO_2 concentration to 2.8 ppm.

At 360 s the plume was no longer visible to the eye and was lost for a short period of time to the mini-DOAS. This, however, was rectified with scanning of the sky with the spectrometer until the invisible plume was tracked for a further period.

Results for all plumes monitored during field work at both mine sites are given in Table 1. The table gives the peak NO_2 concentration as measured by the mini-DOAS above the horizon. Also given in the table is the plume volume at peak concentration and the calculated mass of NO_2 released from the blast. The mass of ANFO typically used in a blast was on average 210 tonnes, ranging from 60 to 565 tonnes. The explosive was distributed over an area of typically 200 m × 100 m containing approximately 200 bole holes with 200 mm diameter and to a depth of 25 m.

From the table the maximum NO_2 concentrations were found to range from 0 to about 7 ppm. This range of concentrations translated to 0–63.3 kg of NO_2 in the plume. However, no correlation can be made between blast charge and NO_2 levels.

During the measurements with the mini-DOAS ground level measurements were also carried out using a portable combustion gas analyser (Greenline 8000) to augment the airborne measurements made by the mini-DOAS. For NO_2 the ground level measures were higher than those observed using the mini-DOAS at higher altitudes. When the results of both measurement methods were applied to

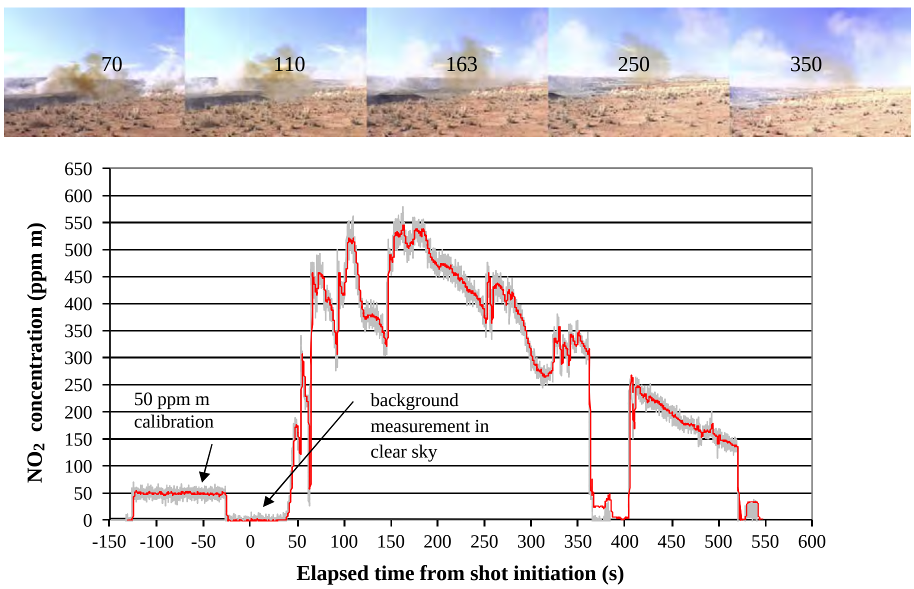

Fig. 5. Typical NO_2 spectrum demonstrating plume colour characteristics relative to concentration level.

Table 1
Through plume measurement results

Date	Total ANFO charge (t)	Peak NO_2 Conc (ppm)	Plume volume ($m^3 \times 10^{-6}$)	Mass of NO_2 (kg)	Emission flux ($kg\,t^{-1}$ ANFO)		
					NO	NO_2	NO_x
12/12/2005	281	3.7	1.4	9.9	0.5	0.03	0.6
13/12/2005	150	0.4	5.3	3.7	0.4	0.03	0.4
14/12/2005	119	0.0	0.0	0.0	0.0	0.00	0.0
21/12/2005	229	1.0	4.4	7.9	0.6	0.04	0.6
22/12/2005	211	0.0	0.0	0.0	0.0	0.00	0.0
23/12/2005	222	0.0	0.0	0.0	0.0	0.00	0.0
5/01/2006	177	1.0	0.2	0.4	0.0	0.00	0.0
6/01/2006	275	1.1	15.3	30.6	1.8	0.12	1.9
12/01/2006	225	1.6	6.2	18.3	1.3	0.08	1.4
18/01/2006	169	1.3	1.7	0.2	0.4	0.02	0.4
23/01/2006	139	2.1	4.2	16.7	1.9	0.12	2.0
25/01/2006	155	0.4	4.4	2.9	0.3	0.02	0.4
30/01/2006	132	0.7	5.3	7.1	0.8	0.05	0.9
22/02/2006	224	0.0	0.00	0.0	0.0	0.00	0.0
1/03/2006	194	1.6	20.6	63.3	5.0	0.32	5.3
12/05/2006	362	6.5	1.9	23.3	1.0	0.06	1.1
15/05/2006	131	0.3	3.2	1.7	0.2	0.01	0.2
19/05/2006	168	0.0	0.00	0.0	0.0	0.00	0.0
30/05/2006	100	0.8	0.00	1.0	0.0	0.00	0.0
1/06/2006	365	0.7	3.5	4.9	0.2	0.01	0.2
6/06/2006	145	0.8	11.5	17.5	1.9	0.12	2.0
15/06/2006	60	0.0	0.00	0.0	0.0	0.00	0.0
26/06/2006	254	4.3	0.3	2.1	0.1	0.01	0.2
27/06/2006	212	5.6	0.9	10.0	0.7	0.04	0.7
28/06/2006	241	0.0	0.00	0.0	0.0	0.00	0.0
6/07/2006	565	2.8	2.7	14.0	0.4	0.03	0.4
13/07/2006	184	7.0	1.0	12.6	1.1	0.07	1.2

dispersion modelling techniques strong agreement was observed.

Point measurements which were made on Greenline 8000 indicated that a loose relationship existed between NO and NO_2 concentration. Although a strong correlation was not found, there is a general trend of increasing NO_2 with increasing NO. It was generally found that the relative proportion of NO to NO_2 from our data set was 27 to 1. This

Table 2
Maximum calculated NO_2 concentrations downwind of source

	200 m	300 m	400 m	500 m	750 m	1000 m	1250 m	1500 m	2000 m	2500 m	3000 m	4000 m	5000 m
WSPD = 0.5 m s^{-1}													
Stab A	83.0	30.0	14.4	7.9	2.5	0.9	0.4	0.2	0.1	0.0	0.0	0.0	0.0
Stab B	145.8	69.3	40.8	25.4	10.1	4.8	2.6	1.6	0.7	0.4	0.2	0.1	0.1
Stab C	219.4	122.0	80.8	55.9	26.8	14.3	8.6	5.6	2.8	1.6	1.0	0.5	0.3
Stab D	321.1	201.5	146.0	113.1	64.6	40.2	26.1	18.6	10.5	6.7	4.5	2.4	1.4
Stab E	390.2	267.4	204.3	165.5	109.6	75.9	54.6	41.3	26.4	17.9	12.7	7.1	4.5
Stab F	464.1	339.8	269.0	222.6	154.5	114.9	88.6	69.7	50.4	37.0	27.8	16.7	11.0
WSPD = 3 m s^{-1}													
Stab A	78.5	29.1	14.2	7.7	2.4	0.9	0.4	0.2	0.1	0.0	0.0	0.0	0.0
Stab B	137.6	67.7	39.7	25.1	10.0	4.8	2.6	1.6	0.7	0.4	0.2	0.1	0.1
Stab C	211.6	118.7	77.6	55.2	26.0	14.0	8.6	5.6	2.8	1.6	1.0	0.5	0.3
Stab D	312.5	197.9	143.2	110.0	62.5	39.3	26.1	18.2	10.5	6.7	4.5	2.4	1.4
Stab E	383.0	267.0	202.1	162.6	106.3	73.7	54.1	40.3	26.1	17.7	12.5	7.2	4.5
Stab F	461.5	344.6	268.4	220.8	151.1	112.3	86.1	67.6	48.9	36.4	27.5	16.6	11.0
WSPD = 7.5 m s^{-1}													
Stab A	62.5	25.5	13.0	7.3	2.3	0.9	0.4	0.2	0.1	0.0	0.0	0.0	0.0
Stab B	111.9	56.1	34.2	22.6	9.4	4.6	2.6	1.6	0.7	0.4	0.2	0.1	0.1
Stab C	173.3	100.4	66.5	47.7	23.8	13.2	8.2	5.4	2.7	1.6	1.0	0.5	0.3
Stab D	261.2	167.9	122.1	92.3	54.8	35.3	23.7	17.2	10.1	6.5	4.4	2.3	1.4
Stab E	325.9	232.2	175.8	139.6	89.5	63.8	46.7	36.0	23.9	16.8	12.1	7.0	4.4
Stab F	394.6	302.7	237.0	194.3	132.2	96.1	73.3	59.0	43.6	33.3	25.7	15.8	10.5
WSPD = 10 m s^{-1}													
Stab A	53.0	22.6	11.9	6.9	2.3	0.9	0.4	0.2	0.1	0.0	0.0	0.0	0.0
Stab B	92.3	49.7	31.0	20.9	9.0	4.5	2.5	1.5	0.7	0.4	0.2	0.1	0.1
Stab C	140.1	84.2	57.7	42.1	21.7	12.6	7.9	5.3	2.7	1.6	1.0	0.5	0.3
Stab D	205.5	138.3	102.4	79.9	48.6	31.8	22.1	16.4	9.7	6.4	4.3	2.3	1.4
Stab E	254.0	184.0	143.0	116.4	78.0	56.2	42.6	33.1	22.7	16.0	11.6	6.9	4.4
Stab F	306.8	235.8	189.6	157.9	109.9	82.8	64.5	52.2	40.0	30.9	24.0	15.2	10.2

relationship enabled the estimation of the NO fluxes in the blast plume with a reasonable level of confidence.

The results obtained in this study are the only published quantitative data available on blast plume gas composition that the authors are aware of and it is useful to compare them to the emission factors currently used for NPI estimates.

Based on the NO_2 measurements and estimates of NO, the flux for NO_x was calculated to be in the range of 0.04–5.3 kg t^{-1} ANFO. The average flux level for all the blast plumes measured was 0.9 kg t^{-1}. This figure is considerably lower than the current NPI emission factor which is 8 kg t^{-1}.

3.2. Modelling

Results of the modelling runs are summarised in Table 2 and show the peak NO_2 concentrations (ppm) at various points downwind of the blast for the six atmospheric stability classes considered.

Examples of the modelled data are plotted in Fig. 6 and Fig. 7. In Fig. 6 a plot is displayed for the concentration estimate of one scenario at a distance of 200 m from the source origin and for a wind speed of 2 m s^{-1} and a stability class C. In this plot 21 lines are shown representing the dose received directly downwind of the source at the locations displayed in Fig. 3. In this figure it is apparent that there is a considerable difference in the concentration predicted at each of the 21 receptors. It should be noted that the distance of 200 m is defined from the origin of the source area (0, 0) as displayed in Fig. 3. At this distance emission sources at 100 m will cause significantly higher concentrations than those occurring at positions toward the origin. In comparison the concentrations predicted at the receptor array 1 km from the source show more normally defined distributions with maxima occurring towards the middle receptors as a result of crosswind diffusion. Receptors toward the edge of the sample array receive less crosswind influence and are, therefore, smaller in concentration. Also apparent in these two figures is the considerable difference in the predicted peak concentrations with the values at 1 km up to 25 times lower than at 200 m. When viewing Table 2, the peak values at 5 km approach ambient levels for all but the most stable conditions which are quite commonly over predicted with Gaussian models. For future studies it is recommended that a long path technique on a mining lease boundary may provide both a measure of the model accuracy as well as a direct measure of the impact in areas directly surrounding the mining area.

The data presented in this study represent a dose directly downwind of the source and as such are a worst case scenario for exposure. The averages of the 21 receptors (i.e. the average concentration directly downwind of the source) for each of the 120 scenarios modelled were used to determine the selected data. The number of scenarios modelled was arbitrarily chosen to allow 10 scenarios to be run on each machine in a cluster of 12 computers. The maximum concentration in Table 2 is the maximum ensemble average obtained from the average of the 21 receptors for the 120 scenarios modelled. Maximum concentrations at individual locations directly downwind of hot spots are obviously higher than the values reported in this table.

When viewing Table 2 it is apparent that the peak concentrations drop dramatically as the receptor moves away from the source. It is also apparent that the peak concentrations vary little as a function of wind speed although the plume width will vary. In AFTOX a downwind concentration is determined in two steps. In the first step the size of the initial plume envelope is estimated. In its default mode AFTOX determines the size of the envelope (assumed to be a cylinder of equal height and width) from the magnitude of the emission rate. In this report the size is set at 10 m to match the grid structure used for the area

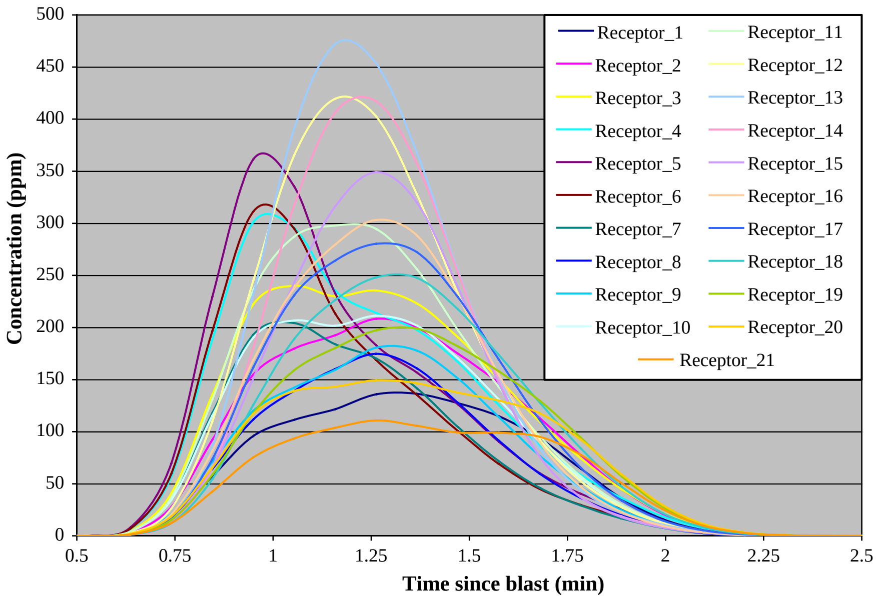

Fig. 6. Calculated NO_2 concentration profiles 200 m from source.

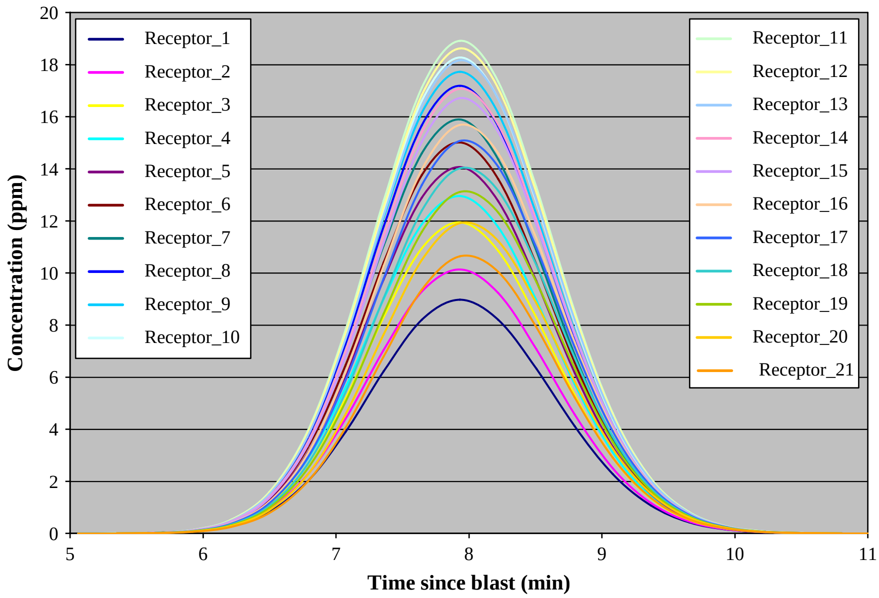

Fig. 7. Calculated NO_2 concentration profiles 1 km from source.

source. AFTOX in this regard ignores the effect of wind speed on the size of the initial envelope and as such the initial concentration of the plume is identical irrespective of wind speed by ignoring longitudinal (i.e. downwind) spread of the initial release. In the second step the concentration downwind of the initial release is determined by estimating the growth of a puff in three dimensions which in this case explicitly includes longitudinal plume spread which is assumed to be equal to the degree of crosswind spread. The degree of this spread is determined solely from the prescribed atmospheric stability class which ignores any wind speed dependence.

While the peak concentrations are similar, the dose received at a receptor is linearly dependent on wind speed. Emissions released into an atmosphere with higher wind speeds result in a receptor receiving doses for a smaller period of time. It should be noted that some of the differences in the peak concentrations displayed in Table 2 result from the number of discrete time steps used to calculate the concentrations. This was set at 25 intervals between the onset and finish of a plume as it passes by the receptor. This time is dependent on atmospheric stability and the distance from the source. In AFTOX, the puffs are assumed to disperse in the direction of plume travel proportionally with the degree of crosswind spread. As such, portions of the plume arrive before and after the main bulk of the emissions and the effect clearly demonstrated in Figs. 6 and 7. The moderate number of discrete times modelled to capture this effect while generally adequate may have led to a degree of variation particularly at larger distances from the source.

Again it should be noted that the modelled figures assume an area wide flux of 100 kg which is larger than observed in the blast recorded during this study. It should also be noted that while some of the concentrations are high close to the source the concentration at a particular location occurs for a brief period of time which is determined by the wind speed.

4. Conclusions

A portable open-path spectroscopic method was found to be effective for measuring NO_2 emissions from blasting. Overall this technique was found to be simpler, safer and more successful than other approaches that in the past have proved to be ineffective in monitoring these short lived plumes.

Quantitative measurements of NO_2 in plumes from blasting were made at two open-cut mines. The results showed that NO_2 was present in most of the plumes but in relatively low concentrations (typically ranging between 0 and 7 ppm). The highest concentration measured during all the field campaigns was about 17 ppm at ground level.

Based on field measurements, the emission factor currently used in compiling the Australian National Pollutant Inventory was found to be approximately eight times greater than that observed in our investigation. This would suggest that an over estimation of NO_x is made if the current factor is used.

Numerical modelling of the behaviour of plumes resulting from blasting was made to assess the possible downwind concentrations of NO_2. These results were compared to ambient NO_x measurements made in Muswellbrook.

- Modelling results were consistent with concentration measurements within the plumes at relatively short distances from the blast (i.e. up to about 1 km).
- Ambient monitoring did not detect NO_x events that could be attributed to individual blasts. Modelling suggested that these emissions would be very low at

distances greater than 5 km from the blast and may be indistinguishable from background levels; typically of the order of several parts per billion, in most cases.

Acknowledgements

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FACTORS AFFECTING ANFO FUMES PRODUCTION

James H. Rowland III and Richard Mainiero

ABSTRACT

For many years there have been small scale tests available for evaluating the toxic fumes production by cap-sensitive explosives (DOT Class 1.1), but these could not be used with blasting agents due to the large charge sizes and heavy confinement required for proper detonation. Considering the extensive use of blasting agents in construction and mining, there is a need to determine the quantities of toxic fumes generated by blasting agents. At the International Society of Explosive Engineers Twenty Third Annual Conference on Explosives and Blasting Technique in 1997, the authors reported on a facility for detonating large (4.54 kg), confined blasting agent charges in a controlled volume that had been constructed at the National Institute for Occupational Safety and Health's Pittsburgh Research Lab's Experimental Mine. Since 1997, this facility has been used to collect data on toxic fumes produced by the detonation of various ammonium nitrate/fuel oil (ANFO) mixtures and several cap-sensitive explosives.

ANFO composition ranging from 1 to 10 percent (pct) fuel oil have been studied. As expected from previous studies, with an increase in fuel oil content the carbon monoxide production increases, while nitric oxide and nitrogen dioxide production decrease. The detonation velocity varies from 3,000 to 4,000 m/sec for the 1 to 10 pct range of fuel oil content, suggesting that ANFO mixes with improper fuel oil content may appear to detonate properly, while their fume production differs significantly from optimum. The study also considers such factors as degree of confinement, water contamination, and aluminum content on blasting agent fume production. Results indicate that water contamination of the ANFO has little effect on carbon monoxide production, but causes significant increase in nitric oxide and nitrogen dioxide production. Decreasing confinement from Schedule 80 steel pipe to 0.4-mm thick sheet metal also has little effect on carbon monoxide production, but significantly increases nitric oxide and nitrogen dioxide production. Adding 5 and 10 pct aluminum to the ANFO had no clear effect on carbon monoxide, nitric oxide, or nitrogen dioxide production.

INTRODUCTION

In February of 1997 a paper entitled " A Technique for Measuring Toxic Gases Produced by Blasting Agents" was presented at the 23rd Annual Conference on Explosives & Blasting Technique in Las Vegas, Nevada. That paper discussed a method for measuring toxic fumes produced by detonation of blasting agents. The research reported here is a continuation of that work.

Detonating ANFO in steel pipe in the Pittsburgh Research Lab (PRL) mine fumes chamber yields a baseline for comparing relative fumes production for blasting agents, but is by no means a predictor of what will happen in the field. In actual blasting operations, the confinement of the detonating ANFO will probably be less than that offered by the 4-in, Schedule 80 steel pipe employed in most tests. Additionally the ANFO evaluated in the PRL mine chamber is carefully mixed the day before and care is taken to prevent contamination. In practice, ANFO may not be exactly the 94/6 ammonium nitrate/fuel oil ratio desired or may be loaded into boreholes weeks before it is shot, exposing the explosive to water seeping into loaded boreholes and possible fuel oil evaporation. The current research looks at these factors and others in an effort to determine how they affect fumes production. Fumes measurements in the mine chamber were carried out for ANFO mixtures other than 94/6, ANFO contaminated with up to 10 pct water, ANFO detonated with less confinement than that offered by Schedule 80 steel pipe, and ANFO contaminated with limestone rock dust. Additionally, several cap-sensitive explosives, as well as ANFO containing up to10 pct aluminum were also studied to gain an understanding of how detonation behavior affects fumes production. In each case carbon monoxide, nitrogen oxides, and ammonia were the toxic gases of primary interest.

EXPERIMENTAL APPROACH

Detonating large blasting agent charges and confining the fumes requires a larger experimental chamber than was employed in past work on cap-sensitive explosives. Towards this end, a chamber was created in the experimental mine at PRL. The facility consists of a portion of mine entry enclosed between two explosion proof bulkheads. Each bulkhead is 40 inches (1 m) thick, constructed of solid concrete block hitched 1 foot (30 cm) into the roof, ribs, and floor. On the intake side, the bulkhead is fitted with a submarine mandoor and a small port for control and sampling lines. On the return side, the bulkhead is fitted with two sealed ventilation ports. Total volume of the chamber is 9,666 ft^3 (274 m^3). The chamber volume was determined by releasing a known quantity of carbon monoxide into the chamber and sampling the atmosphere after it had mixed. Following the shot, a fan mounted at one end of the chamber mixes the chamber atmosphere at 3,500 ft^3/min, after which the chamber is vented using the mine's airflow. The layout of the chamber is illustrated in Figure 1. Up to 10 pound (4.54 kg) charges can be detonated in the chamber using a variety of confinements.

EXPERIMENTAL

A 28-inch (71-cm) length of 4-inch (20-cm) Schedule 80 seamless steel pipe was chosen to provide confinement in most tests of blasting agents and cap-sensitive explosives. Prior to loading the pipe with explosive, a continuous velocity probe of the type described by Santis is taped to the inner surface of the pipe along its length[1]. In conducting a test of a blasting agent, the commercial blasting agent minus its wrapper, or premixed ANFO are loaded into the pipe to a weight of 10 lb (4.54 kg). Initiation is provided by a 2-inch (5-cm) diameter, 2-inch (5-cm) thick cast pentolite booster, initiated by a number 8 instantaneous electric blasting cap. In conducting a test of a cap-sensitive explosive, the cartridge explosive is loaded into the pipe to a weight of about 10 lb (4.54 kg). Cap-sensitive explosives are initiated by a number 8 instantaneous electric blasting cap.

Following detonation of an explosive in the chamber, the fan is run for about 10 minutes to uniformly mix the chamber atmosphere before fumes samples are taken out of the chamber through 1/4-inch (0.6-cm) Teflon or polyethylene tubes for analysis. Teflon sample lines are used for nitrogen oxides and ammonia to minimize loss of these constituents to absorption on the tube surface. Vacutainer[1] samples are taken and sent to the analytical laboratory for analysis; this technique is appropriate for components that are stable in the Vacutainer, namely hydrogen, carbon monoxide, and carbon dioxide. Nitrogen dioxide, nitrogen oxides, and ammonia are not amenable to analysis by the Vacutainer technique and are instead absorbed in chemical solutions in bubbler trains using the technique described by Santis[2]. That method was modified by eliminating the purging of the system with helium and using a gas meter to measure the volume of fumes bubbled through the solutions rather than measuring gas flow rate. An electrochemical carbon monoxide monitor was also employed to act as a backup to the analytical lab's carbon monoxide analysis of the Vacutainer and to allow monitoring of the mixing of the chamber atmosphere.

RESULTS

An ANFO mixture of 94 pct ammonium nitrate, 6 pct fuel oil is close to optimum from the perspective of minimum toxic fumes production. Previous research and theory show that the detonating ANFO will produce excessive levels of nitrogen oxides if the fuel oil content is too low and will produce excessive levels of carbon monoxide and ammonia if the fuel oil content is too high.[3,4,5] This behavior is supported by data collected in the current research, as illustrated in Figures 2, 3, and 4.

In Figure 5 the data from figures 2, 3, and 4 is presented in terms of oxygen balance. Figure 5 is a plot of carbon monoxide production versus oxygen balance for ANFO and several cap-sensitive explosives. As the oxygen balance is increased for ANFO the carbon monoxide production decreases. This would be expected since there is increasing oxygen to convert the carbon monoxide to carbon dioxide. ANFO mixed at 6 pct fuel oil produces approximately the same amount of carbon monoxide as cap-sensitive explosives of equivalent oxygen balance. The opposite is true when looking at nitrogen oxides production as a function of oxygen balance, as illustrated in Figure 6. When the oxygen balance is increased, the nitrogen oxides and nitrogen dioxide production increased. ANFO mixed at 6 pct fuel oil produced significantly more nitrogen oxides and nitrogen dioxide than cap-sensitive explosives. Figure 7 illustrates that as the oxygen balance for ANFO is increased the ammonia production decreases. With the exception of a couple data points that may be anomalous, ANFO mixed at 6 pct fuel oil produced about the same quantity of ammonia as cap-sensitive explosives of equivalent oxygen balance.

Figure 8 shows that adding water to an ANFO mixture of 94 pct ammonium nitrate and 6 pct fuel oil had little effect on carbon monoxide production for water percentages from 0 to 10 pct. However the nitrogen oxides and nitrogen dioxide increased dramatically when water is added to the ANFO mixture. This is demonstrated in Figure 9. Figure 10 shows the effect of water on ammonia fumes production; adding water to the ANFO yields an erratic trend, indicating that further study is needed.

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[1]Reference to Specific products is for informational purposes and does not imply endorsement by NIOSH.

As mentioned earlier, shooting ANFO in 4-inch schedule 80 seamless steel pipe is probably much more confinement than seen in the field. To examine the effect of reduced confinement on fumes production, ANFO was tested in sheet metal and PVC pipe. As seen in Figure 11, reduced confinement doesn't have much effect on carbon monoxide production. Carbon monoxide production for ANFO shot in the PVC pipe was much higher than that for the steel or sheet metal pipe. The high carbon monoxide might be attributed to burning of the PVC pipe. The degree to which the PVC pipe reacted was not studied in detail, but it is safe to assume that at least some of the PVC burned during the ANFO detonation. The high carbon monoxide production would be consistent with the earlier observation that the higher the fuel content of the explosive, the higher the carbon monoxide production.

Explosive packaging is an important consideration relative to toxic fumes production. For example, a blast pattern may contain a number of boreholes that are contaminated with water and the blaster may decide to insert sleeves into the boreholes contaminated with water to keep the ANFO dry. If the sleeves are made of a combustible material they could add to the carbon monoxide production.   Figure 12 shows that the production of nitrogen oxides and nitrogen dioxide increases dramatically with lower confinement, while Figure 13 shows that with less confinement ammonia decreases.

Limestone rock dust (approximately 73 pct through 200 mesh) was added to the ANFO mixture to simulate drill cuttings being mixed with the ANFO as it was loaded into a borehole. The rock dust had little effect on the carbon monoxide production, as illustrated in Figure 14. Figure 15 shows that the addition of the rock dust led to an increase in nitrogen oxides production and a decrease in nitrogen dioxide production. Since the nitrogen oxides consist essentially of nitric oxide and nitrogen dioxide, this indicates that nitric oxide production increased significantly.   Figure 16 shows that adding rock dust to the ANFO caused a significant increase in ammonia production .

Aluminum is sometimes added to ANFO to increase the velocity and the output energy. Figure 14 illustrates that the aluminum added to the ANFO mixture has little effect on the production of carbon monoxide. From Figure 15 it is not clear whether or not the nitrogen oxides and nitrogen dioxide production is affected by the added aluminum. The ammonia increased with the added aluminum, as illustrated in figure 16. It should be noted that the addition of aluminum had no clear effect on the ANFO's detonation velocity. The aluminum added to the ANFO mixture was Fine Aluminum Paint Pigment Powder, Alcoa # 422 flake. This type was used to give the fastest possible burning rate for experimental purposes. For commercial explosives, the lowest and least expensive grade of aluminum is typically used, consisting of ground scrap aluminum of various particle sizes.

DISCUSSION

Several factors that may effect the fumes production of ANFO have been investigated. Probably the easiest to control is the fuel oil content. To minimize toxic fumes production , the ANFO should be mixed at 6 pct fuel oil. Deviating from the 6 pct will lead to excessive fumes. Water contamination may not have an affect on carbon monoxide production, but it increases the production of nitrogen oxides and nitrogen dioxide. At the present time in our research it is not clear how the production of ammonia is affected. The confinement of ANFO doesn't appear to make a difference in the production of carbon monoxide, but it makes a difference in the production of nitrogen oxides , nitrogen dioxide, and ammonia.

In the case of nitrogen oxides and nitrogen dioxide the fumes production will increase, while the ammonia fumes production will decrease.

Adding aluminum or rock dust to ANFO does not affect the fumes production of carbon monoxide. The addition of aluminum does not have a significant affect on nitrogen oxides and nitrogen dioxide production, but the addition of rock dust leads to an increased production of nitrogen oxides. Additionally, the rock dust appears to have an effect on the ratio of nitric oxide to nitrogen dioxide. The addition of aluminum and rock dust increased the production of ammonia. The effect of rock dust on fume production was based on limited data and requires further study to look at the effect of particle size and dust type.

Its important to understand that the data reported here applies only to the test conditions under which the data was collected. For example, the schedule 80 steel pipe may provide more confinement than many field blasts. The research reported here shows that the confinement will affect the quantity of toxic fumes produced. In the field the toxic fumes released from a blast will differ significantly from the data reported here. There is a need to collect data from the field to develop an understanding of how data from the PRL fumes chamber compare to fumes production in the field. This, in return, will help in developing improved tests for evaluating fumes production.

1. Santis, L. D. and R. A. Cortese, A Method of Measuring Continuous Detonation Rates Using Off-the-Shelf Items, Proceedings of the Twenty-Second Annual Conference on Explosives and Blasting Technique, Orlando, FL, February 4-8, 1996.

2. Santis, L. D., J. H. Rowland, III, D. J. Viscusi, and M. H. Weslowski, The Large Chamber Test for Toxic Fumes Analysis for Permissible Explosives, Proceedings of the Twenty-First Annual Conference on Explosives and Blasting Technique, Nashville, TN, February 5-9, 1995.

3. Mainiero, R.J., A Technique for Measuring Toxic Gases Produced by Blasting Agents, Proceedings of the Twenty Third Annual Conference on Explosives and Blasting Technique, Las Vegas, NV, February 2-5, 1997.

4. Blaster's Handbook, Sixteenth Edition, E.I. du Pont de Nemours and Company, 1977, p. 59.

5. Explosives and Rock Blasting, Atlas Powder Company, 1987, p. 25-27.

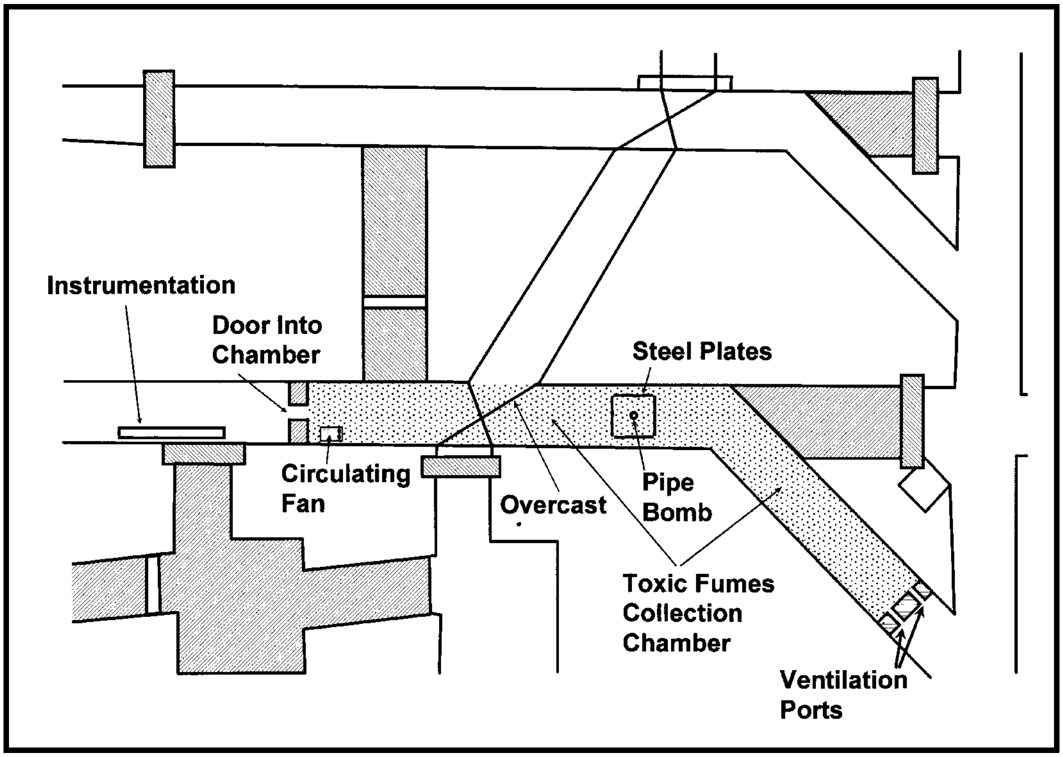


Figure 1. Research was conducted in a chamber created in the underground mine at the Pittsburgh Research Lab.

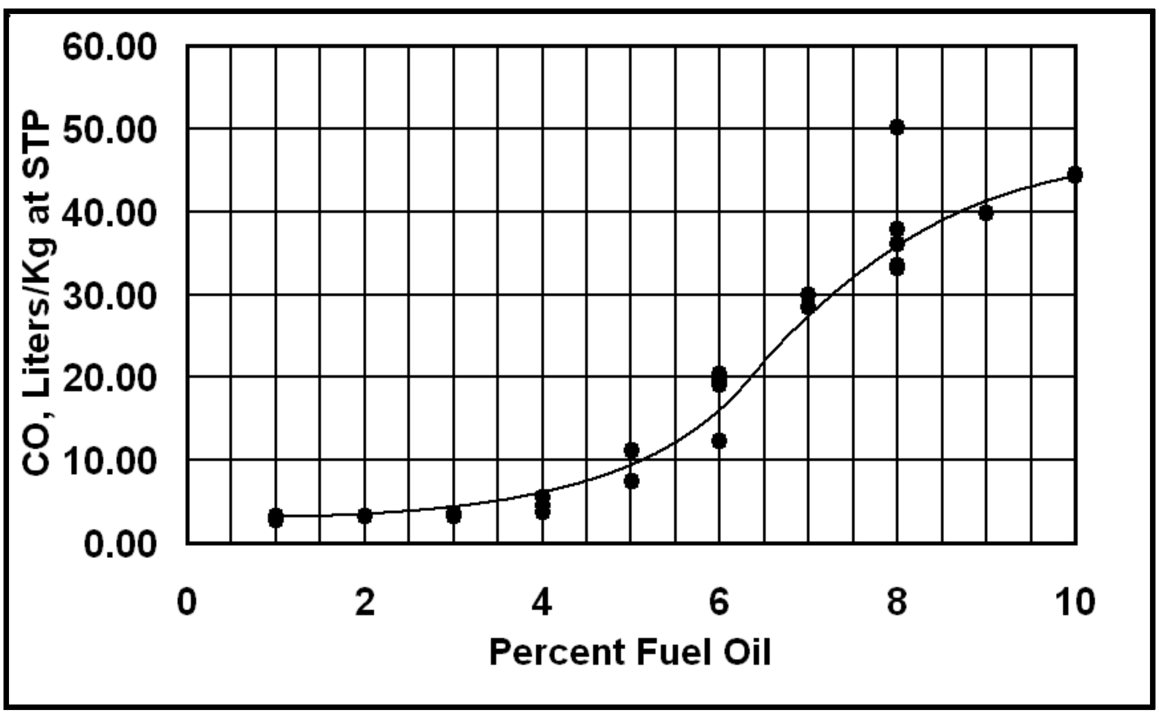


Figure 2. Effect of ANFO fuel oil content on carbon monoxide production. In all figures, the line is a polynomial fit to the data; it is included for illustrative purposes and does not represent a fit of theoretical results.

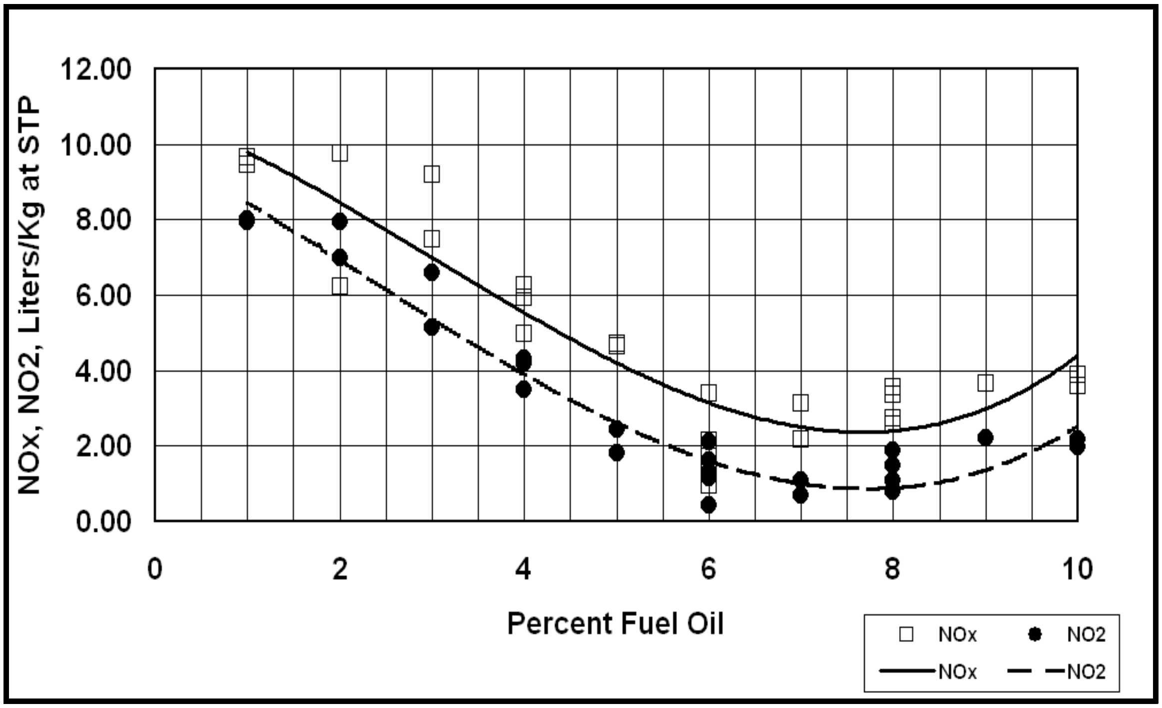


Figure 3. Effect of ANFO fuel oil content on nitrogen oxides and nitrogen dioxide production.

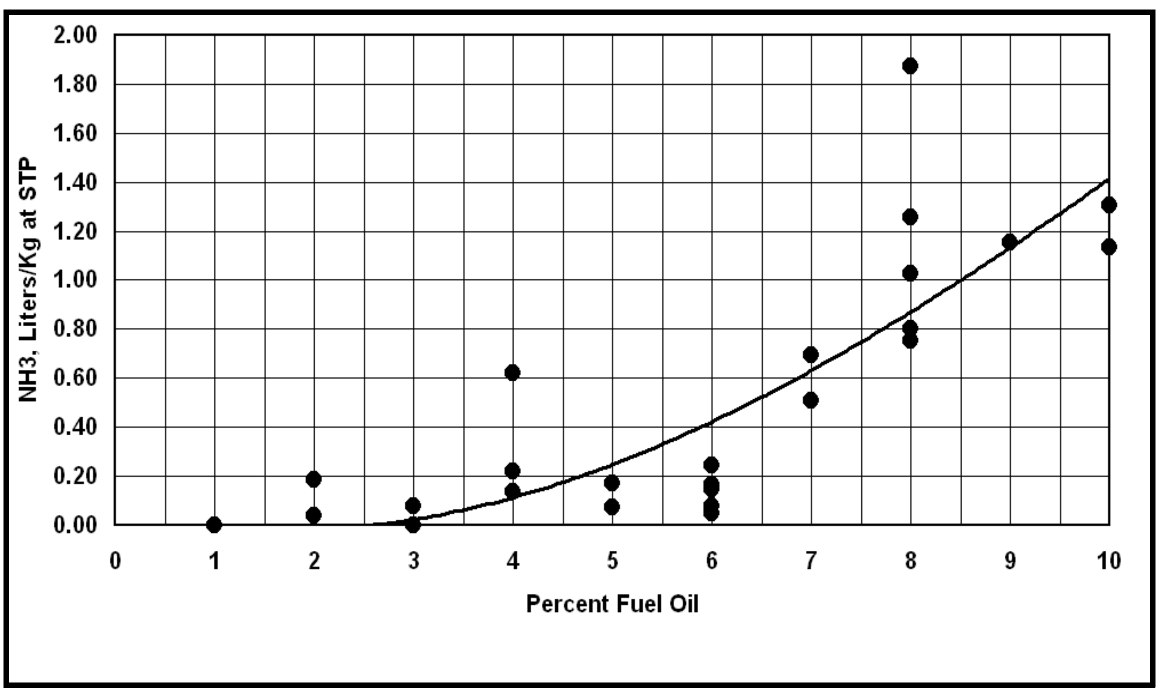


Figure 4. Effect of ANFO fuel oil content on ammonia production.

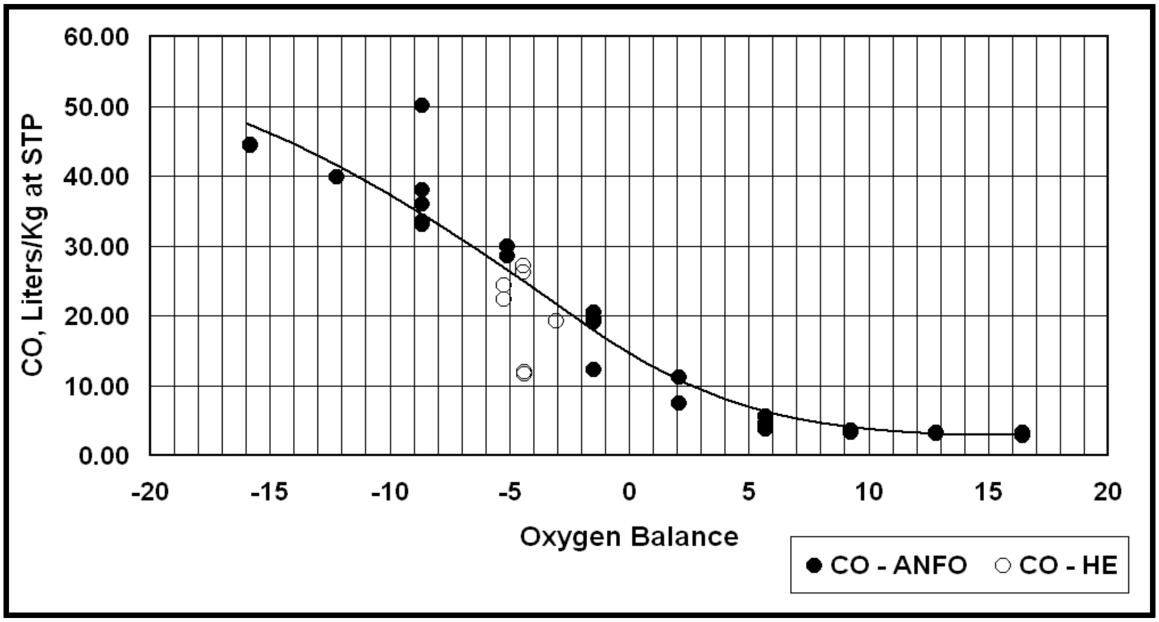


Figure 5. Effect of Oxygen Balance on carbon monoxide production for 94/6 ANFO and high explosives (cap-sensitive explosives).

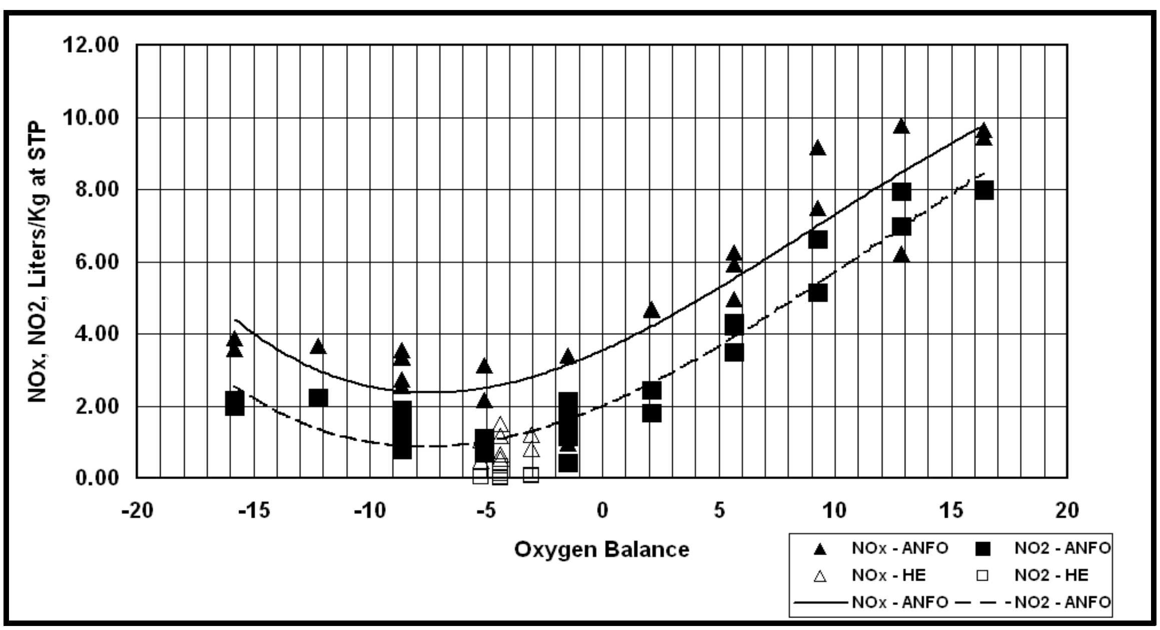


Figure 6. Effect of Oxygen Balance on nitrogen oxides and nitrogen dioxide production for 94/6 ANFO and high explosives (cap-sensitive explosives).

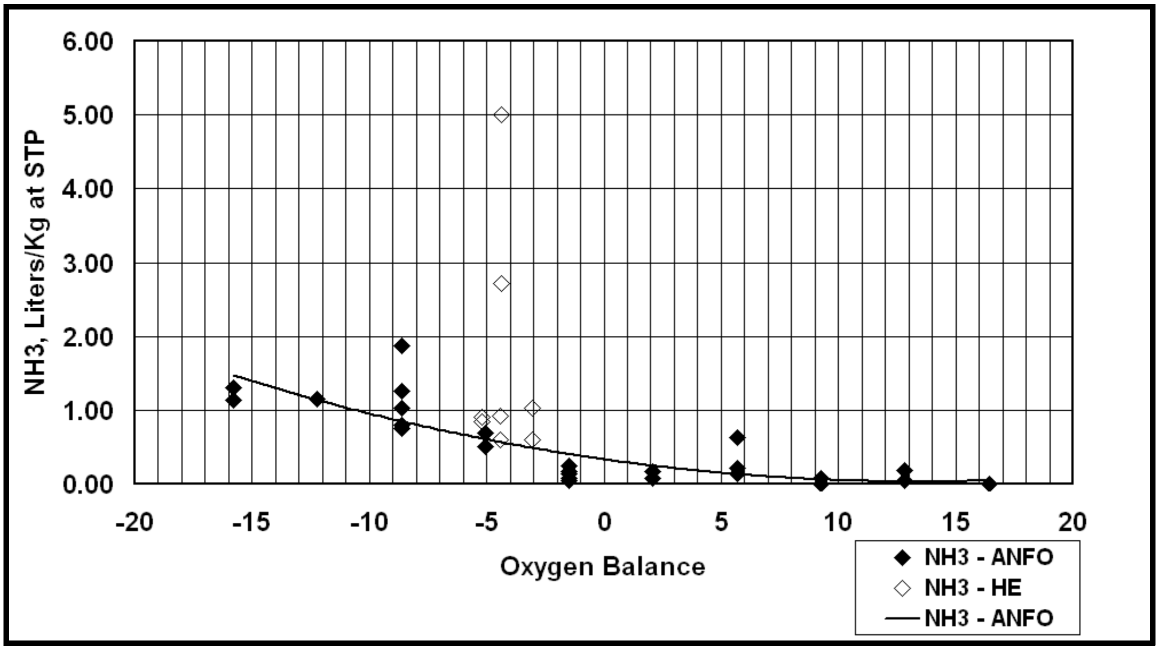


Figure 7. Effect of Oxygen Balance on ammonia production for 94/6 ANFO and high explosives (cap-sensitive explosives).

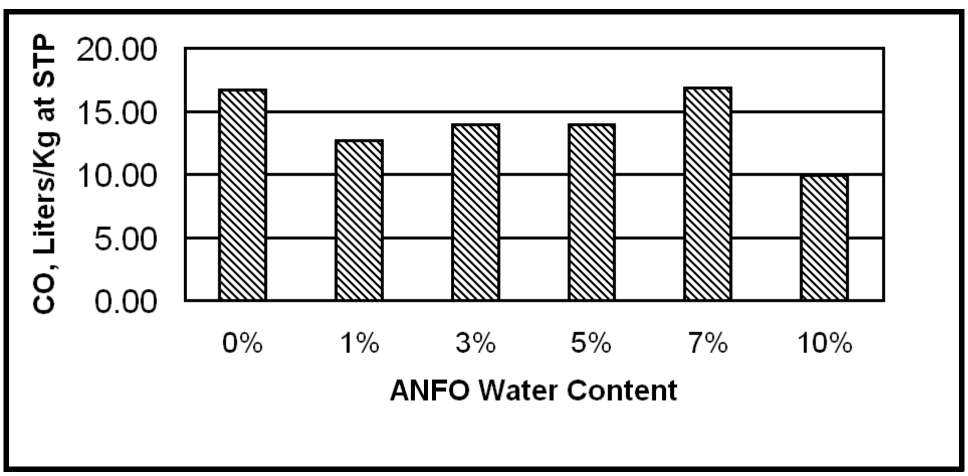


Figure 8. Effect of ANFO water content on carbon monoxide production for a 94/6 mix.

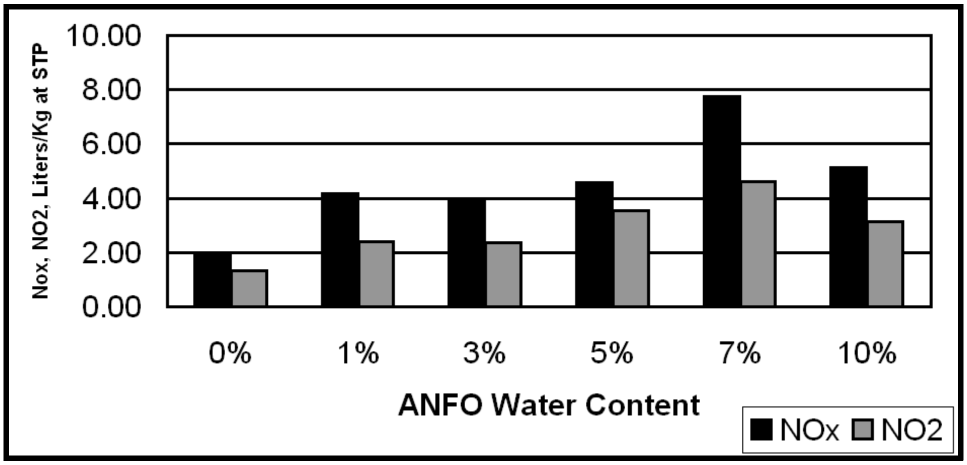


Figure 9. Effect of 94/6 ANFO water content on nitrogen oxides and nitrogen dioxide production.

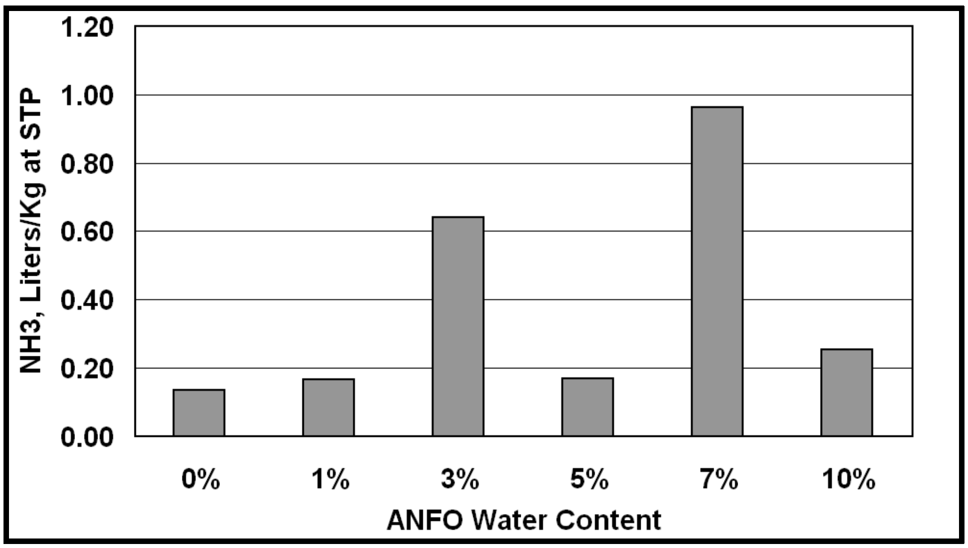


Figure 10. Effect of 94/6 ANFO water content on ammonia production.

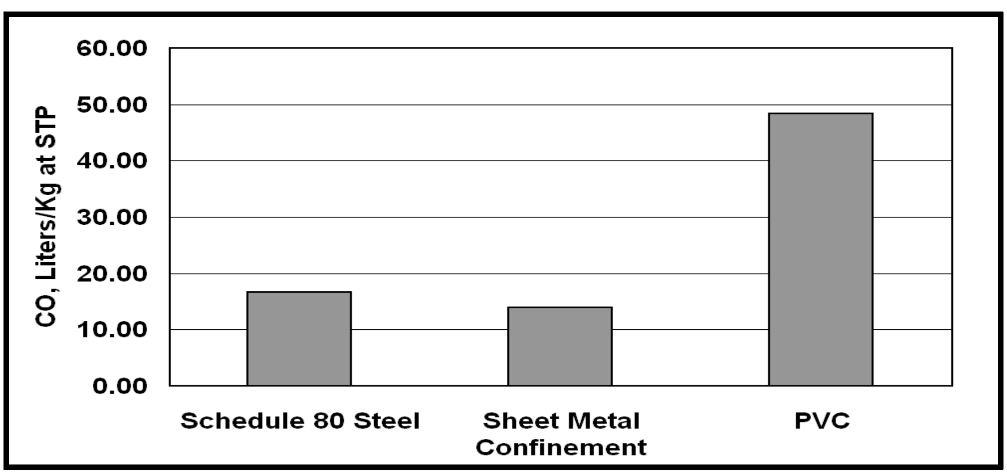


Figure 11. Effect of 94/6 ANFO confinement on carbon monoxide production.

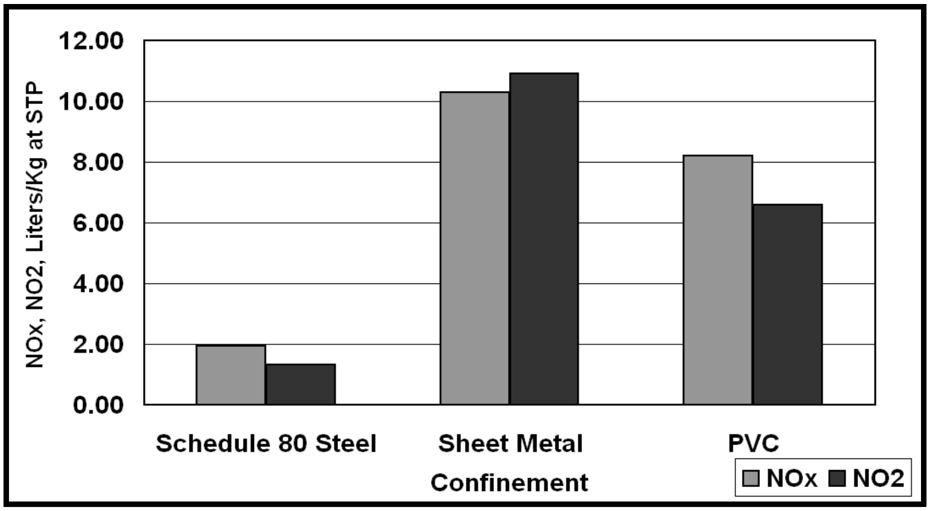


Figure 12. Effect of 94/6 ANFO confinement on nitrogen oxides and nitrogen dioxide production.

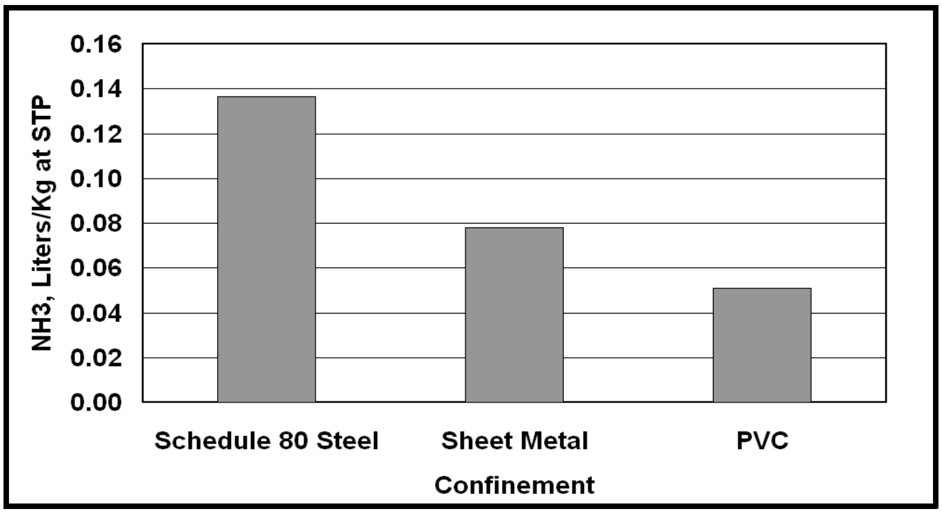


Figure 13. Effect of 94/6 ANFO confinement on ammonia production.

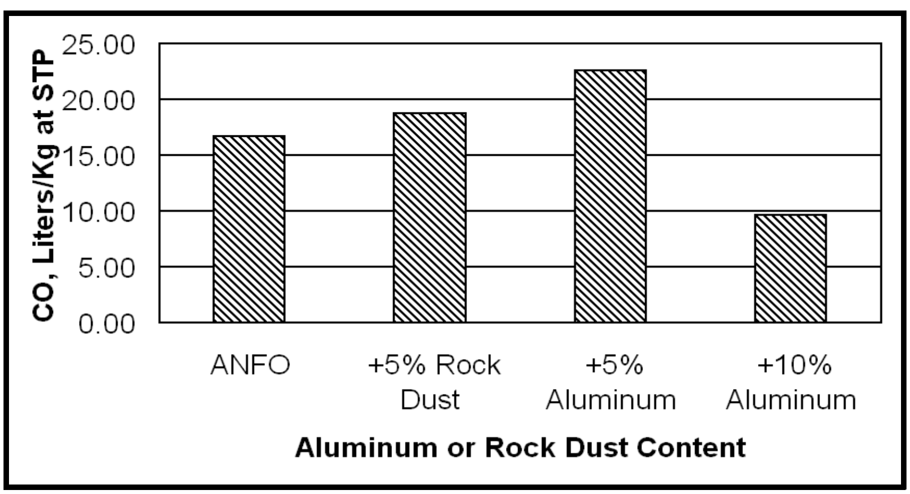


Figure 14. Effect of aluminum and rock dust content on carbon monoxide production.

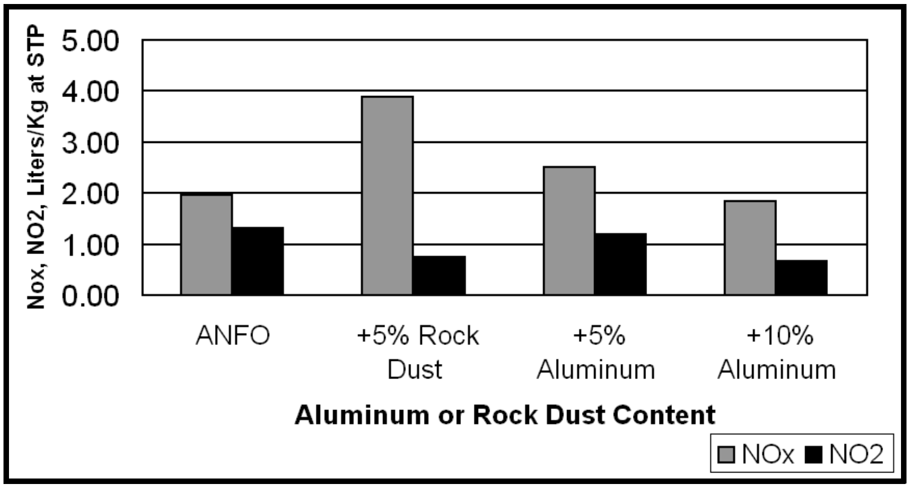


Figure 15. Effect of aluminum and rock dust content on nitrogen oxides and nitrogen dioxide production.

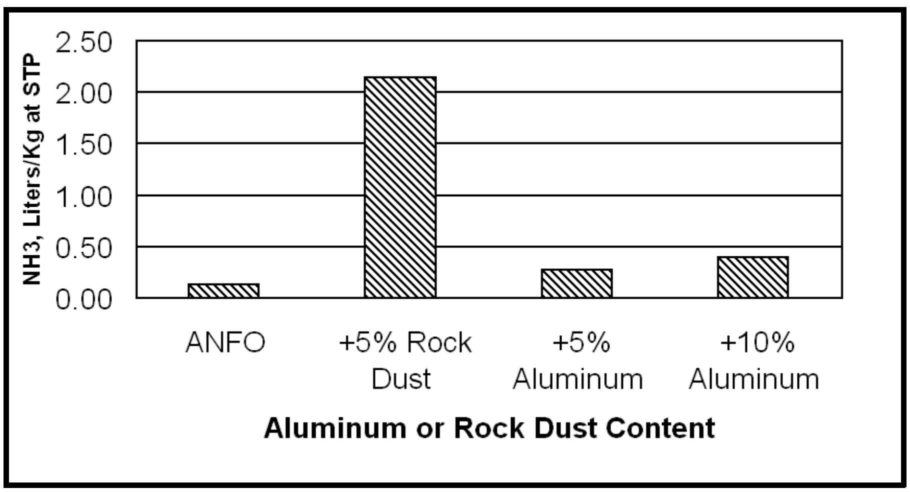


Figure 16. Effect of aluminum or rock dust content on ammonia production.

11.9 Western Surface Coal Mining

11.9.1 General[1]

There are 12 major coal fields in the western states (excluding the Pacific Coast and Alaskan fields), as shown in Figure 11.9-1. Together, they account for more than 64 percent of the surface minable coal reserves in the United States.[2] The 12 coal fields have varying characteristics that may influence fugitive dust emission rates from mining operations including overburden and coal seam thicknesses and structure, mining equipment, operating procedures, terrain, vegetation, precipitation and surface moisture, wind speeds, and temperatures. The operations at a typical western surface mine are shown in Figure 11.9-2. All operations that involve movement of soil or coal, or exposure of erodible surfaces, generate some amount of fugitive dust.

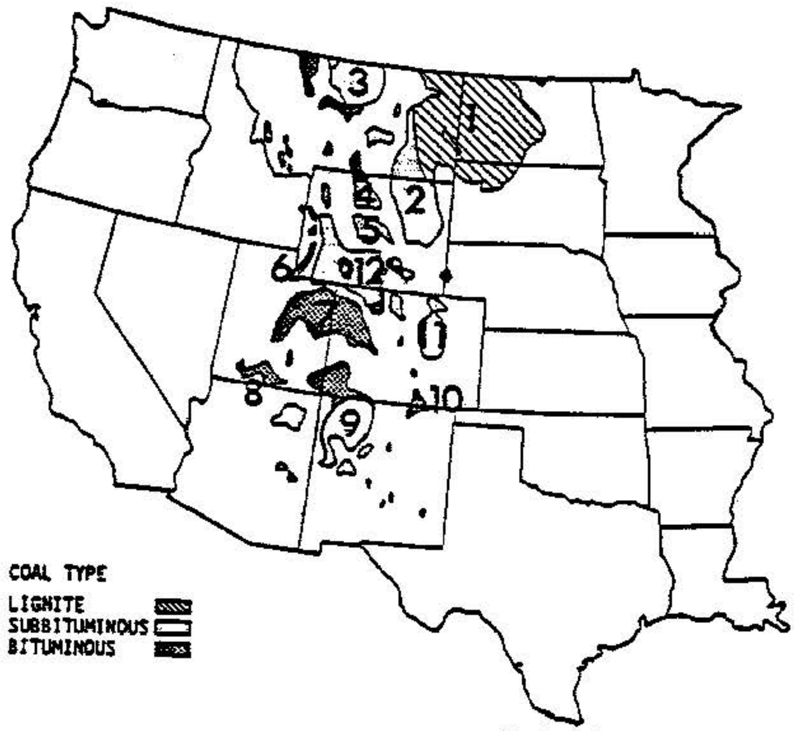
The initial operation is removal of topsoil and subsoil with large scrapers. The topsoil is carried by the scrapers to cover a previously mined and regraded area as part of the reclamation process or is placed in temporary stockpiles. The exposed overburden, the earth that is between the topsoil and the coal seam, is leveled, drilled, and blasted. Then the overburden material is removed down to the coal seam, usually by a dragline or a shovel and truck operation. It is placed in the adjacent mined cut, forming a spoils pile. The uncovered coal seam is then drilled and blasted. A shovel or front end loader loads the broken coal into haul trucks, and it is taken out of the pit along graded haul roads to the tipple, or truck dump. Raw coal sometimes may be dumped onto a temporary storage pile and later rehandled by a front end loader or bulldozer.

