BARSTOW TAC EMISSIONS INVENTORY

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TABLE OF CONTENTS

Page

APPENDICES

TABLES

1.0 INTRODUCTION

This document describes the data and methods used in estimating toxic air contaminant (TAC) emissions, in particular diesel particulate matter and total organic gases, resulting from facility operations and other activities at BNSF's Barstow facility as well as rail-related activities in its direct vicinity. The data describe activities grouped by emission sources and by spatial activity. The emission sources include

- Locomotives
- Cargo Handling equipment
- On-road vehicles
- Off-road equipment
- Stationary sources

Emission factors for diesel particulate matter (PM) and total organic gases (TOG - which are then speciated into other relevant toxic air contaminants) for each source are provided in the document. Emission estimates are based on specific activity data.

2.0 OVERVIEW OF THE BARSTOW YARD

The Barstow BNSF yard is a roughly 5 mile long yard in west-east exposure. It is bordered by a Y near highway 58 on the west side, the City of Barstow with West Main Street and National Trails Highway on the south side and Interstate Highway 15 on the east side. Barstow is the major BNSF hub for California. All trains leaving or arriving in California pass through the Barstow yard. Trains are reconfigured in the Barstow yard and all trains receive a crew change. Furthermore, Barstow is the major California location for services to trains and locomotives, including engine refueling and technical services.

The activities occur, to a large extent, in the western portion of the yard. It contains the hump and classification yard, the ready tracks, the administrative buildings and the locomotive inspection area. A small portion of switching activities occurs in the eastern portion of the yard.

The classification yard is located on the south side of the yard. Trains arrive using the tracks from west. Wagons are then pushed over a hump yard into the classification yard. The hump yard activities are conducted by dedicated switcher engines and so called mother and slugs. Slugs are additional heavy accessories to the locomotive. They are equipped with electric motors but without own power sources. The purpose is to increase the traction for heavy pulling and breaking power. The classification yard itself does not use any locomotive engines. It is operated as a hump yard.

Made-up trains (partially or fully) are pulled by switcher engines into the eastern portion of the Barstow yard and pushed back onto the ready tracks on the north-side of the western portion of the yard. This switching activity represents, besides train passing, all of the activity in the eastern portion of the yard.

Line haul locomotives to pull ready trains are brought in by switcher engines to the ready tracks. Most of the line haul engines have undergone a maintenance interval in the inspection area. Before departure, fueling and engine testing occurs. Furthermore, the crew enters the trains at the ready tracks.

One key element of the Barstow yard is the locomotive inspections. Many trains arriving in Barstow are pulled by locomotives scheduled for inspection. The inspection area is located on the west end of the yard. Depending on the scheduled inspection, engines may enter full or partial circles through the inspection yard before being pulled to the ready tracks for departure. Furthermore, depending on the inspection cycle, trains undergo different engine tests.

Other activities in Barstow are crew changes and refueling of engines. Passing trains all stop in Barstow for crew changes. Some will be refueled as well. Crew and administrative buildings are located near the inspection area. Crews are brought to the trains by on-road vehicles. Two fixed fueling stations utilize pipeline to deliver fuel to locomotives. Furthermore, several direct to locomotive (truck to locomotive) fueling sites are located throughout the yard.

In addition to BNSF operations there are some limited non-BNSF freight trains as well as passenger trains that use BNSF or adjacent tracks. The non-BNSF freight trains are described in the sections below as 'foreign trains'. AMTRAK operates limited services on adjacent tracks. Just east of the yard is an AMTRAK station. Activities of passenger trains are also described in the foreign train section.

3.0 LOCOMOTIVE FACILITY OPERATIONS

As described above, Barstow's locomotive operations are a mix of the make-up of trains and their departure, the passing of complete trains and the servicing of locomotives. The engine-on locomotive operations include sand and refueling (Section 3.1), inspections (Sections 3.2 and 3.3), switching activities (3.4) and maneuvering activities in the hump and classification yards (3.5), as well as passing trains on operating tracks (3.6 and 3.7).

Because different locomotive and engine models have different emissions characteristics, it is important to characterize the types and models of the locomotives that work, arrive and depart, pass or being inspected at the Barstow facility. Furthermore, due to the size of the yard and the distinct locations of some engines, a more detailed spatial differentiation is necessary for some activities. ENVIRON estimated the locomotive fleet fractions for different locomotive types and models using data provided by BNSF. The operation descriptions below each include a uniquely applicable fleet characterization.

3.1 Basic Locomotive Service

A number of locomotives utilizes direct to locomotive (DTL) fueling while in the yard. There are two main DTL stations, one on each side of the ready tracks in the western portion of the yard. Other sites are located throughout the yard. The DTL services utilize on-road trucks to deliver the locomotive fuels. Approximately 2,000,000 gallons of fuel are delivered through the DTL sites. This represents approximately 1,600 fueling events throughout the year. Engines idle for approximately 1.5 hours per fueling event. This results in 2,400 hours idling per year at the DTL locations in the yard. ENVIRON assumes that those fueling events are split between the two main DTL sites on the west and east end of the ready tracks. The other, smaller, DTL sites play an insignificant role and are used sporadically.

A total of 21,602 engines received basic services, basic or full inspections in Barstow in 2005. Of those 19,995 undertook basic locomotive services, which include sand and fuel (SFS) refill and visual checks. This represents approximately 54 locomotives per day to receive basic services. The activities under basic and full inspections are described in section 3.2 and 3.3.

A number of those locomotives, approximately 47 per day, receive sand and fuel as the only basic service at the Barstow yard. (Sand Fuel Service) Basic services refueling utilize the stationary fueling facilities in the maintenance area. Three other basic service categories are also summarized under basic services because locomotives do not undergo intensive mechanical services and do, more importantly, not conduct engine tests. Approximately 7 locomotives per day received truck inspections, a 32-day inspection or a 92-day inspection. Basic services include visual inspections of the engines, simple maintenance tasks and refilling of sand and fuel.

For Barstow, ENVIRON assumes that all trains receiving basic services travel to the sand and fuel (SFS) area from the West. Thus all engines pass the "Y" on the west side of the SFS area and the "Locomotive Wash" area first before entering the site. All engines exit the SFS area to the east, passing the service area on its north side and head towards the ready tracks. Engines are put in-consist (a set of 3-4 engines) while exiting the service area. Since several paths are possible, distances have been averaged for the engines receiving basic services.

The operations recognized under basic services are

(A1) Movement into service area at about 5 mph in Notch 1. This results in approximately 9 minutes travel time
(A2) Idle time while refueling is estimated to be 1 hour.
(A3) Movement within the service area at 5 mph in Notch 1 for 9.4 minutes..
(A4) Idling while put engines "in-consist" for 30 minutes
(A5) Movement out of service area at about 5 mph in Notch 2 for about 13 minutes.

BNSF indicated that this operation occurs throughout a 24-hour period. The activities (duration and modes of operations) for the Basic Services are summarized in Table 3-1.

Table 3-1. Activities for the Basic Services in the Barstow Yard.

Activities	Est. Speed (mph)	Est. Distance (mile)	Est. Time (hour)	Operation Mode
(A1): Movement into service area	5	0.75	0.15	Notch 1
(A2): Idling while refueling	0	0	1.0	Idle
(A3): Movement within service area	5	0.78	0.156	Notch 1
(A4) Idling while put 'in-consist'	0	0	0.5	Idle
(A4): Movement out of service area	5	1.08	0.216	Notch 2

The locomotive roster receiving basic services is taken from a specific roster provided by BNSF for locomotives receiving service in 2005. The roster distinguishes between GE and non-GE engines.

3.2 Basic Engine Inspection

A total of 1,687 engines received further reaching engine inspections in Barstow in 2005. Of those, 523 or approximately 10 per week received basic engine three month and six months inspections. Each of the basic engine inspection undergoes a post-inspection power test.

For Barstow, ENVIRON assumes that all trains receiving basic engine inspections passed through the SFS area to receive sand and fuel first. Thus the same entrance path then the path for basic services applies to basic inspections. Engines enter the SFS area from the West. They then back up to the "Y" to enter the inspection area just north of the SFS area. The operations considered under basic engine inspections are

(B1) Movement into service area at about 5 mph in Notch 1 for about and 9 minutes
(B2) Idling while refueling for approximately 1 hour
(B3) Movement to inspection area at 5 mph in Notch 1 for about 11.6 minutes
(B4) Pre-Load test for all GE engines only for 20 minutes in Notch 8
(B5) After service power test (all engines) for 40 minutes in Notch 8
(B6) Idling while put in-consist for 30 minutes
(B7) Movement out of service area at 5 mph in Notch 2 for about 13 minutes

The activities (duration and modes of operations) for the full engine inspection are summarized in Table 3-2. The fleet characterization based on the service data is provided in Table 3-3.

Table 3-2. Activities for the Basic Engine Inspections in the Barstow Yard.

Activities	Est. Speed (mph)	Est. Distance (mile)	Est. Time (hour)	Operation Mode
(B1): Movement into service area	5	0.75	0.15	Notch 1
(B2) Idling while refueling	0	0	1	Idle
(B3) Movement within service area	5	0.97	0.194	Notch 1
(B4) GE Engine pre-load test	0	0	0.33	Notch 8
(B5) After service power test	0	0	0.67	Notch 8
(B6) Idling while put 'in-consist'	0	0	0.5	Idle
(B7) Movement out of service area	5	1.08	0.216	Notch 2

The roster for locomotives that receive inspections in Barstow in principal reflects the average BNSF California roster because Barstow represents the main inspection yard for the California fleet. Therefore California averages were assumed to develop the emission factors for the Barstow inspection activities.

However, ENVIRON distinguishes between General Electric (GE) and non-GE engines. Inspection test cycles for GE and non-GE engines differ from each other. GE engines undergo a pre-load test in certain inspection cycles. Three GE engines and 520 non-GE engines received basic engine inspections in 2005. The two rosters are presented in Table 3-3.

Table 3-3. Locomotive roster for GE and non-GE engines based on BNSF California average.

Tier	Model	GE engine roster	Non-GE engine roster
Pre-controlled	Switchers	0%	9.6%
Pre-controlled	GP-3x	0%	25.3%
Pre-controlled	GP-4x	0%	32.3%
Pre-controlled	GP-50	0%	1.6%
Pre-controlled	SD-7x	0%	11.4%
Pre-controlled	Dash-7	7.6%	0.9%
Pre-controlled	Dash-9	7.9%	0%
0	GP-60	0%	8.0%
0	SD-7x	0%	10.4%
0	Dash-8	10.0%	0%
0	Dash-9	39.2%	0%
1	Dash-9	22.6%	0%
2	ES44/Dash-9	12.7%	0.5%

3.3 Full Engine Service/Inspection

Full engine inspections are scheduled once a year for most engines. However, there are some 8-month inspections that require a pre- and post-load test of the engine. In 2005, a total of 1164 engines, approximately 22 per week, underwent an inspection that involved power and/or post inspection load testing. Locomotives with General Electric engines also conducted a pre inspection load test.

