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Final Report

Emissions Verification Testing of CSX Multi-helix Fuel Injectors for EMD Switcher Locomotives

Prepared for:

EcoTrans Technologies, LLC
500 Water Street, S/C J340
Jacksonville, FL 32202

February 25, 2005

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SOUTHWEST RESEARCH INSTITUTE®
SAN ANTONIO HOUSTON
WASHINGTON, DC

SwRI Project 03-10152
February 25, 2005

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LIST OF ABBREVIATIONS

AAR	Association of American Railroads
API	American Petroleum Institute
ASTM	American Society for Testing and Materials
BNSF	Burlington Northern Santa Fe Railway
bsfc	brake specific fuel consumption
BTU	British Thermal Units
CFR	Code of Federal Regulations
cm	centimeter
CO	carbon monoxide
CO_2	carbon dioxide
cSt	centistokes
EMD	Electro-Motive Division of General Motors Corporation
EP	end point
EPA	Environmental Protection Agency
°F	degrees Fahrenheit
FBP	final boiling point
FTP	Federal Test Procedure
g	gram
gal	gallon
H_2O	water
HC	hydrocarbons
HFID	heated flame ionization detector
hp	horsepower
hr	hour
IBP	initial boiling point
in	inch
kW	kilowatt
lb	pound
min	minute
mm	millimeter
NDIR	non-dispersive infrared
NO_X	oxides of nitrogen
NTRD	New Technology Research and Development
O_2	Oxygen
PHS	Public Health Service
PM	particulate matter
RFP	Request For Proposal
rpm	revolutions per minute
sec	seconds
SwRI®	Southwest Research Institute®
TCET	Texas Council on Environmental Technology
TDC	top dead center
TERP	Texas Emissions Reduction Plan
wt	weight
%	percent

EXECUTIVE SUMMARY

This report documents results of a program to verify the emission reductions from two 2,000 hp EMD GP38-2 locomotives when equipped with two versions of new multi-helix fuel injectors developed by CSX/EcoTrans. The two locomotives were owned by the Burlington Northern Santa Fe Railway and are typically operated in the Houston, Texas area.

Table ES-1 summarizes the EPA Switch-Cycle duty cycle weighted exhaust emissions for the two BNSF locomotives, both in a baseline condition, and after being equipped with prototype fuel injectors developed by CSX.

Table ES-1 also includes EPA Tier 0 exhaust emission standards for HC, CO, NO_X, and PM. Tier 0 regulations, which went into effect on January 1, 2000, are applicable to locomotives manufactured between January 1, 1973 and December 31, 2001. Tier 1 regulations are applicable to new locomotives manufactured between January 1, 2002 and December 31, 2004.

BNSF2205 was equipped with "CSX Multi-helix" injectors, and demonstrated EPA Tier 1 NO_x levels, as well as Tier 1 levels of HC, CO, and PM emissions.

BNSF2297 was equipped with "CSX VCO" prototype fuel injectors, and also demonstrated EPA Tier 1 NO_x levels, as well as Tier 1 levels of HC, CO, and PM emissions.

TABLE ES-1. EMISSION REDUCTION FOR TWO EMD GP38 LOCOMOTIVES EQUIPPED WITH CSX MULTI-HELIX FUEL INJECTORS

Locomotive/ Configuration	EPA Switch Cycle Weighted Emissions			
	HC, g/hp-hr	CO, g/hp-hr	NO_X, g/hp-hr	PM, g/hp-hr
EPA Tier 0 Maximum	*2.10*	*8.0*	*14.0*	*0.72*
EPA Tier 1 Maximum	*1.20*	*2.5*	*11.0*	*0.54*
BNSF 2205 Baseline	1.10	2.1	11.3	0.47
BNSF 2205 with CSX MH Injectors	0.77	2.3	10.1	0.37
BNSF 2297 Baseline	0.96	1.9	12.1	0.40
BNSF 2297 with CSX VCO Injectors	1.17	2.3	9.5	0.45

I. BACKGROUND

This project was a follow-on to a 2003 TERP-funded project where EcoTrans Technologies Auxiliary Power Units (APUs) were installed in two Burlington Northern Santa Fe (BNSF) 2,000 hp EMD GP38-2 switcher locomotives[1]. The APUs were designed to minimize main engine idling time by providing stand-by services normally provided by the main EMD 16-645-E engine at Idle.

As part of the TERP-funded program, both locomotives were equipped with data loggers to quantify main engine shut off time to determine the emissions benefits associated with the EcoTrans APU system. Both locomotives were monitored over one year of revenue service in the Houston, Texas area. The results of that earlier study are summarized in Table 1, and show that installing an APU in a GP38-2 locomotive resulted in an average projected annual diesel fuel savings of 22,000 gallons, and an average annual reduction in NO_x emissions of 4.7 tons.

TABLE 1. PROJECTED ANNUAL FUEL SAVINGS AND EMISSION REDUCTIONS FROM INSTALLING AN APU ON EMD GP38 LOCOMOTIVES

Locomotive	Projected Annual Fuel Savings and Emission Reductions After Installing Locomotive APUs				
	Fuel Savings, gal/year	HC, tons/year	CO, tons/year	NO_X, tons/year	PM, tons/year
BNSF 2205	21,000	1.0	1.5	4.5	0.16
BNSF 2297	23,000	0.65	1.0	4.8	0.10
Average annual reduction	22,000	0.80	1.3	4.7	0.13

In this NTRD-funded project, further reductions in overall switcher locomotive NO_X emissions were assessed by focusing on the main EMD 16-645-E engine. Specifically, the objective of this project was to characterize the exhaust emissions of the main EMD 16-645-E engine after installing "multi-helix" fuel injectors. These injectors were developed by EcoTrans specifically for EMD switcher locomotive applications to reduce NO_X emissions while minimizing any fuel economy penalty. Two types of double helix injectors were tested in this project, and the test results are the subject of this report.

[1] Fritz, S.G. and R.L. Honc, "Locomotive APU Verification Testing", SwRI Final Report 08-05643, August 2003.

II. TECHNICAL APPROACH

Locomotive exhaust emission tests for this project were performed by Southwest Research Institute® (SwRI®) at the Locomotive Technology Center in San Antonio, Texas. This facility was established in 1993 in cooperation with the Association of American Railroads (AAR) and the Southern Pacific Transportation Company (SP) at a former SP diesel mechanical shop.

Presented below is an overview of the technical approach used to conduct locomotive exhaust emissions testing. Included is a description of the locomotives selected for testing, engine power measurements, fuel consumption measurements, the test fuel used in this program, exhaust emissions test procedures, analytical procedures, particulate measurement procedures, and smoke opacity test procedures.

A. Test Locomotives

The two locomotives tested in this project were provided by the Burlington Northern Santa Fe Railway (BNSF). Both were manufactured by the Electro-Motive Division of General Motors Corporation (EMD). Each locomotive was equipped with a 2,000 hp roots-blown EMD model 16-645-E diesel engine. Table 1 summarizes details on the two BNSF Locomotives, which are shown in Figure 1.

TABLE 2. BNSF LOCOMOTIVE DETAILS

BNSF Locomotive Number	BNSF 2205	BNSF 2297
Locomotive Model	EMD GP38	EMD GP38-2
Locomotive Serial Number	36551	not available
Locomotive Year of Manufacture	1970	1971
Engine Model	EMD 16-645-E	EMD 16-645-E
EMD Engine Serial Number	70-E2-1030	71-C2-1020

B. EMD Engine Power Measurement

Most line-haul locomotives are equipped with the “dynamic brake” feature in which the electric motors used for traction are reverse-excited to become generators for slowing the train. The electrical power generated is dissipated in resistance grids. Locomotives with the self-load feature can dissipate the main alternator power into these “dynamic brake” resistance grids. BNSF 2205 was equipped with dynamic brake grids capable of dissipating the full engine power, and these grids were used to load the stationary locomotive. BNSF 2297 did not have functioning self-load capability, so an external load bank was used.

Figure 1. EMD GP38 Test Locomotives

Engine flywheel (gross) power was determined by direct measurement of the main alternator voltage and current, plus auxiliary power values obtained from load box testing procedures published by EMD. EPA test procedures call for direct measurement of main generator voltage and current, and for the manufacturer to apply a known generator efficiency to calculate gross power. In this case, a single alternator efficiency of 93.9 percent was used for all test points, following EMD load box testing procedures. Power for the various auxiliary systems (auxiliary generator, traction motor blower, inertial separator blower, and radiator fans) was computed using published EMD test procedures. The air compressor on the locomotive was disabled during testing, and compressed air was supplied to the locomotive.

Power and fuel rates were recorded as observed values. AAR-corrected, brake-specific fuel consumption (bsfc) values were computed using published EMD power correction factors. Observed power was used to report brake-specific exhaust emissions in g/hp-hr.

C. Fuel Consumption Measurement

Diesel fuel consumption was measured on a mass basis, using a mass flow meter. The system was equipped with a heat exchanger to control fuel supply temperature at 90±10°F. Hot return fuel which would normally return to the locomotive on-board fuel tank was cooled before returning to the fuel measurement reservoir ("day tank") to assure a consistent fuel supply temperature at the engine.

D. Test Fuel

For this work, a diesel fuel meeting EPA's specification for locomotive emissions test fuel was used for testing. Properties of the test fuel are given in Table 2. The sulfur level of the test fuel was 0.27 weight percent, which is roughly at the mid-point of the EPA specification of 0.2 to 0.4 weight percent sulfur. The test fuel was stored in a rail tank car.

E. Exhaust Emissions Test Procedure

Exhaust emission tests of the main EMD 16-645-E locomotive engines were performed using the locomotive Federal Test Procedure (FTP) detailed in the U.S. Code of Federal Regulations (CFR), Title 40, Part 92, "Emission Standards for Locomotives and Locomotive Engines."

1. Gaseous Emissions Sampling

A gaseous sample probe was designed using EPA locomotive test specifications. Gaseous emissions were sampled within the exhaust stack extension installed on the roof of the locomotive. A heated line was used to transfer the raw exhaust sample to the emission instruments for analysis. Measured gaseous emissions included hydrocarbons (HC), carbon monoxide (CO), carbon dioxide (CO_2), oxygen (O_2), and oxides of nitrogen (NO_X).

Hydrocarbon concentrations in the raw exhaust were determined using a Rosemount Analytical model 402 heated flame ionization detector (HFID), calibrated on propane. NO_X concentration in the raw exhaust was measured with a Rosemount model 955 chemiluminescent analyzer. NO_X correction factors for engine intake manifold air temperature and ambient air humidity were applied as specified by EPA in 40 CFR §86.132(d). Concentrations of CO and CO_2 in the raw exhaust were determined by non-dispersive infrared (NDIR) instruments.

TABLE 2. LOCOMOTIVE TEST FUEL PROPERTIES

Determinations	ASTM Test Method	Locomotive Cert. Fuel EM-3137C-F	EPA Locomotive Spec. [a]
API Gravity @ 60°F	D4052	36.8	32 - 37
specific gravity		0.8408	ns
density (lb/gal)		7.02	ns
Viscosity @ 40°C (cSt)	D445-83	2.52	2.0 - 3.2
Sulfur (Wt%)	D2622-94	0.2668	0.2 - 0.4
Cetane Index	D976	47.7	40 - 48
Cetane Index	D4737	47.8	ns
Cetane Number	D613-84	49.1	40 - 48
Heat of Combustion	D240		
Gross (BTU/lb)		19,565	ns
Net (BTU/lb)		18,361	ns
Gross (BTU/gal)		137,350	ns
Net (btu/gal)		128,900	ns
Carbon-Hydrogen Ratio	D3178		
% Carbon		86.86	ns
% Hydrogen		13.26	ns
Hydrogen/Carbon Ratio		1.82	ns
SFC Aromatics	D5186-96		
Total Mass %		30.8	27 min.
Total Volume Percent [b]		8.9	
PNA Mass %		8.3	
Hydrocarbon Type	D1319-84		
Aromatics (%)		30.9	ns
Olefins (%)		1.3	ns
Saturates (%)		67.8	ns
Flash Point (□F)	D93-80	148	130 min.
Distillation	D86-96		
	% Recovered		Temp. □F
	IBP	354	340 - 400
	10	417	400 - 460
	50	494	470 - 540
	90	592	560 - 630
	EP	660	610 - 690

Notes: a - Diesel fuel for locomotive testing as specified by EPA in 40 CFR 92, §92.113, Table B113-1.
b - Aromatic hydrocarbons expressed in percent volume = 0.916 x (aromatic hydrocarbons expressed in percent weight) + 1.33, per California Code of Regulations, Title 13, §2282 (c)(1).
ns - not specified
nd - not determined

Gaseous mass emission rates were computed using the measured concentration, the observed (measured) fuel consumption rate, and calculated engine airflow. Following the FTP, engine airflow was not directly measured in this test program. Instead, engine airflow was determined using a carbon balance of the carbon-containing constituents in the exhaust (CO_2, CO, and HC) to compute the fuel/air ratio (f/a). Engine airflow rate was then computed using the measured fuel consumption rate and the computed f/a ratio.

2. Particulate Emissions Sampling

Particulate emissions were measured at each test point using a "split then dilute" technique, in which a portion of the raw locomotive exhaust was "split" from the total flow and mixed with filtered air in a 10-inch diameter dilution tunnel. The split sample was transferred to the dilution tunnel through a 2-inch diameter stainless steel tube that was insulated and electrically heated to 375°F.

A particulate sample was extracted from the dilute exhaust stream within the dilution tunnel through sample probes. Particulate was accumulated on 90 mm fluorocarbon-coated glass fiber filters (Pallflex T60A20) at a target filter face velocity of 70 cm/s. The filters were mounted in stainless steel filter holders and connected to the dilution tunnel. Following the FTP, PM sampling began ten seconds after a throttle notch change, and continued for five minutes. Particulate filters were preconditioned and weighed before and after testing, following the FTP. The particulate mass emission rate was computed using the increase of mass on the filters, the volume of dilute exhaust drawn through the filters, and dilution air and raw exhaust flow parameters.

3. Smoke Opacity Test Procedures

Smoke opacity was measured using a modified Public Health Service (PHS) full-flow opacity meter (smokemeter) mounted above one of the two locomotive exhaust stacks. This smokemeter used standard PHS smokemeter optics and electronics, but was modified to a 20-inch diameter to accommodate larger exhaust plume diameters. The construction, calibration, and operation of the smokemeter adhered to the FTP.

The smokemeter was aligned with the long axis of the rectangular exhaust stack, resulting in a through-exhaust path length of approximately 14 inches (as determined by the dimensions of the exhaust stack extension). The center of the light beam was positioned 5±1 inches above the outlet of the exhaust stack extension. A smokemeter control unit was located in the control building. Voltage output proportional to opacity was recorded on a strip chart, along with engine speed. Smoke opacity was continuously monitored during the EPA Locomotive Test Sequence.

4. Duty-Cycle Weighting Factors

Table 3 gives the two duty cycles that were applied to the individual notch data points to compute duty-cycle weighted composite results. The two EPA cycles are specified in Table B132-1 of §92.131 of CFR Title 40, Part 92 of the FTP. For the two locomotives tested in this project, only the EPA Switch cycle is applicable, as *"a locomotive designed or used solely for the primary purpose of propelling railroad cars a short distance, and that is powered by an engine with a maximum power rating of 2,300 hp or less."*

TABLE 3. DUTY CYCLES USED TO COMPUTE WEIGHTED COMPOSITE EMISSIONS

Throttle Notch Setting	EPA Line-Haul Cycle	EPA Switch Cycle
Low Idle	19.0 %	29.9 %
Idle	19.0 %	29.9 %
Dynamic Brake	12.5 %	0.0 %
Notch 1	6.5 %	12.4 %
Notch 2	6.5 %	12.3 %
Notch 3	5.2 %	5.8 %
Notch 4	4.4 %	3.6 %
Notch 5	3.8 %	3.6 %
Notch 6	3.9 %	1.5 %
Notch 7	3.0 %	0.2 %
Notch 8	16.2 %	0.8 %
TOTAL	**100.0 %**	**100.0 %**

III. EMISSION TEST RESULTS

EPA switch duty-cycle weighted exhaust emissions from the two EMD 16-645-E engines are summarized in Table 4, both in a baseline condition, and after being equipped with prototype fuel injectors developed by CSX. Detailed test data are given in Appendices A through D.

Table 4 also includes EPA Tier 0 exhaust emission standards for HC, CO, NO_X, and PM. Tier 0 regulations, which went into effect on January 1, 2000, are applicable to locomotives manufactured between January 1, 1973 and December 31, 2001. Tier 1 regulations are applicable to new locomotives manufactured between January 1, 2002 and December 31, 2004.

BNSF2205 was equipped with "CSX Multi-helix" injectors, and demonstrated EPA Tier 1 NO_x levels, as well as Tier 1 levels of HC, CO, and PM emissions.

BNSF2297 was equipped with "CSX VCO" prototype fuel injectors, and also demonstrated EPA Tier 1 NO_x levels, as well as Tier 1 levels of HC, CO, and PM emissions.