At the tipple, the coal is dumped into a hopper that feeds the primary crusher, then is conveyed through additional coal preparation equipment such as secondary crushers and screens to the storage area. If the mine has open storage piles, the crushed coal passes through a coal stacker onto the pile. The piles, usually worked by bulldozers, are subject to wind erosion. From the storage area, the coal is conveyed to a train loading facility and is put into rail cars. At a captive mine, coal will go from the storage pile to the power plant.

During mine reclamation, which proceeds continuously throughout the life of the mine, overburden spoils piles are smoothed and contoured by bulldozers. Topsoil is placed on the graded spoils, and the land is prepared for revegetation by furrowing, mulching, etc. From the time an area is disturbed until the new vegetation emerges, all disturbed areas are subject to wind erosion.

11.9.2 Emissions

Predictive emission factor equations for open dust sources at western surface coal mines are presented in Tables 11.9-1 and 11.9-2. Each equation applies to a single dust-generating activity, such as vehicle traffic on haul roads. The predictive equation explains much of the observed variance in emission factors by relating emissions to three sets of source parameters: (1) measures of source activity or energy expended (e. g., speed and weight of a vehicle traveling on an unpaved road); (2) properties of the material being disturbed (e. g., suspendable fines in the surface material of an unpaved road); and (3) climate (in this case, mean wind speed).



	Coal field	Strippable reserves (10^6 tons)
1	Fort Union	23,529
2	Powder River	56,727
3	North Central	All underground
4	Bighorn Basin	All underground
5	Wind River	3
6	Hams Fork	1,000
7	Uinta	308
8	Southwestern Utah	224
9	San Juan River	2,318
10	Raton Mesa	All underground
11	Denver	All underground
12	Green River	2,120

Figure 11.9-1. Coal fields of the western United States.[3]

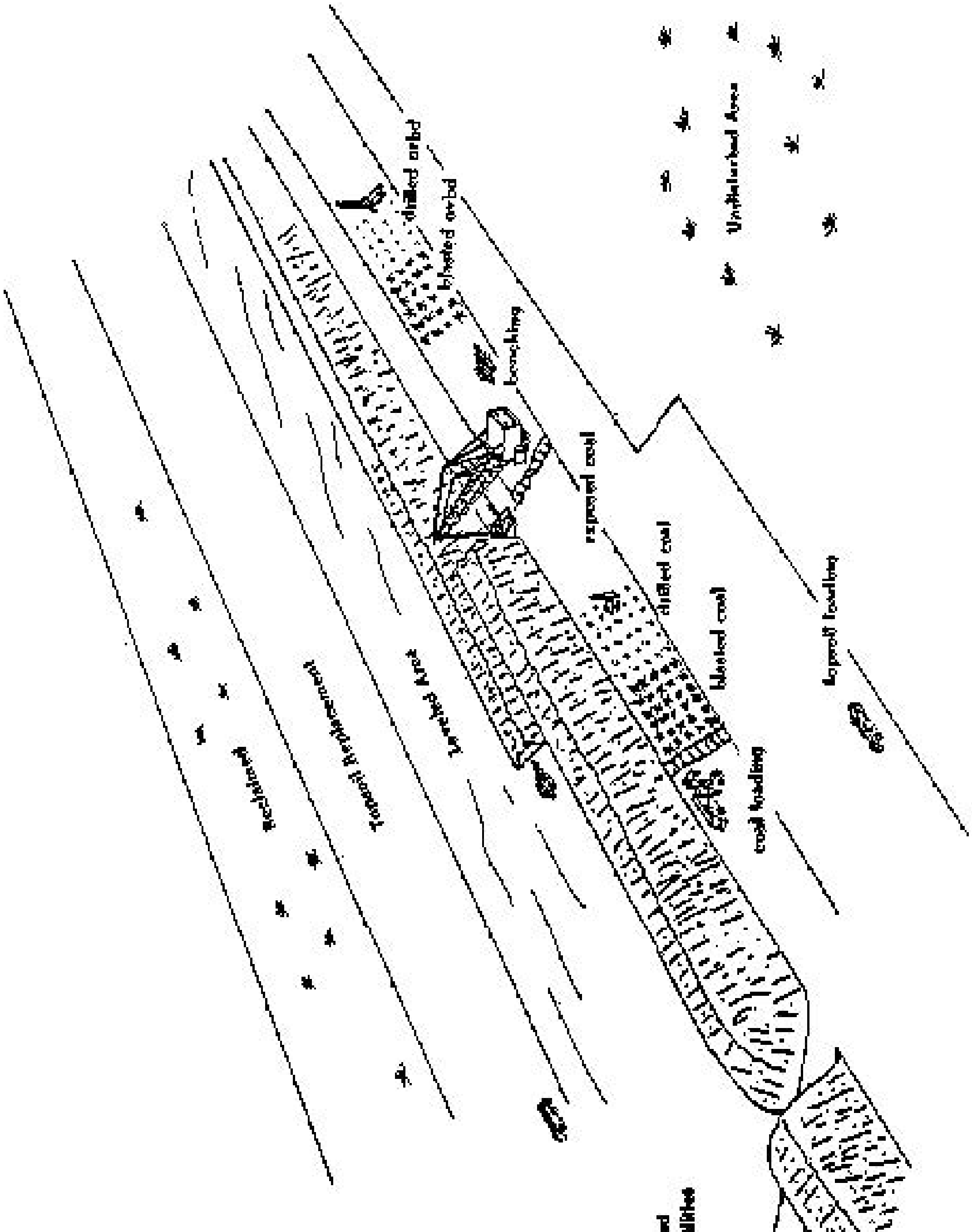


Figure 11.9-2. Operations at typical western surface coal mines.

The equations may be used to estimate particulate emissions generated per unit of source extent or activity (e. g., distance traveled by a haul truck or mass of material transferred). The equations were developed through field sampling of various western surface mine types and are thus applicable to any of the surface coal mines located in the western United States.

In Tables 11.9-1 and 11.9-2, the assigned quality ratings apply within the ranges of source conditions that were tested in developing the equations given in Table 11.9-3. However, the equations should be derated 1 letter value (e. g., A to B) if applied to eastern surface coal mines.

In using the equations to estimate emissions from sources found in a specific western surface mine, it is necessary that reliable values for correction parameters be determined for the specific sources of interest if the assigned quality ratings of the equations are to be applicable. For example, actual silt content of coal or overburden measured at a facility should be used instead of estimated values. In the event that site-specific values for correction parameters cannot be obtained, the appropriate geometric mean values from Table 11.9-3 may be used, but the assigned quality rating of each emission factor equation should be reduced by 1 level (e. g., A to B).

Emission factors for open dust sources not covered in Table 11.9-3 are in Table 11.9-4. These factors were determined through source testing at various western coal mines.

The factors in Table 11.9-4 for mine locations I through V were developed for specific geographical areas. Tables 11.9-5 and 11.9-6 present characteristics of each of these mines (areas). A "mine-specific" emission factor should be used only if the characteristics of the mine for which an emissions estimate is needed are very similar to those of the mine for which the emission factor was developed. The other (nonspecific) emission factors were developed at a variety of mine types and thus are applicable to any western surface coal mine.

As an alternative to the single valued emission factors given in Table 11.9-4 for train or truck loading and for truck or scraper unloading, two empirically derived emission factor equations are presented in Section 13.2.4 of this document. Each equation was developed for a source operation (i. e., batch drop and continuous drop, respectively) comprising a single dust-generating mechanism that crosses industry lines.

Because the predictive equations allow emission factor adjustment to specific source conditions, the equations should be used in place of the single-valued factors in Table 11.9-4 for the sources identified above, if emission estimates for a specific western surface coal mine are needed. However, the generally higher quality ratings assigned to the equations are applicable only if: (1) reliable values of correction parameters have been determined for the specific sources of interest, and (2) the correction parameter values lie within the ranges tested in developing the equations. Caution must be exercised so that only the unbound (sorbed) moisture (i. e., not any bound moisture) is used in determining the moisture content for input to the Chapter 13 equations.

Table 11.9-1 (English Units). EMISSION FACTOR EQUATIONS FOR UNCONTROLLED OPEN DUST SOURCES AT WESTERN SURFACE COAL MINES[a]

Operation	Material	Emissions By Particle Size Range (Aerodynamic Diameter)[b,c]				Units	EMISSION FACTOR RATING
		Emission Factor Equations		Scaling Factors			
		TSP ≤30 µm	≤15 µm	≤10 µm[d]	≤2.5 µm/TSP[e]		
Blasting[f]	Coal or overburden	$0.000014(A)^{1.5}$	ND	0.52[e]	0.03	lb/blast	C_DD
Truck loading	Coal	$\frac{1.16}{(M)^{1.2}}$	$\frac{0.119}{(M)^{0.9}}$	0.75	0.019	lb/ton	BBCC
Bulldozing	Coal	$\frac{78.4\ (s)^{1.2}}{(M)^{1.3}}$	$\frac{18.6\ (s)^{1.5}}{(M)^{1.4}}$	0.75	0.022	lb/hr	CCDD
	Overburden	$\frac{5.7\ (s)^{1.2}}{(M)^{1.3}}$	$\frac{1.0\ (s)^{1.5}}{(M)^{1.4}}$	0.75	0.105	lb/hr	BCDD
Dragline	Overburden	$\frac{0.0021\ (d)^{1.1}}{(M)^{0.3}}$	$\frac{0.0021\ (d)^{0.7}}{(M)^{0.3}}$	0.75	0.017	lb/yd^3	BCDD
Vehicle traffic[g]							
Grading		$0.040\ (S)^{2.5}$	$0.051\ (S)^{2.0}$	0.60	0.031	lb/VMT	CCDD
Active storage pile[h] (wind erosion and maintenance)	Coal	0.72 u	ND	ND	ND	$\frac{lb}{(acre)(hr)}$	C[i]_ _ _

[a] Reference 1, except as noted. VMT = vehicle miles traveled. ND = no data. Quality ratings coded where "Q, X, Y, Z" are ratings for ≤30 µm, ≤15 µm, ≤10 µm, and ≤2.5 µm, respectively. See also note below.

[b] Particulate matter less than or equal to 30 µm in aerodynamic diameter is sometimes termed "suspendable particulate" and is often used as a surrogate for TSP (total suspended particulate). TSP denotes what is measured by a standard high volume sampler (see Section 13.2).

[c] Symbols for equations:

- A = horizontal area (ft^2), with blasting depth ≤ 70 ft. Not for vertical face of a bench.
- M = material moisture content (%)
- s = material silt content (%)
- u = wind speed (mph)
- d = drop height (ft)
- W = mean vehicle weight (tons)
- S = mean vehicle speed (mph)
- w = mean number of wheels

Chino TRI data received from Clyde Durham 1/28/11 email

Average metal content of waste rock, ore for leach, ore for milling, PLS, wastewater etc.

Waste Rock

Metal	Conc. (ppm)	Conc. (%)
Antimony	3.2	0.0003
Arsenic	3.8	0.0004
Barium	111.0	0.0111
Beryllium	NA	NA
Cadmium	1.0	0.0001
Chromium	56.9	0.0057
Cobalt	14.5	0.0015
Copper	533.3	0.0533
Lead	9.0	0.0009
Mercury	NA	NA
Manganese	440.0	0.0440
Nickel	11.0	0.0011
Selenium	NA	NA
Silver	4.0	0.0004
Thallium	NA	NA
Vanadium	37.0	0.0037
Zinc	79.0	0.0079

Ore for Mill

Metal	Conc. (ppm)	Conc. (%)
Antimony	6.7	0.0007
Arsenic	3.9	0.0004
Barium	19	0.0019
Beryllium	NA	NA
Cadmium	2.2	0.0002
Chromium	25.0	0.0025
Cobalt	20	0.0020
Copper	5900	0.5900
Lead	27	0.0027
Mercury	NA	NA
Manganese	662	0.0662
Nickel	12	0.0012
Selenium	NA	NA
Silver	0.8	0.0001
Thallium	NA	NA
Vanadium	43	0.0043
Zinc	110	0.0110

Ore for Leach

Metal	Conc. (ppm)	Conc. (%)
Antimony	4.8	0.0005
Arsenic	3.7	0.0004
Barium	68	0.0068
Beryllium	NA	NA
Cadmium	1.3	0.0001
Chromium	91.0	0.0091
Cobalt	39	0.0039
Copper	2918	0.2918
Lead	15.7	0.0016
Mercury	NA	NA
Manganese	493	0.0493
Nickel	21	0.0021
Selenium	NA	NA
Silver	0.8	0.0001
Thallium	NA	NA
Vanadium	27	0.0027
Zinc	94	0.0094

Copper Concentrate

Metal	Conc. (ppm)	Conc. (%)
Antimony	50	0.005
Arsenic	40	0.004
Barium	80	0.008
Beryllium	10	0.001
Cadmium	20	0.002
Chromium	50	0.005
Cobalt	50	0.005
Copper	250,000	25
Lead	10	0.001
Mercury	5	0.0005
Manganese	100	0.01
Nickel	50	0.005
Selenium	40	0.004
Silver	10	0.001
Thallium	5	0.0005
Vanadium	5	0.0005
Zinc	80	0.008

Moly Concentrate

Metal	Conc. (ppm)	Conc. (%)
Antimony	50	0.005
Arsenic	40	0.004
Barium	80	0.008
Beryllium	10	0.001
Cadmium	20	0.002
Chromium	50	0.005
Cobalt	50	0.005
Copper	50	0.005
Lead	10	0.001
Mercury	5	0.0005
Manganese	100	0.01
Nickel	50	0.005
Selenium	40	0.004
Silver	10	0.001
Thallium	5	0.0005
Vanadium	5	0.0005
Zinc	80	0.008

13.2.5 Industrial Wind Erosion

13.2.5.1 General[1-3]

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:

$$u(z) = \frac{u*}{0.4} \ln \frac{z}{z_o} \qquad (z > z_o) \tag{1}$$

where:

u = wind speed, cm/s
u^* = friction velocity, cm/s
z = height above test surface, cm
z_o = 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.

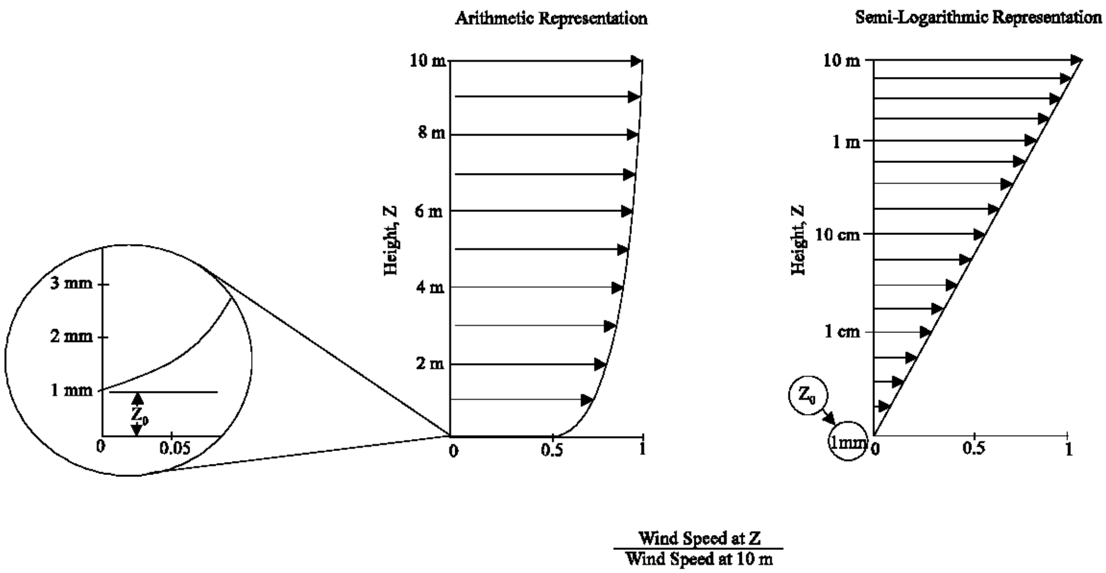


Figure 13.2.5-1. Illustration of logarithmic velocity profile.

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 Equation[4]

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:

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

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 ith 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 um 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:

$$P = 58\ (u^* - u_t^*)^2 + 25\ (u^* - u_t^*)$$
$$P = 0 \text{ for } u^* \le u_t^* \tag{3}$$

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_o = Act	z_o = 0.5 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:

$$u^* = 0.053\ u_{10}^+ \tag{4}$$

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_o) 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:

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

   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)

$$u^+_s = \frac{(u_s)}{u_r} \quad u^+_{10} \tag{6}$$

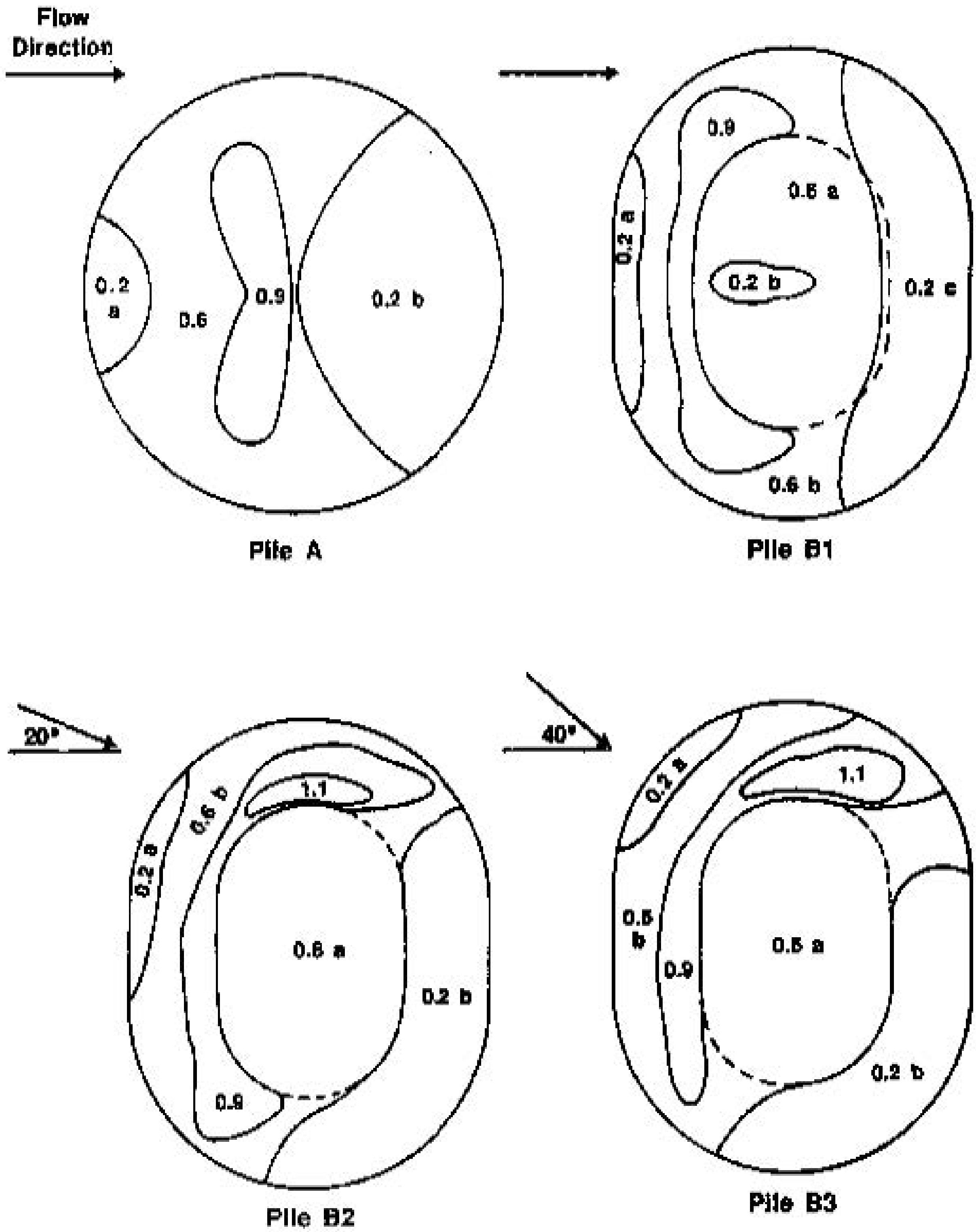


Figure 13.2.5-2. Contours of normalized surface windspeeds, u_s/u_r.

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^*):

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

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^+_{10}) 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 feet [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

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

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.

<u>Step 1</u>: 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.

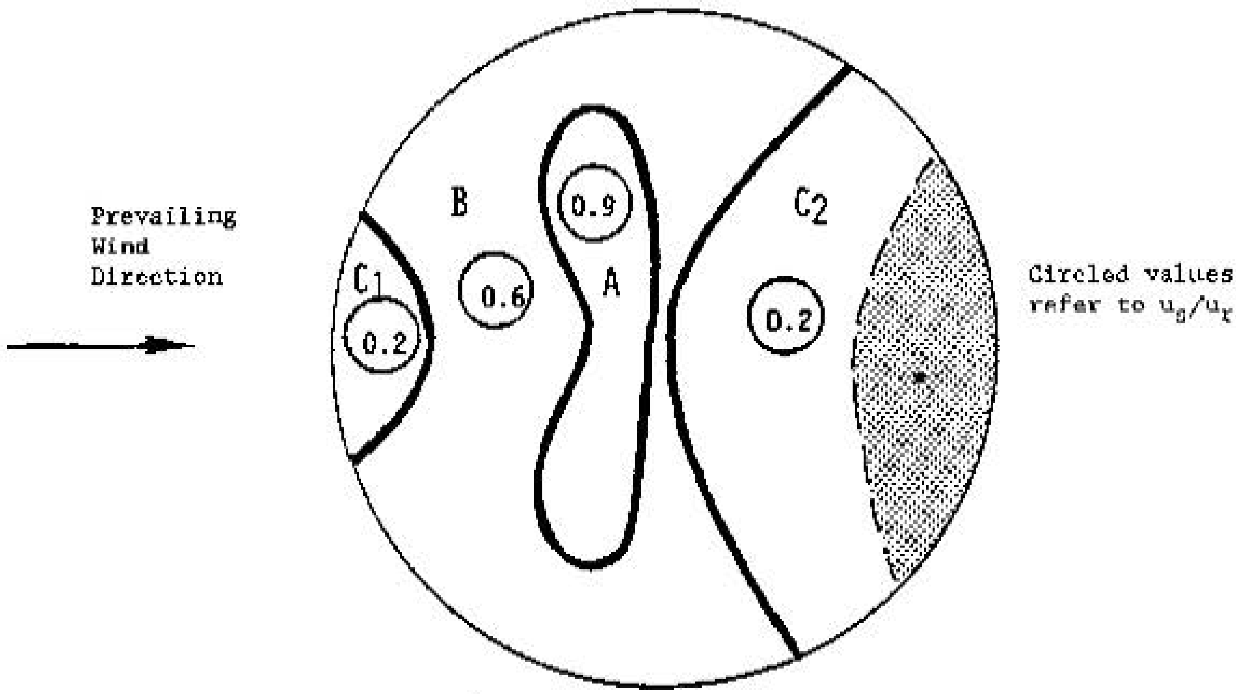
<u>Step 2</u>: Except for a small area near the base of the pile (see Figure 13.2.5-3), the entire pile surface is disturbed every 3 days, corresponding to a value of N = 120 per year. It will be shown that the contribution of the area where daily activity occurs is negligible so that it does not need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

<u>Step 3</u>: 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,

$$u_{10}^{+} = u_7^{+} \left(\frac{\ln(10/0.005)}{\ln(7/0.005)} \right)$$

$$u_{10}^{+} = 1.05\ u_7^{+}$$

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



* A portion of C_2 is disturbed daily by reclaiming activities.

Area ID	$\frac{u_s}{u_r}$	Pile Surface %	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						
			Fastest Mile			
Resultant Dir.	Resultant Speed M.P.H.	Average Speed M.P.H.	Speed M.P.H.	Direction		Date
13	14	15	16	17		22
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}^+		$u^* = 0.1u_s^+$ (m/s)		
	mph	m/s	mph	m/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

<u>Step 5</u>: 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.

<u>Steps 6 and 7</u>: 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:

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

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/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, $u^+_{10} = 1.05\ u^+_7$, so that $u^+_{10} = 33$ 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:

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

$$P = 58(0.77 - 0.54)^2 + 25(0.77 - 0.54)$$

$$= 3.07 + 5.75$$

$$= 8.82 \text{ g/m}^2$$

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

$$E = (0.5)(8.82 \text{ g/m}^2)(670 \text{ m}^2)$$

$$= 3.0 \text{ kg}$$

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Chino TRI data received from Clyde Durham 1/28/11 email

Average metal content of waste rock, ore for leach, ore for milling, PLS, wastewater etc.

Waste Rock

Metal	Conc. (ppm)	Conc. (%)
Antimony	3.2	0.0003
Arsenic	3.8	0.0004
Barium	111.0	0.0111
Beryllium	NA	NA
Cadmium	1.0	0.0001
Chromium	56.9	0.0057
Cobalt	14.5	0.0015
Copper	533.3	0.0533
Lead	9.0	0.0009
Mercury	NA	NA
Manganese	440.0	0.0440
Nickel	11.0	0.0011
Selenium	NA	NA
Silver	4.0	0.0004
Thallium	NA	NA
Vanadium	37.0	0.0037
Zinc	79.0	0.0079

Ore for Mill

Metal	Conc. (ppm)	Conc. (%)
Antimony	6.7	0.0007
Arsenic	3.9	0.0004
Barium	19	0.0019
Beryllium	NA	NA
Cadmium	2.2	0.0002
Chromium	25.0	0.0025
Cobalt	20	0.0020
Copper	5900	0.5900
Lead	27	0.0027
Mercury	NA	NA
Manganese	662	0.0662
Nickel	12	0.0012
Selenium	NA	NA
Silver	0.8	0.0001
Thallium	NA	NA
Vanadium	43	0.0043
Zinc	110	0.0110

Ore for Leach

Metal	Conc. (ppm)	Conc. (%)
Antimony	4.8	0.0005
Arsenic	3.7	0.0004
Barium	68	0.0068
Beryllium	NA	NA
Cadmium	1.3	0.0001
Chromium	91.0	0.0091
Cobalt	39	0.0039
Copper	2918	0.2918
Lead	15.7	0.0016
Mercury	NA	NA
Manganese	493	0.0493
Nickel	21	0.0021
Selenium	NA	NA
Silver	0.8	0.0001
Thallium	NA	NA
Vanadium	27	0.0027
Zinc	94	0.0094

Copper Concentrate

Metal	Conc. (ppm)	Conc. (%)
Antimony	50	0.005
Arsenic	40	0.004
Barium	80	0.008
Beryllium	10	0.001
Cadmium	20	0.002
Chromium	50	0.005
Cobalt	50	0.005
Copper	250,000	25
Lead	10	0.001
Mercury	5	0.0005
Manganese	100	0.01
Nickel	50	0.005
Selenium	40	0.004
Silver	10	0.001
Thallium	5	0.0005
Vanadium	5	0.0005
Zinc	80	0.008

Moly Concentrate

Metal	Conc. (ppm)	Conc. (%)
Antimony	50	0.005
Arsenic	40	0.004
Barium	80	0.008
Beryllium	10	0.001
Cadmium	20	0.002
Chromium	50	0.005
Cobalt	50	0.005
Copper	50	0.005
Lead	10	0.001
Mercury	5	0.0005
Manganese	100	0.01
Nickel	50	0.005
Selenium	40	0.004
Silver	10	0.001
Thallium	5	0.0005
Vanadium	5	0.0005
Zinc	80	0.008

Table 11.19.2-2 (English Units). EMISSION FACTORS FOR CRUSHED STONE PROCESSING OPERATIONS (lb/Ton)[a]

Source [b]	Total Particulate Matter [r,s]	EMISSION FACTOR RATING	Total PM-10	EMISSION FACTOR RATING	Total PM-2.5	EMISSION FACTOR RATING
Primary Crushing (SCC 3-05-020-01)	ND		ND[n]		ND[n]	
Primary Crushing (controlled) (SCC 3-05-020-01)	ND		ND[n]		ND[n]	
Secondary Crushing (SCC 3-05-020-02)	ND		ND[n]		ND[n]	
Secondary Crushing (controlled) (SCC 3-05-020-02)	ND		ND[n]		ND[n]	
Tertiary Crushing (SCC 3-050030-03)	0.0054[d]	E	0.0024[o]	C	ND[n]	
Tertiary Crushing (controlled) (SCC 3-05-020-03)	0.0012[d]	E	0.00054[p]	C	0.00010[q]	E
Fines Crushing (SCC 3-05-020-05)	0.0390[e]	E	0.0150[e]	E	ND	
Fines Crushing (controlled) (SCC 3-05-020-05)	0.0030[f]	E	0.0012[f]	E	0.000070[q]	E
Screening (SCC 3-05-020-02, 03)	0.025[c]	E	0.0087[l]	C	ND	
Screening (controlled) (SCC 3-05-020-02, 03)	0.0022[d]	E	0.00074[m]	C	0.000050[q]	E
Fines Screening (SCC 3-05-020-21)	0.30[g]	E	0.072[g]	E	ND	
Fines Screening (controlled) (SCC 3-05-020-21)	0.0036[g]	E	0.0022[g]	E	ND	
Conveyor Transfer Point (SCC 3-05-020-06)	0.0030[h]	E	0.00110[h]	D	ND	
Conveyor Transfer Point (controlled) (SCC 3-05-020-06)	0.00014[i]	E	4.6×10^{-5}[i]	D	1.3×10^{-5}[q]	E
Wet Drilling - Unfragmented Stone (SCC 3-05-020-10)	ND		8.0×10^{-5}[j]	E	ND	
Truck Unloading -Fragmented Stone (SCC 3-05-020-31)	ND		1.6×10^{-5}[j]	E	ND	
Truck Loading - Conveyor, crushed stone (SCC 3-05-020-32)	ND		0.00010[k]	E	ND	

a. Emission factors represent uncontrolled emissions unless noted. Emission factors in lb/Ton of material of throughput. SCC = Source Classification Code. ND = No data.

b. Controlled sources (with wet suppression) are those that are part of the processing plant that employs current wet suppression technology similar to the study group. The moisture content of the study group without wet suppression systems operating (uncontrolled) ranged from 0.21 to 1.3 percent, and the same facilities operating wet suppression systems (controlled) ranged from 0.55 to 2.88 percent. Due to carry over of the small amount of moisture required, it has been shown that each source, with the exception of crushers, does not need to employ direct water sprays. Although the moisture content was the only variable measured, other process features may have as much influence on emissions from a given source. Visual observations from each source under normal operating conditions are probably the best indicator of which emission factor is most appropriate. Plants that employ substandard control measures as indicated by visual observations should use the uncontrolled factor with an appropriate control efficiency that best reflects the effectiveness of the controls employed.

c. References 1, 3, 7, and 8

d. References 3, 7, and 8

Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors

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MRI Project No. 110397

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Responses to Comments Received on Proposed AP-42 Revisions

Commenter and Date	Source Category	Comment	Response
John Hayden, National Stone, Sand and Gravel Association (NSSGA); June 14, 2006	Unpaved Roads	NSSGA-sponsored tests (report dated Oct. 15, 2004) at California aggregate producing plants support the proposed fine fractions.	This comment reference a test report prepared by Air Control Techniques for the National Stone, Sand & Gravel Association, dated October 4, 2004. The report gives the results of tests to determine unpaved road emissions factors for controlled (wet suppression only) haul roads at two aggregate processing plants. A variation of the plume profiling method using TEOM continuous monitors with PM-2.5 and PM-10 inlets was employed. Tests with road surface moisture content below 1.5 percent were considered to be uncontrolled. Based on the example PM-10 concentration profiles presented in the report, the maximum roadside PM-10 dust concentrations in the subject study were in the range of 300 micrograms per cubic meter. This is an order of magnitude lower than the concentrations typically found in other unpaved road emission factor studies. For the range of plume concentrations measured in the NSSGA-sponsored test program, an average fine fraction (PM-2.5/PM-10 ratio) of 0.15 was reported. This fine fraction value is consistent with the results of the MRI dust tunnel testing in the same concentration range. At plume concentrations more typical of unpaved road emission factor studies, the proposed value of 0.1 is applicable. There is no need for any revisions to the proposed changes to AP-42 as a result of the cited study.
Hao Quinn, Sacramento Metro AQMD; July 20, 2006	Paved vs. unpaved roads	For a particular industrial facility, the PM-10 emission factor equations show higher emissions from paved roads rather than unpaved roads.	***This comment does not relate to the proposed changes to the fine particle fractions***. It is possible that the emissions from a heavily loaded paved road can exceed emissions from an unpaved road with a low-to-moderate silt content at the same industrial facility, even if traveled by the same vehicles. This is the case in the cited example, for which the paved road silt loading is 70 g/m^2.

Commenter and Date	Source Category	Comment	Response
Brian Leahy, Horizon Environmental; July 26, 2006	Unpaved roads	The k value for PM-2.5 does not appear to have changed in the proposed revision.	The latest (2003) approved AP-42 k values for PM-2.5 in Table 13.2.2-2 are 0.23 and 0.27 lb/VMT for industrial and public roads, respectively. The proposed values are 0.15 and 0.18 lb/VMT, which are equivalent to 10 percent of the respective k values for PM-10. There is no need for revisions to the proposed changes to AP-42 as a result of this comment.
Shengxin Jin, NYSDOT Environmental Analysis Bureau; undated	Paved roads	The conversion of proposed k values from g/VMT to g/VKT does not appear correct	Regarding the revised k values for PM-2.5, when the k value of 0.66 g/VKT is multiplied by 1.6 km/mi, it becomes 1.06 g/VMT, which rounds to 1.1 g/VKT given in the proposed revision. Because the k values are given only to two significant figures, the converted values can vary by up to five digits in the second figure, depending on which direction the units conversion is made. For example, when k value of 1.1 g/VKT is divided by 1.6 km/mi, the resulting value rounds to 0.69 g/VKT, but if 1.06 g/VKT is divided by 1.6 km/mi, the resulting value rounds to 0.66 g/VKT. There is no need for revisions to the proposed changes to AP-42 as a result of this comment.
		The stated silt loading impact of antiskid abrasive does not appear correct	***This comment does not relate to the proposed changes to the fine particle fractions***. The commenter is correct in that 500 lb/mi of antiskid abrasive with a 1% silt content produces a silt loading in the range of 0.5 g/m^2 rather than 2 g/m^2. EPA may elect to make a separate modification to correct this discrepancy at a later time.

Proposed Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors

ABSTRACT

A number of fugitive dust studies have indicated that the $PM_{2.5}$ / PM_{10} ratios measured by US EPA federal reference method (FRM) samplers are significantly lower than predicted by AP-42 emission factors. As a result, the $PM_{2.5}$ emission estimates are biased high. The controlled exposure study described in this report was conducted to compare fine fraction ratios derived from FRM samplers to those derived from the cyclone/impactor method that had been used to develop AP-42 emission factors for fugitive dust sources. The study was conducted by the Midwest Research Institute using the same cyclone/impactor samplers and operating method that generated the original AP-42 emission factors and associated $PM_{2.5}$ / PM_{10} ratios. This study was sponsored by the Western Regional Air Partnership.

The study found that concentration measurements used to develop $PM_{2.5}$ emission factors in AP-42 were biased high by a factor of two, as compared to $PM_{2.5}$ measurements from FRM samplers. This factor-of-two bias helps to explain why researchers have often seen a discrepancy in the proportion of fugitive dust found in $PM_{2.5}$ emission inventories and modeled ambient air impacts, as compared to the proportion on ambient filter samples. This study also shows that the $PM_{2.5}$ / PM_{10} ratios for fugitive dust should be in the range of 0.1 to 0.15. Currently, the ratios in AP-42 range from 0.15 to 0.4 for most fugitive dust sources.

It is recommended that the results of this study be used to revise the AP-42 $PM_{2.5}$ emission factors for the following four fugitive dust source categories: paved roads, unpaved roads (public and industrial), aggregate handling and storage piles, and industrial wind erosion (AP-42 Sections 13.2.1, 13.2.2, 13.2.4, & 13.2.5, respectively). Emission estimates for other fugitive dust producing activities, such as construction and demolition will also be affected since they are based on these four source categories.

INTRODUCTION

The Dust Emissions Joint Forum (DEJF) of the Western Regional Air Partnership (WRAP) is engaged in gathering and improving data pertaining to the $PM_{2.5}$ and PM_{10} components of fugitive dust emissions. Most of the $PM_{2.5}$ emission factors in EPA's AP-42 guidance for fugitive dust sources (USEPA, 2005) were determined by using high-volume samplers, each fitted with a cyclone precollector and cascade impactor. Typically, AP-42 recommends that $PM_{2.5}$ emission factors for dust sources be calculated by using PM_{10} emission factor equations along with $PM_{2.5}/PM_{10}$ ratios that have been published by EPA in AP-42.

Beginning with the introduction of the cyclone/impactor method, it was realized particle bounce from the cascade impactor stages to the backup filter may have resulted in inflated $PM_{2.5}$ concentrations, even though steps were taken to minimize particle bounce. This led to an EPA-funded field study in the late 1990s (MRI, 1997) to gather comparative particle sizing data in dust plumes downwind of paved and unpaved roads around the country. The test results indicated that dichotomous samplers produced consistently lower $PM_{2.5}/PM_{10}$ ratios than generated with the cyclone/impactor system. Dichotomous samplers are federal reference method (FRM) samplers that are used to measure compliance with federal air quality standards for particulate matter measured as $PM_{2.5}$ and PM_{10}. Pending the eventual collection of additional data, the decision was made that the true ratios would best be represented by an averaging of the cyclone/impactor data with the dichotomous sampler data.

Based on the results of the EPA-funded field program, modifications were made to the appropriate sections of AP-42 for dust emissions from paved and unpaved roads. The $PM_{2.5}/PM_{10}$ ratio for emissions from unpaved roads (dominated by fugitive dust) was reduced from 0.26 to 0.15, and the $PM_{2.5}/PM_{10}$ ratio for the dust component of emissions from paved roads was reduced from 0.46 to 0.25. In the 2003 revision to AP-42, the non-dust component of paved road emissions was assigned a $PM_{2.5}/PM_{10}$ ratio of 0.76, accounting for vehicle exhaust and brake and tire wear.

Subsequent to the modifications of the $PM_{2.5}/PM_{10}$ ratios in AP-42, additional field test results (mostly from ambient air samplers) indicated that further reductions to the ratios were warranted (Pace, 2005). For example, ambient air monitoring data suggested that the fine fraction dust mass is of the order of 10 percent of the PM_{10} mass, based on chemical fingerprinting of the collected fine and coarse fractions of PM_{10} impacted by dust sources. It is important to note, however, that particle size data applicable to fugitive dust emission factors should be gathered either from the emissions plume or near the point where emissions are generated (within 10 m of the downwind edge of the source).

METHODOLOGY

This led DEJF to fund Midwest Research Institute (MRI) in conducting a controlled study of particle sizing in dust plumes. The objective of the study was to resolve the fine particle bias in the cyclone/impactor system, so that reliable $PM_{2.5}/PM_{10}$ ratios could be developed for as many dust source categories as possible. For this purpose, an air exposure chamber connected to a recirculating supply air stream was used in conjunction with a fluidization system for generating well-mixed dust plumes from a variety of western soils and road surface materials. R&P Model 2000 Partisol samplers were selected as the ground-truthing FRM samplers for PM_{10} and $PM_{2.5}$.

This study was performed in two phases (see below), as described in the attached test report (Cowherd and Donaldson, 2005). The test report serves as the background document to support the recommended revisions to AP-42, and it contains all the quality assurance procedures and results of the testing.

Phase I – Compare $PM_{2.5}$ Measured by Cyclone/Impactor to FRM Sampler

In the first testing phase of the project, $PM_{2.5}$ measurements using the high-volume cascade impactors were compared to simultaneous measurements obtained with EPA FRM samplers for $PM_{2.5}$. As stated above, these tests were conducted in a flow-through wind tunnel and exposure chamber, where the PM_{10} concentration level and uniformity were controlled. The results of the tests provided the basis for quantifying more effectively any sampling bias associated with the cascade impactor system.

Phase 2 – Compare $PM_{2.5}$ to PM_{10} Ratios for Different Geologic Soils

With the same test setup, a second phase of testing was performed with reference method samplers, for the purpose of measuring $PM_{2.5}$ to PM_{10} ratios for fugitive dust from different geologic sources in the West. This testing provided needed information on the magnitude and variability of this ratio, especially for source materials that are recognized as problematic with regard to application of mitigative dust control measures.

RESULTS

The tests that were performed are listed in Tables 6 and 7 of the attached report. The Phase I tests were performed in March and April of 2005. The Phase II tests were performed in June through August of 2005. A total of 100 individual tests were performed, including 17 blank runs (for quality assurance purposes). The raw and intermediate test data are summarized in the tables presented in Appendix A of the attached report.

Based on the 100 wind tunnel tests that were performed in the wind tunnel study, the findings support the following conclusions:

1. $PM_{2.5}$ concentrations measured by the high-volume cyclone/impactor system used to develop AP-42 emission factors for fugitive dust sources have a positive bias by a factor of 2, as compared to the $PM_{2.5}$ concentration measurements from reference-method samplers (see Figure 1). The geometric mean bias is 2.01 and the arithmetic mean bias is 2.15.
2. The $PM_{2.5}$ bias associated with the cyclone/impactor system, as measured under controlled laboratory conditions with dust concentrations held at nearly steady values, closely replicates the bias observed in the prior EPA-funded field study at distributed geographic locations across the country.

3. The $PM_{2.5}/PM_{10}$ ratios measured by the FRM samplers in the current study for a variety of western soils show a decrease in magnitude with increasing PM_{10} concentration (see Figure 2). Soils with a nominally spherical shape are observed to have somewhat lower ratios (at given PM_{10} concentrations) than soils with angular shape. A very similar dependence of $PM_{2.5}/PM_{10}$ ratio on PM_{10} concentration was also observed in the prior field study that used dichotomous samplers as FRM devices.
4. The test data from the current study support a $PM_{2.5}/PM_{10}$ ratio in the range of 0.1 to 0.15 for typical uncontrolled fugitive dust sources (see Figure 2). The $PM_{2.5}/PM_{10}$ ratio of 0.1 is also supported by numerous other studies including the prior EPA-funded field study that used dichotomous samplers as reference devices. It is possible that a ratio as low as 0.05 (as was found in the prior field tests of unpaved road emission factors) might be appropriate for very dusty sources, but this would require extrapolation of the current test data from the wind tunnel study.

DISCUSSION

Peer Review

The test report on the wind tunnel study (Cowherd and Donaldson, 2005) was issued first in draft form for external peer review. Three peer reviewers (having no prior contact with the study) were selected by the DEJF: Patrick Gaffney (California Air Resources Board), John Kinsey (U.S. Environmental Protection Agency), and Mel Zeldin (Private Consultant). In addition, peer review comments were provided by Duane Ono (Great Basin UAPCD) and Richard Countess (Countess Environmental) who helped to develop this study. After the review comments on the draft test report were received, comment/ response logs were prepared by MRI, listing each comment and the response to each comment. The next step was to modify the draft test report in accordance with the responses to the review comments. The final test report was issued on October 12, 2005.

Recommended Particle Size Ratios

Based on the results of the WRAP/DEJF study (see attached test report) and the prior EPA-funded field study, it is proposed that new $PM_{2.5}/PM_{10}$ ratios be adopted for several categories of (uncontrolled) fugitive dust sources, as addressed in AP-42. The proposed ratios (given to the nearest 0.05) are summarized in Table 1. It should be noted that these fine fraction ratios and the emission factors could change in the future if field studies show other differences than those identified through this study.

The proposed $PM_{2.5}/PM_{10}$ ratios in Table 1, apply to dry surface materials, having moisture contents in the range of 1% or less. Such materials when exposed to energetic disturbances produce dust plumes with core PM_{10} concentrations in the range of 5,000 micrograms per cubic meter, near the point of emissions generation. The wind tunnel test data show that dust plumes with lower core concentrations have higher $PM_{2.5}/PM_{10}$

ratios. This might occur, for example, at higher soil (or other surface material) moisture contents. However, the emissions from such sources typically are substantially lower with correspondingly less impact on the ambient environment.

Table 1. Proposed Particle Size Ratios for AP-42

Fugitive dust source category	AP-42 section	$PM_{2.5}/PM_{10}$ Ratio	
		Current	Proposed
Paved Roads	13.2.1	0.25	0.15
Unpaved Roads (Public & Industrial)	13.2.2	0.15	0.1
Construction & Demolition	–	0.208 [1]	0.1
Aggregate Handling & Storage Piles	13.2.4	0.314	0.1 (traffic) 0.15 (transfer)
Industrial Wind Erosion	13.2.5	0.40	0.15
Agricultural Tilling	–	0.222 [2]	0.2 (no change)
Open Area Wind Erosion	–	-	0.15

Notes:

[1] AP-42 Section 13.2.3 suggests using emission factors for individual dust producing activities, e.g., materials handling and unpaved roads. The WRAP Fugitive Dust Handbook recommends using a fine fraction ratio of 0.208 from a report prepared for the US EPA, Estimating Particulate Matter Emissions from Construction Operations (MRI, 1999).

[2] Agricultural tilling was dropped from the 5th edition of AP-42. The WRAP Fugitive Dust Handbook recommends using a fine fraction ratio of 0.222 from Section 7.4 of the California Air Resources Board's Emission Inventory Methodology (CARB, 2003).

The justification for each proposed ratio in Table 1 is provided by source category in the sections below. In each case, reference is made to test reports that contain supporting data.

Paved Roads

For the dust component of particulate emissions from paved roads, a $PM_{2.5}/PM_{10}$ ratio of 0.15 is recommended. The proposed ratio is based on the factor-of-two bias in the cyclone/impactor data for the wind tunnel study, which tested western soils and road surface materials. As shown in Table 1, the current AP-42 ratio is 0.25. It should be recalled that the nondust component of paved road particulate emissions has been assigned a much higher ratio of 0.76, based on inputs from the EPA's MOBILE 6 model.

Unpaved Roads

For the dust component of particulate emissions from unpaved roads, which dominates the total particulate emissions from this source category, a $PM_{2.5}/PM_{10}$ ratio of 0.1 is recommended. The proposed ratio is justified from the test results of the wind tunnel study for a variety of western surface materials. It is also consistent with the factor-of-two bias in the cyclone/impactor data from the wind tunnel study and with the results of the prior field study that used dichotomous samplers as FRM devices (MRI, 1997).

Construction and Demolition

The dust component of particulate emissions from construction and demolition dominate the total particulate emissions from this source category. A $PM_{2.5}/PM_{10}$ ratio of 0.1 is recommended for dust emissions from construction and demolition. The proposed ratio is justified by the fact that the dominant dust source associated with construction and demolition projects is emissions from vehicle travel over unpaved surfaces. This is shown by case studies that calculate particulate emissions from representative construction activities (road, building, and nonbuilding construction). For example, the fine fraction ratio for scraper travel averages about 0.2 (Muleski et al., 2005), before correcting for the factor-of- two bias in the cyclone/impactor system. Moreover this includes the diesel emissions that are contained within the fine fraction component.

It should be noted that if large open areas are disturbed (such as in land clearing) and left unprotected, and the areas are exposed to high winds, open area wind erosion can also be an important contributor to dust emissions from this source category. The recommended fine fraction ratio identified below should be used for the open area wind erosion component.

Aggregate Handling and Storage Piles

Although usually not a major source in comparison with traffic around storage piles, the transfer of aggregate associated with bucket loaders and unloaders or conveyor transfer points is addressed directly in this section of AP-42. A $PM_{2.5}/PM_{10}$ ratio of 0.15 is recommended for transfer operations. This is half the current value in AP-42 and reflects adjustment for the factor-of-two bias in the cyclone/impactor test results.

The dominant dust component of particulate emissions from aggregate handling and storage piles typically consists of loader and truck traffic around the storage piles. AP-42 refers the reader to the unpaved roads section to find appropriate emission factors. A $PM_{2.5}/PM_{10}$ ratio of 0.1 is recommended for this source. The proposed ratio is consistent with that recommended above for traffic on unpaved surfaces.

Industrial Wind Erosion

For the dust component of particulate emissions from industrial wind erosion, a $PM_{2.5}/PM_{10}$ ratio of 0.15 is recommended. Industrial wind erosion is associated with crushed aggregate materials, such as coal or metallic ore piles. Examples would include open storage piles at mining operations. The proposed ratio is justified by portable wind tunnel tests of industrial aggregate materials which produced $PM_{2.5}/PM_{10}$ ratios averaging 0.4, as indicated by the current AP-42 fine fraction ratio given in Table 1. When these results are corrected for the bias associated with the cyclone/impactor system at very high PM_{10} concentrations observed in the effluent from the portable wind tunnel (exceeding 10,000 $\mu g/m^3$), the result is 0.15.

Agricultural Tilling

For the dust component of particulate emissions from agricultural tilling and related land preparation activities, which dominates the total particulate emissions from this source category, no new $PM_{2.5}/PM_{10}$ ratio can be recommended at this time, because of the lack of published test data. However, the current factor of 0.2, as listed in Table 1, appears to be generally consistent with the results of the current wind tunnel tests. It was found that the agricultural soils tested in the wind tunnel produced slightly higher ratios than the other test materials. In addition, the dust plume core concentrations from agricultural operations are generally observed to be less intense because of the lower equipment speeds involved and the lack of repeated travel over the same routes.

Open Area Wind Erosion

For the dust component of particulate emissions from open area wind erosion (not currently addressed in AP-42), a $PM_{2.5}/PM_{10}$ ratio of 0.15 is recommended. Open area wind erosion is associated with exposed soils that have been disturbed, removing the protection afforded by natural crusting. Examples would include freshly tilled agricultural fields prior to planting of crops. The proposed ratio is justified by wind tunnel tests of exposed soils (MRI, 1994), which produced $PM_{2.5}/PM_{10}$ ratios averaging 0.3. When these results are corrected for the bias associated with the cyclone/impactor system, the ratio becomes 0.15. This is consistent with the $PM_{2.5}/PM_{10}$ ratios in the range of 0.12 measured during dust storms on Owens Dry Lake (Ono, 2005).

Specific Revisions to AP-42

This section presents a listing of specific revisions to AP-42, for the purpose of incorporating the proposed $PM_{2.5}/PM_{10}$ ratios. As shown in Table 2, five subsections of AP-42 Section 13.2, Fugitive Dust, are impacted by the proposed changes. However, one of the five sections (13.2.3, Heavy Construction Operations) is impacted only indirectly because it refers to other sections of AP-42 for fugitive dust emission factors.

In most cases, the change in the $PM_{2.5}/PM_{10}$ ratio is accomplished by changing the appropriate PM-2.5 particle size multiplier (k-factor) for the respective emission factor equation. In addition, the changes need to be referenced to the WRAP test report (Cowherd and Donaldson, 2005).

Table 2. Specific revisions to AP-42 that are incorporated into the AP-42 sections included in Attachment A.

Source category	Sub-section	Title	Revision	Comments
13.2.1 Paved Roads	13.2.1.3	*Predictive Emission Factor Equation*	In Table 13.2.1-1, reduce k values for PM-2.5 by 40 percent, e.g., the new value is 1.1 g/VMT (and equivalent values for the other units)	Add ref. number for WRAP test report
	13.2.1.5	*Changes since Fifth Edition*	Modify statement (1) to reflect change in fine fraction	
		References	Add WRAP test report as Ref. 22	
13.2.2 Unpaved Roads	13.2.2.2	*Emission Calculation and Correction Parameters*	In Table 13.2.2-2, reduce k values for PM-2.5 by 33%, e.g., the new value is 0.15 lb/VMT for industrial roads and 0.18 lb/VMT for public roads (and equivalent values for the other units)	Add ref. number for WRAP test report
	13.2.2.4	*Updates since Fifth Edition*	Add sentences describing change in fine fraction	
		References	Add WRAP test report	
13.2.3 Heavy Construction Operations	–	–	No changes required	Refers to other AP-42 sections for emission factors
13.2.4 Aggregate Handling and Storage Piles	13.2.4.3	*Predictive Emission Factor Equations*	In k-factor table for Equation 1 for transfer operations, change PM-2.5 multiplier to 0.053 (dimensionless)	Add ref. number for WRAP test report
		References	Add WRAP test report	
13.2.5 Industrial Wind Erosion	13.2.5.2	*Emissions and Correction Parameters*	In k-factor table for Equation 1, change PM-2.5 multiplier to 0.075 (dimensionless)	Add ref. number for WRAP test report
		References	Add WRAP test report	

CONCLUSION

This study found that concentration measurements used to develop $PM_{2.5}$ emission factors for AP-42 were biased high by a factor of two, as compared to $PM_{2.5}$ measurements from FRM samplers. This factor-of-two bias helps to explain why researchers have often seen a similar discrepancy in the proportion of fugitive dust found in $PM_{2.5}$ emission inventories and modeled ambient impacts, as compared to the proportion observed on ambient filter samples. This study also shows that the $PM_{2.5}$ / PM_{10} ratios for fugitive dust should be in the range of 0.1 to 0.15. Currently, the fine fraction ratios in AP-42 range from 0.15 to 0.4 for most fugitive dust sources.

It is recommended that the results of this study by used to revise the AP-42 $PM_{2.5}$ emission factors for the following four fugitive dust source categories: paved roads, unpaved roads (public and industrial), aggregate handling and storage piles, and industrial wind erosion (AP-42 Sections 13.2.1, 13.2.2, 13.2.4, & 13.2.5, respectively). Emission estimates for other fugitive dust producing activities, such as construction and demolition, will also be affected since they are based on these four source categories. It is recommended that revisions to the current AP-42 sections for these fugitive dust sources be adopted as shown in Attachment A to this report.

IMPLICATIONS

The proposed revisions to AP-42 are needed to ensure the most accurate $PM_{2.5}$ and PM_{10} fugitive dust emissions inventories that are possible for regional haze regulatory purposes, given the available resources and the significant contribution of fugitive dust to visibility impairment. In particular, the revisions will affect the quantity of dust apportioned to the fine ($PM_{2.5}$) versus coarse ($PM_{2.5-10}$) size modes, which have significantly different effects on visibility and long-range transport potentials. This will reduce $PM_{2.5}$ emission estimates for fugitive dust sources to about half their current level. It will also increase the coarse-mode size fraction for fugitive dust, which would be important in the event that a PM coarse standard is adopted by the US EPA and emission inventories are developed.

The revisions will be helpful in developing accurate emission inventories for PM nonattainment, maintenance, and action plan areas throughout the country. Finally, the proposed modifications to the fine fractions associated with EPA's AP-42 emission factors will ensure widespread availability of the most recent and accurate scientific information.

References

Cowherd, C. and J. Donaldson. 2005. *Analysis of the Fine Fraction of Particulate Matter in Fugitive Dust.* Final report prepared for the Western Governors' Association, Western Regional Air Partnership (WRAP), MRI Project No. 110397, October 12, 2005. **[Describes wind tunnel study to determine fine fraction ratios]**

Midwest Research Institute. 1994. *OU3 Wind tunnel Study: Test Report.* Prepared for EG&G Rocky Flats, Golden CO. **[Describes portable wind tunnel tests of emissions from soils and sediments]**

Midwest Research Institute. 1997. *Fugitive Particulate Matter Emissions*. Final report prepared for the U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park NC. April, 1997. **[Prior emission factor field study for paved and unpaved roads, comparing performance of cyclone/impactor system with reference method samplers for PM2.5]**

Muleski, G. E., C. Cowherd, and J. S. Kinsey. 2005. "Particulate Emissions from Construction Activities," *J. Air & Waste Manage. Assoc.* **55:** 772-783. **[Summarizes field test results for emissions from major components of construction projects]**

Ono, Duane. 2005. "Ambient PM2.5/PM10 ratios for Dust Events from the Keeler Dunes." Great Basin UAPCD, Bishop, CA. **[Describes FRM test results for high-wind events on Owens Dry Lake]**

Pace, T. G. 2005. "Examination of Multiplier Used to Estimate $PM_{2.5}$ Fugitive Dust Emissions from PM_{10}." Presented at the EPA Emission Inventory Conference. Las Vegas NV. April 2005. **[Summarizes other field studies that can be used to develop $PM_{2.5}/PM_{10}$ ratios for fugitive dust emissions]**

USEPA. 2005. *Compilation of Air Pollutant Emission Factors, AP-42.* 6th Edition. Research Triangle Park, NC. **[EPA's emission factor handbook]**

CARB, 2003. *Emission Inventory Procedural Manual Volume III: Methods for Assessing Area Source Emissions,* California Air Resources Board, Sacramento, CA. November. **[Summarizes the recommended calculation procedures for agricultural emissions and other sources]**

Midwest Research Institute. 1999. *Estimating Particulate Matter Emissions from Construction Operations*. Prepared for USEPA, Research Triangle Park NC, September. **[Gives field test results for construction operations]**

Figure 1. Phase I test results show that the Cyclone/ Impactor method measured $PM_{2.5}$ concentrations that were two times higher than those measured by Federal Reference Method samplers when simultaneously exposed to the well-mixed dust environment in the wind tunnel.

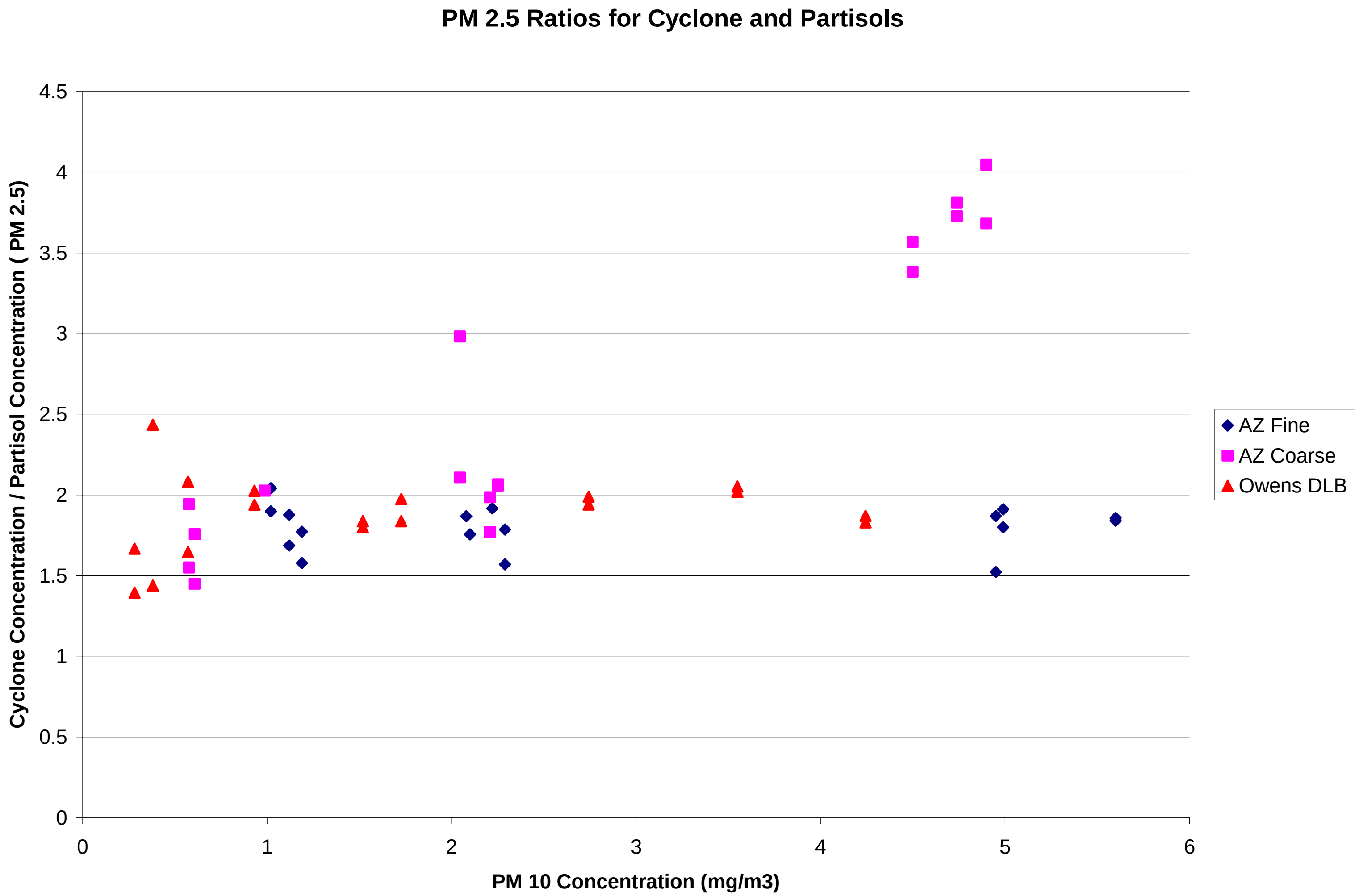

Figure 2. Phase II tests show that the $PM_{2.5}/PM_{10}$ ratio decreased with increasing PM concentrations, and could be expected to be in the range of 0.1 at concentrations that are typical of fugitive dust emission plumes.

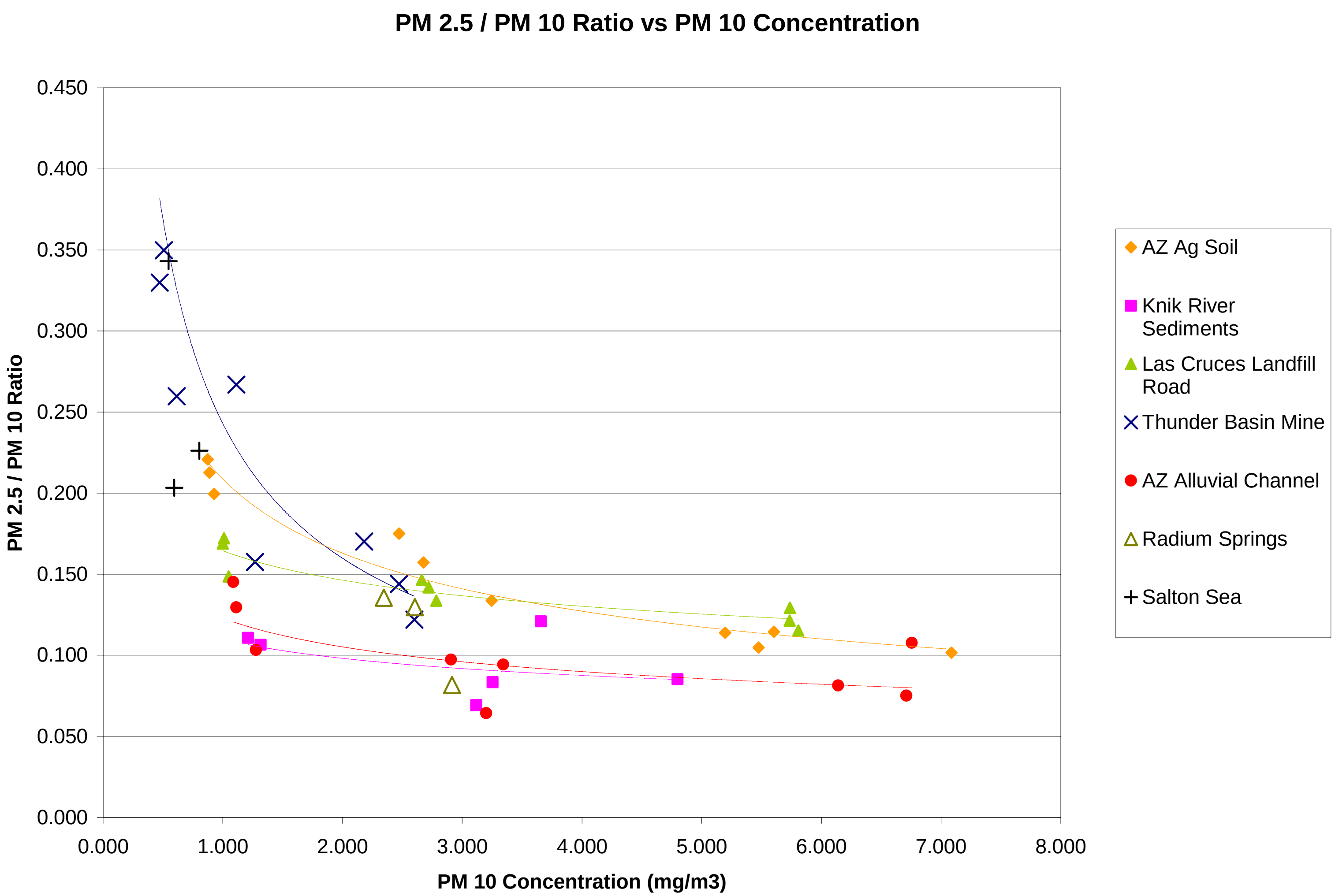

Table 3.1-3. EMISSION FACTORS FOR HAZARDOUS AIR POLLUTANTS FROM NATURAL GAS-FIRED STATIONARY GAS TURBINES[a]

Emission Factors[b] - Uncontrolled		
Pollutant	Emission Factor (lb/MMBtu)[c]	Emission Factor Rating
1,3-Butadiene[d]	< 4.3 E-07	D
Acetaldehyde	4.0 E-05	C
Acrolein	6.4 E-06	C
Benzene[e]	1.2 E-05	A
Ethylbenzene	3.2 E-05	C
Formaldehyde[f]	7.1 E-04	A
Naphthalene	1.3 E-06	C
PAH	2.2 E-06	C
Propylene Oxide[d]	< 2.9 E-05	D
Toluene	1.3 E-04	C
Xylenes	6.4 E-05	C

[a] SCC for natural gas-fired turbines include 2-01-002-01, 2-02-002-01, 2-02-002-03, 2-03-002-02, and 2-03-002-03. Hazardous Air Pollutants as defined in Section 112 (b) of the *Clean Air Act.*

[b] Factors are derived from units operating at high loads ($\geq$80 percent load) only. For information on units operating at other loads, consult the background report for this chapter (Reference 16), available at "www.epa.gov/ttn/chief".

[c] Emission factors based on an average natural gas heating value (HHV) of 1020 Btu/scf at 60^{o}F. To convert from (lb/MMBtu) to (lb/10^6 scf), multiply by 1020. These emission factors can be converted to other natural gas heating values by multiplying the given emission factor by the ratio of the specified heating value to this heating value.

[d] Compound was not detected. The presented emission value is based on one-half of the detection limit.

[e] Benzene with SCONOX catalyst is 9.1 E-07, rating of D.

[f] Formaldehyde with SCONOX catalyst is 2.0 E-05, rating of D.

[Amended at 75 FR page 79140, Dec. 17, 2010]

§ 98.31 Reporting threshold.

You must report GHG emissions under this subpart if your facility contains one or more stationary fuel combustion sources and the facility meets the applicability requirements of either §§98.2(a)(1), 98.2(a)(2), or 98.2(a)(3).

§ 98.32 GHGs to report.

You must report CO_2, CH_4, and N_2O mass emissions from each stationary fuel combustion unit, except as otherwise indicated in this subpart.

[75 FR page 79140, Dec. 17, 2010]

§ 98.33 Calculating GHG emissions.

You must calculate CO_2 emissions according to paragraph (a) of this section, and calculate CH_4 and N_2O emissions according to paragraph (c) of this section.

98.33(a) CO_2 emissions from fuel combustion.

Calculate CO_2 mass emissions by using one of the four calculation methodologies in paragraphs (a)(1) through (a)(4) of this section, subject to the applicable conditions, requirements, and restrictions set forth in paragraph (b) of this section. Alternatively, for units that meet the conditions of paragraph (a)(5) of this section, you may use CO_2 mass emissions calculation methods from part 75 of this chapter, as described in paragraph (a)(5) of this section. For units that combust both biomass and fossil fuels, you must calculate and report CO_2 emissions from the combustion of biomass separately using the methods in paragraph (e) of this section, except as otherwise provided in paragraphs (a)(5)(iv) and (e) of this section and in §98.36(d).

98.33(a)(1) Tier 1 Calculation Methodology.

Calculate the annual CO_2 mass emissions for each type of fuel by using Equation C-1, C-1a, or C-1b of this section (as applicable).

98.33(a)(1)(i)

Use Equation C-1 except when natural gas billing records are used to quantify fuel usage and gas consumption is expressed in units of therms or million Btu. In that case, use Equation C-1a or C-1b, as applicable.

$$CO_2 = 1 x\, 10^{-3} * Fuel * HHV * EF \qquad \text{(Eq. C-1)}$$

Where:

CO_2 = Annual CO_2 mass emissions for the specific fuel type (metric tons).