For Barstow, ENVIRON assumes that all trains receiving full engine inspections passed through the SFS area to receive sand and fuel first. Thus the same entrance path then the path for basic services applies to basic inspections. Engines enter the SFS area from the West. They then back up to the "Y" to enter the inspection area just north of the SFS area and south-east of the administration building. The operations considered under basic engine inspections are

(C1) Movement into service area at about 5 mph in Notch 1 for about 9 minutes
(C2) Idling while refueling for approximately one hour
(C3) Movement into the inspection area at 5 mph in Notch 1 for about 13.3 minutes
(C4) For GE engines, a pre-load test for 20 minutes at Notch 8
(C5) Opacity test for 150 seconds testing occurs at each setting/mode (8 Notches and idle) setting. But overall time for testing estimated to be 35 to 45 minutes, which figures out to be 300 seconds at each mode including 8 notches and idle. ENVIRON assumed 117 seconds for stabilizing and 150 seconds for testing at each engine setting for this work for a total of 40 minutes.
(C6) Final load test for 40 minutes at Notch 8
(C7) Idling while put in-consist for 30 minutes
(C8) Movement out of service area at about 5 mph in Notch 1 for about 13 minutes

The activities (duration and modes of operations) for the full engine inspection are summarized in Table 3-4. The fleet characterization is similar to those for basic engine inspections provided in Table 3-3.

Table 3-4. Activities for the Basic Engine Inspections in the Barstow Yard.

Activities	Est. Speed (mph)	Est. Distance (mile)	Est. Time (hour)	Operation Mode
(C1): Movement into service area	5	0.75	0.15	Notch 1
(C2) Idling while refueling	0	0	1	Idle
(C3) Movement within service area	5	1.11	0.222	Notch 1
(C4) GE Engine pre-load test	0	0	0.33	Notch 8
(C5) Opacity test	0	0	0.67	Idle + notches 1 – 8
(C6) Final load test	0	0	0.67	Notch 8
(C7) Idling while put 'in-consist'	0	0	0.5	Idle
(C8) Movement out of service area	5	1.08	0.216	Notch 2

3.4 Switching Engine Activity

Switching activity is determined by two distinct tasks. In the train arrival area on the west side, two locomotive crews operate 24 hours per day, 7 days a week. The locomotives here are mother and slug, tasked to push rail cars over the hump into the classification yard. East of the classification yard operate six to eight locomotives and mother and slugs. Early and late shifts are run with six and the mid-day shift run with eight engines. Those engines pull partially and fully assembled rail wagons onto the ready tracks.

Switching engine fleet characteristics in the Barstow yard were determined by a roster of engines made available by BNSF in 2007. The locomotive activity data, in particular the train arrival and train departure data was used to separate the switching locomotives from the line-haul locomotives. The data for switching engines are shown in Table 3-5.

The switching engine activity is based on the hours of operation, the engine activity and the engine-specific emission factors.

The Barstow hump yard operates 24 hours, 7 days a week on two shifts. The train compilation and assembly of ready trains in the bowl operates 24 hours, 7 days a week on three shifts. The mid-day shift can be as long as 12 hours. While at the hump yard one unit of switching engines consists of two locomotives and a slug, at the bowl it may be two locomotives or one locomotive and one slug. Thus the total number of switching engines in operation may vary between 3 (night shift) and 10 (late day shift). For the purpose of emission calculations, ENVIRON assumed the operation of 2 locomotives at the bowl in all shifts. Thus total number of 24 switching engines operates in Barstow.

Table 3-5. Locomotive switching Engine fleet characterization for service to the Barstow facility.

Locomotive Model	Certification Tier	HP	Number of Engines	Engine Surrogate
GP25	Precontrolled	2500	1	Switcher
GP30	Precontrolled	2500	6	Switcher
GP35	Precontrolled	2500	12	Switcher
GP38-2B	Precontrolled	2000	1	GP-3x
GP39-2	Precontrolled	2300	1	GP-3x
GP39E	Precontrolled	2300	1	GP-3x
GP9	Precontrolled	1750	1	Switcher
SD39	Precontrolled	2500	8	GP-3x
SD9	Precontrolled	1750	1	Switcher
SW1000N	Precontrolled	1000	4	Switcher
SW1200	Precontrolled	1200	2	Switcher
SW1500	Precontrolled	1500	4	Switcher
SLUG	N/A	N/A	9	N/A

Table 3-6 provides the distribution of switching activity by area and time of the day. Over the course of a day, the switching activity takes place to 83% at the bowl on the east side of the classification yard, stretching all the way to the east end of the Barstow yard. On a temporal basis, emissions peak in the afternoon and evening and are lowest between midnight and 8 a.m.

Table 3-6 Temporal and special distribution of emissions from switching activities in the Barstow yard.

	8 a m		3 p m		12 a m			
	Number	Percent	Number	Percent	Number	Percent	**Total**	**Percent**
Hump yard	2	25%	2	20%		0%	**4**	**1 %**
Bow	6	75%	8	80%	6	100%	**20**	**3%**
Total	**8**	**33%**	**10**	**42%**	**6**	**25%**	**24**	**100%**

The time in mode for switching engine activity in Table 3-7 was determined from event recorder downloads of a sample of five engines operating in the Barstow yard. The five engines all were SD39 engines with 2,500 hp, and are representative of the switching engines dedicated to the services in Barstow. Emission factors are based on the engine roster in Table 3-6.

Table 3-7. Switching engine relative time in mode.

Throttle Notch	Time in Mode
Engine shut off	17.8%
DB	0.0%
Idle	63.7%
1	4.7%
2	3.4%
3	4.5%
4	2.7%
5	1.3%
6	0.6%
7	0.4%
8	1.0%

3.5 Train Arrival and Departures in and from the Yard

The trains that arrive and departure in Barstow are representative of the population of BNSF line haul engines that service California. All engines entering or leaving California stop in or pass through Barstow. The fleet characteristics by model and emission tier level for arriving and departing trains is shown in Table 3-8.

Table 3-8. Fleet characteristics for arriving and departing engines in Barstow.

Tier	Model	Number	Fleet Fraction
Precntrl	Switchers	58	0.11%
Precntrl	GP-3x	3,008	5.56%
Precntrl	GP-4x	6,666	12.32%
Precntrl	GP-50	99	0.18%
Precntrl	GP-60	156	0.29%
Precntrl	Dash-7	30	0.06%
0	GP-60	1,758	3.30%
0	SD-7x	122	0.23%
0	Dash-8	4,930	9.11%
0	Dash-9	24,632	45.53%
1	Dash-9	9,383	17.34%
2	ES44/Dash-9	3,229	5.97%
	Total	**54,101**	

BNSF provided engine counts for arriving and departing trains as well as automatic train reader counts from readers near the yard. Three reader locations, two west and one east of the yard, ensure that all trains passing through Barstow were counted.

For the purpose of differentiating the emission in train arrivals and trains passing through the yard a specific definition for those categories were found. All trains undergo a crew change in Barstow yard, thus all trains stop in the yard. However, ENVIRON determined that all trains just receiving a crew change were still considered passing trains.

Thus only those trains with a wait time of more than 1.5 hours in the yard are considered true arrivals. ENVIRON assumes that trains with stays longer than 1.5 hours either reconfigure the rail cars, or receive other services. Trains below 1.5 hours stay are those that pass through the yard and only stop for crew changes. Passing train emissions will be counted for under the category described in Section 3.6.

Between May 1, 2005 and April 31, 2006, 54,101 BNSF locomotives were counted as true arrivals and departures under the conditions described above. This corresponds to approximately 13,500 trains per year or 37 trains per day, assuming 4 engines per train.

BNSF provided throttle position for a sample engine that arrived and departed out of the Barstow yard. This information, which is representative for trains arriving and departing in Barstow, is shown in Table 3-9. The activity pattern represents an arrival and departure as well as the average amount in idling while in the yard. Trains idle in-between movements in the yard and while they are transiting to other locations such as the service area. Engines may stay longer at the yard than the idle time indicates. However, during longer stays engines may be switched off for periods of time.

Table 3-9. Combined activity by mode for arriving and departing trains.

Throttle Position	Hours in mode
DB	0.34
Idle	4.40
T1	0.49
T2	0.21
T3	0.03
T4	0.01
T5	0.00
T6	0.00
T7	0.00
T8	0.00

3.6 Freight Movements on Mainline

The main line in Barstow runs north of the yard. Its length is approximately 4.7 miles. All BNSF trains from outside the state with origin and destination in California pass through Barstow. As described above, ENVIRON considers all trains that pass through the yard and that undergo a crew change as passing trains. Nearly all trains stop in Barstow to receive at least a crew change.

Two subcategories of freight movements occur on the mainline BNSF and non-BNSF (foreign). All operations for both subcategories are assumed to occur throughout a 24-hour period. BNSF automatic readers capture traffic to and from west as well as to and from east of the yard, going to and leaving from the Barstow yard. The reader locations are to the north of the yard, for trains towards Mojave Desert, to the west for trains to and from the Los Angeles basin and to the east for all trans-continental trains.

The total number of freight trains passing the readers consists of BNSF trains arriving and departing in Barstow as well as BNSF and foreign trains passing through and by the yard. The readers count some trains that travel from north to west without arriving at or passing through the Barstow yard. However, by matching the reader counts with the train arrival and departure data provided by BNSF an accurate estimate of total passing trains was possible. Approximately 156,516 engines arrived or passed through the Barstow yard between May 1, 2005 and April 30, 2006. Of those, 54,101 were engines that arrived in Barstow and 32,256 were foreign engines. The foreign counts also include 728 Amtrak transcontinental trains, which are not considered as freight movements. The number of BNSF freight engines that pass the yard is 70,159.

3.6.1 BNSF Freight Movements

The fleet characteristic for the BNSF engines represents the California average fleet mix. Table 3-10 breaks this fleet mix down to the engine numbers that pass the Barstow yard. The average profile of each passing engine is provided in Table 3-11. The profile is based on a sample of six passing engines. The idle time results from crew changes at the Barstow yard.

Table 3-10. Fleet characterization for BNSF locomotives that are considering passing through the Barstow yard.

Tier	Model	Number of BNSF engines	Number of foreign engines	Fleet Fraction
Precntrl	Switchers	76	34	0.11%
Precntrl	GP-3x	3,901	1,753	5.56%
Precntrl	GP-4x	8,644	3,885	12.32%
Precntrl	GP-50	128	57	0.18%
Precntrl	GP-60	202	91	0.29%
Precntrl	Dash-7	44	20	0.06%
0	GP-60	2,314	1,040	3.30%
0	SD-7x	158	71	0.23%
0	Dash-8	6,394	2,873	9.11%
0	Dash-9	31,944	14,355	45.53%
1	Dash-9	12,168	5,468	17.34%
2	ES44/Dash-9	4,187	1,882	5.97%
	Total	**70,159**	**31,528**	

Table 3-11. Average locomotive profile (time in mode) for passing engines in the Barstow yard.