TABLE 4. EMISSION REDUCTION FOR TWO EMD GP38 LOCOMOTIVES EQUIPPED WITH CSX MULTI-HELIX FUEL INJECTORS

Locomotive/ Configuration	EPA Switch Cycle Weighted Emissions			
	HC, g/hp-hr	CO, g/hp-hr	NO_X, g/hp-hr	PM, g/hp-hr
EPA Tier 0 Maximum	*2.10*	*8.0*	*14.0*	*0.72*
EPA Tier 1 Maximum	*1.20*	*2.5*	*11.0*	*0.54*
BNSF 2205 Baseline	1.10	2.1	11.3	0.47
BNSF 2205 with CSX MH Injectors	0.77	2.3	10.1	0.37
BNSF 2297 Baseline	0.96	1.9	12.1	0.40
BNSF 2297 with CSX VCO Injectors	1.17	2.3	9.5	0.45

APPENDIX A. BNSF2205 BASELINE EMISSION RESULTS

APPENDIX A. BNSF2205 BASELINE EMISSION RESULTS

Locomotive BNSF 2205, EMD-16-645E Engine, Baseline with original H&K injectors @ 4°BTDC
Tested 2/3/05 @ SwRI

Notch	Gross HP	obs Fuel Rate (lb/hr)	HC (g/hr)	CO (g/hr)	Corr. NOx (g/hr)	PM (g/hr)	AAR Corr bsfc	Corr. Fuel Rate (lb/hr)
8	2,042.5	864.0	1,049	7,638	22,236	2,072	0.431	881
7	1,818.2	742.0	860	3,098	19,992	594	0.416	756
6	1,468.9	576.0	543	1,063	15,357	598	0.400	587
5	1,216.8	472.0	449	560	11,841	421	0.395	481
4	938.5	355.0	336	288	8,804	251	0.384	361
3	686.6	272.0	304	299	6,222	192	0.404	277
2	336.3	142.2	216	322	2,825	95	0.431	145
1	148.5	72.0	159	285	1,658	61	0.494	73
Low Idle	10.3	24.6	204	268	652	28	2.434	25
Idle	13.3	31.2	232	447	759	42	2.390	32
DB-2	17.7	40.2	271	681	863	47	2.316	41
						sum =		

AAR 3x3 Weighted Results

Notch	WF	w-BHP	obs w-Fuel w-(lb/hr)	w-Fuel w-(lb/hr)	w-HC w-(g/hr)	w-CO w-(g/hr)	w-NOx w-(g/hr)	w-PM w-(g/hr)
8	25.0%	510.6	216.0	220.1	262.1	1909.5	5559.0	518.0
7	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	25.0%	304.2	118.0	120.3	112.3	139.9	2960.1	105.3
4	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Low Idle	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Idle	50.0%	6.7	15.6	15.9	116.1	223.7	379.6	20.8
DB-2	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sum =	100.0%	821.5	349.6	356.3	490.5	2273.1	8898.7	644.0

AAR 3x3 duty cycle weighted brake-specific emissions => 0.426 obs bsfc, 0.434 corr bsfc, 0.60, 2.77, 10.83, 0.784

Modal Brake-Specific Emissions Notch	HC (g/hp-hr)	CO (g/hp-hr)	Corr. NOx (g/hp-hr)	PM (g/hp-hr)
8	0.51	3.74	10.89	1.01
7	0.47	1.70	11.00	0.33
6	0.37	0.72	10.45	0.41
5	0.37	0.46	9.73	0.35
4	0.36	0.31	9.38	0.27
3	0.44	0.43	9.06	0.28
2	0.64	0.96	8.40	0.28
1	1.07	1.92	11.16	0.41
Low Idle	19.76	25.97	63.29	2.68
Idle	17.46	33.63	57.08	3.12
DB-2	15.32	38.45	48.73	2.68

EPA Switcher Duty Cycle Weighted Results

Notch	WF	w-BHP	obs w-Fuel w-(lb/hr)	w-Fuel w-(lb/hr)	w-HC w-(g/hr)	w-CO w-(g/hr)	w-NOx w-(g/hr)	w-PM w-(g/hr)
8	0.8%	16.3	6.9	7.0	8.4	61.1	177.9	16.6
7	0.2%	3.6	1.5	1.5	1.7	6.2	40.0	1.2
6	1.5%	22.0	8.6	8.8	8.1	15.9	230.4	9.0
5	3.6%	43.8	17.0	17.3	16.2	20.1	426.3	15.2
4	3.6%	33.8	12.8	13.0	12.1	10.4	316.9	9.0
3	5.8%	39.8	15.8	16.1	17.6	17.3	360.9	11.1
2	12.3%	41.4	17.5	17.8	26.5	39.6	347.5	11.6
1	12.4%	18.4	8.9	9.1	19.8	35.4	205.5	7.6
Low Idle	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Idle	59.8%	8.0	18.7	19.0	138.9	267.5	453.9	24.8
DB-2	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sum =	100.0%	227.2	107.7	109.7	249.3	473.5	2559.3	106.1

EPA switcher duty cycle weighted brake-specific emissions => 0.474 obs bsfc, 0.483 corr bsfc, 1.10, 2.08, 11.27, 0.467

Fuel-Specific Emissions Notch	HC (g/lb fuel)	CO (g/lb fuel)	Corr. NOx (g/lb fuel)	PM (g/lb fuel)
8	1.21	8.84	25.74	2.40
7	1.16	4.18	26.94	0.80
6	0.94	1.85	26.66	1.04
5	0.95	1.19	25.09	0.89
4	0.95	0.81	24.80	0.71
3	1.12	1.10	22.87	0.71
2	1.52	2.26	19.87	0.67
1	2.21	3.96	23.02	0.85
Low Idle	8.27	10.87	26.50	1.12
Idle	7.44	14.34	24.33	1.33
DB-2	6.74	16.93	21.46	1.18

EPA Freight Duty Cycle Weighted Results

Notch	WF	w-BHP	obs w-Fuel w-(lb/hr)	w-Fuel w-(lb/hr)	w-HC w-(g/hr)	w-CO w-(g/hr)	w-NOx w-(g/hr)	w-PM w-(g/hr)
8	16.2%	330.9	140.0	142.6	169.9	1237.4	3602.2	335.6
7	3.0%	54.5	22.3	22.7	25.8	92.9	599.8	17.8
6	3.9%	57.3	22.5	22.9	21.2	41.5	598.9	23.3
5	3.8%	46.2	17.9	18.3	17.1	21.3	449.9	16.0
4	4.4%	41.3	15.6	15.9	14.8	12.7	387.4	11.0
3	5.2%	35.7	14.1	14.4	15.8	15.5	323.5	10.0
2	6.5%	21.9	9.2	9.4	14.0	20.9	183.6	6.2
1	6.5%	9.7	4.7	4.8	10.4	18.5	107.7	4.0
Low Idle	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Idle	38.0%	5.1	11.9	12.1	88.2	170.0	288.5	15.8
DB-2	12.5%	2.2	5.0	5.1	33.9	85.1	107.8	5.9
sum =	100.0%	604.7	263.2	268.2	410.9	1715.7	6649.4	445.6

EPA freight duty cycle weighted brake-specific emissions => 0.435 obs bsfc, 0.443 corr bsfc, 0.68, 2.84, 11.00, 0.737

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-11243-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2205	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Low Idle	TEST CONFIGURATION	=	Baseline
TEST DATE	=	2/ 3/ 5	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	1/11			
SwRI FUEL CODE	=	EM-3137C-F	FUEL H/C RATIO	=	1.82
BAROMETER	=	29.66 (in. Hg)	ENGINE INTAKE AIR	=	58.(°F)
DRY BULB TEMP	=	55. (°F)	WET BULB TEMP	=	46. (°F)
ABS HUMIDITY	=	31.69 (GR/LB)	RELATIVE HUMIDITY	=	49. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	4.1
TRACTION MOTOR BLOWER HP	=	1.8
INERTIAL SEPERATOR BLOWER HP	=	.3
RADIATOR FAN HP	=	.0
TOTAL ACCESSORY HP	=	10.2

FUEL RATE (OBS) = 24.6 (LB/HR)
ALT. VOLTS = 5. ALT. AMPS = 9. ALT. EFF. = .937
FLYWHEEL HP = 10.3 OBS. SFC = 2.3885 AAR CORR. SFC = 2.4339 (LB/HP-HR)
CALCULATED A/F = 344.87 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	203.5	19.76	110.PPMC
CO	267.5	25.97	72. PPM
NOX	702.7	68.23	115. PPM (D)
NOX,CORR	651.9	63.30	
CO2		3339.	.59 PCT
O2			20.00 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9278	NOX-KH	= .9090	NOX-KT	= 1.0000
WET EXH HC CF	= .9931	AIR TEMP CF	= 1.0009	BAROM CF	= 1.0069
FUEL TEMP CF	= .9870	FUEL S.G. CF	= 1.0050	FUEL HHV CF	= 1.0111

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6833.0-2
FILTER PAIR WEIGHT GAIN (mg)	2.749
SAMPLE VOLUME (scf)	35.063
DILUTE PM CONCENTRATION (mg/scf)	.078
CO2-BASED DILUTION FACTOR	3.108
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.244
PARTICULATE MASS EMISSION RATE (g/hr)	27.6
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	2.679

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-11243-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2205	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Idle	TEST CONFIGURATION	=	Baseline
TEST DATE	=	2/ 3/ 5	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	2/11			
SwRI FUEL CODE	=	EM-3137C-F	FUEL H/C RATIO	=	1.82
BAROMETER	=	29.66 (in. Hg)	ENGINE INTAKE AIR	=	57.(°F)
DRY BULB TEMP	=	55. (°F)	WET BULB TEMP	=	45. (°F)
ABS HUMIDITY	=	28.33 (GR/LB)	RELATIVE HUMIDITY	=	44. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	5.2
TRACTION MOTOR BLOWER HP	=	3.5
INERTIAL SEPERATOR BLOWER HP	=	.5
RADIATOR FAN HP	=	.0
TOTAL ACCESSORY HP	=	13.2

FUEL RATE (OBS) = 31.2 (LB/HR)
ALT. VOLTS = 6. ALT. AMPS = 11. ALT. EFF. = .937
FLYWHEEL HP = 13.3 OBS. SFC = 2.3445 AAR CORR. SFC = 2.3902 (LB/HP-HR)
CALCULATED A/F = 332.92 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	232.2	17.45	103.PPMC
CO	447.3	33.62	99. PPM
NOX	822.9	61.84	110. PPM (D)
NOX,CORR	759.1	57.05	
CO2		3271.	.61 PCT
O2			20.00 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9225	NOX-KH	= .9023	NOX-KT	= 1.0000
WET EXH HC CF	= .9931	AIR TEMP CF	= 1.0013	BAROM CF	= 1.0069
FUEL TEMP CF	= .9865	FUEL S.G. CF	= 1.0050	FUEL HHV CF	= 1.0111

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6874.0-3
FILTER PAIR WEIGHT GAIN (mg)	3.711
SAMPLE VOLUME (scf)	35.085
DILUTE PM CONCENTRATION (mg/scf)	.106
CO2-BASED DILUTION FACTOR	2.833
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.300
PARTICULATE MASS EMISSION RATE (g/hr)	41.5
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	3.122

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03 11243 001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2205	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	DB-2	TEST CONFIGURATION	=	Baseline
TEST DATE	=	2/ 3/ 5	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	3/11			
SwRI FUEL CODE	=	EM-3137C-F	FUEL H/C RATIO	=	1.82
BAROMETER	=	29.66 (in. Hg)	ENGINE INTAKE AIR	=	58.(°F)
DRY BULB TEMP	=	53. (°F)	WET BULB TEMP	=	45. (°F)
ABS HUMIDITY	=	31.59 (GR/LB)	RELATIVE HUMIDITY	=	53. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	6.3
TRACTION MOTOR BLOWER HP	=	6.3
INERTIAL SEPERATOR BLOWER HP	=	1.0
RADIATOR FAN HP	=	.0
TOTAL ACCESSORY HP	=	17.5

FUEL RATE (OBS) = 40.2 (LB/HR)
ALT. VOLTS = 8. ALT. AMPS = 13. ALT. EFF. = .937
FLYWHEEL HP = 17.7 OBS. SFC = 2.2727 AAR CORR. SFC = 2.3159 (LB/HP-HR)
CALCULATED A/F = 316.93 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	271.1	15.33	98.PPMC
CO	680.6	38.48	122. PPM
NOX	929.7	52.56	102. PPM (D)
NOX,CORR	862.5	48.76	
CO2		3167.	.64 PCT
O2			20.00 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9277	NOX-KH	= .9089	NOX-KT	= 1.0000
WET EXH HC CF	= .9926	AIR TEMP CF	= 1.0009	BAROM CF	= 1.0069
FUEL TEMP CF	= .9865	FUEL S.G. CF	= 1.0050	FUEL HHV CF	= 1.0111

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6875.0-40
FILTER PAIR WEIGHT GAIN (mg)	3.444
SAMPLE VOLUME (scf)	34.714
DILUTE PM CONCENTRATION (mg/scf)	.099
CO2-BASED DILUTION FACTOR	2.808
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.279
PARTICULATE MASS EMISSION RATE (g/hr)	47.4
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	2.679

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-11243-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2205	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 1	TEST CONFIGURATION	=	Baseline
TEST DATE	=	2/ 3/ 5	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	4/11			
SwRI FUEL CODE	=	EM-3137C-F	FUEL H/C RATIO	=	1.82
BAROMETER	=	29.65 (in. Hg)	ENGINE INTAKE AIR	=	57.(°F)
DRY BULB TEMP	=	54. (°F)	WET BULB TEMP	=	45. (°F)
ABS HUMIDITY	=	29.97 (GR/LB)	RELATIVE HUMIDITY	=	48. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	5.2
TRACTION MOTOR BLOWER HP	=	3.6
INERTIAL SEPERATOR BLOWER HP	=	.5
RADIATOR FAN HP	=	.0
TOTAL ACCESSORY HP	=	13.3

FUEL RATE (OBS) = 72.0 (LB/HR)
ALT. VOLTS = 251. ALT. AMPS = 377. ALT. EFF. = .937
FLYWHEEL HP = 148.5 OBS. SFC = .4847 AAR CORR. SFC = .4941 (LB/HP-HR)
CALCULATED A/F = 146.93 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	159.3	1.07	69.PPMC
CO	285.3	1.92	62. PPM
NOX	1782.9	12.00	236. PPM (D)
NOX,CORR	1657.6	11.16	
CO2		692.	1.42 PCT
O2			18.90 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9297	NOX-KH	= .9113	NOX-KT	= 1.0000
WET EXH HC CF	= .9858	AIR TEMP CF	= 1.0013	BAROM CF	= 1.0068
FUEL TEMP CF	= .9865	FUEL S.G. CF	= 1.0050	FUEL HHV CF	= 1.0111

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6876.0-5
FILTER PAIR WEIGHT GAIN (mg)	5.308
SAMPLE VOLUME (scf)	34.673
DILUTE PM CONCENTRATION (mg/scf)	.153
CO2-BASED DILUTION FACTOR	2.825
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.432
PARTICULATE MASS EMISSION RATE (g/hr)	61.3
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.413

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-11243-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2205	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 2	TEST CONFIGURATION	=	Baseline
TEST DATE	=	2/ 3/ 5	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	5/11			
SwRI FUEL CODE	=	EM-3137C-F	FUEL H/C RATIO	=	1.82
BAROMETER	=	29.65 (in. Hg)	ENGINE INTAKE AIR	=	57.(°F)
DRY BULB TEMP	=	53. (°F)	WET BULB TEMP	=	45. (°F)
ABS HUMIDITY	=	31.61 (GR/LB)	RELATIVE HUMIDITY	=	53. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	6.3
TRACTION MOTOR BLOWER HP	=	6.4
INERTIAL SEPERATOR BLOWER HP	=	1.0
RADIATOR FAN HP	=	3.0
TOTAL ACCESSORY HP	=	20.6

FUEL RATE (OBS) = 142.2 (LB/HR)
ALT. VOLTS = 385. ALT. AMPS = 574. ALT. EFF. = .937
FLYWHEEL HP = 336.3 OBS. SFC = .4228 AAR CORR. SFC = .4310 (LB/HP-HR)
CALCULATED A/F = 92.98 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	215.8	.64	74.PPMC
CO	321.9	.96	56. PPM
NOX	3023.2	8.99	321. PPM (D)
NOX,CORR	2825.3	8.40	
CO2		606.	2.26 PCT
O2			17.80 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9345	NOX-KH	= .9174	NOX-KT	= 1.0000
WET EXH HC CF	= .9783	AIR TEMP CF	= 1.0013	BAROM CF	= 1.0068
FUEL TEMP CF	= .9870	FUEL S.G. CF	= 1.0050	FUEL HHV CF	= 1.0111

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6877.0-6
FILTER PAIR WEIGHT GAIN (mg)	4.875
SAMPLE VOLUME (scf)	34.882
DILUTE PM CONCENTRATION (mg/scf)	.140
CO2-BASED DILUTION FACTOR	3.810
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.532
PARTICULATE MASS EMISSION RATE (g/hr)	94.7
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.282

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03 11243 001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2205	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 3	TEST CONFIGURATION	=	Baseline
TEST DATE	=	2/ 3/ 5	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	6/11			
SwRI FUEL CODE	=	EM-3137C-F	FUEL H/C RATIO	=	1.82
BAROMETER	=	29.65 (in. Hg)	ENGINE INTAKE AIR	=	56.(°F)
DRY BULB TEMP	=	53. (°F)	WET BULB TEMP	=	45. (°F)
ABS HUMIDITY	=	31.61 (GR/LB)	RELATIVE HUMIDITY	=	53. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	8.3
TRACTION MOTOR BLOWER HP	=	14.8
INERTIAL SEPERATOR BLOWER HP	=	2.2
RADIATOR FAN HP	=	6.9
TOTAL ACCESSORY HP	=	36.2