Fuel = Mass or volume of fuel combusted per year, from company records as defined in §98.6 (express mass in short tons for solid fuel, volume in standard cubic feet for gaseous fuel, and volume in gallons for liquid fuel).

HHV = Default high heat value of the fuel, from Table C–1 of this subpart (mmBtu per mass or mmBtu per volume, as applicable).

EF = Fuel-specific default CO_2 emission factor, from Table C–1 of this subpart (kg CO_2/mmBtu).

1×10^{-3} = Conversion factor from kilograms to metric tons.

98.33(a)(1)(ii)

If natural gas consumption is obtained from billing records and fuel usage is expressed in therms, use Equation C-1a.

$$CO_2 = 1 x\, 10^{-3} \left[0.1 * Gas * EF\right] \qquad \text{(Eq. C-1a)}$$

Where:

CO_2 = Annual CO_2 mass emissions from natural gas combustion (metric tons).

Gas = Annual natural gas usage, from billing records (therms).

EF = Fuel-specific default CO_2 emission factor for natural gas, from Table C-1 of this subpart (kg CO_2/mmBtu).

0.1 = Conversion factor from therms to mmBtu

1×10^{-3} = Conversion factor from kilograms to metric tons.

98.33(a)(1)(iii)

If natural gas consumption is obtained from billing records and fuel usage is expressed in mmBtu, use Equation C-1b.

$$CO_2 = 1 \, x \, 10^{-3} * Gas * EF \qquad \text{(Eq. C-1b)}$$

Where:

CO_2 = Annual CO_2 mass emissions from natural gas combustion (metric tons).

Gas = Annual natural gas usage, from billing records (mmBtu).

EF = Fuel-specific default CO_2 emission factor for natural gas, from Table C-1 of this subpart (kg CO_2/mmBtu).

1×10^{-3} = Conversion factor from kilograms to metric tons.

98.33(a)(2) Tier 2 Calculation Methodology.

Calculate the annual CO_2 mass emissions for each type of fuel by using either Equation C2a or C2c of this section, as appropriate.

98.33(a)(2)(i)

Equation C-2a of this section applies to any type of fuel listed in Table C-1 of the subpart, except for municipal solid waste (MSW). For MSW combustion, use Equation C-2c of this section.

$$CO_2 = 1 \, x \, 10^{-3} * Fuel * HHV * EF \qquad \text{(Eq. C-2a)}$$

Where:

CO_2 = Annual CO_2 mass emissions for a specific fuel type (metric tons).

Fuel = Mass or volume of the fuel combusted during the year, from company records as defined in §98.6 (express mass in short tons for solid fuel, volume in standard cubic feet for gaseous fuel, and volume in gallons for liquid fuel).

HHV = Annual average high heat value of the fuel from all valid samples for the year (mmBtu per mass or volume). The average HHV shall be calculated according to the requirements of paragraph (a)(2)(ii) of this section.

EF = Fuel-specific default CO_2 emission factor, from Table C–1 of this subpart (kg CO_2/mmBtu).

1×10^{-3} = Conversion factor from kilograms to metric tons.

98.33(a)(2)(ii)

The minimum required sampling frequency for determining the annual average HHV (e.g., monthly, quarterly, semi-annually, or by lot) is specified in §98.34. The method for computing the annual average HHV is a function of unit size and how frequently you perform or receive from the fuel supplier the results of fuel sampling for HHV. The method is specified in paragraph (a)(2)(ii)(A) or (a)(2)(ii)(B) of this section, as

Where:

CH_4 or N_2O = Annual CH_4 or N_2O emissions from the combustion of natural gas (metric tons).

Fuel = Annual natural gas usage, from gas billing records (therms).

EF = Fuel-specific default emission factor for CH_4 or N_2O, from Table C-2 of this subpart (kg CH_4 or N_2O per mmBtu).

0.1 = Conversion factor from therms to mmBtu

1×10^{-3} = Conversion factor from kilograms to metric tons.

98.33(c)(1)(ii)

Use Equation C-8b to calculate CH_4 and N_2O emissions when natural gas usage is obtained from gas billing records in units of mmBtu.

CH_4 *or* N_2O *=* 1×10^{-3} ** Fuel * EF (Eq.* C-8b)

Where:

CH_4 or N_2O = Annual CH_4 or N_2O emissions from the combustion of natural gas (metric tons).

Fuel = Annual natural gas usage, from gas billing records (mmBtu).

EF = Fuel-specific default emission factor for CH_4 or N_2O, from Table C-2 of this subpart (kg CH_4 or N_2O per mmBtu).

1×10^{-3} = Conversion factor from kilograms to metric tons.

98.33(c)(2)

Use Equation C-9a of this section to estimate CH_4 and N_2O emissions for any fuels for which you use the Tier 2 Equation C-2a of this section to estimate CO_2 emissions. Use the same values for fuel consumption and HHV that you use for the Tier 2 calculation.

$$CH_4 \text{ or } N_2O = 1 \times 10^{-3} * HHV * EF * Fuel \qquad \text{(Eq. C-9a)}$$

Where:

CH_4 or N_2O = Annual CH_4 or N_2O emissions from the combustion of a particular type of fuel (metric tons).

Fuel = Mass or volume of the fuel combusted during the reporting year.

HHV = High heat value of the fuel, averaged for all valid measurements for the reporting year (mmBtu per mass or volume).

EF = Fuel-specific default emission factor for CH_4 or N_2O, from Table C–2 of this subpart (kg CH_4 or N_2O per mmBtu).

1×10^{-3} = Conversion factor from kilograms to metric tons.

98.33(c)(3)

Use Equation C–9b of this section to estimate CH_4 and N_2O emissions for any fuels for which you use Equation C–2c of this section to calculate the CO_2 emissions. Use the same values for steam generation and the ratio "B" that you use for Equation C–2c.

$$CH_4 \text{ or } N_2O = 1 \times 10^{-3} \text{ Steam} * B * EF \qquad \text{(Eq. C-9b)}$$

Where:

Table C-1 to Subpart C of Part 98 —Default CO_2 Emission Factors and High Heat Values for Various Types of Fuel

Fuel type	Default high heat value	Default CO_2 emission factor
Coal and coke	mmBtu/short ton	kg CO_2/mmBtu
Anthracite	25.09	103.69
Bituminous	24.93	93.28
Subbituminous	17.25	97.17
Lignite	14.21	97.72
Coal Coke	24.80	113.67
Mixed (Commercial sector)	21.39	94.27
Mixed (Industrial coking)	26.28	93.90
Mixed (Industrial sector)	22.35	94.67
Mixed (Electric Power sector)	19.73	95.52
Natural gas	mmBtu/scf	kg CO_2/mmBtu
(Weighted U.S. Average)	1.026×10^{-3}	53.06
Petroleum products	mmBtu/gallon	kg CO_2/mmBtu
Distillate Fuel Oil No. 1	0.139	73.25
Distillate Fuel Oil No. 2	0.138	73.96
Distillate Fuel Oil No. 4	0.146	75.04
Residual Fuel Oil No. 5	0.140	72.93
Residual Fuel Oil No. 6	0.150	75.10
Used Oil	0.138	74.00
Kerosene	0.135	75.20
Liquefied petroleum gases (LPG) [1]	0.092	61.71
Propane [1]	0.091	62.87
Propylene [2]	0.091	67.77
Ethane [1]	0.068	59.60
Ethanol	0.084	68.44
Ethylene [2]	0.058	65.96
Isobutane [1]	0.099	64.94
Isobutylene [1]	0.103	68.86
Butane [1]	0.103	64.77
Butylene [1]	0.105	68.72
Naphtha (<401 deg F)	0.125	68.02
Natural Gasoline	0.110	66.88
Other Oil (>401 deg F)	0.139	76.22
Pentanes Plus	0.110	70.02
Petrochemical Feedstocks	0.125	71.02
Petroleum Coke	0.143	102.41
Special Naphtha	0.125	72.34
Unfinished Oils	0.139	74.54
Heavy Gas Oils	0.148	74.92
Lubricants	0.144	74.27
Motor Gasoline	0.125	70.22
Aviation Gasoline	0.120	69.25
Kerosene-Type Jet Fuel	0.135	72.22
Asphalt and Road Oil	0.158	75.36

Crude Oil	0.138	74.54
Other fuels—solid	mmBtu/short ton	kg CO_2/mmBtu
Municipal Solid Waste	9.95 [3]	90.7
Tires	28.00	85.97
Plastics	38.00	75.00
Petroleum Coke	30.00	102.41
Other fuels—gaseous	mmBtu/scf	kg CO_2/mmBtu
Blast Furnace Gas	0.092×10^{-3}	274.32
Coke Oven Gas	0.599×10^{-3}	46.85
Propane Gas	2.516×10^{-3}	61.46
Fuel Gas [4]	1.388×10^{-3}	59.00
Biomass fuels—solid	mmBtu/short ton	kg CO_2/mmBtu
Wood and Wood Residuals (dry basis) [5]	17.48	93.80
Agricultural Byproducts	8.25	118.17
Peat	8.00	111.84
Solid Byproducts	10.39	105.51
Biomass fuels—gaseous	mmBtu/scf	kg CO_2/mmBtu
Landfill Gas	0.485×10^{-3}	52.07
Other Biomass Gases	0.655×10^{-3}	52.07
Biomass Fuels—Liquid	mmBtu/gallon	kg CO_2/mmBtu
Ethanol	0.084	68.44
Biodiesel (100%)	0.128	73.84
Rendered Animal Fat	0.125	71.06
Vegetable Oil	0.120	81.55

[1] The HHV for components of LPG determined at 60 °F and saturation pressure with the exception of ethylene.

[2] Ethylene HHV determined at 41 °F (5 °C) and saturation pressure.

[3] Use of this default HHV is allowed only for: (a) Units that combust MSW, do not generate steam, and are allowed to use Tier 1; (b) units that derive no more than 10 percent of their annual heat input from MSW and/or tires; and (c) small batch incinerators that combust no more than 1,000 tons of MSW per year.

[4] Reporters subject to subpart X of this part that are complying with § 98.243(d) or subpart Y of this part may only use the default HHV and the default CO_2 emission factor for fuel gas combustion under the conditions prescribed in § 98.243(d)(2)(i) and (d)(2)(ii) and § 98.252(a)(1) and (a)(2), respectively. Otherwise, reporters subject to subpart X or subpart Y shall use either Tier 3 (Equation C-5) or Tier 4.

[5] Use the following formula to calculate a wet basis HHV for use in Equation C-1: $HHV_w = ((100 - M)/100)*HHV_d$ where HHV_w = wet basis HHV, M = moisture content (percent) and HHV_d = dry basis HHV from Table C-1.

[78 FR page 71950, Nov. 29, 2013]

Table C-2 to Subpart C of Part 98 —Default CH_4 and N_2O Emission Factors for Various Types of Fuel

Fuel type	Default CH_4 emission factor (kg CH_4/mmBtu)	Default N_2O emission factor (kg N_2O/mmBtu)
Coal and Coke (All fuel types in Table C-1)	1.1×10^{-02}	1.6×10^{-03}
Natural Gas	1.0×10^{-03}	1.0×10^{-04}
Petroleum (All fuel types in Table C-1)	3.0×10^{-03}	6.0×10^{-04}
Fuel Gas	3.0×10^{-03}	6.0×10^{-04}
Municipal Solid Waste	3.2×10^{-02}	4.2×10^{-03}
Tires		

	3.2 x 10-02	4.2 x 10-03
Blast Furnace Gas	2.2 x 10-05	1.0 x 10-04
Coke Oven Gas	4.8 x 10-04	1.0 x 10-04
Biomass Fuels—Solid (All fuel types in Table C-1, except wood and wood residuals)	3.2 x 10-02	4.2 x 10-03
Wood and wood residuals	7.2 x 10-03	3.6 x 10-03
Biomass Fuels— Gaseous (All fuel types in Table C-1)	3.2 x 10-03	6.3 x 10-04
Biomass Fuels—Liquid (All fuel types in Table C-1)	1.1 x 10-03	1.1 x 10-04

Note: Those employing this table are assumed to fall under the IPCC definitions of the "Energy Industry" or "Manufacturing Industries and Construction". In all fuels except for coal the values for these two categories are identical. For coal combustion, those who fall within the IPCC "Energy Industry" category may employ a value of 1g of CH_4/mmBtu.

[75 FR page 79154, Dec. 17, 2010; 78 FR page 71952, Nov. 29, 2013]

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Title 40: Protection of Environment
PART 98—MANDATORY GREENHOUSE GAS REPORTING
Subpart A—General Provision

TABLE A-1 TO SUBPART A OF PART 98—GLOBAL WARMING POTENTIALS

GLOBAL WARMING POTENTIALS

[100-Year Time Horizon]

Name	CAS No.	Chemical formula	Global warming potential (100 yr.)
Carbon dioxide	124-38-9	CO_2	1
Methane	74-82-8	CH_4	[a]25
Nitrous oxide	10024-97-2	N_2O	[a]298
HFC-23	75-46-7	CHF_3	[a]14,800
HFC-32	75-10-5	CH_2F_2	[a]675
HFC-41	593-53-3	CH_3F	[a]92
HFC-125	354-33-6	C_2HF_5	[a]3,500
HFC-134	359-35-3	$C_2H_2F_4$	[a]1,100
HFC-134a	811-97-2	CH_2FCF_3	[a]1,430
HFC-143	430-66-0	$C_2H_3F_3$	[a]353
HFC-143a	420-46-2	$C_2H_3F_3$	[a]4,470
HFC-152	624-72-6	CH_2FCH_2F	53
HFC-152a	75-37-6	CH_3CHF_2	[a]124
HFC-161	353-36-6	CH_3CH_2F	12
HFC-227ea	431-89-0	C_3HF_7	[a]3,220
HFC-236cb	677-56-5	$CH_2FCF_2CF_3$	1,340

HFC-236ea	431-63-0	CHF_2CHFCF_3	1,370
HFC-236fa	690-39-1	$C_3H_2F_6$	[a]9,810
HFC-245ca	679-86-7	$C_3H_3F_5$	[a]693
HFC-245fa	460-73-1	$CHF_2CH_2CF_3$	1,030
HFC-365mfc	406-58-6	$CH_3CF_2CH_2CF_3$	794
HFC-43-10mee	138495-42-8	$CF_3CFHCFHCF_2CF_3$	[a]1,640
Sulfur hexafluoride	2551-62-4	SF_6	[a]22,800
Trifluoromethyl sulphur pentafluoride	373-80-8	SF_5CF_3	17,700
Nitrogen trifluoride	7783-54-2	NF_3	17,200
PFC-14 (Perfluoromethane)	75-73-0	CF_4	[a]7,390
PFC-116 (Perfluoroethane)	76-16-4	C_2F_6	[a]12,200
PFC-218 (Perfluoropropane)	76-19-7	C_3F_8	[a]8,830
Perfluorocyclopropane	931-91-9	$C-C_3F_6$	17,340
PFC-3-1-10 (Perfluorobutane)	355-25-9	C_4F_{10}	[a]8,860
PFC-318 (Perfluorocyclobutane)	115-25-3	$C-C_4F_8$	[a]10,300
PFC-4-1-12 (Perfluoropentane)	678-26-2	C_5F_{12}	[a]9,160
PFC-5-1-14 (Perfluorohexane, FC-72)	355-42-0	C_6F_{14}	[a]9,300
PFC-9-1-18	306-94-5	$C_{10}F_{18}$	7,500
HCFE-235da2 (Isoflurane)	26675-46-7	$CHF_2OCHClCF_3$	350
HFE-43-10pccc (H-Galden 1040x, HG-11)	E1730133	$CHF_2OCF_2OC_2F_4OCHF_2$	1,870
HFE-125	3822-68-2	CHF_2OCF_3	14,900
HFE-134 (HG-00)	1691-17-4	CHF_2OCHF_2	6,320
HFE-143a	421-14-7	CH_3OCF_3	756
HFE-227ea	2356-62-9	$CF_3CHFOCF_3$	1,540
HFE-236ca12 (HG-10)	78522-47-1	$CHF_2OCF_2OCHF_2$	2,800
HFE-236ea2 (Desflurane)	57041-67-5	$CHF_2OCHFCF_3$	989
HFE-236fa	20193-67-3	$CF_3CH_2OCF_3$	487

HFE-245cb2	22410-44-2	$CH_3OCF_2CF_3$	708
HFE-245fa1	84011-15-4	$CHF_2CH_2OCF_3$	286
HFE-245fa2	1885-48-9	$CHF_2OCH_2CF_3$	659
HFE-254cb2	425-88-7	$CH_3OCF_2CHF_2$	359
HFE-263fb2	460-43-5	$CF_3CH_2OCH_3$	11
HFE-329mcc2	134769-21-4	$CF_3CF_2OCF_2CHF_2$	919
HFE-338mcf2	156053-88-2	$CF_3CF_2OCH_2CF_3$	552
HFE-338pcc13 (HG-01)	188690-78-0	$CHF_2OCF_2CF_2OCHF_2$	1,500
HFE-347mcc3 (HFE-7000)	375-03-1	$CH_3OCF_2CF_2CF_3$	575
HFE-347mcf2	171182-95-9	$CF_3CF_2OCH_2CHF_2$	374
HFE-347pcf2	406-78-0	$CHF_2CF_2OCH_2CF_3$	580
HFE-356mec3	382-34-3	$CH_3OCF_2CHFCF_3$	101
HFE-356pcc3	160620-20-2	$CH_3OCF_2CF_2CHF_2$	110
HFE-356pcf2	50807-77-7	$CHF_2CH_2OCF_2CHF_2$	265
HFE-356pcf3	35042-99-0	$CHF_2OCH_2CF_2CHF_2$	502
HFE-365mcf3	378-16-5	$CF_3CF_2CH_2OCH_3$	11
HFE-374pc2	512-51-6	$CH_3CH_2OCF_2CHF_2$	557
HFE-449s1 (HFE-7100)	163702-07-6	$C_4F_9OCH_3$	297
Chemical blend	163702-08-7	$(CF_3)_2CFCF_2OCH_3$	
HFE-569sf2 (HFE-7200)	163702-05-4	$C_4F_9OC_2H_5$	59
Chemical blend	163702-06-5	$(CF_3)_2CFCF_2OC_2H_5$	
Sevoflurane (HFE-347mmz1)	28523-86-6	$CH_2FOCH(CF_3)_2$	345
HFE-356mm1	13171-18-1	$(CF_3)_2CHOCH_3$	27
HFE-338mmz1	26103-08-2	$CHF_2OCH(CF_3)_2$	380

(Octafluorotetramethy-lene) hydroxymethyl group	NA	X-$(CF_2)_4$CH(OH)-X	73
HFE-347mmy1	22052-84-2	$CH_3OCF(CF_3)_2$	343
Bis(trifluoromethyl)-methanol	920-66-1	$(CF_3)_2CHOH$	195
2,2,3,3,3-pentafluoropropanol	422-05-9	$CF_3CF_2CH_2OH$	42
PFPMIE (HT-70)	NA	$CF_3OCF(CF_3)CF_2OCF_2OCF_3$	10,300

[a]The GWP for this compound is different than the GWP in the version of Table A-1 to subpart A of part 98 published on October 30, 2009.

[78 FR 71948, Nov. 29, 2013]

TABLE 1.4-2. EMISSION FACTORS FOR CRITERIA POLLUTANTS AND GREENHOUSE GASES FROM NATURAL GAS COMBUSTION[a]

Pollutant	Emission Factor ($lb/10^6$ scf)	Emission Factor Rating
CO_2[b]	120,000	A
Lead	0.0005	D
N_2O (Uncontrolled)	2.2	E
N_2O (Controlled-low-NO_X burner)	0.64	E
PM (Total)[c]	7.6	D
PM (Condensable)[c]	5.7	D
PM (Filterable)[c]	1.9	B
SO_2[d]	0.6	A
TOC	11	B
Methane	2.3	B
VOC	5.5	C

[a] Reference 11. Units are in pounds of pollutant per million standard cubic feet of natural gas fired. Data are for all natural gas combustion sources. To convert from $lb/10^6$ scf to $kg/10^6$ m^3, multiply by 16. To convert from $lb/10^6$ scf to 1b/MMBtu, divide by 1,020. The emission factors in this table may be converted to other natural gas heating values by multiplying the given emission factor by the ratio of the specified heating value to this average heating value. TOC = Total Organic Compounds. VOC = Volatile Organic Compounds.

[b] Based on approximately 100% conversion of fuel carbon to CO_2. $CO_2[lb/10^6$ scf$]$ = (3.67) (CON) (C)(D), where CON = fractional conversion of fuel carbon to CO_2, C = carbon content of fuel by weight (0.76), and D = density of fuel, $4.2x10^4$ $lb/10^6$ scf.

[c] All PM (total, condensible, and filterable) is assumed to be less than 1.0 micrometer in diameter. Therefore, the PM emission factors presented here may be used to estimate PM_{10}, $PM_{2.5}$ or PM_1 emissions. Total PM is the sum of the filterable PM and condensible PM. Condensible PM is the particulate matter collected using EPA Method 202 (or equivalent). Filterable PM is the particulate matter collected on, or prior to, the filter of an EPA Method 5 (or equivalent) sampling train.

[d] Based on 100% conversion of fuel sulfur to SO_2.
Assumes sulfur content is natural gas of 2,000 grains/10^6 scf. The SO_2 emission factor in this table can be converted to other natural gas sulfur contents by multiplying the SO_2 emission factor by the ratio of the site-specific sulfur content (grains/10^6 scf) to 2,000 grains/10^6 scf.

TABLE 1.4-3. EMISSION FACTORS FOR SPECIATED ORGANIC COMPOUNDS FROM NATURAL GAS COMBUSTION[a]

CAS No.	Pollutant	Emission Factor ($lb/10^6$ scf)	Emission Factor Rating
91-57-6	2-Methylnaphthalene[b, c]	2.4E-05	D
56-49-5	3-Methylchloranthrene[b, c]	<1.8E-06	E
	7,12-Dimethylbenz(a)anthracene[b,c]	<1.6E-05	E
83-32-9	Acenaphthene[b,c]	<1.8E-06	E
203-96-8	Acenaphthylene[b,c]	<1.8E-06	E
120-12-7	Anthracene[b,c]	<2.4E-06	E
56-55-3	Benz(a)anthracene[b,c]	<1.8E-06	E
71-43-2	Benzene[b]	2.1E-03	B
50-32-8	Benzo(a)pyrene[b,c]	<1.2E-06	E
205-99-2	Benzo(b)fluoranthene[b,c]	<1.8E-06	E
191-24-2	Benzo(g,h,i)perylene[b,c]	<1.2E-06	E
205-82-3	Benzo(k)fluoranthene[b,c]	<1.8E-06	E
106-97-8	Butane	2.1E+00	E
218-01-9	Chrysene[b,c]	<1.8E-06	E
53-70-3	Dibenzo(a,h)anthracene[b,c]	<1.2E-06	E
25321-22-6	Dichlorobenzene[b]	1.2E-03	E
74-84-0	Ethane	3.1E+00	E
206-44-0	Fluoranthene[b,c]	3.0E-06	E
86-73-7	Fluorene[b,c]	2.8E-06	E
50-00-0	Formaldehyde[b]	7.5E-02	B
110-54-3	Hexane[b]	1.8E+00	E
193-39-5	Indeno(1,2,3-cd)pyrene[b,c]	<1.8E-06	E
91-20-3	Naphthalene[b]	6.1E-04	E
109-66-0	Pentane	2.6E+00	E
85-01-8	Phenanathrene[b,c]	1.7E-05	D

13.4 Wet Cooling Towers

13.4.1 General[1]

Cooling towers are heat exchangers that are used to dissipate large heat loads to the atmosphere. They are used as an important component in many industrial and commercial processes needing to dissipate heat. Cooling towers may range in size from less than $5.3(10)^6$ kilojoules (kJ) ($5[10]^6$ British thermal units per hour [Btu/hr]) for small air conditioning cooling towers to over $5275(10)^6$ kJ/hr ($5000[10^6]$ Btu/hr) for large power plant cooling towers.

When water is used as the heat transfer medium, wet, or evaporative, cooling towers may be used. Wet cooling towers rely on the latent heat of water evaporation to exchange heat between the process and the air passing through the cooling tower. The cooling water may be an integral part of the process or may provide cooling via heat exchangers.

Although cooling towers can be classified several ways, the primary classification is into dry towers or wet towers, and some hybrid wet-dry combinations exist. Subclassifications can include the draft type and/or the location of the draft relative to the heat transfer medium, the type of heat transfer medium, the relative direction of air movement, and the type of water distribution system.

In wet cooling towers, heat transfer is measured by the decrease in the process temperature and a corresponding increase in both the moisture content and the wet bulb temperature of the air passing through the cooling tower. (There also may be a change in the sensible, or dry bulb, temperature, but its contribution to the heat transfer process is very small and is typically ignored when designing wet cooling towers.) Wet cooling towers typically contain a wetted medium called "fill" to promote evaporation by providing a large surface area and/or by creating many water drops with a large cumulative surface area.

Cooling towers can be categorized by the type of heat transfer; the type of draft and location of the draft, relative to the heat transfer medium; the type of heat transfer medium; the relative direction of air and water contact; and the type of water distribution system. Since wet, or evaporative, cooling towers are the dominant type, and they also generate air pollutants, this section will address only that type of tower. Diagrams of the various tower configurations are shown in Figure 13.4-1 and Figure 13.4-2.

13.4.2 Emissions And Controls[1]

Because wet cooling towers provide direct contact between the cooling water and the air passing through the tower, some of the liquid water may be entrained in the air stream and be carried out of the tower as "drift" droplets. Therefore, the particulate matter constituent of the drift droplets may be classified as an emission.

The magnitude of drift loss is influenced by the number and size of droplets produced within the cooling tower, which in turn are determined by the fill design, the air and water patterns, and other interrelated factors. Tower maintenance and operation levels also can influence the formation of drift droplets. For example, excessive water flow, excessive airflow, and water bypassing the tower drift eliminators can promote and/or increase drift emissions.

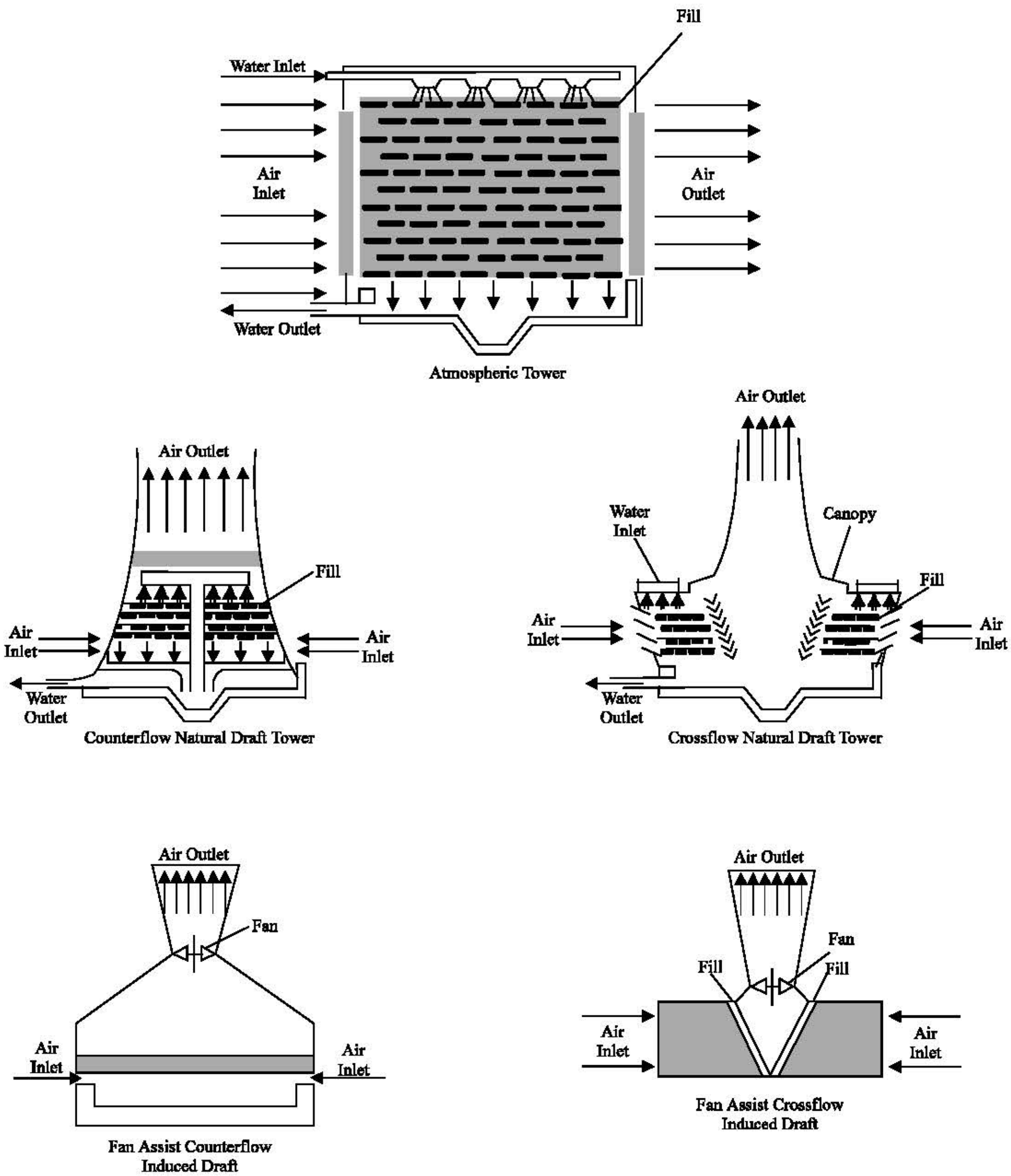

Figure 13.4-1 Atmospheric and natural draft cooling towers.

Because the drift droplets generally contain the same chemical impurities as the water circulating through the tower, these impurities can be converted to airborne emissions. Large drift droplets settle out of the tower exhaust air stream and deposit near the tower. This process can lead to wetting, icing, salt deposition, and related problems such as damage to equipment or to vegetation. Other drift droplets may evaporate before being deposited in the area surrounding the tower, and they also can produce PM-10 emissions. PM-10 is generated when the drift droplets evaporate and leave fine particulate matter formed by crystallization of dissolved solids. Dissolved solids found in cooling tower drift can consist of mineral matter, chemicals for corrosion inhibition, etc.

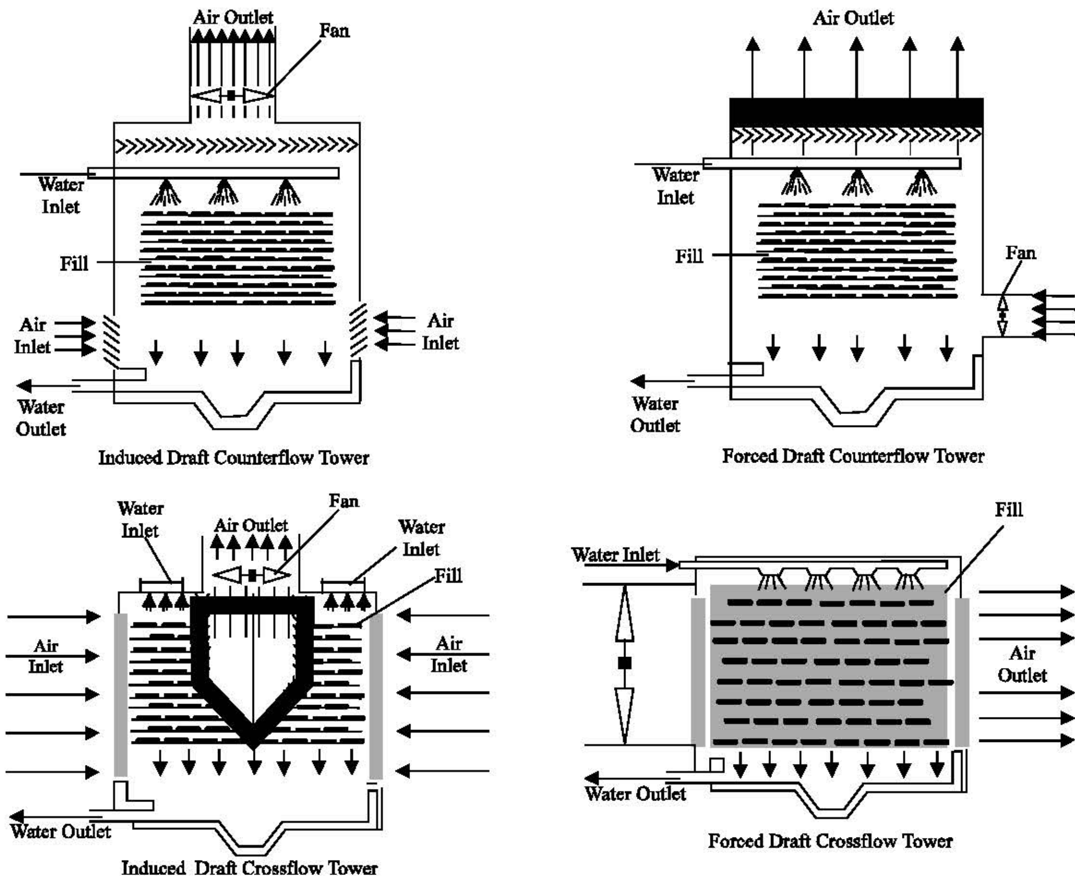

Figure 13.4-2. Mechanical draft cooling towers.

To reduce the drift from cooling towers, drift eliminators are usually incorporated into the tower design to remove as many droplets as practical from the air stream before exiting the tower. The drift eliminators used in cooling towers rely on inertial separation caused by direction changes while passing through the eliminators. Types of drift eliminator configurations include herringbone (blade-type), wave form, and cellular (or honeycomb) designs. The cellular units generally are the most efficient. Drift eliminators may include various materials, such as ceramics, fiber reinforced cement, fiberglass, metal, plastic, and wood installed or formed into closely spaced slats, sheets, honeycomb assemblies, or tiles. The materials may include other features, such as corrugations and water removal channels, to enhance the drift removal further.

Table 13.4-1 provides available particulate emission factors for wet cooling towers. Separate emission factors are given for induced draft and natural draft cooling towers. Several features in Table 13.4-1 should be noted. First, a *conservatively high* PM-10 emission factor can be obtained by (a) multiplying the total liquid drift factor by the total dissolved solids (TDS) fraction in the circulating water and (b) assuming that, once the water evaporates, all remaining solid particles are within the PM-10 size range.

Second, if TDS data for the cooling tower are not available, a source-specific TDS content can be estimated by obtaining the TDS data for the make-up water and multiplying them by the cooling tower cycles of concentration. The cycles of concentration ratio is the ratio of a measured

Table 13.4-1 (Metric And English Units). PARTICULATE EMISSIONS FACTORS FOR WET COOLING TOWERS[a]

Tower Type[d]	Total Liquid Drift[b] Circulating Water Flow[b]	g/daL	lb/10^3 gal	EMISSION FACTOR RATING	PM-10[c] g/daL[e]	lb/10^3 gal	EMISSION FACTOR RATING
Induced Draft (SCC 3-85-001-01, 3-85-001-20, 3-85-002-01)	0.020	2.0	1.7	D	0.023	0.019	E
Natural Draft (SCC 3-85-001-02, 3-85-002-02)	0.00088	0.088	0.073	E	ND	ND	—

[a] References 1-17. Numbers are given to 2 significant digits. ND = no data. SCC = Source Classification Code.

[b] References 2,5-7,9-10,12-13,15-16. Total liquid drift is water droplets entrained in the cooling tower exit air stream. Factors are for % of circulating water flow (10^{-2} L drift/L [10^{-2} gal drift/gal] water flow) and g drift/daL (lb drift/10^3 gal) circulating water flow. 0.12 g/daL = 0.1 lb/10^3 gal; 1 daL = 10^1 L.

[c] See discussion in text on how to use the table to obtain PM-10 emission estimates. Values shown above are the arithmetic average of test results from References 2,4,8, and 11-14, and they imply an effective TDS content of approximately 12,000 parts per million (ppm) in the circulating water.

[d] See Figure 13.4-1 and Figure 13.4-2. Additional SCCs for wet cooling towers of unspecified draft type are 3-85-001-10 and 3-85-002-10.

[e] Expressed as g PM-10/daL (lb PM-10/10^3 gal) circulating water flow.

parameter for the cooling tower water (such as conductivity, calcium, chlorides, or phosphate) to that parameter for the make-up water. This estimated cooling tower TDS can be used to calculate the PM-10 emission factor as above. If neither of these methods can be used, the arithmetic average PM-10 factor given in Table 13.4-1 can be used. Table 13.4-1 presents the arithmetic average PM-10 factor calculated from the test data in References 2, 4, 8, and 11 - 14. Note that this average corresponds to an effective cooling tower recirculating water TDS content of approximately 11,500 ppm for induced draft towers. (This can be found by dividing the total liquid drift factor into the PM-10 factor.)

As an alternative approach, if TDS data are unavailable for an induced draft tower, a value may be selected from Table 13.4-2 and then be combined with the total liquid drift factor in Table 13.4-1 to determine an apparent PM-10 factor.

As shown in Table 13.4-2, available data do not suggest that there is any significant difference between TDS levels in counter and cross flow towers. Data for natural draft towers are not available.

Table 13.4-2. SUMMARY STATISTICS FOR TOTAL DISSOLVED SOLIDS (TDS) CONTENT IN CIRCULATING WATER[a]

Type Of Draft	No. Of Cases	Range Of TDS Values (ppm)	Geometric Mean TDS Value (ppm)
Counter Flow	10	3700 - 55,000	18,500
Cross Flow	7	380 - 91,000	24,000
Overall[b]	17	380 - 91,000	20,600

[a] References 2,4,8,11-14.
[b] Data unavailable for natural draft towers.

References For Section 13.4

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11. *Isokinetic Droplet Emission Measurements Of Selected Induced Draft Cooling Towers*, Kerr-McGee Chemical Corporation, Trona, CA, and Environmental Systems Corporation, Knoxville, TN, November 1986.

12. Confidential Cooling Tower Drift Test Report For Member Of The Cooling Tower Institute, Houston, TX, Midwest Research Institute, Kansas City, MO, December 1984.

13. Confidential Cooling Tower Drift Test Report For Member Of The Cooling Tower Institute, Houston, TX, Midwest Research Institute, Kansas City, MO, August 1984.

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15. *Chalk Point Cooling Tower Project*, Volumes 1 and 2, JHU PPSP-CPCTP-16, John Hopkins University, Laurel, MD, August 1977.

16. *Comparative Evaluation Of Cooling Tower Drift Eliminator Performance*, MIT-EL 77-004, Energy Laboratory And Department of Nuclear Engineering, Massachusetts Institute Of Technology, Cambridge, MA, June 1977.

17. G. O. Schrecker, *et al.*, *Drift Data Acquired On Mechanical Salt Water Cooling Devices*, EPA-650/2-75-060, U. S. Environmental Protection Agency, Cincinnati, OH, July 1975.

Table 11.19.2-2 (English Units). EMISSION FACTORS FOR CRUSHED STONE PROCESSING OPERATIONS (lb/Ton)[a]

Source [b]	Total Particulate Matter [r,s]	EMISSION FACTOR RATING	Total PM-10	EMISSION FACTOR RATING	Total PM-2.5	EMISSION FACTOR RATING
Primary Crushing (SCC 3-05-020-01)	ND		ND[n]		ND[n]	
Primary Crushing (controlled) (SCC 3-05-020-01)	ND		ND[n]		ND[n]	
Secondary Crushing (SCC 3-05-020-02)	ND		ND[n]		ND[n]	
Secondary Crushing (controlled) (SCC 3-05-020-02)	ND		ND[n]		ND[n]	
Tertiary Crushing (SCC 3-050030-03)	0.0054[d]	E	0.0024[o]	C	ND[n]	
Tertiary Crushing (controlled) (SCC 3-05-020-03)	0.0012[d]	E	0.00054[p]	C	0.00010[q]	E
Fines Crushing (SCC 3-05-020-05)	0.0390[e]	E	0.0150[e]	E	ND	
Fines Crushing (controlled) (SCC 3-05-020-05)	0.0030[f]	E	0.0012[f]	E	0.000070[q]	E
Screening (SCC 3-05-020-02, 03)	0.025[c]	E	0.0087[l]	C	ND	
Screening (controlled) (SCC 3-05-020-02, 03)	0.0022[d]	E	0.00074[m]	C	0.000050[q]	E
Fines Screening (SCC 3-05-020-21)	0.30[g]	E	0.072[g]	E	ND	
Fines Screening (controlled) (SCC 3-05-020-21)	0.0036[g]	E	0.0022[g]	E	ND	
Conveyor Transfer Point (SCC 3-05-020-06)	0.0030[h]	E	0.00110[h]	D	ND	
Conveyor Transfer Point (controlled) (SCC 3-05-020-06)	0.00014[i]	E	4.6×10^{-5}[i]	D	1.3×10^{-5}[q]	E
Wet Drilling - Unfragmented Stone (SCC 3-05-020-10)	ND		8.0×10^{-5}[j]	E	ND	
Truck Unloading -Fragmented Stone (SCC 3-05-020-31)	ND		1.6×10^{-5}[j]	E	ND	
Truck Loading - Conveyor, crushed stone (SCC 3-05-020-32)	ND		0.00010[k]	E	ND	

a. Emission factors represent uncontrolled emissions unless noted. Emission factors in lb/Ton of material of throughput. SCC = Source Classification Code. ND = No data.

b. Controlled sources (with wet suppression) are those that are part of the processing plant that employs current wet suppression technology similar to the study group. The moisture content of the study group without wet suppression systems operating (uncontrolled) ranged from 0.21 to 1.3 percent, and the same facilities operating wet suppression systems (controlled) ranged from 0.55 to 2.88 percent. Due to carry over of the small amount of moisture required, it has been shown that each source, with the exception of crushers, does not need to employ direct water sprays. Although the moisture content was the only variable measured, other process features may have as much influence on emissions from a given source. Visual observations from each source under normal operating conditions are probably the best indicator of which emission factor is most appropriate. Plants that employ substandard control measures as indicated by visual observations should use the uncontrolled factor with an appropriate control efficiency that best reflects the effectiveness of the controls employed.

c. References 1, 3, 7, and 8

d. References 3, 7, and 8

Table 11.24-2 (English Units). EMISSION FACTORS FOR METALLIC MINERALS PROCESSING[a,b]

EMISSION FACTOR RATINGS: (A-E) Follow The Emission Factor

Source	Filterable[b,c]			
	PM	RATING	PM-10	RATING
Low-moisture ore[c]				
Primary crushing (SCC 3-03-024-01)[d]	0.5	C	0.05	C
Secondary crushing (SCC 303-024-02)[d]	1.2	D	ND	
Tertiary crushing (SCC 3-03-024-03)[d]	2.7	E	0.16	E
Wet grinding	Neg		Neg	
Dry grinding with air conveying and/or air classification (SCC 3-03-024-09)[e]	28.8	C	26	C
Dry grinding without air conveying and/or air classification (SCC 3-03-024-10)[e]	2.4	D	0.31	D
Drying--all minerals except titanium/zirconium sands (SCC 3-03-024-11)[f]	19.7	C	12	C
Drying--titanium/zirconium with cyclones (SCC 3-03-024-11)[f]	0.5	C	ND	C
Material handling and transfer--all minerals except bauxite (SCC 3-03-024-04)[g]	0.12	C	0.06	C
Material handling and transfer--bauxite/alumina (SCC 3-03-024-04)[g,h]	1.1	C	ND	
High-moisture ore[c]				
Primary crushing (SCC 3-03-024-05)[d]	0.02	C	0.009	C
Secondary crushing (SCC 3-03-024-06)[d]	0.05	D	0.02	D
Tertiary crushing (SCC 3-03-024-07)[d]	0.06	E	0.02	E
Wet grinding	Neg		Neg	
Dry grinding with air conveying and/or air classification (SCC 3-03-024-09)[e]	28.8	C	26	C
Dry grinding without air conveying and/or air classification (SCC 3-03-024-10)[e]	2.4	D	0.31	D
Drying--all minerals except titanium/zirconium sands (SCC 3-03-024-11)[f]	19.7	C	12	C
Drying--titanium/zirconium with cyclones (SCC 3-03-024-11)[f]	0.5	C	ND	
Material handling and transfer--all minerals except bauxite (SCC 3-03-024-08)[g]	0.01	C	0.004	C
Material handling and transfer--bauxite/alumina (SCC 3-03-024-08)[g,h]	ND		ND	

[a] References 9-12; factors represent uncontrolled emissions unless otherwise noted; controlled emission factors are discussed in Section 11.24.3. All emission factors are in lb/ton of material processed unless noted. SCC = Source Classification Code. Neg = negligible. ND = no data.

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

[c] Defined in Section 11.24.2.

[d] Based on weight of material entering primary crusher.

[e] Based on weight of material entering grinder; emission factors are the same for both low-moisture and high-moisture ore because material is usually dried before entering grinder.

[f] Based on weight of material exiting dryer; emission factors are the same for both high-moisture and low-moisture ores; SO_x emissions are fuel dependent (see Chapter 1); NO_x emissions depend on burner design and combustion temperature (see Chapter 1).

[g] Based on weight of material transferred; applies to each loading or unloading operation and to each conveyor belt transfer point.

[h] Bauxite with moisture content as high as 15 to 18% can exhibit the emission characteristics of low-moisture ore; use low-moisture ore emission factor for bauxite unless material exhibits obvious sticky, nondusting characteristics.

Table 5.2-7 (Metric And English Units). EVAPORATIVE EMISSIONS FROM GASOLINE SERVICE STATION OPERATIONS[a]

Emission Source	Emission Rate	
	mg/L Throughput	lb/10^3 gal Throughput
Filling underground tank (Stage I)		
Submerged filling	880	7.3
Splash filling	1,380	11.5
Balanced submerged filling	40	0.3
Underground tank breathing and emptying[b]	120	1.0
Vehicle refueling operations (Stage II)		
Displacement losses (uncontrolled)[c]	1,320	11.0
Displacement losses (controlled)	132	1.1
Spillage	80	0.7

[a] Factors are for VOC as well as total organic emissions, because of the methane and ethane content of gasoline evaporative emissions is negligible.
[b] Includes any vapor loss between underground tank and gas pump.
[c] Based on Equation 6, using average conditions.

A second source of vapor emissions from service stations is underground tank breathing. Breathing losses occur daily and are attributable to gasoline evaporation and barometric pressure changes. The frequency with which gasoline is withdrawn from the tank, allowing fresh air to enter to enhance evaporation, also has a major effect on the quantity of these emissions. An average breathing emission rate is 120 mg/L (1.0 lb/1000 gal) of throughput.

5.2.2.3 Motor Vehicle Refueling -

Service station vehicle refueling activity also produces evaporative emissions. Vehicle refueling emissions come from vapors displaced from the automobile tank by dispensed gasoline and from spillage. The quantity of displaced vapors depends on gasoline temperature, auto tank temperature, gasoline RVP, and dispensing rate. Equation 6 can be used to estimate uncontrolled displacement losses from vehicle refueling for a particular set of conditions.[14]

$$E_R = 264.2\ [(-5.909) - 0.0949\ (\Delta T) + 0.0884\ (T_D) + 0.485\ (RVP)] \tag{6}$$

where:

E_R = refueling emissions, mg/L
ΔT = difference between temperature of fuel in vehicle tank and temperature of dispensed fuel, °F
T_D = temperature of dispensed fuel, °F
RVP = Reid vapor pressure, psia

Note that this equation and the spillage loss factor are incorporated into the *MOBILE* model. The *MOBILE* model allows for disabling of this calculation if it is desired to include these emissions in the stationary area source portion of an inventory rather than in the mobile source portion. It is estimated that the uncontrolled emissions from vapors displaced during vehicle refueling average 1320 mg/L (11.0 lb/1000 gal) of dispensed gasoline.[5,13]

Spillage loss is made up of contributions from prefill and postfill nozzle drip and from spit-back and

Table 11.17-4 (English Units). EMISSION FACTORS FOR LIME MANUFACTURING RAW MATERIAL AND PRODUCT PROCESSING AND HANDLING[a]

Source	Filterable[b]			
	PM	EMISSION FACTOR RATING	PM-10	EMISSION FACTOR RATING
Primary crusher[c] (SCC 3-05-016-01)	0.017	E	ND	
Scalping screen and hammermill (secondary crusher) (SCC 3-05-016-02)[c]	0.62	E	ND	
Primary crusher with fabric filter[d] (SCC 3-05-016-01)	0.00043	D	ND	
Primary screen with fabric filter[e] (SCC 3-05-016-16)	0.00061	D	ND	
Crushed material conveyor transfer with fabric filter[f] (SCC 3-05-016-24)	8.8×10^{-5}	D	ND	
Secondary and tertiary screen with fabric filter[g] (SCC 3-05-016-25)	0.00013	D	ND	
Product transfer and conveying (SCC 3-05-016-15)[h]	2.2	E	ND	
Product loading, enclosed truck (SCC 3-05-016-26)[h]	0.61	D	ND	
Product loading, open truck (SCC 3-05-016-27)[h]	1.5	D	ND	

[a] Factors represent uncontrolled emissions unless otherwise noted. Factors are lb/ton of material processed unless noted. ND = no data. SCC = Source Classification Code.
[b] Filterable PM is that PM collected on or before the filter of an EPA Method 5 (or equivalent) sampling train.
[c] Reference 8; factors are lb/ton.
[d] Reference 35. Factors are lb/ton of material processed. Includes scalping screen, scalping screen discharges, primary crusher, primary crusher discharges, and ore discharge.
[e] Reference 35. Factors are lb/ton of material processed. Includes primary screening, including the screen feed, screen discharge, and surge bin discharge.
[f] Reference 35. Factors are lb/ton of material processed. Based on average of three runs each of emissions from two conveyor transfer points on the conveyor from the primary crusher to the primary stockpile.
[g] Reference 35. Emission factors in units of kg/Mg of material processed. Based on sum of emissions from two emission points that include conveyor transfer point for the primary stockpile underflow to the secondary screen, secondary screen, tertiary screen, and tertiary screen discharge.
[h] Reference 12; units are lb/ton of product loaded.

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
Stone quarrying and processing	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
Taconite mining and processing	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
Municipal solid waste landfills	4	Sand	1	—	2.6	1	—	7.4
		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]

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

$$E = k(0.0032)\ \frac{\left(\frac{U}{5}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\ \text{(pound [lb]/ton)} \qquad (1)$$

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 Controls[12-13]

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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2012. The engine for construction equipment.

75 - 147 kW at 1500 - 2500 rpm

The new 1 litre class.

These are the characteristics of the 2012:

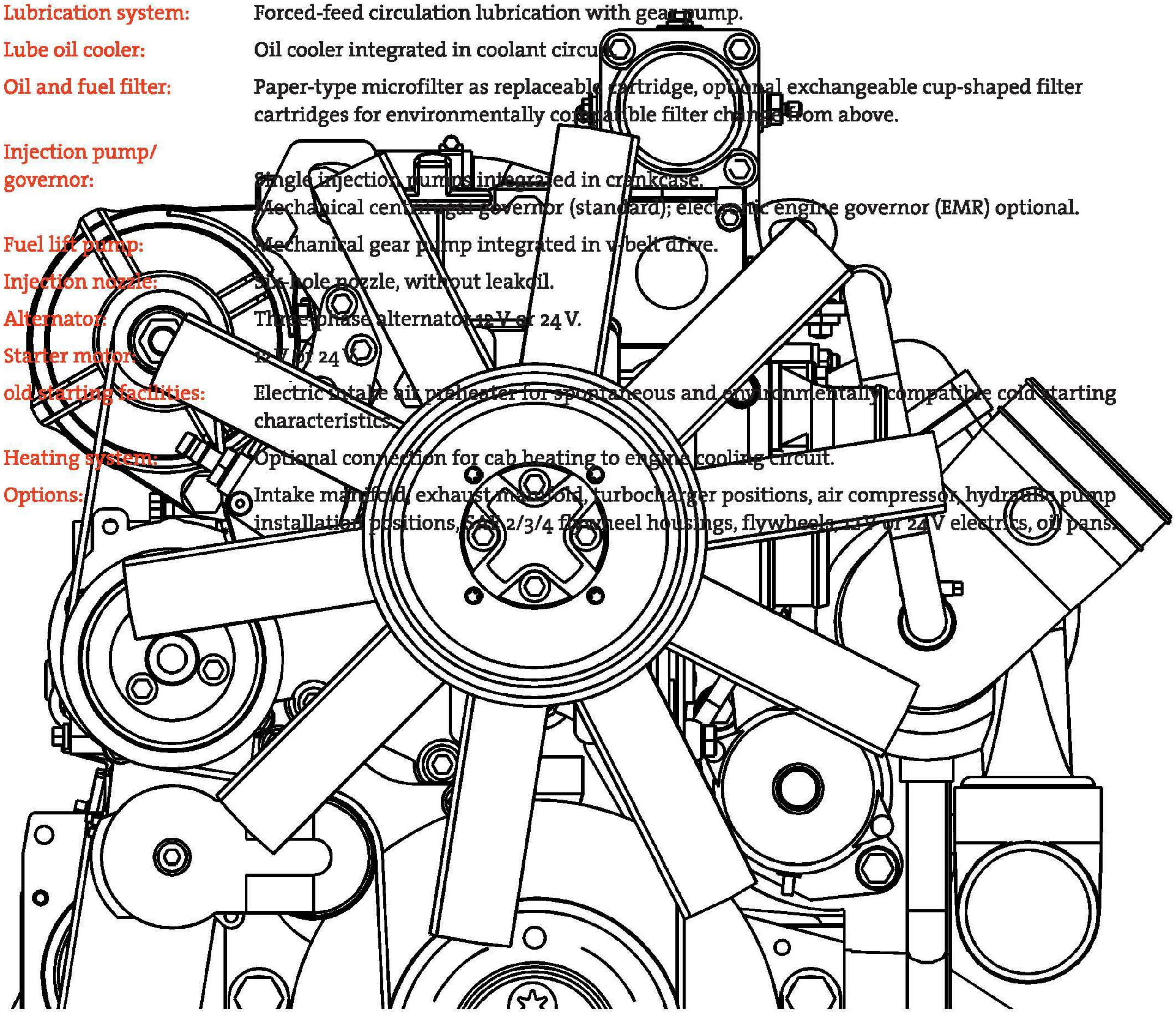
Modern liquid-cooled 4- and 6-cylinder in-line engines.
1 litre displacement per cylinder. Compact design and high power-to-volume-ratio.
Turbocharging and turbocharging with charge air cooling.
High-pressure fuel injection up to 1600 bar.
Electronic engine governor with diagnostic facilities and CAN-bus optional.
3 separate mounting options for gear-driven hydraulic pumps.
Easy accessible service points on one engine side.
Wedge ribbed belt drive with automatic belt tensioner optional.

Your benefits:

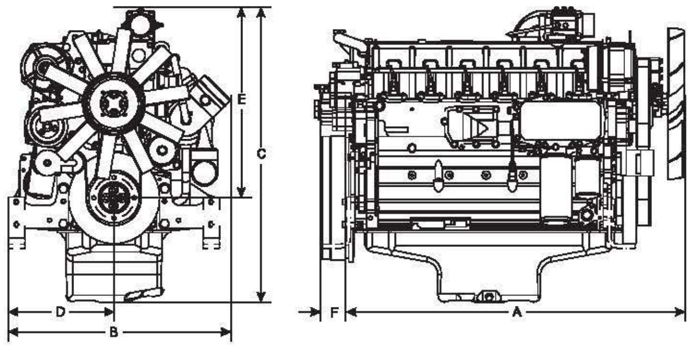
- Fast and powerful response to changing operating duties, dynamic power development.
- Low cost for noise insulation measures. High comfort in the driver's cab because of low noise level. Low noise emission, low environmental impact.
- High operating economy thanks to low fuel consumption, long oil change intervals and low maintenance requirement.
- Low exhaust emission for a clean environment. Meets exhaust regulation EU-RL 97/68 (Step 2) and US-EPA Nonroad (Tier 2).
- High reliability even under extreme working conditions.

Engine description

Type of cooling:	Liquid cooling, thermostatically controlled at engine outlet. Charge-air-cooled engines with air-to-air charge air cooler.
Crankcase:	High grey cast iron crankcase, for monobloc construction.
Mass balance shafts:	4-cylinder optional with full mass balance by 2 shafts integrated into the crankcase.
Crankcase breather:	Closed-circuit crankcase breather.
Cylinder head:	Grey cast block-type cylinder head.
Valve arrangement/ timing:	Two valves per cylinder, actuated from gear driven camshaft via tappets, push rods and rocker arms.
Piston:	Three-ring aluminium piston.
Piston cooling:	Oil cooled with spray nozzles.
Connecting rod:	Forged steed rod.
Crankshaft:	Forged steel shaft with integral counterweights, 4-cylinder version with integral mass balancing shafts.
Camshaft:	Steel shaft.
Lubrication system:	Forced-feed circulation lubrication with gear pump.
Lube oil cooler:	Oil cooler integrated in coolant circuit.
Oil and fuel filter:	Paper-type microfilter as replaceable cartridge, optional exchangeable cup-shaped filter cartridges for environmentally compatible filter change from above.
Injection pump/ governor:	Single injection pumps integrated in crankcase. Mechanical centrifugal governor (standard); electronic engine governor (EMR) optional.
Fuel lift pump:	Mechanical gear pump integrated in v-belt drive.
Injection nozzle:	Six-hole nozzle, without leakoil.
Alternator:	Three-phase alternator 12 V or 24 V.
Starter motor:	12 V or 24 V.
old starting facilities:	Electric intake air preheater for spontaneous and environmentally compatible cold starting characteristics.
Heating system:	Optional connection for cab heating to engine cooling circuit.
Options:	Intake manifold, exhaust manifold, turbocharger positions, air compressor, hydraulic pump installation positions, SAE 2/3/4 flywheel housings, flywheels, 12 V or 24 V electrics, oil pans.



Dimensions



Engine with belt drive		A	B	C	D	E	F
BF 4 M 2012	mm	742	643	741	300	506	105
BF 4 M 2012 C	mm	742	643	835	300	600	105
BF 6 M 2012 C	mm	998	628	920	300	600	105

Engine with wedge ribbed belt drive (Poly-V)		A	B	C	D	E	F
BF 4 M 2012	mm	798	643	741	300	506	105
BF 4 M 2012 C	mm	798	643	835	300	600	105
BF 6 M 2012 C	mm	1015	628	920	300	600	105

Technical data

Engine type		BF 4 M 2012	BF 4 M 2012 C	BF 6 M 2012 C
Number of cylinders		4	4	6
Bore/stroke	mm	101/126	101/126	101/126
Displacement	l	4.04	4.04	6.06
Compression ratio		19	19	19
Max. rated speed	rpm	2500	2500	2500
Mean piston speed	m/s	10.5	10.5	10.5

Power ratings for construction equipment engines 1)				
Power ratings for industrial engines 2)	kW	74.9	103	155
at speed	rpm	2500	2500	2500
Mean effective pressure	bar	8.9	12.2	12.3
Max. torque	Nm	390	493	743
at speed	rpm	1500	1500	1500
Minimum idle speed	rpm	800	800	800
Specific fuel consumption 3)	g/kWh	208	202	202
Weight to DIN 70020, part 7A 4)	kg	391	391	509

Modell designation

BF 6 M 2012 C

C = Charge air cooler

Engine family designation

M = Liquit cooled

Number of cylinders

B = Turbocharging
F = High-speed four-stroke engine

1) Power ratings without deduction of fan power requirement.

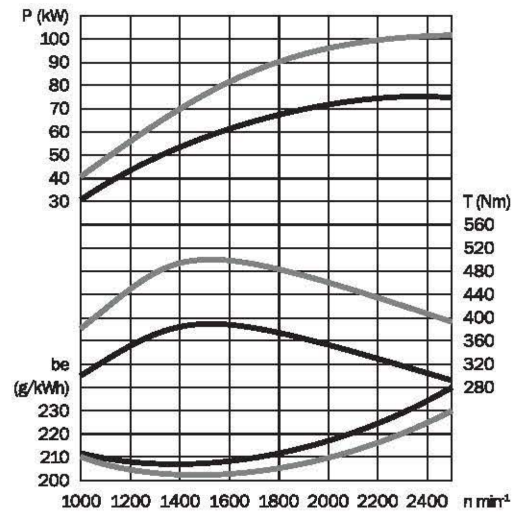
2) Fuel stop power to ISO 3046/1.

3) Specific fuel consumption based on diesel fuel with a specific gravity of 0.835 kg/dm³ at 15°C.

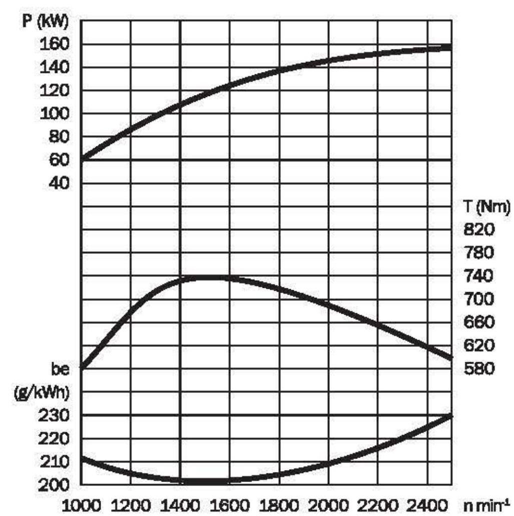
4) Without starter motor/alternator, radiator and liquids, however with flywheel and flywheel housing.

The values given in this data sheet are for information purposes only and not binding. The information given in the offer is decisive.

Standard engines



▶ BF 4 M 2012 ▶ BF 4 M 2012 C



▶ BF 6 M 2012 C

Order-Nr 0031 1969 / 05 / 2003 / VM-V

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3.3 Gasoline And Diesel Industrial Engines

3.3.1 General

The engine category addressed by this section covers a wide variety of industrial applications of both gasoline and diesel internal combustion (IC) engines such as aerial lifts, fork lifts, mobile refrigeration units, generators, pumps, industrial sweepers/scrubbers, material handling equipment (such as conveyors), and portable well-drilling equipment. The three primary fuels for reciprocating IC engines are gasoline, diesel fuel oil (No.2), and natural gas. Gasoline is used primarily for mobile and portable engines. Diesel fuel oil is the most versatile fuel and is used in IC engines of all sizes. The rated power of these engines covers a rather substantial range, up to 250 horsepower (hp) for gasoline engines and up to 600 hp for diesel engines. (Diesel engines greater than 600 hp are covered in Section 3.4, "Large Stationary Diesel And All Stationary Dual-fuel Engines".) Understandably, substantial differences in engine duty cycles exist. It was necessary, therefore, to make reasonable assumptions concerning usage in order to formulate some of the emission factors.

3.3.2 Process Description

All reciprocating IC engines operate by the same basic process. A combustible mixture is first compressed in a small volume between the head of a piston and its surrounding cylinder. The mixture is then ignited, and the resulting high-pressure products of combustion push the piston through the cylinder. This movement is converted from linear to rotary motion by a crankshaft. The piston returns, pushing out exhaust gases, and the cycle is repeated.

There are 2 methods used for stationary reciprocating IC engines: compression ignition (CI) and spark ignition (SI). This section deals with both types of reciprocating IC engines. All diesel-fueled engines are compression ignited, and all gasoline-fueled engines are spark ignited.

In CI engines, combustion air is first compression heated in the cylinder, and diesel fuel oil is then injected into the hot air. Ignition is spontaneous because the air temperature is above the autoignition temperature of the fuel. SI engines initiate combustion by the spark of an electrical discharge. Usually the fuel is mixed with the air in a carburetor (for gasoline) or at the intake valve (for natural gas), but occasionally the fuel is injected into the compressed air in the cylinder.

CI engines usually operate at a higher compression ratio (ratio of cylinder volume when the piston is at the bottom of its stroke to the volume when it is at the top) than SI engines because fuel is not present during compression; hence there is no danger of premature autoignition. Since engine thermal efficiency rises with increasing pressure ratio (and pressure ratio varies directly with compression ratio), CI engines are more efficient than SI engines. This increased efficiency is gained at the expense of poorer response to load changes and a heavier structure to withstand the higher pressures.[1]

3.3.3 Emissions

Most of the pollutants from IC engines are emitted through the exhaust. However, some total organic compounds (TOC) escape from the crankcase as a result of blowby (gases that are vented from the oil pan after they have escaped from the cylinder past the piston rings) and from the fuel tank and carburetor because of evaporation. Nearly all of the TOCs from diesel CI engines enter the atmosphere from the exhaust. Evaporative losses are insignificant in diesel engines due to the low volatility of diesel fuels.

The primary pollutants from internal combustion engines are oxides of nitrogen (NO_x), total organic compounds (TOC), carbon monoxide (CO), and particulates, which include both visible (smoke) and nonvisible emissions. Nitrogen oxide formation is directly related to high pressures and temperatures during the combustion process and to the nitrogen content, if any, of the fuel. The other pollutants, HC, CO, and smoke, are primarily the result of incomplete combustion. Ash and metallic additives in the fuel also contribute to the particulate content of the exhaust. Sulfur oxides (SO_x) also appear in the exhaust from IC engines. The sulfur compounds, mainly sulfur dioxide (SO_2), are directly related to the sulfur content of the fuel.[2]

3.3.3.1 Nitrogen Oxides -

Nitrogen oxide formation occurs by two fundamentally different mechanisms. The predominant mechanism with internal combustion engines is thermal NO_x which arises from the thermal dissociation and subsequent reaction of nitrogen (N_2) and oxygen (O_2) molecules in the combustion air. Most thermal NO_x is formed in the high-temperature region of the flame from dissociated molecular nitrogen in the combustion air. Some NO_x, called prompt NO_x, is formed in the early part of the flame from reaction of nitrogen intermediary species, and HC radicals in the flame. The second mechanism, fuel NO_x, stems from the evolution and reaction of fuel-bound nitrogen compounds with oxygen. Gasoline, and most distillate oils have no chemically-bound fuel N_2 and essentially all NO_x formed is thermal NO_x.

3.3.3.2 Total Organic Compounds -

The pollutants commonly classified as hydrocarbons are composed of a wide variety of organic compounds and are discharged into the atmosphere when some of the fuel remains unburned or is only partially burned during the combustion process. Most unburned hydrocarbon emissions result from fuel droplets that were transported or injected into the quench layer during combustion. This is the region immediately adjacent to the combustion chamber surfaces, where heat transfer outward through the cylinder walls causes the mixture temperatures to be too low to support combustion.