Throttle Position	Time in Mode (hrs)
DB	0.07
Idle	0.23
T1	0.01
T2	0.03
T3	0.03
T4	0.02
T5	0.01
T6	0.00
T7	0.00
T8	0.01
Total time	0.41

3.6.2 Foreign (non-BNSF) Freight Movements

32,256 foreign (non-BNSF) locomotives passed the Barstow facility between May 1, 2005 and April 30, 2006. Of those 728 were Amtrak trains and subtracted from the foreign freight train counts. Thus 31,528 foreign engines passed the yard pulling or pushing freight trains. ENVIRON made the assumption that the fleet mix and time in mode for these engines would be the same than those of the BNSF engines. (Table 3-11) Furthermore, ENVIRON also assumes the same duty cycle for the foreign passing trains, as they need to match with the traffic flow created by the main BNSF traffic.

3.7 Commuter Rail Operations on Adjacent Mainline

Barstow's adjacent mainline also serves passenger transportation. However, the only passenger transportation on the line is a daily train in both directions with destinations Los Angeles and Chicago, IL. Thus a total of 728 passenger trains pass through Barstow. Other destinations are served with bus connectors, for example to Bakersfield, CA, and Las Vegas, NV.

Exact fleet characteristics are not known for the AMTRAK locomotives. However, both ARB and BNSF have indicated the predominance of F59PHI (EMD 710E3, 3000 hp) engines in the AMTRAK fleets, which for purposes of emissions estimates in this study are modeled using the average emission levels from the EPA (1997) study for the two 12 cylinder EMD 710G3 engines based on similarities in engine design, size, and power rating.

4.0 LOCOMOTIVE EMISSION FACTORS FOR DIESEL PARTICULATE MATTER

Emission factors used in this study were based primarily on the emission factors used in the California Air Resources Board (ARB)'s Risk Assessment Study for the Union Pacific Roseville facility, and the Southwest Research Institute (SwRI, 2000) study sponsored by ARB, entitled "Diesel Fuel Effects on Locomotive Exhaust Emissions." Since the publication date of the Roseville report, ARB provided ENVIRON with additional emission factors for criteria pollutants, and made some adjustments to the original Roseville data (ARB, 2006a). ENVIRON also received permission from the engine owners to obtain additional emission factor data from the Exhaust Plume Study performed by SwRI (2005). The PM emission factors relevant to all locomotives in the Barstow facility are summarized in Tables 4-1a and 4-1b for several different locomotive model groups and certification tiers. Specific locomotives and engines in each locomotive model group can be inferred from the fleet characterization tables provided above.

Based on conversation with the principal researcher on all the locomotive studies (SwRI, 2006), ENVIRON learned that a default fuel sulfur content of 0.3% was used on all test results and certification data produced with locomotives to date (the emission rates in SwRI, 2000 were those with 0.3% sulfur fuel). The emission rates using this fuel are reflected in Table 4-1a.

Table 4-1a. PM emission factors for locomotives used in the study, assuming default fuel sulfur content (0.3%).

Locomotive Model Group	Cert Tier[a]	Emission Factors (g/hr) by Throttle Notch									
		Idle	DB[b]	1	2	3	4	5	6	7	8
Switchers [c]	Precntl	31.0	56.0	23.0	76.0	138.0	159.0	201.0	308.0	345.0	448.0
GP-3x [c]	Precntl	38.0	72.0	31.0	110.0	186.0	212.0	267.0	417.0	463.0	608.0
GP-4x [c]	Precntl	47.9	80.0	35.7	134.3	226.4	258.5	336.0	551.9	638.6	821.3
GP-50 [c]	Precntl	26.0	64.1	51.3	142.5	301.5	311.2	394.0	663.8	725.3	927.8
GP-60 [c]	Precntl	48.6	98.5	48.7	131.7	284.5	299.4	375.3	645.7	743.6	941.6
SD-7x [c]	Precntl	24.0	4.8	41.0	65.7	156.8	243.1	321.1	374.8	475.2	589.2
Dash-7 [c]	Precntl	65.0	180.5	108.2	121.2	359.5	327.7	331.5	299.4	336.7	420.0
Dash-9 [d]	Precntl	32.1	53.9	54.2	108.1	219.9	289.1	370.6	437.7	486.1	705.7
EMD 12-710G3 [e]	Precntl	27.5	54.5	34.0	112.5	208.0	234.5	291.0	423.0	545.0	727.5
GP-60 [f]	0	21.1	25.4	37.6	75.5	239.4	352.2	517.8	724.8	1125.9	1319. 8
SD-7x [c]	0	14.8	15.1	36.8	61.1	230.4	379.8	450.8	866.2	1019.1	1105. 7
Dash-8 [c]	0	37.0	147.5	86.0	133.1	291.4	293.2	327.7	373.5	469.4	615.2
Dash-9 [g]	0	33.8	50.7	56.1	117.4	229.2	263.8	615.9	573.9	608.0	566.6
Dash-9 [f]	1	16.9	88.4	62.1	140.2	304.0	383.5	423.9	520.2	544.6	778.1
ES44/Dash-9 [f]	2	7.7	42.0	69.3	145.8	304.3	365.0	405.2	418.4	513.5	607.5

[a] Precntl : Precontrolled
[b] DB: Dynamic Braking
[c] Final locomotive emission factors (an update to the Roseville study emission factors Table B-1) received via email from Dan Donohue of ARB, May 9, 2006.
[d] "Diesel Fuel Effects on Locomotive Exhaust Emissions," Southwest Research Institute, October 2000.
[e] EPA, 1997.
[f] Confidential data from SwRI, 2006.
[g] Average of ARB and SwRI, 2006.

Table 4-1b provides emission factors adjusted for fuel sulfur content of 0.105%. This adjustment was performed according to documented ARB procedures from the OFFROAD Modeling Change Technical Memo (Wong, 2005). All locomotive emissions presented in this document utilized the emission factors from Table 4-1b.

Table 4-1b. Emission Factors for locomotives used in the study, adjusted for reduced fuel sulfur content (0.105%).

Locomotive Model Group	Cert Tier[a]	Emission Factors (g/hr) by Throttle Notch									
		Idle	DB[b]	1	2	3	4	5	6	7	8
Switchers [c]	Precntl	31.0	56.0	23.0	76.0	131.8	146.1	181.5	283.2	324.4	420.7
GP-3x [c]	Precntl	38.0	72.0	31.0	110.0	177.7	194.8	241.2	383.4	435.3	570.9
GP-4x [c]	Precntl	47.9	80.0	35.7	134.3	216.2	237.5	303.5	507.4	600.4	771.2
GP-50 [c]	Precntl	26.0	64.1	51.3	142.5	288.0	285.9	355.8	610.4	681.9	871.2
GP-60 [c]	Precntl	48.6	98.5	48.7	131.7	271.7	275.1	338.9	593.7	699.1	884.2
SD-7x [c]	Precntl	24.0	4.8	41.0	65.7	149.8	223.4	290.0	344.6	446.8	553.3
Dash-7 [c]	Precntl	65.0	180.5	108.2	121.2	322.6	302.9	307.7	268.4	275.2	341.2
Dash-9 [d]	Precntl	32.1	53.9	54.2	108.1	197.3	267.3	343.9	392.4	397.3	573.3
EMD 12-710G3 [e]	Precntl	27.5	54.5	34.0	112.5	186.6	216.8	270.1	379.3	445.4	591.0
GP-60 [f]	0	21.1	25.4	37.6	75.5	228.7	323.6	467.7	666.4	1058.5	1239.3
SD-7x [c]	0	14.8	15.1	36.8	61.1	220.1	349.0	407.1	796.5	958.1	1038.3
Dash-8 [c]	0	37.0	147.5	86.0	133.1	261.5	271.0	304.1	334.9	383.6	499.7
Dash-9 [g]	0	33.8	50.7	56.1	117.4	205.7	243.9	571.5	514.6	496.9	460.3
Dash-9 [f]	1	16.9	88.4	62.1	140.2	272.8	354.5	393.4	466.4	445.1	632.1
ES44/Dash-9 [f]	2	7.7	42.0	69.3	145.8	273.0	337.4	376.0	375.1	419.6	493.5

[a] Precntl : Precontrolled
[b] DB: Dynamic Braking
[c] Final locomotive emission factors (an update to the Roseville study emission factors Table B-1) received via email from Dan Donohue of ARB, May 9, 2006.
[d] "Diesel Fuel Effects on Locomotive Exhaust Emissions," Southwest Research Institute, October 2000.
[e] EPA, 1997.
[f] Confidential data from SwRI, 2006.
[g] Average of ARB and SwRI, 2006.

The sulfur content value of 0.105% used for the adjustment was obtained by averaging data provided by BNSF for diesel fuel dispensed and corresponding sulfur level at all California sites and those near California. For sites outside of California, ENVIRON assumed that half of the fuel dispensed would be used in California, because trains moving in either direction may be fueled there. In reality, it is likely that less than half of the out-of-state fuel dispense will be used in California, because many of those sites are a significant distance from the state border. The data and overall estimates are shown in Table 4-2.

Table 4-2. Fuel sulfur and total annual fueling at various locomotive fueling locations.

Location	State	Total Gallons	% Sulfur
Holbrook	AZ	21,935	0.192
Phoenix	AZ	3,542,292	0.034
Flagstaff	AZ	2,019	0.192
Kingman	AZ	334,309	0.034
Vacaville	CA	33,074	0.034
Redding	CA	1,004	0.192
Summit	CA	1,750	0.192
San Diego	CA	530	0.192
Bakersfield	CA	240,976	0.034
Barstow	CA	1,946,092	0.015
Oakland	CA	1,762,993	0.034
Needles	CA	770,667	0.192
Bakersfield	CA	131,075	0.034
Bakersfield	CA	11,070	0.034
Corona	CA	103,982	0.034
Fresno	CA	2,669,884	0.034
Kaiser	CA	460,390	0.034
Kings Park	CA	61,900	0.034
Pittsburg	CA	12,695	0.034
Riverbank	CA	2,070,244	0.034
Barstow	CA	9,940,295	0.034
San Diego	CA	111,369	0.192
Stockton	CA	1,018,965	0.034
Stuart Mesa	CA	41,509	0.192
Terminal Island	CA	14,816,643	0.192
Victorville	CA	66,042	0.034
Watson	CA	1,152,454	0.192
Bakersfield	CA	11,236	0.192
Winslow	AZ	3,496,072	0.170
Belen	NM	202,462,278	0.192
Barstow	CA	52,439,321	0.015
Commerce	CA	31,573,289	0.015
Richmond	CA	22,255,177	0.034
Klamath Falls	OR	3,070,865	0.381

The fuel sulfur correction methodology described by ARB (2005a) was used to adjust PM emission rates from an average fuel sulfur level of 0.3% to 0.105% using the fuel sulfur - PM relationship equation, A + B * (fuel sulfur, ppm). The emission reductions calculated for GE and EMD engines shown in Table 4-3 were applied to the base emission rates to calculate the emission rates at the in-use fuel sulfur levels.