FUEL RATE (OBS) = 272.0 (LB/HR)
ALT. VOLTS = 555. ALT. AMPS = 820. ALT. EFF. = .937
FLYWHEEL HP = 686.6 OBS. SFC = .3961 AAR CORR. SFC = .4040 (LB/HP-HR)
CALCULATED A/F = 65.49 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	303.7	.44	77.PPMC
CO	298.6	.43	39. PPM
NOX	6653.3	9.69	526. PPM (D)
NOX,CORR	6221.9	9.06	
CO2		569.	3.23 PCT
O2			16.40 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9352	NOX-KH	= .9181	NOX-KT	= 1.0000
WET EXH HC CF	= .9700	AIR TEMP CF	= 1.0018	BAROM CF	= 1.0068
FUEL TEMP CF	= .9880	FUEL S.G. CF	= 1.0050	FUEL HHV CF	= 1.0111

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6878.0-7
FILTER PAIR WEIGHT GAIN (mg)	7.094
SAMPLE VOLUME (scf)	34.907
DILUTE PM CONCENTRATION (mg/scf)	.203
CO2-BASED DILUTION FACTOR	3.927
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.798
PARTICULATE MASS EMISSION RATE (g/hr)	192.1
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.280

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03 11243 001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2205	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 4	TEST CONFIGURATION	=	Baseline
TEST DATE	=	2/ 3/ 5	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	7/11			
SwRI FUEL CODE	=	EM-3137C-F	FUEL H/C RATIO	=	1.82
BAROMETER	=	29.65 (in. Hg)	ENGINE INTAKE AIR	=	56.(°F)
DRY BULB TEMP	=	53. (°F)	WET BULB TEMP	=	45. (°F)
ABS HUMIDITY	=	31.61 (GR/LB)	RELATIVE HUMIDITY	=	53. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	9.5
TRACTION MOTOR BLOWER HP	=	22.1
INERTIAL SEPERATOR BLOWER HP	=	3.3
RADIATOR FAN HP	=	10.2
TOTAL ACCESSORY HP	=	49.2

FUEL RATE (OBS) = 355.0 (LB/HR)
ALT. VOLTS = 653. ALT. AMPS = 954. ALT. EFF. = .937
FLYWHEEL HP = 938.5 OBS. SFC = .3783 AAR CORR. SFC = .3858 (LB/HP-HR)
CALCULATED A/F = 57.02 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	335.6	.36	75.PPMC
CO	288.0	.31	33. PPM
NOX	9413.3	10.03	657. PPM (D)
NOX,CORR	8804.0	9.38	
CO2		544.	3.72 PCT
O2			15.80 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9353	NOX-KH	= .9183	NOX-KT	= 1.0000
WET EXH HC CF	= .9658	AIR TEMP CF	= 1.0018	BAROM CF	= 1.0068
FUEL TEMP CF	= .9885	FUEL S.G. CF	= 1.0050	FUEL HHV CF	= 1.0111

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6879.0-8
FILTER PAIR WEIGHT GAIN (mg)	7.341
SAMPLE VOLUME (scf)	34.910
DILUTE PM CONCENTRATION (mg/scf)	.210
CO2-BASED DILUTION FACTOR	4.349
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.915
PARTICULATE MASS EMISSION RATE (g/hr)	250.7
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.267

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-11240-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2205	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 5	TEST CONFIGURATION	=	Baseline
TEST DATE	=	2/ 3/ 5	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	8/11			
SwRI FUEL CODE	=	EM-3137C-F	FUEL H/C RATIO	=	1.82
BAROMETER	=	29.65 (in. Hg)	ENGINE INTAKE AIR	=	57.(°F)
DRY BULB TEMP	=	53. (°F)	WET BULB TEMP	=	45. (°F)
ABS HUMIDITY	=	31.61 (GR/LB)	RELATIVE HUMIDITY	=	53. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	10.9
TRACTION MOTOR BLOWER HP	=	33.8
INERTIAL SEPERATOR BLOWER HP	=	5.1
RADIATOR FAN HP	=	15.6
TOTAL ACCESSORY HP	=	69.4

FUEL RATE (OBS) = 472.0 (LB/HR)
ALT. VOLTS = 744. ALT. AMPS = 1079. ALT. EFF. = .937
FLYWHEEL HP = 1216.8 OBS. SFC = .3879 AAR CORR. SFC = .3954 (LB/HP-HR)
CALCULATED A/F = 50.48 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	449.0	.37	85.PPMC
CO	559.6	.46	55. PPM
NOX	12659.0	10.40	752. PPM (D)
NOX,CORR	11840.5	9.73	
CO2		557.	4.21 PCT
O2			15.00 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9353	NOX-KH	= .9184	NOX-KT	= 1.0000
WET EXH HC CF	= .9616	AIR TEMP CF	= 1.0013	BAROM CF	= 1.0068
FUEL TEMP CF	= .9885	FUEL S.G. CF	= 1.0050	FUEL HHV CF	= 1.0111

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6880.0-9
FILTER PAIR WEIGHT GAIN (mg)	9.829
SAMPLE VOLUME (scf)	35.265
DILUTE PM CONCENTRATION (mg/scf)	.279
CO2-BASED DILUTION FACTOR	4.675
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	1.303
PARTICULATE MASS EMISSION RATE (g/hr)	421.3
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.346

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03 11243 001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2205	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 6	TEST CONFIGURATION	=	Baseline
TEST DATE	=	2/ 3/ 5	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	9/11			
SwRI FUEL CODE	=	EM-3137C-F	FUEL H/C RATIO	=	1.82
BAROMETER	=	29.64 (in. Hg)	ENGINE INTAKE AIR	=	57.(°F)
DRY BULB TEMP	=	53. (°F)	WET BULB TEMP	=	45. (°F)
ABS HUMIDITY	=	31.62 (GR/LB)	RELATIVE HUMIDITY	=	53. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	12.1
TRACTION MOTOR BLOWER HP	=	46.5
INERTIAL SEPERATOR BLOWER HP	=	7.0
RADIATOR FAN HP	=	21.5
TOTAL ACCESSORY HP	=	91.2

FUEL RATE (OBS) = 576.0 (LB/HR)
ALT. VOLTS = 818. ALT. AMPS = 1179. ALT. EFF. = .937
FLYWHEEL HP = 1468.9 OBS. SFC = .3921 AAR CORR. SFC = .3997 (LB/HP-HR)
CALCULATED A/F = 47.15 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	542.6	.37	90.PPMC
CO	1062.9	.72	91. PPM
NOX	16417.4	11.18	857. PPM (D)
NOX,CORR	15356.8	10.45	
CO2		563.	4.51 PCT
O2			14.80 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9354	NOX-KH	= .9184	NOX-KT	= 1.0000
WET EXH HC CF	= .9591	AIR TEMP CF	= 1.0013	BAROM CF	= 1.0067
FUEL TEMP CF	= .9890	FUEL S.G. CF	= 1.0050	FUEL HHV CF	= 1.0111

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6881.0-10
FILTER PAIR WEIGHT GAIN (mg)	11.178
SAMPLE VOLUME (scf)	34.850
DILUTE PM CONCENTRATION (mg/scf)	.321
CO2-BASED DILUTION FACTOR	5.049
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	1.619
PARTICULATE MASS EMISSION RATE (g/hr)	597.7
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.407

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-11243-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2205	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 7	TEST CONFIGURATION	=	Baseline
TEST DATE	=	2/ 3/ 5	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	10/11			
SwRI FUEL CODE	=	EM-3137C-F	FUEL H/C RATIO	=	1.82
BAROMETER	=	29.66 (in. Hg)	ENGINE INTAKE AIR	=	59.(°F)
DRY BULB TEMP	=	53. (°F)	WET BULB TEMP	=	45. (°F)
ABS HUMIDITY	=	31.59 (GR/LB)	RELATIVE HUMIDITY	=	53. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	13.9
TRACTION MOTOR BLOWER HP	=	70.0
INERTIAL SEPERATOR BLOWER HP	=	10.5
RADIATOR FAN HP	=	32.4
TOTAL ACCESSORY HP	=	130.8

FUEL RATE (OBS) = 742.0 (LB/HR)
ALT. VOLTS = 910. ALT. AMPS = 1298. ALT. EFF. = .937
FLYWHEEL HP = 1818.2 OBS. SFC = .4081 AAR CORR. SFC = .4157 (LB/HP-HR)
CALCULATED A/F = 41.67 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	859.8	.47	125.PPMC
CO	3098.1	1.70	234. PPM
NOX	21373.2	11.76	982. PPM (D)
NOX,CORR	19992.3	11.00	
CO2		584.	5.10 PCT
O2			14.00 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9354	NOX-KH	= .9184	NOX-KT	= 1.0000
WET EXH HC CF	= .9541	AIR TEMP CF	= 1.0004	BAROM CF	= 1.0069
FUEL TEMP CF	= .9900	FUEL S.G. CF	= 1.0050	FUEL HHV CF	= 1.0111

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6882.0-11
FILTER PAIR WEIGHT GAIN (mg)	9.791
SAMPLE VOLUME (scf)	34.518
DILUTE PM CONCENTRATION (mg/scf)	.284
CO2-BASED DILUTION FACTOR	4.972
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	1.410
PARTICULATE MASS EMISSION RATE (g/hr)	594.3
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.327

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-11243-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2205	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 8	TEST CONFIGURATION	=	Baseline
TEST DATE	=	2/ 3/ 5	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	11/11			
SwRI FUEL CODE	=	EM-3137C-F	FUEL H/C RATIO	=	1.82
BAROMETER	=	29.67 (in. Hg)	ENGINE INTAKE AIR	=	58.(°F)
DRY BULB TEMP	=	53. (°F)	WET BULB TEMP	=	45. (°F)
ABS HUMIDITY	=	31.58 (GR/LB)	RELATIVE HUMIDITY	=	53. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	15.1
TRACTION MOTOR BLOWER HP	=	90.0
INERTIAL SEPERATOR BLOWER HP	=	13.5
RADIATOR FAN HP	=	83.3
TOTAL ACCESSORY HP	=	205.9

FUEL RATE (OBS) = 864.0 (LB/HR)
ALT. VOLTS = 953. ALT. AMPS = 1349. ALT. EFF. = .937
FLYWHEEL HP = 2042.5 OBS. SFC = .4230 AAR CORR. SFC = .4311 (LB/HP-HR)
CALCULATED A/F = 37.51 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	1048.5	.51	145.PPMC
CO	7638.1	3.74	551. PPM
NOX	23771.8	11.64	1044. PPM (D)
NOX,CORR	22235.9	10.89	
CO2		602.	5.65 PCT
O2			13.30 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9354	NOX-KH	= .9184	NOX-KT	= 1.0000
WET EXH HC CF	= .9494	AIR TEMP CF	= 1.0009	BAROM CF	= 1.0070
FUEL TEMP CF	= .9900	FUEL S.G. CF	= 1.0050	FUEL HHV CF	= 1.0111

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6883.0-12
FILTER PAIR WEIGHT GAIN (mg)	29.585
SAMPLE VOLUME (scf)	34.285
DILUTE PM CONCENTRATION (mg/scf)	.863
CO2-BASED DILUTION FACTOR	5.423
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	4.679
PARTICULATE MASS EMISSION RATE (g/hr)	2071.8
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	1.014

2/3/2005 BNSF2205

Notch	Barom in. Hg	Ambient Dry Bulb °F	Ambient Wet Bulb °F	Fuel Rate lb/hr	HC ppmC	CO ppm	Raw CO2 %	Dil CO2 %	BG CO2 ppm	Nox ppm	O2 %	Engine Speed (rpm)	FA # of Fans L/H	FB Gen Volts	Gen Amps	Fuel Temp °F	Intake Air °F	Intake Manifold °F
Low Idle	29.66	55.0	46.0	24.6	110.2	72.1	0.59	0.2307	628.9	115.3	20.0	248	0	5.1	8.9	86	58	80
Idle	29.66	55.0	45.0	31.2	102.7	98.5	0.61	0.2490	552.3	110.3	20.0	309	0	6.2	10.7	87	57	78
DB-2	29.66	53.0	45.0	40.2	97.7	122.2	0.64	0.2596	527.2	101.6	20.0	375	0	7.8	13.3	87	58	82
Notch 1	29.65	54.0	45.0	72.0	68.9	61.9	1.42	0.5295	527.2	235.5	18.9	310	0	251.3	376.8	87	57	77
Notch 2	29.65	53.0	45.0	142.2	74.4	56.1	2.26	0.6234	577.7	320.7	17.8	376	1	385.3	573.6	86	57	79
Notch 3	29.65	53.0	45.0	272.0	77.4	38.8	3.23	0.8411	552.3	526.2	16.4	498	1	555.2	820.0	84	56	85
Notch 4	29.65	53.0	45.0	355.0	75.1	33.0	3.72	0.8711	552.3	656.5	15.8	569	1	652.8	957.6	83	56	93
Notch 5	29.65	53.0	45.0	472.0	85.2	54.6	4.21	0.9124	552.3	751.8	15.0	655	1	744.4	1,079.0	83	57	106
Notch 6	29.64	53.0	45.0	576.0	90.2	91.1	4.51	0.9019	527.2	856.5	14.8	729	1	818.0	1,179.0	82	57	122
Notch 7	29.66	53.0	45.0	742.0	125.2	233.8	5.10	1.0232	502.3	981.8	14.0	835	1	910.0	1,298.0	80	59	146
Notch 8	29.67	53.0	45.0	864.0	145.3	551.3	5.65	1.0349	502.3	1044.4	13.3	908	2	953.0	1,349.0	80	58	166

LOCOMOTIVE TEST SUMMARY

SwRI project No. _____ **Test Date** 2/3/2005 **Unit Number** BNSF2205

Notch		Idle Low	Idle/ DB-1	DB-2	1	2	3	4	5	6	7	8
Observed Fuel Rate at X minutes into test point (lb/hr)												
1 min.		24.8	31.0	39.9	73.0	141	271	351	473	576	741	864
3 min.		24.6	31.4	39.9	73.0	142	272	352	472	575	742	864
5 min.		25.5	31.9	40.3	71.9	143	271	356	470	575	740	865
Averaged Fuel Rate over Time												
Cumulative Fuel Used (lbs)		4.1	5.2	6.7	12.0	15.4	27.2	35.5	47.2	60.0	74.2	86.4
Over X Minutes		10	10	10	10	6	6	6	6	6.25	6	6
x 60. = Fuel Rate (lb/hr)		24.6	31.2	40.2	72.0	142.2	272	355	472	576	742	864
Traction Volts/2		----------	----------	----------	122.9	188.4	271.5	319	364	400	445	466
MG Volts = xxx X 2.045		----------	----------	----------	251.3	385.3	555.2	652.8	744.4	818.0	910	953.0
Current Shunt mV		----------	----------	----------	4.71	7.17	10.25	11.92	13.49	14.74	16.22	16.86
Traction Current = Shunt mV * 80		----------	----------	----------	376.8	573.6	820	953.6	1079	1179	1298	1349
Baro (in Hg)		29.61	29.61	29.61	29.60	29.60	29.60	29.60	29.60	29.60	29.60	29.61
Dry Bulb Temperature (°F)		55	56	53	54	53	53	53	53	53	53	53
Wet Bulb Temperature (°F)		46	45	45	45	45	45	45	45	45	45	45
# of Fans (Low / ~~High~~)		0	0	0	0	0	1	0	1	1	1	2
LS Run # / HSD Run #		497	498	499	500	501	502	503	504	505	506	507
RPM		249	311	376	303	375	484	561	645	721	830	901
SS Smoke, % Opacity		5%	5%	10%	10%	10%	8%	7%	11%	11%	13%	14%

Notes: 1 - Air compressor locked off. (Form = Loco Test Sum 8-25-03.xls)

Test Configuration: Baseline test (2 stack) **Operator:** JCH

Smoke File Name 194 **Start time:** 6824

RAD SHUTTER SYSTEM STUCK OPEN. + ENG SPEED CREEPS UP AFTER NOTCH CHANGE

SwRI Project No.:0311243.01.001

LOCOMOTIVE ENGINE TEST SUMMARY

TEST DATE: 1/30/2005

NOTCH		L.Idle	Idle	DB2	N1	N2	N3	N4	N5	N6	N7	N8
HC (ppmC)	RANGE	500	500	500	100	100	100	500	500	500	500	500
	METER DIV.	22	20.5	19.5	69	74.5	77.5	15	17	18	25	29
	CONC., ppmC	110.2	102.7	97.7	68.9	74.4	77.4	75.1	85.2	90.2	125.2	145.3
CO		300	300	300	300	300	300	300	300	300	300	1000
		25	34	42	21.5	19.5	13.5	11.5	19	31.5	78.5	60
	CONC., ppm	72.1	98.5	122.2	61.9	56.1	38.8	33.0	54.6	91.1	233.8	551.3
CO_2 (%)	RANGE	2	2	2	2	6	6	6	6	16	16	16
	METER DIV.	35	36	37.5	74	49	63.5	70	76	49	53	56.5
	CONC., %	0.59	0.61	0.64	1.42	2.26	3.23	3.72	4.21	4.51	5.10	5.65
NOx (ppm)	RANGE	250	250	250	1000	1000	1000	1000	1000	2500	2500	2500
	METER DIV.	46	44	40.5	23.5	32	52.5	65.5	75	33.5	38.5	41
	CONC., ppm	115.3	110.3	101.6	235.5	320.7	526.2	656.5	751.8	856.5	981.8	1044.4
O_2 (%)	RANGE	25	25	25	25	25	25	25	25	25	25	25
	METER DIV.	80	80	80	75.5	71	65.5	63	60	59	56	53
	CONC., %	20.0	20.0	20.0	18.9	17.8	16.4	15.8	15.0	14.8	14.0	13.3
LCO_2 (ppm)	RANGE	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
TUNNEL DILUTE	MTR DIV.	39.5	41.5	43	68	74.5	87	88.5	90.5	90	95.5	96
	CONC., ppm	2306.9	2469.7	2595.6	5295.4	6233.5	8411.1	8710.5	9123.9	9019.0	10232.1	10349.1
LCO_2 (ppm)	RANGE	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
BG	MTR DIV.	13.5	12	11.5	11.5	12.5	12	12	12	11.5	11	11
	CONC., ppm	628.9	552.3	527.2	527.2	577.7	552.3	552.3	552.3	527.2	502.3	502.3