Partially burned hydrocarbons can occur because of poor air and fuel homogeneity due to incomplete mixing, before or during combustion; incorrect air/fuel ratios in the cylinder during combustion due to maladjustment of the engine fuel system; excessively large fuel droplets (diesel engines); and low cylinder temperature due to excessive cooling (quenching) through the walls or early cooling of the gases by expansion of the combustion volume caused by piston motion before combustion is completed.[2]

3.3.3.3 Carbon Monoxide -

Carbon monoxide is a colorless, odorless, relatively inert gas formed as an intermediate combustion product that appears in the exhaust when the reaction of CO to CO_2 cannot proceed to completion. This situation occurs if there is a lack of available oxygen near the hydrocarbon (fuel) molecule during combustion, if the gas temperature is too low, or if the residence time in the cylinder is too short. The oxidation rate of CO is limited by reaction kinetics and, as a consequence, can be accelerated only to a certain extent by improvements in air and fuel mixing during the combustion process.[2-3]

3.3.3.4 Smoke and Particulate Matter -

White, blue, and black smoke may be emitted from IC engines. Liquid particulates appear as white smoke in the exhaust during an engine cold start, idling, or low load operation. These are formed in the quench layer adjacent to the cylinder walls, where the temperature is not high enough to ignite the fuel. Blue smoke is emitted when lubricating oil leaks, often past worn piston rings, into the combustion chamber and is partially burned. Proper maintenance is the most effective method of preventing blue smoke emissions from all types of IC engines. The primary constituent of black smoke is agglomerated carbon particles (soot) formed in regions of the combustion mixtures that are oxygen deficient.[2]

3.3.3.5 Sulfur Oxides -

Sulfur oxides emissions are a function of only the sulfur content in the fuel rather than any combustion variables. In fact, during the combustion process, essentially all the sulfur in the fuel is oxidized to SO_2. The oxidation of SO_2 gives sulfur trioxide (SO_3), which reacts with water to give sulfuric acid (H_2SO_4), a contributor to acid precipitation. Sulfuric acid reacts with basic substances to give sulfates, which are fine particulates that contribute to PM-10 and visibility reduction. Sulfur oxide emissions also contribute to corrosion of the engine parts.[2-3]

3.3.4 Control Technologies

Control measures to date are primarily directed at limiting NO_x and CO emissions since they are the primary pollutants from these engines. From a NO_x control viewpoint, the most important distinction between different engine models and types of reciprocating engines is whether they are rich-burn or lean-burn. Rich-burn engines have an air-to-fuel ratio operating range that is near stoichiometric or fuel-rich of stoichiometric and as a result the exhaust gas has little or no excess oxygen. A lean-burn engine has an air-to-fuel operating range that is fuel-lean of stoichiometric; therefore, the exhaust from these engines is characterized by medium to high levels of O_2. The most common NO_x control technique for diesel and dual-fuel engines focuses on modifying the combustion process. However, selective catalytic reduction (SCR) and nonselective catalytic reduction (NSCR) which are post-combustion techniques are becoming available. Controls for CO have been partly adapted from mobile sources.[4]

Combustion modifications include injection timing retard (ITR), preignition chamber combustion (PCC), air-to-fuel ratio adjustments, and derating. Injection of fuel into the cylinder of a CI engine initiates the combustion process. Retarding the timing of the diesel fuel injection causes the combustion process to occur later in the power stroke when the piston is in the downward motion and combustion chamber volume is increasing. By increasing the volume, the combustion temperature and pressure are lowered, thereby lowering NO_x formation. ITR reduces NO_x from all diesel engines; however, the effectiveness is specific to each engine model. The amount of NO_x reduction with ITR diminishes with increasing levels of retard.[4]

Improved swirl patterns promote thorough air and fuel mixing and may include a precombustion chamber (PCC). A PCC is an antechamber that ignites a fuel-rich mixture that propagates to the main combustion chamber. The high exit velocity from the PCC results in improved mixing and complete combustion of the lean air/fuel mixture which lowers combustion temperature, thereby reducing NO_x emissions.[4]

The air-to-fuel ratio for each cylinder can be adjusted by controlling the amount of fuel that enters each cylinder. At air-to-fuel ratios less than stoichiometric (fuel-rich), combustion occurs under conditions of insufficient oxygen which causes NO_x to decrease because of lower oxygen and lower temperatures. Derating involves restricting the engine operation to lower than normal levels of power production for the given application. Derating reduces cylinder pressures and temperatures, thereby lowering NO_x formation rates.[4]

SCR is an add-on NO_x control placed in the exhaust stream following the engine and involves injecting ammonia (NH_3) into the flue gas. The NH_3 reacts with NO_x in the presence of a catalyst to form water and nitrogen. The effectiveness of SCR depends on fuel quality and engine duty cycle (load fluctuations). Contaminants in the fuel may poison or mask the catalyst surface causing a reduction or termination in catalyst activity. Load fluctuations can cause variations in exhaust temperature and NO_x concentration which can create problems with the effectiveness of the SCR system.[4]

NSCR is often referred to as a three-way conversion catalyst system because the catalyst reactor simultaneously reduces NO_x, CO, and HC and involves placing a catalyst in the exhaust stream of the engine. The reaction requires that the O_2 levels be kept low and that the engine be operated at fuel-rich air-to-fuel ratios.[4]

The most accurate method for calculating such emissions is on the basis of "brake-specific" emission factors (pounds per horsepower-hour [lb/hp-hr]). Emissions are the product of the brake-specific emission factor, the usage in hours, the rated power available, and the load factor (the power actually used divided by the power available). However, for emission inventory purposes, it is often easier to assess this activity on the basis of fuel used.

Once reasonable usage and duty cycles for this category were ascertained, emission values were aggregated to arrive at the factors for criteria and organic pollutants presented. Factors in Table 3.3-1 are in pounds per million British thermal unit (lb/MMBtu). Emission data for a specific design type were weighted according to estimated material share for industrial engines. The emission factors in these tables, because of their aggregate nature, are most appropriately applied to a population of industrial engines rather than to an individual power plant. Table 3.3-2 shows unweighted speciated organic compound and air toxic emission factors based upon only 2 engines. Their inclusion in this section is intended for rough order-of-magnitude estimates only.

Table 3.3-3 summarizes whether the various diesel emission reduction technologies (some of which may be applicable to gasoline engines) will generally increase or decrease the selected parameter. These technologies are categorized into fuel modifications, engine modifications, and exhaust after-treatments. Current data are insufficient to quantify the results of the modifications. Table 3.3-3 provides general information on the trends of changes on selected parameters.

3.3.5 Updates Since the Fifth Edition

The Fifth Edition was released in January 1995. Revisions to this section since that date are summarized below. For further detail, consult the memoranda describing each supplement or the background report for this section.

Supplement A, February 1996

No changes.

Supplement B, October 1996

- Text was revised concerning emissions and controls.
- The CO_2 emission factor was adjusted to reflect 98.5 percent conversion efficiency.

Table 3.3-1. EMISSION FACTORS FOR UNCONTROLLED GASOLINE AND DIESEL INDUSTRIAL ENGINES[a]

Pollutant	Gasoline Fuel (SCC 2-02-003-01, 2-03-003-01)		Diesel Fuel (SCC 2-02-001-02, 2-03-001-01)		EMISSION FACTOR RATING
	Emission Factor (lb/hp-hr) (power output)	Emission Factor (lb/MMBtu) (fuel input)	Emission Factor (lb/hp-hr) (power output)	Emission Factor (lb/MMBtu) (fuel input)	
NO_x	0.011	1.63	0.031	4.41	D
CO	6.96 E-03[d]	0.99[d]	6.68 E-03	0.95	D
SO_x	5.91 E-04	0.084	2.05 E-03	0.29	D
PM-10[b]	7.21 E-04	0.10	2.20 E-03	0.31	D
CO_2[c]	1.08	154	1.15	164	B
Aldehydes	4.85 E-04	0.07	4.63 E-04	0.07	D
TOC					
Exhaust	0.015	2.10	2.47 E-03	0.35	D
Evaporative	6.61 E-04	0.09	0.00	0.00	E
Crankcase	4.85 E-03	0.69	4.41 E-05	0.01	E
Refueling	1.08 E-03	0.15	0.00	0.00	E

[a] References 2,5-6,9-14. When necessary, an average brake-specific fuel consumption (BSFC) of 7,000 Btu/hp-hr was used to convert from lb/MMBtu to lb/hp-hr. To convert from lb/hp-hr to kg/kw-hr, multiply by 0.608. To convert from lb/MMBtu to ng/J, multiply by 430. SCC = Source Classification Code. TOC = total organic compounds.

[b] PM-10 = particulate matter less than or equal to 10 µm aerodynamic diameter. All particulate is assumed to be ≤ 1 µm in size.

[c] Assumes 99% conversion of carbon in fuel to CO_2 with 87 weight % carbon in diesel, 86 weight % carbon in gasoline, average BSFC of 7,000 Btu/hp-hr, diesel heating value of 19,300 Btu/lb, and gasoline heating value of 20,300 Btu/lb.

[d] Instead of 0.439 lb/hp-hr (power output) and 62.7 lb/mmBtu (fuel input), the correct emissions factors values are 6.96 E-03 lb/hp-hr (power output) and 0.99 lb/mmBtu (fuel input), respectively. This is an editorial correction. March 24, 2009

Table 3.3-2. SPECIATED ORGANIC COMPOUND EMISSION FACTORS FOR UNCONTROLLED DIESEL ENGINES[a]

EMISSION FACTOR RATING: E

Pollutant	Emission Factor (Fuel Input) (lb/MMBtu)
Benzene[b]	9.33 E-04
Toluene[b]	4.09 E-04
Xylenes[b]	2.85 E-04
Propylene	2.58 E-03
1,3-Butadiene[b,c]	<3.91 E-05
Formaldehyde[b]	1.18 E-03
Acetaldehyde[b]	7.67 E-04
Acrolein[b]	<9.25 E-05
Polycyclic aromatic hydrocarbons (PAH)	
Naphthalene[b]	8.48 E-05
Acenaphthylene	<5.06 E-06
Acenaphthene	<1.42 E-06
Fluorene	2.92 E-05
Phenanthrene	2.94 E-05
Anthracene	1.87 E-06
Fluoranthene	7.61 E-06
Pyrene	4.78 E-06
Benzo(a)anthracene	1.68 E-06
Chrysene	3.53 E-07
Benzo(b)fluoranthene	<9.91 E-08
Benzo(k)fluoranthene	<1.55 E-07
Benzo(a)pyrene	<1.88 E-07
Indeno(1,2,3-cd)pyrene	<3.75 E-07
Dibenz(a,h)anthracene	<5.83 E-07
Benzo(g,h,l)perylene	<4.89 E-07
TOTAL PAH	1.68 E-04

[a] Based on the uncontrolled levels of 2 diesel engines from References 6-7. Source Classification Codes 2-02-001-02, 2-03-001-01. To convert from lb/MMBtu to ng/J, multiply by 430.
[b] Hazardous air pollutant listed in the *Clean Air Act*.
[c] Based on data from 1 engine.

Table 3.3-3. EFFECT OF VARIOUS EMISSION CONTROL TECHNOLOGIES ON DIESEL ENGINES[a]

Technology	Affected Parameter	
	Increase	Decrease
Fuel modifications		
Sulfur content increase	PM, wear	
Aromatic content increase	PM, NO_x	
Cetane number		PM, NO_x
10% and 90% boiling point		PM
Fuel additives		PM, NO_x
Water/Fuel emulsions		NO_x
Engine modifications		
Injection timing retard	PM, BSFC	NO_x, power
Fuel injection pressure	PM, NO_x	
Injection rate control		NO_x, PM
Rapid spill nozzles		PM
Electronic timing & metering		NO_x, PM
Injector nozzle geometry		PM
Combustion chamber modifications		NO_x, PM
Turbocharging	PM, power	NO_x
Charge cooling		NO_x
Exhaust gas recirculation	PM, power, wear	NO_x
Oil consumption control		PM, wear
Exhaust after-treatment		
Particulate traps		PM
Selective catalytic reduction		NO_x
Oxidation catalysts		TOC, CO, PM

[a] Reference 8. PM = particulate matter. BSFC = brake-specific fuel consumption.

References For Section 3.3

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C6.6 ACERT™ Industrial Engine

Tier 4 Interim/Stage IIIB

89-129.4 bkW/119.3-173.5 bhp @ 2200 rpm

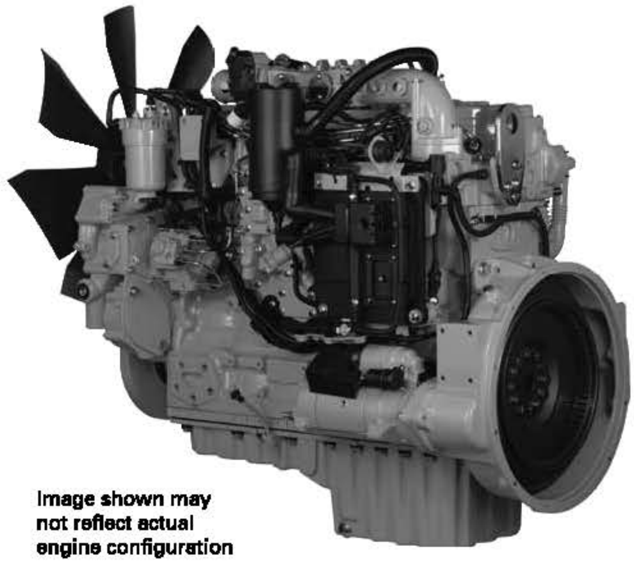


Image shown may not reflect actual engine configuration

CAT® ENGINE SPECIFICATIONS

I-6, 4-Stroke-Cycle Diesel

Bore	105.0 mm (4.13 in)
Stroke	127 mm (5.00 in)
Displacement	6.6 L (402.8 in^3)
Aspiration	Turbocharged-Aftercooled
Compression Ratio	16.5:1
Combustion System	Direct injection
Rotation (from flywheel end)	Counterclockwise
Capacity for Liquids	
Cooling System	13.7 L (14.5 U.S. qts)
Lube System (refill) sump dependent	13-16 L (13.7-16.9 U.S. qts)
Engine Weight, Net Dry (approximate)	695 kg (1532 lbs)

FEATURES

Emissions
Designed to meet 2012 EPA (U.S.) Tier 4 Interim, EU Stage IIIB and Japanese MLIT emissions requirements.

Reliable, Quiet, and Durable Power
World-class manufacturing capability and processes coupled with proven core engine designs assure reliability, quiet operation, and many hours of productive life.

High Performance
Turbocharger with smart wastegate available on some ratings for fast response, high power, and increased torque.

Fuel Efficiency
Fuel consumption optimized to match operating cycles of a wide range of equipment and applications. No additional fluids or additives are required, which lowers operating costs.

Fuel & Oil
Tier 4 Interim/Stage IIIB engines require Ultra Low Sulfur Diesel (ULSD) fuel containing a maximum of 15 ppm sulfur, and new oil formulations to support the new technology. Cat® engines are designed to accommodate B20 biofuel. Your Cat dealer can provide more information regarding fuel and oil.

Broad Application Range
Industry leading range of factory configurable ratings and options for agricultural, materials-handling, construction, mining, aircraft ground support, and other industrial applications.

Package Size
Ideal for equipment with narrow engine compartments. Multiple installation options minimize total package size.

Low-Cost Maintenance
Worldwide service delivers ease of maintenance and simplifies the servicing routine. Hydraulic tappets, multi-vee belts, "no ash service" aftertreatment, and 500-hour oil change intervals enable low-cost maintenance. Many service items have a choice of location on either side of the engine to enable choice of service access. The S•O•S℠ program is available from your Cat dealer to determine oil change intervals and provide optimal performance.

Quality
Every Cat engine is manufactured to stringent standards in order to assure customer satisfaction.

World-class Product Support Offered Through Global Cat Dealer Network
- Scheduled maintenance, including S•O•S℠ sample
- Customer Support Agreements (CSA)
- Cat Extended Service Coverage (ESC)
- Superior dealer service network
- Extended dealer service network through the Cat Industrial Service Distributor (ISD) program

Web Site: For additional information on all your power requirements, visit www.cat-industrial.com.

STANDARD ENGINE EQUIPMENT

Air Inlet
Standard air cleaners

Control System
Full electronic control system, all connectors and wiring looms waterproof and designed to withstand harsh off-highway environments, flexible and configurable software features and well supported SAE J1939 CAN bus enables highly integrated machines

Cooling System
Top tank temperature 108°C (226°F) as standard to minimize cooling pack size, 50:50 water glycol mix, detailed guidance on cooling system design and validation available to ensure machine reliability

Exhaust System
Diesel particulate filter supplied with a range of inlet and outlet options, no ash service requirement, low temperature regeneration

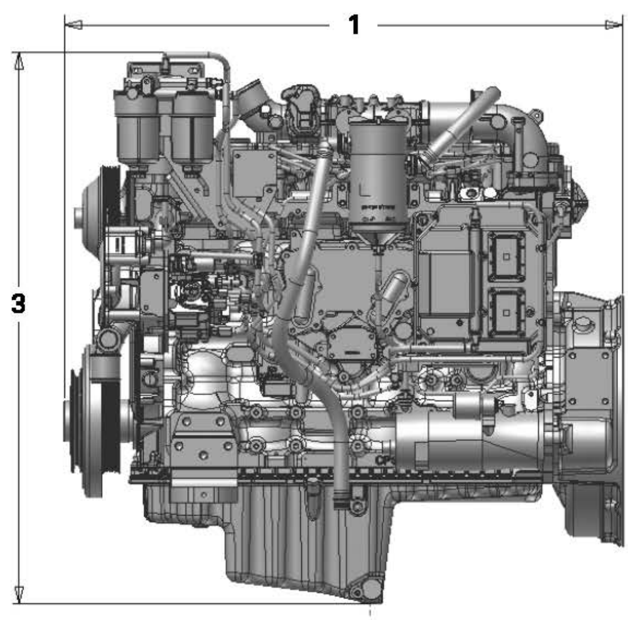
Flywheels and Flywheel Housing
Wide choice of drivetrain interfaces, including but not limited to SAE1, SAE2, and SAE3 configurations

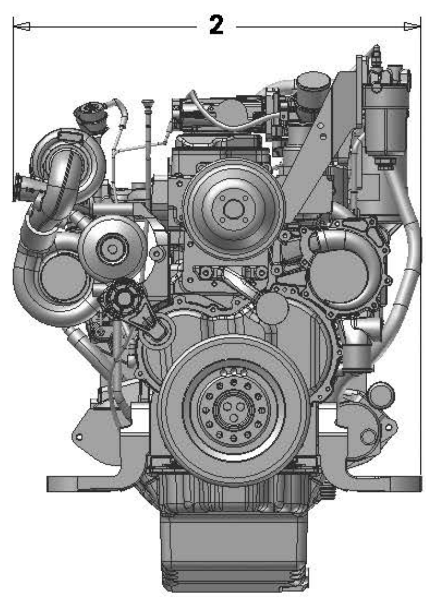
Fuel System
Electronic high pressure common rail, ACERT™ Technology, innovative filter design to ensure maximum protection of the engine

Lube System
Choice of sumps for different applications

Power Take Off
SAE A or SAE B flanges on left-hand side, engine power can also be taken from the front of the engine on some applications, factory fitted compressors are also available.

DIMENSIONS





(1) Length — 1063.7 mm (41.9 in) (2) Width — 753 mm (29.6 in) (3) Height — 907 mm (35.7 in)

Note: Final dimensions dependent on selected options

CAT

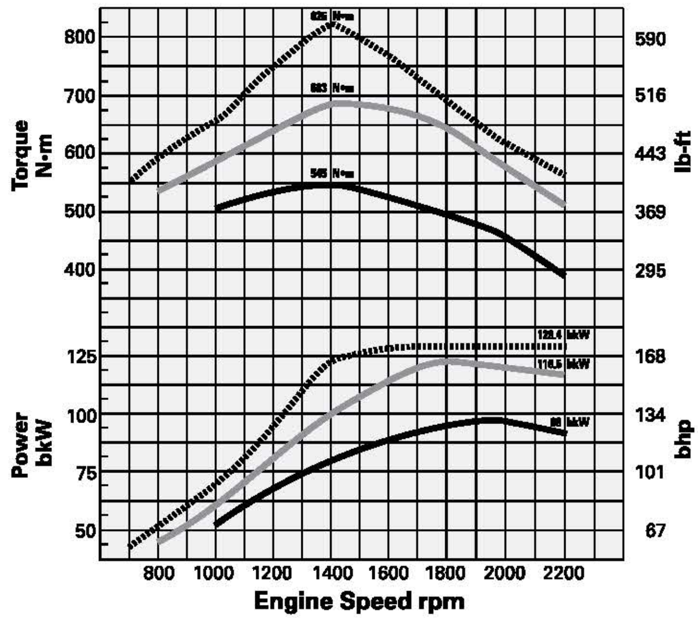
C6.6 ACERT™
Industrial Engine

Tier 4 Interim/Stage IIIB
89-129.4 bkW/119.3-173.5 bhp @ 2200 rpm

PERFORMANCE DATA — PRELIMINARY

Turbocharged-Aftercooled — 2200 rpm

Rated Speed



Rated Speed

Rating	Speed rpm	Peak Power bkW	Peak Power bhp	Speed rpm	Peak Torque N•m	Peak Torque lb-ft
C	2200	89.0	119.3	1400	545	402.0
C	2200	116.5	156.2	1400	683	503.8
C	2200	129.4	173.5	1400	825	608.5

RATING DEFINITIONS AND CONDITIONS

IND-C (Intermittent) is the horsepower and speed capability of the engine where maximum power and/or speed are cyclic (time at full load not to exceed 50%).

Additional ratings are available for specific customer requirements. Consult your Cat dealer.

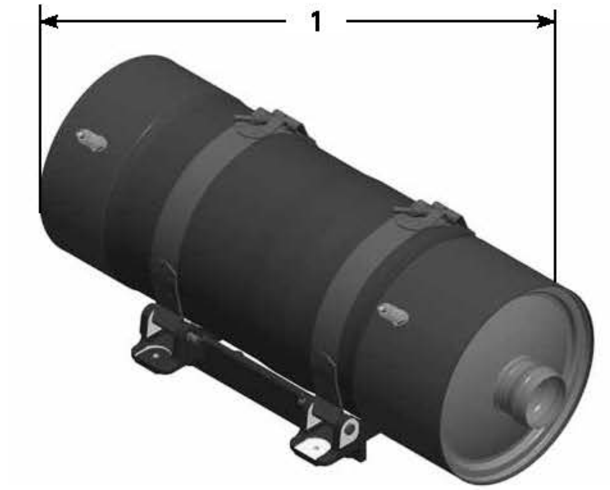
Rating Conditions are based on ISO/TR14396, inlet air standard conditions with a total barometric pressure of 100 kPa (29.5 in Hg), with a vapor pressure of 1 kPa (.295 in Hg), and 25°C (77°F). Performance is measured using fuel to EPA specifications in 40 CFR Part 1065 and EU specifications in Directive 97/68/EC with a density of 0.845-0.850 kg/L @ 15°C (59°F) and fuel inlet temperature 40°C (104°F).

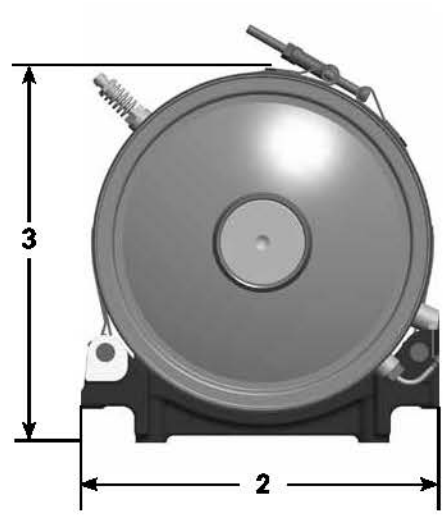
CAT

C6.6 ACERT™ Industrial Engine

Tier 4 Interim/Stage IIIB
89-129.4 bkW/119.3-173.5 bhp @ 2200 rpm

AFTERTREATMENT CONFIGURATION





283 mm (11.1 in) DIAMETER BASE CONFIGURATION SHOWN
Approximate Size and Weight
(1) Length — 852.7 mm (33.6 in)
(2) Width — 364.6 mm (14.35 in)
(3) Height — 352 mm (13.9 in)
Weight — 40 kg (88.1 lbs)

AFTERTREATMENT FEATURES

Regeneration: Low temperature regeneration completely transparent to the operator

Mounting: Extensive range of inlets and outlets, as well as remote and on-engine installations, provide flexibility for many installations.

Service: Service-free DPF for the emissions life of the engine

Available in 12V or 24V systems

STANDARD EMISSIONS CONTROL EQUIPMENT

DOC: Diesel Oxidation Catalyst

DPF: Diesel Particulate Filter

3" flex pipe connection kit with straight, 45°, and 90° options for flexibility

LEHH0022-02 (11-10)

C7.1 ACERT™ Industrial Engine

Tier 4 Interim/Stage IIIB

140-225 bkW/187.7-301.8 bhp @ 2200 rpm

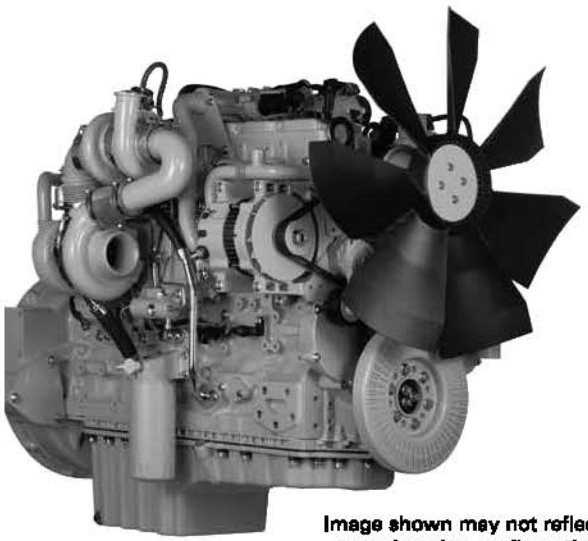


Image shown may not reflect actual engine configuration

CAT® ENGINE SPECIFICATIONS

I-6, 4-Stroke-Cycle Diesel

Bore .... 105 mm (4.13 in.)
Stroke .... 135 mm (5.3 in.)
Displacement .... 7.01 L (427.7 in³)
Aspiration ...... Series Turbocharged Aftercooled
Compression Ratio........................ 16.5:1
Combustion System .... Direct Injection
Rotation (from flywheel end) ... Counterclockwise
Capacity for Liquids
  Cooling System .... 15.2 L (16 U.S. qts.)
  Lube Oil System (refill) sump
    dependent .... 16.5-21.5 L (17.4-22.7 U.S. qts.)
Engine Weight, Net Dry
  (approximate)................ 715 kg (1576 lbs.)

FEATURES

Emissions
Designed to meet 2011 EPA (U.S.) Tier 4 Interim and EU Stage IIIB emissions requirements. Also expected to meet Japanese MLIT emissions requirements once available.

Reliable, Quiet, and Durable Power
World-class manufacturing capability and processes coupled with proven core engine designs assure reliability, quiet operation, and many hours of productive life.

High Performance
Series turbocharging with smart wastegate available on all ratings for fast response, high power, and increased torque.

Fuel Efficiency
Fuel consumption optimized to match operating cycles of a wide range of equipment and applications. No additional fluids or additives are required which lowers operating costs.

Broad Application Range
Industry leading range of factory configurable ratings and options for agricultural, materials-handling, construction, mining, aircraft ground support, and other industrial applications.

Package Size
Exceptional power density enables standardization across numerous applications. Multiple installation options minimize total package size. Ideal for equipment with narrow engine compartments.

Low-Cost Maintenance
Hydraulic tappets, multi-vee belts, minimum 4500-hour diesel particulate filter ash service interval and 500-hour oil change intervals enable low-cost maintenance. Many service items have a choice of location on either side of the engine to enable choice of service access.

Testing
Every Cat® engine is quality tested under full load to ensure proper engine performance.

World-class Product Support Offered Through Global Cat Dealer Network
- Scheduled maintenance
- Customer Support Agreements (CSA)
- Cat Extended Service Coverage (ESC)
- Superior dealer service network
- Extended dealer service network through the Cat Industrial Service Distributor (ISD) program

Web Site: For additional information on all your power requirements, visit www.cat-industrial.com.

STANDARD ENGINE EQUIPMENT

Air Inlet
Heavy-duty air cleaners available

Control System
Full electronic control system, all connectors and wiring looms waterproof and designed to withstand harsh off-highway environments, flexible and configurable software features and well supported SAE J1939 CAN bus enables highly integrated machines

Cooling System
Top tank temperature 108° C (226° F) as standard to minimize cooling pack size, 50:50 water glycol mix, detailed guidance on cooling system design and validation available to ensure machine reliability

Exhaust System
Diesel particulate filter and regeneration system supplied, with a range of inlet and outlet options

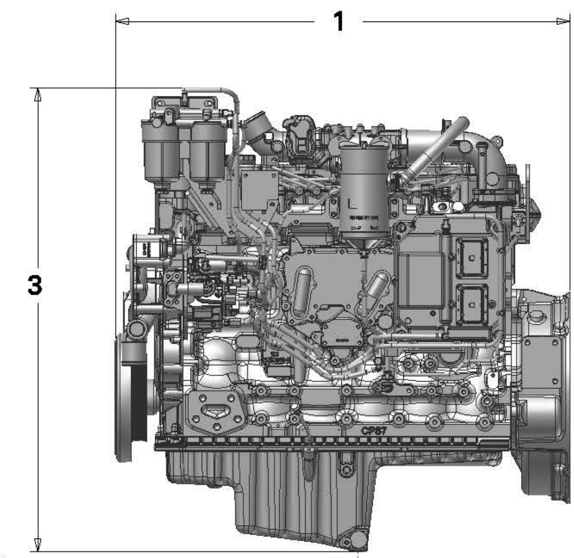
Flywheels and Flywheel Housing
Wide choice of drivetrain interfaces, including SAE1, SAE2 or SAE3 configurations

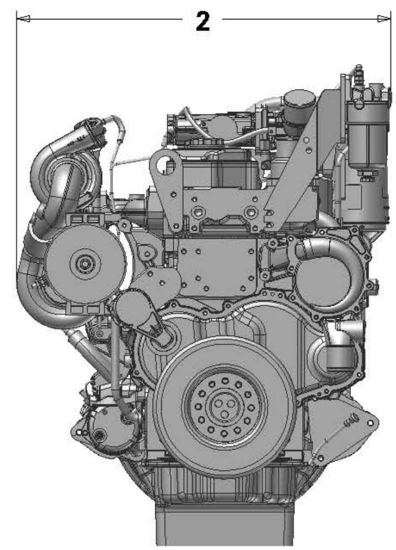
Fuel System
Electronic high pressure common rail, ACERT™ Technology

Lube System
Wide choice of sumps for different applications

Power Take Off
SAE A or SAE B flanges on left-hand side. Right-hand side twin PTO also available. Engine power can also be taken from the front of the engine on some applications, factory fitted compressors are also available

DIMENSIONS





(1) Length — 1065 mm (41.9 in) (2) Width — 820 mm (32.3 in.) (3) Height — 907 mm (35.7 in.)

Note: Final dimensions dependent on selected options

CATERPILLAR®

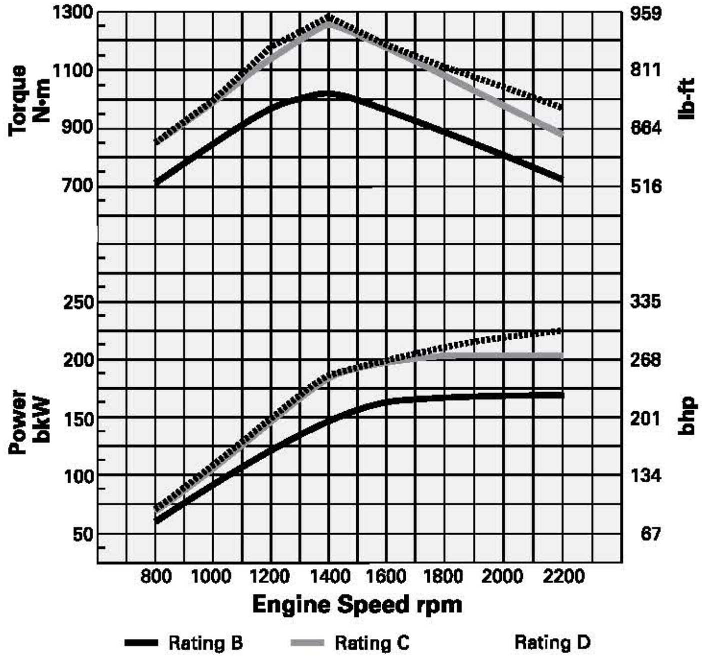
C7.1 ACERT™ Industrial Engine

Tier 4 Interim/Stage IIIB
140-225 bkW/187.7-301.8 bhp @ 2200 rpm

PERFORMANCE DATA — PRELIMINARY

Turbocharged Aftercooled — 2200 rpm (Industrial C Rating) 205 bkW (275 bhp)

Rated Speed



Speed Range

Rating	Speed rpm	Peak Power bkW	Peak Power bhp	Speed rpm	Peak Torque N•m	Peak Torque lb-ft
B	2200	168	225	1400	1028	758
C	2200	205	275	1400	1257	927
D	2200	225	301.8	1400	1274	940

RATING DEFINITIONS AND CONDITIONS

IND-B for service where power and/or speed are cyclic (time at full load not to exceed 80%).

IND-C (Intermittent) is the horsepower and speed capability of the engine where maximum power and/or speed are cyclic (time at full load not to exceed 50%).

IND-D for service where maximum power is required for periodic overloads.

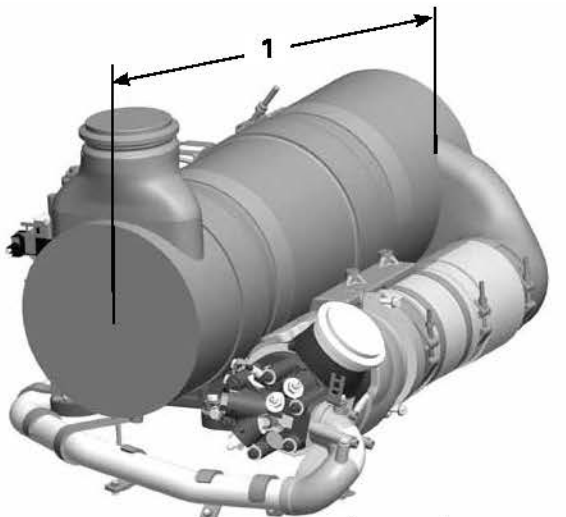
Additional ratings are available for specific customer requirements. Consult your Caterpillar dealer.

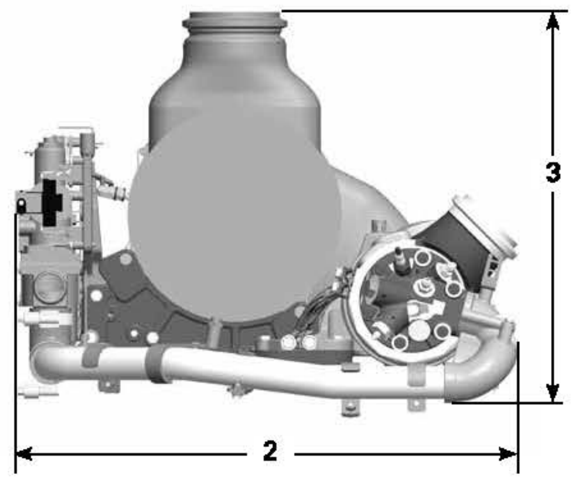
Engine Performance Diesel Engines — 7 liter and higher are based on SAE J1995, inlet air standard conditions of 99 kPa (29.31 in. Hg) dry barometer and 25° C (77° F) temperature. Performance measured using a standard fuel with fuel gravity of 35° API having a lower heating value of 42,780 kJ/kg (18,390 btu/lb) when used at 29° C (84.2° F) with a density of 838.9 g/L.

C7.1 ACERT™ Industrial Engine

Tier 4 Interim/Stage IIIB
140-225 bkW/187.7-301.8 bhp @ 2200 rpm

AFTERTREATMENT CONFIGURATION





Images shown may not reflect actual aftertreatment.

Less than or equal to 172 bkW (231 bhp)
10" DIAMETER BASE CONFIGURATION
Approximate Size and Weight
(1) Length — 886 mm (34.9 in.)
(2) Width — 620 mm (24.4 in.)
(3) Height — 713 mm (28 in.)
Weight — 124 kg (273.4 lbs.)

Greater than 172 bkW (231 bhp)
12" DIAMETER BASE CONFIGURATION
Approximate Size and Weight
(1) Length — 886 mm (34.9 in.)
(2) Width — 644 mm (23.4 in.)
(3) Height — 715 mm (28.15 in.)
Weight — 134 kg (295.4 lbs.)

CEM Options include:
Basic Aftertreatment Package (DPF/DOC)

Multiple Customizable Configuration Options Available
Each Option Will Be Available As:
250 mm (10 in) Cat Regeneration System + DOC/DPF (up to 172 bkW (231 bhp)

304.8 mm (12 in) Cat Regeneration System + DOC/DPF

Note: Final dimensions dependent on configuration

AFTERTREATMENT FEATURES

Regeneration: Cat Regeneration System maximizes fuel efficiency during regeneration

Flexibility: Flexible regen options maximize uptime

Mounting: Remote installation options provide OEM flexibility for many applications

Service: Minimum 4500-hour diesel particulate filter ash service interval

Available in 12- or 24-volt systems

STANDARD EMISSIONS CONTROL EQUIPMENT

Cat Regeneration System

CEM: Clean Emissions Module

DOC: Diesel Oxidation Catalyst

DPF: Diesel Particulate Filter

NRS: NOx Reduction System

3" flex pipe connection kit with straight, 45°, and 90° options for flexibility

LEHH0006-01 (5-10)
Printed in U.S.A.

C9.3 ACERT™ Industrial Power Unit

Tier 4 Interim/Stage IIIB

224-261 bkW (300-350 bhp) @ 1800-2200 rpm

Image shown may not reflect actual power unit configuration

CAT® ENGINE SPECIFICATIONS

I-6, 4-Stroke-Cycle Diesel

Bore	115 mm (4.53 in.)
Stroke	149 mm (5.87 in.)
Displacement	9.3 L (567.5 in³)
Aspiration	Turbocharged Aftercooled
Compression Ratio	17.0:1
Combustion System	Direct Injection
Rotation (from flywheel end)	Counterclockwise
Capacity for Liquids	
Cooling System	22.2 L (23.5 U.S. qts.)
Lube Oil System (refill)*	30 L (31.7 U.S. qts.)
Engine Weight, Net Dry (approximate)	885 kg (1950 lb)

*500-hour service interval

FEATURES

Emissions
Designed to meet 2011 EPA (U.S.) Tier 4 Interim and EU Stage IIIB emissions requirements. Also expected to meet Japanese MLIT emissions requirements once available.

Reliable, Quiet, and Durable Power
World-class manufacturing capability and processes coupled with proven core engine designs assure reliability, quiet operation, and many hours of productive life.

High Performance
Simple and efficient turbocharger with balance valve provides optimal air management and improved fuel efficiency.

Fuel Efficiency
Fuel consumption optimized to match operating cycles of a wide range of equipment and applications.

Broad Application Range
Industry leading range of factory configurable ratings and options for agricultural, materials-handling, construction, mining, forestry, waste, and other industrial applications.

Package
Exceptional power density enables standardization across numerous applications. Available factory-installed configurations: full package, including radiator and Clean Emissions Module (CEM); package with CEM, but no radiator; and package with radiator, but no CEM.

Low-Cost Maintenance
Worldwide service availability improves ease of maintenance and simplifies the servicing routine. Minimum 4500-hour diesel particulate filter ash service interval and 500-hour oil change intervals (dependent on having lube oil system capacity as listed in Cat® engine specifications above) enable low-cost maintenance.

Testing
Every Cat engine is quality tested to ensure proper engine performance.

World-class Product Support Offered Through Global Cat Dealer Network
- Scheduled maintenance
- Customer Support Agreements (CSA)
- Cat Extended Service Coverage (ESC)
- Superior dealer service network
- Extended dealer service network through the Cat Industrial Service Distributor (ISD) program

Web Site: For additional information on all your power requirements, visit www.cat-industrial.com.

STANDARD ENGINE EQUIPMENT

Air Inlet System
Turbocharged Air-to-Air Aftercooled

Control System
Electronic control system, over-foam wiring harness, automatic altitude compensation, power compensated for fuel temperature, configurable software features, engine monitoring system SAE J1939 broadcast and control, integrated Electronic Control Unit (ECU)

Cooling System
Vertical outlet thermostat housing, centrifugal water pump, guidance on cooling system design available to ensure machine reliability

Exhaust System
CEM that includes Diesel Particulate Filter (DPF), Diesel Oxidation Filter (DOC), and Cat Regeneration System

Flywheels and Flywheel Housing
SAE No. 1 flywheel housing

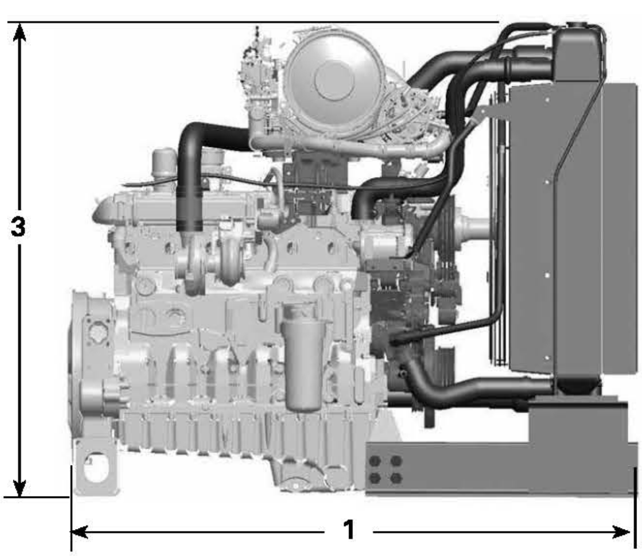
Fuel System
High pressure common rail, primary fuel filter, secondary fuel filters, fuel transfer pump, electronic fuel priming

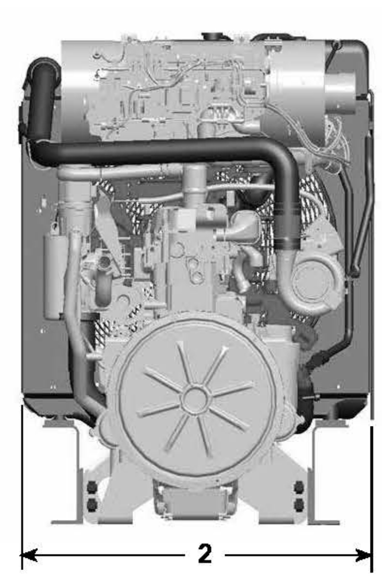
Lube System
Open crankcase ventilation system, oil cooler, oil filler, oil filter, oil dipstick, oil pump (gear driven), choice of sumps (front, rear, and center)

Power Take Off
SAE A, SAE B, and SAE C drives available

General
Paint: Cat yellow, vibration damper, lifting eyes

DIMENSIONS





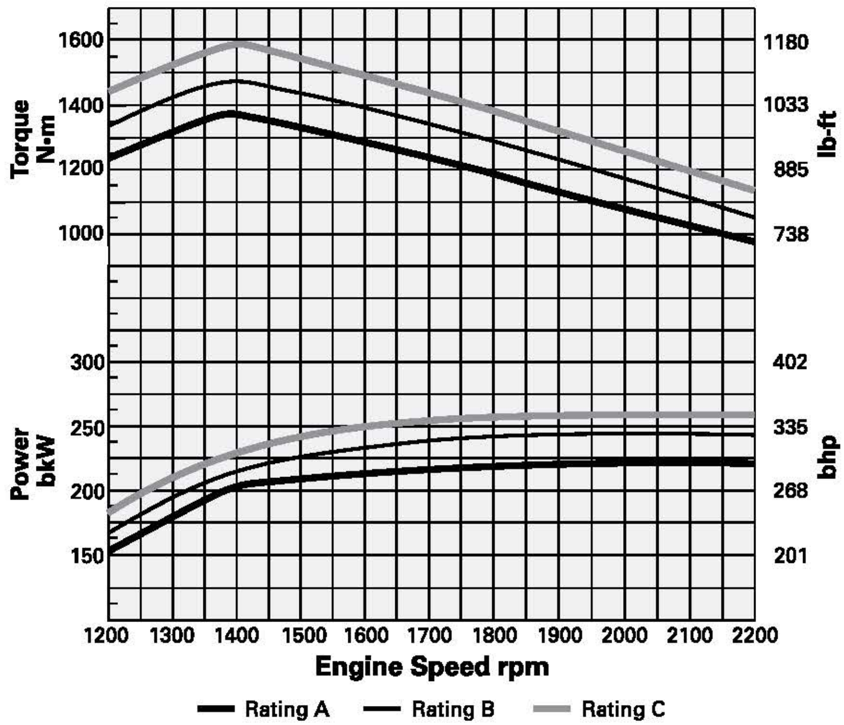
(1) Length — 1845 mm (72.6 in.) (2) Width — 1118 mm (44.0 in.) (3) Height — 1554 mm (61.2 in.)

Note: Final dimensions dependent on selected options

PERFORMANCE DATA — PRELIMINARY

Turbocharged Aftercooled — 1800-2200 rpm

Rated Speed



Speed Range

Rating	Speed rpm	Peak Power bkW	Peak Power bhp	Speed rpm	Peak Torque N•m	Peak Torque lb-ft
A	2200	224	300	1400	1369	1010
B	2200	242	325	1400	1483	1094
C	2200	261	350	1400	1597	1178

RATING DEFINITIONS AND CONDITIONS

IND-A (Continuous) for heavy duty service where the engine is operated at maximum power and speed up to 100% of the time without interruption or load cycling.

IND-B for service where power and/or speed are cyclic (time at full load not to exceed 80%).

IND-C (Intermittent) is the horsepower and speed capability of the engine where maximum power and/or speed are cyclic (time at full load not to exceed 50%).

Additional ratings are available for specific customer requirements. Consult your Cat dealer.

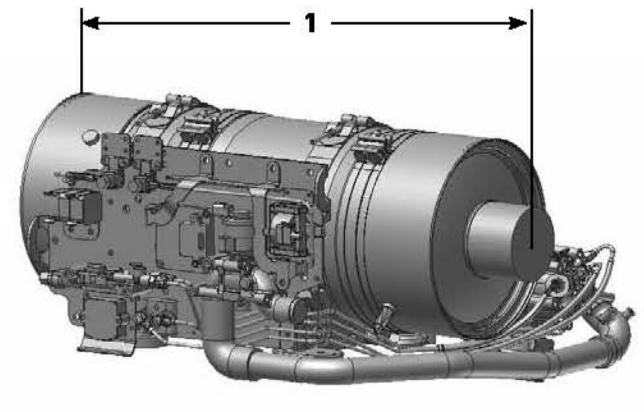
Engine Performance Diesel Engines — 7 liter and higher are based on SAE J1995, inlet air standard conditions of 99 kPa (29.31 in. Hg) dry barometer and 25° C (77° F) temperature. Performance measured using a standard fuel with fuel gravity of 35° API having a lower heating value of 42,780 kJ/kg (18,390 btu/lb) when used at 29° C (84.2° F) with a density of 838.9 g/L.

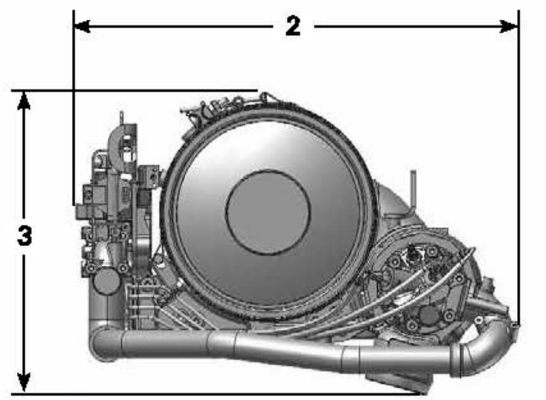
CATERPILLAR®

C9.3 ACERT™ Industrial Power Unit

Tier 4 Interim/Stage IIIB
224-261 bkW (300-350 bhp) @ 1800-2200 rpm

AFTERTREATMENT CONFIGURATION





Images shown may not reflect actual aftertreatment.

12" DIAMETER BASE CONFIGURATION SHOWN
Approximate Size and Weight
(1) Length — 1097 mm (43 in.)
(2) Width — 762 mm (30 in.)
(3) Height — 468 mm (18 in.)
Weight — 130 kg (287 lbs)

CEM Options
Base configuration includes DPF, DOC, and supporting structure

AFTERTREATMENT FEATURES

Regeneration: Cat Regeneration System maximizes fuel efficiency during regeneration

Flexibility: Flexible regen options maximize uptime

Service: Minimum 4500-hour diesel particulate filter ash service interval

Available in 12- or 24-volt systems

STANDARD EMISSIONS CONTROL EQUIPMENT

Cat Regeneration System

CEM: Clean Emissions Module

DOC: Diesel Oxidation Catalyst

DPF: Diesel Particulate Filter

NRS: NOx Reduction System

 Printed in U.S.A.

Chino Mines Company
NSR Consolidation Application

Solution Extraction Plant VOC Fugitive Emissions

The fugitive VOC emissions from the solvent extraction tanks were estimated using the methodology developed by BHP Copper in the study "Quantification of Volatile Organic Compound (VOC) Emissions from the Solution Extraction Process" (July 1997). The BHP method is based on Fick's Law to determine the diffusive flux of the individual components in the organic in air. The equation used is:

$$\text{Diff F} = (Ci - Ch) \times D/H$$

Where:
- Diff F, g/m^2-s = diffusive flux of constituent in air
- C*i*, ppm = constituent concentration at liquid surface (from manufacturer data)
- C*h*, ppm = constituent concentration at a distance, H, above the liquid surface
- D = constituent diffusivity (calculated from EPA link: http://www.epa.gov/athens/learn2model/part-two/onsite/estdiffusion.htm; where T = 25.84°C, and P = 1 atm, per 1995 met. data)
- H, m = distance above liquid surface

This method includes assumptions, fundamental equations, and tabulated chemical data to estimate VOC emissions. Three assumptions govern the scope of their method:

1. Only chemicals with a significant vapor pressure are included in the emissions losses calculation.
2. The driving force for VOC diffusion is the concentration gradient that exists between the surface of the solution and headspace. In the 1997 study, the headspace was assumed to be 1 meter. For the Tyrone SX/EW tanks, 2 ft (or 0.61 m) was assumed to be a reasonable headspace.

This methodology was selected for the Phelps Dodge Tyrone SX/EW emission calculations due to its direct applicability and credibility.

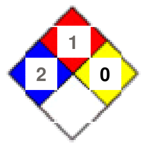
FREEPORT-MCMORAN COPPER & GOLD

Freeport McMoRan Copper & Gold

CYTEC INDUSTRIES
ACORGA OR25 SOLVENT EXTRACTION REAGENT

File Name: **057175** Revision Date: **9/7/2010**
Internal ID: Language: **English**
Internal ID: **C-1001 A** Format: **No Format Specified**

Additional Details

NFPA	HMIS	HMIS III
	Health Flammability **Reactivity** **PPE**	Health Flammability Physical Hazard **PPE**

Approval Status: APPROVED PRODUCT

More...

MSDS Contents

CYTEC

MSDS: 0045191

PRINT DATE: 09/07/2010

REVISION DATE: 09/07/2010

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: ACORGA(R*) OR25 SOLVENT EXTRACTION REAGENT

SYNONYMS: NONE

CHEMICAL FAMILY: SALICYLALDOXIME DERIVATIVE

MOLECULAR FORMULA: MIXTURE

MOLECULAR WEIGHT: MIXTURE

CYTEC INDUSTRIES INC.
FIVE GARRET MOUNTAIN PLAZA
WOODLAND PARK
NEW JERSEY 07424
USA

FOR PRODUCT INFORMATION CALL: 1-800/652-6013.

OUTSIDE THE USA AND CANADA CALL: 1-973/357-3193.

EMERGENCY PHONE (24 HOURS/DAY) - FOR EMERGENCY INVOLVING SPILL, LEAK, FIRE, EXPOSURE OR ACCIDENT CALL:

ASIA PACIFIC REGION:
AUSTRALIA: +61-3-9663-2130 OR 1800-033-111
CHINA (PRC): +86(0)532-8388-9090 (NRCC)
NEW GUINEA: +61-3-9663-2130
NEW ZEALAND: +61-3-9663-2130 OR 0800-734-607
ALL OTHERS: +65-633-44-177 (CARECHEM24 SINGAPORE)

CANADA: 1-905-356-8310 (CYTEC WELLAND, CANADA PLANT)

EUROPE/AFRICA/MIDDLE EAST: +44-(0)208-762-8322 (CARECHEM24 UK)

LATIN AMERICA:
BRAZIL: 0800 0111 767 (SOS COTEC)
CHILE: +56-2-247-3600 (CITUC QUIMICO)
ALL OTHERS: +52-376-73 74122 (CYTEC ATEQUIZA, MEXICO PLANT)

USA: +1-703-527-3887 OR 1-800-424-9300 (CHEMTREC)

2. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW:

APPEARANCE AND ODOR:

COLOR: CLEAR AMBER

APPEARANCE: LIQUID

ODOR: NONE

STATEMENTS OF HAZARD:

WARNING!

CAUSES EYE AND SKIN IRRITATION

POTENTIAL HEALTH EFFECTS:

EFFECTS OF EXPOSURE:
THE ACUTE ORAL (RAT) LD50 AND DERMAL (RABBIT) LD50 VALUES ARE ESTIMATED TO BE >1,900 MG/KG AND >2,000 MG/KG, RESPECTIVELY. DIRECT CONTACT WITH THIS MATERIAL MAY CAUSE MODERATE EYE AND SKIN IRRITATION. OVEREXPOSURE TO VAPORS MAY CAUSE IRRITATION OF THE RESPIRATORY TRACT AND EYES AND MAY CAUSE CENTRAL NERVOUS SYSTEM EFFECTS. REFER TO SECTION 11 FOR TOXICOLOGY INFORMATION ON THE REGULATED COMPONENTS OF THIS PRODUCT.

3. COMPOSITION/INFORMATION ON INGREDIENTS

OSHA REGULATED COMPONENTS:

COMPONENT / CAS NO.	% (W/W)	CARCINOGEN
SALICYLALDOXIME DERIVATIVE	40 - 60	
PETROLEUM DISTILLATE HYDROTREATED LIGHT 64742-47-8	1 - 5	

4. FIRST AID MEASURES

INGESTION:
IF SWALLOWED, CALL A PHYSICIAN IMMEDIATELY. ONLY INDUCE VOMITING AT THE INSTRUCTION OF A PHYSICIAN. NEVER GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS PERSON.

SKIN CONTACT:
REMOVE CONTAMINATED CLOTHING AND SHOES WITHOUT DELAY. WASH IMMEDIATELY WITH PLENTY OF WATER. DO NOT REUSE CONTAMINATED CLOTHING WITHOUT LAUNDERING. GET MEDICAL ATTENTION IF PAIN OR IRRITATION PERSISTS AFTER WASHING OR IF SIGNS AND SYMPTOMS OF OVEREXPOSURE APPEAR.

EYE CONTACT:
RINSE IMMEDIATELY WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES. OBTAIN MEDICAL ADVICE IF THERE ARE PERSISTENT SYMPTOMS.

INHALATION:
REMOVE TO FRESH AIR. IF BREATHING IS DIFFICULT, GIVE OXYGEN. OBTAIN MEDICAL ADVICE IF THERE ARE PERSISTENT SYMPTOMS.

5. FIREFIGHTING MEASURES

SUITABLE EXTINGUISHING MEDIA:
USE WATER SPRAY OR FOG, CARBON DIOXIDE OR DRY CHEMICAL.

PROTECTIVE EQUIPMENT:
FIREFIGHTERS, AND OTHERS EXPOSED, WEAR SELF-CONTAINED BREATHING APPARATUS. WEAR FULL FIREFIGHTING PROTECTIVE CLOTHING. SEE MSDS SECTION 8 (EXPOSURE CONTROLS/PERSONAL PROTECTION).

SPECIAL HAZARDS:
KEEP CONTAINERS COOL BY SPRAYING WITH WATER IF EXPOSED TO FIRE.

6. ACCIDENTAL RELEASE MEASURES

PERSONAL PRECAUTIONS:
WHERE EXPOSURE LEVEL IS NOT KNOWN, WEAR APPROVED, POSITIVE PRESSURE, SELF-CONTAINED RESPIRATOR. WHERE EXPOSURE LEVEL IS KNOWN, WEAR APPROVED RESPIRATOR SUITABLE FOR LEVEL OF EXPOSURE. IN ADDITION TO THE PROTECTIVE CLOTHING/EQUIPMENT IN SECTION 8 (EXPOSURE CONTROLS/PERSONAL PROTECTION), WEAR IMPERMEABLE BOOTS.

METHODS FOR CLEANING UP:
COVER SPILLS WITH SOME INERT ABSORBENT MATERIAL; SWEEP UP AND PLACE IN A WASTE DISPOSAL CONTAINER. FLUSH SPILL AREA WITH WATER.

ENVIRONMENTAL PRECAUTIONS:
USE APPROPRIATE CONTAINMENT TO AVOID ENVIRONMENTAL CONTAMINATION.

7. HANDLING AND STORAGE

HANDLING:

PRECAUTIONARY MEASURES:
AVOID CONTACT WITH EYES, SKIN AND CLOTHING. WASH THOROUGHLY AFTER HANDLING.

SPECIAL HANDLING STATEMENTS: NONE

STORAGE: NONE

STORAGE TEMPERATURE: STORE AT 0 - 38 DEG. C 32 - 100.4 DEG. F

REASON: QUALITY.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

ENGINEERING MEASURES:
WHERE THIS MATERIAL IS NOT USED IN A CLOSED SYSTEM, GOOD ENCLOSURE AND LOCAL EXHAUST VENTILATION SHOULD BE PROVIDED TO CONTROL EXPOSURE.

RESPIRATORY PROTECTION:
WHERE EXPOSURES ARE BELOW THE ESTABLISHED EXPOSURE LIMIT, NO RESPIRATORY PROTECTION IS REQUIRED. WHERE EXPOSURES EXCEED THE ESTABLISHED EXPOSURE LIMIT, USE RESPIRATORY PROTECTION RECOMMENDED FOR THE MATERIAL AND LEVEL OF EXPOSURE.

EYE PROTECTION:
WEAR EYE/FACE PROTECTION SUCH AS CHEMICAL SPLASH PROOF GOGGLES OR FACE SHIELD.

SKIN PROTECTION:
AVOID SKIN CONTACT. WEAR IMPERMEABLE GLOVES AND SUITABLE PROTECTIVE CLOTHING.

ADDITIONAL ADVICE:
FOOD, BEVERAGES, AND TOBACCO PRODUCTS SHOULD NOT BE CARRIED, STORED, OR CONSUMED WHERE THIS MATERIAL IS IN USE. BEFORE EATING, DRINKING, OR SMOKING, WASH FACE AND HANDS THOROUGHLY WITH SOAP AND WATER.

EXPOSURE LIMIT(S):

64742-47-8 PETROLEUM DISTILLATE HYDROTREATED LIGHT:

OSHA (PEL): 165 PPM (1200 MG/M3) (SUPPLIER)

ACGIH (TLV): NOT ESTABLISHED

OTHER VALUE:
1200 MG/M3 (SUPPLIER)
165 PPM (SUPPLIER)

9. PHYSICAL AND CHEMICAL PROPERTIES

COLOR: CLEAR AMBER

APPEARANCE: LIQUID

ODOR: NONE

BOILING POINT: NOT AVAILABLE

MELTING POINT: NOT AVAILABLE

VAPOR PRESSURE: NOT AVAILABLE

SPECIFIC GRAVITY/DENSITY: 0.97 - 0.99 @ 20 DEG. C

VAPOR DENSITY: NOT AVAILABLE

PERCENT VOLATILE (% BY WT.): NOT AVAILABLE

pH: NOT APPLICABLE

SATURATION IN AIR (% BY VOL.): NOT AVAILABLE

EVAPORATION RATE: NOT AVAILABLE

SOLUBILITY IN WATER: INSOLUBLE

VOLATILE ORGANIC CONTENT: NOT AVAILABLE

FLASH POINT: >130 DEG. C 266 DEG. F - PENSKY-MARTENS CLOSED CUP

FLAMMABLE LIMITS (% BY VOL): NOT AVAILABLE

AUTOIGNITION TEMPERATURE: NOT AVAILABLE

DECOMPOSITION TEMPERATURE: NOT AVAILABLE

PARTITION COEFFICIENT (n-OCTANOL/WATER): NOT AVAILABLE

ODOR THRESHOLD: NOT AVAILABLE

10. STABILITY AND REACTIVITY

STABILITY: STABLE

CONDITIONS TO AVOID: NONE KNOWN

POLYMERIZATION: WILL NOT OCCUR

CONDITIONS TO AVOID: NONE KNOWN

MATERIALS TO AVOID:
STRONG OXIDIZING AGENTS.
OXYGEN

HAZARDOUS DECOMPOSITION PRODUCTS: OXIDES OF CARBON AND NITROGEN, AMMONIA

11. TOXICOLOGICAL INFORMATION

TOXICOLOGICAL INFORMATION FOR THE PRODUCT IS FOUND UNDER SECTION 2. HAZARDS IDENTIFICATION.

TOXICOLOGICAL INFORMATION ON THE REGULATED COMPONENTS OF THIS PRODUCT IS AS FOLLOWS:
PETROLEUM DISTILLATES, HYDROTREATED LIGHT (CAS# 64742-47-8) HAS ACUTE ORAL (RAT) AND DERMAL (RABBIT) LD50 VALUES OF >5 G/KG AND >3.16 G/KG, RESPECTIVELY. PROLONGED OR REPEATED SKIN CONTACT TENDS TO REMOVE SKIN OILS, POSSIBLY LEADING TO IRRITATION AND DERMATITIS. DIRECT CONTACT MAY CAUSE EYE IRRITATION. OVEREXPOSURE TO HIGH VAPOR CONCENTRATIONS, >APPROX. 700 PPM, ARE IRRITATING TO THE EYES AND RESPIRATORY TRACT AND MAY CAUSE HEADACHES, DIZZINESS, DROWSINESS, AND OTHER CENTRAL NERVOUS SYSTEM EFFECTS, INCLUDING DEATH. ASPIRATION OF MINUTE AMOUNTS DURING INGESTION OR VOMITING MAY CAUSE MILD TO SEVERE PULMONARY INJURY AND POSSIBLY DEATH. IN A 90-DAY ORAL GAVAGE (RATS) STUDY AT 100, 500, OR 1000 MG/KG, NO TREATMENT-RELATED MORTALITIES WERE OBSERVED. THERE WERE NO SIGNIFICANT CHANGES IN BODY WEIGHTS OR FOOD CONSUMPTION IN ANY DOSE GROUPS. INCREASED LIVER WEIGHTS WERE OBSERVED IN MALE AND FEMALE RATS AT 500 AND 1000 MG/KG. INCREASED KIDNEY WEIGHTS WERE OBSERVED ONLY IN MALE RATS AT 500 AND 1000 MG/KG. TESTES WEIGHTS WERE SIGNIFICANTLY ELEVATED IN MALE RATS AT 1000 MG/KG. KIDNEY EFFECTS, INDICATIVE OF LIGHT HYDROCARBON NEPHROPATHY, OCCURED IN MALE RAT KIDNEYS AT ALL DOSE LEVELS. HISTOLOGICAL FINDINGS OF HEPATOCELLULAR HYPERTROPHY WERE SEEN IN THE LIVERS OF MALE RATS AT 1000 MG/KG AND IN FEMALE RATS AT 500 AND 1000 MG/KG. ALL TREATMENT-RELATED EFFECTS WERE REVERSIBLE WITHIN THE 4-WEEK RECOVERY PERIOD. OBSERVED KIDNEY EFFECTS (INCLUDING LIGHT HYDROCARBON NEPHROPATHY AND INCREASED KIDNEY WEIGHT) ARE A UNIQUE RESPONSE BY MALE RATS TO CHRONIC HYDROCARBON EXPOSURE, WHICH THE U.S. EPA HAS DECLARED 'NOT RELEVANT TO HUMANS'. HIGH-DOSE LIVER EFFECTS (INCLUDING HEPATOCELLULAR HYPERTROPHY, OR ENLARGED LIVER CELLS) ARE A DIRECT CONSEQUENCE OF THE SUSTAINED HIGH-FAT 'HYDROCARBON DIET'. THE NO OBSERVED ADVERSE EFFECT LEVEL (NOAEL) FOR THIS STUDY WAS 1000 MG/KG.

SALICYLALDOXIME DERIVATIVE HAS AN ORAL LD50 (RAT) OF 1.25 TO 5 ML/KG, A DERMAL LD50 (RAT) OF >2.5 ML/KG, AND AN INHALATION LC50 (RAT) OF >1.6 MG/L/1 HR./70 DEG. C. RAT SKIN TESTING INDICATES IT IS A MODERATE DERMAL IRRITANT, AND RABBIT EYE TESTING INDICATED A SLIGHT POTENTIAL FOR IRRITATION. GUINEA PIG DERMAL SENSITIZATION TESTS WERE NEGATIVE. IT IS EXPECTED TO BE IRRITATING TO EYES, SKIN, AND ALL MUCOUS MEMBRANES. INGESTION IS EXPECTED TO CAUSE MODERATE TO SEVERE GASTROINTESTINAL IRRITATION. SYMPTOMS OF INHALATION EXPOSURE MAY INCLUDE COUGHING, CHOKING, PAIN AND MODERATE TO SEVERE IRRITATION OF MUCOUS MEMBRANES. DEPENDING ON QUANTITY AND DURATION OF EXPOSURE, CONTACT WILL LIKELY CAUSE MODERATE SKIN AND EYE IRRITATION. OVEREXPOSURE CAN CAUSE CENTRAL NERVOUS SYSTEM (CNS) DEPRESSION, WITH SYMPTOMS RANGING FROM HEADACHE AND CONFUSION TO COMA AND RESPIRATORY FAILURE. THIS MATERIAL IS LIKELY TO BE AN ENDOCRINE DISRUPTER.

CALIFORNIA PROPOSITION 65 WARNING (APPLICABLE IN CALIFORNIA ONLY):
THIS PRODUCT CONTAINS (A) CHEMICAL(S) KNOWN TO THE STATE OF CALIFORNIA TO CAUSE BIRTH DEFECTS OR OTHER REPRODUCTIVE HARM.

12. ECOLOGICAL INFORMATION

VERY TOXIC TO AQUATIC ORGANISMS, MAY CAUSE LONG-TERM ADVERSE EFFECTS IN THE AQUATIC ENVIRONMENT.

THE ECOLOGICAL ASSESSMENT FOR THIS MATERIAL IS BASED ON AN EVALUATION OF ITS COMPONENTS.

13. DISPOSAL CONSIDERATIONS

THE INFORMATION ON RCRA WASTE CLASSIFICATION AND DISPOSAL METHODOLOGY PROVIDED BELOW APPLIES ONLY TO THE PRODUCT, AS SUPPLIED. IF THE MATERIAL HAS BEEN ALTERED OR CONTAMINATED, OR IT HAS EXCEEDED ITS RECOMMENDED SHELF LIFE, THE GUIDANCE MAY BE INAPPLICABLE. HAZARDOUS WASTE CLASSIFICATION UNDER FEDERAL REGULATIONS (40 CFR PART 261 ET SEQ) IS DEPENDENT UPON WHETHER A MATERIAL IS A RCRA 'LISTED HAZARDOUS WASTE' OR HAS ANY OF THE FOUR RCRA 'HAZARDOUS WASTE CHARACTERISTICS.' REFER TO 40 CFR PART 261.33 TO DETERMINE IF A GIVEN MATERIAL TO BE DISPOSED OF IS A RCRA 'LISTED HAZARDOUS WASTE'; INFORMATION CONTAINED IN SECTION 15 OF THIS MSDS IS NOT INTENDED TO INDICATE IF THE PRODUCT IS A 'LISTED HAZARDOUS WASTE.'

RCRA HAZARDOUS WASTE CHARACTERISTICS:

THERE ARE FOUR CHARACTERISTICS DEFINED IN 40 CFR SECTION 261.21-61.24: IGNITABILITY, CORROSIVITY, REACTIVITY, AND TOXICITY. TO DETERMINE IGNITABILITY, SEE SECTION 9 OF THIS MSDS (FLASH POINT). FOR CORROSIVITY, SEE SECTIONS 9 AND 14 (pH AND DOT CORROSIVITY). FOR REACTIVITY, SEE SECTION 10 (INCOMPATIBLE MATERIALS). FOR TOXICITY, SEE SECTION 3 (COMPOSITION). FEDERAL REGULATIONS ARE SUBJECT TO CHANGE. STATE AND LOCAL REQUIREMENTS, WHICH MAY DIFFER FROM OR BE MORE STRINGENT THAN THE FEDERAL REGULATIONS, MAY ALSO APPLY TO THE CLASSIFICATION OF THE MATERIAL IF IT IS TO BE DISPOSED. THE COMPANY ENCOURAGES THE RECYCLE, RECOVERY AND REUSE OF MATERIALS, WHERE PERMITTED, AS AN ALTERNATE TO DISPOSAL AS A WASTE. THE COMPANY RECOMMENDS THAT ORGANIC MATERIALS CLASSIFIED AS RCRA HAZARDOUS WASTES BE DISPOSED OF BY THERMAL TREATMENT OR INCINERATION AT EPA APPROVED FACILITIES. THE COMPANY HAS PROVIDED THE FOREGOING FOR INFORMATION ONLY; THE PERSON GENERATING THE WASTE IS RESPONSIBLE FOR DETERMINING THE WASTE CLASSIFICATION AND DISPOSAL METHOD.