Table 4-3. Fuel sulfur emission reductions by notch and Engine type.

Notch	B	A	Fuel Sulfur 0.3% EF (g/hp-hr)	Fuel Sulfur 0.105% EF (g/hp-hr)	Reduction
GE 4-stroke Engine					
8	0.00001308	0.0967	0.13594	0.110434	18.76%
7	0.00001102	0.0845	0.11756	0.096071	18.28%
6	0.00000654	0.1037	0.12332	0.110567	10.34%
5	0.00000548	0.132	0.14844	0.137754	7.20%
4	0.00000663	0.1513	0.17119	0.1582615	7.55%
3	0.00000979	0.1565	0.18587	0.1667795	10.27%
EMD 2-stroke engine					
8	0.0000123	0.3563	0.3932	0.369215	6.10%
7	0.0000096	0.284	0.3128	0.29408	5.98%
6	0.0000134	0.2843	0.3245	0.29837	8.05%
5	0.000015	0.2572	0.3022	0.27295	9.68%
4	0.0000125	0.2629	0.3004	0.276025	8.11%
3	0.0000065	0.2635	0.283	0.270325	4.48%

5.0 LOCOMOTIVE DIESEL PM EMISSION ESTIMATES

5.1 Basic Service

Estimated annual PM emissions for basic service activities at BNSF's Barstow yard are presented in Table 5-1. The activities under basic services include refueling as well as truck inspections, 32 and 92 day inspections without engine tests. Per in-consist unit, one lead engine load test occurs. ENVIRON calculated these emissions using the Barstow characteristic fleet mix, the movement to site and an engine idling for approximately 1.5 hours. Basic services occur year round mostly during day time hours between 8 a.m. and 8 p.m. 19,995 engines undertook basic services in Barstow in 2005.

Engines are put in-consist, a set of 3-4 engines, before leaving the service area. During the process of assembling the in-consist engines, each engines idles for approximately 30 minutes. The emission from in-consist idling are listed separately for all engines that underwent service in Table 5-4 because of its distinct location in the yard.

In addition, approximately 1600 fuelings occurred at the DTL sites throughout the yard. ENVIRON assumes that those fueling events took place at the two main DTL sites on the west and east end of the ready tracks. The other sites are negligible. PM emissions at those sites are also provided in Table 5-1.

Table 5-1. Estimated annual PM emissions associated with refueling of locomotive engines in Barstow.

Locomotive Model Group	Cert Tier	Number of engines basic service	PM Emissions basic service (grams)	Number of engines refueling at DTL sites	PM Emissonis at main DTL sites (grams)
Switchers	Precontrolled	1,173	**63,876**	2	**80**
GP-3x	Precontrolled	3,084	**219,722**	89	**5,071**
GP-4x	Precontrolled	3,948	**346,939**	197	**14,176**
GP-50	Precontrolled	191	**13,849**	3	**114**
SD-7x	Precontrolled	1394	**70,741**	5	**336**
Dash-7	Precontrolled	691	**85,916**	1	**97**
Dash-9	Precontrolled	605	**43,611**	0	
GP-60	0	979	**47,886**	53	**1,670**
SD-7x	0	1,270	**49,845**	4	**80**
Dash-8	0	771	**70,918**	146	**8,082**
Dash-9	0	3,023	**230,834**	728	**36,973**
Dash-9	1	1,740	**115,168**	277	**7,034**
ES44/Dash-9	2	1,045	**63,140**	95	**1,103**
Total		**19,915**	**1,422,444**	**1600**	**74,817**

5.2 Basic Engine Inspection with Engine Test

Estimated annual PM emissions for basic engine inspection with engine tests at BNSF's Barstow yard are presented in Table 5-2. The activities under basic engine inspection include both test cycles for GE engines and non-GE engines. However, the predominant engine types are non-GE

engines. All engines undergo a post inspection engine test. ENVIRON calculated these emissions using the Barstow characteristic fleet mix, differentiated in GE and non-GE engines, the movement to site and an engine testing times. Basic engine inspections occur year round mostly during day time hours **between 8 a.m. and 8 p.m.** 523 engines undertook basic engine inspections in Barstow in 2005.

Engines are put in-consist, a set of 3-4 engines, before leaving the service area. During the process of assembling the in-consist engines, each engines idles for approximately 30 minutes. The emission from in-consist idling are listed separately for all engines that underwent service in Table 5-4 because of its distinct location in the yard.

Table 5-2. Estimated annual PM emissions associated with basic engine inspections in Barstow.

Locomotive Model Group	Cert Tier	# of Loco	PM Emissions (grams)
Switchers	Precntl	50	**16,849**
GP-3x	Precntl	131	**59,768**
GP-4x	Precntl	168	**101,847**
GP-50	Precntl	8	**5,358**
SD-7x	Precntl	59	**25,113**
Dash-7	Precntl	5	**1,716**
Dash-9	Precntl	1	**152**
GP-60	0	42	**36,728**
SD-7x	0	54	**39,836**
Dash-8	0	1	**178**
Dash-9	0	1	**634**
Dash-9	1	1	**474**
ES44/Dash-9	2	3	**1,297**
Total		**523**	**289,953**

5.3 Full Engine Service/Inspection

Estimated annual PM emissions for full engine inspection with engine tests at BNSF's Barstow yard are presented in Table 5-3. The activities under full engine inspection include both test cycles for GE engines and non-GE engines. All engines undergo a post inspection engine load and opacity test. GE engines also undergo a pre-inspection load test. ENVIRON calculated these emissions using the Barstow characteristic fleet mix, differentiated in GE and non-GE engines. The movement to the site and the engine testing times were taken into account. Full engine inspections occur year round mostly during day time hours **between 8 a.m. and 8 p.m.** 1,164 engines were fully inspected and tested in Barstow in 2005.

Engines are put in-consist, a set of 3-4 engines, before leaving the service area. During the process of assembling the in-consist engines, each engines idles for approximately 30 minutes. The emission from in-consist idling are listed separately for all engines that underwent service in Table 5-4 because of its distinct location in the yard.

Table 5-3. Estimated annual PM emissions associated with full engine inspections at Barstow.

Locomotive Model Group	Cert Tier	# of Loco	PM Emissions (grams)
Switchers	Precntl	22	**9,929**
GP-3x	Precntl	58	**35,218**
GP-4x	Precntl	74	**60,169**
GP-50	Precntl	4	**3,194**
SD-7x	Precntl	26	**14,948**
Dash-7	Precntl	73	**45,764**
Dash-9	Precntl	73	**60,632**
GP-60	0	18	**21,577**
SD-7x	0	24	**24,153**
Dash-8	0	94	**71,997**
Dash-9	0	367	**272,159**
Dash-9	1	211	**192,190**
ES44/Dash-9	2	120	**89,333**
Total		**1,164**	**901,261**

Emissions from idling while the engines are put in-consist of 3-4 engines are listed in Table 5-4. Those emissions encompass all engines that received service in Barstow.

Table 5-4. Estimated annual PM emissions associated with engine idling from all engines that underwent engine service and inspections.

Locomotive Model Group	Cert Tier	# of Loco	PM Emissions (grams)
Switchers	Precntl	1,272	**19,722**
GP-3x	Precntl	3,345	**63,559**
GP-4x	Precntl	4,283	**102,655**
GP-50	Precntl	207	**2,696**
SD-7x	Precntl	1,512	**18,153**
Dash-7	Precntl	750	**24,357**
Dash-9	Precntl	657	**10,541**
GP-60	0	1,062	**11,203**
SD-7x	0	1,378	**10,183**
Dash-8	0	836	**15,443**
Dash-9	0	3,280	**55,483**
Dash-9	1	1,887	**15,949**
ES44/Dash-9	2	1,134	**4,366**
Total		**21,602**	**354,11**

5.4 Switching Engine Activity

Estimated annual PM emissions for switching activities at the Barstow facility are presented in Table 5-5. The emissions from switching split into two dedicated locations, the hump yard near west entrance of the Barstow yard and the classification yard east of the train arrival and maintenance area. Switching activities in the classification yard stretches all the way to the east border of the Barstow yard.

Besides the spatial differentiation, Barstow switching activities also show a temporal differentiation. There are no late night shifts at the hump yard. Furthermore, the afternoon shift in the classification yard utilizes more switching engines than morning and late night. Table 5-5 thus also identifies the temporal emissions besides the Barstow total.

Switching activities are conducted with switcher and GP-3x model engines. ENVIRON calculated these emissions using the engine-specific emission factors by notch in Table 4-1b, the fleet characteristics in Table 3-5, and the relative time in mode data from Table 3-7. The switching activity over 365 days per year was distributed equally across all engines in the switching fleet. The switching engine activity is known only by the engine hours and selected downloads of the time in mode (notch) for the activity in the general area.

Table 5-5. Estimated annual PM emissions associated with switching activities in the Barstow yard.

Areas in the Barstow yard	Total PM Emissions [grams)	8:00 a.m. – 3:00 p.m. [g)	3:00 p.m. – 12:00 a.m. [g}	12:00 a.m. – 8:00 a.m. [g}
Hump yard	**905,613**	452,807	452,807	0
Classification yard	**3,320,583**	996,175	1,328,233	996,175
Total	**4,226,196**	**1,448,982**	**1,781,040**	**996,175**

5.5 Train Arrival and Departures in and from the Yard

Trains arriving and departing in Barstow have a similar fleet mix then passing BNSF trains. The fleet characteristic of Table 3-10 was used to estimate the emissions. Emissions were derived based on the activity, shown in Table 3-11, for an arriving and departing train. The emissions for all engines arriving and departing are shown in Table 5-6.

Table 5-6. Emissions from trains with destination Barstow.

Model Group	Cert Tier	Total
Switchers	Precntl	**11,718**
GP-3x	Precntl	**766,349**
GP-4x	Precntl	**2,093,762**
GP-50	Precntl	**22,722**
GP-60	Precntl	**52,323**
Dash-7	Precntl	**15,747**
GP-60	0	**304,930**
SD-7x	0	**16,570**
Dash-8	0	**1,571,038**
Dash-9	0	**6,140,871**
Dash-9	1	**1,915,441**
ES44/Dash-9	2	**490,912**
Total		**13,402,382**

5.6 Freight Movements on Adjacent Mainline

For the purpose of this study, ENVIRON considered all trains that pass through the yard, without significant delays, as freight movements on mainline. This also includes trains that undergo a crew change. A similar fleet characteristic to that from arriving trains was used. The activity profile for passing trains is provided in Table 3-11 and was used to calculate emissions. The same characteristic and profile was applied to non-BNSF trains. The PM emission estimates for BNSF freight movements during 2005 are presented in Table 5-7 and those for other foreign engines in Table 5-8.

Table 5-7. Estimated annual PM emissions associated with BNSF freight movements along the mainline through the Barstow facility.