Test Configuration: BNSF 2205 Baseline

Operator: RGW

APPENDIX B. BNSF2205 EMISSION RESULTS WITH CSX MH INJECTORS

APPENDIX B. BNSF2205 EMISSION RESULTS WITH CSX MH INJECTORS

Locomotive BNSF 2205, EMD-16-645E Engine, 2°BTDC with "Double Helix" injectors @ 0.78 rack
Tested 2/4/05 @ SwRI

AAR 3x3 Weighted Results

Notch	Gross HP	obs Fuel Rate (lb/hr)	HC (g/hr)	CO (g/hr)	Corr. NOx (g/hr)	PM (g/hr)	AAR Corr bsfc	Corr. Fuel Rate (lb/hr)	WF	w-BHP	obs w-Fuel w-(lb/hr)	w-Fuel w-(lb/hr)	w-HC w-(g/hr)	w-CO w-(g/hr)	w-NOx w-(g/hr)	w-PM w-(g/hr)
8	1,966.4	887.0	984	19,800	15,898	2,176	0.459	902	25.0%	491.6	221.8	225.6	245.9	4950.1	3974.6	544.0
7	1,804.4	747.0	645	7,481	14,672	1,228	0.421	760	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	1,457.1	573.0	479	1,923	11,677	552	0.400	583	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	1,249.1	480.0	429	827	9,788	364	0.392	489	25.0%	312.3	120.0	122.3	107.3	206.8	2447.0	91.1
4	1,044.5	399.0	418	442	8,761	316	0.389	407	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	734.4	282.0	87	266	6,029	228	0.391	287	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	324.6	137.0	54	341	2,609	49	0.430	140	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	147.9	70.8	38	355	1,816	24	0.488	72	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Low Idle	10.3	25.8	166	211	633	14	2.555	26	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Idle	13.4	31.8	195	327	769	20	2.424	32	50.0%	6.7	15.9	16.2	97.4	163.3	384.6	9.8
DB-2	17.7	41.7	396	934	769	69	2.394	42	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
						sum =			100.0%	810.6	357.7	364.1	450.5	5320.2	6806.1	644.9

AAR 3x3 duty cycle weighted brake-specific emissions => 0.441 obs bsfc, 0.449 corr bsfc; 0.56, 6.56, 8.40, 0.796

Modal Brake-Specific Emissions Notch	HC (g/hp-hr)	CO (g/hp-hr)	Corr. NOx (g/hp-hr)	PM (g/hp-hr)
8	0.50	10.07	8.08	1.11
7	0.36	4.15	8.13	0.68
6	0.33	1.32	8.01	0.38
5	0.34	0.66	7.84	0.29
4	0.40	0.42	8.39	0.30
3	0.12	0.36	8.21	0.31
2	0.17	1.05	8.04	0.15
1	0.26	2.40	12.28	0.16
Low Idle	16.14	20.49	61.42	1.39
Idle	14.53	24.37	57.40	1.46
DB-2	22.40	52.77	43.44	3.88

EPA Switcher Duty Cycle Weighted Results

Notch	WF	w-BHP	obs w-Fuel w-(lb/hr)	w-Fuel w-(lb/hr)	w-HC w-(g/hr)	w-CO w-(g/hr)	w-NOx w-(g/hr)	w-PM w-(g/hr)
8	0.8%	15.7	7.1	7.2	7.9	158.4	127.2	17.4
7	0.2%	3.6	1.5	1.5	1.3	15.0	29.3	2.5
6	1.5%	21.9	8.6	8.7	7.2	28.8	175.2	8.3
5	3.6%	45.0	17.3	17.6	15.4	29.8	352.4	13.1
4	3.6%	37.6	14.4	14.6	15.1	15.9	315.4	11.4
3	5.8%	42.6	16.4	16.7	5.0	15.4	349.7	13.2
2	12.3%	39.9	16.9	17.2	6.6	42.0	321.0	6.1
1	12.4%	18.3	8.8	8.9	4.8	44.0	225.2	3.0
Low Idle	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Idle	59.8%	8.0	19.0	19.4	116.4	195.3	459.9	11.7
DB-2	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sum =	100.0%	232.6	109.8	111.9	179.7	544.6	2355.2	86.6

EPA switcher duty cycle weighted brake-specific emissions => 0.472 obs bsfc, 0.481 corr bsfc; 0.77, 2.34, 10.12, 0.372

Fuel-Specific Emissions Notch	HC (g/lb fuel)	CO (g/lb fuel)	Corr. NOx (g/lb fuel)	PM (g/lb fuel)
8	1.11	22.32	17.92	2.45
7	0.86	10.02	19.64	1.64
6	0.84	3.36	20.38	0.96
5	0.89	1.72	20.39	0.76
4	1.05	1.11	21.96	0.79
3	0.31	0.94	21.38	0.81
2	0.39	2.49	19.05	0.36
1	0.54	5.01	25.65	0.34
Low Idle	6.44	8.18	24.52	0.55
Idle	6.12	10.27	24.19	0.62
DB-2	9.51	22.40	18.44	1.65

EPA Freight Duty Cycle Weighted Results

Notch	WF	w-BHP	obs w-Fuel w-(lb/hr)	w-Fuel w-(lb/hr)	w-HC w-(g/hr)	w-CO w-(g/hr)	w-NOx w-(g/hr)	w-PM w-(g/hr)
8	16.2%	318.6	143.7	146.2	159.3	3207.7	2575.5	352.5
7	3.0%	54.1	22.4	22.8	19.3	224.4	440.2	36.8
6	3.9%	56.8	22.3	22.7	18.7	75.0	455.4	21.5
5	3.8%	47.5	18.2	18.6	16.3	31.4	371.9	13.8
4	4.4%	46.0	17.6	17.9	18.4	19.4	385.5	13.9
3	5.2%	38.2	14.7	14.9	4.5	13.8	313.5	11.8
2	6.5%	21.1	8.9	9.1	3.5	22.2	169.6	3.2
1	6.5%	9.6	4.6	4.7	2.5	23.1	118.1	1.6
Low Idle	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Idle	38.0%	5.1	12.1	12.3	74.0	124.1	292.3	7.4
DB-2	12.5%	2.2	5.2	5.3	49.6	116.8	96.1	8.6
sum =	100.0%	599.1	269.7	274.6	366.1	3857.9	5218.1	471.3

EPA freight duty cycle weighted brake-specific emissions => 0.450 obs bsfc, 0.458 corr bsfc; 0.61, 6.44, 8.71, 0.787

LOCOMOTIVE EMISSIONS SWRI PROJECT NO. 03-11240-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2205	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Low Idle	TEST CONFIGURATION	=	2°BTDC
TEST DATE	=	2/ 4/ 5	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	1/11			
SwRI FUEL CODE	=	EM-3137C-F	FUEL H/C RATIO	=	1.82
BAROMETER	=	29.69 (in. Hg)	ENGINE INTAKE AIR	=	57.(°F)
DRY BULB TEMP	=	52. (°F)	WET BULB TEMP	=	45. (°F)
ABS HUMIDITY	=	33.18 (GR/LB)	RELATIVE HUMIDITY	=	57. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	4.1
TRACTION MOTOR BLOWER HP	=	1.8
INERTIAL SEPERATOR BLOWER HP	=	.3
RADIATOR FAN HP	=	.0
TOTAL ACCESSORY HP	=	10.2

FUEL RATE (OBS) = 25.8 (LB/HR)
ALT. VOLTS = 4. ALT. AMPS = 8. ALT. EFF. = .937
FLYWHEEL HP = 10.3 OBS. SFC = 2.5057 AAR CORR. SFC = 2.5551 (LB/HP-HR)
CALCULATED A/F = 325.35 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	166.2	16.14	91.PPMC
CO	211.0	20.49	58. PPM
NOX	680.1	66.05	113. PPM (D)
NOX,CORR	632.6	61.44	
CO2		3528.	.63 PCT
O2			20.00 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9302	NOX-KH	= .9120	NOX-KT	= 1.0000
WET EXH HC CF	= .9927	AIR TEMP CF	= 1.0013	BAROM CF	= 1.0072
FUEL TEMP CF	= .9870	FUEL S.G. CF	= 1.0050	FUEL HHV CF	= 1.0111

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6884.0-13
FILTER PAIR WEIGHT GAIN (mg)	1.557
SAMPLE VOLUME (scf)	35.479
DILUTE PM CONCENTRATION (mg/scf)	.044
CO2-BASED DILUTION FACTOR	2.903
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.127
PARTICULATE MASS EMISSION RATE (g/hr)	14.3
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	1.386

LOCOMOTIVE EMISSIONS SWRI PROJECT NO. 03-11243-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2205	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Idle	TEST CONFIGURATION	=	2°BTDC
TEST DATE	=	2/ 4/ 5	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	2/11			
SwRI FUEL CODE	=	EM-3137C-F	FUEL H/C RATIO	=	1.82
BAROMETER	=	29.68 (in. Hg)	ENGINE INTAKE AIR	=	58.(°F)
DRY BULB TEMP	=	52. (°F)	WET BULB TEMP	=	45. (°F)
ABS HUMIDITY	=	33.20 (GR/LB)	RELATIVE HUMIDITY	=	57. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	5.2
TRACTION MOTOR BLOWER HP	=	3.6
INERTIAL SEPERATOR BLOWER HP	=	.5
RADIATOR FAN HP	=	.0
TOTAL ACCESSORY HP	=	13.3

FUEL RATE (OBS) = 31.8 (LB/HR)
ALT. VOLTS = 6. ALT. AMPS = 9. ALT. EFF. = .937
FLYWHEEL HP = 13.4 OBS. SFC = 2.3785 AAR CORR. SFC = 2.4241 (LB/HP-HR)
CALCULATED A/F = 280.46 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	194.7	14.56	100.PPMC
CO	326.6	24.43	84. PPM
NOX	826.6	61.82	129. PPM (D)
NOX,CORR	769.1	57.53	
CO2		3344.	.73 PCT
O2			19.90 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9305	NOX-KH	= .9123	NOX-KT	= 1.0000
WET EXH HC CF	= .9918	AIR TEMP CF	= 1.0009	BAROM CF	= 1.0071
FUEL TEMP CF	= .9865	FUEL S.G. CF	= 1.0050	FUEL HHV CF	= 1.0111

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6885.0-14
FILTER PAIR WEIGHT GAIN (mg)	1.780
SAMPLE VOLUME (scf)	35.414
DILUTE PM CONCENTRATION (mg/scf)	.050
CO2-BASED DILUTION FACTOR	3.272
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.164
PARTICULATE MASS EMISSION RATE (g/hr)	19.6
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	1.465

LOCOMOTIVE EMISSIONS SWRI PROJECT NO. 03-11243-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2205	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	DB-2	TEST CONFIGURATION	=	2°BTDC
TEST DATE	=	2/ 4/ 5	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	3/11			
SwRI FUEL CODE	=	EM-3137C-F	FUEL H/C RATIO	=	1.82
BAROMETER	=	29.67 (in. Hg)	ENGINE INTAKE AIR	=	59.(°F)
DRY BULB TEMP	=	53. (°F)	WET BULB TEMP	=	45. (°F)
ABS HUMIDITY	=	31.58 (GR/LB)	RELATIVE HUMIDITY	=	53. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	6.3
TRACTION MOTOR BLOWER HP	=	6.4
INERTIAL SEPERATOR BLOWER HP	=	1.0
RADIATOR FAN HP	=	.0
TOTAL ACCESSORY HP	=	17.6

FUEL RATE (OBS) = 41.7 (LB/HR)
ALT. VOLTS = 7. ALT. AMPS = 12. ALT. EFF. = .937
FLYWHEEL HP = 17.7 OBS. SFC = 2.3504 AAR CORR. SFC = 2.3941 (LB/HP-HR)
CALCULATED A/F = 290.36 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	396.4	22.34	150.PPMC
CO	934.1	52.65	177. PPM
NOX	828.6	46.70	95. PPM (D)
NOX,CORR	768.8	43.33	
CO2		3234.	.69 PCT
O2			19.90 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9278	NOX-KH	= .9090	NOX-KT	= 1.0000
WET EXH HC CF	= .9922	AIR TEMP CF	= 1.0004	BAROM CF	= 1.0070
FUEL TEMP CF	= .9860	FUEL S.G. CF	= 1.0050	FUEL HHV CF	= 1.0111

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6886.0-15
FILTER PAIR WEIGHT GAIN (mg)	4.590
SAMPLE VOLUME (scf)	35.027
DILUTE PM CONCENTRATION (mg/scf)	.131
CO2-BASED DILUTION FACTOR	3.242
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.425
PARTICULATE MASS EMISSION RATE (g/hr)	68.7
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	3.872

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-11243-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2205	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 1	TEST CONFIGURATION	=	2°BTDC
TEST DATE	=	2/ 4/ 5	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	4/11			
SwRI FUEL CODE	=	EM-3137C-F	FUEL H/C RATIO	=	1.82
BAROMETER	=	29.67 (in. Hg)	ENGINE INTAKE AIR	=	58.(°F)
DRY BULB TEMP	=	53. (°F)	WET BULB TEMP	=	45. (°F)
ABS HUMIDITY	=	31.58 (GR/LB)	RELATIVE HUMIDITY	=	53. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	5.2
TRACTION MOTOR BLOWER HP	=	3.6
INERTIAL SEPERATOR BLOWER HP	=	.5
RADIATOR FAN HP	=	.0
TOTAL ACCESSORY HP	=	13.3

FUEL RATE (OBS) = 70.8 (LB/HR)

ALT. VOLTS = 251. ALT. AMPS = 376. ALT. EFF. = .937

FLYWHEEL HP = 147.9 OBS. SFC = .4785 AAR CORR. SFC = .4877 (LB/HP-HR)

CALCULATED A/F = 150.46 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	38.4	.26	17.PPMC
CO	355.0	2.40	77. PPM
NOX	1948.9	13.17	256. PPM (D)
NOX,CORR	1816.2	12.28	
CO2		685.	1.39 PCT
O2			18.80 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9319	NOX-KH	= .9141	NOX-KT	= 1.0000
WET EXH HC CF	= .9860	AIR TEMP CF	= 1.0009	BAROM CF	= 1.0070
FUEL TEMP CF	= .9865	FUEL S.G. CF	= 1.0050	FUEL HHV CF	= 1.0111

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6887.0-16
FILTER PAIR WEIGHT GAIN (mg)	1.873
SAMPLE VOLUME (scf)	35.203
DILUTE PM CONCENTRATION (mg/scf)	.053
CO2-BASED DILUTION FACTOR	3.160
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.168
PARTICULATE MASS EMISSION RATE (g/hr)	24.0
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.162

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-11040 001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2205	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 2	TEST CONFIGURATION	=	2°BTDC
TEST DATE	=	2/ 4/ 5	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	5/11			
SwRI FUEL CODE	=	EM-3137C-F	FUEL H/C RATIO	=	1.82
BAROMETER	=	29.68 (in. Hg)	ENGINE INTAKE AIR	=	57.(°F)
DRY BULB TEMP	=	54. (°F)	WET BULB TEMP	=	46. (°F)
ABS HUMIDITY	=	33.29 (GR/LB)	RELATIVE HUMIDITY	=	53. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	6.3
TRACTION MOTOR BLOWER HP	=	6.3
INERTIAL SEPERATOR BLOWER HP	=	.9
RADIATOR FAN HP	=	2.9
TOTAL ACCESSORY HP	=	20.5

FUEL RATE (OBS) = 137.0 (LB/HR)
ALT. VOLTS = 380. ALT. AMPS = 561. ALT. EFF. = .937
FLYWHEEL HP = 324.6 OBS. SFC = .4221 AAR CORR. SFC = .4304 (LB/HP-HR)
CALCULATED A/F = 99.75 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	53.9	.17	18.PPMC
CO	341.2	1.05	58. PPM
NOX	2785.5	8.58	286. PPM (D)
NOX,CORR	2609.4	8.04	
CO2		606.	2.11 PCT
O2			17.90 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9368	NOX-KH	= .9202	NOX-KT	= 1.0000
WET EXH HC CF	= .9796	AIR TEMP CF	= 1.0013	BAROM CF	= 1.0071
FUEL TEMP CF	= .9875	FUEL S.G. CF	= 1.0050	FUEL HHV CF	= 1.0111

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6888.0-17
FILTER PAIR WEIGHT GAIN (mg)	2.390
SAMPLE VOLUME (scf)	35.299
DILUTE PM CONCENTRATION (mg/scf)	.068
CO2-BASED DILUTION FACTOR	3.964
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.268
PARTICULATE MASS EMISSION RATE (g/hr)	49.3
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.152

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-11243-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2205	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 3	TEST CONFIGURATION	=	2°BTDC
TEST DATE	=	2/ 4/ 5	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	6/11			
SwRI FUEL CODE	=	EM-3137C-F	FUEL H/C RATIO	=	1.82
BAROMETER	=	29.67 (in. Hg)	ENGINE INTAKE AIR	=	59.(°F)
DRY BULB TEMP	=	54. (°F)	WET BULB TEMP	=	46. (°F)
ABS HUMIDITY	=	33.31 (GR/LB)	RELATIVE HUMIDITY	=	53. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	8.3
TRACTION MOTOR BLOWER HP	=	14.7
INERTIAL SEPERATOR BLOWER HP	=	2.2
RADIATOR FAN HP	=	.0
TOTAL ACCESSORY HP	=	29.2