14. TRANSPORT INFORMATION

THIS SECTION PROVIDES BASIC SHIPPING CLASSIFICATION INFORMATION. REFER TO APPROPRIATE TRANSPORTATION REGULATIONS FOR SPECIFIC REQUIREMENTS.

US DOT:

DANGEROUS GOODS?: X

PROPER SHIPPING NAME: ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S.

HAZARD CLASS: 9

PACKING GROUP: III

UN/ID NUMBER: UN3082

TRANSPORT LABEL REQUIRED:
MISCELLANEOUS
MARINE POLLUTANT

MARINE POLLUTANT:

TECHNICAL NAME (N.O.S.): SALICYLALDOXIME DERIVATIVE

COMMENTS:

MARINE POLLUTANTS:
DOT REQUIREMENTS SPECIFIC TO MARINE POLLUTANTS DO NOT APPLY TO NON-BULK PACKAGINGS TRANSPORTED BY MOTOR VEHICLES, RAIL CARS OR AIRCRAFT.

TRANSPORT CANADA:

DANGEROUS GOODS?: X

PROPER SHIPPING NAME: ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S.

HAZARD CLASS: 9

PACKING GROUP: III

UN NUMBER: UN3082

TRANSPORT LABEL REQUIRED:
MISCELLANEOUS
MARINE POLLUTANT

MARINE POLLUTANT:

TECHNICAL NAME (N.O.S.): SALICYLALDOXIME DERIVATIVE

ICAO / IATA:

DANGEROUS GOODS?: X

PROPER SHIPPING NAME: ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S.

HAZARD CLASS: 9

PACKING GROUP: III

UN NUMBER: UN3082

TRANSPORT LABEL REQUIRED: MISCELLANEOUS

PACKING INSTRUCTIONS/MAXIMUM NET QUANTITY PER PACKAGE:
PASSENGER AIRCRAFT: 914; 450 L
CARGO AIRCRAFT: 914; 450 L

TECHNICAL NAME (N.O.S.): SALICYLALDOXIME DERIVATIVE

IMO:

DANGEROUS GOODS?: X

PROPER SHIPPING NAME: ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S.

HAZARD CLASS: 9

UN NUMBER: UN3082

PACKING GROUP: III

TRANSPORT LABEL REQUIRED:
MISCELLANEOUS
MARINE POLLUTANT

MARINE POLLUTANT:

TECHNICAL NAME (N.O.S.): SALICYLALDOXIME DERIVATIVE

15. REGULATORY INFORMATION

INVENTORY INFORMATION:

UNITED STATES (USA):
ALL COMPONENTS OF THIS PRODUCT ARE INCLUDED ON THE TSCA CHEMICAL INVENTORY OR ARE NOT REQUIRED TO BE LISTED ON THE TSCA CHEMICAL INVENTORY.

THIS PRODUCT CONTAINS A CHEMICAL SUBSTANCE THAT IS SUBJECT TO EXPORT NOTIFICATION UNDER SECTION 12 (B) OF THE TOXIC SUBSTANCES CONTROL ACT, 15 U. S. C. 2601 ET. SEQ. (THIS REQUIREMENT APPLIES TO EXPORTS FROM THE UNITED STATES ONLY.)

CANADA:
COMPONENTS OF THIS PRODUCT HAVE BEEN REPORTED TO ENVIRONMENT CANADA IN ACCORDANCE WITH SECTIONS 66 AND/OR 81 OF THE CANADIAN ENVIRONMENTAL PROTECTION ACT (1999), AND ARE INCLUDED ON THE DOMESTIC SUBSTANCES LIST.

AUSTRALIA:
ALL COMPONENTS OF THIS PRODUCT ARE INCLUDED IN THE AUSTRALIAN INVENTORY OF CHEMICAL SUBSTANCES (AICS) OR ARE NOT REQUIRED TO BE LISTED ON AICS.

CHINA:
ALL COMPONENTS OF THIS PRODUCT ARE INCLUDED ON THE CHINESE INVENTORY OR ARE NOT REQUIRED TO BE LISTED ON THE CHINESE INVENTORY.

JAPAN:
ALL COMPONENTS OF THIS PRODUCT ARE INCLUDED ON THE JAPANESE (ENCS) INVENTORY OR ARE NOT REQUIRED TO BE LISTED ON THE JAPANESE INVENTORY.

KOREA:
ALL COMPONENTS OF THIS PRODUCT ARE INCLUDED ON THE KOREAN (ECL) INVENTORY OR ARE NOT REQUIRED TO BE LISTED ON THE KOREAN INVENTORY.

PHILIPPINES:
ALL COMPONENTS OF THIS PRODUCT ARE NOT INCLUDED ON THE PHILIPPINE (PICCS) INVENTORY.

OTHER ENVIRONMENTAL INFORMATION:
THE FOLLOWING COMPONENTS OF THIS PRODUCT MAY BE SUBJECT TO REPORTING REQUIREMENTS PURSUANT TO SECTION 313 OF CERCLA (40 CFR 372), SECTION 12(B) OF TSCA, OR MAY BE SUBJECT TO RELEASE REPORTING REQUIREMENTS (40 CFR 307, 40 CFR 311, ETC.) SEE SECTION 13 FOR INFORMATION ON WASTE CLASSIFICATION AND WASTE DISPOSAL OF THIS PRODUCT.

COMPONENT / CAS NO.	%	TPQ (LBS)	RQ(LBS)	S313	TSCA 12B
SALICYLALDOXIME DERIVATIVE	40 - 60	NONE	0	NO	YES

PRODUCT HAZARD CLASSIFICATION UNDER SECTION 311 OF SARA: ACUTE

16. OTHER INFORMATION

NFPA HAZARD RATING (NATIONAL FIRE PROTECTION ASSOCIATION):

HEALTH	2	- MATERIALS THAT, UNDER EMERGENCY CONDITIONS, CAN CAUSE TEMPORARY INCAPACITATION OR RESIDUAL INJURY.
FIRE	1	- MATERIALS THAT MUST BE PREHEATED BEFORE IGNITION CAN OCCUR.
INSTABILITY	0	- MATERIALS THAT IN THEMSELVES ARE NORMALLY STABLE, EVEN UNDER

FIRE EXPOSURE CONDITIONS.

REASONS FOR ISSUE: NEW PRODUCT

RANDY DESKIN, PH.D., DABT +1-973-357-3100

THIS INFORMATION IS GIVEN WITHOUT ANY WARRANTY OR REPRESENTATION. WE DO NOT ASSUME ANY LEGAL RESPONSIBILITY FOR SAME, NOR DO WE GIVE PERMISSION, INDUCEMENT, OR RECOMMENDATION TO PRACTICE ANY PATENTED INVENTION WITHOUT A LICENSE. IT IS OFFERED SOLELY FOR YOUR CONSIDERATION, INVESTIGATION, AND VERIFICATION. BEFORE USING ANY PRODUCT, READ ITS LABEL.

MSDS:	0015532
Print Date:	01/08/2008
Revision Date:	07/19/2004

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name:	**ACORGA® M5910 Extraction Reagent**
Synonyms:	None
Chemical Family:	5-Nonyl-salicylaldoxime solvent hydrotreated distillate
Molecular Formula:	Mixture
Molecular Weight:	Mixture

CYTEC INDUSTRIES INC., FIVE GARRET MOUNTAIN PLAZA, WEST PATERSON, NEW JERSEY 07424, USA
For Product Information call 1-800/652-6013. Outside the USA and Canada call 1-973/357-3193.
EMERGENCY PHONE: For emergency involving spill, leak, fire, exposure or accident call CHEMTREC: 1-800/424-9300. Outside the USA and Canada call 1-703/527-3887.

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2. COMPOSITION/INFORMATION ON INGREDIENTS

OSHA REGULATED COMPONENTS

Component / CAS No.	% (w/w)	OSHA (PEL):	ACGIH (TLV)	Carcinogen
Salicylaldoxime derivative -	30 - 60	Not established	Not established	-
Petroleum distillate hydrotreated light 64742-47-8	2.5	500 ppm 1200 mg/m^3 (Supplier) 165 ppm (Supplier)	(skin)	-

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

APPEARANCE AND ODOR:

Color:	clear amber
Appearance:	liquid
Odor:	none

STATEMENTS OF HAZARD:

WARNING! CAUSES EYE AND SKIN IRRITATION

POTENTIAL HEALTH EFFECTS

EFFECTS OF EXPOSURE:
The acute oral (rat) and dermal (rabbit) LD50 values are estimated to be between 1,200 - 5,000 mg/kg and greater than 2,000 mg/kg, respectively.

Direct contact with this material may cause moderate eye and skin irritation. Overexposure to vapors may cause irritation of the respiratory tract and eyes and may cause central nervous system effects. Refer to Section 11 for toxicology information on the regulated components of this product.

4. FIRST AID MEASURES

Ingestion:
If swallowed, call a physician immediately. Only induce vomiting at the instruction of a physician. Never give anything by mouth to an unconscious person.

Skin Contact:
Wash immediately with plenty of water and soap.

Eye Contact:
Rinse immediately with plenty of water for at least 15 minutes. Obtain medical advice if there are persistent symptoms.

Inhalation:
Remove to fresh air. If breathing is difficult, give oxygen. Obtain medical advice if there are persistent symptoms.

5. FIRE-FIGHTING MEASURES

Suitable Extinguishing Media:
Use water spray or fog, carbon dioxide or dry chemical.

Protective Equipment:
Firefighters, and others exposed, wear self-contained breathing apparatus. Wear full firefighting protective clothing. See MSDS Section 8 (Exposure Controls/Personal Protection).

Special Hazards:
Keep containers cool by spraying with water if exposed to fire.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions:
Where exposure level is not known, wear approved, positive pressure, self-contained respirator. Where exposure level is known, wear approved respirator suitable for level of exposure. In addition to the protective clothing/equipment in Section 8 (Exposure Controls/Personal Protection), wear impermeable boots.

Methods For Cleaning Up:
Remove sources of ignition. Cover spills with some inert absorbent material; sweep up and place in a waste disposal container. Flush spill area with water.

Environmental Precautions:
Use appropriate containment to avoid environmental contamination.

7. HANDLING AND STORAGE

HANDLING

Precautionary Measures: Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

Special Handling Statements: None

STORAGE
Areas containing this material should have fire safe practices and electrical equipment in accordance with applicable regulations and/or guidelines. Standards are primarily based on the material`s flashpoint, but may also take into account properties such as miscibility with water or toxicity. All local and national regulations should be followed.
In the Americas, National Fire Protection Association (NFPA) 30: Flammable and Combustible Liquids Code, is a widely used standard. NFPA 30 establishes storage conditions for the following classes of materials: Class I Flammable Liquids, Flashpoint <37.8 °C. Class II Combustible Liquids, 37.8 °C < Flashpoint <60 °C. Class IIIa Combustible Liquids, 60 °C < Flashpoint < 93 °C. Class IIIb Combustible Liquids, Flashpoint > 93 °C.

Storage Temperature: Room temperature
Reason: Integrity.

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8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Measures:
Where this material is not used in a closed system, good enclosure and local exhaust ventilation should be provided to control exposure.

Respiratory Protection:
For operations where inhalation exposure can occur, use an approved respirator recommended by an industrial hygienist after an evaluation of the operation. Where inhalation exposure can not occur, no respiratory protection is required. A full facepiece respirator also provides eye and face protection.

Eye Protection:
Wear eye/face protection such as chemical splash proof goggles or face shield. Eyewash equipment and safety shower should be provided in areas of potential exposure.

Skin Protection:
Avoid skin contact. Wear impermeable gloves and suitable protective clothing.

Additional Advice:
Food, beverages, and tobacco products should not be carried, stored, or consumed where this material is in use. Before eating, drinking, or smoking, wash face and hands thoroughly with soap and water.

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9. PHYSICAL AND CHEMICAL PROPERTIES

Color:	clear amber		
Appearance:	liquid		
Odor:	none		
Boiling Point:	Not available		
Melting Point:	Not available		
Vapor Pressure:	Not available		
Specific Gravity/Density:	0.96 - 0.99@ 25°C		
Vapor Density:	Not available		
Percent Volatile (% by wt.):	Not available		
pH:	Not available		
Saturation In Air (% By Vol.):	Not available		
Evaporation Rate:	Not available		
Solubility In Water:	Insoluble		
Volatile Organic Content:	Not available		
Flash Point:	118.3 °C	245 °F	Pensky-Martens Closed Cup
Flammable Limits (% By Vol):	Not available		
Autoignition Temperature:	Not available		
Decomposition Temperature:	Not available		
Partition coefficient (n-octanol/water):	Insoluble		
Odor Threshold:	Not available		

9. PHYSICAL AND CHEMICAL PROPERTIES

10. STABILITY AND REACTIVITY

Stability:	Stable
Conditions To Avoid:	None known
Polymerization:	Will not occur
Conditions To Avoid:	None known
Materials To Avoid:	oxygen Strong oxidizing agents.
Hazardous Decomposition Products:	oxides of carbon Ammonia (NH3) nitrogen oxides

11. TOXICOLOGICAL INFORMATION

Toxicological information for the product is found under Section 3. HAZARDS IDENTIFICATION.
Toxicological information on the regulated components of this product is as follows:

Petroleum distillates, hydrotreated light (CAS# 64742-47-8) has acute oral (rat) and dermal (rabbit) LD50 values of >5 g/kg and >3.16 g/kg, respectively. Prolonged or repeated skin contact tends to remove skin oils, possibly leading to irritation and dermatitis. Direct contact may cause eye irritation. Overexposure to high vapor concentrations, >~700 ppm, are irritating to the eyes and respiratory tract and may cause headaches, dizziness, drowsiness, and other central nervous system effects, including death. Aspiration of minute amounts during ingestion or vomiting may cause mild to severe pulmonary injury and possibly death. In a 90-day oral gavage (rats) study at 100, 500, or 1000 mg/kg, no treatment-related mortalities were observed. There were no significant changes in body weights or food consumption in any dose groups. Increased liver weights were observed in male and female rats a 500 and 1000 mg/kg. Increased kidney weights were observed only in male rats at 500 and 1000 mg/kg. Testes weights were significantly elevated in male rats at 1000 mg/kg. Kidney effects, indicative of light hydrocarbon nephropathy, occured in male rat kidneys at all dose levels. Histological findings of hepatocellular hypertrophy were seeen in the livers of male rats at 1000 mg/kg and in female rats at 500 and 1000 mg/kg. All treatment-related effects were reversible within the 4-week recovery period. Observed kidney effects (including light hydrocarbon nephropathy and increased kidney weight) are a unique response by male rats to chronic hydrocarbon exposure, which th U.S. EPA has declared `not relevant to humans`. High-dose liver effects (including hepatocellular hypertrophy, or enlarged liver cells) are a direct consequence of the sustained high-fat `hydrocarbon diet`. The No Observed Adverse Effect Level (NOAEL) for this study was 1000 mg/kg.

Salicylaldoxime derivative has an oral LD50 (rat) of 1.25 to 5 mL/Kg, a dermal LD50 (rat) of > 2.5 mL/Kg, and an inhalation LC50 (rat) of > 1.6 mg/L/1 hr./70 °C. Rat skin testing indicates it is a moderate dermal irritant, and rabbit eye testing indicated a slight potential for irritation. Guinea pig dermal sensitization tests were negative. It is expected to be irritating to eyes, skin, and all mucous membranes. Ingestion is expected to cause moderate to severe gastrointestinal irritation. Symptoms of inhalation exposure may include coughing, choking, pain and moderate to severe irritation of mucous membranes. Depending on quantity and duration of exposure, contact will likely cause moderate skin and eye irritation. Overexposure can cause central nervous system (CNS) depression, with symptoms ranging from headache and confusion to coma and respiratory failure. This material is likely to be an endocrine disrupter.

12. ECOLOGICAL INFORMATION

Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
The ecological assessment for this material is based on an evaluation of its components.

12. ECOLOGICAL INFORMATION

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13. DISPOSAL CONSIDERATIONS

The information on RCRA waste classification and disposal methodology provided below applies only to the product, as supplied. If the material has been altered or contaminated, or it has exceeded its recommended shelf life, the guidance may be inapplicable. Hazardous waste classification under federal regulations (40 CFR Part 261 et seq) is dependent upon whether a material is a RCRA `listed hazardous waste`or has any of the four RCRA `hazardous waste characteristics.`Refer to 40 CFR Part 261.33 to determine if a given material to be disposed of is a RCRA `listed hazardous waste`; information contained in Section 15 of this MSDS is not intended to indicate if the product is a `listed hazardous waste.`RCRA Hazardous Waste Characteristics: There are four characteristics defined in 40 CFR Section 261.21-61.24: Ignitability, Corrosivity, Reactivity, and Toxicity. To determine Ignitability, see Section 9 of this MSDS (flash point). For Corrosivity, see Sections 9 and 14 (pH and DOT corrosivity). For Reactivity, see Section 10 (incompatible materials). For Toxicity, see Section 2 (composition). Federal regulations are subject to change. State and local requirements, which may differ from or be more stringent than the federal regulations, may also apply to the classification of the material if it is to be disposed. The Company encourages the recycle, recovery and reuse of materials, where permitted, as an alternate to disposal as a waste. The Company recommends that organic materials classified as RCRA hazardous wastes be disposed of by thermal treatment or incineration at EPA approved facilities. The Company has provided the foregoing for information only; the person generating the waste is responsible for determining the waste classification and disposal method.

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14. TRANSPORT INFORMATION

This section provides basic shipping classification information. Refer to appropriate transportation regulations for specific requirements.

US DOT

Proper Shipping Name: ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S.
Hazard Class: 9
Packing Group: III
UN/ID Number: UN3082
Transport Label Required: Miscellaneous
Marine Pollutant
Technical Name (N.O.S.): Salicylaldoxime derivative
Hazardous Substances:
Not applicable
Comments: Marine Pollutants - DOT requirements specific to Marine Pollutants do not apply to non-bulk packagings transported by motor vehicles, rail cars or aircraft.

TRANSPORT CANADA

Proper Shipping Name: ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S.
Hazard Class: 9
Packing Group: III

UN Number: UN3082
Transport Label Required: Miscellaneous
Marine Pollutant
Technical Name (N.O.S.): Salicylaldoxime derivative

ICAO / IATA

Proper Shipping Name: Environmentally hazardous substance, liquid, n.o.s.
Hazard Class: 9
Packing Group: III
UN Number: UN3082
Transport Label Required: Miscellaneous
Packing Instructions/Maximum Net Quantity Per Package:
Passenger Aircraft: 914; 450 L
Cargo Aircraft: 914; 450 L
Technical Name (N.O.S.): Salicylaldoxime derivative

Comments: Special Provision A97 states that substances classified as UN3077 or UN3082 by the regulations of other modes of transport may also be transported by air under these entries. This classification does NOT apply if the regulations of the other modes of transport allow the substances to be shipped as “Non-Dangerous Goods” because of package size or transport mode.

IMO

Proper Shipping Name: ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S.
Hazard Class: 9
UN Number: UN3082
Packing Group: III
Transport Label Required: Miscellaneous
Marine Pollutant
Technical Name (N.O.S.): Salicylaldoxime derivative

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15. REGULATORY INFORMATION

INVENTORY INFORMATION

United States (USA): All components of this product are included on the TSCA Chemical Inventory or are not required to be listed on the TSCA Chemical Inventory.
This product contains a chemical substance that is subject to export notification under Section 12 (b) of the Toxic Substances Control Act, 15 U. S. C. 2601 et. seq. (This requirement applies to exports from the United States only.)

Canada: All components of this product are included on the Domestic Substances List (DSL) or are not required to be listed on the DSL.

European Union (EU): All components of this product are included on the European Inventory of Existing Chemical Substances (EINECS) or are not required to be listed on EINECS.

Australia: All components of this product are included in the Australian Inventory of Chemical Substances (AICS).

China: All components of this product are included on the Chinese inventory or are not required to be listed on the Chinese inventory.

Japan: All components of this product are included on the Japanese (ENCS) inventory or are not required to be listed on the Japanese inventory.

Korea: All components of this product are included on the Korean (ECL) inventory or are not required to be listed on the Korean inventory.

Philippines: All components of this product are NOT included on the Philippine (PICCS) inventory.

OTHER ENVIRONMENTAL INFORMATION
The following components of this product may be subject to reporting requirements pursuant to Section 313 of CERCLA (40 CFR 372), Section 12(b) of TSCA, or may be subject to release reporting requirements (40 CFR 307, 40 CFR 311, etc.) See Section 13 for information on waste classification and waste disposal of this product.

Component / CAS No.	%	TPQ (lbs)	RQ(lbs)	S313	TSCA 12B
Salicylaldoxime derivative -	30 - 60	None	0	No	Yes

PRODUCT HAZARD CLASSIFICATION UNDER SECTION 311 OF SARA
- Acute

16. OTHER INFORMATION

NFPA Hazard Rating (National Fire Protection Association)

Health: 2 - Materials that, under emergency conditions, can cause temporary incapacitation or residual injury.

Fire: 1 - Materials that must be preheated before ignition can occur.

Reactivity: 0 - Materials that in themselves are normally stable, even under fire exposure conditions.

Reasons For Issue: Revised Section 14

Randy Deskin, Ph.D., DABT +1-973-357-3100

CYTEC

Technology ahead of its time™

MSDS: 0014831
Date: 10/01/2003

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name:	**ACORGA® M5640 Solvent Extraction Reagent**
Synonyms:	none
Molecular Weight:	Mixture

CYTEC INDUSTRIES INC., FIVE GARRET MOUNTAIN PLAZA, WEST PATERSON, NEW JERSEY 07424, USA
For Product Information call 1-800/652-6013. Outside the USA and Canada call 1-973/357-3193.
EMERGENCY PHONE: For emergency involving spill, leak, fire, exposure or accident call CHEMTREC: 1-800/424-9300. Outside the USA and Canada call 1-703/527-3887.

® indicates trademark registered in the U.S. Outside the U.S., mark may be registered, pending or a trademark. Mark is or may be used under license.

2. COMPOSITION/INFORMATION ON INGREDIENTS

OSHA REGULATED COMPONENTS

Component / CAS No.	% (w/w)	OSHA (PEL):	ACGIH (TLV)	Carcinogen
Petroleum distillate hydrotreated light 64742-47-8	10 - 30	500 ppm 1200 mg/m^3 (Supplier) 165 ppm (Supplier)	Not Established	-
5-Nonyl-2-hydroxy-benzaldoxime 174333-80-3	30 - 60	Not Established	Not Established	-

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

APPEARANCE AND ODOR:

Color:	clear amber
Appearance:	liquid
Odor:	none

STATEMENTS OF HAZARD:

WARNING! CAUSES EYE AND SKIN IRRITATION
COMBUSTIBLE LIQUID AND VAPOR

POTENTIAL HEALTH EFFECTS

EFFECTS OF OVEREXPOSURE:
The acute oral (rat) and dermal (rabbit) LD50 is estimated to be between 1,600 - 3,000 mg/kg and greater than 2,000 mg/kg, respectively.

Direct contact with this material may cause moderate eye and skin irritation. Overexposure to vapors may cause irritation of the respiratory tract and eyes and may cause central nervous system effects. Refer to Section 11 for toxicology information on the regulated components of this product.

4. FIRST AID MEASURES

Ingestion:
If swallowed, call a physician immediately. Only induce vomiting at the instruction of a physician. Never give anything by mouth to an unconscious person.

Skin Contact:
Wash immediately with plenty of water and soap.

Eye Contact:
Rinse immediately with plenty of water for at least 15 minutes. Obtain medical advice if there are persistent symptoms.

Inhalation:
Remove to fresh air. If breathing is difficult, give oxygen. Obtain medical advice if there are persistant symptoms.

5. FIRE-FIGHTING MEASURES

Extinguishing Media:
Use water spray, alcohol foam, carbon dioxide or dry chemical to extinguish fires. Water stream may be ineffective.

Protective Equipment:
Firefighters, and others exposed, wear self-contained breathing apparatus. Wear full firefighting protective clothing. See Section 8 (Exposure Controls/Personal Protection).

Special Hazards:
Keep containers cool by spraying with water if exposed to fire.

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions:
Where exposure level is not known, wear approved, positive pressure, self-contained respirator. Where exposure level is known, wear approved respirator suitable for level of exposure. In addition to the protective clothing/equipment in Section 8 (Exposure Controls/Personal Protection), wear impermeable boots.

Methods For Cleaning Up:
Remove sources of ignition. Cover spills with some inert absorbent material; sweep up and place in a waste disposal container. Flush spill area with water.

7. HANDLING AND STORAGE

HANDLING

Precautionary Measures: Avoid contact with eyes, skin and clothing. Wash thoroughly after handling. Keep away from heat, sparks and flame. Keep container closed.

Handling Statements: None

STORAGE

Areas containing this material should have fire safe practices and electrical equipment in accordance with applicable regualtions and/or guidelines. Standards are primarily based on the material`s flashpoint, but may also take into account properties such as miscibility with water or toxicity. All local and national regulations should be followed.
In the Americas, National Fire Protection Association (NFPA) 30: Flammable and Combustible Liquids Code, is a widely used standard. NFPA 30 establishes storage conditions for the following classes of materials: Class I Flammable Liquids, Flashpoint <37.8 °C. Class II Combustible Liquids, 37.8 °C < Flashpoint <60 °C. Class IIIa Combustible Liquids, 60 °C < Flashpoint < 93 °C. Class IIIb Combustible Liquids, Flashpoint > 93 °C.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Measures:
Where this material is not used in a closed system, good enclosure and local exhaust ventilation should be provided to control exposure.

Respiratory Protection:
Where exposures are below the established exposure limit, no respiratory protection is required. Where exposures exceed the established exposure limit, use respiratory protection recommended for the material and level of exposure.

Eye Protection:
Wear eye/face protection such as chemical splash proof goggles or face shield.

Skin Protection:
Avoid skin contact. Wear impermeable gloves and suitable protective clothing.

Additional Advice:
Food, beverages, and tobacco products should not be carried, stored, or consumed where this material is in use. Before eating, drinking, or smoking, wash face and hands thoroughly with soap and water.

9. PHYSICAL AND CHEMICAL PROPERTIES

Color:	clear amber
Appearance:	liquid
Odor:	none
Boiling Point:	Not available
Melting Point:	Not available
Vapor Pressure:	mm Hg @ 20 °C Not available
Specific Gravity:	0.96 - 0.97
Vapor Density:	(air = 1)Not available
Percent Volatile (By Wt.):	Not available
pH:	Not available
Saturation In Air (% By Vol.):	Not available
Evaporation Rate:	Not available
Solubility In Water:	Insoluble
Volatile Organic Content:	Not available
Flash Point:	91 °C 196 °F Pensky-Martens Closed Cup
Flammable Limits (% By Vol):	Not available
Autoignition Temperature:	Not available
Decomposition Temperature:	Not available
Partition coefficient (n-octanol/water):	Not available
Odor Threshold:	See Section 2 for exposure limits.

10. STABILITY AND REACTIVITY

Stability:	Stable
Conditions To Avoid:	None known
Polymerization:	Will not occur
Conditions To Avoid:	None known
Materials To Avoid:	oxygen Strong oxidizing agents.
Hazardous Decomposition Products:	oxides of carbon and nitrogen, ammonia

11. TOXICOLOGICAL INFORMATION

Toxicological information for the product is found under Section 3. HAZARDS IDENTIFICATION.
Toxicological information on the regulated components of this product is as follows:

Petroleum distillates, hydrotreated light (CAS# 64742-47-8) has acute oral (rat) and dermal (rabbit) LD50 values of >5 g/kg and >3.16 g/kg, respectively. Prolonged or repeated skin contact tends to remove skin oils, possibly leading to irritation and dermatitis. Direct contact may cause eye irritation. Overexposure to high vapor concentrations, >~700 ppm, are irritating to the eyes and respiratory tract and may cause headaches, dizziness, drowsiness, and other central nervous system effects, including death. Aspiration of minute amounts during ingestion or vomiting may cause mild to severe pulmonary injury and possibly death. In a 90-day oral gavage (rats) study at 100, 500, or 1000 mg/kg, no treatment-related mortalities were observed. There were no significant changes in body weights or food consumption in any dose groups. Increased liver weights were observed in male and female rats a 500 and 1000 mg/kg. Increased kidney weights were observed only in male rats at 500 and 1000 mg/kg. Testes weights were significantly elevated in male rats at 1000 mg/kg. Kidney effects, indicative of light hydrocarbon nephropathy, occured in male rat kidneys at all dose levels. Histological findings of hepatocellular hypertrophy were seeen in the livers of male rats at 1000 mg/kg and in female rats at 500 and 1000 mg/kg. All treatment-related effects were reversible within the 4-week recovery period. Observed kidney effects (including light hydrocarbon nephropathy and increased kidney weight) are a unique response by male rats to chronic hydrocarbon exposure, which th U.S. EPA has declared `not relevant to humans`. High-dose liver effects (including hepatocellular hypertrophy, or enlarged liver cells) are a direct consequence of the sustained high-fat `hydrocarbon diet`. The No Observed Adverse Effect Level (NOAEL) for this study was 1000 mg/kg.

5-Nonyl-2-hydroxy-benzaldoxime has an oral LD50 (rat) of 1.25 to 5 mL/Kg, a dermal LD50 (rat) of > 2.5 mL/Kg, and an inhalation LC50 (rat) of > 1.6 mg/L/1 hr./70 °C. Rat skin testing indicates it is a moderate dermal irritant, and rabbit eye testing indicated a slight potential for irritation. Guinea pig dermal sensitization tests were negative. It is expected to be irritating to eyes, skin, and all mucous membranes. Ingestion of 5-Nonyl-2-hydroxy-benzaldoxime is expected to cause moderate to severe gastrointestinal irritation. Symptoms of inhalation exposure may include coughing, choking, pain and moderate to severe irritation of mucous membranes. Depending on quantity and duration of exposure, contact will likely cause moderate skin and eye irritation. In a 14-day subacute feeding study in rats, doses of 0.1 ml/kg did not produce any adverse effects. Overexposure (based on aromatic oxime) can cause central nervous system (CNS) depression, with symptoms ranging from headache and confusion to coma and respiratory failure. This material is likely to be an endocrine disrupter.

California Proposition 65 Warning (applicable in California only) - This product contains (a) chemical(s) known to the State of California to cause birth defects or other reproductive harm.

12. ECOLOGICAL INFORMATION

Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
The ecological assessment for this material is based on an evaluation of its components.

13. DISPOSAL CONSIDERATIONS

The information on RCRA waste classification and disposal methodology provided below applies only to the Cytec product, as supplied. If the material has been altered or contaminated, or it has exceeded its recommended shelf life, the guidance may be inapplicable. Hazardous waste classification under federal regulations (40 CFR Part 261 et seq) is dependent upon whether a material is a RCRA `listed hazardous waste`or has any of the four RCRA `hazardous waste characteristics.`Refer to 40 CFR Part 261.33 to determine if a given material to be disposed of is a RCRA `listed hazardous waste`; information contained in Section 15 of this MSDS is not intended to indicate if the product is a `listed hazardous waste.`RCRA Hazardous Waste Characteristics: There are four characteristics defined in 40 CFR Section 261.21-61.24: Ignitability, Corrosivity, Reactivity, and Toxicity. To determine Ignitability, see Section 9 of this MSDS (flash point). For Corrosivity, see Sections 9 and 14 (pH and DOT corrosivity). For Reactivity, see Section 10 (incompatible materials). For Toxicity, see Section 2 (composition). Federal regulations are subject to change. State and local requirements, which may differ from or be more stringent than the federal regulations, may also apply to the classification of the material if it is to be disposed. Cytec encourages the recycle, recovery and reuse of materials, where permitted, as an alternate to disposal as a waste. Cytec recommends that organic materials classified as RCRA hazardous wastes be disposed of by thermal treatment or incineration at EPA approved facilities. Cytec has provided the foregoing for information only; the person generating the waste is responsible for determining the waste classification and disposal method.

14. TRANSPORT INFORMATION

This section provides basic shipping classification information. Refer to appropriate transportation regulations for specific requirements.

US DOT

Proper Shipping Name: Combustible liquid, n.o.s.
Hazard Class: Combustible liquid
Packing Group: III
UN/ID Number: NA1993
Transport Label Required: Marine Pollutant
Technical Name (N.O.S.): Contains alkyl phenol and alkanes
Hazardous Substances:
Not applicable
Comments: DOT requirements specific to marine pollutants do not apply to non-bulk packagings transported by motor vehicles, rail cars or aircraft.

TRANSPORT CANADA

Proper Shipping Name: Environmentally hazardous substance, liquid, n.o.s.
Hazard Class: 9
Packing Group: III

UN Number: 3082
Transport Label Required: Miscellaneous
Marine Pollutant
Technical Name (N.O.S.): Contains alkyl phenol and alkanes

ICAO / IATA

Proper Shipping Name: Not applicable/Not regulated
Packing Instructions/Maximum Net Quantity Per Package:
Passenger Aircraft: -
Cargo Aircraft: -

IMO

Proper Shipping Name: Environmentally hazardous substance, liquid, n.o.s.
Hazard Class: 9
UN Number: 3082
Packing Group: III
Transport Label Required: Miscellaneous
Marine Pollutant
Technical Name (N.O.S.): Contains alkyl phenol and alkanes

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15. REGULATORY INFORMATION

INVENTORY INFORMATION

United States (USA): All components of this product are included on the TSCA Inventory in compliance with the Toxic Substances Control Act, 15 U. S. C. 2601 et. seq.
This product contains a chemical substance that is subject to export notification under Section 12 (b) of the Toxic Substances Control Act, 15 U. S. C. 2601 et. seq. (This requirement applies to exports from the United States only.)

Canada: Components of this product have been reported to Environment Canada in accordance with Sections 66 and/or 81 of the Canadian Environmental Protection Act (1999), and are included on the Domestic Substances List.

European Union (EU): All components of this product are included in the European Inventory of Existing Chemical Substances (EINECS) in compliance with Council Directive 67/548/EEC and its amendments.

Australia: All components of this product are included in the Australian Inventory of Chemical Substances (AICS).

China: All components of this product are included on the Chinese inventory or are not required to be listed on the Chinese inventory.

Japan: All components of this product are included on the Japanese (ENCS) inventory or are not required to be listed on the Japanese inventory.

Korea: All components of this product are included on the Korean (ECL) inventory or are not required to be listed on the Korean inventory.

Philippines: All components of this product are NOT included on the Philippine (PICCS) inventory.

OTHER ENVIRONMENTAL INFORMATION

The following components of this product may be subject to reporting requirements pursuant to Section 313 of CERCLA (40 CFR 372), Section 12(b) of TSCA, or may be subject to release reporting requirements (40 CFR 307, 40 CFR 311, etc.) See Section 13 for information on waste classification and waste disposal of this product.

Component / CAS No.	%	TPQ(lbs)	RQ(lbs)	S313	TSCA 12B
5-Nonyl-2-hydroxy-benzaldoxime 174333-80-3	30 - 60	None	0	No	Yes

PRODUCT HAZARD CLASSIFICATION UNDER SECTION 311 OF SARA

- Acute
- Fire

16. OTHER INFORMATION

NFPA Hazard Rating (National Fire Protection Association)

Health: 2 - Materials that, under emergency conditions, can cause temporary incapacitation or residual injury.

Fire: 2 - Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur.

Reactivity: 0 - Materials that in themselves are normally stable, even under fire exposure conditions.

Reasons For Issue: New Product

Randy Deskin, Ph.D., DABT +1-973-357-3100

Cognis Corporation

Material Safety Data Sheet

SDS no. : 320811

LIX 684 N-LV

Revision: 08/10/2010
printing date: 08/10/2010

1. Chemical product and company identification

Product name:
LIX 684 N-LV

Supplier
Cognis Corporation
5051 Estecreek Drive
Cincinnati, OH 45232-1446
USA
Phone: +1 (866) 910-0598
Fax-no.: +1 (513) 482-3576

Emergency Information Chemtrec:
+1-800-424-9300

2. Composition/information on ingredients

General chemical description:
Alkylated phenol oxime solution

COMPONENT:	CAS-No.	CONCENTRATION (Wt. %):
Proprietary component(s)		100

3. Hazards identification

EMERGENCY OVERVIEW

Warning:	Combustible liquid. Causes skin and eye irritation. May cause an allergic skin reaction.

State:
liquid

Odor:
of mineral oil

Color(s):
amber

Routes of entry:
Skin contact, Eye contact

Potential Health Acute Effects:
Inhalation:
Prolonged or excessive inhalation may cause respiratory tract irritation.

Skin contact:
Causes skin irritation.
May cause an allergic skin reaction.

Eye contact:
Causes eye irritation.

Ingestion:
May be harmful if swallowed.

Existing conditions aggravated by exposure:
May aggravate existing skin, eye and respiratory conditions.

Potential Chronic Health Effects:
None known

4. First aid measures

After inhalation:
After inhalation of spray mist: seek medical advice.
Move to fresh air.

After skin contact:
Remove contaminated clothing and footwear.
Wash thoroughly with soap and water.
If adverse health effects develop seek medical attention.

After eye contact:
Rinse immediately with plenty of running water (for 10 minutes). Seek medical attention if necessary.

After ingestion:
Do not induce vomiting, seek medical advice immediately.
Product presents an aspiration hazard.
If vomiting occurs naturally, keep airway clear.
Never give anything by mouth if the victim is rapidly losing consciousness, or is unconscious or convulsing.

5. Fire fighting measures

Flash point:
> 201,2 °F (> 94 °C)
ISO 2719-88;; flashpoint

Autoignition temperature:

Not determined

Flammable/Explosive limits:
Lower limits:
Not determined.
Upper limits:
Not determined.

Suitable extinguishing media:
Water Spray
Carbon dioxide.
Foam.
Dry Chemical

Improper extinguishing media:
High pressure waterjet

Special protection equipment for firefighters:
Wear self-contained breathing apparatus.
Wear full protective clothing.

Unusual fire or explosion hazards:
Formation of toxic gases is possible during heating or in fires.

Hazardous combustion products:
Carbon dioxide., carbon monoxide, nitrogen oxides

Additional fire fighting advice:
In case of fire, keep containers cool with water spray.

6. Accidental release measures

General information:
Avoid open flames and sources of ignition.
Clean up spills immediately.

Personal precautions:
Avoid contact with skin and eyes.
Ensure adequate ventilation.
Keep unprotected persons away.
Ensure cleanup is performed only by trained personnel wearing appropriate personal protective clothing and equipment.

Environmental precautions:
Do not empty into drains / surface water / ground water.

Methods for cleaning and take-up:
Contain by diking then pump into suitable containers.
Soak up small spills with absorbent material and place in labeled containers for recovery or disposal.

7. Handling and storage

Handling:
Handling advice:
Avoid naked flames, sparking and sources of ignition.
Ensure that workrooms are adequately ventilated.
Open and handle container with care.

Storage:
Shelf life:
36 months

Storage conditions to keep:
Store in a cool place in closed original container.
Ensure that storage and workrooms are adequately ventilated.

8. Exposure controls/personal protection

Indication for system design:
Ensure adequate ventilation.

Components with specific control parameters for workplace:

Valid for NAFTA Region (CA, US, MX)

Name on list	Basis	Type	Value	Category	Remarks
JET FUELS (NON-AEROSOL), AS TOTAL HYDROCARBON VAPOR	ACGIH	Skin designation.			Can be absorbed through the skin.
JET FUELS (NON-AEROSOL), AS TOTAL HYDROCARBON VAPOR	ACGIH	Time Weighted Average (TWA).	200 mg/m^3		P: Application restricted to conditions in which there are negligible aerosol exposures.
KEROSENE (NON-AEROSOL), AS TOTAL HYDROCARBON VAPOR	ACGIH	Time Weighted Average (TWA).	200 mg/m^3		P: Application restricted to conditions in which there are negligible aerosol exposures.
KEROSENE (NON-AEROSOL), AS TOTAL HYDROCARBON VAPOR	ACGIH	Skin designation.			Can be absorbed through the skin.
KEROSENE	NIOSH	Recommended exposure limit (REL):	100 mg/m^3		
EXX-PRINT 283D, EXXSOL (HEAVY ALIPHATIC PETROLEUM SOLVENT)LPA-142, 150, 170 SOLVENT (100% PARAFFINIC, NAPHTHENIC SOLVENT, HEAVY ALIPHATIC PETROLEUM SOLVENT; HYDROTREATED DISTILLATE)ISOPAR M (SYNTHETIC ISOPARAFFINIC HYDROCARBON)LVT 200 SOLVENT (HYDROTREATED LIGHT DISTILLATE)OROFOM SX (HYDROTREATED DISTILLATE, LIGHT C1 - C16)	TX ESL	Short-Term ESL:	3500 others	1 hourug/m3	
OROFOM SX (HYDROTREATED DISTILLATE, LIGHT C1 - C16)ISOPAR M (SYNTHETIC ISOPARAFFINIC HYDROCARBON)EXX-PRINT 283D, EXXSOL (HEAVY ALIPHATIC PETROLEUM SOLVENT)LVT 200 SOLVENT (HYDROTREATED LIGHT DISTILLATE)LPA-142, 150, 170 SOLVENT (100% PARAFFINIC,	TX ESL	Annual ESL:	350 others	ug/m3	

NAPHTHENIC SOLVENT, HEAVY ALIPHATIC PETROLEUM SOLVENT; HYDROTREATED DISTILLATE)					

Personal protection measures:
Respiratory protection:
Suitable breathing mask when there is inadequate ventilation.
NIOSH/MSHA approved respirator if necessary.
Follow manufacturer's recommendations.

Hand protection:
Appropriate chemical resistant gloves.

Eye protection:
Goggles which can be tightly sealed.

Skin protection:
Wear suitable protective clothing.

9. Physical and chemical properties

General description:

State:	liquid
Odor:	of mineral oil
Color(s):	amber

Designation	Value	Method
Density (25 °C (77°F))	0.97 - 0.98 g/cm3	no information
Solubility in	Insoluble	no information

10. Stability and reactivity

Stability:
Conditions to avoid:
Avoid heating.
Prolonged exposure to elevated temperatures may result in exothermic decomposition accompanied by a pressure build-up
in sealed containers.

Decomposition advices:
No decomposition if used according to specifications.

Reactivity:
Materials to avoid:
Reaction with oxidants.

Hazardous polymerization:
Will not occur

11. Toxicological information

General toxicological information:
No toxicity information available or testing conducted on this product.
Any health or toxicological information included in Section 3 was based on data associated with the components or an analogous product.

Acute oral toxicity:
LD50 > 2000 mg/kg body weight

Skin irritation:
irritating

Eye irritation:
irritating

12. Ecological information

General ecological information:
The ecological evaluation of the product is based on data from the raw material and/or comparable substances.

Acute bacterial toxicity:
EC0 > 10 - <= 100 mg product/l.

Ultimate biodegradation:
The total of the organic components contained in the product achieve values below 60% BOD/COD or CO2 liberation, or below 70% DOC reduction in tests for ease of degradability. Threshold values for 'readily degradable' (e.g. to OECD method 301) are not reached.

13. Disposal considerations

Waste disposal of product:

Dispose of product by incineration in an approved chemical waste facility (or by other approved methods) in accordance with applicable federal, state, and local regulations.
Avoid landfilling liquids.
Reclaim where possible.

14. Transport information

U.S. Department of Transportation Ground (49 CFR):

Proper shipping name:	Environmentally hazardous substances, liquid, n.o.s. (Alkylated Phenol oxime)
Hazard class or division:	9
Danger Labels:	9
Identification number:	UN 3082
Packing group:	III
Marine pollutant:	Environmentally Hazardous
ERG/EMS:	171
RQ:	None

International Air Transportation (ICAO/IATA):

Proper shipping name:	Environmentally hazardous substance, liquid, n.o.s. (Alkylated Phenol oxime)
Hazard class or division:	9
Danger Labels:	9
Identification number:	UN 3082
Packing group:	III
RQ:	None

Water Transportation (IMO/IMDG):

Proper shipping name:	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (Alkylated Phenol oxime)
Hazard class or division:	9
Danger Labels:	9
Identification number:	UN 3082
Packing group:	III
Marine pollutant:	Environmentally Hazardous
ERG/EMS:	F-A;S-F
RQ:	None

The transport information provided represents the regulatory transport classification of the product without consideration to packaging, quantity, or modal restrictions and exceptions. It is the user's responsibility to determine the appropriate packaging and modal requirements and/or limitations for the product quantity being shipped.

15. Regulatory information

TSCA Inventory Status:	This product and/or all of its components are either included on or exempt from the TSCA Inventory of Chemical Substances.
SARA 311/312 Hazard Categories:	Immediate Health, Fire
TSCA 12(b) Components:	none
SARA 313 Toxic Chemicals:	none
SARA 302 Extremely Hazardous Substances:	none
CERCLA Hazardous Chemicals:	none
California Proposition 65:	No California Proposition 65 listed chemicals are known to be present.

16. Other information

NFPA Rating (US)	Value
Health	2
Fire	2
Reactivity	1
Special Hazard	

HMIS Rating (US)	Value
Health	2
Flammability	2
Reactivity	1

All information, recommendations, and suggestions appearing herein concerning our product are based upon tests and data believed to be reliable. However, it is the user's responsibility to determine the safety, toxicity, and suitability for his own use of the product described herein. Since the actual use by others is beyond our control, no guarantee, express or implied, is being made as to the effects of such use, the results obtained, or the safety and toxicity of the product nor is their any assumed liability arising out of use, by others, of the product referred to herein. The information herein is not to be construed as absolutely complete since additional information may be necessary or desirable when particular or exceptional conditions or circumstances exist or because of applicable laws or government regulations.

730721-00 ESCAID 115
MATERIAL SAFETY DATA BULLETIN

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1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: ESCAID 115
SUPPLIER: EXXON MOBIL CORPORATION
3225 GALLOWS RD.
FAIRFAX, VA 22037

24 - Hour Health and Safety Emergency (call collect): 609-737-4411
24 - Hour Transportation Emergency (Primary) CHEMTREC: 800-424-9300
(Secondary) 281-834-3296
Product and Technical Information:
Lubricants and Specialties: 800-662-4525 800-443-9966
Fuels Products: 800-947-9147
MSDS Fax on Demand: 713-613-3661
MSDS on Internet: http://www.exxon.com
http://www.mobil.com

2. COMPOSITION/INFORMATION ON INGREDIENTS

CHEMICAL NAMES AND SYNONYMS: HYDROCARBON

GLOBALLY REPORTABLE MSDS INGREDIENTS:

Substance Name	Approx. Wt%
REFINED MINERAL OIL (64771-72-8)	100

See Section 8 for exposure limits (if applicable).

3. HAZARDS IDENTIFICATION

This product is considered hazardous according to regulatory guidelines (See Section 15).

EMERGENCY OVERVIEW: Clear Straw Yellow Liquid. DOT ERG No. : NA

POTENTIAL HEALTH EFFECTS: This product can irritate and defat the skin. Prolonged and/or repeated skin contact may cause dermatitis. High concentrations of vapors may be irritating to the eyes and respiratory system and act as an anesthetic. Low viscosity material-if swallowed may enter the lungs and cause lung damage.

For further health effects/toxicological data, see Section 11.

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4. FIRST AID MEASURES

EYE CONTACT: Flush thoroughly with water. If irritation occurs, call a physician.
SKIN CONTACT: Wash contact areas with soap and water. Immediately remove contaminated clothing. Launder contaminated clothing before reuse. (See Section 16 - Injection Injury)
INHALATION: Remove from further exposure. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance. If breathing has stopped, assist ventilation with mechanical device or use mouth-to-mouth resuscitation.
INGESTION: Seek immediate medical attention. Do not induce vomiting.
NOTE TO PHYSICIANS: Material if aspirated into the lungs may cause chemical pneumonitis. PRE-EXISTING MEDICAL CONDITIONS WHICH MAY BE AGGRAVATED BY EXPOSURE: Hydrocarbon Solvents/Petroleum Hydrocarbons- Skin contact may aggravate an existing dermatitis.

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5. FIRE-FIGHTING MEASURES

EXTINGUISHING MEDIA: Carbon dioxide, foam, dry chemical and water fog.
SPECIAL FIRE FIGHTING PROCEDURES: Water should be used to keep fire-exposed containers cool. Prevent runoff from fire control or dilution from entering streams, sewers, or drinking water supply.
SPECIAL PROTECTIVE EQUIPMENT: For fires in enclosed areas, fire fighters must use self-contained breathing apparatus.
UNUSUAL FIRE AND EXPLOSION HAZARDS: None.
COMBUSTION PRODUCTS: Fumes, smoke, carbon monoxide, sulfur oxides, aldehydes and other decomposition products, in the case of incomplete combustion.
Flash Point C(F): > 93(200) (ASTM D-93).
Flammable Limits (approx.% vol.in air) - LEL: 1.4%, UEL: 8.7%
NFPA HAZARD ID: Health: 1, Flammability: 1, Reactivity: 0

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6. ACCIDENTAL RELEASE MEASURES

NOTIFICATION PROCEDURES: Report spills/releases as required to appropriate authorities. U.S. Coast Guard and EPA regulations require immediate reporting of spills/releases that could reach any waterway including intermittent dry creeks. Report spill/release to Coast Guard National Response Center toll free number (800)424-8802. In case of accident or road spill notify CHEMTREC (800) 424-9300.
PROCEDURES IF MATERIAL IS RELEASED OR SPILLED:
LAND SPILL: Eliminate sources of ignition. Shut off source taking normal safety precautions. Take measures to minimize the effects on ground water. Recover by pumping using explosion-proof equipment or contain spilled liquid with sand or other suitable absorbent and

remove mechanically into containers. If necessary, dispose of adsorbed residues as directed in Section 13.
WATER SPILL: Eliminate sources of ignition and warn other ships in the vicinity to stay clear. Notify port and other relevant authorities. Confine with booms if skimming equipment is avaliable to recover the spill. Otherwise disperse in unconfined waters, if permitted by local authorities and environmental agencies. If permitted by regulatory authorities the use of suitable dispersants should be considered where recommended in local oil spill procedures.

ENVIRONMENTAL PRECAUTIONS: Prevent material from entering sewers, water sources or low lying areas; advise the relevant authorities if it has, or if it contaminates soil/vegetation.

PERSONAL PRECAUTIONS: See Section 8

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7. HANDLING AND STORAGE

HANDLING: Keep product away from high energy ignition sources, heat, sparks, pilot lights, static electricity, and open flame. Harmful in contact with or if absorbed through the skin. Avoid inhalation of vapors or mists. Use in well ventilated area away from all ignition sources. Do not fill container in or on a vehicle. Static electricity may ignite vapors and cause fire. Place container on ground when filling and keep nozzle in contact with container. See Section 8 for additional personal protection advice when handling this product.

STORAGE: Store in a cool area. Small containers of approved design, properly sealed and labeled, should be stored in well ventilated surroundings and kept out of reach of children. Eliminate all sources of ignition from the storage and handling area.

SPECIAL PRECAUTIONS: To prevent and minimize fire or explosion risk from static accumulation and discharge, effectively bond and/or ground product transfer system. Do not use electronic devices (including but not limited to cellular phones, computers, calculators, pagers, etc.) in or around any fueling operation or storage area unless the devices are certified intrinsically safe by an approved national testing agency and to the safety standards required by national and/or local laws and regulations. Electrical equipment and fittings must comply with local fire prevention regulations for this class of product. Use the correct grounding procedures. Refer to national or local regulations covering safety at petroleum handling and storage areas for this product.

EMPTY CONTAINER WARNING: Empty containers retain residue (liquid and/or vapor) and can be dangerous. DO NOT PRESSURIZE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION; THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Do not attempt to refill or clean container since residue is difficult to remove. Empty drums should be completely drained, properly bunged and promptly returned to a drum reconditioner. All containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations.

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8. EXPOSURE CONTROLS/PERSONAL PROTECTION

OCCUPATIONAL EXPOSURE LIMITS:

ExxonMobil recommends an 8-hour time-weighted average (TWA) exposure of 1200 mg/m3 total vapor (approx. 165 ppm).

VENTILATION: Use in well ventilated area with local exhaust ventilation. If mists are generated, use adequate ventilation, local exhaust or enclosures to control below exposure limits.
RESPIRATORY PROTECTION: Use supplied-air respiratory protection in confined or enclosed spaces, if needed.
EYE PROTECTION: If splash with liquid is possible, chemical type goggles should be worn.
SKIN PROTECTION: Impervious gloves should be worn. Good personal hygiene practices should always be followed.

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9. PHYSICAL AND CHEMICAL PROPERTIES

Typical physical properties are given below. Consult Product Data Sheet for specific details.

APPEARANCE: Liquid
COLOR: Clear Straw Yellow
ODOR: Hydrocarbon
ODOR THRESHOLD-ppm: NE
pH: NA
BOILING POINT C(F): > 232(450)
MELTING POINT C(F): NA
FLASH POINT C(F): > 93(200) (ASTM D-93)
FLAMMABILITY (solids): NE
AUTO FLAMMABILITY C(F): NE
EXPLOSIVE PROPERTIES: NA
OXIDIZING PROPERTIES: NA
VAPOR PRESSURE-mmHg 20 C: < 5.0
VAPOR DENSITY: NE
EVAPORATION RATE: NE
RELATIVE DENSITY, 15/4 C: 0.77
SOLUBILITY IN WATER: Negligible
PARTITION COEFFICIENT: > 3.5
VISCOSITY AT 40 C, cSt: < 7.0
VISCOSITY AT 100 C, cSt: NE
POUR POINT C(F): 9(48)
FREEZING POINT C(F): NE
VOLATILE ORGANIC COMPOUND: NE
DMSO EXTRACT, IP-346 (WT.%): NA
NA=NOT APPLICABLE NE=NOT ESTABLISHED D=DECOMPOSES

FOR FURTHER TECHNICAL INFORMATION, CONTACT YOUR MARKETING REPRESENTATIVE

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10. STABILITY AND REACTIVITY

STABILITY (THERMAL, LIGHT, ETC.): Stable.
CONDITIONS TO AVOID: Extreme heat and high energy sources of ignition.
INCOMPATIBILITY (MATERIALS TO AVOID): Halogens, strong acids,

alkalies, and oxidizers.
HAZARDOUS DECOMPOSITION PRODUCTS: Product does not decompose at ambient temperatures.
HAZARDOUS POLYMERIZATION: Will not occur.

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11. TOXICOLOGICAL DATA

---ACUTE TOXICOLOGY---

ORAL TOXICITY (RATS): Practically non-toxic (LD50: greater than 2000 mg/kg). ---Based on testing of similar products and/or the components.
DERMAL TOXICITY (RABBITS): Practically non-toxic (LD50: greater than 2000 mg/kg). ---Based on testing of similar products and/or the components.
INHALATION TOXICITY (RATS): Practically non-toxic (LC50: greater than 5 mg/l). ---Based on testing of similar products and/or the components.
EYE IRRITATION (RABBITS): Practically non-irritating. (Draize score: greater than 6 but 15 or less). ---Based on testing of similar products and/or the components.
SKIN IRRITATION (RABBITS): Practically non-irritating. (Primary Irritation Index: greater than 0.5 but less than 3). ---Based on testing of similar products and/or the components.

---CHRONIC TOXICOLOGY (SUMMARY)---

Prolonged repeated skin contact with low viscosity materials may defat the skin resulting in possible irritation and dermatitis.

---

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL FATE AND EFFECTS:

In the absence of specific environmental data for this product, this assessment is based on information for representative products.

ECOTOXICITY: Available ectoxicity data (LL50 >1000 mg/L) indicates that adverse effects to aquatic organisms are not expected from this product.

MOBILITY: When released into the environment, adsorption to sediment and soil will be the predominant behavior.

PERSISTENCE AND DEGRADABILITY: This product is expected to be inherently biodegradable.

BIOACCUMULATIVE POTENTIAL: Bioaccumulation is unlikely due to the very low water solubility of this product, therefore bioavailability to aquatic organisms is minimal.

---

13. DISPOSAL CONSIDERATIONS

WASTE DISPOSAL: Product is suitable for burning for fuel value in compliance with applicable laws and regulations and consideration of product characteristics at time of disposal.

RCRA INFORMATION: The unused product, in our opinion, is not specifically listed by the EPA as a hazardous waste (40 CFR, Part 261D), nor is it formulated to contain materials which are listed hazardous wastes. It does not exhibit the hazardous characteristics of ignitability, corrosivity, or reactivity. The unused product is not formulated with substances covered by the Toxicity Characteristic Leaching Procedure (TCLP). However, used product may be regulated.

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14. TRANSPORT INFORMATION

USA DOT: NOT REGULATED BY USA DOT.

IMO: NOT REGULATED BY IMO.

IATA: NOT REGULATED BY IATA.

STATIC ACCUMULATOR (50 picosiemens or less): YES

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15. REGULATORY INFORMATION

US OSHA HAZARD COMMUNICATION STANDARD: Product assessed in accordance with OSHA 29 CFR 1910.1200 and determined to be hazardous.

Governmental Inventory Status: All components comply with TSCA, EINICS/ELINCS, AICS, DSL, KOREA, and PHILIPPINES.

U.S. Superfund Amendments and Reauthorization Act (SARA) Title III:
This product contains no "EXTREMELY HAZARDOUS SUBSTANCES".

SARA (311/312) REPORTABLE HAZARD CATEGORIES:
CHRONIC ACUTE

This product contains no chemicals subject to the supplier notification requirements of SARA (313) toxic release program.

The following product ingredients are cited on the lists below:

CHEMICAL NAME	CAS NUMBER	LIST CITATIONS *
*** NO REPORTABLE INGREDIENTS ***		

--- REGULATORY LISTS SEARCHED ---

1=ACGIH ALL	6=IARC 1	11=TSCA 4	16=CA P65 CARC	21=LA RTK
2=ACGIH A1	7=IARC 2A	12=TSCA 5a2	17=CA P65 REPRO	22=MI 293

3=ACGIH A2	8=IARC 2B	13=TSCA 5e	18=CA RTK	23=MN RTK
4=NTP CARC	9=OSHA CARC	14=TSCA 6	19=FL RTK	24=NJ RTK
5=NTP SUS	10=OSHA Z	15=TSCA 12b	20=IL RTK	25=PA RTK
				26=RI RTK

* EPA recently added new chemical substances to its TSCA Section 4 test rules. Please contact the supplier to confirm whether the ingredients in this product currently appear on a TSCA 4 or TSCA 12b list.
Code key:CARC=Carcinogen; SUS=Suspected Carcinogen; REPRO=Reproductive

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16. OTHER INFORMATION

USE: DRILLING FLUID

NOTE: PRODUCTS OF EXXON MOBIL CORPORATION AND ITS AFFILIATED COMPANIES ARE NOT FORMULATED TO CONTAIN PCBS.

Health studies have shown that many hydrocarbons pose potential human health risks which may vary from person to person. Information provided on this MSDS reflects intended use. This product should not be used for other applications. In any case, the following advice should be considered:

INJECTION INJURY WARNING: If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

Precautionary Label Text:

CONTAINS PARAFFINS

CAUTION!

MAY CAUSE SKIN IRRITATION ON PROLONGED, REPEATED CONTACT. MAY CAUSE NOSE, THROAT AND LUNG IRRITATION, DIZZINESS, NAUSEA, LOSS OF CONSCIOUSNESS. LOW VISCOSITY MATERIAL-IF SWALLOWED, MAY BE ASPIRATED AND CAN CAUSE SERIOUS OR FATAL LUNG DAMAGE.

Keep away from heat, sparks, and flame. Avoid breathing vapor. Avoid contact with skin or clothing. Keep container closed. Use with adequate ventilation.

In case of contact, wash skin with soap and water. Remove contaminated clothing. Destroy or wash clothing before reuse. If swallowed, seek immediate medical attention. Do not induce vomiting. Only induce vomiting at the instruction of a physician.

For industrial use only. Not intended or suitable for use in or around a household or dwelling.

Refer to product Material Safety Data Sheet for further safety and health information.

****
For Internal Use Only: MHC: 1* 1* 1* 1* 1*, MPPEC: C, TRN: 730721-00, CMCS97: 97V824, REQ: PETROLEUM SPECIALTIES, SAFE USE: C
EHS Approval Date: 31MAY2002
****

Prepared by: ExxonMobil Oil Corporation
Environmental Health and Safety Department, Clinton, USA

ExxonMobil Chemical Company
(a division of Exxon Mobil Corporation)
13501 Katy Freeway
Houston, Texas 77079, U.S.A. ("Seller")

WSP CHEMICALS & TECHNOLOGY LLC
KARINA CORREA
XXXXXXXXXXXXXXXXXXXXXX

Email Address: Karina.Correa@arcadis-us.com

Issue Date: 03 MAY 2011

Subject: Regulatory Declaration and/or Product Stewardship Information Statement(s) - Request

Dear Sir/Madam:

In response to your request, please find enclosed the regulatory declaration and/or product stewardship information statement(s) for the following product(s):

ESCAID 115 FLUID

These statements are provided by or on behalf of the above referenced ExxonMobil selling affiliate.

If you have any questions or need additional information please contact your ExxonMobil sales representative.

Enclosure(s):

ESCAID 115 FLUID - HAZARDOUS AIR POLLUTANTS-HAPS
Reference Number: 0065562

STATEMENT

Issue Date: 03 MAY 2011
At request of: WSP CHEMICALS & TECHNOLOGY LLC
Product Name(s): ESCAID 115 FLUID
Material Code(s): 5221643

With regard to the compliance status of the ExxonMobil Chemical product referenced above with the regulation(s) identified below the following can be declared:

The federal Clean Air Act Amendments of 1990 (CAAA) established a federal operating permit program under the Title V of the Act. This program applies to all sources of air pollutants and is administered at the state level. One category of pollutants covered by Title V is Hazardous Air Pollutants (HAPs). ExxonMobil Chemical Company has identified nine listed HAPs which may be contituents in Hydrocarbon Fluid products. For many ExxonMobil Chemical Company solvents, these individual HAPs appear at levels below 10 parts per million, possibly resulting in an insignificant contribution toward permitted HAP emissions.

Benzene: < 0.4 ppm (Periodic Analysis Minimum Detection Limit)

Toluene: < 0.4 ppm (Periodic Analysis Minimum Detection Limit)

Xylenes (all isomers): < 1 ppm

Ethylbenzene: < 0.4 ppm (Periodic Analysis Minimum Detection Limit)

Cumene: < 0.4 ppm (Periodic Analysis Minimum Detection Limit)

Naphthalene: < 0.4 ppm (Periodic Analysis Minimum Detection Limit)

n-Hexane: < 1 ppm

Styrene: < 0.4 ppm (Periodic Analysis Minimum Detection Limit)

2,2,4-Trimethylpentane: < 1 ppm

Total HAP: < 10 ppm

VALIDITY DATE: This document is valid until the next relevant legislative and/or regulatory change with a maximum of one year as of the date of issue of the statement.

Reference Number: 0065562

EXXON MOBIL CHEMICAL

MATERIAL SAFETY DATA SHEET

EXXON MOBIL CHEMICAL COMPANY
A DIVISION OF EXXON MOBIL CORPORATION

ESCAID 110 FLUID

DATE PREPARED: AUG 13, 2002

MSDS NO.: 92881582

------SECTION 1 CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ------

PRODUCT NAME: ESCAID 110 FLUID

CHEMICAL NAME: ALIPHATIC HYDROCARBON

CAS: 64742-47-8

CHEMICAL FAMILY: PETROLEUM HYDROCARBON

PRODUCT DESCRIPTION: CLEAR COLORLESS LIQUID.

CONTACT ADDRESS:
EXXONMOBIL CHEMICAL COMPANY
P.O. BOX 3272
HOUSTON, TEXAS 77253-3272

EMERGENCY TELEPHONE NUMBERS: (24 HOURS)
CHEMTREC: (800) 424-9300
EXXONMOBIL CHEMICAL COMPANY: (800) 726-2015

NON EMERGENCY TELEPHONE NUMBERS: (8AM-5PM M-F)

FOR GENERAL PRODUCT INFORMATION CALL: (281) 870-6000

FOR HEALTH AND MEDICAL INFORMATION CALL: (281) 870-6884

------SECTION 2 COMPOSITION/INFORMATION ON INGREDIENTS ------

THIS PRODUCT IS HAZARDOUS AS DEFINED IN 29 CFR 1910.1200.

OSHA HAZARD: COMBUSTIBLE

------SECTION 3 HAZARDS IDENTIFICATION ------

POTENTIAL HEALTH EFFECTS:

EYE CONTACT: SLIGHTLY IRRITATING BUT DOES NOT INJURE EYE TISSUE.

SKIN CONTACT:
LOW ORDER OF TOXICITY. FREQUENT OR PROLONGED CONTACT MAY IRRITATE AND CAUSE DERMATITIS. SKIN CONTACT MAY AGGRAVATE AN EXISTING DERMATITIS CONDITION.

INHALATION:
HIGH VAPOR/AEROSOL CONCENTRATIONS (ATTAINABLE AT ELEVATED TEMPERATURES WELL ABOVE AMBIENT) ARE IRRITATING TO THE EYES AND THE RESPIRATORY TRACT, AND MAY CAUSE HEADACHES, DIZZINESS, ANESTHESIA, DROWSINESS, UNCONSCIOUSNESS, AND OTHER CENTRAL NERVOUS SYSTEM EFFECTS, INCLUDING DEATH EFFECTS, INCLUDING DEATH.

INGESTION:
SMALL AMOUNTS OF THIS PRODUCT ASPIRATED INTO THE RESPIRATORY SYSTEM DURING INGESTION OR VOMITING MAY CAUSE MILD TO SEVERE PULMONARY INJURY, POSSIBLY PROGRESSING TO DEATH.
MINIMAL TOXICITY.

CHRONIC EFFECTS:
AT HIGH ORAL DOSES, THIS PRODUCT CAUSED REVERSIBLE DAMAGE TO THE LIVER AND KIDNEY (MALE ONLY) OF RATS. THESE EFFECTS ARE NOT RELEVANT TO HUMANS AT OCCUPATIONAL LEVELS OF EXPOSURE.

------SECTION 4 FIRST AID MEASURES ------

EYE CONTACT:
FLUSH EYES WITH LARGE AMOUNTS OF WATER UNTIL IRRITATION SUBSIDES.
IF IRRITATION PERSISTS, GET MEDICAL ATTENTION.

SKIN CONTACT:
FLUSH WITH LARGE AMOUNTS OF WATER; USE SOAP IF AVAILABLE. REMOVE GROSSLY CONTAMINATED CLOTHING, INCLUDING SHOES, AND LAUNDER BEFORE REUSE.

INHALATION:
USING PROPER RESPIRATORY PROTECTION, IMMEDIATELY REMOVE THE AFFECTED VICTIM FROM EXPOSURE. ADMINISTER ARTIFICIAL RESPIRATION IF BREATHING IS STOPPED.
KEEP AT REST. CALL FOR PROMPT MEDICAL ATTENTION.

INGESTION:
IF SWALLOWED, DO NOT INDUCE VOMITING. KEEP AT REST.
GET PROMPT MEDICAL ATTENTION.

------SECTION 5 FIRE-FIGHTING MEASURES ------

FLASH POINT: 170 DEG F.
METHOD: PMCC ASTM D93
NOTE: MINIMUM

FLAMMABLE LIMITS:
LEL: 1.3
UEL: 8.1 @ 77 DEG F.

NOTE: APPROXIMATE

AUTOIGNITION TEMPERATURE: 421 DEG F.
NOTE: APPROXIMATE

GENERAL HAZARD:
COMBUSTIBLE LIQUID, CAN FORM COMBUSTIBLE MIXTURES AT TEMPERATURES AT OR ABOVE THE FLASHPOINT.

STATIC DISCHARGE, MATERIAL CAN ACCUMULATE STATIC CHARGES WHICH CAN CAUSE AN INCENDIARY ELECTRICAL DISCHARGE.
"EMPTY" CONTAINERS RETAIN PRODUCT RESIDUE (LIQUID AND/OR VAPOR) AND CAN BE DANGEROUS. DO NOT PRESSURIZE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND, OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION; THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. EMPTY DRUMS SHOULD BE COMPLETELY DRAINED, PROPERLY BUNGED AND PROMPTLY RETURNED TO A DRUM RECONDITIONER, OR PROPERLY DISPOSED OF.