Model Group	Cert Tier	Total
Switchers	Precntl	**1,987**
GP-3x	Precntl	**134,640**
GP-4x	Precntl	**371,477**
GP-50	Precntl	**5,340**
GP-60	Precntl	**9,774**
Dash-7	Precntl	**2,303**
GP-60	0	**93,371**
SD-7x	0	**5,727**
Dash-8	0	**280,507**
Dash-9	0	**1,171,602**
Dash-9	1	**475,503**
ES44/Dash-9	2	**134,785**
Total		**2,687,014**

Table 5-8. Estimated annual PM emissions associated with non-BNSF freight movements along the mainline through the Barstow facility.

Model Group	Cert Tier	Total
Switchers	Precntl	**893**
GP-3x	Precntl	**60,504**
GP-4x	Precntl	**166,934**
GP-50	Precntl	**2,400**
GP-60	Precntl	**4,932**
Dash-7	Precntl	**1,035**
GP-60	0	**41,959**
SD-7x	0	**2,573**
Dash-8	0	**126,054**
Dash-9	0	**526,494**
Dash-9	1	**213,681**
ES44/Dash-9	2	**60,570**
Total		**1,207,488**

5.7 Commuter Rail Operations on Adjacent Mainline

The annual PM emission estimates for commuter movements on the adjacent mainline are presented in Table 5-9. Time in notch for these locomotives was assumed to be the same as was modeled for the freight locomotives.

Table 5-9. Estimated annual PM missions associated with commuter movements along the mainline of the Barstow yard.

Model Group	Locomotive Model Group	Cert Tier	# of Loco	Total
AMTRAK	EMD 12 710G3	Precntl	728	23,276

6.0 NON-LOCOMOTIVE FACILITY OPERATIONS, EMISSION FACTORS AND EMISSION ESTIMATES

The operations at the Barstow facility also include non-locomotive activity within the yard. A description of the operations is included in Sections 6.1 - 6.5.

6.1. Cargo Handling Equipment Operations

The BNSF yard in Barstow has no cargo handling operations, except for emergencies operations. Emissions in this category were estimated using input on CHE characteristics for all of BNSF's California sites. Only one piece of equipment of model year 1987 operates at the Barstow site. The annual hours of operation are 240 hours according to input from BNSF. Emissions from the piece of equipment are provided in Table 6-1.

Table 6-1. CHE DPM Emissions Estimates for Barstow (grams per year - 2005).

Equipment Type	Fuel Type	Number	PM (gpy)
Material handling equipment	D	1	24,962

6.2. On-road Truck Operations

On-road truck activity is limited to few service operations. As stated above, the Barstow yard does not operate cargo loading or unloading. Thus the only on-road trucks operating the site are fuel trucks and delivery vehicles. Delivery vehicles were discarded because their operations are in-frequent and un-predictable.

Four direct to locomotive (DTL) fueling sites operate in Barstow. Locomotives fuel on two west and two east DTL stations. Those stations are in addition to fixed fueling facilities that obtain their fuel by pipeline. Approximately 2 million gallons of fuel per year are delivered by truck, compared to approximately 58 million gallons by pipeline. Assuming that trucks deliver about 6,000 gallons per truck load, a total of 333 truck loads are needed to deliver 2 million gallons of fuel. In order to simplify calculations, one fuel truck trip per day was assumed in Barstow, resulting in 365 truck trips per year.

The fueling trucks stay entirely within the Barstow yard. The sources of fuel are the fuel storage tanks west of the administration buildings. The two DTL fueling sites are 1.5 and 3.3 miles away from the BNSF yard entrance. Because ENVIRON assumed only one fuel truck trip per day that services several locomotives, it was anticipated that every truck travels to both DTL fueling sites. A round trip servicing both DTL sites is 6.37 miles long. It was assumed that trucks idle for 10 minutes prior to departure and for 60 minutes at each DTL site.

Due to the limited number of samples an average age distribution, created through EMFAC model was used. Because its high accuracy, the vehicle mile normalized age distribution for the South Coast Air Basin was used for the calculation. The HHDDV emission rates were calculated for each aged engine by interpolating between 15 and 20 mph to determine the emission rates at an average speed of 16.7 mph. The speed of 16.7 mph had been observed with trucks traveling in BNSF's Barstow yard and was used for Barstow as well. Emissions from fueling trucks are summarized in Table 6-2.

Table 6-2. Emissions estimates for fueling truck trips at the Barstow yard

Mode or Location	Fueling Trucks	
	Per trip emissions (PM10 g/trip)	Total Emissions (365 trips) (PM10 g/yr)
On-site travel	13.82	5,045
Idle at DTL site	5.68	2,073
Idle at storage site	0.47	173
Sum (g/yr)		**7,290**

6.3 On-road Fleet Vehicle Operations

BNSF operates approximately 90 on-road licensed vehicles out of its Barstow facility. The vehicles provide service to BNSF trains, tracks and other assets. There are several facilities within the yard, where those vehicles may have business or may be stationed. Furthermore, the BNSF yard in Barstow has two main entrances. One is located in the north-west corner, next to the administration building and the other is located south next to the ready tracks. ENVIRON assumed an equal usage of the north and the south entrances. A distribution based on aerial inspection of the site, using satellite images, was chosen to calculate an average miles traveled in the yard for each vehicle. Table 6-3 lists all distances as well as the assumed distribution of business. 7,

Table 6-3 Entrances, facilities, distances and distribution of traffic for fleet vehicles at the Barstow facility

Location	Distance from north entrance in miles	Distance from south entrance in miles	Average distance	Percent of traffic
Small facility east of ready tracks, bldg. # 22	2.33	1.71	1.82	10%
Medium size facility near classification yard, bldg. # 20	1.42	0.89	0.91	20%
Medium size facility west of ready tracks, bldg. # 15,16	1.10	0.40	0.59	20%
Main administration office, bldg. # 7	0.14	1.37	0.57	40%
Maintenance area and main shop, bldg. # 10	0.29	1.42	0.66	10%
Weighted Average			**0.97**	

The 90 on-road vehicles stationed in Barstow include gasoline and diesel powered vehicles as well as vehicles from light duty trucks to heavy duty vehicles. ENVIRON used the EMFAC model average trip distance by vehicle type for the South Coast in 2005 due to the proximity of Barstow and its service area in Southern California. The trip distance was used to determine the number of trips for each vehicle by dividing it into the annual mileage accumulation. The annual mileage was determined from the odometer reading divided by the age of the vehicle, which likely overestimates the annual mileage because vehicles tend to be used less as they age. BNSF fleet vehicles were assumed to be distributed to the five locations as shown in Table 6-3. The distribution resulted in weighted average trip length of 0.79 miles. This distance was used as the distance traveled within the site for each trip. Table 6-4 provides the vehicle categories that are present in Barstow and their overall activity estimates.

Table 6-4. BNSF On-road fleet vehicle activity at the Barstow facility.

EMFAC Vehicle Type	Fuel	# of Vehicles	Estimated Average Annual Mileage per Vehicle	Estimated Average Annual Mileage on Site per Vehicle
LDT1	Gasoline	2	21,333	3,213
LDT2	Gasoline	20	21,071	3,135
MDV	Gasoline	7	20,990	3,050
LHDT1	Diesel	2	16,067	2,736
LHDT1	Gasoline	33	25,529	15,729
LHDT2	Gasoline	1	12,577	7,610
MHDT	Diesel	10	16,124	6,165
MHDT	Gasoline	4	10,570	10,570
HHDT	Diesel	12	12,775	309

Annual PM and TOG emission factors from EMFAC and on-site emissions estimates for the fleet vehicles are presented in Table 6-5. Note that gasoline and diesel vehicle estimates were kept separate, so that gasoline TOG exhaust and evaporative emissions could be speciated into TACs differently. ARB Speciate Profile #2105 will be used for the gasoline TOG exhaust emissions, and Profile #422 will be used for the gasoline TOG evaporative emissions.

Table 6-5. BNSF on-road fleet vehicle emissions at Barstow.

EMFAC Vehicle Type	Fuel	PM Emissions (grams)	TOG Exhaust Emissions (grams)	TOG Evaporative Emissions (grams)
LDT1/LDT2/MDV/LHDT1/LHDT 2/MHDT BNSF fleet vehicles	Gasoline	11,070	1,513,344	749,741
LHDT1/MHDT/HHDT BNSF fleet vehicles	Diesel	27,219	28,135	--

6.4. Other Off-Road Equipment

6.4.1. Transport Refrigeration Unit Operations

Transportation Refrigeration units (TRUs) are used to regulate temperatures during the transport of products with controlled temperature requirements. In BNSF operations, temperatures are regulated by TRUs in shipping containers and in railcars when the material that is being shipped requires such temperature regulation.

TRU emissions were estimated in accordance with the methodology presented by an early version of the OFFROAD model provided by ARB (2006c). TRU yearly activity was estimated using the time onsite by TRU configuration (either railcar or shipping container) and mode of transport was provided by BNSF. This activity data was used along with ARB default age, horsepower, and load factor input estimates in the OFFROAD model to estimate TRU emissions. An additional factor of 0.6 was used to account for the only temporary use of TRU units. All TRUs are assumed to use diesel fuel.

Boxcars

Barstow site boxcar TRU activity is shown in Table 6-6. As TRUs are not expected to be operating when a boxcar is not loaded, the TRU activity presented here represents loaded TRU shipping containers only. TRU Emissions associated with boxcars residing in Barstow are presented in Table 6-7.

Table 6-6. Barstow site Boxcar TRU yearly activity.

Transport Mode	Yearly Visits	Average Time Onsite / Visit (hours)
Train Arrival – Train Departure	3,040	18

Table 6-7. Barstow site Boxcar TRU emissions (grams per year).

Mode	TOG	PM
Train Arrival – Train Departure	2,286,467	45,990

Containers

Barstow site container TRU activity and associated emissions are shown in Table 6-8. As TRUs are not expected to be operating when a shipping container is not loaded, the TRU activity presented here represents loaded TRU shipping containers only. Since Barstow essentially does not have intermodal operations, those emissions are comparatively small.

Table 6-8. Barstow site shipping container TRU yearly activity and emissions (grams per year).

Yearly Visits	Total Time Onsite (hours)	Average Time Onsite / Visit (hours)	TOG (gpy)	PM (gpy)
529	1,058	2	44,208	8,995

6.4.2 Track Maintenance Equipment Operations

Track maintenance equipment includes equipment used to service tracks anywhere in California though it may be housed at any given facility. This equipment category includes large and small engines and equipment.

Activity

BNSF California track maintenance equipment can be used on any or all tracks within California to maintain the network. Therefore, the approach used to determine the activity and emissions for a given facility was to develop the on-site emissions as a portion of the estimated emissions from all track maintenance equipment throughout California. The relative track mileage (including all tracks, main line and other tracks) at the Barstow yard compared to the California total track mileage was used to establish the apportion factor.

The Barstow site has 87 miles of track within its boundaries compared with the California regional total of 3,779 miles. This represents 2.3% of the total California track mileage that is maintained.