FUEL RATE (OBS) = 282.0 (LB/HR)
ALT. VOLTS = 580. ALT. AMPS = 851. ALT. EFF. = .937
FLYWHEEL HP = 734.4 OBS. SFC = .3840 AAR CORR. SFC = .3911 (LB/HP-HR)
CALCULATED A/F = 63.49 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	86.8	.12	22.PPMC
CO	266.0	.36	34. PPM
NOX	6429.7	8.76	506. PPM (D)
NOX,CORR	6028.9	8.21	
CO2		553.	3.34 PCT
O2			16.20 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9377	NOX-KH	= .9213	NOX-KT	= 1.0000
WET EXH HC CF	= .9689	AIR TEMP CF	= 1.0004	BAROM CF	= 1.0070
FUEL TEMP CF	= .9885	FUEL S.G. CF	= 1.0050	FUEL HHV CF	= 1.0111

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6889.0-18
FILTER PAIR WEIGHT GAIN (mg)	6.889
SAMPLE VOLUME (scf)	35.462
DILUTE PM CONCENTRATION (mg/scf)	.194
CO2-BASED DILUTION FACTOR	4.843
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.941
PARTICULATE MASS EMISSION RATE (g/hr)	227.7
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.310

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-11243-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2205	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 4	TEST CONFIGURATION	=	2°BTDC
TEST DATE	=	2/ 4/ 5	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	7/11			
SwRI FUEL CODE	=	EM-3137C-F	FUEL H/C RATIO	=	1.82
BAROMETER	=	29.66 (in. Hg)	ENGINE INTAKE AIR	=	57.(°F)
DRY BULB TEMP	=	55. (°F)	WET BULB TEMP	=	46. (°F)
ABS HUMIDITY	=	31.69 (GR/LB)	RELATIVE HUMIDITY	=	49. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	9.5
TRACTION MOTOR BLOWER HP	=	21.9
INERTIAL SEPERATOR BLOWER HP	=	3.3
RADIATOR FAN HP	=	10.1
TOTAL ACCESSORY HP	=	48.8

FUEL RATE (OBS) = 399.0 (LB/HR)

ALT. VOLTS = 692. ALT. AMPS = 1007. ALT. EFF. = .937

FLYWHEEL HP = 1044.5 OBS. SFC = .3820 AAR CORR. SFC = .3894 (LB/HP-HR)

CALCULATED A/F = 52.55 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	418.1	.40	90.PPMC
CO	441.5	.42	49. PPM
NOX	9365.8	8.97	632. PPM (D)
NOX,CORR	8761.2	8.39	
CO2		549.	4.04 PCT
O2			15.20 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9354	NOX-KH	= .9185	NOX-KT	= 1.0000
WET EXH HC CF	= .9631	AIR TEMP CF	= 1.0013	BAROM CF	= 1.0069
FUEL TEMP CF	= .9885	FUEL S.G. CF	= 1.0050	FUEL HHV CF	= 1.0111

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6890.0-19
FILTER PAIR WEIGHT GAIN (mg)	6.939
SAMPLE VOLUME (scf)	35.384
DILUTE PM CONCENTRATION (mg/scf)	.196
CO2-BASED DILUTION FACTOR	5.657
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	1.109
PARTICULATE MASS EMISSION RATE (g/hr)	315.5
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.302

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-11240 001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2205	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 5	TEST CONFIGURATION	=	2°BTDC
TEST DATE	=	2/ 4/ 5	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	8/11			
SwRI FUEL CODE	=	EM-3137C-F	FUEL H/C RATIO	=	1.82
BAROMETER	=	29.65 (in. Hg)	ENGINE INTAKE AIR	=	58.(°F)
DRY BULB TEMP	=	53. (°F)	WET BULB TEMP	=	45. (°F)
ABS HUMIDITY	=	31.61 (GR/LB)	RELATIVE HUMIDITY	=	53. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	10.9
TRACTION MOTOR BLOWER HP	=	33.6
INERTIAL SEPERATOR BLOWER HP	=	5.0
RADIATOR FAN HP	=	15.5
TOTAL ACCESSORY HP	=	69.1

FUEL RATE (OBS) = 480.0 (LB/HR)

ALT. VOLTS = 756. ALT. AMPS = 1093. ALT. EFF. = .937

FLYWHEEL HP = 1249.1 OBS. SFC = .3843 AAR CORR. SFC = .3916 (LB/HP-HR)

CALCULATED A/F = 50.45 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	429.1	.34	80.PPMC
CO	827.2	.66	79. PPM
NOX	10464.5	8.38	611. PPM (D)
NOX,CORR	9788.0	7.84	
CO2		552.	4.21 PCT
O2			14.90 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9353	NOX-KH	= .9184	NOX-KT	= 1.0000
WET EXH HC CF	= .9616	AIR TEMP CF	= 1.0009	BAROM CF	= 1.0068
FUEL TEMP CF	= .9885	FUEL S.G. CF	= 1.0050	FUEL HHV CF	= 1.0111

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6891.0-20
FILTER PAIR WEIGHT GAIN (mg)	6.989
SAMPLE VOLUME (scf)	35.141
DILUTE PM CONCENTRATION (mg/scf)	.199
CO2-BASED DILUTION FACTOR	5.575
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	1.109
PARTICULATE MASS EMISSION RATE (g/hr)	364.4
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.292

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-11243-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2205	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 6	TEST CONFIGURATION	=	2°BTDC
TEST DATE	=	2/ 4/ 5	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	9/11			
SwRI FUEL CODE	=	EM-3137C-F	FUEL H/C RATIO	=	1.82
BAROMETER	=	29.64 (in. Hg)	ENGINE INTAKE AIR	=	61.(°F)
DRY BULB TEMP	=	53. (°F)	WET BULB TEMP	=	45. (°F)
ABS HUMIDITY	=	31.62 (GR/LB)	RELATIVE HUMIDITY	=	53. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	12.1
TRACTION MOTOR BLOWER HP	=	46.2
INERTIAL SEPERATOR BLOWER HP	=	6.9
RADIATOR FAN HP	=	21.3
TOTAL ACCESSORY HP	=	90.5

FUEL RATE (OBS) = 573.0 (LB/HR)

ALT. VOLTS = 816. ALT. AMPS = 1172. ALT. EFF. = .937

FLYWHEEL HP = 1457.1 OBS. SFC = .3932 AAR CORR. SFC = .4001 (LB/HP-HR)

CALCULATED A/F = 47.08 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	478.7	.33	80.PPMC
CO	1922.8	1.32	166. PPM
NOX	12483.4	8.57	656. PPM (D)
NOX,CORR	11676.9	8.01	
CO2		564.	4.51 PCT
O2			14.60 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9354	NOX-KH	= .9184	NOX-KT	= 1.0000
WET EXH HC CF	= .9590	AIR TEMP CF	= .9995	BAROM CF	= 1.0067
FUEL TEMP CF	= .9890	FUEL S.G. CF	= 1.0050	FUEL HHV CF	= 1.0111

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	7418.0-21
FILTER PAIR WEIGHT GAIN (mg)	9.084
SAMPLE VOLUME (scf)	33.826
DILUTE PM CONCENTRATION (mg/scf)	.269
CO2-BASED DILUTION FACTOR	5.610
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	1.507
PARTICULATE MASS EMISSION RATE (g/hr)	552.4
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.379

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-11243-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2205	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 7	TEST CONFIGURATION	=	2°BTDC
TEST DATE	=	2/ 4/ 5	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	10/11			
SwRI FUEL CODE	=	EM-3137C-F	FUEL H/C RATIO	=	1.82
BAROMETER	=	29.63 (in. Hg)	ENGINE INTAKE AIR	=	61.(°F)
DRY BULB TEMP	=	53. (°F)	WET BULB TEMP	=	45. (°F)
ABS HUMIDITY	=	31.64 (GR/LB)	RELATIVE HUMIDITY	=	53. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	13.9
TRACTION MOTOR BLOWER HP	=	69.4
INERTIAL SEPERATOR BLOWER HP	=	10.4
RADIATOR FAN HP	=	32.1
TOTAL ACCESSORY HP	=	129.8

FUEL RATE (OBS) = 747.0 (LB/HR)
ALT. VOLTS = 908. ALT. AMPS = 1291. ALT. EFF. = .937
FLYWHEEL HP = 1804.4 OBS. SFC = .4140 AAR CORR. SFC = .4212 (LB/HP-HR)
CALCULATED A/F = 40.80 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	644.9	.36	95.PPMC
CO	7481.3	4.15	573. PPM
NOX	15684.6	8.69	731. PPM (D)
NOX,CORR	14672.3	8.13	
CO2		589.	5.18 PCT
O2			13.80 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9355	NOX-KH	= .9185	NOX-KT	= 1.0000
WET EXH HC CF	= .9532	AIR TEMP CF	= .9995	BAROM CF	= 1.0066
FUEL TEMP CF	= .9895	FUEL S.G. CF	= 1.0050	FUEL HHV CF	= 1.0111

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	7419.0-22
FILTER PAIR WEIGHT GAIN (mg)	13.830
SAMPLE VOLUME (scf)	31.033
DILUTE PM CONCENTRATION (mg/scf)	.446
CO2-BASED DILUTION FACTOR	6.629
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	2.954
PARTICULATE MASS EMISSION RATE (g/hr)	1227.8
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.680

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-11243-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2205	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 8	TEST CONFIGURATION	=	2°BTDC
TEST DATE	=	2/ 4/ 5	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	11/11			
SwRI FUEL CODE	=	EM-3137C-F	FUEL H/C RATIO	=	1.82
BAROMETER	=	29.63 (in. Hg)	ENGINE INTAKE AIR	=	61.(°F)
DRY BULB TEMP	=	54. (°F)	WET BULB TEMP	=	46. (°F)
ABS HUMIDITY	=	33.37 (GR/LB)	RELATIVE HUMIDITY	=	53. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	15.1
TRACTION MOTOR BLOWER HP	=	89.4
INERTIAL SEPERATOR BLOWER HP	=	13.4
RADIATOR FAN HP	=	82.7
TOTAL ACCESSORY HP	=	204.7

FUEL RATE (OBS) = 887.0 (LB/HR)

ALT. VOLTS = 953. ALT. AMPS = 1294. ALT. EFF. = .937

FLYWHEEL HP = 1966.4 OBS. SFC = .4511 AAR CORR. SFC = .4589 (LB/HP-HR)

CALCULATED A/F = 35.42 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	983.5	.50	140.PPMC
CO	19800.4	10.07	1475. PPM
NOX	16949.2	8.62	769. PPM (D)
NOX,CORR	15898.3	8.09	
CO2		633.	5.90 PCT
O2			12.80 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9380	NOX-KH	= .9217	NOX-KT	= 1.0000
WET EXH HC CF	= .9467	AIR TEMP CF	= .9995	BAROM CF	= 1.0066
FUEL TEMP CF	= .9900	FUEL S.G. CF	= 1.0050	FUEL HHV CF	= 1.0111

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	7420.0-23
FILTER PAIR WEIGHT GAIN (mg)	21.062
SAMPLE VOLUME (scf)	30.771
DILUTE PM CONCENTRATION (mg/scf)	.684
CO2-BASED DILUTION FACTOR	7.395
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	5.062
PARTICULATE MASS EMISSION RATE (g/hr)	2176.0
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	1.107

2/4/2005 BNSF2205

Notch	Barom in. Hg	Ambient Dry Bulb °F	Ambient Wet Bulb °F	Fuel Rate lb/hr	HC ppmC	CO ppm	Raw CO2 %	Dil CO2 %	BG CO2 ppm	Nox ppm	O2 %	Engine Speed (rpm)	FA # of Fans L/H	FB Gen Volts	FB Gen Amps	Fuel Temp °F	Intake Air °F	Intake Manifold °F
Low Idle	29.69	52.0	45.0	25.8	90.9	57.5	0.63	0.2596	681.0	112.8	20.0	248	0	4.4	7.7	86	57	74
Idle	29.68	52.0	45.0	31.8	100.2	83.8	0.73	0.2681	681.0	129.1	19.9	310	0	5.5	9.4	87	58	76
DB-2	29.67	53.0	45.0	41.7	150.3	176.5	0.69	0.2596	707.3	95.3	19.9	376	0	7.2	12.1	88	59	81
Notch 1	29.67	53.0	45.0	70.8	16.5	76.5	1.39	0.4837	733.9	255.6	18.8	310	0	250.7	376.0	87	58	77
Notch 2	29.68	54.0	46.0	137.0	18.0	57.5	2.11	0.5786	760.7	285.7	17.9	375	1	379.6	560.8	85	57	78
Notch 3	29.67	54.0	46.0	282.0	22.0	34.4	3.34	0.7299	760.7	506.2	16.2	497	0	579.9	851.2	83	59	88
Notch 4	29.66	55.0	46.0	399.0	90.2	48.9	4.04	0.7475	707.3	631.5	15.2	568	1	692.1	1,007.0	83	57	94
Notch 5	29.65	53.0	45.0	480.0	80.1	79.4	4.21	0.7838	681.0	611.4	14.9	654	1	755.7	1,093.0	83	58	107
Notch 6	29.64	53.0	45.0	573.0	80.1	165.9	4.51	0.8313	707.3	655.6	14.6	727	1	816.2	1,172.0	82	61	122
Notch 7	29.63	53.0	45.0	747.0	95.2	572.9	5.18	0.8026	654.8	731.1	13.8	833	1	908.0	1,291.0	81	61	147
Notch 8	29.63	54.0	46.0	887.0	140.3	1475.3	5.90	0.8216	733.9	768.7	12.8	907	2	953.0	1,294.0	80	61	167

LOCOMOTIVE TEST SUMMARY

SwRI project No. _____ **Test Date** 2/4/2005 **Unit Number** BNSF2205

Notch		Idle Low	Idle/ DB-1	DB-2	1	2	3	4	5	6	7	8
Observed Fuel Rate at X minutes into test point (lb/hr)												
1 min.		26.4	31.4	41.7	70.5	136	281	399	481	572	749	886
3 min.		25.8	32.0	41.7	71.0	137	281	400	481	573	747	887
5 min.		25.8	32.2	42.3	70.5	137	283	399	480	572	746	887
Averaged Fuel Rate over Time												
Cumulative Fuel Used (lbs)		4.3	5.3	7.3	12.4	13.7	28.9	39.9	48.0	57.3	74.7	88.7
Over X Minutes		10	10	10.5	10.5	6	6.1	6	6	6	6	6
x 60. = Fuel Rate (lb/hr)		25.8	31.8	41.7	70.8	137	282	399	480	573	747	887
Traction Volts/2		----------	----------	----------	122.6	185.6	283.6	338.4	369.5	399.1	444	466
MG Volts = xxx X 2.045		----------	----------	----------	250.7	379.6	579.9	692.1	755.7	816.2	908.0	953
Current Shunt mV		----------	----------	----------	4.70	7.01	10.64	12.59	13.66	14.65	16.14	16.81
Traction Current = Shunt mV * 80		----------	----------	----------	376	560.8	851.2	1007	1093	1172	1291	1294
Baro (in Hg)		29.64	29.64	29.62	29.61	29.63	29.62	29.61	29.59	29.60	29.59	29.58
Dry Bulb Temperature (°F)		52	52	53	53	54	54	55	53	53	53	54
Wet Bulb Temperature (°F)		45	45	45	45	46	46	46	45	45	45	46
# of Fans (Low / High)		0	0	0	0	1	0	1	1	1	1	2
LS Run # / HSD Run #		508	509	510	511	512	513	514	515	516	517	518
ENG SPEED		248	311	376	303	367	486	564	655	722	813	904
SS Smoke, % Opacity		0	-3%	-5%	-2%	-1%	-5%	-5%	15%	5%	5%	5%

Notes: 1 - Air compressor locked off. (Form = Loco Test Sum 8-25-03.xls)

Test Configuration: Ted's new inj test (2 of 4 stacks) **Operator:** JCH

Smoke File Name 195 **Start time:** 3840

SwRI Project No.:

LOCOMOTIVE ENGINE TEST SUMMARY

TEST DATE: 2/4/2005

NOTCH		L.Idle	Idle	DB2	N1	N2	N3	N4	N5	N6	N7	N8
HC (ppmC)	RANGE	100	500	500	100	100	100	500	500	500	500	500
	METER DIV.	91	20	30	16.5	18	22	18	16	16	19	28
	CONC., ppmC	90.9	100.2	150.3	16.5	18.0	22.0	90.2	80.1	80.1	95.2	140.3
CO		300	300	300	300	300	300	300	300	300	1000	3000
		20	29	60	26.5	20	12	17	27.5	56.5	62	61
	CONC., ppm	57.5	83.8	176.5	76.5	57.5	34.4	48.9	79.4	165.9	572.9	1475.3
CO_2 (%)	RANGE	2	2	2	2	6	6	6	6	16	16	16
	METER DIV.	37	42	40	73	46.5	65	74	76	49	53.5	58
	CONC., %	0.63	0.73	0.69	1.39	2.11	3.34	4.04	4.21	4.51	5.18	5.90
NOx (ppm)	RANGE	250	250	250	1000	1000	1000	1000	1000	2500	2500	2500
	METER DIV.	45	51.5	38	25.5	28.5	50.5	63	61	25.5	28.5	30
	CONC., ppm	112.8	129.1	95.3	255.6	285.7	506.2	631.5	611.4	655.6	731.1	768.7
O_2 (%)	RANGE	25	25	25	25	25	25	25	25	25	25	25
	METER DIV.	80	79.5	79.5	75	71.5	64.5	60.5	59.5	58.5	55	51
	CONC., %	20.0	19.9	19.9	18.8	17.9	16.2	15.2	14.9	14.6	13.8	12.8
LCO_2 (ppm)	RANGE	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
TUNNEL DILUTE	MTR DIV.	43	44	43	64.5	71.5	81	82	84	86.5	85	86
	CONC., ppm	2595.6	2681.4	2595.6	4836.9	5785.8	7298.8	7475.1	7838.4	8313.3	8025.6	8216.4
LCO_2 (ppm)	RANGE	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
BG	MTR DIV.	14.5	14.5	15	15.5	16	16	15	14.5	15	14	15.5
	CONC., ppm	681.0	681.0	707.3	733.9	760.7	760.7	707.3	681.0	707.3	654.8	733.9