FIRE FIGHTING:
USE WATER SPRAY TO COOL FIRE EXPOSED SURFACES AND TO PROTECT PERSONNEL
ISOLATE "FUEL" SUPPLY FROM FIRE.
USE FOAM, DRY CHEMICAL, OR WATER SPRAY TO EXTINGUISH FIRE.
AVOID SPRAYING WATER DIRECTLY INTO STORAGE CONTAINERS DUE TO DANGER OF BOILOVER.

THIS LIQUID IS VOLATILE AND GIVES OFF INVISIBLE VAPORS. EITHER THE LIQUID OR VAPOR MAY SETTLE IN LOW AREAS OR TRAVEL SOME DISTANCE ALONG THE GROUND OR SURFACE TO IGNITION SOURCES WHERE THEY MAY IGNITE OR EXPLODE.

DECOMPOSITION PRODUCTS UNDER FIRE CONDITIONS: NO UNUSUAL

------SECTION 6 ACCIDENTAL RELEASE MEASURES ------

LAND SPILL:
ELIMINATE SOURCES OF IGNITION. PREVENT ADDITIONAL DISCHARGE OF MATERIAL, IF POSSIBLE TO DO SO WITHOUT HAZARD. FOR SMALL SPILLS IMPLEMENT CLEANUP PROCEDURES; FOR LARGE SPILLS IMPLEMENT CLEANUP PROCEDURES AND, IF IN PUBLIC AREA, KEEP PUBLIC AWAY AND ADVISE AUTHORITIES. ALSO, IF THIS PRODUCT IS SUBJECT TO CERCLA REPORTING (SEE SECTION 15 REGULATORY INFORMATION) NOTIFY THE NATIONAL RESPONSE CENTER.
PREVENT LIQUID FROM ENTERING SEWERS, WATERCOURSES, OR LOW AREAS. CONTAIN SPILLED LIQUID WITH SAND OR EARTH. DO NOT USE COMBUSTIBLE MATERIALS SUCH AS SAWDUST.
RECOVER BY PUMPING (USE AN EXPLOSION PROOF OR HAND PUMP) OR WITH A SUITABLE ABSORBENT.
CONSULT AN EXPERT ON DISPOSAL OF RECOVERED MATERIAL AND ENSURE CONFORMITY TO LOCAL DISPOSAL REGULATIONS.

WATER SPILL:
ELIMINATE SOURCES OF IGNITION. WARN OCCUPANTS AND SHIPPING IN SURROUNDING AND DOWNWIND AREAS OF FIRE AND EXPLOSION HAZARD AND REQUEST ALL TO STAY CLEAR.

REMOVE FROM SURFACE BY SKIMMING OR WITH SUITABLE ADSORBENTS. IF ALLOWED BY LOCAL AUTHORITIES AND ENVIRONMENTAL AGENCIES, SINKING AND/OR SUITABLE DISPERSANTS MAY BE USED IN NON-CONFINED WATERS.
CONSULT AN EXPERT ON DISPOSAL OF RECOVERED MATERIAL AND ENSURE CONFORMITY TO LOCAL DISPOSAL REGULATIONS.

------SECTION 7 STORAGE AND HANDLING ------

ELECTROSTATIC ACCUMULATION HAZARD:
YES, USE PROPER BONDING AND/OR GROUNDING PROCEDURE.
ADDITIONAL INFORMATION REGARDING SAFE HANDLING OF PRODUCTS WITH STATIC ACCUMULATION POTENTIAL CAN BE ORDERED BY CONTACTING THE AMERICAN PETROLEUM INSTITUTE (API) FOR API RECOMMENDED PRACTICE 2003, ENTITLED "PROTECTION AGAINST IGNITIONS ARISING OUT OF STATIC, LIGHTNING, AND STRAY CURRENTS" (AMERICAN PETROLEUM INSTITUTE, 1220 L STREET NORTHWEST, WASHINGTON, DC 20005), OR THE NATIONAL FIRE PROTECTION ASSOCIATION, (NFPA) FOR NFPA 77 ENTITLED "STATIC ELECTRICITY" (NATIONAL FIRE PROTECTION ASSOCIATION, 1 BATTERYMARCH PARK, P.O. BOX 9101, QUINCY, MA 02269-9101).

STORAGE TEMPERATURE, DEG. F: AMBIENT

LOADING/UNLOADING TEMPERATURE, DEG. F: AMBIENT

STORAGE/TRANSPORT PRESSURE, MMHg: ATMOSPHERIC

LOADING/UNLOADING VISCOSITY, CST: 2.0 APPROXIMATE

STORAGE AND HANDLING:
KEEP CONTAINER CLOSED. HANDLE AND OPEN CONTAINERS WITH CARE. STORE IN A COOL, WELL VENTILATED PLACE AWAY FROM INCOMPATIBLE MATERIALS.
DO NOT HANDLE OR STORE NEAR AN OPEN FLAME, HEAT OR OTHER SOURCES OF IGNITION. PROTECT MATERIAL FROM DIRECT SUNLIGHT.
MATERIAL WILL ACCUMULATE STATIC CHARGES WHICH MAY CAUSE AN ELECTRICAL SPARK (IGNITION SOURCE). USE PROPER BONDING AND/OR GROUNDING PROCEDURES.
DO NOT PRESSURIZE, CUT, HEAT, OR WELD CONTAINERS. EMPTY PRODUCT CONTAINERS MAY CONTAIN PRODUCT RESIDUE. DO NOT REUSE EMPTY CONTAINERS WITHOUT COMMERCIAL CLEANING OR RECONDITIONING.

------SECTION 8 EXPOSURE CONTROLS/PERSONAL PROTECTION ------

EXPOSURE CONTROLS:
THE USE OF LOCAL EXHAUST VENTILATION IS RECOMMENDED TO CONTROL PROCESS EMISSIONS NEAR THE SOURCE. LABORATORY SAMPLES SHOULD BE HANDLED IN A LAB HOOD. PROVIDE MECHANICAL VENTILATION OF CONFINED SPACES.
SEE RESPIRATORY PROTECTION RECOMMENDATIONS.

PERSONAL PROTECTION:
FOR OPEN SYSTEMS WHERE CONTACT IS LIKELY, WEAR SAFETY GLASSES WITH SIDE SHIELDS, LONG SLEEVES, AND CHEMICAL RESISTANT GLOVES.
WHERE CONTACT MAY OCCUR, WEAR SAFETY GLASSES WITH SIDE SHIELDS.
WHERE CONCENTRATIONS IN AIR MAY EXCEED THE LIMITS GIVEN IN THIS SECTION AND ENGINEERING, WORK PRACTICE OR OTHER MEANS OF EXPOSURE REDUCTION ARE NOT

ADEQUATE, NIOSH APPROVED RESPIRATORS MAY BE NECESSARY TO PREVENT OVEREXPOSURE BY INHALATION.

WORKPLACE EXPOSURE GUIDELINES:

EXXONMOBIL RECOMMENDS THE FOLLOWING OCCUPATIONAL EXPOSURE LIMITS:
A TWA OF 1200 MG/M3 (165 PPM) BASED ON TOTAL HYDROCARBON.

------SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES ------

SPECIFIC GRAVITY, AT DEG. F: 0.80 AT 60

VAPOR PRESSURE, MMHg AT DEG. F: <1 AT 68

DENSITY AT DEG. F: 67 LBS/GAL AT 59

SOLUBILITY IN WATER, WT. % AT DEG. F: LESS THAN 0.01 AT 77

VISCOSITY OF LIQUID, CST AT DEG. F: 1.3-1.9 AT 100

SP. GRAV. OF VAPOR, AT 1 ATM (AIR = 1): 5.30

FREEZING/MELTING POINT, DEG. F: -22

EVAPORATION RATE, n-Bu ACETATE = 1: LESS THAN 0.1

BOILING POINT, DEG. F: 408 TO 442

------SECTION 10 STABILITY AND REACTIVITY ------

STABILITY: STABLE

CONDITIONS TO AVOID INSTABILITY: NOT APPLICABLE

HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

CONDITIONS TO AVOID HAZARDOUS POLYMERIZATION: NOT APPLICABLE

MATERIALS AND CONDITIONS TO AVOID INCOMPATIBILITY: STRONG OXIDIZING AGENTS

HAZARDOUS DECOMPOSITION PRODUCTS: NONE

------SECTION 11 TOXICOLOGICAL INFORMATION ------

PLEASE REFER TO SECTION 3 FOR AVAILABLE INFORMATION ON POTENTIAL HEALTH EFFECTS.

------SECTION 12 ECOLOGICAL INFORMATION ------

NO SPECIFIC ECOLOGICAL DATA ARE AVAILABLE FOR THIS PRODUCT. PLEASE REFER

TO SECTION 6 FOR INFORMATION REGARDING ACCIDENTAL RELEASES AND SECTION 15 FOR REGULATORY REPORTING INFORMATION.

------SECTION 13 DISPOSAL CONSIDERATIONS ------

PLEASE REFER TO SECTIONS 5,6 AND 15 FOR DISPOSAL AND REGULATORY INFORMATION.

------SECTION 14 TRANSPORT INFORMATION ------

DEPARTMENT OF TRANSPORTATION (DOT):
DOT SHIPPING DESCRIPTION:
PETROLEUM DISTILLATE, N.O.S., COMBUSTIBLE LIQUID.
UN 1268, III

NOTE:
IN CONTAINERS OF 119 GALLONS CAPACITY OR LESS THIS PRODUCT IS NOT REGULATED BY DOT.

------SECTION 15 REGULATORY INFORMATION ------

TSCA:
THIS PRODUCT IS LISTED ON THE TSCA INVENTORY AT CAS REGISTRY NUMBER 64742-47-8

CLEAN WATER ACT/OIL POLLUTION ACT:
THIS PRODUCT IS CLASSIFIED AS AN OIL UNDER SECTION 311 OF THE CLEAN WATER ACT (40 CFR 110) AND THE OIL POLLUTION ACT OF 1990. DISCHARGE OR SPILLS WHICH PRODUCE A VISIBLE SHEEN ON EITHER SURFACE WATER, OR IN WATERWAYS/SEWERS WHICH LEAD TO SURFACE WATER, MUST BE REPORTED TO THE NATIONAL RESPONSE CENTER AT 800-424-8802.

CERCLA:
IF THIS PRODUCT IS ACCIDENTALLY SPILLED, IT IS NOT SUBJECT TO ANY SPECIAL REPORTING UNDER THE REQUIREMENTS OF THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT (CERCLA). WE RECOMMEND YOU CONTACT LOCAL AUTHORITIES TO DETERMINE IF THERE MAY BE OTHER LOCAL REPORTING REQUIREMENTS.

SARA TITLE III:
UNDER THE PROVISIONS OF TITLE III, SECTIONS 311/312 OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT, THIS PRODUCT IS CLASSIFIED INTO THE FOLLOWING HAZARD CATEGORIES: FIRE.
THIS INFORMATION MAY BE SUBJECT TO THE PROVISIONS OF THE COMMUNITY RIGHT-TO-KNOW REPORTING REQUIREMENTS (40 CFR 370) IF THRESHOLD QUANTITY CRITERIA ARE MET. THIS PRODUCT DOES NOT CONTAIN SECTION 313 REPORTABLE INGREDIENTS.

------SECTION 16 OTHER INFORMATION ------

HAZARD RATING SYSTEMS:
THIS INFORMATION IS FOR PEOPLE TRAINED IN:

NATIONAL PAINT & COATINGS ASSOCIATION'S (NPCA)
HAZARDOUS MATERIALS IDENTIFICATION SYSTEM (HMIS)
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA 704)

IDENTIFICATION OF THE FIRE HAZARDS OF MATERIALS:

	NPCA-HMIS	NFPA 704
HEALTH	1	1
FLAMMABILITY	2	2
REACTIVITY	0	0

KEY:
4 = SEVERE
3 = SERIOUS
2 = MODERATE
1 = SLIGHT
0 = MINIMAL

CAUTION:
HMIS RATINGS ARE BASED ON A 0-4 RATING SCALE WITH 1 REPRESENTING MINIMAL HAZARD OR RISKS, AND 4 REPRESENTING SIGNIFICANT HAZARDS OR RISKS. RECOMMENDED HMIS RATINGS SHOULD NOT BE USED IN THE ABSENCE OF A FULLY IMPLEMENTED HMIS HAZARD COMMUNICATION PROGRAM.

REVISION SUMMARY:
SINCE JUNE 16, 2000 THIS MSDS HAS BEEN REVISED IN SECTION(S): 3

REFERENCE NUMBER: HDHA-C-25168

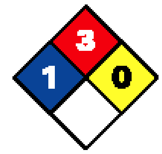
SUPERSEDES ISSUES DATE: JUNE 16, 2000

THIS INFORMATION RELATES TO THE SPECIFIC MATERIAL DESIGNATED AND MAY NOT BE VALID FOR SUCH MATERIAL USED IN COMBINATION WITH ANY OTHER MATERIALS OR IN ANY PROCESS. SUCH INFORMATION IS TO THE BEST OF OUR KNOWLEDGE AND BELIEF, ACCURATE AND RELIABLE AS OF THE DATE COMPILED. HOWEVER, NO REPRESENTATION, WARRANTY OR GUARANTEE IS MADE AS TO ITS ACCURACY, RELIABILITY OR COMPLETENESS. IT IS THE USER'S RESPONSIBILITY TO SATISFY HIMSELF AS TO THE SUITABILITY AND COMPLETENESS OF SUCH INFORMATION FOR HIS OWN PARTICULAR USE. WE DO NOT ACCEPT LIABILITY FOR ANY LOSS OR DAMAGE THAT MAY OCCUR FROM THE USE OF THIS INFORMATION NOR DO WE OFFER WARRANTY AGAINST PATENT INFRINGEMENT.

MATERIAL SAFETY DATA SHEET

Gasoline, All Grades **MSDS No. 9950**

EMERGENCY OVERVIEW
DANGER!
EXTREMELY FLAMMABLE - EYE AND MUCOUS MEMBRANE IRRITANT - EFFECTS CENTRAL NERVOUS SYSTEM - HARMFUL OR FATAL IF SWALLOWED - ASPIRATION HAZARD



NFPA 704 (Section 16)

High fire hazard. Keep away from heat, spark, open flame, and other ignition sources.

If ingested, do NOT induce vomiting, as this may cause chemical pneumonia (fluid in the lungs). Contact may cause eye, skin and mucous membrane irritation. Harmful if absorbed through the skin. Avoid prolonged breathing of vapors or mists. Inhalation may cause irritation, anesthetic effects (dizziness, nausea, headache, intoxication), and respiratory system effects.

Long-term exposure may cause effects to specific organs, such as to the liver, kidneys, blood, nervous system, and skin. Contains benzene, which can cause blood disease, including anemia and leukemia.

1. CHEMICAL PRODUCT and COMPANY INFORMATION

Hess Corporation
1 Hess Plaza
Woodbridge, NJ 07095-0961

EMERGENCY TELEPHONE NUMBER (24 hrs):	**CHEMTREC (800)424-9300**
COMPANY CONTACT (business hours):	Corporate Safety (732)750-6000
MSDS (Environment, Health, Safety) Internet Website	www.hess.com

SYNONYMS: Hess Conventional (Oxygenated and Non-oxygenated) Gasoline; Reformulated Gasoline (RFG); Reformulated Gasoline Blendstock for Oxygenate Blending (RBOB); Unleaded Motor or Automotive Gasoline

See Section 16 for abbreviations and acronyms.

2. COMPOSITION and INFORMATION ON INGREDIENTS *

INGREDIENT NAME (CAS No.)	CONCENTRATION PERCENT BY WEIGHT
Gasoline (86290-81-5)	100
Benzene (71-43-2)	0.1 - 4.9 (0.1 - 1.3 reformulated gasoline)
n-Butane (106-97-8)	< 10
Ethyl Alcohol (Ethanol) (64-17-5)	0 - 10
Ethyl benzene (100-41-4)	< 3
n-Hexane (110-54-3)	0.5 to 4
Methyl-tertiary butyl ether (MTBE) (1634-04-4)	0 to 15.0
Tertiary-amyl methyl ether (TAME) (994-05-8)	0 to 17.2
Toluene (108-88-3)	1 - 25
1,2,4- Trimethylbenzene (95-63-6)	< 6
Xylene, mixed isomers (1330-20-7)	1 - 15

A complex blend of petroleum-derived normal and branched-chain alkane, cycloalkane, alkene, and aromatic hydrocarbons. May contain antioxidant and multifunctional additives. Non-oxygenated Conventional Gasoline and RBOB do not have oxygenates (Ethanol or MTBE and/or TAME).

Oxygenated Conventional and Reformulated Gasoline will have oxygenates for octane enhancement or as legally required.

3. HAZARDS IDENTIFICATION

EYES
Moderate irritant. Contact with liquid or vapor may cause irritation.

SKIN
Practically non-toxic if absorbed following acute (single) exposure. May cause skin irritation with prolonged or repeated contact. Liquid may be absorbed through the skin in toxic amounts if large areas of skin are exposed repeatedly.

INGESTION
The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonia (fluid in the lungs), severe lung damage, respiratory failure and even death.

Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest, and death may occur.

INHALATION
Excessive exposure may cause irritations to the nose, throat, lungs and respiratory tract. Central nervous system (brain) effects may include headache, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death.

WARNING: the burning of any hydrocarbon as a fuel in an area without adequate ventilation may result in hazardous levels of combustion products, including carbon monoxide, and inadequate oxygen levels, which may cause unconsciousness, suffocation, and death.

CHRONIC EFFECTS and CARCINOGENICITY
Contains benzene, a regulated human carcinogen. Benzene has the potential to cause anemia and other blood diseases, including leukemia, after repeated and prolonged exposure. Exposure to light hydrocarbons in the same boiling range as this product has been associated in animal studies with systemic toxicity. See also Section 11 - Toxicological Information.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE
Irritation from skin exposure may aggravate existing open wounds, skin disorders, and dermatitis (rash). Chronic respiratory disease, liver or kidney dysfunction, or pre-existing central nervous system disorders may be aggravated by exposure.

4. FIRST AID MEASURES

EYES
In case of contact with eyes, immediately flush with clean, low-pressure water for at least 15 min. Hold eyelids open to ensure adequate flushing. Seek medical attention.

SKIN
Remove contaminated clothing. Wash contaminated areas thoroughly with soap and water or waterless hand cleanser. Obtain medical attention if irritation or redness develops.

INGESTION

DO NOT INDUCE VOMITING. Do not give liquids. Obtain immediate medical attention. If spontaneous vomiting occurs, lean victim forward to reduce the risk of aspiration. Small amounts of material which enter the mouth should be rinsed out until the taste is dissipated.

INHALATION

Remove person to fresh air. If person is not breathing, ensure an open airway and provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.

5. FIRE FIGHTING MEASURES

FLAMMABLE PROPERTIES:

FLASH POINT:	-45 °F (-43°C)
AUTOIGNITION TEMPERATURE:	highly variable; > 530 °F (>280 °C)
OSHA/NFPA FLAMMABILITY CLASS:	1A (flammable liquid)
LOWER EXPLOSIVE LIMIT (%):	1.4%
UPPER EXPLOSIVE LIMIT (%):	7.6%

FIRE AND EXPLOSION HAZARDS

Vapors may be ignited rapidly when exposed to heat, spark, open flame or other source of ignition. Flowing product may be ignited by self-generated static electricity. When mixed with air and exposed to an ignition source, flammable vapors can burn in the open or explode in confined spaces. Being heavier than air, vapors may travel long distances to an ignition source and flash back. Runoff to sewer may cause fire or explosion hazard.

EXTINGUISHING MEDIA

SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, CO2, water spray, fire fighting foam, or Halon.

LARGE FIRES: Water spray, fog or fire fighting foam. Water may be ineffective for fighting the fire, but may be used to cool fire-exposed containers.

During certain times of the year and/or in certain geographical locations, gasoline may contain MTBE and/or TAME. Firefighting foam suitable for polar solvents is recommended for fuel with greater than 10% oxygenate concentration - refer to NFPA 11 “Low Expansion Foam - 1994 Edition.”

FIRE FIGHTING INSTRUCTIONS

Small fires in the incipient (beginning) stage may typically be extinguished using handheld portable fire extinguishers and other fire fighting equipment.

Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH/MSHA- approved pressure-demand self-contained breathing apparatus with full facepiece and full protective clothing.

Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied fire fighting foam.

See Section 16 for the NFPA 704 Hazard Rating.

6. ACCIDENTAL RELEASE MEASURES

ACTIVATE FACILITY SPILL CONTINGENCY or EMERGENCY PLAN.

Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel, diking, sewers, etc. to confirm spill areas. Spills may infiltrate subsurface soil and groundwater; professional assistance may be necessary to determine the extent of subsurface impact.

Carefully contain and stop the source of the spill, if safe to do so. Protect bodies of water by diking, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of fire fighting foam may be useful in certain situations to reduce vapors. The proper use of water spray may effectively disperse product vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection.

Take up with sand or other oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container for reclamation or disposal - caution, flammable vapors may accumulate in closed containers. Response and clean-up crews must be properly trained and must utilize proper protective equipment (see Section 8).

7. HANDLING and STORAGE

HANDLING PRECAUTIONS

******USE ONLY AS A MOTOR FUEL******
******DO NOT SIPHON BY MOUTH******

Handle as a flammable liquid. Keep away from heat, sparks, and open flame! Electrical equipment should be approved for classified area. Bond and ground containers during product transfer to reduce the possibility of static-initiated fire or explosion.

Special slow load procedures for "switch loading" must be followed to avoid the static ignition hazard that can exist when higher flash point material (such as fuel oil) is loaded into tanks previously containing low flash point products (such as this product) - see API Publication 2003, "Protection Against Ignitions Arising Out Of Static, Lightning and Stray Currents.

STORAGE PRECAUTIONS

Keep away from flame, sparks, excessive temperatures and open flame. Use approved vented containers. Keep containers closed and clearly labeled. Empty product containers or vessels may contain explosive vapors. Do not pressurize, cut, heat, weld or expose such containers to sources of ignition.

Store in a well-ventilated area. This storage area should comply with NFPA 30 "Flammable and Combustible Liquid Code". Avoid storage near incompatible materials. The cleaning of tanks previously containing this product should follow API Recommended Practice (RP) 2013 "Cleaning Mobile Tanks In Flammable and Combustible Liquid Service" and API RP 2015 "Cleaning Petroleum Storage Tanks".

WORK/HYGIENIC PRACTICES

Emergency eye wash capability should be available in the near proximity to operations presenting a potential splash exposure. Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Do not use as a cleaning solvent on the skin. Do not use solvents or harsh abrasive skin cleaners for washing this product from exposed skin areas. Waterless hand cleaners are effective. Promptly remove contaminated clothing and launder before reuse. Use care when laundering to prevent the formation of flammable vapors which could ignite via washer or dryer. Consider the need to discard contaminated leather shoes and gloves.

8. EXPOSURE CONTROLS and PERSONAL PROTECTION

EXPOSURE LIMITS

Component (CAS No.)	Source	TWA (ppm)	STEL (ppm)	Exposure Limits Note
Gasoline (86290-81-5)	ACGIH	300	500	A3
Benzene (71-43-2)	OSHA	1	5	Carcinogen
	ACGIH	0.5	2.5	A1, skin
	USCG	1	5	
n-Butane (106-97-8)	ACGIH	1000	--	Aliphatic Hydrocarbon Gases Alkane (C1-C4)
Ethyl Alcohol (ethanol) (64-17-5)	OSHA	1000	--	
	ACGIH	1000	--	A4
Ethyl benzene (100-41-4)	OSHA	100	--	
	ACGIH	100	125	A3
n-Hexane (110-54-3)	OSHA	500	--	
	ACGIH	50	--	Skin
Methyl-tertiary butyl ether [MTBE] (1634-04-4)	ACGIH	50		A3
Tertiary-amyl methyl ether [TAME] (994-05-8)				None established
Toluene (108-88-3)	OSHA	200		Ceiling: 300 ppm; Peak: 500 ppm (10 min.)
	ACGIH	20	--	A4
1,2,4- Trimethylbenzene (95-63-6)	ACGIH	25	--	
Xylene, mixed isomers (1330-20-7)	OSHA	100	--	
	ACGIH	100	150	A4

ENGINEERING CONTROLS

Use adequate ventilation to keep vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces.

EYE/FACE PROTECTION

Safety glasses or goggles are recommended where there is a possibility of splashing or spraying.

SKIN PROTECTION

Gloves constructed of nitrile or neoprene are recommended. Chemical protective clothing such as that made of of E.I. DuPont Tychem ®, products or equivalent is recommended based on degree of exposure.

Note: The resistance of specific material may vary from product to product as well as with degree of exposure. Consult manufacturer specifications for further information.

RESPIRATORY PROTECTION

A NIOSH-approved air-purifying respirator with organic vapor cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited. Refer to OSHA 29 CFR 1910.134, NIOSH Respirator Decision Logic, and the manufacturer for additional guidance on respiratory protection selection and limitations.

Use a positive pressure, air-supplied respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.

9. PHYSICAL and CHEMICAL PROPERTIES

APPEARANCE

A translucent, straw-colored or light yellow liquid

ODOR
A strong, characteristic aromatic hydrocarbon odor. Oxygenated gasoline with MTBE and/or TAME may have a sweet, ether-like odor and is detectable at a lower concentration than non-oxygenated gasoline.

ODOR THRESHOLD

	Odor Detection	Odor Recognition
Non-oxygenated gasoline:	0.5 - 0.6 ppm	0.8 - 1.1 ppm
Gasoline with 15% MTBE:	0.2 - 0.3 ppm	0.4 - 0.7 ppm
Gasoline with 15% TAME:	0.1 ppm	0.2 ppm

BASIC PHYSICAL PROPERTIES

BOILING RANGE:	85 to 437 ^oF (39 to 200 ^oC)
VAPOR PRESSURE:	6.4 - 15 RVP @ 100 ^oF (38 ^oC) (275-475 mm Hg @ 68 ^oF (20 ^oC)
VAPOR DENSITY (air = 1):	AP 3 to 4
SPECIFIC GRAVITY (H_2O = 1):	0.70 – 0.78
EVAPORATION RATE:	10-11 (n-butyl acetate = 1)
PERCENT VOLATILES:	100 %
SOLUBILITY (H_2O):	Non-oxygenated gasoline - negligible (< 0.1% @ 77 ^oF). Gasoline with 15% MTBE - slight (0.1 - 3% @ 77 ^oF); ethanol is readily soluble in water

10. STABILITY and REACTIVITY)

STABILITY: Stable. Hazardous polymerization will not occur.

CONDITIONS TO AVOID
Avoid high temperatures, open flames, sparks, welding, smoking and other ignition sources

INCOMPATIBLE MATERIALS
Keep away from strong oxidizers.

HAZARDOUS DECOMPOSITION PRODUCTS
Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke). Contact with nitric and sulfuric acids will form nitrocresols that can decompose violently.

11. TOXICOLOGICAL PROPERTIES

ACUTE TOXICITY
Acute Dermal LD50 (rabbits): > 5 ml/kg
Primary dermal irritation (rabbits): slightly irritating
Guinea pig sensitization: negative
Acute Oral LD50 (rat): 18.75 ml/kg
Draize eye irritation (rabbits): non-irritating

CHRONIC EFFECTS AND CARCINOGENICITY
Carcinogenicity: OSHA: NO IARC: YES - 2B NTP: NO ACGIH: YES (A3)

IARC has determined that gasoline and gasoline exhaust are possibly carcinogenic in humans. Inhalation exposure to completely vaporized unleaded gasoline caused kidney cancers in male rats and liver tumors in female mice. The U.S. EPA has determined that the male kidney tumors are species-specific and are irrelevant for human health risk assessment. The significance of the tumors seen in female mice is not known. Exposure to light hydrocarbons in the same boiling range as this product has been associated in animal studies with effects to the central and peripheral nervous systems, liver, and kidneys. The significance of these animal models to predict similar human response to gasoline is uncertain.

This product contains benzene. Human health studies indicate that prolonged and/or repeated overexposure to benzene may cause damage to the blood-forming system (particularly bone marrow), and serious blood disorders such as aplastic anemia and leukemia. Benzene is listed as a human carcinogen by the NTP, IARC, OSHA and ACGIH.

This product may contain methyl tertiary butyl ether (MTBE): animal and human health effects studies indicate that MTBE may cause eye, skin, and respiratory tract irritation, central nervous system depression and neurotoxicity. MTBE is classified as an animal carcinogen (A3) by the ACGIH.

12. ECOLOGICAL INFORMATION

Keep out of sewers, drainage areas and waterways. Report spills and releases, as applicable, under Federal and State regulations. If released, oxygenates such as ethers and alcohols will be expected to exhibit fairly high mobility in soil, and therefore may leach into groundwater. The API (www.api.org) provides a number of useful references addressing petroleum and oxygenate contamination of groundwater.

13. DISPOSAL CONSIDERATIONS

Consult federal, state and local waste regulations to determine appropriate disposal options.

14. TRANSPORTATION INFORMATION

PLACARD:

DOT PROPER SHIPPING NAME:	Gasoline
DOT HAZARD CLASS and PACKING GROUP:	3, PG II
DOT IDENTIFICATION NUMBER:	UN 1203
DOT SHIPPING LABEL:	FLAMMABLE LIQUID

15. REGULATORY INFORMATION

U.S. FEDERAL, STATE, and LOCAL REGULATORY INFORMATION

This product and its constituents listed herein are on the EPA TSCA Inventory. Any spill or uncontrolled release of this product, including any substantial threat of release, may be subject to federal, state and/or local reporting requirements. This product and/or its constituents may also be subject to other federal, state, or local regulations; consult those regulations applicable to your facility/operation.

CLEAN WATER ACT (OIL SPILLS)

Any spill or release of this product to "navigable waters" (essentially any surface water, including certain wetlands) or adjoining shorelines sufficient to cause a visible sheen or deposit of a sludge or emulsion must be reported immediately to the National Response Center (1-800-424-8802) as required by U.S. Federal Law. Also contact appropriate state and local regulatory agencies as required.

CERCLA SECTION 103 and SARA SECTION 304 (RELEASE TO THE ENVIRONMENT)

The CERCLA definition of hazardous substances contains a “petroleum exclusion” clause which exempts crude oil, refined, and unrefined petroleum products and any indigenous components of such. However, other federal reporting requirements (e.g., SARA Section 304 as well as the Clean Water Act if the spill occurs on navigable waters) may still apply.

SARA SECTION 311/312 - HAZARD CLASSES

ACUTE HEALTH	CHRONIC HEALTH	FIRE	SUDDEN RELEASE OF PRESSURE	REACTIVE
X	X	X	--	--

SARA SECTION 313 - SUPPLIER NOTIFICATION

This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-To-Know Act (EPCRA) of 1986 and of 40 CFR 372:

INGREDIENT NAME (CAS NUMBER)	CONCENTRATION WT. PERCENT
Benzene (71-43-2)	0.1 to 4.9 (0.1 to 1.3 for reformulated gasoline)
Ethyl benzene (100-41-4)	< 3

n-Hexane (110-54-3)	0.5 to 4
Methyl-tertiary butyl ether (MTBE) (1634-04-4)	0 to 15.0
Toluene (108-88-3)	1 to 15
1,2,4- Trimethylbenzene (95-63-6)	< 6
Xylene, mixed isomers (1330-20-7)	1 to 15

US EPA guidance documents (www.epa.gov/tri) for reporting Persistent Bioaccumulating Toxics (PBTs) indicate this product may contain the following deminimis levels of toxic chemicals subject to Section 313 reporting:

INGREDIENT NAME (CAS NUMBER)	CONCENTRATION - Parts per million (ppm) by weight
Polycyclic aromatic compounds (PACs)	17
Benzo (g,h,i) perylene (191-24-2)	2.55
Lead (7439-92-1)	0.079

CALIFORNIA PROPOSITION 65 LIST OF CHEMICALS
This product contains the following chemicals that are included on the Proposition 65 "List of Chemicals" required by the California Safe Drinking Water and Toxic Enforcement Act of 1986:

INGREDIENT NAME (CAS NUMBER)	Date Listed
Benzene	2/27/1987
Ethyl benzene	6/11/2004
Toluene	1/1/1991

CANADIAN REGULATORY INFORMATION (WHMIS)
Class B, Division 2 (Flammable Liquid)
Class D, Division 2A (Very toxic by other means) and Class D, Division 2B (Toxic by other means)

16. OTHER INFORMATION

NFPA® HAZARD RATING	HEALTH:	1	Slight
	FIRE:	3	Serious
	REACTIVITY:	0	Minimal
HMIS® HAZARD RATING	HEALTH:	1 *	Slight
	FIRE:	3	Serious
	PHYSICAL:	0	Minimal
			* CHRONIC

SUPERSEDES MSDS DATED: 07/01/06

ABBREVIATIONS:

AP = Approximately	< = Less than	> = Greater than
N/A = Not Applicable	N/D = Not Determined	ppm = parts per million

ACRONYMS:

ACGIH	American Conference of Governmental Industrial Hygienists
AIHA	American Industrial Hygiene Association
ANSI	American National Standards Institute (212)642-4900
API	American Petroleum Institute (202)682-8000
CERCLA	Comprehensive Emergency Response, Compensation, and Liability Act
DOT	U.S. Department of Transportation [General Info: (800)467-4922]
EPA	U.S. Environmental Protection Agency
HMIS	Hazardous Materials Information System

IARC	International Agency For Research On Cancer
MSHA	Mine Safety and Health Administration
NFPA	National Fire Protection Association (617)770-3000
NIOSH	National Institute of Occupational Safety and Health
NOIC	Notice of Intended Change (proposed change to ACGIH TLV)
NTP	National Toxicology Program
OPA	Oil Pollution Act of 1990
OSHA	U.S. Occupational Safety & Health Administration
PEL	Permissible Exposure Limit (OSHA)
RCRA	Resource Conservation and Recovery Act
REL	Recommended Exposure Limit (NIOSH)
SARA	Superfund Amendments and Reauthorization Act of 1986 Title III
SCBA	Self-Contained Breathing Apparatus
SPCC	Spill Prevention, Control, and Countermeasures
STEL	Short-Term Exposure Limit (generally 15 minutes)
TLV	Threshold Limit Value (ACGIH)
TSCA	Toxic Substances Control Act
TWA	Time Weighted Average (8 hr.)
WEEL	Workplace Environmental Exposure Level (AIHA)
WHMIS	Workplace Hazardous Materials Information System (Canada)

DISCLAIMER OF EXPRESSED AND IMPLIED WARRANTIES

Information presented herein has been compiled from sources considered to be dependable, and is accurate and reliable to the best of our knowledge and belief, but is not guaranteed to be so. Since conditions of use are beyond our control, we make no warranties, expressed or implied, except those that may be contained in our written contract of sale or acknowledgment.

Vendor assumes no responsibility for injury to vendee or third persons proximately caused by the material if reasonable safety procedures are not adhered to as stipulated in the data sheet. Additionally, vendor assumes no responsibility for injury to vendee or third persons proximately caused by abnormal use of the material, even if reasonable safety procedures are followed. Furthermore, vendee assumes the risk in their use of the material.

Shell Chemicals

Data Sheet

Issued:

23-Jul-2009

Product Name	**ShellSol D70**
Product Code	**Q7712** **Africa**
Product Category	**Aliphatics**
CAS Registry Number	64742-47-8
EINECS Number	265-149-8
Description	ShellSol D70 is a very low aromatic, inert hydrocarbon solvent.

Typical Properties

Property	**Unit**	**Method**	**Value**
Density @15°C	kg/l	ASTM D4052	0.793
Density @20°C	kg/l	ASTM D4052	0.790
Cubic Expansion Coefficient @20°C	(10^-4)/°C	-	9
Refractive Index @20°C	-	ASTM D1218	1.436
Color	Saybolt	ASTM D156	+30
Distillation, IBP	°C	ASTM D1078	200
Distillation, DP	°C	ASTM D1078	240
Relative Evaporation Rate (nBuAc=1)	-	ASTM D3539	0.01
Vapor Pressure @20°C	kPa	Calculated	0.05
Saturated Vapor Concentration @20°C	g/m^3	Calculated	4
Paraffins	% m/m	GC	60
Naphthenes	% m/m	GC	40
Aromatics	% m/m	SMS 2728	< 0.5
Benzene	mg/kg	GC	< 3
Sulfur	mg/kg	ASTM D5453	< 10
Flash Point	°C	ASTM D93	77
Explosion Limit: Lower	%v/v	-	0.6
Explosion Limit: Upper	%v/v	-	5.5
Electrical Conductivity @20°C	pS/m	-	< 1
Aniline Point	°C	ASTM D611	77
Pour Point	°C	ASTM D97	< -50
Surface Tension @20°C	mN/m	Du Nouy ring	26
Viscosity @25°C	mm^2/s	ASTM D445	2.0
Hildebrand Solubility Parameter	(cal/cm^3)^½	-	7.6
Hydrogen Bonding Index	-	-	0

	Fractional Polarity	-	-	0
	Molecular Weight	g/mol	Calculated	174

Test Methods	Copies of copyrighted test methods can be obtained from the issuing organisations: American Society for Testing and Materials (ASTM) : www.astm.org Shell Method Series (SMS) methods are issued by Shell Golabl Solutions International B.V., Shell Research and Technology Centre, Amsterdam, The Netherlands. Copies of SMS can be obtained through your local Shell Chemicals company. For routine quality control analyses, local test methods may be applied that are different from those mentioned in this datasheet. Such methods have been validated and can be obtained through your local Shell Chemicals company.
Quality	ShellSol D70 does not contain detectable quantities of polycyclic aromatics, heavy metals or chlorinated compounds.
Storage and Handling	Provided proper storage and handling precautions are taken we would expect ShellSol D70 to be technically stable for at least 12 months. For detailed advice on Storage and Handling please refer to the Material Safety Data Sheet on www.shell.com/chemicals
Hazard Information	For detailed Hazard Information please refer to the Material Safety Data Sheet on www.shell.com/chemicals.
Warranty	All products purchased or supplied by Shell Chemicals are subject to terms and conditions set out in the contract, order acknowledgment and/or bill of lading. Shell Chemicals warrant that their product will meet those specifications designated as such herein or in other publications. All other information including that herein, supplied by Shell Chemicals is considered accurate but is furnished upon the express condition that the customer shall make its own assessment to determine the products' suitability for a particular purpose. Shell Chemicals make no other warranty either expressed or implied, regarding such other information, the data upon which the same is based, or the results to be obtained from use thereof; that any products shall be merchantable or fit for any purpose; or that the use of such other information or product will not infringe any patent. The expression 'Shell Chemicals' refers to the companies of the Shell Group that are engaged in chemical businesses. Each of the companies that make up the Shell Group of companies is an independent entity and has its own separate identity.
Trademark	ShellSol is a Shell Trademark.

PENRECO(R*)

MATERIAL SAFETY DATA SHEET

PENRECO(R*) 170ES

MSDS CODE: 776576

STATUS: FINAL

DATE OF ISSUE: 02-AUG-2006

------1. PRODUCT AND COMPANY IDENTIFICATION ------

PRODUCT NAME: PENRECO(R*) 170ES

INTENDED USE: HIGH-PURITY HYDROCARBON SOLVENT

RESPONSIBLE PARTY:
PENRECO
8701 NEW TRAILS DR. SUITE 175
THE WOODLANDS, TX 77381

CUSTOMER SERVICE:
800-245-3952
WWW.PENRECO.COM

TECHNICAL INFORMATION: 800-245-3952

EMERGENCY OVERVIEW:

24 HOUR EMERGENCY TELEPHONE NUMBERS:
SPILL, LEAK, FIRE OR ACCIDENT CALL CHEMTREC:
NORTH AMERICA: (800) 424-9300
OTHERS: (703) 527-3887 (COLLECT)
CALIFORNIA POISON CONTROL SYSTEM: (800) 356-3129

HEALTH HAZARDS/PRECAUTIONARY MEASURES:
ASPIRATION HAZARD IF SWALLOWED. CAN ENTER LUNGS AND CAUSE DAMAGE. USE WITH VENTILATION ADEQUATE TO KEEP EXPOSURE BELOW RECOMMENDED LIMITS, IF ANY. AVOID CONTACT WITH EYES, SKIN AND CLOTHING. WASH THOROUGHLY AFTER HANDLING. DO NOT TASTE OR SWALLOW.

PHYSICAL HAZARDS/PRECAUTIONARY MEASURES:
COMBUSTIBLE LIQUID AND VAPOR. KEEP AWAY FROM HEAT, SPARKS, FLAMES, STATIC ELECTRICITY OR OTHER SOURCES OF IGNITION.

APPEARANCE: CLEAR, COLORLESS

PHYSICAL FORM: LIQUID

ODOR: NEGLIGIBLE

NFPA 704 HAZARD CLASS:
HEALTH 1
FLAMMABILITY 2
INSTABILITY 0

LEGEND:
0 (LEAST)
1 (SLIGHT)
2 (MODERATE)
3 (HIGH)
4 (EXTREME)

------2. COMPOSITION / INFORMATION ON INGREDIENTS ------

NON-HAZARDOUS COMPONENTS:

COMPONENT	CONCENTRATION (WT%)	ACGIH	OSHA	NIOSH	OTHER
HYDROTREATED DISTILLATE, LIGHT..C9-16 64742-47-8	100	NE	NE	NE	NE

NOTE:
STATE, LOCAL OR OTHER AGENCIES OR ADVISORY GROUPS MAY HAVE ESTABLISHED MORE STRINGENT LIMITS. CONSULT AN INDUSTRIAL HYGIENIST OR SIMILAR PROFESSIONAL, OR YOUR LOCAL AGENCIES, FOR FURTHER INFORMATION.

1% = 10,000 PPM.

NE = NOT ESTABLISHED

------3. HAZARDS IDENTIFICATION ------

POTENTIAL HEALTH EFFECTS:

EYE:
CONTACT MAY CAUSE MILD EYE IRRITATION INCLUDING STINGING, WATERING, AND REDNESS.

SKIN:
CONTACT MAY CAUSE MILD SKIN IRRITATION INCLUDING REDNESS, AND A BURNING SENSATION. PROLONGED OR REPEATED CONTACT CAN WORSEN IRRITATION BY CAUSING DRYING AND CRACKING OF THE SKIN LEADING TO DERMATITIS (INFLAMMATION). NO HARMFUL EFFECTS FROM SKIN ABSORPTION ARE EXPECTED.

INHALATION (BREATHING):
EXPECTED TO HAVE A LOW DEGREE OF TOXICITY BY INHALATION.

INGESTION (SWALLOWING): LOW DEGREE OF TOXICITY BY INGESTION.

ASPIRATION HAZARD:
THIS MATERIAL CAN ENTER LUNGS DURING SWALLOWING OR VOMITING AND CAUSE LUNG INFLAMMATION AND DAMAGE.

SIGNS AND SYMPTOMS:
EFFECTS OF OVEREXPOSURE MAY INCLUDE IRRITATION OF THE RESPIRATORY TRACT, IRRITATION OF THE DIGESTIVE TRACT, NAUSEA, VOMITING, TRANSIENT EXCITATION FOLLOWED BY SIGNS OF NERVOUS SYSTEM DEPRESSION (E.G., HEADACHE, DROWSINESS, DIZZINESS, LOSS OF COORDINATION, DISORIENTATION AND FATIGUE).

CANCER:
THERE IS INADEQUATE INFORMATION TO EVALUATE THE CANCER HAZARD OF THIS MATERIAL. SEE SECTION 11 FOR INFORMATION ON THE INDIVIDUAL COMPONENTS, IF ANY.

TARGET ORGANS: INADEQUATE DATA AVAILABLE FOR THIS MATERIAL.

DEVELOPMENTAL: INADEQUATE DATA AVAILABLE FOR THIS MATERIAL.

PRE-EXISTING MEDICAL CONDITIONS:
CONDITIONS AGGRAVATED BY EXPOSURE MAY INCLUDE SKIN DISORDERS.

------4. FIRST AID MEASURES ------

EYE:
IF IRRITATION OR REDNESS DEVELOPS, MOVE VICTIM AWAY FROM EXPOSURE AND INTO FRESH AIR. FLUSH EYES WITH CLEAN WATER. IF SYMPTOMS PERSIST, SEEK MEDICAL ATTENTION.

SKIN:
WIPE MATERIAL FROM SKIN AND REMOVE CONTAMINATED SHOES AND CLOTHING. CLEANSE AFFECTED AREA(S) THOROUGHLY BY WASHING WITH MILD SOAP AND WATER AND, IF NECESSARY, A WATERLESS SKIN CLEANSER. IF IRRITATION OR REDNESS DEVELOPS AND PERSISTS, SEEK MEDICAL ATTENTION.

INHALATION (BREATHING):
IF RESPIRATORY SYMPTOMS DEVELOP, MOVE VICTIM AWAY FROM SOURCE OF EXPOSURE AND INTO FRESH AIR. IF SYMPTOMS PERSIST, SEEK MEDICAL ATTENTION. IF VICTIM IS NOT BREATHING, CLEAR AIRWAY AND IMMEDIATELY BEGIN ARTIFICIAL RESPIRATION. IF BREATHING DIFFICULTIES DEVELOP, OXYGEN SHOULD BE ADMINISTERED BY QUALIFIED PERSONNEL. SEEK IMMEDIATE MEDICAL ATTENTION.

INGESTION (SWALLOWING):

ASPIRATION HAZARD:
DO NOT INDUCE VOMITING OR GIVE ANYTHING BY MOUTH BECAUSE THIS MATERIAL CAN ENTER THE LUNGS AND CAUSE SEVERE LUNG DAMAGE. IF VICTIM IS DROWSY OR UNCONSCIOUS AND VOMITING, PLACE ON THE LEFT SIDE WITH THE HEAD DOWN. IF POSSIBLE, DO NOT LEAVE VICTIM UNATTENDED AND OBSERVE CLOSELY FOR ADEQUACY OF BREATHING. SEEK MEDICAL ATTENTION.

------5. FIRE-FIGHTING MEASURES ------

FLAMMABLE PROPERTIES:

FLASH POINT: 170 DEG. F/77 DEG. C
TEST METHOD: PENSKY-MARTENS CLOSED CUP (PMCC), ASTM D93, EPA 1010

OSHA FLAMMABILITY CLASS: COMBUSTIBLE LIQUID

LEL (VOL % IN AIR): 1.0
UEL (VOL % IN AIR): 6.0

AUTOIGNITION TEMPERATURE: NO DATA

UNUSUAL FIRE & EXPLOSION HAZARDS:
THIS MATERIAL IS COMBUSTIBLE AND CAN BE IGNITED BY HEAT, SPARKS, FLAMES, OR OTHER SOURCES OF IGNITION (E.G., STATIC ELECTRICITY, PILOT LIGHTS, OR MECHANICAL/ELECTRICAL EQUIPMENT). MAY CREATE VAPOR/AIR EXPLOSION HAZARD IF HEATED. IF CONTAINER IS NOT PROPERLY COOLED, IT CAN RUPTURE IN THE HEAT OF A FIRE. VAPORS ARE HEAVIER THAN AIR AND CAN ACCUMULATE IN LOW AREAS.

EXTINGUISHING MEDIA:
DRY CHEMICAL, CARBON DIOXIDE, FOAM, OR WATER SPRAY IS RECOMMENDED. WATER OR FOAM MAY CAUSE FROTHING OF MATERIALS HEATED ABOVE 212 DEG. F. CARBON DIOXIDE CAN DISPLACE OXYGEN. USE CAUTION WHEN APPLYING CARBON DIOXIDE IN CONFINED SPACES.

FIRE FIGHTING INSTRUCTIONS:
FOR FIRES BEYOND THE INCIPIENT STAGE, EMERGENCY RESPONDERS IN THE IMMEDIATE HAZARD AREA SHOULD WEAR BUNKER GEAR. WHEN THE POTENTIAL CHEMICAL HAZARD IS UNKNOWN, IN ENCLOSED OR CONFINED SPACES, OR WHEN EXPLICITLY REQUIRED BY DOT, A SELF CONTAINED BREATHING APPARATUS SHOULD BE WORN. IN ADDITION, WEAR OTHER APPROPRIATE PROTECTIVE EQUIPMENT AS CONDITIONS WARRANT (SEE SECTION 8).

ISOLATE IMMEDIATE HAZARD AREA, KEEP UNAUTHORIZED PERSONNEL OUT.
STOP SPILL/RELEASE IF IT CAN BE DONE WITH MINIMAL RISK. MOVE UNDAMAGED CONTAINERS FROM IMMEDIATE HAZARD AREA IF IT CAN BE DONE WITH MINIMAL RISK.

WATER SPRAY MAY BE USEFUL IN MINIMIZING OR DISPERSING VAPORS AND TO PROTECT PERSONNEL. COOL EQUIPMENT EXPOSED TO FIRE WITH WATER, IF IT CAN BE DONE WITH MINIMAL RISK. AVOID SPREADING BURNING LIQUID WITH WATER USED FOR COOLING PURPOSES.

------6. ACCIDENTAL RELEASE MEASURES ------

COMBUSTIBLE. KEEP ALL SOURCES OF IGNITION AWAY FROM SPILL/RELEASE. THE USE OF EXPLOSION-PROOF ELECTRICAL EQUIPMENT IS RECOMMENDED.

STAY UPWIND AND AWAY FROM SPILL/RELEASE. NOTIFY PERSONS DOWN WIND OF THE SPILL/RELEASE, ISOLATE IMMEDIATE HAZARD AREA AND KEEP UNAUTHORIZED PERSONNEL OUT. STOP SPILL/RELEASE IF IT CAN BE DONE WITH MINIMAL RISK. WEAR APPROPRIATE PROTECTIVE EQUIPMENT, INCLUDING RESPIRATORY PROTECTION, AS CONDITIONS WARRANT (SEE SECTION 8).

PREVENT SPILLED MATERIAL FROM ENTERING SEWERS, STORM DRAINS, OTHER UNAUTHORIZED DRAINAGE SYSTEMS, AND NATURAL WATERWAYS. DIKE FAR AHEAD OF SPILL FOR LATER RECOVERY OR DISPOSAL. SPILLED MATERIAL MAY BE ABSORBED INTO AN APPROPRIATE ABSORBENT MATERIAL. NOTIFY FIRE AUTHORITIES AND APPROPRIATE FEDERAL, STATE, AND LOCAL AGENCIES. IMMEDIATE CLEANUP OF ANY SPILL IS RECOMMENDED.

------7. HANDLING AND STORAGE ------

HANDLING:
OPEN CONTAINER SLOWLY TO RELIEVE ANY PRESSURE. BOND AND GROUND ALL EQUIPMENT WHEN TRANSFERRING FROM ONE VESSEL TO ANOTHER. CAN ACCUMULATE STATIC CHARGE BY FLOW OR AGITATION. CAN BE IGNITED BY STATIC DISCHARGE. THE USE OF EXPLOSION-PROOF ELECTRICAL EQUIPMENT IS RECOMMENDED AND MAY BE REQUIRED (SEE APPROPRIATE FIRE CODES). REFER TO NFPA-704 AND/OR API RP 2003 FOR SPECIFIC BONDING/GROUNDING REQUIREMENTS. DO NOT ENTER CONFINED SPACES SUCH AS TANKS OR PITS WITHOUT FOLLOWING PROPER ENTRY PROCEDURES SUCH AS ASTM D-4276 AND 29 CFR 1910.146. THE USE OF APPROPRIATE RESPIRATORY PROTECTION IS ADVISED WHEN CONCENTRATIONS EXCEED ANY ESTABLISHED EXPOSURE LIMITS (SEE SECTIONS 2 AND 8).

DO NOT WEAR CONTAMINATED CLOTHING OR SHOES. KEEP CONTAMINATED CLOTHING AWAY FROM SOURCES OF IGNITION SUCH AS SPARKS OR OPEN FLAMES. USE GOOD PERSONAL HYGIENE PRACTICES.

"EMPTY" CONTAINERS RETAIN RESIDUE AND MAY BE DANGEROUS. DO NOT PRESSURIZE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND, OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, OR OTHER SOURCES OF IGNITION. THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. "EMPTY" DRUMS SHOULD BE COMPLETELY DRAINED, PROPERLY BUNGED, AND PROMPTLY SHIPPED TO THE SUPPLIER OR A DRUM RECONDITIONER. ALL CONTAINERS SHOULD BE DISPOSED OF IN AN ENVIRONMENTALLY SAFE MANNER AND IN ACCORDANCE WITH GOVERNMENTAL REGULATIONS.

BEFORE WORKING ON OR IN TANKS WHICH CONTAIN OR HAVE CONTAINED THIS MATERIAL, REFER TO OSHA REGULATIONS, ANSI Z49.1, AND OTHER REFERENCES PERTAINING TO CLEANING, REPAIRING, WELDING, OR OTHER CONTEMPLATED OPERATIONS.

STORAGE:
KEEP CONTAINER(S) TIGHTLY CLOSED. USE AND STORE THIS MATERIAL IN COOL, DRY, WELL-VENTILATED AREAS AWAY FROM HEAT AND ALL SOURCES OF IGNITION. POST AREA "NO SMOKING OR OPEN FLAME." STORE ONLY IN APPROVED CONTAINERS. KEEP AWAY FROM ANY INCOMPATIBLE MATERIAL (SEE SECTION 10). PROTECT CONTAINER(S) AGAINST PHYSICAL DAMAGE. OUTDOOR OR DETACHED STORAGE IS PREFERRED. INDOOR STORAGE SHOULD MEET OSHA STANDARDS AND APPROPRIATE FIRE CODES. KEEP AWAY FROM ANY INCOMPATIBLE MATERIAL (SEE SECTION 10). PROTECT CONTAINER(S) AGAINST PHYSICAL DAMAGE. OUTDOOR OR DETACHED STORAGE IS PREFERRED. INDOOR STORAGE SHOULD MEET OSHA STANDARDS AND APPROPRIATE FIRE CODES.

------8. EXPOSURE CONTROLS / PERSONAL PROTECTION ------

ENGINEERING CONTROLS:
IF CURRENT VENTILATION PRACTICES ARE NOT ADEQUATE TO MAINTAIN AIRBORNE CONCENTRATIONS BELOW THE ESTABLISHED EXPOSURE LIMITS (SEE SECTION 2),

ADDITIONAL ENGINEERING CONTROLS MAY BE REQUIRED. WHERE EXPLOSIVE MIXTURES MAY BE PRESENT, ELECTRICAL SYSTEMS SAFE FOR SUCH LOCATIONS MUST BE USED (SEE APPROPRIATE ELECTRICAL CODES).

PERSONAL PROTECTIVE EQUIPMENT (PPE):

RESPIRATORY:
THE USE OF RESPIRATORY PROTECTION IS ADVISED WHEN CONCENTRATIONS ARE EXPECTED TO EXCEED THE ESTABLISHED EXPOSURE LIMITS (SEE SECTION 2). DEPENDING ON THE AIRBORNE CONCENTRATION, USE A RESPIRATOR WITH ORGANIC VAPOR CARTRIDGES (NIOSH CERTIFIED) OR SUPPLIED-AIR EQUIPMENT.

SKIN:
THE USE OF NITRILE GLOVES IMPERVIOUS TO THE SPECIFIC MATERIAL HANDLED IS ADVISED TO PREVENT SKIN CONTACT, POSSIBLE IRRITATION, AND SKIN DAMAGE (SEE GLOVE MANUFACTURER LITERATURE FOR INFORMATION ON PERMEABILITY). DEPENDING ON CONDITIONS OF USE, NITRILE APRON AND/OR ARM COVERS MAY BE NECESSARY.

EYE/FACE:
APPROVED EYE PROTECTION TO SAFEGUARD AGAINST POTENTIAL EYE CONTACT, IRRITATION, OR INJURY IS RECOMMENDED. DEPENDING ON CONDITIONS OF USE, A FACE SHIELD MAY BE NECESSARY.

OTHER PROTECTIVE EQUIPMENT:
A SOURCE OF CLEAN WATER SHOULD BE AVAILABLE IN THE WORK AREA FOR FLUSHING EYES AND SKIN. IMPERVIOUS CLOTHING SHOULD BE WORN AS NEEDED.

SUGGESTIONS FOR THE USE OF SPECIFIC PROTECTIVE MATERIALS ARE BASED ON READILY AVAILABLE PUBLISHED DATA. USERS SHOULD CHECK WITH SPECIFIC MANUFACTURERS TO CONFIRM THE PERFORMANCE OF THEIR PRODUCTS.

------9. PHYSICAL AND CHEMICAL PROPERTIES ------

NOTE:
UNLESS OTHERWISE STATED, VALUES ARE DETERMINED AT 20 DEG. C (68 DEG. F) AND 760 MMHg (1 ATM).

APPEARANCE: CLEAR, COLORLESS

PHYSICAL FORM: LIQUID

ODOR: NEGLIGIBLE

ODOR THRESHOLD: NO DATA

pH: NOT APPLICABLE

VAPOR PRESSURE (MMHg): <0.5 @ 68 DEG. F / 20 DEG. C

VAPOR DENSITY (AIR=1): 6.2

BOILING POINT/RANGE: 370-470 DEG. F (187.8-243.3 DEG. C)

MELTING/FREEZING POINT: NOT APPLICABLE

SOLUBILITY IN WATER: INSOLUBLE

SOLUBILITY IN OTHER SOLVENTS: SOLUBLE IN HYDROCARBONS

PARTITION COEFFICIENT (n-OCTANOL/WATER) (KOW): NO DATA

SPECIFIC GRAVITY: 0.80-0.82

EVAPORATION RATE (nBuAc=1): NO DATA

FLASH POINT: 170 DEG. F/77 DEG. C
TEST METHOD: PENSKY-MARTENS CLOSED CUP (PMCC), ASTM D93, EPA 1010

LEL (VOL % IN AIR): 1.0
UEL (VOL % IN AIR): 6.0

AUTOIGNITION TEMPERATURE: NO DATA

DECOMPOSITION TEMPERATURE: NO DATA

------10. STABILITY AND REACTIVITY ------

STABILITY:
STABLE UNDER NORMAL AMBIENT AND ANTICIPATED STORAGE AND HANDLING CONDITIONS OF TEMPERATURE AND PRESSURE.

CONDITIONS TO AVOID:
AVOID ALL POSSIBLE SOURCES OF IGNITION (SEE SECTIONS 5 AND 7).

MATERIALS TO AVOID (INCOMPATIBLE MATERIALS):
AVOID CONTACT WITH STRONG OXIDIZING AGENTS, STRONG REDUCING AGENTS.

HAZARDOUS DECOMPOSITION PRODUCTS:
COMBUSTION CAN YIELD CARBON DIOXIDE AND CARBON MONOXIDE.

HAZARDOUS POLYMERIZATION: WILL NOT OCCUR.

------11. TOXICOLOGICAL INFORMATION ------

CHRONIC DATA:

HYDROTREATED DISTILLATE, LIGHT ..C9-16 64742-47-8:

CARCINOGENICITY:
PROLONGED AND REPEATED SKIN EXPOSURE OF MICE TO CERTAIN MIDDLE DISTILLATE STREAMS HAS RESULTED IN DERMATITIS, WHICH HAS BEEN ASSOCIATED WITH THE PROMOTION OF SKIN TUMORS VIA A NON-GENOTOXIC MECHANISM. THIS MATERIAL HAS NOT BEEN IDENTIFIED AS A CARCINOGEN BY NTP, IARC, OR OSHA.

ACUTE DATA:

HYDROTREATED DISTILLATE, LIGHT ..C9-16 64742-47-8:
DERMAL LD50 = >2 G/KG (RABBIT) (BASED ON SIMILAR MATERIAL)
INHALATION LC50 = >5 MG/L (4-HR., RAT) (BASED ON SIMILAR MATERIAL)
ORAL LD50 = >5 G/KG (RAT) (BASED ON SIMILAR MATERIAL)

------12. ECOLOGICAL INFORMATION ------

NOT EVALUATED.

------13. DISPOSAL CONSIDERATIONS ------

THIS MATERIAL, IF DISCARDED AS PRODUCED, WOULD BE A RCRA "CHARACTERISTIC" HAZARDOUS WASTE DUE TO THE CHARACTERISTIC(S) OF IGNITABILITY (D001). IF THE SPILLED OR RELEASED MATERIAL IMPACTS SOIL, WATER, OR OTHER MEDIA, CHARACTERISTIC TESTING OF THE CONTAMINATED MATERIALS MAY BE REQUIRED PRIOR TO THEIR DISPOSAL. FURTHER, THIS MATERIAL, ONCE IT BECOMES A WASTE, IS SUBJECT TO THE LAND DISPOSAL RESTRICTIONS IN 40 CFR 268.40 AND MAY REQUIRE TREATMENT PRIOR TO DISPOSAL TO MEET SPECIFIC STANDARDS. CONSULT STATE AND LOCAL REGULATIONS TO DETERMINE WHETHER THEY ARE MORE STRINGENT THAN THE FEDERAL REQUIREMENTS.

CONTAINER CONTENTS SHOULD BE COMPLETELY USED AND CONTAINERS SHOULD BE EMPTIED PRIOR TO DISCARD. CONTAINER RINSATE COULD BE CONSIDERED A RCRA HAZARDOUS WASTE AND MUST BE DISPOSED OF WITH CARE AND IN FULL COMPLIANCE WITH FEDERAL, STATE AND LOCAL REGULATIONS. LARGER EMPTY CONTAINERS, SUCH AS DRUMS, SHOULD BE RETURNED TO THE DISTRIBUTOR OR TO A DRUM RECONDITIONER. TO ASSURE PROPER DISPOSAL OF SMALLER EMPTY CONTAINERS, CONSULT WITH STATE AND LOCAL REGULATIONS AND DISPOSAL AUTHORITIES.

------14. TRANSPORTATION INFORMATION ------

U.S. DEPARTMENT OF TRANSPORTATION (DOT):

SHIPPING DESCRIPTION:
PETROLEUM DISTILLATES, N.O.S., COMBUSTIBLE LIQUID, UN1268, III (BULK ONLY)

BULK PACKAGE/PLACARD MARKING: COMBUSTIBLE/1268

NON-BULK PACKAGE MARKING: NOT REGULATED (173.150 (F) (2))

NON-BULK PACKAGE LABELING: NOT REGULATED (173.150 (F) (2))

PACKAGING - REFERENCES (EXCEPTIONS, NON-BULK, BULK):
NONE, NONE, 49 CFR 173.241

HAZARDOUS SUBSTANCE: NONE

EMERGENCY RESPONSE GUIDE: 128

INTERNATIONAL MARITIME DANGEROUS GOODS (IMDG):

SHIPPING DESCRIPTION: NOT REGULATED. FLASH POINT IS ABOVE 61 DEG. C, CC.
NOTE: FEDERAL COMPLIANCE REQUIREMENTS MAY APPLY. SEE 49 CFR 171.12.

INTERNATIONAL CIVIL AVIATION ORG. / INTERNATIONAL AIR TRANSPORT ASSOC. (ICAO/IATA):
UN/ID #: NOT REGULATED. FLASH POINT IS ABOVE 61 DEG. C, CC.
NOTE: FEDERAL COMPLIANCE REQUIREMENTS MAY APPLY. SEE 49 CFR 171.11.

------15. REGULATORY INFORMATION ------

U.S. REGULATIONS:

CERCLA/SARA - SECTION 311/312 (TITLE III HAZARD CATEGORIES):
ACUTE HEALTH: NO
CHRONIC HEALTH: NO
FIRE HAZARD: YES
PRESSURE HAZARD: NO
REACTIVE HAZARD: NO

CERCLA/SARA - SECTION 313 AND 40 CFR 372:
THIS MATERIAL CONTAINS THE FOLLOWING CHEMICALS SUBJECT TO THE REPORTING REQUIREMENTS OF SARA 313 AND 40 CFR 372: NONE KNOWN

EPA (CERCLA) REPORTABLE QUANTITY (IN POUNDS): NONE KNOWN

CERCLA/SARA - SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES AND TPQS (IN POUNDS):

THIS MATERIAL CONTAINS THE FOLLOWING CHEMICALS SUBJECT TO THE REPORTING REQUIREMENTS OF SARA 302 AND 40 CFR 372: NONE KNOWN

CALIFORNIA PROPOSITION 65:

WARNING:

THIS MATERIAL MAY CONTAIN THE FOLLOWING CHEMICALS WHICH ARE KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER, BIRTH DEFECTS OR OTHER REPRODUCTIVE HARM, AND ARE SUBJECT TO THE REQUIREMENTS OF CALIFORNIA PROPOSITION 65 (CA HEALTH & SAFETY CODE SECTION 25249.5): NONE KNOWN

CARCINOGEN IDENTIFICATION:
THIS MATERIAL HAS NOT BEEN IDENTIFIED AS A CARCINOGEN BY NTP, IARC, OR OSHA. SEE SECTION 11 FOR CARCINOGENICITY INFORMATION OF INDIVIDUAL COMPONENTS, IF ANY.

TSCA: ALL COMPONENTS ARE LISTED ON THE TSCA INVENTORY.

INTERNATIONAL REGULATIONS:

CANADIAN REGULATIONS:
THIS PRODUCT HAS BEEN CLASSIFIED IN ACCORDANCE WITH THE HAZARD CRITERIA OF THE CONTROLLED PRODUCTS REGULATIONS (CPR) AND THE MSDS CONTAINS ALL THE INFORMATION REQUIRED BY THE CPR.

DOMESTIC SUBSTANCES LIST: LISTED

WHMIS HAZARD CLASS:
B3 - COMBUSTIBLE LIQUIDS

INTERNATIONAL INVENTORIES:
AUSTRALIA (AICS)
CANADA (DSL)
CHINA
EUROPE (EINECS)
JAPAN (ENCS)
KOREA (ECL)
PHILIPPINES (PICCS)

EXPORT CONTROL CLASSIFICATION NUMBER: EAR99

------16. OTHER INFORMATION ------

ISSUE DATE: 02-AUG-2006

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REVISED SECTIONS OR BASIS FOR REVISION: PERIODIC REVIEW AND UPDATE

MSDS CODE: 776576

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APPENDIX K-2. EMISSIONS FACTORS FOR FUEL COMBUSTION FROM NATURAL GAS, LPG, AND OIL-FIRED RESIDENTIAL WATER HEATERS

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TABLE

Table K-2.1 Estimated National Average Emissions Factors for Household Fuel Combustion of Natural Gas, Fuel Oil #2, and LPG

	Carbon (kg/GJ)	NO_x (g/GJ)	SO_2 (g/GJ)
Natural Gas	13.8	42	0
Fuel Oil #2	18.7	61	218
LPG	16.0	66	7

There are significant differences in state regulations, making it difficult to generalize about localized emissions. For residential fuel oil combustion, stricter state standards exist in the northeastern United States and southern California than elsewhere. State and local agencies like southern California's South Coast Air Quality Management District (SCAQMD), the New Jersey Department of Environmental Protection, and the New York Department of Environmental Conservation have established regulations for residential fuel combustion emissions. These regulations, however, are local to individual counties and do not apply to all regions in the Northeast or even all of California.

K-2.2 EMISSIONS FACTORS BY FUEL TYPE

K-2.2.1 All Fuels: Carbon

NEMS-BRS tracks emissions of carbon as CO_2, but factors are included here for completeness. The combustion of natural gas, fuel oil #2, and LPG oxidizes virtually all carbon in the fuel to CO_2. This facilitates estimating carbon emissions factors because the carbon content of the fuel is the only determinant of emissions. The carbon estimates in Table K-2.1 are based on EPA's assessment of carbon combustion from natural gas, fuel oil #2, and LPG use. Other sources of information include the U.S. DOE's Energy Information Administration (EIA), Oregon State EPA, and the Gas Research Institute (GRI). All agree to within ± 2.0 % of EPA's assessed estimate of carbon emissions. EPA's carbon emissions factors for natural gas, fuel oil #2, and LPG combustion are therefore a reasonable evaluation of nationally averaged carbon emissions rates.

Carbon monoxide (CO) can be formed by incomplete carbon oxidization, causing a severe health hazard. CO emissions only result from poorly functioning appliances, and since NEMS-BRS assumes that all water heaters are functioning properly, it is unlikely that these emissions will change.