Appendix I shows a list of all BNSF track maintenance equipment located in California with horsepower and operational parameters. Based on BNSF staff knowledge of equipment characteristics, it was assumed that all track maintenance equipment was diesel powered except two forklifts (equipment IDs TM1 and TM2) which were assumed to be powered by 4-stroke gasoline engines. Forklifts TM1 and TM2 could not be assumed to be diesel powered because diesel forklifts of 16 to 25 horsepower diesel forklifts were not included in the ARB OFFROAD model.

If rated horsepower was not available, horsepower was assumed to be the ARB default (ARB, 2006c) for the most populous horsepower range for the assigned ARB equipment category and type. Load factors were assumed to be ARB OFFROAD model default factors (ARB, 2006c).

Emissions

Exhaust emissions from track maintenance equipment were estimated using the draft version of the OFFROAD model (ARB, 2006c). Emissions from track maintenance equipment at the Barstow facility along with California totals are shown in Table 6-9.

Table 6-9. Track maintenance equipment emissions estimates (grams per year).

	Gasoline			Diesel	
Site	Evaporative TOG	Exhaust TOG	PM	TOG	PM
Barstow	494	2,808	81	283,272	103,704
California Totals	21,469	121,981	3,525	12,305,162	4,504,844

6.4.3 Other Off-road Equipment (including Portable Engine) Operations

There is no other mobile off-road equipment at the Barstow yard.

6.5 Stationary Sources

Air quality permits for the Barstow facility show several types of stationary sources for potential evaluation.

Source types

1) Gasoline storage and dispensing unit [2 on site]
2) Diesel-fueled internal combustion engines / generator sets (ICEs) [4 on site]

The gasoline storage and dispensing units are comprised of two 1000 gallon tanks with a hose and nozzle. The tanks are located near the east and west ends of the ready tracks. The throughput of those units were 7,601 and 29,960 gallons per year (2005) respectively. (permit # 9183) Phase I and II vapor recovery systems are in place. The estimated TAC emissions associated with gasoline storage and dispensing operations are mainly from filling/working loss, breathing loss dispensing and spillage loss. The emissions were estimated using the South Coast Air Quality Management District (SCAQMD) methodology, which contained emission factors and followed

guidance from the Gasoline Service Station Industry-Wide Risk Assessment Guidelines (CAPCOA, 1997) prepared by the Toxics Committee of the California Air Pollution Control Officers Association (CAPCOA). The estimated annual TOG emissions are shown in Table 6-10.

Table 6-10. TOG emissions for the gasoline dispensing and storage facility at the Barstow facility.

Specifications	Loading (grams)	Breathing (grams)	Fueling (grams)	Spillage (grams	Total TOG Emissions (grams)
Gasoline Dispensing and Storage Facility with Aboveground Storage Tank (Phase and Vapor Recovery)	7,156	3,578	10,734	7,156	28,623

The relevant parameters for the diesel ICE, as well as its estimated annual PM emissions are presented in Table 6-11. To estimate emissions from the the diesel ICE at the Barstow site, maximum permitted operating hours and maximum state- or district-permitted PM certification levels contained in the SCAQMD permit application # E007694 was used.

Table 6-11. Parameters and PM emissions estimates for the diesel-fueled ICE at the Barstow.

Specifications	Brake horsepower (hp)	Maximum Est. Operation Time (hr/yr)	PM Emissions (grams)
IC Engine, Emergency Diesel Generator #1, mode 1500 DS-4	2200	52	36,324
IC Engine, Emergency Diesel Generator #2, mode 1500 DS-4	2200	52	36,324
IC Engine, Emergency Diesel Generator #2, mode 1500 DS-4	210	52	10,897
600 KW Standby Generator, Generac mode SD600, Diesel Engine, Mode P222LE	275	52	14,270
Total			**97,814**

7.0 TOTAL TAC EMISSIONS FROM BNSF'S BARSTOW FACILITY

The estimated total annual diesel PM (DPM) emissions associated with the operations in the Barstow facility are summarized in Table 7-1.

Table 7-1. Estimated total annual DPM emissions associated with the operations in the Barstow facility.

Facility Operations	PM Emissions		Percentage
	Grams	Metric Tons	
Basic Services	1,749,085 [1]	1.75	7%
DTL fueling idling emissions	74,817	0.07	0 %
Basic Engine Inspection	298,531 [2]	0.30	1%
Full Engine Service/ Inspection	920,353 [3]	0.92	4%
Switching	4,226,196	4.23	17%
Arriving and Departing Trains	13,402,382	13.40	53%
Adjacent Freight Movements	3,894,502	3.89	15%
Adjacent Commuter Rail Operations	23,276	0.02	0%
Cargo and ng Equipment Operations	24,962	0.02	0%
On-Road Container Truck Operations	N/A	N/A	N/A
On-Road Container Truck Operations Contractors	7,290	0.01	0%
On-Road Fleet Vehicle	27,219	0.03	0%
Other Off-Road TRU	474,196	0.47	2%
Other Off-Road Track Maintenance	103,704	0.10	0%
Other Off-Road Portable Engines	N/A	N/A	N/A
Stationary Sources	97,814	0.10	0%
Total	**25,324,327**	**25.32**	**100%**

[1] Including 326,641 grams from in-consist idling.
[2] Including 8,578 grams from in-consist idling.
[3] Including 19,092 grams from in-consist idling.

The estimated total annual emissions of total organic gases (TOG) (for speciation into the other TACs) associated with gasoline, LPG, and CNG operations in the Barstow facility are summarized in Table 7-2. Diesel TOG is not included in the tabulation.

Table 7-2. Estimated total annual TOG emissions from gasoline/LPG/NG fueled engines associated with the operations in the Barstow facility.

Facility Operations	TOG Emissions		Percentage
	Grams	Metric Tons	
Basic Services	N/A	N/A	N/A
Basic Engine Inspection	N/A	N/A	N/A
Full Engine Service/ Inspection	N/A	N/A	N/A
Switching	N/A	N/A	N/A
Arriving and Departing Trains	N/A	N/A	N/A
Adjacent Freight Movements	N/A	N/A	N/A
Adjacent Commuter Rail Operations	N/A	N/A	N/A
Cargo Handling Equipment Operations	N/A	N/A	N/A
On-Road Container Truck Operations	N/A	N/A	N/A
On-Road Fleet Vehicle Exhaust	1,513,344	1.51	66%
On-Road Fleet Vehicle Evaporative	749,741	0.75	33%
Other Off-Road TRU	N/A	N/A	N/A
Other Off-Road Track Maintenance Exhaust	2,808	0.00	0%
Other Off-Road Track Maintenance Evaporative	494	0.00	0%
Other Off-Road Other Portable Engines Exhaust	N/A	N/A	N/A
Other Off-Road Other Portable Engines Evaporative	N/A	N/A	N/A
Stationary Sources	28,623	0 03	1%
Total	**2,295,010**	**2.30**	**100%**

8.0 REFERENCES

ARB. 2006a. Email from Dan Donohue of ARB to Chris Lindhjem of ENVIRON, May.

ARB. 2006b. E-mail communication from Sandee Kidd with Draft OFFROAD Model Emission Factors, ARB. April.

ARB. 2006c. Draft OFFROAD, and Draft EMFAC2005 models on disk. August, 2006. Cargo handling equipment emissions provided September.

ARB. 2005a. OFFROAD Modeling Change Technical Memo, "Changes to the Locomotive Inventory," prepared by Walter Wong, preliminary draft. March 16, 2005. Available online March 31, 2006 http //www.arb.ca.gov/msei/on-road/downloads/docs/Locomotive_Memo.pdf

ARB 2005b. Staff Report Initial Statement of Reasons for Proposed Rulemaking. Public hearing to consider adoption of the proposed regulation for mobile cargo handling equipment at ports and intermodal rail yards. Appendix B Emission Inventory Methodology. December 8-9. Available at http //www.arb.ca.gov/regact/cargo2005/cargo2005.htm

ARB. 2003a. Staff Report Initial Statement Of Reasons For Proposed Rulemaking Airborne Toxic Control Measure For In-Use Diesel-Fueled Transport Refrigeration Units (TRU) and TRU Generator Sets, and Facilities Where TRUs Operate, California Air Resources Board, http //www.arb.ca.gov/regact/trude03/trude03.htm, October.

ARB. 2003b. OFFROAD modeling change technical memo; October.

ARB. 2000a. "EMFAC Technical Support Document HC Conversions". California Air Resources Board, http //www.arb.ca.gov/msei/on-road/doctable_test.htm, February.

ARB. 2000b. "MSC #99-32 Public Meeting to Consider Approval of California s Emissions Inventory of Off-Road Large Compression-Ignited Engines (≥25hp) Using the New OFFROAD Emissions Model", Staff Report, California Air Resources Board, http //www.arb.ca.gov/msei/off-road/pubs.htm, January.

ARB. 1998. "MSC #98-27 Public Meeting to Consider Approval of the California Off-Road Large Spark-Ignited Engine Emissions Inventory", Staff Report, California Air Resources Board, http //www.arb.ca.gov/msei/off-road/pubs.htm, October.

EEA. 1997. "Documentation of Input Factors for the New Off-Road Mobile Source Emissions Inventory Model", Energy and Environmental Analysis, Inc., February.

EMFAC. 2003. EMFAC model version Emfav2002 V2.2 Apr 23. California Air Resources Board.

EPA. 2005. "Conversion Factors for Hydrocarbon Emission Components", U.S. Environmental Protection Agency, EPA420-R-05-015, December.

Port of Los Angeles 2005. "Port of Los Angeles Baseline Air Emission Inventory - 2001," Prepared by Starcrest.

SwRI. 2006. Personal communication between S. Fritz of SwRI and C. Lindhjem of ENVIRON, May.

SwRI, 2005. "Exhaust Plume Study," correspondence with Steve Fritz at SwRI, September and May.

SwRI, 2000 "Diesel Fuel Effects on Locomotive Exhaust Emissions." Prepared for California Air Resources Board, October.