Test Configuration: BNSF 2205 New Injectors- 2* BTDC

Operator: RGW

APPENDIX C. BNSF2297 BASELINE EMISSION RESULTS

APPENDIX C. BNSF2297 BASELINE EMISSION RESULTS

Locomotive BNSF 2297, EMD-16-645E Engine, Baseline H&K @ 4°BTDC
Tested 10/2/03 PM @ SwRI

AAR 3x3 Weighted Results

Notch	Gross HP	obs Fuel Rate (lb/hr)	HC (g/hr)	CO (g/hr)	Corr. NOx (g/hr)	PM (g/hr)	AAR Corr bsfc	Corr. Fuel Rate (lb/hr)	WF	w-BHP	obs w-Fuel w-(lb/hr)	w-Fuel w-(lb/hr)	w-HC w-(g/hr)	w-CO w-(g/hr)	w-NOx w-(g/hr)	w-PM w-(g/hr)
8	2,006.9	835.0	1,798	14,170	22,176	1,528	0.416	835	25.0%	501.7	208.8	208.8	449.6	3542.4	5544.1	382.0
7	1,825.6	721.0	1,874	7,204	19,662	1,106	0.395	722	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	1,445.4	557.0	581	1,763	15,760	575	0.386	557	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	1,199.5	458.0	501	791	12,987	434	0.382	458	25.0%	299.9	114.5	114.6	125.2	197.7	3246.7	108.5
4	898.1	332.0	379	381	8,824	272	0.370	332	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	531.1	204.0	238	378	4,398	107	0.385	205	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	246.0	103.0	154	323	1,990	59	0.420	103	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	40.1	36.6	131	134	946	20	0.916	37	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Low Idle	9.8	22.8	119	103	682	21	2.341	23	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Idle	12.9	29.6	131	149	773	18	2.301	30	50.0%	6.5	14.8	14.8	65.6	74.6	386.4	9.1
DB-2	16.6	35.4	146	199	834	23	2.141	36	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
						sum =			100.0%	808.1	338.1	338.2	640.3	3814.7	9177.2	499.6

AAR 3x3 duty cycle weighted brake-specific emissions => 0.418 obs bsfc, 0.419 corr bsfc, 0.79, 4.72, 11.36, 0.618

Modal Brake-Specific Emissions Notch	HC (g/hp-hr)	CO (g/hp-hr)	Corr. NOx (g/hp-hr)	PM (g/hp-hr)
8	0.90	7.06	11.05	0.76
7	1.03	3.95	10.77	0.61
6	0.40	1.22	10.90	0.40
5	0.42	0.66	10.83	0.36
4	0.42	0.42	9.83	0.30
3	0.45	0.71	8.28	0.20
2	0.62	1.31	8.09	0.24
1	3.26	3.34	23.60	0.49
Low Idle	12.16	10.55	69.55	2.18
Idle	10.16	11.56	59.91	1.41
DB-2	8.81	11.96	50.25	1.36

EPA Switcher Duty Cycle Weighted Results

Notch	WF	w-BHP	obs w-Fuel w-(lb/hr)	w-Fuel w-(lb/hr)	w-HC w-(g/hr)	w-CO w-(g/hr)	w-NOx w-(g/hr)	w-PM w-(g/hr)
8	0.8%	16.1	6.7	6.7	14.4	113.4	177.4	12.2
7	0.2%	3.7	1.4	1.4	3.7	14.4	39.3	2.2
6	1.5%	21.7	8.4	8.4	8.7	26.4	236.4	8.6
5	3.6%	43.2	16.5	16.5	18.0	28.5	467.5	15.6
4	3.6%	32.3	12.0	12.0	13.7	13.7	317.7	9.8
3	5.8%	30.8	11.8	11.9	13.8	21.9	255.1	6.2
2	12.3%	30.3	12.7	12.7	18.9	39.8	244.8	7.3
1	12.4%	5.0	4.5	4.6	16.2	16.6	117.3	2.5
Low Idle	29.9%	2.9	6.8	6.9	35.6	30.9	203.8	6.4
Idle	29.9%	3.9	8.9	8.9	39.2	44.6	231.1	5.4
DB-2	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sum =	100.0%	189.7	89.6	89.8	182.3	350.2	2290.4	76.2

EPA switcher duty cycle weighted brake-specific emissions => 0.472 obs bsfc, 0.473 corr bsfc, 0.96, 1.85, 12.07, 0.402

Fuel-Specific Emissions Notch	HC (g/lb fuel)	CO (g/lb fuel)	Corr. NOx (g/lb fuel)	PM (g/lb fuel)
8	2.15	16.97	26.56	1.83
7	2.60	9.99	27.27	1.53
6	1.04	3.17	28.29	1.03
5	1.09	1.73	28.36	0.95
4	1.14	1.15	26.58	0.82
3	1.17	1.85	21.56	0.52
2	1.49	3.14	19.32	0.58
1	3.57	3.66	25.86	0.54
Low Idle	5.23	4.54	29.89	0.94
Idle	4.43	5.04	26.11	0.61
DB-2	4.13	5.61	23.56	0.64

EPA Freight Duty Cycle Weighted Results

Notch	WF	w-BHP	obs w-Fuel w-(lb/hr)	w-Fuel w-(lb/hr)	w-HC w-(g/hr)	w-CO w-(g/hr)	w-NOx w-(g/hr)	w-PM w-(g/hr)
8	16.2%	325.1	135.3	135.3	291.3	2295.5	3592.6	247.5
7	3.0%	54.8	21.6	21.7	56.2	216.1	589.9	33.2
6	3.9%	56.4	21.7	21.7	22.7	68.8	614.6	22.4
5	3.8%	45.6	17.4	17.4	19.0	30.1	493.5	16.5
4	4.4%	39.5	14.6	14.6	16.7	16.7	388.3	11.9
3	5.2%	27.6	10.6	10.6	12.4	19.7	228.7	5.5
2	6.5%	16.0	6.7	6.7	10.0	21.0	129.3	3.9
1	6.5%	2.6	2.4	2.4	8.5	8.7	61.5	1.3
Low Idle	19.0%	1.9	4.3	4.4	22.6	19.6	129.5	4.1
Idle	19.0%	2.5	5.6	5.6	24.9	28.3	146.8	3.5
DB-2	12.5%	2.1	4.4	4.4	18.3	24.8	104.3	2.8
sum =	100.0%	574.0	244.7	244.9	502.6	2749.3	6479.0	352.6

EPA freight duty cycle weighted brake-specific emissions => 0.426 obs bsfc, 0.427 corr bsfc, 0.88, 4.79, 11.29, 0.614

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 08-10152.01

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2297	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Low Idle	TEST CONFIGURATION	=	Baseline
TEST DATE	=	10/ 2/ 3	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	1/11			
SwRI FUEL CODE	=	EM-3137A-F	FUEL H/C RATIO	=	1.79
BAROMETER	=	29.40 (in. Hg)	ENGINE INTAKE AIR	=	82.(°F)
DRY BULB TEMP	=	78. (°F)	WET BULB TEMP	=	63. (°F)
ABS HUMIDITY	=	62.72 (GR/LB)	RELATIVE HUMIDITY	=	43. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	4.0
TRACTION MOTOR BLOWER HP	=	1.5
INERTIAL SEPERATOR BLOWER HP	=	.2
RADIATOR FAN HP	=	.0
TOTAL ACCESSORY HP	=	9.7

FUEL RATE (OBS) = 22.8 (LB/HR)
ALT. VOLTS = 4. ALT. AMPS = 8. ALT. EFF. = .937
FLYWHEEL HP = 9.8 OBS. SFC = 2.3333 AAR CORR. SFC = 2.3412 (LB/HP-HR)
CALCULATED A/F = 339.01 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	119.2	12.20	71.PPMC
CO	103.4	10.58	31. PPM
NOX	696.2	71.25	125. PPM (D)
NOX,CORR	681.6	69.75	
CO2		3315.	.61 PCT
O2			20.00 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF =	.9790	NOX-KH =	.9732	NOX-KT =	1.0000
WET EXH HC CF=	.9916	AIR TEMP CF =	.9901	BAROM CF =	1.0047
FUEL TEMP CF =	.9845	FUEL S.G. CF =	.9972	FUEL HHV CF =	1.0087

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6350.0-299
FILTER PAIR WEIGHT GAIN (mg)	1.580
SAMPLE VOLUME (scf)	39.983
DILUTE PM CONCENTRATION (mg/scf)	.040
CO2-BASED DILUTION FACTOR	5.239
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.207
PARTICULATE MASS EMISSION RATE (g/hr)	21.4
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	2.186

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 08-10152.01

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2297	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Idle	TEST CONFIGURATION	=	Baseline
TEST DATE	=	10/ 2/ 3	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	2/11			
SwRI FUEL CODE	=	EM-3137A-F	FUEL H/C RATIO	=	1.79
BAROMETER	=	29.34 (in. Hg)	ENGINE INTAKE AIR	=	81.(°F)
DRY BULB TEMP	=	79. (°F)	WET BULB TEMP	=	64. (°F)
ABS HUMIDITY	=	66.06 (GR/LB)	RELATIVE HUMIDITY	=	44. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	5.1
TRACTION MOTOR BLOWER HP	=	3.2
INERTIAL SEPERATOR BLOWER HP	=	.5
RADIATOR FAN HP	=	.0
TOTAL ACCESSORY HP	=	12.8

FUEL RATE (OBS) = 29.6 (LB/HR)
ALT. VOLTS = 5. ALT. AMPS = 11. ALT. EFF. = .937
FLYWHEEL HP = 12.9 OBS. SFC = 2.2933 AAR CORR. SFC = 2.3009 (LB/HP-HR)
CALCULATED A/F = 323.56 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC
HC	131.1	10.16	63.PPMC
CO	149.1	11.55	36. PPM
NOX	784.9	60.81	114. PPM (D)
NOX,CORR	772.8	59.87	
CO2		3262.	.64 PCT
O2			19.90 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF =	.9847	NOX-KH =	.9805	NOX-KT =	1.0000
WET EXH HC CF=	.9911	AIR TEMP CF =	.9905	BAROM CF =	1.0041
FUEL TEMP CF =	.9850	FUEL S.G. CF =	.9972	FUEL HHV CF =	1.0087

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6351.0-300
FILTER PAIR WEIGHT GAIN (mg)	1.275
SAMPLE VOLUME (scf)	39.857
DILUTE PM CONCENTRATION (mg/scf)	.032
CO2-BASED DILUTION FACTOR	4.453
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.142
PARTICULATE MASS EMISSION RATE (g/hr)	18.2
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	1.411

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 08-10152.01

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2297	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	DB-2	TEST CONFIGURATION	=	Baseline
TEST DATE	=	10/ 2/ 3	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	3/11			
SwRI FUEL CODE	=	EM-3137A-F	FUEL H/C RATIO	=	1.79
BAROMETER	=	29.33 (in. Hg)	ENGINE INTAKE AIR	=	80.(°F)
DRY BULB TEMP	=	79. (°F)	WET BULB TEMP	=	64. (°F)
ABS HUMIDITY	=	66.09 (GR/LB)	RELATIVE HUMIDITY	=	44. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	6.1
TRACTION MOTOR BLOWER HP	=	5.5
INERTIAL SEPERATOR BLOWER HP	=	.8
RADIATOR FAN HP	=	.0
TOTAL ACCESSORY HP	=	16.5

FUEL RATE (OBS) = 35.4 (LB/HR)
ALT. VOLTS = 6. ALT. AMPS = 13. ALT. EFF. = .937
FLYWHEEL HP = 16.6 OBS. SFC = 2.1334 AAR CORR. SFC = 2.1413 (LB/HP-HR)
CALCULATED A/F = 309.13 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	146.2	8.81	61.PPMC
CO	198.5	11.96	42. PPM
NOX	847.1	51.05	108. PPM (D)
NOX,CORR	834.2	50.27	
CO2		3035.	.67 PCT
O2			19.80 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF =	.9847	NOX-KH =	.9805	NOX-KT =	1.0000
WET EXH HC CF=	.9909	AIR TEMP CF =	.9910	BAROM CF =	1.0041
FUEL TEMP CF =	.9845	FUEL S.G. CF =	.9972	FUEL HHV CF =	1.0087

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6352.0-301
FILTER PAIR WEIGHT GAIN (mg)	1.700
SAMPLE VOLUME (scf)	39.419
DILUTE PM CONCENTRATION (mg/scf)	.043
CO2-BASED DILUTION FACTOR	3.576
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.154
PARTICULATE MASS EMISSION RATE (g/hr)	22.5
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	1.358

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 08-10152.01

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2297	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 1	TEST CONFIGURATION	=	Baseline
TEST DATE	=	10/ 2/ 3	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	4/11			
SwRI FUEL CODE	=	EM-3137A-F	FUEL H/C RATIO	=	1.79
BAROMETER	=	29.32 (in. Hg)	ENGINE INTAKE AIR	=	81.(°F)
DRY BULB TEMP	=	80. (°F)	WET BULB TEMP	=	64. (°F)
ABS HUMIDITY	=	64.45 (GR/LB)	RELATIVE HUMIDITY	=	41. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	5.1
TRACTION MOTOR BLOWER HP	=	3.2
INERTIAL SEPERATOR BLOWER HP	=	.5
RADIATOR FAN HP	=	.0
TOTAL ACCESSORY HP	=	12.8

FUEL RATE (OBS) = 36.6 (LB/HR)
ALT. VOLTS = 103. ALT. AMPS = 185. ALT. EFF. = .937
FLYWHEEL HP = 40.1 OBS. SFC = .9135 AAR CORR. SFC = .9163 (LB/HP-HR)
CALCULATED A/F = 256.73 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	130.8	3.26	64.PPMC
CO	133.8	3.34	33. PPM
NOX	963.6	24.05	143. PPM (D)
NOX,CORR	946.3	23.62	
CO2		1304.	.81 PCT
O2			19.50 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF =	.9820	NOX-KH =	.9771	NOX-KT =	1.0000
WET EXH HC CF=	.9897	AIR TEMP CF =	.9905	BAROM CF =	1.0040
FUEL TEMP CF =	.9850	FUEL S.G. CF =	.9972	FUEL HHV CF =	1.0087

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6353.0-302
FILTER PAIR WEIGHT GAIN (mg)	1.678
SAMPLE VOLUME (scf)	38.713
DILUTE PM CONCENTRATION (mg/scf)	.043
CO2-BASED DILUTION FACTOR	3.630
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.157
PARTICULATE MASS EMISSION RATE (g/hr)	19.8
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.493

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 08-10152.01

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2297	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 2	TEST CONFIGURATION	=	Baseline
TEST DATE	=	10/ 2/ 3	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	5/11			
SwRI FUEL CODE	=	EM-3137A-F	FUEL H/C RATIO	=	1.79
BAROMETER	=	29.32 (in. Hg)	ENGINE INTAKE AIR	=	81.(°F)
DRY BULB TEMP	=	80. (°F)	WET BULB TEMP	=	64. (°F)
ABS HUMIDITY	=	64.45 (GR/LB)	RELATIVE HUMIDITY	=	41. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	6.1
TRACTION MOTOR BLOWER HP	=	5.5
INERTIAL SEPERATOR BLOWER HP	=	.8
RADIATOR FAN HP	=	2.5
TOTAL ACCESSORY HP	=	18.9

FUEL RATE (OBS) = 103.0 (LB/HR)
ALT. VOLTS = 301. ALT. AMPS = 528. ALT. EFF. = .937
FLYWHEEL HP = 246.0 OBS. SFC = .4187 AAR CORR. SFC = .4201 (LB/HP-HR)
CALCULATED A/F = 116.64 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	153.5	.62	58.PPMC
CO	323.4	1.31	62. PPM
NOX	2023.3	8.23	236. PPM (D)
NOX,CORR	1989.9	8.09	
CO2		601.	1.80 PCT
O2			18.20 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF =	.9835	NOX-KH =	.9790	NOX-KT =	1.0000
WET EXH HC CF=	.9811	AIR TEMP CF =	.9905	BAROM CF =	1.0040
FUEL TEMP CF =	.9855	FUEL S.G. CF =	.9972	FUEL HHV CF =	1.0087

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6354.0-303
FILTER PAIR WEIGHT GAIN (mg)	3.131
SAMPLE VOLUME (scf)	37.895
DILUTE PM CONCENTRATION (mg/scf)	.083
CO2-BASED DILUTION FACTOR	4.451
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.368
PARTICULATE MASS EMISSION RATE (g/hr)	59.3
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.241

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 08-10152.01

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2297	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 3	TEST CONFIGURATION	=	Baseline
TEST DATE	=	10/ 2/ 3	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	6/11			
SwRI FUEL CODE	=	EM-3137A-F	FUEL H/C RATIO	=	1.79
BAROMETER	=	29.31 (in. Hg)	ENGINE INTAKE AIR	=	81.(°F)
DRY BULB TEMP	=	80. (°F)	WET BULB TEMP	=	64. (°F)
ABS HUMIDITY	=	64.48 (GR/LB)	RELATIVE HUMIDITY	=	41. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	8.3
TRACTION MOTOR BLOWER HP	=	13.8
INERTIAL SEPERATOR BLOWER HP	=	2.1
RADIATOR FAN HP	=	6.4
TOTAL ACCESSORY HP	=	34.5