K-2.2.3.2 Sulfur Dioxide

Emissions of SO_2 are a direct function of the sulfur content of the fuel. Assuming complete combustion of sulfur to SO_2 makes it easy to assess and compare emissions across data sources. Individual state and county regulations limiting the amount of sulfur in residential fuel oil, however, reveal substantial variability in SO_2 emissions factors from EPA's estimate of 218g of SO_2/GJ of fuel energy content. This is roughly equivalent to 0.5% sulfur content by weight using an emissions factor for fuel oil #2 of 43,950 g/GJ weight per unit energy content. A straight multiplication of the fuel energy content and the percentage of sulfur content in the fuel provide the emissions factor.

In the state of New York, SO_2 emissions limits range from 88-659 g/GJ depending on the county. In New Hampshire, the emissions rate of SO_2 from high-sulfur distillate fuel oil combustion cannot exceed 176 g/GJ. In Maine and Michigan, the regulations are higher than EPA's assessment, limiting SO_2 emissions from fuel oil to 500 g of SO_2/GJ of heat input. Such broad ranges and varying limits in certain regions are a strong argument for using EPA's averaged national value over a regionally weighted average incorporating the various state and county regulations.

Comparing the sulfur content of fuel oil from different refineries also demonstrates regional variability. Most sources were obtained through online websites detailing product specifications. Mobil Corporation's residential heating fuel oil (#2 high-sulfur) for most states contains a maximum 0.5% sulfur by mass (219 g of SO_2/GJ of heat input), which is very close to EPA's emissions factor. Mobil also markets fuel with lower sulfur content to some regions in the Northeast. For example, Mobil's lowest sulfur content residential heating fuel oil contains 0.2% sulfur by weight (88 g/GJ), as required in New York City, Philadelphia, parts of Delaware, and most of New Jersey. Other regional regulations adhered to by Mobil are 132 g/GJ for most of Pennsylvania and parts of New Jersey, a limit of 127 g of SO_2/GJ of heat input for the state of Illinois, and an SO_2 emissions factor of 145 g/GJ in Massachusetts. The sulfur contents of distillate fuel oil from Chevron, Phillips 66, and the American Society for Testing and Materials (ASTM) exactly match EPA's estimate, substantiating the use of the latter for the analysis. Considerable variation does exist among counties and states, especially in the Northeast. Nonetheless, EPA provides a reasonable estimate of emissions from residential oil-fired water heaters that is representative of the national average.

K-2.2.4 LPG

K-2.2.4.1 Oxides of Nitrogen

Although NES results are presented for LPG, EPA estimates emissions for only propane and butane, fuels within the LPG family of gases. In the United States, the composition of LPG is typically 90% propane (C_3H_8) by liquid volume, 5% propylene (C_3H_6), and 2.5% butane (C_4H_{10}).[4] This analysis uses EPA's propane emissions estimate to verify its comparability with LPG combustion or determines a more suitable estimate from other sources that best represents LPG emissions rates.

REFERENCES

1. U.S. Environmental Protection Agency, *Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources,* 1998. October. < http://www.epa.gov/ttn/chief/ap42.html>

2. South Coast Air Quality Management District, March, 1995. < http://www.aqmd.gov/rules/r1121.html>

3. New Jersey State Department of Environmental Protection, September 1993. <http://www.state.nj.us/dep/aqm/2719968.htm#Boilers>

4. United States Hemispheric Clean Cities Program, 1994. <http://www.hemis-ccities.doe.gov/altfuels/propane.html>

5. U.S. Environmental Protection Agency, *Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources, Chapter 1, External Combustion Sources,* 1998. October. < http://www.epa.gov/ttn/chief/ap42c1.html>

1.5 Liquefied Petroleum Gas Combustion

1.5.1 General[1]

Liquefied petroleum gas (LPG or LP-gas) consists of propane, propylene, butane, and butylenes; the product used for domestic heating is composed primarily of propane. This gas, obtained mostly from gas wells (but also, to a lesser extent, as a refinery by-product) is stored as a liquid under moderate pressures. There are three grades of LPG available as heating fuels: commercial-grade propane, engine fuel-grade propane (also known as HD-5 propane), and commercial-grade butane. In addition, there are high-purity grades of LPG available for laboratory work and for use as aerosol propellants. Specifications for the various LPG grades are available from the American Society for Testing and Materials and the Gas Processors Association. A typical heating value for commercial-grade propane and HD-5 propane is 90,500 British thermal units per gallon (Btu/gal), after vaporization; for commercial-grade butane, the value is 97,400 Btu/gal.

The largest market for LPG is the domestic/commercial market, followed by the chemical industry (where it is used as a petrochemical feedstock) and the agriculture industry. Propane is also used as an engine fuel as an alternative to gasoline and as a standby fuel for facilities that have interruptible natural gas service contracts.

1.5.2 Firing Practices[2]

The combustion processes that use LPG are very similar to those that use natural gas. Use of LPG in commercial and industrial applications may require a vaporizer to provide the burner with the proper mix of air and fuel. The burner itself will usually have different fuel injector tips as well as different fuel-to-air ratio controller settings than a natural gas burner since the LPG stoichiometric requirements are different than natural gas requirements. LPG is fired as a primary and backup fuel in small commercial and industrial boilers and space heating equipment and can be used to generate heat and process steam for industrial facilities and in most domestic appliances that typically use natural gas.

1.5.3 Emissions[1,3-5]

1.5.3.1 Criteria Pollutants -

LPG is considered a "clean" fuel because it does not produce visible emissions. However, gaseous pollutants such as nitrogen oxides (NO_x), carbon monoxide (CO), and organic compounds are produced as are small amounts of sulfur dioxide (SO_2) and particulate matter (PM). The most significant factors affecting NO_x, CO, and organic emissions are burner design, burner adjustment, boiler operating parameters, and flue gas venting. Improper design, blocking and clogging of the flue vent, and insufficient combustion air result in improper combustion and the emission of aldehydes, CO, hydrocarbons, and other organics. NO_x emissions are a function of a number of variables, including temperature, excess air, fuel and air mixing, and residence time in the combustion zone. The amount of SO_2 emitted is directly proportional to the amount of sulfur in the fuel. PM emissions are very low and result from soot, aerosols formed by condensable emitted species, or boiler scale dislodged during combustion. Emission factors for LPG combustion are presented in Table 1.5-1.

Table 1.5-1 presents emission factors on a volume basis (lb/10^3gal). To convert to an energy basis (lb/MMBtu), divide by a heating value of 91.5 MMBtu/10^3gal for propane and 102 MMBtu/10^3gal for butane.

1.5.3.2 Greenhouse Gases[6-11] -

Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) emissions are all produced during LPG combustion. Nearly all of the fuel carbon (99.5 percent) in LPG is converted to CO_2 during the combustion process. This conversion is relatively independent of firing configuration. Although the formation of CO acts to reduce CO_2 emissions, the amount of CO produced is insignificant compared to the amount of CO_2 produced. The majority of the 0.5 percent of fuel carbon not converted to CO_2 is due to incomplete combustion in the fuel stream.

Formation of N_2O during the combustion process is governed by a complex series of reactions and its formation is dependent upon many factors. Formation of N_2O is minimized when combustion temperatures are kept high (above 1475°F) and excess air is kept to a minimum (less than 1 percent).

Methane emissions are highest during periods of low-temperature combustion or incomplete combustion, such as the start-up or shut-down cycle for boilers. Typically, conditions that favor formation of N_2O also favor emissions of CH_4.

1.5.4 Controls

The only controls developed for LPG combustion are to reduce NO_x emissions. NO_x controls have been developed for firetube and watertube boilers firing propane or butane. Vendors are now guaranteeing retrofit systems to levels as low as 30 to 40 ppm (based on 3 percent oxygen). These systems use a combination of low-NO_x burners and flue gas recirculation (FGR). Some burner vendors use water or steam injection into the flame zone for NO_x reduction. This is a trimming technique which may be necessary during backup fuel periods because LPG typically has a higher NO_x-forming potential than natural gas; conventional natural gas emission control systems may not be sufficient to reduce LPG emissions to mandated levels. Also, LPG burners are more prone to sooting under the modified combustion conditions required for low NO_x emissions. The extent of allowable combustion modifications for LPG may be more limited than for natural gas.

One NO_x control system that has been demonstrated on small commercial boilers is FGR. NO_x emissions from propane combustion can be reduced by as much as 50 percent by recirculating about 16 percent of the flue gas. NO_x emission reductions of over 60 percent have been achieved with FGR and low-NO_x burners used in combination.

1.5.5 Updates Since the Fifth Edition

The Fifth Edition was released in January 1995. Revisions to this section since that date are summarized below. For further detail, consult the memoranda describing each supplement or the background report for this section.

Supplement A, February 1996

No changes.

Supplement B, October 1996

- Text was added concerning firing practices.
- The CO_2 emission factor was updated.
- Emission factors were added for N_2O and CH_4.

July 2008

The PM filterable, NOx, CO and TOC emissions factors were updated and the PM condensable and PM total emissions factors were added using the revised PM, NOx, CO and TOC emissions factors for natural gas combustion for small boilers (see July 1998 revisions to section 1.4, Natural Gas Combustion).

Table 1.5-1. EMISSION FACTORS FOR LPG COMBUSTION[a]

EMISSION FACTOR RATING: E

Pollutant	Butane Emission Factor ($lb/10^3$ gal)		Propane Emission Factor ($lb/10^3$ gal)	
	Industrial Boilers[b] (SCC 1-02-010-01)	Commercial Boilers[c] (SCC 1-03-010-01)	Industrial Boilers[b] (SCC 1-02-010-02)	Commercial Boilers[c] (SCC 1-03-010-02)
PM, Filterable [d]	0.2	0.2	0.2	0.2
PM, Condensable	0.6	0.6	0.5	0.5
PM, Total	0.8	0.8	0.7	0.7
SO_2[e]	0.09S	0.09S	0.10S	0.10S
NO_x[f]	15	15	13	13
N_2O[g]	0.9	0.9	0.9	0.9
CO_2[h,j]	14,300	14,300	12,500	12,500
CO	8.4	8.4	7.5	7.5
TOC	1.1	1.1	1.0	1.0
CH_4[k]	0.2	0.2	0.2	0.2

[a] Assumes PM, CO, and TOC emissions are the same, on a heat input basis, as for natural gas combustion. Use heat contents of 91.5×10^6 Btu/10^3 gallon for propane, 102×10^6 Btu/10^3 gallon for butane, 1020×10^6 Btu/10^6 scf for methane when calculating an equivalent heat input basis. For example, the equation for converting from methane's emissions factors to propane's emissions factors is as follows: lb pollutant/10^3 gallons of propane = (lb pollutant /10^6 ft^3 methane) * (91.5×10^6 Btu/10^3 gallons of propane) / (1020×10^6 Btu/10^6 scf of methane). The NO_x emission factors have been multiplied by a correction factor of 1.5, which is the approximate ratio of propane/butane NO_x emissions to natural gas NO_x emissions. To convert from lb/10^3 gal to kg/10^3 L, multiply by 0.12. SCC = Source Classification Code.

[b] Heat input capacities generally between 10 and 100 million Btu/hour.

[c] Heat input capacities generally between 0.3 and 10 million Btu/hour.

[d] Filterable particulate matter (PM) is that PM collected on or prior to the filter of an EPA Method 5 (or equivalent) sampling train. For natural gas, a fuel with similar combustion characteristics, all PM is less than 10 μm in aerodynamic equivalent diameter (PM-10).

[e] S equals the sulfur content expressed in gr/100 ft^3 gas vapor. For example, if the butane sulfur content is 0.18 gr/100 ft^3, the emission factor would be (0.09×0.18) = 0.016 lb of SO_2/10^3 gal butane burned.

[f] Expressed as NO_2.

[g] Reference 12.

[h] Assuming 99.5% conversion of fuel carbon to CO_2.

[j] EMISSION FACTOR RATING = C.

[k] Reference 13.

References For Section 1.5

1. Written Communication from W. Butterbaugh of the National Propane Gas Association, Lisle, Illinois, to J. McSorley of the U. S. Environmental Protection Agency, Research Triangle Park, NC, August 19, 1992.

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4. *Nitrous Oxide Reduction With The Weishaupt Flue Gas Recirculation System*, Weishaupt Research and Development Institute, January 1987.

5. Phone communication memorandum of conversation between B. Lusher of Acurex Environmental and D. Childress of Suburban/Petrolane, Durham, NC, May 14, 1992.

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9. G. Marland and R. M. Rotty, *Carbon Dioxide Emissions From Fossil Fuels: A Procedure For Estimation And Results For 1951-1981*, DOE/NBB-0036 TR-003, Carbon Dioxide Research Division, Office of Energy Research, U.S. Department of Energy, Oak Ridge, TN, 1983.

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11. *Sector-Specific Issues And Reporting Methodologies Supporting The General Guidelines For The Voluntary Reporting Of Greenhouse Gases Under Section 1605(b) Of The Energy Policy Act Of 1992,* Volume 2 of 3, DOE/PO-0028, U.S. Department of Energy, 1994.

12. A. Rosland, *Greenhouse Gas Emissions In Norway: Inventories And Estimation Methods*, Ministry of Environment, Oslo, Norway, 1993.

13. *Inventory Methods Manual For Estimating Canadian Emissions Of Greenhouse Gases*, Prepared for Environment Canada by Ortech Corporation, 1994.

Chino Mines Company
NSR Consolidation Application

Sulfuric Acid Mist Emissions from SX/EW Tankhouse

The following sections describe the derivation of equations used to calculate annual acid mist emissions.

A. Driving Mechanisms for Natural Ventilation

The two driving forces that produce natural ventilation in a building are wind pressure (wind effect) and thermal buoyancy (stack effect) caused by a temperature difference.

1. Flow due to wind effect (Q_w):

Factors affecting ventilation wind forces include average velocity, prevailing direction, seasonal and daily variation in velocity and direction, and local obstructions such as nearby buildings, hills, trees, and shrubbery. The following equation shows the quantity of air forced through ventilation inlet openings by wind:

$$Q_w = (88)C_w A_w V \qquad (1)$$

where Q_w = wind effect air flow (ft^3/min)
C_w = effectiveness of openings (orifice coefficient)
A_w = area of windward inlet openings (ft^2)
V = wind velocity (MPH)
88 = conversion factor (MPH to ft/min)

2. Flow due to stack effect (Q_s):

The pressure flow relationship for the movement of air through a building is given by the following equation:

$$h_{th} = h(1 - s_h) \qquad (2)$$

where h_{th} = thermostatic head (ft of air)
h = height of feet of hot air in an enclosure
s_h = specific gravity of hot air relative to cold air

But, since the specific gravity of the cooler air is equal to unity (since it is made the point of reference), s_h becomes:

$$s_h = \frac{s_c T_o}{T_i} = \frac{T_o}{T_i} \qquad (3)$$

where s_c = specific gravity of cool air in an enclosure
T_i = absolute temperature of the hot interior air

T_o = absolute temperature of the cooler air

Combining equations (2) and (3):

$$h_{th} = h(1 - \frac{T_o}{T_i}) = h\frac{(T_i - T_o)}{T_i} = h\frac{\Delta T}{T_i} \tag{4}$$

Since the value of h_{th} is in feet of air, it can be used directly in the following equation to ascertain velocity through an orifice:

$$v = C_s\sqrt{2gh_{th}} \tag{5}$$

where v = orifice velocity (ft/s)
C_s = effectiveness of openings (orifice coefficient)
g = gravitational constant (32.2 ft/s^2)
h_{th} = thermostatic head (ft)

Combining equations (4) and (5):

$$v = C_s\sqrt{(2)(32.2)h\frac{\Delta T}{T_i}} = 8.02C_s\sqrt{h\frac{\Delta T}{T_i}} \tag{6}$$

Orifice flowrates can be calculated by multiplying the orifice velocity by the orifice cross sectional area:

$$Q_s = (8.02)(60)C_sA\sqrt{h\frac{\Delta T}{T_i}} \tag{7}$$

where Q_s = stack effect air flow (ft^3/min)
A = flow area (ft^2)
60 = conversion factor (ft/s to ft/min)

According to the ASHRAE Fundamentals Handbook, the thermal effect flowrate is greatest when the inlet and outlet openings are equal. In the case of unequal openings, the smaller area should be used in the equation and the flowrate corrected using the correction factor F_c. This correction is determined from Figure 7 located on page 26.11 of the 2005 Fundamentals Handbook.

To calculate h, the following equation can be used:

$$h = \frac{H}{1 + \frac{A_1^2 T_i}{A_2^2 T_o}} \tag{8}$$

where A_1 = area of lower openings (ft^2)
A_2 = area of upper openings (ft^2)

H = distance from lower to upper openings (ft)

Combining equations (7) and (8), and taking into account the correction factor, F_c:

$$Q_s = (481.2)F_c C_s A \sqrt{\frac{\frac{H\Delta T}{T_i}}{1+\frac{A_1^2 T_i}{A_2^2 T_o}}} \quad (9)$$

3. Combining wind effect and stack effect flowrates:
Wind effect and stack effect ventilation rates are combined according to the following equation:

$$Q = \sqrt{Q_w^2 + Q_s^2} \quad (10)$$

Substituting equations (1) and (9) into (10) yields the final equation:

$$Q = \sqrt{(7{,}744)C_w^2 A_w^2 V^2 + (231{,}533.44)F_c^2 C_s^2 A^2 \frac{\frac{H\Delta T}{T_i}}{1+\frac{A_1^2 T_i}{A_2^2 T_o}}} \quad (11)$$

4. Calculation of acid mist emission
When the ventilation rate and acid mist concentration are known, the acid mist emissions can be determined from the following equation:

$$E_A = kQZ \quad (12)$$

where E_A = Acid mist emission rate (ton/yr)
k = Conversion factor
Z = Acid mist concentration (mg/ m^3)

References ASHRAE Fundamentals Handbook. Chapter 26, “Ventilation and Infiltration” Atlanta, GA: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 2001.

through ventilation inlet openings by wind or determines the proper size of openings to produce given airflow rates:

$$Q = C_v A U \tag{29}$$

where

Q = airflow rate, m^3/s
C_v = effectiveness of openings (C_v is assumed to be 0.5 to 0.6 for perpendicular winds and 0.25 to 0.35 for diagonal winds)
A = free area of inlet openings, m^2
U = wind speed, m/s

Inlets should face directly into the prevailing wind. If they are not advantageously placed, flow will be less than that predicted by Equation (29); if the inlets are unusually well placed, flow will be slightly more. Desirable outlet locations are (1) on the leeward side of the building directly opposite the inlet, (2) on the roof, in the low-pressure area caused by a flow discontinuity of the wind, (3) on the side adjacent to the windward face where low-pressure areas occur, (4) in a dormer on the leeward side, (5) in roof ventilators, or (6) by stacks. Chapter 16 gives a general description of the wind pressure distribution on a building. The inlets should be placed in the exterior high-pressure regions; the outlets should be placed in the exterior low-pressure regions.

Flow Caused by Thermal Forces Only

If building internal resistance is not significant, the flow caused by stack effect can be expressed by

$$Q = C_D A \sqrt{2g\Delta H_{NPL}(T_i - T_o)/T_i} \tag{30}$$

where

Q = airflow rate, m^3/s
C_D = discharge coefficient for opening
ΔH_{NPL} = height from midpoint of lower opening to NPL, m
T_i = indoor temperature, K
T_o = outdoor temperature, K

Equation (30) applies when $T_i > T_o$. If $T_i < T_o$, replace T_i in the denominator with T_o, and replace $(T_i - T_o)$ in the numerator with $(T_o - T_i)$. An average temperature should be used for T_i if there is thermal stratification. If the building has more than one opening, the outlet and inlet areas are considered equal. The discharge coefficient C_D accounts for all viscous effects such as surface drag and interfacial mixing.

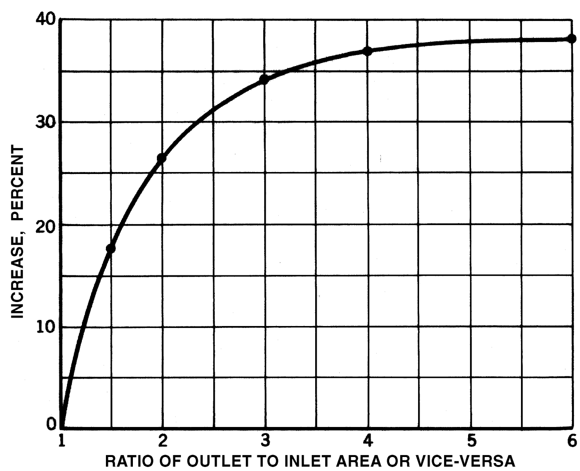

Fig. 7 Increase in Flow Caused by Excess Area of One Opening over the Other

Estimation of ΔH_{NPL} is difficult for naturally ventilated buildings. If one window or door represents a large fraction (approximately 90%) of the total opening area in the envelope, then the NPL is at the mid-height of that aperture, and ΔH_{NPL} equals one-half the height of the aperture. For this condition, flow through the opening is bidirectional (i.e., air from the warmer side flows through the top of the opening, and air from the colder side flows through the bottom). Interfacial mixing occurs across the counterflow interface, and the orifice coefficient can be calculated according to the following equation (Kiel and Wilson 1986):

$$C_D = 0.40 + 0.0045|T_i - T_o| \tag{31}$$

If enough other openings are available, the airflow through the opening will be unidirectional, and mixing cannot occur. A discharge coefficient of C_D = 0.65 should then be used. Additional information on stack-driven airflows for natural ventilation can be found in Foster and Down (1987).

Greatest flow per unit area of openings is obtained when inlet and outlet areas are equal; Equations (30) and (31) are based on this equality. Increasing the outlet area over inlet area (or vice versa) increases airflow but not in proportion to the added area. When openings are unequal, use the smaller area in Equation (30) and add the increase as determined from Figure 7.

Natural Ventilation Guidelines

Several general guidelines should be observed in designing for natural ventilation. Some of these may conflict with other climate-responsive strategies (such as using orientation and shading devices to minimize solar gain) or other design considerations.

1. In hot, humid climates, use mechanical cooling. If mechanical cooling is not available, air velocities should be maximized in the occupied zones. In hot, arid climates, consider evaporative cooling. Airflow throughout the building should be maximized for structural cooling, particularly at night when the temperature is low.
2. Topography, landscaping, and surrounding buildings should be used to redirect airflow and give maximum exposure to breezes. Vegetation can funnel breezes and avoid wind dams, which reduce the driving pressure differential around the building. Site objects should not obstruct inlet openings.
3. The building should be shaped to expose maximum shell openings to breezes.
4. Architectural elements such as wing walls, parapets, and overhangs should be used to promote airflow into the building interior.
5. The long facade of the building and the majority of the door and window openings should be oriented with respect to the prevailing summer breezes. If there is no prevailing direction, openings should be sufficient to provide ventilation regardless of wind direction.
6. Windows should be located in opposing pressure zones. Two openings on opposite sides of a space increase the ventilation flow. Openings on adjacent sides force air to change direction, providing ventilation to a greater area. The benefits of the window arrangement depend on the outlet location relative to the direction of the inlet airstream.
7. If a room has only one external wall, better airflow is achieved with two widely spaced windows.
8. If the openings are at the same level and near the ceiling, much of the flow may bypass the occupied level and be ineffective in diluting contaminants there.
9. Vertical distance between openings is required to take advantage of the stack effect; the greater the vertical distance, the greater the ventilation.

Chino Mines Company
NSR Consolidation Application

Solution Extraction Plant VOC Fugitive Emissions

The fugitive VOC emissions from the solvent extraction tanks were estimated using the methodology developed by BHP Copper in the study "Quantification of Volatile Organic Compound (VOC) Emissions from the Solution Extraction Process" (July 1997). The BHP method is based on Fick's Law to determine the diffusive flux of the individual components in the organic in air. The equation used is:

$$\text{Diff F} = (Ci - Ch) \times D/H$$

Where:
Diff F, g/m^2-s = diffusive flux of constituent in air
Ci, ppm = constituent concentration at liquid surface (from manufacturer data)
Ch, ppm = constituent concentration at a distance, H, above the liquid surface
D = constituent diffusivity (calculated from EPA link: http://www.epa.gov/athens/learn2model/part-two/onsite/estdiffusion.htm; where T = 25.84°C, and P = 1 atm, per 1995 met. data)
H, m = distance above liquid surface

This method includes assumptions, fundamental equations, and tabulated chemical data to estimate VOC emissions. Three assumptions govern the scope of their method:

1. Only chemicals with a significant vapor pressure are included in the emissions losses calculation.
2. The driving force for VOC diffusion is the concentration gradient that exists between the surface of the solution and headspace. In the 1997 study, the headspace was assumed to be 1 meter. For the Tyrone SX/EW tanks, 2 ft (or 0.61 m) was assumed to be a reasonable headspace.

This methodology was selected for the Phelps Dodge Tyrone SX/EW emission calculations due to its direct applicability and credibility.

ENGINE MODEL: D399 (JWAC)

GENERAL ENGINE DATA

Rated BHP (29.38 in Hg at 85° F)	 1300
Full Load rpm	 1300
Bore and stroke — inches	6.25 X 8.0
Displacement — cubic inches	 3927
Combustion system	..... PC
Aspiration type	..... TA
Compression ratio	..... 15.1

MOUNTING

Dry weight - Engine pounds	15,145

AIR INTAKE SYSTEM

Maximum allowable system restriction:	
clean dry element — inches water ..	15
dirty element	30

EXHAUST SYSTEM

Maximum allowable back pressure inches water	27

COOLING SYSTEM

Top tank temperature:	
maximum allowable — ° F	210
Cooling capability for:	
maximum ambient temperature — ° F	110
Heat rejection — BTU/minute:	
rated	51,000
Coolant capacity — quarts	...340
Minimum recommended pressure cap — psi	... 7

FUEL AND GOVERNOR SYSTEM

Type	.SCROLI
Maximum fuel flow to transfer pump at gph at rated conditions	104.6
Maximum fuel consumption — gph at rated conditions	73.5
Fuel return line flow — gph	10
Maximum allowable restriction to pump — inches Hg	11
Maximum allowable return line restriction inches Hg	10
Shutoff:	
Energized to run	NO
Energized to shutoff	YES
Mechanical shaft	NO

LUBE OIL SYSTEM

Capacity — refill — filter and lines — quarts	440
Sump capacity — low — quarts	392
Type oil — API* class.	CD
Oil pressure — psi — SAE** 30 at 210° F:	
maximum	63
minimum	56

ELECTRICAL SYSTEM

Minimum recommended battery capacity	
0° F and above	
24V starter—CCA @ 0° F	1260
Below 0° F	
24V starter—CCA @ 0° F	1260

PERFORMANCE DATA

Low idle rpm	 600
High idle rpm	 1420
Altitude capability — feet ..	 5500
Performance curve number	.TD0231-0
Peak torque — pound foot .	 5555
Peak torque rpm	 1100
Combustion air flow — CFM	 3005
Exhaust stack air flow — CFM	7795
Specific heat rejection — BTU/BHP minute:	
full load	39.2

*American Petroleum Institute
**Society of Automotive Engineers

INDUSTRIAL ENGINE DATA SHEET D399 PCTA 1300 @ 1300 RPM DATE: 11-1-79

3.4 Large Stationary Diesel And All Stationary Dual-fuel Engines

3.4.1 General

The primary domestic use of large stationary diesel engines (greater than 600 horsepower [hp]) is in oil and gas exploration and production. These engines, in groups of 3 to 5, supply mechanical power to operate drilling (rotary table), mud pumping, and hoisting equipment, and may also operate pumps or auxiliary power generators. Another frequent application of large stationary diesels is electricity generation for both base and standby service. Smaller uses include irrigation, hoisting, and nuclear power plant emergency cooling water pump operation.

Dual-fuel engines were developed to obtain compression ignition performance and the economy of natural gas, using a minimum of 5 to 6 percent diesel fuel to ignite the natural gas. Large dual-fuel engines have been used almost exclusively for prime electric power generation. This section includes all dual-fuel engines.

3.4.2 Process Description

All reciprocating internal combustion (IC) engines operate by the same basic process. A combustible mixture is first compressed in a small volume between the head of a piston and its surrounding cylinder. The mixture is then ignited, and the resulting high-pressure products of combustion push the piston through the cylinder. This movement is converted from linear to rotary motion by a crankshaft. The piston returns, pushing out exhaust gases, and the cycle is repeated.

There are 2 ignition methods used in stationary reciprocating IC engines, compression ignition (CI) and spark ignition (SI). In CI engines, combustion air is first compression heated in the cylinder, and diesel fuel oil is then injected into the hot air. Ignition is spontaneous because the air temperature is above the autoignition temperature of the fuel. SI engines initiate combustion by the spark of an electrical discharge. Usually the fuel is mixed with the air in a carburetor (for gasoline) or at the intake valve (for natural gas), but occasionally the fuel is injected into the compressed air in the cylinder. Although all diesel- fueled engines are compression ignited and all gasoline- and gas-fueled engines are spark ignited, gas can be used in a CI engine if a small amount of diesel fuel is injected into the compressed gas/air mixture to burn any mixture ratio of gas and diesel oil (hence the name dual fuel), from 6 to 100 percent diesel oil.

CI engines usually operate at a higher compression ratio (ratio of cylinder volume when the piston is at the bottom of its stroke to the volume when it is at the top) than SI engines because fuel is not present during compression; hence there is no danger of premature autoignition. Since engine thermal efficiency rises with increasing pressure ratio (and pressure ratio varies directly with compression ratio), CI engines are more efficient than SI engines. This increased efficiency is gained at the expense of poorer response to load changes and a heavier structure to withstand the higher pressures.[1]

3.4.3 Emissions And Controls

Most of the pollutants from IC engines are emitted through the exhaust. However, some total organic compounds (TOC) escape from the crankcase as a result of blowby (gases that are vented from the oil pan after they have escaped from the cylinder past the piston rings) and from the fuel tank and carburetor because of evaporation. Nearly all of the TOCs from diesel CI engines enter the atmosphere from the exhaust. Crankcase blowby is minor because TOCs are not present during compression of the charge. Evaporative losses are insignificant in diesel engines due to the low volatility of diesel fuels. In general, evaporative losses are also negligible in engines using gaseous fuels because these engines receive their fuel continuously from a pipe rather than via a fuel storage tank and fuel pump.

The primary pollutants from internal combustion engines are oxides of nitrogen (NO_x), hydrocarbons and other organic compounds, carbon monoxide (CO), and particulates, which include both visible (smoke) and nonvisible emissions. Nitrogen oxide formation is directly related to high pressures and temperatures during the combustion process and to the nitrogen content, if any, of the fuel. The other pollutants, HC, CO, and smoke, are primarily the result of incomplete combustion. Ash and metallic additives in the fuel also contribute to the particulate content of the exhaust. Sulfur oxides also appear in the exhaust from IC engines. The sulfur compounds, mainly sulfur dioxide (SO_2), are directly related to the sulfur content of the fuel.[2]

3.4.3.1 Nitrogen Oxides -

Nitrogen oxide formation occurs by two fundamentally different mechanisms. The predominant mechanism with internal combustion engines is thermal NO_x which arises from the thermal dissociation and subsequent reaction of nitrogen (N_2) and oxygen (O_2) molecules in the combustion air. Most thermal NO_x is formed in the high-temperature region of the flame from dissociated molecular nitrogen in the combustion air. Some NO_x, called prompt NO_x, is formed in the early part of the flame from reaction of nitrogen intermediary species, and HC radicals in the flame. The second mechanism, fuel NO_x, stems from the evolution and reaction of fuel-bound nitrogen compounds with oxygen. Gasoline, and most distillate oils, have no chemically-bound fuel N_2 and essentially all NO_x formed is thermal NO_x.

3.4.3.2 Total Organic Compounds -

The pollutants commonly classified as hydrocarbons are composed of a wide variety of organic compounds and are discharged into the atmosphere when some of the fuel remains unburned or is only partially burned during the combustion process. Most unburned hydrocarbon emissions result from fuel droplets that were transported or injected into the quench layer during combustion. This is the region immediately adjacent to the combustion chamber surfaces, where heat transfer outward through the cylinder walls causes the mixture temperatures to be too low to support combustion.

Partially burned hydrocarbons can occur because of poor air and fuel homogeneity due to incomplete mixing, before or during combustion; incorrect air/fuel ratios in the cylinder during combustion due to maladjustment of the engine fuel system; excessively large fuel droplets (diesel engines); and low cylinder temperature due to excessive cooling (quenching) through the walls or early cooling of the gases by expansion of the combustion volume caused by piston motion before combustion is completed.[2]

3.4.3.3 Carbon Monoxide -

Carbon monoxide is a colorless, odorless, relatively inert gas formed as an intermediate combustion product that appears in the exhaust when the reaction of CO to CO_2 cannot proceed to completion. This situation occurs if there is a lack of available oxygen near the hydrocarbon (fuel) molecule during combustion, if the gas temperature is too low, or if the residence time in the cylinder is too short. The oxidation rate of CO is limited by reaction kinetics and, as a consequence, can be accelerated only to a certain extent by improvements in air and fuel mixing during the combustion process.[2-3]

3.4.3.4 Smoke, Particulate Matter, and PM-10 -

White, blue, and black smoke may be emitted from IC engines. Liquid particulates appear as white smoke in the exhaust during an engine cold start, idling, or low load operation. These are formed in the quench layer adjacent to the cylinder walls, where the temperature is not high enough to ignite the fuel. Blue smoke is emitted when lubricating oil leaks, often past worn piston rings, into the combustion chamber and is partially burned. Proper maintenance is the most effective method of preventing blue smoke emissions from all types of IC engines. The primary constituent of black smoke is agglomerated carbon particles (soot).[2]

3.4.3.5 Sulfur Oxides -

Sulfur oxide emissions are a function of only the sulfur content in the fuel rather than any combustion variables. In fact, during the combustion process, essentially all the sulfur in the fuel is oxidized to SO_2. The oxidation of SO_2 gives sulfur trioxide (SO_3), which reacts with water to give sulfuric acid (H_2SO_4), a contributor to acid precipitation. Sulfuric acid reacts with basic substances to give sulfates, which are fine particulates that contribute to PM-10 and visibility reduction. Sulfur oxide emissions also contribute to corrosion of the engine parts.[2,3]

Table 3.4-1 contains gaseous emission factors for the pollutants discussed above, expressed in units of pounds per horsepower-hour (lb/hp-hr), and pounds per million British thermal unit (lb/MMBtu). Table 3.4-2 shows the particulate and particle-sizing emission factors. Table 3.4-3 shows the speciated organic compound emission factors and Table 3.4-4 shows the emission factors for polycyclic aromatic hydrocarbons (PAH). These tables do not provide a complete speciated organic compound and PAH listing because they are based only on a single engine test; they are to be used only for rough order of magnitude comparisons.

Table 3.4-5 shows the NO_x reduction and fuel consumption penalties for diesel and dual-fueled engines based on some of the available control techniques. The emission reductions shown are those that have been demonstrated. The effectiveness of controls on a particular engine will depend on the specific design of each engine, and the effectiveness of each technique could vary considerably. Other NO_x control techniques exist but are not included in Table 3.4-5. These techniques include internal/external exhaust gas recirculation, combustion chamber modification, manifold air cooling, and turbocharging.

3.4.4 Control Technologies

Control measures to date are primarily directed at limiting NO_x and CO emissions since they are the primary pollutants from these engines. From a NO_x control viewpoint, the most important distinction between different engine models and types of reciprocating engines is whether they are rich-burn or lean-burn. Rich-burn engines have an air-to-fuel ratio operating range that is near stoichiometric or fuel-rich of stoichiometric and as a result the exhaust gas has little or no excess oxygen. A lean-burn engine has an air-to-fuel operating range that is fuel-lean of stoichiometric; therefore, the exhaust from these engines is characterized by medium to high levels of O_2. The most common NO_x control technique for diesel and dual fuel engines focuses on modifying the combustion process. However, selective catalytic reduction (SCR) and nonselective catalytic reduction (NSCR) which are post-combustion techniques are becoming available. Control for CO have been partly adapted from mobile sources.[5]

Combustion modifications include injection timing retard (ITR), preignition chamber combustion (PCC), air-to-fuel ratio, and derating. Injection of fuel into the cylinder of a CI engine initiates the combustion process. Retarding the timing of the diesel fuel injection causes the combustion process to occur later in the power stroke when the piston is in the downward motion and combustion chamber volume is increasing. By increasing the volume, the combustion temperature and pressure are lowered, thereby lowering NO_x formation. ITR reduces NO_x from all diesel engines; however, the effectiveness is specific to each engine model. The amount of NO_x reduction with ITR diminishes with increasing levels of retard.[5]

Improved swirl patterns promote thorough air and fuel mixing and may include a precombustion chamber (PCC). A PCC is an antechamber that ignites a fuel-rich mixture that propagates to the main combustion chamber. The high exit velocity from the PCC results in improved mixing and complete combustion of the lean air/fuel mixture which lowers combustion temperature, thereby reducing NO_x emissions.[5]

The air-to-fuel ratio for each cylinder can be adjusted by controlling the amount of fuel that enters each cylinder. At air-to-fuel ratios less than stoichiometric (fuel-rich), combustion occurs under conditions of insufficient oxygen which causes NO_x to decrease because of lower oxygen and lower temperatures. Derating involves restricting engine operation to lower than normal levels of power production for the given application. Derating reduces cylinder pressures and temperatures thereby lowering NO_x formation rates.[5]

SCR is an add-on NO_x control placed in the exhaust stream following the engine and involves injecting ammonia (NH_3) into the flue gas. The NH_3 reacts with the NO_x in the presence of a catalyst to form water and nitrogen. The effectiveness of SCR depends on fuel quality and engine duty cycle (load fluctuations). Contaminants in the fuel may poison or mask the catalyst surface causing a reduction or termination in catalyst activity. Load fluctuations can cause variations in exhaust temperature and NO_x concentration which can create problems with the effectiveness of the SCR system.[5]

NSCR is often referred to as a three-way conversion catalyst system because the catalyst reactor simultaneously reduces NO_x, CO, and HC and involves placing a catalyst in the exhaust stream of the engine. The reaction requires that the O_2 levels be kept low and that the engine be operated at fuel-rich air-to-fuel ratios.[5]

3.4.5 Updates Since the Fifth Edition

The Fifth Edition was released in January 1995. Revisions to this section since that date are summarized below. For further detail, consult the memoranda describing each supplement or the background report for this section.

Supplement A, February 1996

No changes.

Supplement B, October 1996

- The general text was updated.
- Controlled NO_x factors and PM factors were added for diesel units.
- Math errors were corrected in factors for CO from diesel units and for uncontrolled NO_x from dual fueled units.

Table 3.4-1. GASEOUS EMISSION FACTORS FOR LARGE STATIONARY DIESEL AND ALL STATIONARY DUAL-FUEL ENGINES[a]

	Diesel Fuel (SCC 2-02-004-01)			Dual Fuel[b] (SCC 2-02-004-02)		
Pollutant	Emission Factor (lb/hp-hr) (power output)	Emission Factor (lb/MMBtu) (fuel input)	EMISSION FACTOR RATING	Emission Factor (lb/hp-hr) (power output)	Emission Factor (lb/MMBtu) (fuel input)	EMISSION FACTOR RATING
NO_x						
Uncontrolled	0.024	3.2	B	0.018	2.7	D
Controlled	0.013[c]	1.9[c]	B	ND	ND	NA
CO	5.5 E-03	0.85	C	7.5 E-03	1.16	D
SO_x[d]	8.09 E-03S_1	1.01S_1	B	4.06 E-04S_1 + 9.57 E-03S_2	0.05S_1 + 0.895S_2	B
CO_2[e]	1.16	165	B	0.772	110	B
PM	0.0007[c]	0.1[c]	B	ND	ND	NA
TOC (as CH_4)	7.05 E-04	0.09	C	5.29 E-03	0.8	D
Methane	f	f	E	3.97 E-03	0.6	E
Nonmethane	f	f	E	1.32 E-03	0.2[g]	E

[a] Based on uncontrolled levels for each fuel, from References 2,6-7. When necessary, the average heating value of diesel was assumed to be 19,300 Btu/lb with a density of 7.1 lb/gallon. The power output and fuel input values were averaged independently from each other, because of the use of actual brake-specific fuel consumption (BSFC) values for each data point and of the use of data possibly sufficient to calculate only 1 of the 2 emission factors (e. g., enough information to calculate lb/MMBtu, but not lb/hp-hr). Factors are based on averages across all manufacturers and duty cycles. The actual emissions from a particular engine or manufacturer could vary considerably from these levels. To convert from lb/hp-hr to kg/kw-hr, multiply by 0.608. To convert from lb/MMBtu to ng/J, multiply by 430. SCC = Source Classification Code.

[b] Dual fuel assumes 95% natural gas and 5% diesel fuel.

[c] References 8-26. Controlled NO_x is by ignition timing retard.

[d] Assumes that all sulfur in the fuel is converted to SO_2. S_1 = % sulfur in fuel oil; S_2 = % sulfur in natural gas. For example, if sulfer content is 1.5%, then S = 1.5.

[e] Assumes 100% conversion of carbon in fuel to CO_2 with 87 weight % carbon in diesel, 70 weight % carbon in natural gas, dual-fuel mixture of 5% diesel with 95% natural gas, average BSFC of 7,000 Btu/hp-hr, diesel heating value of 19,300 Btu/lb, and natural gas heating value of 1050 Btu/scf.

[f] Based on data from 1 engine, TOC is by weight 9% methane and 91% nonmethane.

[g] Assumes that nonmethane organic compounds are 25% of TOC emissions from dual-fuel engines. Molecular weight of nonmethane gas stream is assumed to be that of methane.

Table 3.4-2. PARTICULATE AND PARTICLE-SIZING EMISSION FACTORS FOR LARGE UNCONTROLLED STATIONARY DIESEL ENGINES[a]

EMISSION FACTOR RATING: E

Pollutant	Emission Factor (lb/MMBtu) (fuel input)
Filterable particulate[b]	
< 1 μm	0.0478
< 3 μm	0.0479
< 10 μm	0.0496
Total filterable particulate	0.0620
Condensable particulate	0.0077
Total PM-10[c]	0.0573
Total particulate[d]	0.0697

[a] Based on 1 uncontrolled diesel engine from Reference 6. Source Classification Code 2-02-004-01. The data for the particulate emissions were collected using Method 5, and the particle size distributions were collected using a Source Assessment Sampling System. To convert from lb/MMBtu to ng/J, multiply by 430. PM-10 = particulate matter ≤ 10 micrometers (μm) aerometric diameter.

[b] Particle size is expressed as aerodynamic diameter.

[c] Total PM-10 is the sum of filterable particulate less than 10 μm aerodynamic diameter and condensable particulate.

[d] Total particulate is the sum of the total filterable particulate and condensable particulate.

Table 3.4-3. SPECIATED ORGANIC COMPOUND EMISSION FACTORS FOR LARGE UNCONTROLLED STATIONARY DIESEL ENGINES[a]

EMISSION FACTOR RATING: E

Pollutant	Emission Factor (lb/MMBtu) (fuel input)
Benzene[b]	7.76 E-04
Toluene[b]	2.81 E-04
Xylenes[b]	1.93 E-04
Propylene	2.79 E-03
Formaldehyde[b]	7.89 E-05
Acetaldehyde[b]	2.52 E-05
Acrolein[b]	7.88 E-06

[a]Based on 1 uncontrolled diesel engine from Reference 7. Source Classification Code 2-02-004-01. Not enough information to calculate the output-specific emission factors of lb/hp-hr. To convert from lb/MMBtu to ng/J, multiply by 430.
[b]Hazardous air pollutant listed in the *Clean Air Act*.

Table 3.4-4. PAH EMISSION FACTORS FOR LARGE UNCONTROLLED STATIONARY DIESEL ENGINES[a]

EMISSION FACTOR RATING: E

PAH	Emission Factor (lb/MMBtu) (fuel input)
Naphthalene[b]	1.30 E-04
Acenaphthylene	9.23 E-06
Acenaphthene	4.68 E-06
Fluorene	1.28 E-05
Phenanthrene	4.08 E-05
Anthracene	1.23 E-06
Fluoranthene	4.03 E-06
Pyrene	3.71 E-06
Benz(a)anthracene	6.22 E-07
Chrysene	1.53 E-06
Benzo(b)fluoranthene	1.11 E-06
Benzo(k)fluoranthene	<2.18 E-07
Benzo(a)pyrene	<2.57 E-07
Indeno(1,2,3-cd)pyrene	<4.14 E-07
Dibenz(a,h)anthracene	<3.46 E-07
Benzo(g,h,l)perylene	<5.56 E-07
TOTAL PAH	<2.12 E-04

[a] Based on 1 uncontrolled diesel engine from Reference 7. Source Classification Code 2-02-004-01. Not enough information to calculate the output-specific emission factors of lb/hp-hr. To convert from lb/MMBtu to ng/J, multiply by 430.

[b] Hazardous air pollutant listed in the *Clean Air Act*.

Table 3.4-5. NO_x REDUCTION AND FUEL CONSUMPTION PENALTIES FOR LARGE STATIONARY DIESEL AND DUAL-FUEL ENGINES[a]

Control Approach		Diesel (SCC 2-02-004-01)		Dual Fuel (SCC 2-02-004-02)	
		NO_x Reduction (%)	ΔBSFC[b] (%)	NO_x Reduction (%)	ΔBSFC (%)
Derate	10%	ND	ND	<20	4
	20%	<20	4	ND	ND
	25%	5 - 23	1 - 5	1 - 33	1 - 7
Retard	2°	<20	4	<20	3
	4°	<40	4	<40	1
	8°	28 - 45	2 - 8	50 - 73	3 - 5
Air-to-fuel	3%	ND	ND	<20	0
	±10%	7 - 8	3	25 - 40	1 - 3
Water injection (H_2O/fuel ratio)	50%	25 - 35	2 - 4	ND	ND
SCR		80 - 95	0	80 - 95	0

[a] References 1,27-28. The reductions shown are typical and will vary depending on the engine and duty cycle. SCC = Source Classification Code. ΔBSFC = change in brake-specific fuel consumption. ND = no data.

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20. *Compliance Test Report For Emissions Of Particulate From An Emergency Diesel Generator*, Meriden - Wallingford Hospital, Meriden, CT, TRC Environmental Consultants, 1987.

21. *Compliance Test Report Johnson Memorial Hospital Emergency Generator Exhaust Stack*, Stafford Springs, CT, ROJAC Environmental Services, 1987.

22. *Compliance Test Report Union Carbide Corporation Generator Exhaust Stack*, Danbury, CT, ROJAC Environmental Services, 1988.

23. *Compliance Test Report Hartford Insurance Company Emergency Generator Exhaust Stack*, Bloomfield, CT, ROJAC Environmental Services, 1987.

24. *Compliance Test Report Hartford Insurance Group Emergency Generator Exhaust Stack*, Hartford, CT, ROJAC Environmental Services, 1987.

25. *Compliance Test Report Southern New England Telephone Company Emergency Generator Exhaust Stack*, North Haven, CT, ROJAC Environmental Services, 1988.

26. *Compliance Test Report Pfizer, Inc. Two Emergency Generator Exhaust Stacks*, Groton, CT, ROJAC Environmental Services, 1987.

27. L. M. Campbell, *et al.*, *Sourcebook: NO_x Control Technology Data, Control Technology Center*, EPA-600/2-91-029, U. S. Environmental Protection Agency, Cincinnati, OH, July 1991.

28. *Catalysts For Air Pollution Control*, Manufacturers Of Emission Controls Association (MECA), Washington, DC, March 1992.

CATERPILLAR®

3056
MARINE PROPULSION

153 bkW
(205 bhp)

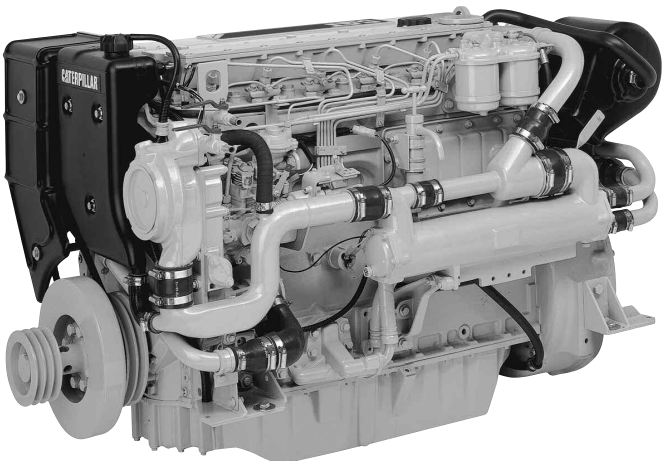


Image may not reflect actual engine

SPECIFICATIONS

I-6, 4-Stroke-Cycle-Diesel

Emissions . . . . . IMO Compliant
Bore . . . . . 100 mm (3.94 in.)
Stroke . . . . . 127 mm (5.0 in.)
Displacement . . . . . 6 L (365 cu. in.)
Aspiration . . . . . DITA
Rotation (from flywheel end) . . Counterclockwise
Compression Ratio 16.0:1
Capacity for Liquids
  Cooling System . . . . . 25.3 L (6.5 gal)
  Lube Oil System (refill) . . . . . 15 L (3.9 gal)
Oil Change Interval . . . . . 400 hr
  API CF-4, 15W40, 10W30
Engine Weight (approx) . . . . . 609 kg (1,342 lb)

STANDARD ENGINE EQUIPMENT

Air Inlet System
Air cleaner with closed system fumes disposal, sea water aftercooler, dry insulated turbocharger, thermostart air inlet heater

Charging System
Charging alternator (12-volt, 70 ampere or 24-volt, 40 ampere)

Control System
Mechanical governor

Cooling System
Gear-driven centrifugal jacket water pump and self-priming sea water pump, heat exchanger with cupro-nickel tube bundle or keel cooling connections, de-aeration expansion tank, integral plate-type engine oil cooler, sea water strainer, thermostat and housing

Exhaust System
Dry insulated turbocharger, watercooled exhaust manifold

Flywheel and Flywheel Housing
SAE No. 3 (126 teeth)

Fuel System
Twin fuel filter

Lube System
Crankcase breather (closed system), twin oil filter, engine-mounted oil sump drain pump, RH service oil level gauge

Mounting System
Adjustable mounts

Protection System
Shutoff solenoid (ETS), alarm switches (high jacket water temperature, low oil pressure)

Starting System
Electric starting motor (12-volt and 24-volt)

General
Vibration damper, Caterpillar yellow paint, lifting eyes

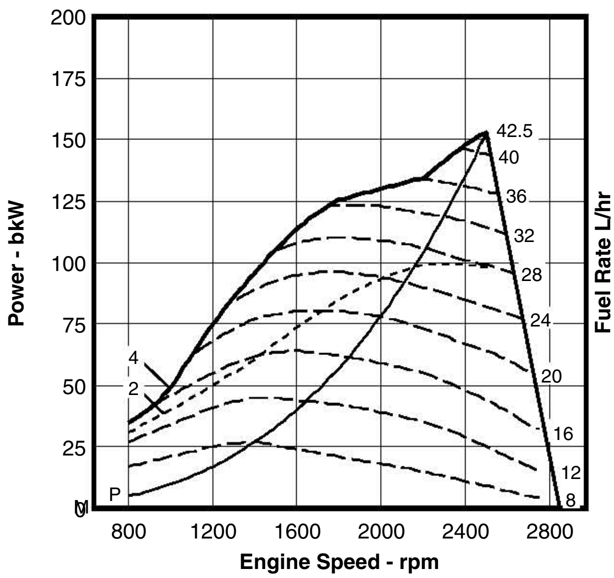
CATERPILLAR®

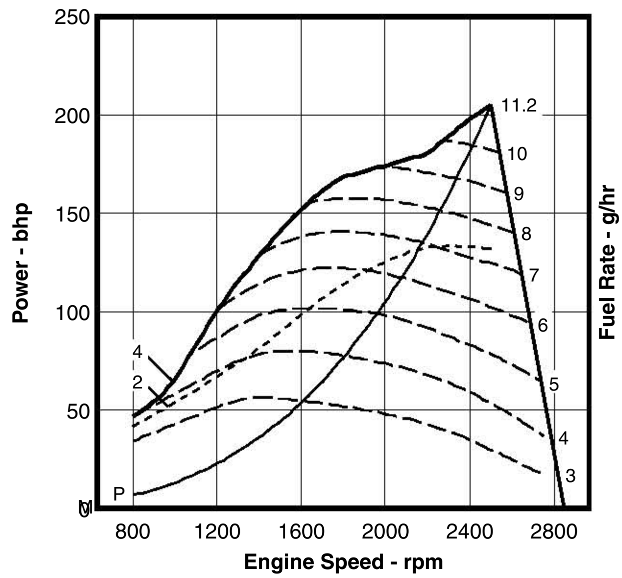
3056 MARINE PROPULSION

153 bkW (205 bhp)

PERFORMANCE CURVES

C Rating — DM6309-00 IMO Compliant





153 kW — SI Metric

Performance Data

	Engine Speed rpm	Engine Power kW	BSFC g/ kW-h	Fuel Rate L/h	Boost Press kPa Gauge	Intake Air Flow m^3/min	Exh Manif Temp °C	Exh Gas Flow m^3/min
Zone	2500	98.4	238	27.9	92.9	10.9	416	22.3
Limit	2400	99.2	232	27.4	90.2	10.4	412	21.6
Curve: 2	2200	99.0	222	26.1	85.1	9.5	410	19.4
	2000	93.5	214	23.9	77.7	8.4	408	16.2
	1800	84.9	209	21.2	68.4	7.2	409	12.8
	1600	73.6	208	18.2	55.6	5.9	409	10.6
	1400	60.8	215	15.6	41.1	4.7	408	10.2
	1200	50.0	243	14.5	28.5	3.6	406	11.5
	1000	40.1	294	14.1	16.8	2.5	404	13.9
	800	31.0	367	13.6	6.0	1.5	400	16.4
Zone	2500	153.0	233	42.5	125.6	12.6	563	31.3
Limit	2400	147.8	230	40.5	122.2	12.0	543	29.2
Curve: 4	2200	134.5	224	35.9	112.4	10.8	505	25.0
	2000	130.0	220	34.1	110.6	9.5	515	22.7
	1800	125.6	218	32.6	109.0	8.1	540	20.3
	1600	113.6	219	29.7	96.6	6.9	547	17.5
	1400	95.9	226	25.8	74.0	5.9	542	15.0
	1200	75.0	250	22.3	49.2	4.6	522	11.5
	1000	49.0	295	17.2	22.6	2.6	465	9.9
	800	34.8	365	15.2	7.8	1.5	438	13.4
Prop	2500	153.0	233	42.5	125.6	12.6	563	31.3
Demand	2400	135.4	229	36.9	113.8	11.6	506	27.0
Curve: P	2200	104.3	222	27.6	88.8	9.7	422	20.1
	2000	78.3	219	20.4	66.4	7.8	369	13.0
	1800	57.1	221	15.0	46.9	6.2	327	6.8
	1600	40.1	229	10.9	31.6	5.0	287	7.1
	1400	26.9	246	7.9	21.3	4.0	248	6.8
	1200	16.9	308	6.2	14.6	3.0	208	4.8
	1000	9.8	471	5.5	9.9	2.2	169	3.0
	800	5.0	761	4.5	6.3	1.6	132	2.4

Brake Mean Effective Pressure...1227 kPa

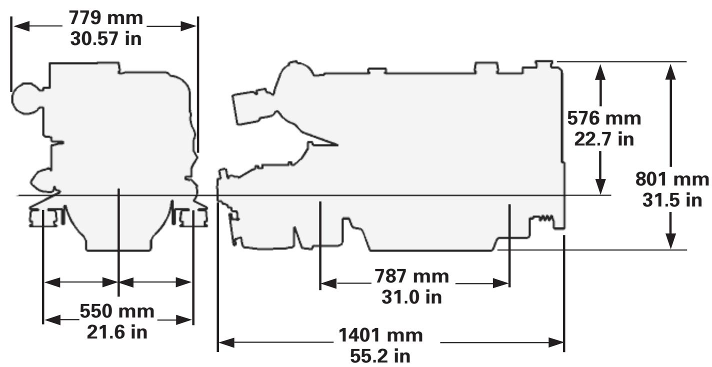
205 hp — English

Performance Data

	Engine Speed rpm	Engine Power hp	BSFC lb/ hp-h	Fuel Rate gph	Boost Press in.Hg. Gauge	Intake Air Flow cfm	Exh Manif Temp °F	Exh Gas Flow cfm
Zone	2500	132	.392	7.4	27.5	385	781	788
Limit	2400	133	.381	7.2	26.7	367	774	762
Curve: 2	2200	133	.364	6.9	25.2	335	769	685
	2000	125	.352	6.3	23.0	296	766	572
	1800	114	.344	5.6	20.2	254	768	452
	1600	99	.342	4.8	16.5	208	769	374
	1400	82	.353	4.1	12.2	166	767	360
	1200	67	.399	3.8	8.4	127	763	406
	1000	54	.483	3.7	5.0	88	758	491
	800	42	.604	3.6	1.8	53	752	579
Zone	2500	205	.383	11.2	37.2	445	1046	1105
Limit	2400	198	.377	10.7	36.2	423	1010	1031
Curve: 4	2200	180	.368	9.5	33.3	381	941	883
	2000	174	.362	9.0	32.8	335	960	802
	1800	168	.358	8.6	32.3	286	1003	717
	1600	152	.360	7.8	28.6	244	1016	618
	1400	129	.372	6.8	21.9	208	1008	530
	1200	101	.410	5.9	14.6	162	972	406
	1000	66	.486	4.5	6.7	92	869	350
	800	47	.601	4.0	2.3	53	820	473
Prop	2500	205	.383	11.2	37.2	445	1046	1105
Demand	2400	182	.376	9.7	33.7	410	943	953
Curve: P	2200	140	.364	7.3	26.3	343	792	710
	2000	105	.360	5.4	19.7	275	696	459
	1800	77	.363	4.0	13.9	219	620	240
	1600	54	.376	2.9	9.4	177	548	251
	1400	36	.404	2.1	6.3	141	479	240
	1200	23	.506	1.6	4.3	106	406	170
	1000	13	.774	1.5	2.9	78	335	106
	800	7	1.250	1.2	1.9	57	269	85

Brake Mean Effective Pressure...178 psi

DIMENSIONS



with ZF Hurth HSW 630 A Gearbox

RATING DEFINITIONS AND CONDITIONS

C RATING – Vessels such as ferries, harbor tugs, fishing boats moving at higher speeds out and back (e.g. lobster, crayfish, and tuna), offshore service boats, and also displacement hull yachts and short trip coastal freighters where engine load and speed are cyclical.

RATINGS are based on SAE J1228/ISO8665 standard conditions of 100 kPa (29.61 in. Hg), 25° C (77° F), and 30% relative humidity. These ratings also apply at ISO3046/1, DIN6271/3, and BS5514 conditions of 100 kPa (29.61 in. Hg), 27° C (81° F), and 60% relative humidity. Ratings are valid for air cleaner inlet temperatures up to and including 50° C (122° F) and for sea water temperatures up to and including 38° C (100° F) at sea level.

FUEL RATES are based on fuel oil of 35° API [16° C (60° F)] gravity having an LHV of 42 780 kJ/kg (18,390 Btu/lb) when used at 29° C (85° F) and weighing 838.9 g/liter (7.001 lbs/U.S. gal). Fuel consumption shown with all oil, fuel, and water pumps, engine driven. For a “without pumps” condition, deduct approximately 0.5% for each pump not engine driven.

Additional ratings may be available for specific customer requirements. Consult your Caterpillar representative for additional information.

Table 3.3-1. EMISSION FACTORS FOR UNCONTROLLED GASOLINE AND DIESEL INDUSTRIAL ENGINES[a]

Pollutant	Gasoline Fuel (SCC 2-02-003-01, 2-03-003-01)		Diesel Fuel (SCC 2-02-001-02, 2-03-001-01)		EMISSION FACTOR RATING
	Emission Factor (lb/hp-hr) (power output)	Emission Factor (lb/MMBtu) (fuel input)	Emission Factor (lb/hp-hr) (power output)	Emission Factor (lb/MMBtu) (fuel input)	
NO_x	0.011	1.63	0.031	4.41	D
CO	6.96 E-03[d]	0.99[d]	6.68 E-03	0.95	D
SO_x	5.91 E-04	0.084	2.05 E-03	0.29	D
PM-10[b]	7.21 E-04	0.10	2.20 E-03	0.31	D
CO_2[c]	1.08	154	1.15	164	B
Aldehydes	4.85 E-04	0.07	4.63 E-04	0.07	D
TOC					
Exhaust	0.015	2.10	2.47 E-03	0.35	D
Evaporative	6.61 E-04	0.09	0.00	0.00	E
Crankcase	4.85 E-03	0.69	4.41 E-05	0.01	E
Refueling	1.08 E-03	0.15	0.00	0.00	E

[a] References 2,5-6,9-14. When necessary, an average brake-specific fuel consumption (BSFC) of 7,000 Btu/hp-hr was used to convert from lb/MMBtu to lb/hp-hr. To convert from lb/hp-hr to kg/kw-hr, multiply by 0.608. To convert from lb/MMBtu to ng/J, multiply by 430. SCC = Source Classification Code. TOC = total organic compounds.

[b] PM-10 = particulate matter less than or equal to 10 µm aerodynamic diameter. All particulate is assumed to be $\leq$ 1 µm in size.

[c] Assumes 99% conversion of carbon in fuel to CO_2 with 87 weight % carbon in diesel, 86 weight % carbon in gasoline, average BSFC of 7,000 Btu/hp-hr, diesel heating value of 19,300 Btu/lb, and gasoline heating value of 20,300 Btu/lb.

[d] Instead of 0.439 lb/hp-hr (power output) and 62.7 lb/mmBtu (fuel input), the correct emissions factors values are 6.96 E-03 lb/hp-hr (power output) and 0.99 lb/mmBtu (fuel input), respectively. This is an editorial correction. March 24, 2009

Table 3.3-2. SPECIATED ORGANIC COMPOUND EMISSION FACTORS FOR UNCONTROLLED DIESEL ENGINES[a]

EMISSION FACTOR RATING: E

Pollutant	Emission Factor (Fuel Input) (lb/MMBtu)
Benzene[b]	9.33 E-04
Toluene[b]	4.09 E-04
Xylenes[b]	2.85 E-04
Propylene	2.58 E-03
1,3-Butadiene[b,c]	<3.91 E-05
Formaldehyde[b]	1.18 E-03
Acetaldehyde[b]	7.67 E-04
Acrolein[b]	<9.25 E-05
Polycyclic aromatic hydrocarbons (PAH)	
Naphthalene[b]	8.48 E-05
Acenaphthylene	<5.06 E-06
Acenaphthene	<1.42 E-06
Fluorene	2.92 E-05
Phenanthrene	2.94 E-05
Anthracene	1.87 E-06
Fluoranthene	7.61 E-06
Pyrene	4.78 E-06
Benzo(a)anthracene	1.68 E-06
Chrysene	3.53 E-07
Benzo(b)fluoranthene	<9.91 E-08
Benzo(k)fluoranthene	<1.55 E-07
Benzo(a)pyrene	<1.88 E-07
Indeno(1,2,3-cd)pyrene	<3.75 E-07
Dibenz(a,h)anthracene	<5.83 E-07
Benzo(g,h,l)perylene	<4.89 E-07
TOTAL PAH	1.68 E-04

[a] Based on the uncontrolled levels of 2 diesel engines from References 6-7. Source Classification Codes 2-02-001-02, 2-03-001-01. To convert from lb/MMBtu to ng/J, multiply by 430.
[b] Hazardous air pollutant listed in the *Clean Air Act*.
[c] Based on data from 1 engine.

Federal Environment and Safety Codified Regulations
TITLE 40—Protection of Environment
PART 98—MANDATORY GREENHOUSE GAS REPORTING
SUBPART C—General Stationary Fuel Combustion Sources

Table C-1 to Subpart C of Part 98 —Default CO_2 Emission Factors and High Heat Values for Various Types of Fuel

Fuel type	Default high heat value	Default CO_2 emission factor
Coal and coke	mmBtu/short ton	kg CO_2 /mmBtu
Anthracite	25.09	103.69
Bituminous	24.93	93.28
Subbituminous	17.25	97.17
Lignite	14.21	97.72
Coal Coke	24.80	113.67
Mixed (Commercial sector)	21.39	94.27
Mixed (Industrial coking)	26.28	93.90
Mixed (Industrial sector)	22.35	94.67
Mixed (Electric Power sector)	19.73	95.52
Natural gas	mmBtu/scf	kg CO_2 /mmBtu
(Weighted U.S. Average)	1.026×10^{-3}	53.06
Petroleum products—liquid	mmBtu/gallon	kg CO_2/mmBtu
Distillate Fuel Oil No. 1	0.139	73.25
Distillate Fuel Oil No. 2	0.138	73.96
Distillate Fuel Oil No. 4	0.146	75.04
Residual Fuel Oil No. 5	0.140	72.93
Residual Fuel Oil No. 6	0.150	75.10
Used Oil	0.138	74.00
Kerosene	0.135	75.20
Liquefied petroleum gases (LPG) [1]	0.092	61.71
Propane [1]	0.091	62.87
Propylene [2]	0.091	67.77
Ethane [1]	0.068	59.60
Ethanol	0.084	68.44
Ethylene [2]	0.058	65.96
Isobutane [1]	0.099	64.94
Isobutylene [1]	0.103	68.86
Butane [1]	0.103	64.77
Butylene [1]	0.105	68.72
Naphtha (<401 deg F)	0.125	68.02
Natural Gasoline	0.110	66.88
Other Oil (>401 deg F)	0.139	76.22

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SUBPART C—General Stationary Fuel Combustion Sources

Table C-2 to Subpart C of Part 98 —Default CH_4 and N_2O Emission Factors for Various Types of Fuel

Fuel type	Default CH_4 emission factor (kg CH_4 /mmBtu)	Default N_2O emission factor (kg N_2O/mmBtu)
Coal and Coke (All fuel types in Table C-1)	1.1×10^{-02}	1.6×10^{-03}
Natural Gas	1.0×10^{-03}	1.0×10^{-04}
Petroleum Products (All fuel types in Table C-1)	3.0×10^{-03}	6.0×10^{-04}
Fuel Gas	3.0×10^{-03}	6.0×10^{-04}
Other Fuels—Solid	3.2×10^{-02}	4.2×10^{-03}
Blast Furnace Gas	2.2×10^{-05}	1.0×10^{-04}
Coke Oven Gas	4.8×10^{-04}	1.0×10^{-04}
Biomass Fuels—Solid (All fuel types in Table C-1, except wood and wood residuals)	3.2×10^{-02}	4.2×10^{-03}
Wood and wood residuals	7.2×10^{-03}	3.6×10^{-03}
Biomass Fuels—Gaseous (All fuel types in Table C-1)	3.2×10^{-03}	6.3×10^{-04}
Biomass Fuels—Liquid (All fuel types in Table C-1)	1.1×10^{-03}	1.1×10^{-04}

Note: Those employing this table are assumed to fall under the IPCC definitions of the “Energy Industry” or “Manufacturing Industries and Construction”. In all fuels except for coal the values for these two categories are identical. For coal combustion, those who fall within the IPCC “Energy Industry” category may employ a value of 1g of CH_4 /mmBtu.