Wong, ARB, March 2005, http //www.arb.ca.gov/ei/areasrc/arbomobilsrctrains.htm

APPENDIX A

Track Maintenance Equipment

Equipment ID	Equipment Type	ARB Category	ARB Equipment type	Engine Model Year	Engine Horsepower	Dual Engine (Y/N)	Operating Hours Per week	Average Operating Hours Per Year
TM1	FORKLIFT	Industrial	Forklifts	1998	17	N	30	1440
TM2	FORKLIFT	Industrial	Forklifts	1985	17	N	30	1440
TM3	ANCHOR APPLICATOR	Industrial	Other General Industrial	1988	50	N	25	1200
TM4	ANCH REMVR	Industrial	Other General Industrial	1994	90	N	15	720
TM5	ANCHOR BOXER	Industrial	Other General Industrial	1987	76	N	25	1200
TM6	ANCHOR BOXER	Industrial	Other General Industrial	1987	76	N	25	1200
TM7	ANCHOR REMOVER	Industrial	Other General Industrial	1995	50	N	20	960
TM8	ANCHOR APP/REM	Industrial	Other General Industrial	2004	50	N	25	1200
TM9	ANCHOR APP/REM	Industrial	Other General Industrial	2004	50	N	25	1200
TM10	ANCHOR APP/REM	Industrial	Other General Industrial	2004	50	N	25	1200
TM11	AIR COMPRESSOR	Commercial	Air Compressors	1989	35	N	12	576
TM12	AIR COMPRESSOR	Commercial	Air Compressors	1989[a]	35	N	15	720
TM13	AIR COMPRESSOR	Commercial	Air Compressors	1989[a]	35	N	10	480
TM14	AIR COMPRESSOR	Commercial	Air Compressors	1989[a]	35	N	10	480
TM15	ADZ/CRIB-DCF	Industrial	Other General Industrial	2002	90	N	15	720
TM16	DBL BRM	Industrial	Other General Industrial	1983	100	N	0	0
TM17	DBL BRM	Industrial	Other General Industrial	1985	100	N	0	0
TM18	DBL BRM TRLR	Industrial	Other General Industrial	2000	100	N	25	1200
TM19	BALLAST REGULATOR	Industrial	Other General Industrial	1981	64	N	17.29	829.92
TM20	BALLAST REGULATOR	Industrial	Other General Industrial	1991	64	N	0	0
TM21	BALLAST REGULATOR	Industrial	Other General Industrial	1986	64	N	0	0
TM22	BALLAST REGULATOR	Industrial	Other General Industrial	1979	64	N	45	2160
TM23	BALLAST REGULATOR	Industrial	Other General Industrial	1984	175	N	45	2160
TM24	BALLAST REGULATOR	Industrial	Other General Industrial	1983	175	N	0	0
TM25	BALLAST REGULATOR	Industrial	Other General Industrial	1985	175	N	0	0
TM26	BALLAST REGULATOR	Industrial	Other General Industrial	1996	175	N	10.2	489.6
TM27	BALLAST REGULATOR	Industrial	Other General Industrial	1996	175	N	31.33	1503.84
TM28	BALLAST REGULATOR	Industrial	Other General Industrial	1996	175	N	0	0
TM29	BALLAST REGULATOR	Industrial	Other General Industrial	2003	175	N	15	720
TM30	LOCOMOTIVE CRANE	Construction	Cranes	1979	250	N	0	0
TM31	TRUCK CRANE	Construction	Cranes	1986	175	Y	0	0
TM32	RUBBER TIRED CRANE	Construction	Cranes	1982	175	N	0	0
TM33	RUBBER TIRED CRANE	Construction	Cranes	1999	175	N	0	0

Equipment ID	Equipment Type	ARB Category	ARB Equipment type	Engine Model Year	Engine Horsepower	Dual Engine (Y/N)	Operating Hours Per week	Average Operating Hours Per Year
TM34	RUBBER TIRED CRANE	Construction	Cranes	2001	175	N	0	0
TM35	WHL LDR	Construction	Rubber Tired Loaders	1974	300	N	3.06	146.88
TM36	CRN/LDR HR	Construction	Cranes	1974	100	N	0	0
TM37	CRN/LDR HR	Construction	Cranes	1984	100	N	0	0
TM38	CRN/LDR HR	Construction	Cranes	1984	100	N	3.36	161.28
TM39	CRN/LDR HR	Construction	Cranes	1984	100	N	28.8	1382.4
TM40	WHL LDR*GP	Construction	Rubber Tired Loaders	1995	120	N	0	0
TM41	SKID-LDR FBHTAH	Construction	Sk d Steer Loaders	2003	74	N	0	0
TM42	CRN/LDR HR	Construction	Cranes	2004	100	N	26.56	1274.88
TM43	BK-HO/LDR	Construction	Tractors/Loaders/Backhoes	1992	75 5	N	2	96
TM44	BK-HO/LDR	Construction	Tractors/Loaders/Backhoes	1992	75 5	N	0	0
TM45	BK-HO/LDR EH	Construction	Tractors/Loaders/Backhoes	1995	69	N	12.37	593.76
TM46	BK-HO/LDR EH	Construction	Tractors/Loaders/Backhoes	1995	69	N	46.38	2226.24
TM47	BK-HO/LDR EF	Construction	Tractors/Loaders/Backhoes	1998	78	N	0	0
TM48	BK-HO/LDR EF	Construction	Tractors/Loaders/Backhoes	1999	78	N	0	0
TM49	BK-HO/LDR EF	Construction	Tractors/Loaders/Backhoes	1999	78	N	12.88	618.24
TM50	BK-HO/LDR EF	Construction	Tractors/Loaders/Backhoes	1999	78	N	7.31	350.88
TM51	BK-HO/LDR EF	Construction	Tractors/Loaders/Backhoes	1999	78	N	8.91	427.68
TM52	BK-HO/LDR EF	Construction	Tractors/Loaders/Backhoes	2000	78	N	0	0
TM53	BK-HO/LDR EF	Construction	Tractors/Loaders/Backhoes	2003	88	N	0	0
TM54	BK-HO/LDR EF	Construction	Tractors/Loaders/Backhoes	2004	88	N	1.65	79.2
TM55	BK-HO/LDR EF	Construction	Tractors/Loaders/Backhoes	2004	88	N	9.93	476.64
TM56	BK-HO/LDR EF	Construction	Tractors/Loaders/Backhoes	2004	88	N	6.13	294.24
TM57	BK-HO/LFR EF	Construction	Tractors/Loaders/Backhoes	1989[a]	119	N	15	720
TM58	BK-HO/LFR EF	Construction	Tractors/Loaders/Backhoes	1989[a]	85	N	15	720
TM59	BK-HO/LFR EF	Construction	Tractors/Loaders/Backhoes	1989[a]	74	N	15	720
TM60	BK-HO/LFR EF	Construction	Tractors/Loaders/Backhoes	1989[a]	74	N	15	720
TM61	BK-HO/LFR EF	Construction	Tractors/Loaders/Backhoes	1989[a]	74	N	15	720
TM62	BK-HO/LFR EF	Construction	Tractors/Loaders/Backhoes	1989[a]	74	N	15	720
TM63	BK-HO/LFR EF	Construction	Tractors/Loaders/Backhoes	1989[a]	74	N	15	720
TM64	BK-HO/LFR EF	Construction	Tractors/Loaders/Backhoes	1989[a]	74	N	15	720
TM65	BK-HO/LFR EF	Construction	Tractors/Loaders/Backhoes	1989[a]	74	N	15	720
TM66	BK-HO/LFR EF	Construction	Tractors/Loaders/Backhoes	1989[a]	85	N	15	720
TM67	BK-HO/LFR EF	Construction	Tractors/Loaders/Backhoes	1989[a]	99	N	15	720

Equipment ID	Equipment Type	ARB Category	ARB Equipment type	Engine Model Year	Engine Horsepower	Dual Engine (Y/N)	Operating Hours Per week	Average Operating Hours Per Year
TM68	BK-HO/LFR EF	Construction	Tractors/Loaders/Backhoes	1989[a]	74	N	15	720
TM69	BK-HO/LFR EF	Construction	Tractors/Loaders/Backhoes	1989[a]	74	N	15	720
TM70	BK-HO/LFR EF	Construction	Tractors/Loaders/Backhoes	1989[a]	85	N	15	720
TM71	Directional Boring Machine	Construction	Bore/Drill Rigs	2002[a]	82[b]	N	15	720
TM72	Manlift	Industrial	Aerial Lifts	1989[a]	34[b]	N	15	720
TM73	Trencher	Construction	Trenchers	1998[a]	39	N	15	720
TM74	Trencher	Construction	Trenchers	1998[a]	39	N	15	720
TM75	Trencher	Construction	Trenchers	1998[a]	39	N	15	720
TM76	Trencher Rider	Construction	Trenchers	1998[a]	79	N	15	720
TM77	RAIL LIFTER	Industrial	Other General Industrial	1997	19	N	20	960
TM78	TIE SPIKER	Industrial	Other General Industrial	1986	19	N	0	0
TM79	TIE SPIKER	Industrial	Other General Industrial	1986	19	N	0	0
TM80	TIE SPIKER	Industrial	Other General Industrial	1991	19	N	3.1	148.8
TM81	TIE SPIKER	Industrial	Other General Industrial	2002	90	N	10	480
TM82	TIE SPIKER	Industrial	Other General Industrial	2002	90	N	10	480
TM83	TIE SPIKER	Industrial	Other General Industrial	2002	90	N	10	480
TM84	SPIKE PULLER	Industrial	Other General Industrial	1984	35	N	10	480
TM85	SPIKE PULLER	Industrial	Other General Industrial	1995	35	N	10	480
TM86	SPIKE PULLER	Industrial	Other General Industrial	1995	35	N	10	480
TM87	SPIKE PULLER	Industrial	Other General Industrial	1986	35	N	0	0
TM88	DITCHER/SPREADER	Industrial	Other General Industrial	1980	97[b]	N	15	720
TM89	TIE TAMPER	Industrial	Other General Industrial	1985	175	N	20	960
TM90	TIE TAMPER	Industrial	Other General Industrial	1985	175	N	3.74	179.52
TM91	TIE TAMPER	Industrial	Other General Industrial	1989	250	N	22.4	1075.2
TM92	TIE TAMPER	Industrial	Other General Industrial	1995	250	N	40	1920
TM93	TIE TAMPER	Industrial	Other General Industrial	1996	250	N	40	1920
TM94	TIE TAMPER	Industrial	Other General Industrial	1996	250	N	90	4320
TM95	TIE TAMPER	Industrial	Other General Industrial	1996	250	N	40	1920
TM96	TIE TAMPER	Industrial	Other General Industrial	1997	250	N	0.92	44.16
TM97	TIE TAMPER	Industrial	Other General Industrial	2000	250	N	35	1680
TM98	TIE TAMPER	Industrial	Other General Industrial	2000	300	N	40	1920
TM99	TIE TAMPER	Industrial	Other General Industrial	2001	250	N	31	1488
TM100	TIE TAMPER	Industrial	Other General Industrial	2002	300	N	35	1680
TM101	TIE TAMPER	Industrial	Other General Industrial	2003	250	N	0	0