FUEL RATE (OBS) = 204.0 (LB/HR)
ALT. VOLTS = 444. ALT. AMPS = 782. ALT. EFF. = .937
FLYWHEEL HP = 531.1 OBS. SFC = .3841 AAR CORR. SFC = .3853 (LB/HP-HR)
CALCULATED A/F = 74.95 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	238.2	.45	71.PPMC
CO	378.0	.71	57. PPM
NOX	4469.8	8.42	411. PPM (D)
NOX,CORR	4397.7	8.28	
CO2		552.	2.82 PCT
O2			16.90 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF =	.9839	NOX-KH =	.9795	NOX-KT =	1.0000
WET EXH HC CF=	.9724	AIR TEMP CF =	.9905	BAROM CF =	1.0039
FUEL TEMP CF =	.9850	FUEL S.G. CF =	.9972	FUEL HHV CF =	1.0087

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6355.0-304
FILTER PAIR WEIGHT GAIN (mg)	3.681
SAMPLE VOLUME (scf)	39.287
DILUTE PM CONCENTRATION (mg/scf)	.094
CO2-BASED DILUTION FACTOR	5.517
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.517
PARTICULATE MASS EMISSION RATE (g/hr)	106.6
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.201

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 08-10152.01

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2297	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 4	TEST CONFIGURATION	=	Baseline
TEST DATE	=	10/ 2/ 3	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	7/11			
SwRI FUEL CODE	=	EM-3137A-F	FUEL H/C RATIO	=	1.79
BAROMETER	=	29.31 (in. Hg)	ENGINE INTAKE AIR	=	85.(°F)
DRY BULB TEMP	=	80. (°F)	WET BULB TEMP	=	64. (°F)
ABS HUMIDITY	=	64.48 (GR/LB)	RELATIVE HUMIDITY	=	41. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	9.4
TRACTION MOTOR BLOWER HP	=	20.1
INERTIAL SEPERATOR BLOWER HP	=	3.0
RADIATOR FAN HP	=	9.3
TOTAL ACCESSORY HP	=	45.9

FUEL RATE (OBS) = 332.0 (LB/HR)
ALT. VOLTS = 586. ALT. AMPS = 1018. ALT. EFF. = .937
FLYWHEEL HP = 898.1 OBS. SFC = .3697 AAR CORR. SFC = .3701 (LB/HP-HR)
CALCULATED A/F = 52.90 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	379.3	.42	98.PPMC
CO	380.5	.42	50. PPM
NOX	8967.9	9.99	722. PPM (D)
NOX,CORR	8824.1	9.83	
CO2		532.	4.02 PCT
O2			15.30 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9840	NOX-KH	= .9796	NOX-KT	= 1.0000
WET EXH HC CF	= .9623	AIR TEMP CF	= .9887	BAROM CF	= 1.0039
FUEL TEMP CF	= .9850	FUEL S.G. CF	= .9972	FUEL HHV CF	= 1.0087

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	6356.0-305
FILTER PAIR WEIGHT GAIN (mg)	7.549
SAMPLE VOLUME (scf)	39.311
DILUTE PM CONCENTRATION (mg/scf)	.192
CO2-BASED DILUTION FACTOR	5.936
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	1.140
PARTICULATE MASS EMISSION RATE (g/hr)	271.5
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.302

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 08-10152.01

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2297	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 5	TEST CONFIGURATION	=	Baseline
TEST DATE	=	10/ 2/ 3	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	8/11			
SwRI FUEL CODE	=	EM-3137A-F	FUEL H/C RATIO	=	1.79
BAROMETER	=	29.30 (in. Hg)	ENGINE INTAKE AIR	=	86.(°F)
DRY BULB TEMP	=	80. (°F)	WET BULB TEMP	=	64. (°F)
ABS HUMIDITY	=	64.51 (GR/LB)	RELATIVE HUMIDITY	=	41. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	10.9
TRACTION MOTOR BLOWER HP	=	31.7
INERTIAL SEPERATOR BLOWER HP	=	4.8
RADIATOR FAN HP	=	14.7
TOTAL ACCESSORY HP	=	66.0

FUEL RATE (OBS) = 458.0 (LB/HR)

ALT. VOLTS = 682. ALT. AMPS = 1164. ALT. EFF. = .937

FLYWHEEL HP = 1199.5 OBS. SFC = .3818 AAR CORR. SFC = .3821 (LB/HP-HR)

CALCULATED A/F = 44.79 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	500.8	.42	110.PPMC
CO	790.9	.66	90. PPM
NOX	13197.6	11.00	912. PPM (D)
NOX,CORR	12986.9	10.83	
CO2		549.	4.76 PCT
O2			14.30 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9840	NOX-KH	= .9797	NOX-KT	= 1.0000
WET EXH HC CF	= .9562	AIR TEMP CF	= .9883	BAROM CF	= 1.0038
FUEL TEMP CF	= .9845	FUEL S.G. CF	= .9972	FUEL HHV CF	= 1.0087

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	2696.0-34
FILTER PAIR WEIGHT GAIN (mg)	7.946
SAMPLE VOLUME (scf)	39.861
DILUTE PM CONCENTRATION (mg/scf)	.199
CO2-BASED DILUTION FACTOR	7.802
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	1.555
PARTICULATE MASS EMISSION RATE (g/hr)	434.1
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.362

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 08-10152.01

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2297	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 6	TEST CONFIGURATION	=	Baseline
TEST DATE	=	10/ 2/ 3	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	9/11			
SwRI FUEL CODE	=	EM-3137A-F	FUEL H/C RATIO	=	1.79
BAROMETER	=	29.30 (in. Hg)	ENGINE INTAKE AIR	=	87.(°F)
DRY BULB TEMP	=	81. (°F)	WET BULB TEMP	=	65. (°F)
ABS HUMIDITY	=	67.78 (GR/LB)	RELATIVE HUMIDITY	=	42. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	12.0
TRACTION MOTOR BLOWER HP	=	42.2
INERTIAL SEPERATOR BLOWER HP	=	6.3
RADIATOR FAN HP	=	39.0
TOTAL ACCESSORY HP	=	103.6

FUEL RATE (OBS) = 557.0 (LB/HR)

ALT. VOLTS = 740. ALT. AMPS = 1270. ALT. EFF. = .937

FLYWHEEL HP 1445.4 OBS. SFC = .3854 AAR CORR. SFC = .3855 (LB/HP-HR)

CALCULATED A/F = 39.90 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	581.0	.40	118.PPMC
CO	1763.3	1.22	185. PPM
NOX	15935.4	11.03	1019. PPM (D)
NOX,CORR	15759.9	10.90	
CO2		554.	5.35 PCT
O2			13.80 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF =	.9890	NOX-KH =	.9860	NOX-KT =	1.0000
WET EXH HC CF=	.9512	AIR TEMP CF =	.9878	BAROM CF =	1.0038
FUEL TEMP CF =	.9850	FUEL S.G. CF =	.9972	FUEL HHV CF =	1.0087

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	2697.0-35
FILTER PAIR WEIGHT GAIN (mg)	7.922
SAMPLE VOLUME (scf)	39.813
DILUTE PM CONCENTRATION (mg/scf)	.199
CO2-BASED DILUTION FACTOR	9.528
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	1.896
PARTICULATE MASS EMISSION RATE (g/hr)	574.8
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.398

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 08-10152.01

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2297	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 7	TEST CONFIGURATION	=	Baseline
TEST DATE	=	10/ 2/ 3	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	10/11			
SwRI FUEL CODE	=	EM-3137A-F	FUEL H/C RATIO	=	1.79
BAROMETER	=	29.29 (in. Hg)	ENGINE INTAKE AIR	=	85.(°F)
DRY BULB TEMP	=	80. (°F)	WET BULB TEMP	=	64. (°F)
ABS HUMIDITY	=	64.54 (GR/LB)	RELATIVE HUMIDITY	=	41. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	13.8
TRACTION MOTOR BLOWER HP	=	64.2
INERTIAL SEPERATOR BLOWER HP	=	9.6
RADIATOR FAN HP	=	59.4
TOTAL ACCESSORY HP	=	151.1

FUEL RATE (OBS) = 721.0 (LB/HR)
ALT. VOLTS = 825. ALT. AMPS = 1422. ALT. EFF. = .937
FLYWHEEL HP = 1825.6 OBS. SFC = .3949 AAR CORR. SFC = .3954 (LB/HP-HR)
CALCULATED A/F = 35.28 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	1873.6	1.03	331.PPMC
CO	7203.7	3.95	663. PPM
NOX	19980.2	10.94	1120. PPM (D)
NOX,CORR	19662.4	10.77	
CO2		561.	6.00 PCT
O2			12.80 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9841	NOX-KH	= .9797	NOX-KT	= 1.0000
WET EXH HC CF	= .9458	AIR TEMP CF	= .9887	BAROM CF	= 1.0037
FUEL TEMP CF	= .9850	FUEL S.G. CF	= .9972	FUEL HHV CF	= 1.0087

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	2698.0-36
FILTER PAIR WEIGHT GAIN (mg)	19.218
SAMPLE VOLUME (scf)	39.182
DILUTE PM CONCENTRATION (mg/scf)	.490
CO2-BASED DILUTION FACTOR	6.476
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	3.176
PARTICULATE MASS EMISSION RATE (g/hr)	1105.7
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.606

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 08-10152.01

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2297	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 8	TEST CONFIGURATION	=	Baseline
TEST DATE	=	10/ 2/ 3	ENGINE MODEL	=	EMD 16-645E
TEST NUMBER	=	11/11			
SwRI FUEL CODE	=	EM-3137A-F	FUEL H/C RATIO	=	1.79
BAROMETER	=	29.29 (in. Hg)	ENGINE INTAKE AIR	=	87.(°F)
DRY BULB TEMP	=	82. (°F)	WET BULB TEMP	=	65. (°F)
ABS HUMIDITY	=	66.13 (GR/LB)	RELATIVE HUMIDITY	=	40. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	14.9
TRACTION MOTOR BLOWER HP	=	81.1
INERTIAL SEPERATOR BLOWER HP	=	12.2
RADIATOR FAN HP	=	75.0
TOTAL ACCESSORY HP	=	187.2

FUEL RATE (OBS) = 835.0 (LB/HR)

ALT. VOLTS = 870. ALT. AMPS = 1465. ALT. EFF. = .937

FLYWHEEL HP 2006.9 OBS. SFC = .4161 AAR CORR. SFC = .4161 (LB/HP-HR)

CALCULATED A/F = 33.20 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	1798.2	.90	291.PPMC
CO	14169.5	7.06	1198. PPM
NOX	22479.9	11.20	1157. PPM (D)
NOX.CORR	22176.3	11.05	
CO2		587.	6.34 PCT
O2			12.30 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= .9865	NOX-KH	= .9828	NOX-KT	= 1.0000
WET EXH HC CF	= .9427	AIR TEMP CF	= .9878	BAROM CF	= 1.0037
FUEL TEMP CF	= .9850	FUEL S.G. CF	= .9972	FUEL HHV CF	= 1.0087

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	2699.0-37
FILTER PAIR WEIGHT GAIN (mg)	15.852
SAMPLE VOLUME (scf)	38.514
DILUTE PM CONCENTRATION (mg/scf)	.412
CO2-BASED DILUTION FACTOR	9.766
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	4.020
PARTICULATE MASS EMISSION RATE (g/hr)	1527.9
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.761

Notch	Barom in. Hg	Ambient Dry Bulb °F	Ambient Wet Bulb °F	Fuel Rate lb/hr	HC ppmC	CO ppm	Raw CO2 %	Dil CO2 %	BG CO2 ppm	Nox ppm	O2 %	Engine Speed (rpm)	# of Fans	Gen Volts	Gen Amps	Fuel Temp °F	Intake Air °F	Intake Manifold °F
Low Idle	29.40	78.0	63.0	22.8	70.9	30.60	0.61	0.1553	495.2	125.4	20.0	238	0	3.8	8.0	91	82	101
Idle	29.34	79.0	64.0	29.6	62.9	35.60	0.64	0.1788	471.7	114.1	19.9	306	0	5.2	10.5	90	81	100
DB-2	29.33	79.0	64.0	35.4	61.4	41.50	0.67	0.2228	518.9	107.8	19.8	366	0	6.3	12.7	91	80	102
Notch 1	29.32	80.0	64.0	36.6	63.9	32.60	0.81	0.2548	471.7	142.9	19.5	305	0	103.3	185.0	90	81	99
Notch 2	29.32	80.0	64.0	103.0	58.4	61.90	5.39	0.4336	471.7	235.7	18.2	365	1	301.0	528.0	89	81	101
Notch 3	29.31	80.0	64.0	204.0	70.9	57.10	2.82	0.5364	471.7	411.0	16.9	496	1	444.3	782.4	90	81	108
Notch 4	29.31	80.0	64.0	332.0	97.8	50.30	4.02	0.6929	471.7	721.7	15.3	563	1	586.2	1,017.7	90	85	117
Notch 5	29.30	80.0	64.0	458.0	110.2	89.80	4.76	0.6260	471.7	912.1	14.3	655	1	681.9	1,163.6	91	86	131
Notch 6	29.30	81.0	65.0	557.0	117.7	185.30	5.35	0.5797	495.2	1019.3	13.8	721	2	739.8	1,269.6	90	87	143
Notch 7	29.29	80.0	64.0	721.0	330.6	663.10	6.00	0.9251	518.9	1119.5	12.8	829	2	824.5	1,421.6	90	85	159
Notch 8	29.29	82.0	65.0	835.0	290.5	1198.10	6.34	0.6587	495.2	1157.0	12.3	897	2	869.6	1,464.8	90	87	177

SwRI Project No.: 03.10152.01.001

LOCOMOTIVE ENGINE TEST SUMMARY

TEST DATE: 10/2/2003

NOTCH		L.Idle	Idle	DB2	N1	N2	N3	N4	N5	N6	N7	N8
HC (ppmC)	RANGE	100	100	100	100	100	100	100	500	500	500	500
	METER DIV.	71	63	61.5	64	58.5	71	98	22	23.5	66	58
	CONC., ppmC	70.9	62.9	61.4	63.9	58.4	70.9	97.8	110.2	117.7	330.6	290.5
CO (ppm)	RANGE	100	100	100	100	100	100	100	100	250	1000	3000
		30	35	41	32	62	57	50	90	75	66	46
	CONC., ppm	30.6	35.6	41.5	32.6	61.9	57.1	50.3	89.8	185.3	663.1	1198.1
CO_2 (%)	RANGE	2	2	2	2	2 ~~8~~	6	6	6	16	16	16
	METER DIV.	36	37.5	39	46	56F 90	57.5	74	83	54	58	60
	CONC., %	0.61	0.64	0.67	0.81	1.80 ~~5.39~~	2.82	4.02	4.76	5.35	6.00	6.34
NOx (ppm)	RANGE	250	250	250	250	250	1000	1000	1000	2500	2500	2500
	METER DIV.	50	45.5	43	57	94	41	72	91	40	44	45.5
	CONC., ppm	125.4	114.1	107.8	142.9	235.7	411.0	721.7	912.1	1019.3	1119.5	1157.0
O_2 (%)	RANGE	25	25	25	25	25	25	25	25	25	25	25
	METER DIV.	80	79.5	79	78	72.5	67.5	61	57	55	51	49
	CONC., %	20.0	19.9	19.8	19.5	18.2	16.9	15.3	14.3	13.8	12.8	12.3
LCO_2 (ppm)	RANGE	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
TUNNEL DILUTE	MTR DIV.	30.5	34	40	44	62	70	80	76	73	91.5	78
	CONC., ppm	1552.7	1788.1	2227.5	2548.2	4335.9	5364.0	6929.0	6260.3	5797.3	9251.0	6587.0
LCO_2 (ppm)	RANGE	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
BG	MTR DIV.	11.5	11	12	11	11	11	11	11	11.5	12	11.5
	CONC., ppm	495.2	471.7	518.9	471.7	471.7	471.7	471.7	471.7	495.2	518.9	495.2

Test Configuration: BNSF 2297 Baseline

Operator: EJ

LOCOMOTIVE TEST SUMMARY

SwRI project No. 03.10152.01.001 Test Date 10/2/03 Unit Number BNSF 2297

Notch	~~N8P~~	Idle Low	Idle/ DB-1	DB-2	1	2	3	4	5	6	7	8
							*					Δ
Observed Fuel Rate at X minutes into test point (lb/hr)												
1 min.		23.3	29.5	35.2	35	102	193	327	454	555	726	832
3 min.		23.5	29.6	36.6	35	105	201	334	457	558	720	840
5 min.		22.8	29.0	35.4	38	106	205	333	456	554	719	835
Averaged Fuel Rate over Time												
Cumulative Fuel Used (lbs)		3.8	4.9	5.9	6.1	10.3	20.4	33.2	45.8	55.7	72.1	83.5
Over X Minutes		~~22.8~~ 10	10	10	10	6	6	6	6	6	6	6
x 60. = Fuel Rate (lb/hr)		22.8	29.6	35.4	36.6	103	204	332	458	557	721	835
Traction Volts/2		—	—	—	57.5	143.5	162.1	290	336	365	409	430
MG Volts = xxx X 2.014		—	—	—	103.7	289.0	326.5	584.1	676.7	735.1	823.7	866.0
Current Shunt mV		—	—	—	4.63	12.82	17.82	25.20	29.43	31.67	35.17	36.96
Traction Current = Shunt mV * 40		—	—	—	185.2	512.8	712.8	1008	1177	1267	1407	1478
~~Turbo Speed (Hz * 3.53)~~		—										
~~Load Regulator (%)~~		—										
Baro (in Hg)		29.40	29.36	29.33	29.33	29.32	29.31	29.31	29.30	29.30	29.30	29.29
Dry Bulb Temperature (°F)		78	79	79	80	80	80	80	80	81	80	82
Wet Bulb Temperature (°F)		63	64	64	64	64	64	64	64	65	64	65
# of Fans		0	0	0	0	1	1	1	1	2	2	2
LS Run #		2899	2900	2901	2902	2903	2904	2905	2906	2907	2908	2908
SS Smoke, % Opacity		2%	2%	2%	5%	4%	3%	3%	4%	3%	4%	6%