[75 FR page 79154, Dec. 17, 2010; 78 FR page 71952, Nov. 29, 2013; 81 FR page 89252, Dec. 9, 2016]

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Federal Environment and Safety Codified Regulations
TITLE 40—Protection of Environment
PART 98—MANDATORY GREENHOUSE GAS REPORTING
SUBPART A—General Provision

Table A-1 to Subpart A of Part 98 —Global Warming Potentials

[100-Year Time Horizon]

Name	CAS No.	Chemical formula	Global warming potential (100 yr.)
Chemical-Specific GWPs			
Carbon dioxide	124-38-9	CO_2	1
Methane	74-82-8	CH_4	[a] 25
Nitrous oxide	10024-97-2	N_2O	[a] 298
Fully Fluorinated GHGs			
Sulfur hexafluoride	2551-62-4	SF_6	[a] 22,800
Trifluoromethyl sulphur pentafluoride	373-80-8	SF_5CF_3	17,700
Nitrogen trifluoride	7783-54-2	NF_3	17,200
PFC-14 (Perfluoromethane)	75-73-0	CF_4	[a] 7,390
PFC-116 (Perfluoroethane)	76-16-4	C_2F_6	[a] 12,200
PFC-218 (Perfluoropropane)	76-19-7	C_3F_8	[a] 8,830
Perfluorocyclopropane	931-91-9	$C\text{-}C_3F_6$	17,340
PFC-3-1-10 (Perfluorobutane)	355-25-9	C_4F_{10}	[a] 8,860
PFC-318 (Perfluorocyclobutane)	115-25-3	$C\text{-}C_4F_8$	[a] 10,300
PFC-4-1-12 (Perfluoropentane)	678-26-2	C_5F_{12}	[a] 9,160
PFC-5-1-14 (Perfluorohexane, FC-72)	355-42-0	C_6F_{14}	[a] 9,300
PFC-6-1-12	335-57-9	C_7F_{16}; $CF_3(CF_2)_5CF_3$	[b] 7,820
PFC-7-1-18	307-34-6	C_8F_{18}; $CF_3(CF_2)_6CF_3$	[b] 7,620
PFC-9-1-18	306-94-5	$C_{10}F_{18}$	7,500
PFPMIE (HT-70)	NA	$CF_3OCF(CF_3)CF_2OCF_2OCF_3$	10,300
Perfluorodecalin (cis)	60433-11-6	$Z\text{-}C_{10}F_{18}$	[b] 7,236
Perfluorodecalin (trans)	60433-12-7	$E\text{-}C_{10}F_{18}$	[b] 6,288
Saturated Hydrofluorocarbons (HFCs) With Two or Fewer Carbon-Hydrogen Bonds			
HFC-23	75-46-7	CHF_3	[a] 14,800
HFC-32	75-10-5	CH_2F_2	[a] 675
HFC-125	354-33-6	C_2HF_5	[a] 3,500
HFC-134	359-35-3	$C_2H_2F_4$	[a] 1,100
HFC-134a	811-97-2	CH_2FCF_3	[a] 1,430
HFC-227ca	2252-84-8	$CF_3CF_2CHF_2$	[b] 2640

Table 11.17-2 (cont.).

Source	Filterable[b] PM	Filterable[b] EMISSION FACTOR RATING	Filterable[b] PM-10	Filterable[b] EMISSION FACTOR RATING	Condensable PM[c] Inorganic	Condensable PM[c] EMISSION FACTOR RATING	Condensable PM[c] Organic	Condensable PM[c] EMISSION FACTOR RATING
Gas-fired parallel flow regenerative kiln with fabric filter (SCC 3-05-016-23)	0.026[z]	D	ND		ND		ND	
Atmospheric hydrator with wet scrubber (SCC 3-05-016-09)	0.067[aa]	D	ND		0.013[aa]	D	ND	
Product cooler (SCC 3-05-016-11)	6.8[y]	E	ND		0.023[y]	E	ND	

[a] Factors represent uncontrolled emissions unless otherwise noted. Factors are lb/ton of lime produced unless noted. ND = no data. SCC = Source Classification Code.
[b] Filterable PM is that PM collected on or prior to the filter of an EPA Method 5 (or equivalent) sampling train.
[c] Condensable PM is that PM collected in the impinger portion of a PM sampling train.
[d] References 11-12.
[e] References 4,11-12.
[f] References 9,13.
[g] Reference 11.
[h] Reference 12.
[j] References 12,20,31,33.
[k] References 4,12,20,31,33.
[m] References 8,20-23,33.
[n] References 4,12.
[p] References 10,28-29.
[q] References 10,15-16.
[r] Reference 14.
[s] References 17,32.
[t] Reference 19.
[u] Reference 30.
[v] Reference 13.
[w] Reference 18.
[x] Reference 34.
[y] Reference 25.
[z] Reference 35.
[aa] Reference 24; units are lb/ton of hydrated lime produced.

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]

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

$$E = k(0.0032) \frac{\left(\frac{U}{5}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \text{ (pound [lb]/ton)} \tag{1}$$

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

Table 11.19.2-2 (English Units). EMISSION FACTORS FOR CRUSHED STONE PROCESSING OPERATIONS (lb/Ton)[a]

Source [b]	Total Particulate Matter [r,s]	EMISSION FACTOR RATING	Total PM-10	EMISSION FACTOR RATING	Total PM-2.5	EMISSION FACTOR RATING
Primary Crushing (SCC 3-05-020-01)	ND		ND[n]		ND[n]	
Primary Crushing (controlled) (SCC 3-05-020-01)	ND		ND[n]		ND[n]	
Secondary Crushing (SCC 3-05-020-02)	ND		ND[n]		ND[n]	
Secondary Crushing (controlled) (SCC 3-05-020-02)	ND		ND[n]		ND[n]	
Tertiary Crushing (SCC 3-050030-03)	0.0054[d]	E	0.0024[o]	C	ND[n]	
Tertiary Crushing (controlled) (SCC 3-05-020-03)	0.0012[d]	E	0.00054[p]	C	0.00010[q]	E
Fines Crushing (SCC 3-05-020-05)	0.0390[e]	E	0.0150[e]	E	ND	
Fines Crushing (controlled) (SCC 3-05-020-05)	0.0030[f]	E	0.0012[f]	E	0.000070[q]	E
Screening (SCC 3-05-020-02, 03)	0.025[c]	E	0.0087[l]	C	ND	
Screening (controlled) (SCC 3-05-020-02, 03)	0.0022[d]	E	0.00074[m]	C	0.000050[q]	E
Fines Screening (SCC 3-05-020-21)	0.30[g]	E	0.072[g]	E	ND	
Fines Screening (controlled) (SCC 3-05-020-21)	0.0036[g]	E	0.0022[g]	E	ND	
Conveyor Transfer Point (SCC 3-05-020-06)	0.0030[h]	E	0.00110[h]	D	ND	
Conveyor Transfer Point (controlled) (SCC 3-05-020-06)	0.00014[i]	E	4.6×10^{-5}[i]	D	1.3×10^{-5}[q]	E
Wet Drilling - Unfragmented Stone (SCC 3-05-020-10)	ND		8.0×10^{-5}[j]	E	ND	
Truck Unloading -Fragmented Stone (SCC 3-05-020-31)	ND		1.6×10^{-5}[j]	E	ND	
Truck Loading - Conveyor, crushed stone (SCC 3-05-020-32)	ND		0.00010[k]	E	ND	

a. Emission factors represent uncontrolled emissions unless noted. Emission factors in lb/Ton of material of throughput. SCC = Source Classification Code. ND = No data.

b. Controlled sources (with wet suppression) are those that are part of the processing plant that employs current wet suppression technology similar to the study group. The moisture content of the study group without wet suppression systems operating (uncontrolled) ranged from 0.21 to 1.3 percent, and the same facilities operating wet suppression systems (controlled) ranged from 0.55 to 2.88 percent. Due to carry over of the small amount of moisture required, it has been shown that each source, with the exception of crushers, does not need to employ direct water sprays. Although the moisture content was the only variable measured, other process features may have as much influence on emissions from a given source. Visual observations from each source under normal operating conditions are probably the best indicator of which emission factor is most appropriate. Plants that employ substandard control measures as indicated by visual observations should use the uncontrolled factor with an appropriate control efficiency that best reflects the effectiveness of the controls employed.

c. References 1, 3, 7, and 8

d. References 3, 7, and 8

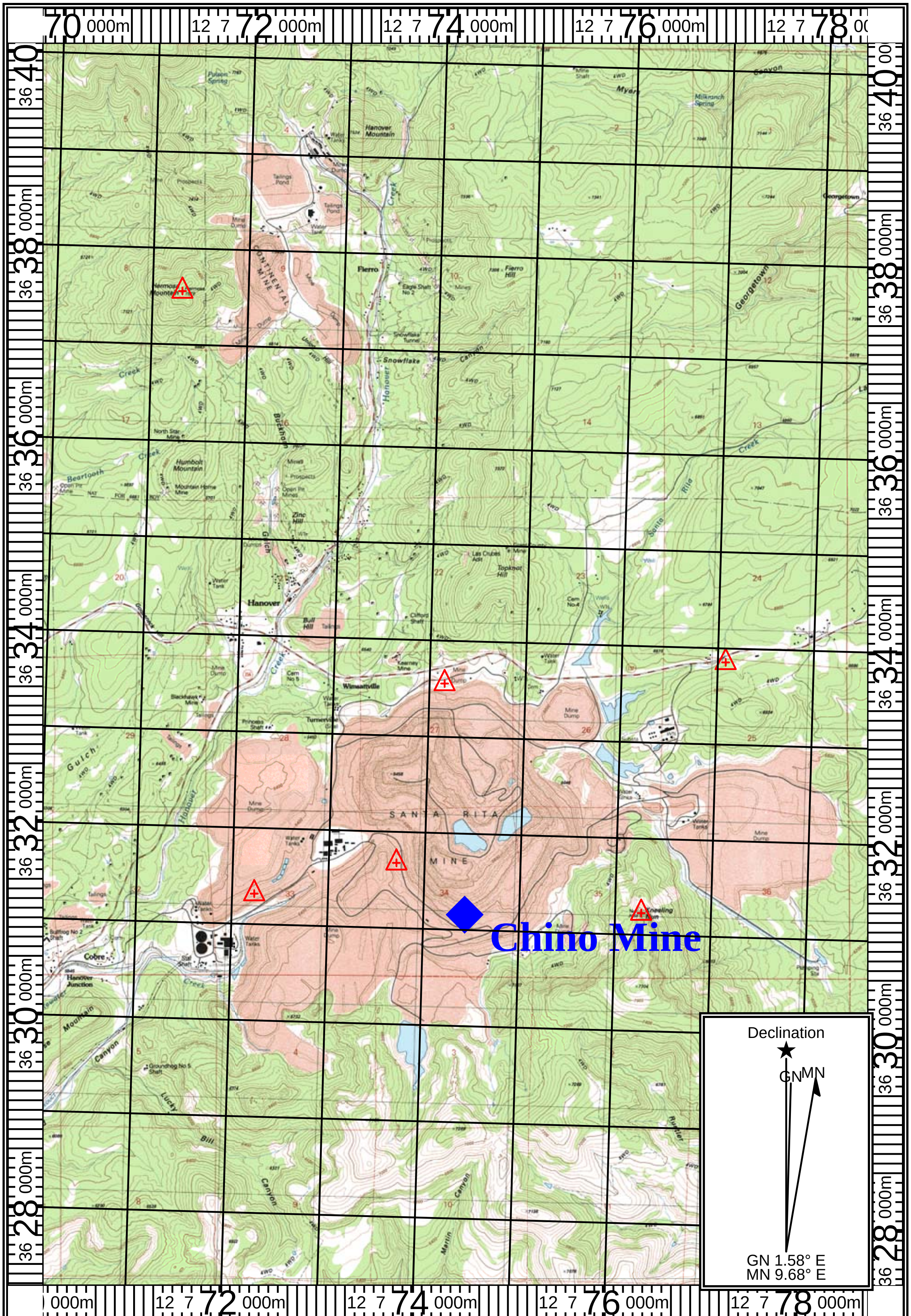
Section 8

Map(s)

A map such as a 7.5 minute topographic quadrangle showing the exact location of the source. The map shall also include the following:

The UTM or Longitudinal coordinate system on both axes	An indicator showing which direction is north
A minimum radius around the plant of 0.8km (0.5 miles)	Access and haul roads
Topographic features of the area	Facility property boundaries
The name of the map	The area which will be restricted to public access
A graphical scale	

A map of the facility is attached.



Map Name: SANTA RITA MINE Scale: 1 inch = 4,761 ft. Horizontal Datum: WGS84

Print Date: 11/17/19 Map Center: 12 0774500 E 3631100 N

Section 9

Proof of Public Notice

(for NSR applications submitting under 20.2.72 or 20.2.74 NMAC)
(This proof is required by: 20.2.72.203.A.14 NMAC "Documentary Proof of applicant's public notice")

☑ **I have read the AQB "Guidelines for Public Notification for Air Quality Permit Applications"**
This document provides detailed instructions about public notice requirements for various permitting actions. It also provides public notice examples and certification forms. Material mistakes in the public notice will require a re-notice before issuance of the permit.

Unless otherwise allowed elsewhere in this document, the following items document proof of the applicant's Public Notification. Please include this page in your proof of public notice submittal with checkmarks indicating which documents are being submitted with the application.

New Permit and **Significant Permit Revision** public notices must include all items in this list.

Technical Revision public notices require only items 1, 5, 9, and 10.

Per the Guidelines for Public Notification document mentioned above, include:

1. ☐ A copy of the certified letter receipts with post marks (20.2.72.203.B NMAC)
2. ☐ A list of the places where the public notice has been posted in at least four publicly accessible and conspicuous places, including the proposed or existing facility entrance. (e.g: post office, library, grocery, etc.)
3. ☐ A copy of the property tax record (20.2.72.203.B NMAC).
4. ☐ A sample of the letters sent to the owners of record.
5. ☐ A sample of the letters sent to counties, municipalities, and Indian tribes.
6. ☐ A sample of the public notice posted and a verification of the local postings.
7. ☐ A table of the noticed citizens, counties, municipalities and tribes and to whom the notices were sent in each group.
8. ☐ A copy of the public service announcement (PSA) sent to a local radio station and documentary proof of submittal.
9. ☐ A copy of the classified or legal ad including the page header (date and newspaper title) or its affidavit of publication stating the ad date, and a copy of the ad. When appropriate, this ad shall be printed in both English and Spanish.
10. ☐ A copy of the display ad including the page header (date and newspaper title) or its affidavit of publication stating the ad date, and a copy of the ad. When appropriate, this ad shall be printed in both English and Spanish.
11. ☐ A map with a graphic scale showing the facility boundary and the surrounding area in which owners of record were notified by mail. This is necessary for verification that the correct facility boundary was used in determining distance for notifying land owners of record.

This application is being submitted pursuant to 20.2.70.300.B.(2) NMAC and 20.2.70.404.C.(1)(a). No public notice is required.

Section 10

Written Description of the Routine Operations of the Facility

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<u>A written description of the routine operations of the facility</u>. Include a description of how each piece of equipment will be operated, how controls will be used, and the fate of both the products and waste generated. For modifications and/or revisions, explain how the changes will affect the existing process. In a separate paragraph describe the major process bottlenecks that limit production. The purpose of this description is to provide sufficient information about plant operations for the permit writer to determine appropriate emission sources.

Freeport-McMoRan Chino Mines Company owns and operates the Chino Mine (Chino). The Chino mine is an open-pit copper mining operation located approximately 15 miles east of Silver City in Grant County, New Mexico (UTM Zone 12 and Air Quality Control Region 12). The primary purpose of the facility is to produce copper cathode using the Solvent Extraction/Electrowinning (SXEW) process and copper concentrate using a wet flotation process. Chino is a minor source under the Prevention of Significant Deterioration (PSD) rules as currently permitted and will remain a minor source after the proposed significant revision. Chino will also remain a major source for operating permit purposes under Title V (20.2.70 NMAC).

Chino includes two open pits, the Santa Rita open pit and the Continental open pit (formally known as the Cobre Mine or herein as “Cobre”) located approximately 3 miles north of the Santa Rita open pit. Chino consists of unpaved haul roads and storage stockpiles. Ore mined from Cobre is transported via the Cobre Haul Road for future processing. Additional operations include a mill, which includes a primary crusher, conveyor belts and concentrator, two screening plants, loading of magnetite into over-the road trucks, a power plant, and a solution extraction and electrowinning plant.

In this Title V Renewal and Significant Modification Application, Freeport requests the authorization for blasting near the Cobre Haul Road Borrow Pit; the authorization of 119,700 lb/day for Borrow Pit blasting; the retirement of Mase 1 from the facility; the construction of baghouse to control SAG mill tunnel; the removal of units LmSlk and ENG-1; the replacement of Fire Emergency Pump; and the addition of two emergency standby generators.

Section 11

Source Determination

Source submitting under 20.2.70, 20.2.72, 20.2.73, and 20.2.74 NMAC

Sources applying for a construction permit, PSD permit, or operating permit shall evaluate surrounding and/or associated sources (including those sources directly connected to this source for business reasons) and complete this section. Responses to the following questions shall be consistent with the Air Quality Bureau's permitting guidance, Single Source Determination Guidance, which may be found on the Applications Page in the Permitting Section of the Air Quality Bureau website.

Typically, buildings, structures, installations, or facilities that have the same SIC code, that are under common ownership or control, and that are contiguous or adjacent constitute a single stationary source for 20.2.70, 20.2.72, 20.2.73, and 20.2.74 NMAC applicability purposes. Submission of your analysis of these factors in support of the responses below is optional, unless requested by NMED.

A. Identify the emission sources evaluated in this section (list and describe)**:**
Please refer to Table 2-A of this Title V Renewal.

B. Apply the 3 criteria for determining a single source:

SIC Code: Surrounding or associated sources belong to the same 2-digit industrial grouping (2-digit SIC code) as this facility, OR surrounding or associated sources that belong to different 2-digit SIC codes are support facilities for this source.

☑ **Yes** ☐ **No**

Common Ownership or Control: Surrounding or associated sources are under common ownership or control as this source.

☑ **Yes** ☐ **No**

Contiguous or Adjacent: Surrounding or associated sources are contiguous or adjacent with this source.

☑ **Yes** ☐ **No**

C. Make a determination:

☑ The source, as described in this application, constitutes the entire source for 20.2.70, 20.2.72, 20.2.73, or 20.2.74 NMAC applicability purposes. If in "A" above you evaluated only the source that is the subject of this application, all "**YES**" boxes should be checked. If in "A" above you evaluated other sources as well, you must check **AT LEAST ONE** of the boxes "**NO**" to conclude that the source, as described in the application, is the entire source for 20.2.70, 20.2.72, 20.2.73, and 20.2.74 NMAC applicability purposes.

☑ The source, as described in this application, **does not** constitute the entire source for 20.2.70, 20.2.72, 20.2.73, or 20.2.74 NMAC applicability purposes (A permit may be issued for a portion of a source). The entire source consists of the following facilities or emissions sources (list and describe):

Section 12

Section 12.A
PSD Applicability Determination for All Sources

(Submitting under 20.2.72, 20.2.74 NMAC)

A PSD applicability determination for all sources. For sources applying for a significant permit revision, apply the applicable requirements of 20.2.74.AG and 20.2.74.200 NMAC and to determine whether this facility is a major or minor PSD source, and whether this modification is a major or a minor PSD modification. It may be helpful to refer to the procedures for Determining the Net Emissions Change at a Source as specified by Table A-5 (Page A.45) of the EPA New Source Review Workshop Manual to determine if the revision is subject to PSD review.

A. This facility is:

- ☑ **a minor PSD source before and after this modification (if so, delete C and D below).**
- ☐ **a major PSD source before this modification. This modification will make this a PSD minor source.**
- ☐ **an existing PSD Major Source that has never had a major modification requiring a BACT analysis.**
- ☐ **an existing PSD Major Source that has had a major modification requiring a BACT analysis**
- ☐ **a new PSD Major Source after this modification.**

B. This facility will remain a PSD Minor

Section 13

Determination of State & Federal Air Quality Regulations

This section lists each state and federal air quality regulation that may apply to your facility and/or equipment that are stationary sources of regulated air pollutants.

Not all state and federal air quality regulations are included in this list. Go to the Code of Federal Regulations (CFR) or to the Air Quality Bureau's regulation page to see the full set of air quality regulations.

Required Information for Specific Equipment:
For regulations that apply to specific source types, in the 'Justification' column **provide any information needed to determine if the regulation does or does not apply**. **For example**, to determine if emissions standards at 40 CFR 60, Subpart IIII apply to your three identical stationary engines, we need to know the construction date as defined in that regulation; the manufacturer date; the date of reconstruction or modification, if any; if they are or are not fire pump engines; if they are or are not emergency engines as defined in that regulation; their site ratings; and the cylinder displacement.

Required Information for Regulations that Apply to the Entire Facility:
See instructions in the 'Justification' column for the information that is needed to determine if an 'Entire Facility' type of regulation applies (e.g. 20.2.70 or 20.2.73 NMAC).

Regulatory Citations for Regulations That Do Not, but Could Apply:
If there is a state or federal air quality regulation that does not apply, but you have a piece of equipment in a source category for which a regulation has been promulgated, you must **provide the low level regulatory citation showing why your piece of equipment is not subject to or exempt from the regulation. For example** if you have a stationary internal combustion engine that is not subject to 40 CFR 63, Subpart ZZZZ because it is an existing 2 stroke lean burn stationary RICE with a site rating of more than 500 brake HP located at a major source of HAP emissions, your citation would be 40 CFR 63.6590(b)(3)(i). **We don't want a discussion of every non-applicable regulation, but if it is possible a regulation could apply, explain why it does not. For example,** if your facility is a power plant, you do not need to include a citation to show that 40 CFR 60, Subpart OOO does not apply to your non-existent rock crusher.

Regulatory Citations for Emission Standards:
For each unit that is subject to an emission standard in a source specific regulation, such as 40 CFR 60, Subpart OOO or 40 CFR 63, Subpart HH, include the low level regulatory citation of that emission standard. Emission standards can be numerical emission limits, work practice standards, or other requirements such as maintenance. **Here are examples:** a glycol dehydrator is subject to the general standards at 63.764C(1)(i) through (iii); an engine is subject to 63.6601, Tables 2a and 2b; a crusher is subject to 60.672(b), Table 3 and all transfer points are subject to 60.672(e)(1)

Federally Enforceable Conditions:
All federal regulations are federally enforceable. All Air Quality Bureau State regulations are federally enforceable except for the following: affirmative defense portions at 20.2.7.6.B, 20.2.7.110(B)(15), 20.2.7.11 through 20.2.7.113, 20.2.7.115, and 20.2.7.116; 20.2.37; 20.2.42; 20.2.43; 20.2.62; 20.2.63; 20.2.86; 20.2.89; and 20.2.90 NMAC. Federally enforceable means that EPA can enforce the regulation as well as the Air Quality Bureau and federally enforceable regulations can count toward determining a facility's potential to emit (PTE) for the Title V, PSD, and nonattainment permit regulations.

INCLUDE ANY OTHER INFORMATION NEEDED TO COMPLETE AN APPLICABILITY DETERMINATION OR THAT IS RELEVENT TO YOUR FACILITY'S NOTICE OF INTENT OR PERMIT.

EPA Applicability Determination Index for 40 CFR 60, 61, 63, etc: http://cfpub.epa.gov/adi/

Table for STATE REGULATIONS:

STATE REGU-LATIONS CITATION	Title	Applies? Enter Yes or No	Unit(s) or Facility	JUSTIFICATION: (You may delete instructions or statements that do not apply in the justification column to shorten the document.)
20.2.1 NMAC	General Provisions	Yes	Facility	General Provisions apply to Notice of Intent, Construction, and Title V permit applications.
20.2.3 NMAC	Ambient Air Quality Standards NMAAQS	Yes	Facility	20.2.3 NMAC is a SIP approved regulation that limits the maximum allowable concentration of Total Suspended Particulates, Sulfur Compounds, Carbon Monoxide and Nitrogen Dioxide. The facility meets maximum allowable concentrations of TSP, SO_2, H_2S, NO_x, and CO under this regulation.
20.2.7 NMAC	Excess Emissions	Yes	Facility	This regulation establishes requirements for the facility if operations at the facility result in any excess emissions. The owner or operator will operate the source at the facility having an excess emission, to the extent practicable, including associated air pollution control equipment, in a manner consistent with good air pollution control practices for minimizing emissions. The facility will also notify the NMED of any excess emission per 20.2.7.110 NMAC.
20.2.23 NMAC	Fugitive Dust Control	No	N/A	This facility is authorized under a construction permit pursuant to the New Mexico Air Quality Control Act and is therefore not subject to this regulation.
20.2.33 NMAC	Gas Burning Equipment - Nitrogen Dioxide	No	N/A	This facility does not have gas burning equipment having a heat input of greater than 1,000,000 million British Thermal Units per year per unit. This regulation does not apply.
20.2.34 NMAC	Oil Burning Equipment: NO_2	No	N/A	This facility does not have oil burning equipment having a heat input of greater than 1,000,000 million British Thermal Units per year per unit. The facility is not subject to this regulation and does not have emission sources that meet the applicability requirements under 20.2.34.108 NMAC.
20.2.35 NMAC	Natural Gas Processing Plant – Sulfur	No	N/A	The purpose of this regulation is to establish sulfur emissions standards for natural gas processing plants [20.2.35.6 NMAC]. This facility is not a natural gas processing plant, as defined in the regulation [20.2.35.7 NMAC]. As this facility is not defined as a natural gas processing plant under this regulation, the facility is not subject to this regulation.
20.2.37 and 20.2.36 NMAC	Petroleum Processing Facilities and Petroleum Refineries	No	N/A	The purpose of this regulation is to minimize emissions from petroleum or natural gas processing facilities [20.2.37.6 NMAC]. This facility not a natural gas or petroleum processing facility, as defined in the regulation [20.2.37.7 NMAC]. As this facility is not defined as a natural gas or petroleum processing facility, the facility is not subject to this regulation.
20.2.38 NMAC	Hydrocarbon Storage Facility	No	N/A	This regulation applies to storage facilities which are operated in conjunction with a petroleum production or petroleum processing facility. The Chino facility is not a petroleum production or processing facility, therefore this regulation does not apply.
20.2.39 NMAC	Sulfur Recovery Plant - Sulfur	No	N/A	This regulation establishes sulfur emission standards for sulfur recovery plants which are not part of petroleum or natural gas processing facilities. This regulation does not apply to this facility because it does not have elements of a sulfur recovery plant.
20.2.61.109 NMAC	Smoke & Visible Emissions	Yes	F-2-1-1.4, F-2-1-1.5, CH SCRN ENG, CB SCRN ENG, SXEW Boilers No. 1-3	All stationary combustion equipment (emergency generators, boilers, heat recovery generator, engines, and turbine) at the facility are subject to this regulation and comply by limiting opacity to a maximum of 20%.
20.2.70 NMAC	Operating Permits	Yes	Facility	This regulation establishes requirements for obtaining an operating permit. This regulation does apply as the facility is a Title V major source of NO_x, CO, PM_{10}, and $PM_{2.5}$. This facility operates under Title V Permit P066-R3M1.

STATE REGU-LATIONS CITATION	Title	Applies? Enter Yes or No	Unit(s) or Facility	JUSTIFICATION: (You may delete instructions or statements that do not apply in the justification column to shorten the document.)
20.2.71 NMAC	Operating Permit Fees	Yes	Facility	This regulation establishes a schedule of operating permit emission fees. The facility is subject to 20.2.70 NMAC and is therefore subject to requirements of this regulation.
20.2.72 NMAC	Construction Permits	Yes	Facility	This regulation establishes the requirements for obtaining a construction permit. The facility is a stationary source that has potential emission rates greater than 10 pounds per hour or 25 tons per year of any regulated air contaminant for which there is a National or New Mexico Air Quality Standard. The facility has a construction permit (NSR Permit) 0298-M10R1 to meet the requirements of this regulation.
20.2.73 NMAC	NOI & Emissions Inventory Requirements	Yes	Facility	This regulation establishes emission inventory requirements. The facility meets the applicability requirements of 20.2.73.300 NMAC. The facility will meet all applicable reporting requirements under 20.2.73.300.B.1 NMAC.
20.2.74 NMAC	Permits – Prevention of Significant Deterioration (PSD)	No	N/A	This regulation establishes requirements for obtaining a prevention of significant deterioration permit. Facility-wide non-fugitive emission rates are below PSD major thresholds. This regulation does not apply.
20.2.75 NMAC	Construction Permit Fees	Yes	Facility	This application is being submitted pursuant to 20.2.70.300.B.2 NMAC, which is subject to 20.2.71 NMAC which establishes Operating Emission Fees. Freeport-McMoRan is expected to submit a payment for their facility's emission rate. 20.2.75 NMAC establishes fees associated with permits submitted under 20.2.72 NMAC, therefore this facility is not subject to this regulation.
20.2.77 NMAC	New Source Performance	Yes	Diesel Emergency Generators, Natural Gas emergency Generator, LPG Emergency Generators, F-2-1-1.5, F-2-1-1.4, PC-01, PC DUMP, CTS-01, CV-01A, CV-01B, CV-01C, SAG-F1, IC-01, SCDP, CB SCRN ENG, CH SCRN ENG, WH Crush	This regulation establishes state authority to implement NSPS for stationary sources subject to 40 CFR 60. This regulation applies as the following NSPS subparts apply: - Subpart Dc – Unit F-2-1-1.5 is subject - Subpart GG – Unit F-2-1-1.4 is subject - Subpart LL – Metallic mineral processing units are subject: PC-01, PC DUMP, CTS-01, CV-01A, CV-01B, CV-01C, SAG-F1, IC 01, SCDP - Subpart OOO – Nonmetallic mineral processing unit is WH Crush - Subpart IIII –12 diesel emergency generators Subpart JJJJ-1 natural gas emergency generator and 6 LPG emergency generators
20.2.78 NMAC	Emission Standards for HAPS	No	N/A	This regulation establishes state authority to implement emission standards for hazardous air pollutants subject to 40 CFR Part 61, as amended through December 31, 2010. This facility does not emit hazardous air pollutants which are subject to the requirements of 40 CFR Part 61 and is therefore not subject to this regulation.

STATE REGU-LATIONS CITATION	Title	Applies? Enter Yes or No	Unit(s) or Facility	JUSTIFICATION: (You may delete instructions or statements that do not apply in the justification column to shorten the document.)
20.2.79 NMAC	Permits – Nonattainment Areas	No	N/A	This regulation establishes the requirements for obtaining a nonattainment area permit. The facility is not located in a non-attainment area and therefore is not subject to this regulation.
20.2.80 NMAC	Stack Heights	No	N/A	This regulation establishes requirements for the evaluation of stack heights and other dispersion techniques. This regulation does not apply as all stacks at the facility follow good engineering practice.
20.2.82 NMAC	MACT Standards for source categories of HAPS	Yes	Diesel Emergency Generators, Natural Gas emergency Generator, LPG Emergency Generators, CH SCRN ENG, CB SCRN ENG, GDF	This regulation established state authority to implement MACT Standards for source categories of HAPs. This regulation applies to all sources emitting hazardous air pollutants, which are subject to the requirements of 40 CFR Part 63. This regulation applies as the following MACT subparts apply: - Subpart ZZZZ – The following engines are subject: Diesel Emergency Generators, Natural Gas emergency Generator, LPG Emergency Generators, CH SCRN ENG, CB SCRN ENG Subpart CCCCCC – Unit GDF is subject

Table for Applicable FEDERAL REGULATIONS:

FEDERAL REGULATIONS CITATION	Title	Applies? Enter Yes or No	Unit(s) or Facility	JUSTIFICATION:
40 CFR 50	NAAQS	Yes	Facility	This regulation defines national ambient air quality standards. The facility meets all applicable national ambient air quality standards for NO_x, CO, SO_2, lead, ozone, PM_{10}, and $PM_{2.5}$ under this regulation.
NSPS 40 CFR 60, Subpart A	General Provisions	Yes	Diesel Emergency Generators, Natural Gas emergency Generator, LPG Emergency Generators, F-2-1-1.5, F-2-1-1.4, PC-01, PC DUMP, CTS-01, CV-01A, CV-01B, CV-01C, SAG-F1, IC-01, SCDP, CB SCRN ENG, CH SCRN ENG, WH Crush	This regulation defines general provisions for relevant standards that have been set under this part. This subpart applies as the following NSPS subparts apply: - Subpart Dc – Unit F-2-1-1.5 is subject - Subpart GG – Unit F-2-1-1.4 is subject - Subpart LL – Metallic mineral processing units are subject: PC-01, PC DUMP, CTS-01, CV-01A, CV-01B, CV-01C, SAG-F1, IC 01, SCDP - Subpart OOO – Nonmetallic mineral processing unit is WH Crush. - Subpart IIII –12 diesel emergency generators Subpart JJJJ-1 natural gas emergency generator and 6 LPG emergency generators
NSPS 40 CFR60.40a, Subpart Da	Subpart Da, Performance Standards for **Electric Utility Steam Generating Units**	No	N/A	This regulation establishes standards of performance for electric utility steam generating units. This regulation does not apply as this facility does not operate any electric utility steam generating units.
NSPS 40 CFR60.40b Subpart Db	**Electric Utility Steam Generating Units**	No	N/A	This regulation establishes standards of performance for industrial-commercial-institutional steam generating units. This regulation does not apply because the facility's steam generating units do not have capacities which exceed the 100 MMBtu/hr threshold.
40 CFR 60.40c, Subpart Dc	Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units	Yes	F-2-1-1.5	This regulation establishes standards of performance for small industrial-commercial-institutional steam generating units. This regulation applies to unit F-2-1-1.5 as its heat input (48.8 MMBtu/hr) exceeds the 10 MMBtu/hr threshold. The SXEW Boilers No. 1, 2, 3, 4, and 5 are below the 10 MMBtu/hr threshold and are not subject.
NSPS 40 CFR 60, Subpart Ka	Standards of Performance for **Storage Vessels for Petroleum Liquids** for which Construction, Reconstruction, or Modification Commenced After May 18, 1978, and **Prior** to July 23, 1984	No	N/A	This regulation establishes performance standards for storage vessels for petroleum liquids for which construction, reconstruction, or modification commenced after May 18, 1978, and prior to July 23, 1984. There are no petroleum liquid storage vessels located at the facility which are an affected facility under this subpart. Specifically, there are no storage vessels with capacity greater than 40,000 gallons which are used to store petroleum liquids as defined in §60.111a(b). Diesel fuel is not considered petroleum liquid under this definition. Accordingly, this regulation does not apply.
NSPS 40 CFR	Standards of Performance for	No	N/A	This regulation establishes performance standards for storage vessels with a capacity greater than or equal to 75 cubic meters

[FEDERAL REGULATIONS]() CITATION	Title	Applies? Enter Yes or No	Unit(s) or Facility	JUSTIFICATION:
60, Subpart Kb	**Volatile Organic Liquid Storage Vessels** (Including Petroleum Liquid Storage Vessels) for Which Construction, Reconstruction, or Modification Commenced **After** July 23, 1984			(m^3) that is used to store volatile organic liquids (VOL) for which construction, reconstruction, or modification is commenced after July 23, 1984. This facility does not have any organic liquid storage vessels with capacities greater than or equal to 151 m 3 storing a liquid with a maximum true vapor pressure less than 3.5 kilopascals (kPa) or with capacities greater than or equal to 75 m 3 but less than 151 m 3 storing a liquid with a maximum true vapor pressure less than 15.0 kPa; therefore, this regulation is not applicable §60.110b(b)].
NSPS 40 CFR 60.330 Subpart GG	**Stationary Gas Turbines**	Yes	F-2-1-1.4	This regulations establishes standards of performance for stationary gas turbines with a heat input at a peak load equal to or greater than 10 MMBtu/hr based on the lower heating value of the fuel fired and have commenced construction, modification, or reconstruction after October 3, 1977. Unit F-2-1-1.4 has a heat input of 455 MMBtu/hr which exceeds the threshold and commenced construction after October 3, 1977. Accordingly, this regulation applies.
NSPS 40 60.380 Subpart LL	Performance Standards for **Metallic Mineral Processing Plants**	Yes	PC-01, PC DUMP, CTS-01, CV-01A, CV-01B, CV-01C, SAG-F1, IC-01, SCDP	The provisions of this subpart are applicable to the following affected facilities in metallic mineral processing plants: each crusher and screen in open-pit mines; each crusher, screen, bucket elevator, conveyor belt transfer point, thermal dryer, product packaging station, storage bin, enclosed storage area, truck loading station, truck unloading station, railcar loading station, and railcar unloading station at the mill or concentrator. This facility includes several units involved in metallic mineral (copper and molybdenum) processing, therefore this regulation is applicable.
NSPS 40 CFR 60, Subpart KKK	Leaks of VOC from **Onshore Gas Plants**	No	N/A	This regulation establishes standards of performance for equipment leaks of VOC from onshore natural gas processing plants for which construction, reconstruction, or modification commenced after January 20, 1984, and on or before August 23, 2011. The facility is not a natural gas processing plant as defined in this regulation [40 CFR Part 60.631]. This regulation does not apply because this facility does not meet the definition of a natural gas processing plant as stated in the regulation.
NSPS 40 CFR Part 60 Subpart LLL	Standards of Performance for **Onshore Natural Gas Processing**: SO_2 Emissions	No	N/A	This regulation establishes standards of performance for SO_2 emissions from onshore natural gas processing for which construction, reconstruction, or modification commenced after January 20, 1984 and on or before August 23, 2011. The facility does not have a sweetening unit or considered a natural gas processing plant and does not meet the applicability requirements of this regulation under 40 CFR Part 60.640 (a). The facility is not subject to this regulation.
NSPS 40 Part 60 Subpart OOO	Standards of Performance for **Nonmetallic Mineral Processing Plants**	Yes	WH Crush	This regulation establishes standards for the following affected facilities in fixed or portable nonmetallic mineral processing plants: each crusher, grinding mill, screening operation, bucket elevator, belt conveyor, bagging operation, storage bin, enclosed truck or railcar loading station is an applicable unit. The unit WH Crush processes nonmetallic minerals through a crusher at greater than 150 tph, therefore this regulation is applicable.
NSPS 40 CFR	Standards of Performance for	No	N/A	The rule applies to "affected" facilities that are constructed, modified, or reconstructed after August 23, 2011 (40 CFR 60.5365): gas wells, including fractured and hydraulically

FEDERAL REGU-LATIONS CITATION	Title	Applies? Enter Yes or No	Unit(s) or Facility	JUSTIFICATION:
Part 60 Subpart OOOO	Crude Oil and Natural Gas Production, Transmission, and Distribution for which construction, modification or reconstruction commenced after August 23, 2011 and before September 18, 2015			refractured wells, centrifugal compressors, reciprocating compressors, pneumatic controllers, certain equipment at natural gas processing plants, sweetening units at natural gas processing plants, and storage vessels. The facility does not contain any "affected" facilities. This regulation is not applicable.
NSPS 40 CFR Part 60 Subpart OOOOa	Standards of Performance for Crude Oil and Natural Gas Facilities for which Construction, Modification or Reconstruction Commenced After September 18, 2015	No	N/A	**The rule applies to "affected" facilities that are constructed, modified, or reconstructed after August 23, 2011 (40 CFR 60.5365): gas wells, including fractured and hydraulically refractured wells, centrifugal compressors, reciprocating compressors, pneumatic controllers, certain equipment at natural gas processing plants, sweetening units at natural gas processing plants, and storage vessels. The facility does not contain any "affected" facilities. This regulation is not applicable**.
NSPS 40 CFR 60 Subpart IIII	Standards of performance for Stationary Compression Ignition Internal Combustion Engines	Yes	Diesel Emergency Generators, CB SCRN ENG, CH SCRN ENG	This regulation establishes standards of performance for stationary compression ignition combustion engines. The 12 diesel emergency engines commenced construction after July 11, 2005. These engines are subject to this regulation. Engines CB SCRN ENG and CH SCRN ENG commenced construction after July 11, 2005 and were manufactured after April 1, 2006. Engine CB SCRN ENG was manufactured in February 2012 and engine CH SCRN ENG was manufactured in August 2006. These engines are subject to NSPS Subpart IIII.
NSPS 40 CFR Part 60 Subpart JJJJ	Standards of Performance for Stationary Spark Ignition Internal Combustion Engines	Yes	Natural Gas emergency Generator, LPG Emergency Generators	**This regulation establishes standards of performance for stationary spark ignition combustion engines which commenced construction after June 12, 2006. The only units at the facility that have been constructed after the JJJJ trigger date are the natural gas and LPG emergency engines. Therefore this regulation is applicable.**
NSPS 40 CFR 60 Subpart TTTT	Standards of Performance for Greenhouse Gas Emissions for Electric Generating Units	No	N/A	This subpart establishes emission guidelines and approval criteria for State or multi-State plans that establish emission standards limiting greenhouse gas (GHG) emissions from an affected steam generating unit, integrated gasification combined cycle (IGCC), or stationary combustion turbine. An affected steam generating unit, IGCC, or stationary combustion turbine shall, for the purposes of this subpart, be referred to as an affected EGU. This regulation does not apply as this facility does not operate any electric utility steam generating units.
NSPS 40 CFR 60 Subpart UUUU	Emissions Guidelines for Greenhouse Gas Emissions and Compliance Times for Electric Utility Generating Units	No	N/A	This subpart establishes national emission limitations and work practice standards for hazardous air pollutants (HAP) emitted from coal- and oil-fired electric utility steam generating units (EGUs) as defined in § 63.10042 of this subpart. This subpart also establishes requirements to demonstrate initial and continuous compliance with the emission limitations. The turbine and heat recovery steam

[FEDERAL REGULATIONS]() CITATION	Title	Applies? Enter Yes or No	Unit(s) or Facility	JUSTIFICATION:
				generator located at the facility are fueled by natural gas, therefore this regulation does not apply.
NESHAP 40 CFR 61 Subpart A	General Provisions	No	N/A	This regulation defines general provisions for relevant standards that have been set under this part. This regulation does not apply to the facility because the facility does not emit or have the triggering substances on site and/or the facility is not involved in the triggering activity. The facility is not subject to this regulation. None of the subparts of Part 61 apply.
NESHAP 40 CFR 61 Subpart E	National Emission Standards for **Mercury**	No	N/A	This regulation establishes a national emission standard for mercury. The facility does not have stationary sources which process mercury ore to recover mercury, use mercury chlor-alkali cells to produce chlorine gas and alkali metal hydroxide, and incinerate or dry wastewater treatment plant sludge [40 CFR Part 61.50]. The facility is not subject to this regulation.
NESHAP 40 CFR 61 Subpart V	National Emission Standards for **Equipment Leaks** (Fugitive Emission Sources)	No	N/A	This regulation establishes national emission standards for equipment leaks (fugitive emission sources). The facility does not have equipment that operates in volatile hazardous air pollutant (VHAP) service [40 CFR Part 61.240]. The regulated activities subject to this regulation do not take place at this facility. The facility is not subject to this regulation.
MACT 40 CFR 63, Subpart A	General Provisions	Yes	Diesel Emergency Generators, Natural Gas emergency Generator, LPG Emergency Generators, CH SCRN ENG, CB SCRN ENG, GDF	This regulation defines general provisions for relevant standards that have been set under this part. This subpart applies as the following MACT subparts apply: - Subpart ZZZZ – The following engines are subject: Diesel Emergency Generators, Natural Gas emergency Generator, LPG Emergency Generators, CH SCRN ENG, CB SCRN ENG Subpart CCCCCC – Unit GDF is subject
MACT 40 CFR 63.760 Subpart HH	**Oil and Natural Gas Production Facilities**	No	N/A	This regulation establishes national emission standards for hazardous air pollutants from oil and natural gas production facilities. Not applicable because the facility is not an "Oil and Natural Gas Production Facility."
MACT 40 CFR 63 Subpart HHH	Oil and Natural Gas Production Facilities	No	N/A	This subpart applies to owners and operators of natural gas transmission and storage facilities that transport or store natural gas prior to entering the pipeline to a local distribution company or to a final end user (if there is no local distribution company), and that are major sources of hazardous air pollutants (HAP) emissions as defined in §63.1271. This regulation does not apply because this facility is not a natural gas transmission or storage facility as defined in this regulation [40 CFR Part 63.1270(a)].
MACT 40 CFR 63 Subpart DDDDD	National Emission Standards for Hazardous Air Pollutants for Major Industrial, Commercial, and Institutional Boilers & Process Heaters	No	N/A	This subpart establishes national emission limitations and work practice standards for hazardous air pollutants (HAP) emitted from industrial, commercial, and institutional boilers and process heaters located at major sources of HAP. This subpart also establishes requirements to demonstrate initial and continuous compliance with the emission limitations and work practice standards. Chino is not a major source of HAP therefore this regulation does not apply.

FEDERAL REGU-LATIONS CITATION	Title	Applies? Enter Yes or No	Unit(s) or Facility	JUSTIFICATION:
MACT 40 CFR 63 Subpart UUUUU	National Emission Standards for Hazardous Air Pollutants Coal & Oil Fire Electric Utility Steam Generating Unit	No	N/A	This subpart establishes national emission limitations and work practice standards for hazardous air pollutants (HAP) emitted from coal- and oil-fired electric utility steam generating units (EGUs) as defined in § 63.10042 of this subpart. This subpart also establishes requirements to demonstrate initial and continuous compliance with the emission limitations. The turbine and heat recovery steam generator located at the facility are fueled by natural gas, therefore this regulation does not apply.
MACT 40 CFR 63 Subpart ZZZZ	National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines (**RICE MACT**)	Yes	15-Diesel Emergency Generators, 1-Natural Gas emergency Generator, 8-LPG Emergency Generators, CH SCRN, ENG, CB SCRN ENG	This regulation defines national emissions standards for HAPs for stationary reciprocating Internal Combustion Engines. The natural gas and LPG emergency generators are new SI RICE sources located at an area source of HAPs. These units must meet the requirements of 40 CFR 60 Subpart JJJJ which also comply with the requirements of 40CFR 63 Subpart ZZZZ. Units CB SCRN ENG, CH SCRN ENG, and the diesel emergency generators are new stationary RICE located at an area source of HAPs as the engines commenced construction after June 12, 2006. New compression ignition RICE at an area source of HAPs must meet the requirements of 40 CFR 63 Subpart ZZZZ by complying with the requirements of 40 CFR 60 Subpart IIII.
MACT 40 CFR 63, Subpart CCCCCC	National Emission Standards for Hazardous Air Pollutants for Source Category: Gasoline Dispensing Facilities	Yes	GDF	This subpart establishes national emission limitations and management practices for hazardous air pollutants (HAP) emitted from the loading of gasoline storage tanks at gasoline dispensing facilities (GDF). The affected source to which this subpart applies is each GDF that is located at an area source. This facility is an area source which has loading of gasoline storage tanks at gasoline dispensing facilities. This regulation applies.
40 CFR 64	**Compliance Assurance Monitoring**	Yes	N/A	This regulation defines compliance assurance monitoring. The facility does not use a control device to meet an emission standard or limitation for units with potential uncontrolled emissions greater than 100 tons per year of a regulated pollutant. This regulation does not apply.
40 CFR 68	**Chemical Accident Prevention**	No	N/A	The facility is not an affected facility because it does not have quantities of materials regulated by 40 CFR Part 68 that are in excess of the triggering threshold.
Title IV – Acid Rain 40 CFR 72	**Acid Rain**	No	N/A	This part establishes the acid rain program. This part does not apply because the facility is not covered by this regulation [40 CFR Part 72.6].

FEDERAL REGU-LATIONS CITATION	Title	Applies? Enter Yes or No	Unit(s) or Facility	JUSTIFICATION:
Title IV – Acid Rain 40 CFR 73	**Sulfur Dioxide** Allowance Emissions	No	N/A	This regulation establishes sulfur dioxide allowance emissions for certain types of facilities. This part does not apply because the facility is not the type covered by this regulation [40 CFR Part 73.2].
Title IV-Acid Rain 40 CFR 75	**Continuous Emissions Monitoring**	No	N/A	This regulation does not apply as this facility does not generate commercial electric power or electric power for sale.
Title IV – Acid Rain 40 CFR 76	**Acid Rain** Nitrogen Oxides **Emission Reduction Program**	No	N/A	This regulation establishes an acid rain nitrogen oxides emission reduction program. This regulation applies to each coal-fired utility unit that is subject to an acid rain emissions limitation or reduction requirement for SO_2. This part does not apply because the facility does not operate any coal-fired units [40 CFR Part 76.1].
Title VI – 40 CFR 82	**Protection of Stratospheric Ozone**	Yes	Facility	This regulation establishes a regulation for protection of the stratospheric ozone. The regulation is applicable because the facility does "service", "maintain" or "repair" class I or class II appliances and "disposes" of the appliances [40 CFR Part 82.1(a)].

Section 14

Operational Plan to Mitigate Emissions

(Submitting under 20.2.70, 20.2.72, 20.2.74 NMAC)

☑ **Title V Sources** (20.2.70 NMAC)**:** By checking this box and certifying this application the permittee certifies that it has developed an **Operational Plan to Mitigate Emissions During Startups, Shutdowns, and Emergencies** defining the measures to be taken to mitigate source emissions during startups, shutdowns, and emergencies as required by 20.2.70.300.D.5(f) and (g) NMAC. This plan shall be kept on site to be made available to the Department upon request. This plan should not be submitted with this application.

☐ **NSR** (20.2.72 NMAC)**, PSD** (20.2.74 NMAC) **& Nonattainment** (20.2.79 NMAC) **Sources:** By checking this box and certifying this application the permittee certifies that it has developed an **Operational Plan to Mitigate Source Emissions During Malfunction, Startup, or Shutdown** defining the measures to be taken to mitigate source emissions during malfunction, startup, or shutdown as required by 20.2.72.203.A.5 NMAC. This plan shall be kept on site to be made available to the Department upon request. This plan should not be submitted with this application.

☑ **Title V** (20.2.70 NMAC)**, NSR** (20.2.72 NMAC)**, PSD** (20.2.74 NMAC) **& Nonattainment** (20.2.79 NMAC) **Sources:** By checking this box and certifying this application the permittee certifies that it has established and implemented a Plan to Minimize Emissions During Routine or Predictable Startup, Shutdown, and Scheduled Maintenance through work practice standards and good air pollution control practices as required by 20.2.7.14.A and B NMAC. This plan shall be kept on site or at the nearest field office to be made available to the Department upon request. This plan should not be submitted with this application.

N/A – All SSM emissions at this facility do not require an increase in requested allowables greater than those listed in Table 2-E. Equipment located at this facility is equipped with various safety devices and features that aid in the prevention of excess emissions in the event of an operational emergency. If an operational emergency does occur and excess emissions occur Freeport will submit the required Excess Emissions Report per 20.2.7 NMAC. Corrective action to eliminate the excess emissions and prevent recurrence in the future will be undertaken as quickly as safety allows.

Section 15

Alternative Operating Scenarios

(Submitting under 20.2.70, 20.2.72, 20.2.74 NMAC)

Alternative Operating Scenarios: Provide all information required by the department to define alternative operating scenarios. This includes process, material and product changes; facility emissions information; air pollution control equipment requirements; any applicable requirements; monitoring, recordkeeping, and reporting requirements; and compliance certification requirements. Please ensure applicable Tables in this application are clearly marked to show alternative operating scenario.

Construction Scenarios: When a permit is modified authorizing new construction to an existing facility, NMED includes a condition to clearly address which permit condition(s) (from the previous permit and the new permit) govern during the interval between the date of issuance of the modification permit and the completion of construction of the modification(s). There are many possible variables that need to be addressed such as: Is simultaneous operation of the old and new units permitted and, if so for example, for how long and under what restraints? In general, these types of requirements will be addressed in Section A100 of the permit, but additional requirements may be added elsewhere. Look in A100 of our NSR and/or TV permit template for sample language dealing with these requirements. Find these permit templates at: https://www.env.nm.gov/aqb/permit/aqb_pol.html. Compliance with standards must be maintained during construction, which should not usually be a problem unless simultaneous operation of old and new equipment is requested.

In this section, under the bolded title "Construction Scenarios", specify any information necessary to write these conditions, such as: conservative-realistic estimated time for completion of construction of the various units, whether simultaneous operation of old and new units is being requested (and, if so, modeled), whether the old units will be removed or decommissioned, any PSD ramifications, any temporary limits requested during phased construction, whether any increase in emissions is being requested as SSM emissions or will instead be handled as a separate Construction Scenario (with corresponding emission limits and conditions, etc.

Chino seeks to continue operation under the below Control, mining and blasting scenarios, as currently permitted.

Table 105.D1: Control Scenario 1 (Cobre Haul Roads)

Mining Scenario	Throughput (tons/day)	Control Efficiency[1] (%)
Total Material	126,000	96.8
South Waste Rock Disposal (SWRDF stockpile)	75,00	88.8
Chino (Ore)	86,000	96.8

[1] Control efficiencies are derived from a combination of controls. A control efficiency of 88.8% is based on a combination of base-course treatment, blading, and watering with a maximum speed limit of 35 miles/hour. A control efficiency of 96.8% is based on a combination of base-course treatment, blading, watering, and a dust suppressant.

The Cobre Mining Scenarios table is included for reference only as it relates to the historical air dispersion modeling for the facility. Four different mining scenarios at the Cobre portion of the mine were modeled to ensure that the most conservative impacts were represented within the model. The four mining scenarios have been previously reviewed and approved by NMED and are not changing with this application. This Table details the Cobre Mining Scenarios with volume associated source elevations.

Cobre Mining Scenarios

Scenario with Description	Height of Hanover Mountain (ft)
Scenario1 (S1) – Mining Hanover Mountain	7,261.2
Scenario 2 (S2) – Mining Hanover Middle	7,145.0
Scenario 3 (S3) – Mining Hanover Mountain	7,043.0
Scenario 4 (S4) – Mining Hanover Base	6,948.8

Blasting at Hanover Mountain (Scenario B1) and Santa Rita Pit (Scenario B2) never occur within the same hour; and continue to operate at different times as permitted in NSR permit 0298-M10. Table 5 below represents the mining and blasting scenarios that have been previously modeled and approved by NMED.

Table 5. Current Mining and Blasting Scenarios

Scenario Number	Height of Hanover Mountain (ft)	Blasting Location
S1-B1	7,261.2	Hanover Mountain
S1-B2	7,261.2	Santa Rita Pit
S2-B1	7,145.0	Hanover Mountain
S2-B2	7,145.0	Santa Rita Pit
S3-B1	7,043.0	Hanover Mountain
S3-B2	7,043.0	Santa Rita Pit
S4-B1	6,948.8	Hanover Mountain
S4-B2	6,948.8	Santa Rita Pit

Blasting at both Hanover Mountain and Santa Rita Pit occur up to four times per day during daylight hours only. In the previous permitting action of NSR permit 0298-M10 these blasting scenarios were modeled and have not been modified with this permitting action. Blasting will remain unchanged from the currently permitted and approved methodologies as described in this section.

Emissions from haul roads, screening operations, and material handling in Control Scenario 2 will not be modified with this permitting action and will continue to operate at the rates below in Table 105.D2.

Table 105.D2: Control Scenario 2 (Chino-Cobre Haul Roads)

Haul Road	Throughput (tons/day)	Control Efficiency[1] (%)
Maintenance Entrance Road	100,000	88.8
Cobre Haul Road	66,000	96.8
SWRDF Road	75,000	88.8
Hanover Mountain Road	126,000	96.8
Muffler Road	100,000	88.8
South Stockpile Road	100,000	88.8
3A/9 Dam	100,000	88.8
West Stockpile	100,000	88.8
Café to Lampbright	160,000	88.8
LBX Road	160,000	88.8
Upper Lampbright	160,000	88.8
Lower Lampbright	160,000	88.8
Crusher/Stockpiles/Rehandle	100,000	88.8
Roundabout	100,000	88.8
Princess Ramp/Lee Hill Road	66,000	88.8
NOBS	46,000	88.8
Magnetite	4,500	88.8

[1] Control efficiencies are derived from a combination of controls. A control efficiency of 88.8% is based on a combination of base-course treatment, blading, and watering with a maximum speed limit of 35 miles/hour. A control efficiency of 96.8% is based on a combination of bas

In addition to the pre-existing Control Scenarios 1 & 2, a borrow pit is to be constructed near the Cobre Haul Road. Four one-time blasts will be conducted to construct the pit, they are set to occur during daylight hours from 0900 hrs to 1500 hrs and will never occur simultaneously as blasting at either Hanover Mountain or the Santa Rita Pit. Furthermore, these blasts and associated material handling are not to interfere with any other operations at the facility.

Section 16

Air Dispersion Modeling

1) Minor Source Construction (20.2.72 NMAC) and Prevention of Significant Deterioration (PSD) (20.2.74 NMAC) ambient impact analysis (modeling): Provide an ambient impact analysis as required at 20.2.72.203.A(4) and/or 20.2.74.303 NMAC and as outlined in the Air Quality Bureau's Dispersion Modeling Guidelines found on the Planning Section's modeling website. If air dispersion modeling has been waived for one or more pollutants, attach the AQB Modeling Section modeling waiver approval documentation.
2) SSM Modeling: Applicants must conduct dispersion modeling for the total short term emissions during routine or predictable startup, shutdown, or maintenance (SSM) using realistic worst case scenarios following guidance from the Air Quality Bureau's dispersion modeling section. Refer to "Guidance for Submittal of Startup, Shutdown, Maintenance Emissions in Permit Applications (http://www.env.nm.gov/aqb/permit/app_form.html) for more detailed instructions on SSM emissions modeling requirements.
3) Title V (20.2.70 NMAC) ambient impact analysis: Title V applications must specify the construction permit and/or Title V Permit number(s) for which air quality dispersion modeling was last approved. Facilities that have only a Title V permit, such as landfills and air curtain incinerators, are subject to the same modeling required for preconstruction permits required by 20.2.72 and 20.2.74 NMAC.

What is the purpose of this application?	Enter an X for each purpose that applies
New PSD major source or PSD major modification (20.2.74 NMAC). See #1 above.	
New Minor Source or significant permit revision under 20.2.72 NMAC (20.2.72.219.D NMAC). See #1 above. **Note:** Neither modeling nor a modeling waiver is required for VOC emissions.	
Reporting existing pollutants that were not previously reported.	
Reporting existing pollutants where the ambient impact is being addressed for the first time.	
Title V application (new, renewal, significant, or minor modification. 20.2.70 NMAC). See #3 above.	X
Relocation (20.2.72.202.B.4 or 72.202.D.3.c NMAC)	
Minor Source Technical Permit Revision 20.2.72.219.B.1.d.vi NMAC for like-kind unit replacements.	
Other: i.e. SSM modeling. See #2 above.	
This application does not require modeling since this is a No Permit Required (NPR) application.	
This application does not require modeling since this is a Notice of Intent (NOI) application (20.2.73 NMAC).	
This application does not require modeling according to 20.2.70.7.E(11), 20.2.72.203.A(4), 20.2.74.303, 20.2.79.109.D NMAC and in accordance with the Air Quality Bureau's Modeling Guidelines.	

Check each box that applies:

☐ See attached, approved modeling **waiver for all** pollutants from the facility.
☐ See attached, approved modeling **waiver for some** pollutants from the facility.
☐ Attached in Universal Application Form 4 (UA4) is a **modeling report for all** pollutants from the facility.
☐ Attached in UA4 is a **modeling report for some** pollutants from the facility.
☑ No modeling is required.

Section 17

Compliance Test History

(Submitting under 20.2.70, 20.2.72, 20.2.74 NMAC)

To show compliance with existing NSR permits conditions, you must submit a compliance test history. The table below provides an example.

Compliance Test History Table

Unit No.	Test Description	Test Date
F-2-1-1.4	Testing in accordance with EPA Test Method 19 as required by NSR permit 0298-M8-R5 and Title V permit P066--R3M1 sections A401(B) and B11A(1).	03/06/2018
F-2-1-1.4	Testing in accordance with EPA Test Method 19 as required by NSR permit 0298-M8-R5 and Title V permit P066--R3M1 sections A401(B) and B11A(1).	11/16/2022
CB SCRN ENG	Testing in accordance with EPA Test Method 19 as required by NSR permit 0298-M8-R5 and Title V permit P066--R3M1 sections A401(B) and B11A(1).	11/16/2022

Section 19

Requirements for Title V Program

Who Must Use this Attachment:

* Any major source as defined in 20.2.70 NMAC.

* Any source, including an area source, subject to a standard or other requirement promulgated under Section 111 - Standards of Performance for New Stationary Sources, or Section 112 Hazardous Air Pollutants, of the 1990 federal Clean Air Act ("federal Act"). Non-major sources subject to Sections 111 or 112 of the federal Act are exempt from the obligation to obtain an 20.2.70 NMAC operating permit until such time that the EPA Administrator completes rulemakings that require such sources to obtain operating permits. In addition, sources that would be required to obtain an operating permit solely because they are subject to regulations or requirements under Section 112(r) of the federal Act are exempt from the requirement to obtain an Operating Permit.

* Any Acid Rain source as defined under title IV of the federal Act. The Acid Rain program has additional forms. See http://www.env.nm.gov/aqb/index.html. Sources that are subject to both the Title V and Acid Rain regulations are encouraged to submit both applications simultaneously.

* Any source in a source category designated by the EPA Administrator ("Administrator"), in whole or in part, by regulation, after notice and comment.

19.1 - 40 CFR 64, Compliance Assurance Monitoring (CAM) (20.2.70.300.D.10.e NMAC)

Any source subject to 40CFR, Part 64 (Compliance Assurance Monitoring) must submit all the information required by section 64.7 with the operating permit application. The applicant must prepare a separate section of the application package for this purpose; if the information is already listed elsewhere in the application package, make reference to that location. Facilities not subject to Part 64 are invited to submit periodic monitoring protocols with the application to help the AQB to comply with 20.2.70 NMAC. Sources subject to 40 CFR Part 64, must submit a statement indicating your source's compliance status with any enhanced monitoring and compliance certification requirements of the federal Act.

The Chino Mine is not subject to 40 CFR 64 for a Compliance Assurance Monitoring (CAM) plan.

19.2 - Compliance Status (20.2.70.300.D.10.a & 10.b NMAC)

Describe the facility's compliance status with each applicable requirement at the time this permit application is submitted. This statement should include descriptions of or references to all methods used for determining compliance. This statement should include descriptions of monitoring, recordkeeping and reporting requirements and test methods used to determine compliance with all applicable requirements. Refer to Section 2, Tables 2-N and 2-O of the Application Form as necessary. (20.2.70.300.D.11 NMAC) For facilities with existing Title V permits, refer to most recent Compliance Certification for existing requirements. Address new requirements such as CAM, here, including steps being taken to achieve compliance.

Based on information provided, Freeport believes that the Chino Mine is in compliance with each applicable requirement identified in Section 13. In the event that Freeport should discover new information affecting the compliance status of the facility, Freeport will make appropriate notifications and/or take corrective actions.

19.3 - Continued Compliance (20.2.70.300.D.10.c NMAC)

Provide a statement that your facility will continue to be in compliance with requirements for which it is in compliance at the time of permit application. This statement must also include a commitment to comply with other applicable requirements as they come into effect during the permit term. This compliance must occur in a timely manner or be consistent with such schedule expressly required by the applicable requirement.

The facility will continue to be in compliance with requirements for which it is in compliance at the time of this Title V renewal and significant modification and will comply with other applicable requirements as they come into effect during the permit term.

19.4 - Schedule for Submission of Compliance (20.2.70.300.D.10.d NMAC)

You must provide a proposed schedule for submission to the department of compliance certifications during the permit term. This certification must be submitted annually unless the applicable requirement or the department specifies a more frequent period. A sample form for these certifications will be attached to the permit.

Compliance certification will be submitted annually, as required by Title V Operating Permit P-066R3M1, condition A109.B.

19.5 - Stratospheric Ozone and Climate Protection

In addition to completing the four (4) questions below, you must submit a statement indicating your source's compliance status with requirements of Title VI, Section 608 (National Recycling and Emissions Reduction Program) and Section 609 (Servicing of Motor Vehicle Air Conditioners).

1. Does your facility have any air conditioners or refrigeration equipment that uses CFCs, HCFCs or other ozone-depleting substances? ☐ **Yes** ☐ **No**
2. Does any air conditioner(s) or any piece(s) of refrigeration equipment contain a refrigeration charge greater than 50 lbs? ☐ **Yes** ☐ **No**

   (If the answer is yes, describe the type of equipment and how many units are at the facility.)
3. Do your facility personnel maintain, service, repair, or dispose of any motor vehicle air conditioners (MVACs) or appliances ("appliance" and "MVAC" as defined at 82. 152)? ☐ **Yes** ☐ **No**
4. Cite and describe which Title VI requirements are applicable to your facility (i.e. 40 CFR Part 82, Subpart A through G.)

This regulation establishes requirements for protection of the stratospheric ozone. Chino hires a contractor to perform the service, maintenance, and repairs of appliances. These contractors will meet all of the applicable requirements.

19.6 - Compliance Plan and Schedule

Applications for sources, which are not in compliance with all applicable requirements at the time the permit application is submitted to the department, must include a proposed compliance plan as part of the permit application package. This plan shall include the information requested below:

A. **Description of Compliance Status:** (20.2.70.300.D.11.a NMAC)
A narrative description of your facility's compliance status with respect to all applicable requirements (as defined in 20.2.70 NMAC) at the time this permit application is submitted to the department.

B. **Compliance plan:** (20.2.70.300.D.11.B NMAC)
A narrative description of the means by which your facility will achieve compliance with applicable requirements with which it is not in compliance at the time you submit your permit application package.

C. Compliance schedule: (20.2.70.300D.11.c NMAC)
A schedule of remedial measures that you plan to take, including an enforceable sequence of actions with milestones, which will lead to compliance with all applicable requirements for your source. This schedule of compliance must be at least as stringent as that contained in any consent decree or administrative order to which your source is subject. The obligations of any consent decree or administrative order are not in any way diminished by the schedule of compliance.

D. Schedule of Certified Progress Reports: (20.2.70.300.D.11.d NMAC)
A proposed schedule for submission to the department of certified progress reports must also be included in the compliance schedule. The proposed schedule must call for these reports to be submitted at least every six (6) months.

E. Acid Rain Sources: (20.2.70.300.D.11.e NMAC)
If your source is an acid rain source as defined by EPA, the following applies to you. For the portion of your acid rain source subject to the acid rain provisions of title IV of the federal Act, the compliance plan must also include any additional requirements under the acid rain provisions of title IV of the federal Act. Some requirements of title IV regarding the schedule and methods the source will use to achieve compliance with the acid rain emissions limitations may supersede the requirements of title V and 20.2.70 NMAC. You will need to consult with the Air Quality Bureau permitting staff concerning how to properly meet this requirement.

NOTE: The Acid Rain program has additional forms. See http://www.env.nm.gov/aqb/index.html. Sources that are subject to both the Title V and Acid Rain regulations are **encouraged** to submit both applications **simultaneously**.

The facility is not subject to 40 CFR 64 therefore no compliance plan is required.

19.7 - 112(r) Risk Management Plan (RMP)

Any major sources subject to section 112(r) of the Clean Air Act must list all substances that cause the source to be subject to section 112(r) in the application. The permittee must state when the RMP was submitted to and approved by EPA.

The Freeport Chino Mine is not required to have a Risk Management Plan.

19.8 - Distance to Other States, Bernalillo, Indian Tribes and Pueblos

Will the property on which the facility is proposed to be constructed or operated be closer than 80 km (50 miles) from other states, local pollution control programs, and Indian tribes and pueblos (20.2.70.402.A.2 and 20.2.70.7.B NMAC)?

(If the answer is yes, state which apply and provide the distances.)

There are not any states, local pollution control programs, or Indian tribes and pueblos closer than 50 miles to the Chino Mine.

19.9 - Responsible Official

Provide the Responsible Official as defined in 20.2.70.7.AD NMAC:

Randy Ellison - Plant Operator
(575) 912-5640; rellsion@fmi.com
P.O Box 10 Bayard, NM 88023

Section 20

Other Relevant Information

Other relevant information. Use this attachment to clarify any part in the application that you think needs explaining. Reference the section, table, column, and/or field. Include any additional text, tables, calculations or clarifying information.

Additionally, the applicant may propose specific permit language for AQB consideration. In the case of a revision to an existing permit, the applicant should provide the old language and the new language in track changes format to highlight the proposed changes. If proposing language for a new facility or language for a new unit, submit the proposed operating condition(s), along with the associated monitoring, recordkeeping, and reporting conditions. In either case, please limit the proposed language to the affected portion of the permit.

N/A – No other relevant information is being included with this application.

Section 22: Certification

Company Name: Freeport-McMoRan Chino Mines Co.

I, Randy Ellison, hereby certify that the information and data submitted in this application are true and as accurate as possible, to the best of my knowledge and professional expertise and experience.

Signed this ____ day of August, 2022, upon my oath or affirmation, before a notary of the State of

New Mexico.

*Signature

8/2/2022
Date

Randy Ellison
Printed Name

Vice President, General Manager
Title

Scribed and sworn before me on this 2nd day of August, 2022

My authorization as a notary of the State of NEW MEXICO expires on the

27th day of February, 2025.

Ruth Fox
Notary's Signature

Aug. 2, 2022
Date

Ruth Fox
Notary's Printed Name

STATE OF NEW MEXICO
NOTARY PUBLIC
RUTH FOX
Commission # 1068850
My Comm. Exp. Feb. 27, 2025

*For Title V applications, the signature must be of the Responsible Official as defined in 20.2.70.7.AE NMAC.