Equipment ID	Equipment Type	ARB Category	ARB Equipment type	Engine Model Year	Engine Horsepower	Dual Engine (Y/N)	Operating Hours Per week	Average Operating Hours Per Year
TM102	TIE TAMPER	Industrial	Other General Industrial	1995	175	N	0	0
TM103	TIE TAMPER	Industrial	Other General Industrial	1987	175	N	0	0
TM104	TIE TAMPER	Industrial	Other General Industrial	1985	150	N	15	720
TM105	TIE CRANE	Construction	Cranes	1982	64	N	15	720
TM106	TIE CRANE	Construction	Cranes	1982	64	N	0	0
TM107	TIE CRANE	Construction	Cranes	1985	64	N	0	0
TM108	TIE CRANE	Construction	Cranes	1986	64	N	0	0
TM109	TIE PLUGGER	Industrial	Other General Industrial	2000	90	N	20	960
TM110	TIE PLUGGER	Industrial	Other General Industrial	2002	90	N	20	960
TM111	TIE PLUGGER	Industrial	Other General Industrial	2003	90	N	20	960
TM112	TIE INSERT/EXTRACT	Industrial	Other General Industrial	1985	175	N	0	0
TM113	TIE INSERT/EXTRACT	Industrial	Other General Industrial	1985	175	N	0	0
TM114	TIE INSERT/EXTRACT	Industrial	Other General Industrial	1987	175	N	41.58	1995.84
TM115	DOZER	Construction	Crawler Tractors	1985	145	N	0	0
TM116	WELDER	Commercial	Welders	1984	64	N	25	1200
TM117	WELDER	Commercial	Welders	1984	64	N	25	1200
TM118	WELDER	Commercial	Welders	1986	64	N	25	1200
TM119	WELDER	Commercial	Welders	1987	64	N	25	1200
TM120	WELDER	Commercial	Welders	1988	40	N	25	1200
TM121	WELDER	Commercial	Welders	1988	64	N	25	1200
TM122	WELDER	Commercial	Welders	1988	64	N	25	1200
TM123	WELDER	Commercial	Welders	1998	64	N	25	1200
TM124	WELDER	Commercial	Welders	1999	64	N	25	1200
TM125	WELDER	Commercial	Welders	1999	64	N	25	1200
TM126	WELDER	Commercial	Welders	1999	64	N	25	1200
TM127	WELDER	Commercial	Welders	2000	64	N	25	1200
TM128	WELDER	Commercial	Welders	2000	64	N	25	1200
TM129	WELDER	Commercial	Welders	2000	40	N	25	1200
TM130	WELDER	Commercial	Welders	2000	40	N	25	1200
TM131	WELDER	Commercial	Welders	2001	64	N	25	1200
TM132	WELDER	Commercial	Welders	2003	40	N	25	1200
TM133	WELDER	Commercial	Welders	2003	64	N	25	1200
TM134	WELDER	Commercial	Welders	2003	40	N	25	1200
TM135	WELDER	Commercial	Welders	2004	64	N	25	1200
TM136	WELDER	Commercial	Welders	2004	64	N	25	1200

Equipment ID	Equipment Type	ARB Category	ARB Equipment type	Engine Model Year	Engine Horsepower	Dual Engine (Y/N)	Operating Hours Per week	Average Operating Hours Per Year
TM137	WELDER	Commercial	Welders	2004	64	N	25	1200
TM138	WELDER	Commercial	Welders	2004	40	N	25	1200
TM139	WELDER	Commercial	Welders	2005	40	N	25	1200
TM140	WELDER	Commercial	Welders	2005	40	N	25	1200
TM141	WELDER	Commercial	Welders	2005	40	N	25	1200
TM142	WELDER	Commercial	Welders	2005	40	N	25	1200
TM143	RAIL HEATER	Industrial	Other General Industrial	1982	90	N	25	1200
TM144	RAIL HEATER	Industrial	Other General Industrial	1995	90	N	25	1200
TM145	SPIKE RECLAIMER	Industrial	Other General Industrial	1992	90	N	25	1200
TM146	TIE PLATE RETRIEVER	Industrial	Other General Industrial	2003	25	N	25	1200
TM147	TRACK STABILIZER	Industrial	Other General Industrial	1989	300	N	9.26	444.48
TM148	TRACK STABILIZER	Industrial	Other General Industrial	2000	300	N	45	2160
TM149	TRACK STABILIZER	Industrial	Other General Industrial	2001	300	N	45	2160

[a] Model year estimated as 2005 minus ARB default useful life.

[b] Horsepower estimated as ARB default for the most populous horsepower range for the associated equipment type.

APPENDIX B

Description Of Locations And Activities

Barstow

Barstow yard	The Barstow BNSF yard is a roughly 5 mile long yard in West-East exposure. It is bordered by a Y near highway 58 on the West side, The City of Barstow with West Main Street and National Trails Highway on the South side and Interstate Highway 15 on the East side. Barstow is the major BNSF hub for California; Each BNSF train leaving or arriving in California passes through Barstow. The Barstow yard's main activity area is West of North 1st Avenue. (West portion of the yard) The significantly smaller portion East of North 1st Avenue is used for some train switching activity between classification yard and ready tracks. (East portion of the yard)
DTL	Several direct to locomotive fueling stations are spread out in the yard. The main DTL sites are on the west and east end of the ready tracks.
East fueling station	One of two fixed fueling stations (pipeline to locomotive) is located on the East side of the ready tracks.
Hump yard/classification yard	On the South side of the West portion of the yard is the hump yard (classification yard). Rail cars that are push over the hump eastward are sorted in the classification yard. The classification tracks take most of the area on the South-East side of the West portion of the Barstow yard. Switcher trains pull rail cars from here into the train make-up area, North of the classification yard. For this maneuvering they move into the East portion of the Barstow yard.
Locomotive inspection area	A large portion of on the West end of the yard is dedicated to locomotive inspections and maintenance. Locomotives pass through a set of facilities, each dedicated to a specific inspection cycle. At the East end of the inspection line, for those locomotives in annual inspections, the area is dedicated for running power, load and opacity tests.
Passing tracks	North of the yard in West-East delineation run the passing tracks.
Ready tracks	On the West side of the train make up yard are the ready tracks where trains stag for departure. Crews enter the trains on the ready tracks and conduct their technical checks.

Train arrival area	At the West end of the yard, South of the inspection area, are the tracks for train arrival. Arriving locomotives go from here to refueling and maintenance. Rail cars are pushed over into a hump yard for train classification and make up. The switcher trains for this purpose are often mother and slough units. Their activity is located in the train arrival area.
Train make up yard	On the North side of the Western portion of the Barstow yard is the train make up yard. Switcher engines pull rail cars from the classification yard and assemble full trains in the make up yard. Line locomotives are passively hauled to the train make up yard as well.
West fueling station	One of two fixed fueling stations (pipeline to locomotive) is located on the West side of the ready tracks.

APPENDIX C

Glossary / Definition Of Terms

Boxcar	Boxcars are closed rail cars that can be loaded with consumer goods and packed bulk cargo. Box cars may be refrigerated for temperature sensitive cargo.
Can storage	Empty truck trailers and empty containers on trailers are called cans. Can storage areas are those areas where the trailers are parked for dispatching.
Chassis storage	Chassis are the trailer chassis that can take standard containers.
Classification yard	A classification yard is a rail yard used to separate and sort rail cars. Classification yards characteristics are a tree-like multiplying of rail tracks. Rail cars may be pushed by switcher locomotives directly or pushed over a hump (see hump yard) for sorting with kinetic energy.
Containers	Standard ocean shipping containers are boxes, usually made out of steel, to carry consumer goods, product cargo and bulk cargo. Ocean containers most common lengths are 20', 40', 45', 48' and 53' feet. Their capacity is measured in twenty-foot equivalent units (TEU). Maximum gross weight of a 20' container is 24 metric tonnes, with a maximum payload of 21.5 metric tonnes. 40' containers have a maximum gross weight of 30.5 tonnes. Containers can be refrigerated units or designed to carry liquids and other specialty cargo.
Diesel Particulate Matter (DPM)	DPM refers to the particulate matter emitted from self igniting internal combustion engines (diesel engines). DPM has been added to the list of TAC by the State of California
DTL	Stands for direct to locomotive and refers to the fueling of locomotives from mobile fueling trucks. See locomotive fueling location.
Engines	Refer to the diesel engines of the locomotives
Fly-over rail	A fly-over rail is an elevated structure to avoid the intersection of a passing line with tracks in the rail yard.
Foreign freight movement	Foreign freight movement is trains operated by other carriers than BNSF that pass through or by the yard or that get handled in the yard. Foreign traffic also may include passenger rail services.
Hump yard	A sorting yard that utilizes the energy of gravity to passively roll rail cars down a slope into an array of tracks. Rail cars are usually pushed over a hump, which creates the down slope, by a switcher locomotive.

Intermodal freight transport	Activities of freight transport that utilizes multiple modes of transport, including ship, rail and truck, without handling the freight itself.
Job, Barstow yard	A job on the Barstow rail yard consists of two locomotives or a mother and slough engine configuration. This engine works rail cars in the hump yard or on the make-up tracks.
Job, San Bernardino	A job at the San Bernardino rail yard refers to one switching action. This switching action usually utilizes 4 switching locomotives and 2 - 4 road locomotives.
Line haul locomotive	Line haul is the long distance hauling with dedicated destinations. Locomotives that pull or push those long distance line haul trains are either referred to as line haul or road locomotives.
Load testing	Load testings are conducted after annual inspections (GE engines also before the annual inspections). Load testing refers to the power testing of the locomotive engine in each of the notch settings under load conditions. Each notch setting load test runs for 60 minutes (45 minutes for pre-testing respectively).
Locomotives	Refer to the single propulsion unit on rail. Locomotives can be diesel powered, diesel electric or a diesel generator set with a separate electric motor on rails.
Mode and time in mode	Mode and time in mode here are the engine power settings of locomotive engines. Locomotive diesel engines have 8 power modes, or notch settings, plus one setting for idle. (note mode can also refer to the mode of transport, which means the different types of freight transport equipment like ship, train, truck etc.)
Notch setting	Locomotive diesel engines have 8 power modes, called notch settings, plus one setting for idle. The time spend in each notch setting determines energy output and emissions and is also called time in mode. (see mode)
Opacity testing	Opacity test measures the smoke and particulate emissions from the engine using an optical methodology. Opacity testing is conducted once a year concurrently with the load testing. Opacity testing is a 60 minute test including warm-up etc. The opacity test itself requires 28 minutes.
Passing trains	Trains that pass the yard on an adjacent track. Passing trains can be freight or passenger trains and can be BNSF or foreign trains.

Power testing	A shortened version of the load testing. Power testing occurs at the M184 inspections. Power testing is a 20 pre-load, # and 30 post-load test.
Road locomotives	See line haul locomotives.
Roster	Refers to a location specific mix of locomotives and engines that determines the combined emission factors for that location. Locations can be entire yards or functional sections of rail yards.
Run through trains	Trains that drive through the yard without uncoupling or adding railcars.
Switcher locomotive or engine	Switcher locomotives are locomotives operating exclusively on and around rail yards to maneuver the rail cars for arriving, sorting and departure. Switcher engines have sometime less power than line-haul locomotives. However, switcher engines are often retired line-haul locomotives and thus of the same configuration and power.
Toxic Air Contaminants (TAC)	TACs refer to a set of chemicals determined by the -
Train make up	The build up of complete trains from individual rail cars to depart for a specific destination.
Trains	Trains are full length locomotives with rail cars. Line haul trains are usually pulled by locomotive contests of 3 - 5 units. Thus 100 trains equates to 300 - 500 locomotive units.