Notes: 1 - Air compressor locked off. (Form = Loco Test Sum 8-25-03.xls)

Test Configuration: BASELINE

Operator: [illegible]

Smoke File Name 970.PRN Start Time: 1975

* POWER DRIFT DAQ OK-

Δ = 896 RPM

APPENDIX D. BNSF2297 EMISSION RESULTS WITH CSX VCO INJECTORS

APPENDIX D. BNSF2297 EMISSION RESULTS WITH CSX VCO INJECTORS

Locomotive BNSF 2297, EMD-16-645E Engine, CSX VCO + check @ 2°BTDC
Tested 10/4/03 @ SwRI

Notch	Gross HP	obs Fuel Rate (lb/hr)	HC (g/hr)	CO (g/hr)	Corr. NOx (g/hr)	PM (g/hr)	AAR Corr bsfc	Corr. Fuel Rate (lb/hr)	WF	w-BHP	obs w-Fuel w-(lb/hr)	w-Fuel w-(lb/hr)	w-HC w-(g/hr)	w-CO w-(g/hr)	w-NOx w-(g/hr)	w-PM w-(g/hr)
								AAR 3x3 Weighted Results								
8	1,971.5	810.0	723	3,505	19,346	719	0.413	814	25.0%	492.9	202.5	203.6	180.7	876.3	4836.6	179.9
7	1,773.9	697.2	458	1,652	17,188	578	0.395	701	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	1,411.6	537.0	304	753	13,156	419	0.382	540	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	1,202.6	444.0	273	554	10,809	392	0.371	446	25.0%	300.7	111.0	111.5	68.4	138.4	2702.1	98.1
4	840.1	312.0	267	522	6,186	327	0.374	314	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	425.0	177.0	289	634	2,538	148	0.419	178	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	281.2	116.3	321	767	1,454	188	0.416	117	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	43.5	38.0	254	372	766	24	0.880	38	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Low Idle	9.9	23.0	139	241	546	15	2.334	23	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Idle	13.0	29.3	189	338	612	19	2.264	29	50.0%	6.5	14.7	14.7	94.7	169.2	305.8	9.4
DB-2	16.8	36.0	275	471	672	53	2.161	36	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
						sum =			100.0%	800.0	328.2	329.8	343.7	1183.9	7844.5	287.3
AAR 3x3 duty cycle weighted brake-specific emissions =>											0.410 obs bsfc	0.412 corr bsfc	0.43	1.48	9.81	0.359

Modal Brake-Specific Emissions Notch	HC (g/hp-hr)	CO (g/hp-hr)	Corr. NOx (g/hp-hr)	PM (g/hp-hr)
8	0.37	1.78	9.81	0.36
7	0.26	0.93	9.69	0.33
6	0.22	0.53	9.32	0.30
5	0.23	0.46	8.99	0.33
4	0.32	0.62	7.36	0.39
3	0.68	1.49	5.97	0.35
2	1.14	2.73	5.17	0.67
1	5.83	8.55	17.60	0.56
Low Idle	14.04	24.33	55.15	1.53
Idle	14.56	26.02	47.04	1.44
DB-2	16.37	28.04	40.02	3.18

EPA Switcher Duty Cycle Weighted Results

Notch	WF	w-BHP	obs w-Fuel w-(lb/hr)	w-Fuel w-(lb/hr)	w-HC w-(g/hr)	w-CO w-(g/hr)	w-NOx w-(g/hr)	w-PM w-(g/hr)
8	0.8%	15.8	6.5	6.5	5.8	28.0	154.8	5.8
7	0.2%	3.5	1.4	1.4	0.9	3.3	34.4	1.2
6	1.5%	21.2	8.1	8.1	4.6	11.3	197.3	6.3
5	3.6%	43.3	16.0	16.1	9.8	19.9	389.1	14.1
4	3.6%	30.2	11.2	11.3	9.6	18.8	222.7	11.8
3	5.8%	24.7	10.3	10.3	16.7	36.7	147.2	8.6
2	12.3%	34.6	14.3	14.4	39.5	94.4	178.8	23.1
1	12.4%	5.4	4.7	4.7	31.4	46.1	94.9	3.0
Low Idle	29.9%	3.0	6.9	6.9	41.6	72.0	163.3	4.5
Idle	29.9%	3.9	8.8	8.8	56.6	101.2	182.8	5.6
DB-2	0.0%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sum =	100.0%	185.5	88.1	88.5	216.6	431.8	1765.4	83.9
EPA switcher duty cycle weighted brake-specific emissions =>			0.475 obs bsfc	0.477 corr bsfc	1.17	2.33	9.52	0.452

Fuel-Specific Emissions Notch	HC (g/lb fuel)	CO (g/lb fuel)	Corr. NOx (g/lb fuel)	PM (g/lb fuel)
8	0.89	4.33	23.88	0.89
7	0.66	2.37	24.65	0.83
6	0.57	1.40	24.50	0.78
5	0.62	1.25	24.34	0.88
4	0.86	1.67	19.83	1.05
3	1.63	3.58	14.34	0.84
2	2.76	6.60	12.50	1.61
1	6.67	9.79	20.15	0.64
Low Idle	6.04	10.47	23.74	0.66
Idle	6.46	11.55	20.87	0.64
DB-2	7.64	13.08	18.68	1.48

EPA Freight Duty Cycle Weighted Results

Notch	WF	w-BHP	obs w-Fuel w-(lb/hr)	w-Fuel w-(lb/hr)	w-HC w-(g/hr)	w-CO w-(g/hr)	w-NOx w-(g/hr)	w-PM w-(g/hr)
8	16.2%	319.4	131.2	131.9	117.1	567.9	3134.1	116.5
7	3.0%	53.2	20.9	21.0	13.7	49.6	515.6	17.3
6	3.9%	55.1	20.9	21.0	11.9	29.4	513.1	16.3
5	3.8%	45.7	16.9	17.0	10.4	21.0	410.7	14.9
4	4.4%	37.0	13.7	13.8	11.8	23.0	272.2	14.4
3	5.2%	22.1	9.2	9.3	15.0	32.9	132.0	7.7
2	6.5%	18.3	7.6	7.6	20.9	49.9	94.5	12.2
1	6.5%	2.8	2.5	2.5	16.5	24.2	49.8	1.6
Low Idle	19.0%	1.9	4.4	4.4	26.4	45.8	103.7	2.9
Idle	19.0%	2.5	5.6	5.6	36.0	64.3	116.2	3.6
DB-2	12.5%	2.1	4.5	4.5	34.4	58.9	84.1	6.7
sum =	100.0%	560.0	237.3	238.6	313.9	966.7	5426.0	214.1
EPA freight duty cycle weighted brake-specific emissions =>			0.424 obs bsfc	0.426 corr bsfc	0.56	1.73	9.69	0.382

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-10152-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2297	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Low Idle	TEST CONFIGURATION	=	2°BTDC
TEST DATE	=	10/ 4/ 3	ENGINE MODEL	=	EMD 16-645-E
TEST NUMBER	=	1/11			
SwRI FUEL CODE	=	EM-3137A-F	FUEL H/C RATIO	=	1.79
BAROMETER	=	29.27 (in. Hg)	ENGINE INTAKE AIR	=	72.(°F)
DRY BULB TEMP	=	69. (°F)	WET BULB TEMP	=	67. (°F)
ABS HUMIDITY	=	98.53 (GR/LB)	RELATIVE HUMIDITY	=	89. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	4.0
TRACTION MOTOR BLOWER HP	=	1.6
INERTIAL SEPERATOR BLOWER HP	=	.2
RADIATOR FAN HP	=	.0
TOTAL ACCESSORY HP	=	9.9

FUEL RATE (OBS) = 23.0 (LB/HR)
ALT. VOLTS = 4. ALT. AMPS = 8. ALT. EFF. = .937
FLYWHEEL HP = 9.9 OBS. SFC = 2.3207 AAR CORR. SFC = 2.3336 (LB/HP-HR)
CALCULATED A/F = 325.53 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	139.0	14.03	85.PPMC
CO	240.9	24.31	74. PPM
NOX	512.5	51.71	95. PPM (D)
NOX,CORR	546.0	55.09	
CO2		3270.	.63 PCT
O2			19.80 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= 1.0654	NOX-KH	= 1.0535	NOX-KT	= 1.0000
WET EXH HC CF=	.9897	AIR TEMP CF =	.9946	BAROM CF	= 1.0035
FUEL TEMP CF =	.9835	FUEL S.G. CF =	.9988	FUEL HHV CF	= 1.0074

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	2738.0-52
FILTER PAIR WEIGHT GAIN (mg)	1.108
SAMPLE VOLUME (scf)	38.591
DILUTE PM CONCENTRATION (mg/scf)	.029
CO2-BASED DILUTION FACTOR	5.266
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.151
PARTICULATE MASS EMISSION RATE (g/hr)	15.1
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	1.525

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-10152-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2297	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Idle	TEST CONFIGURATION	=	2°BTDC
TEST DATE	=	10/ 4/ 3	ENGINE MODEL	=	EMD 16-645-E
TEST NUMBER	=	2/11			
SwRI FUEL CODE	=	EM-3137A-F	FUEL H/C RATIO	=	1.79
BAROMETER	=	29.27 (in. Hg)	ENGINE INTAKE AIR	=	71.(°F)
DRY BULB TEMP	=	69. (°F)	WET BULB TEMP	=	67. (°F)
ABS HUMIDITY	=	98.53 (GR/LB)	RELATIVE HUMIDITY	=	89. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	5.1
TRACTION MOTOR BLOWER HP	=	3.3
INERTIAL SEPERATOR BLOWER HP	=	.5
RADIATOR FAN HP	=	.0
TOTAL ACCESSORY HP	=	12.9

FUEL RATE (OBS) = 29.3 (LB/HR)
ALT. VOLTS = 5. ALT. AMPS = 10. ALT. EFF. = .937
FLYWHEEL HP = 13.0 OBS. SFC = 2.2506 AAR CORR. SFC = 2.2641 (LB/HP-HR)
CALCULATED A/F = 319.77 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	189.3	14.54	93.PPMC
CO	338.3	25.99	83. PPM
NOX	574.0	44.09	85. PPM (D)
NOX,CORR	611.5	46.97	
CO2		3164.	.64 PCT
O2			19.70 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= 1.0654	NOX-KH	= 1.0535	NOX-KT	= 1.0000
WET EXH HC CF=	.9896	AIR TEMP CF	= .9950	BAROM CF	= 1.0035
FUEL TEMP CF =	.9840	FUEL S.G. CF =	.9988	FUEL HHV CF	= 1.0074

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	2739.0-53
FILTER PAIR WEIGHT GAIN (mg)	1.198
SAMPLE VOLUME (scf)	39.886
DILUTE PM CONCENTRATION (mg/scf)	.030
CO2-BASED DILUTION FACTOR	4.966
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.149
PARTICULATE MASS EMISSION RATE (g/hr)	18.7
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	1.433

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-10152-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2297	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	DB2	TEST CONFIGURATION	=	2°BTDC
TEST DATE	=	10/ 4/ 3	ENGINE MODEL	=	EMD 16-645-E
TEST NUMBER	=	3/11			
SwRI FUEL CODE	=	EM-3137A-F	FUEL H/C RATIO	=	1.79
BAROMETER	=	29.28 (in. Hg)	ENGINE INTAKE AIR	=	71.(°F)
DRY BULB TEMP	=	70. (°F)	WET BULB TEMP	=	67. (°F)
ABS HUMIDITY	=	98.87 (GR/LB)	RELATIVE HUMIDITY	=	89. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	6.1
TRACTION MOTOR BLOWER HP	=	5.7
INERTIAL SEPERATOR BLOWER HP	=	.9
RADIATOR FAN HP	=	.0
TOTAL ACCESSORY HP	=	16.6

FUEL RATE (OBS) = 36.0 (LB/HR)
ALT. VOLTS = 6. ALT. AMPS = 13. ALT. EFF. = .937
FLYWHEEL HP = 16.8 OBS. SFC = 2.1475 AAR CORR. SFC = 2.1605 (LB/HP-HR)
CALCULATED A/F = 304.15 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	275.0	16.40	115.PPMC
CO	471.0	28.09	98. PPM
NOX	630.6	37.62	80. PPM (D)
NOX,CORR	672.4	40.11	
CO2		3006.	.67 PCT
O2			19.50 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= 1.0663	NOX-KH	= 1.0542	NOX-KT	= 1.0000
WET EXH HC CF=	.9893	AIR TEMP CF	= .9950	BAROM CF	= 1.0036
FUEL TEMP CF =	.9845	FUEL S.G. CF	= .9988	FUEL HHV CF	= 1.0074

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	2740.0-54
FILTER PAIR WEIGHT GAIN (mg)	3.550
SAMPLE VOLUME (scf)	40.042
DILUTE PM CONCENTRATION (mg/scf)	.089
CO2-BASED DILUTION FACTOR	4.119
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.365
PARTICULATE MASS EMISSION RATE (g/hr)	53.4
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	3.185

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-10152-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2297	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	N1	TEST CONFIGURATION	=	2°BTDC
TEST DATE	=	10/ 4/ 3	ENGINE MODEL	=	EMD 16-645-E
TEST NUMBER	=	4/11			
SwRI FUEL CODE	=	EM-3137A-F	FUEL H/C RATIO	=	1.79
BAROMETER	=	29.29 (in. Hg)	ENGINE INTAKE AIR	=	71.(°F)
DRY BULB TEMP	=	70. (°F)	WET BULB TEMP	=	68. (°F)
ABS HUMIDITY	=	99.22 (GR/LB)	RELATIVE HUMIDITY	=	88. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	5.1
TRACTION MOTOR BLOWER HP	=	3.3
INERTIAL SEPERATOR BLOWER HP	=	.5
RADIATOR FAN HP	=	.0
TOTAL ACCESSORY HP	=	12.9

FUEL RATE (OBS) = 38.0 (LB/HR)
ALT. VOLTS = 109. ALT. AMPS = 196. ALT. EFF. = .937
FLYWHEEL HP = 43.5 OBS. SFC = .8743 AAR CORR. SFC = .8797 (LB/HP-HR)
CALCULATED A/F = 244.21 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	253.5	5.83	125.PPMC
CO	372.1	8.56	92. PPM
NOX	717.8	16.52	108. PPM (D)
NOX,CORR	765.7	17.62	
CO2		1231.	.84 PCT
O2			19.40 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= 1.0667	NOX-KH	= 1.0545	NOX-KT	= 1.0000
WET EXH HC CF=	.9878	AIR TEMP CF	= .9950	BAROM CF	= 1.0037
FUEL TEMP CF =	.9845	FUEL S.G. CF =	.9988	FUEL HHV CF	= 1.0074

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	2741.0-55
FILTER PAIR WEIGHT GAIN (mg)	1.948
SAMPLE VOLUME (scf)	39.838
DILUTE PM CONCENTRATION (mg/scf)	.049
CO2-BASED DILUTION FACTOR	3.998
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.195
PARTICULATE MASS EMISSION RATE (g/hr)	24.2
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.558

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-10152-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2297	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	N2	TEST CONFIGURATION	=	2°BTDC
TEST DATE	=	10/ 4/ 3	ENGINE MODEL	=	EMD 16-645-E
TEST NUMBER	=	5/11			
SwRI FUEL CODE	=	EM-3137A-F	FUEL H/C RATIO	=	1.79
BAROMETER	=	29.29 (in. Hg)	ENGINE INTAKE AIR	=	71.(°F)
DRY BULB TEMP	=	70. (°F)	WET BULB TEMP	=	68. (°F)
ABS HUMIDITY	=	100.13 (GR/LB)	RELATIVE HUMIDITY	=	88. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	6.1
TRACTION MOTOR BLOWER HP	=	5.7
INERTIAL SEPERATOR BLOWER HP	=	.9
RADIATOR FAN HP	=	.0
TOTAL ACCESSORY HP	=	16.6

FUEL RATE (OBS) = 116.3 (LB/HR)
ALT. VOLTS = 324. ALT. AMPS = 571. ALT. EFF. = .937
FLYWHEEL HP = 281.2 OBS. SFC = .4136 AAR CORR. SFC = .4162 (LB/HP-HR)
CALCULATED A/F = 96.71 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	321.4	1.14	130.PPMC
CO	767.3	2.73	157. PPM
NOX	1368.1	4.87	171. PPM (D)
NOX,CORR	1453.8	5.17	
CO2		590.	2.16 PCT
O2			17.50 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= 1.0626	NOX-KH	= 1.0512	NOX-KT	= 1.0000
WET EXH HC CF=	.9763	AIR TEMP CF	= .9950	BAROM CF	= 1.0037
FUEL TEMP CF =	.9850	FUEL S.G. CF =	.9988	FUEL HHV CF	= 1.0074

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	2742.0-56
FILTER PAIR WEIGHT GAIN (mg)	10.034
SAMPLE VOLUME (scf)	35.306
DILUTE PM CONCENTRATION (mg/scf)	.284
CO2-BASED DILUTION FACTOR	4.368
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	1.241
PARTICULATE MASS EMISSION RATE (g/hr)	187.7
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.668

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-10152-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2297	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	N3	TEST CONFIGURATION	=	2°BTDC
TEST DATE	=	10/ 4/ 3	ENGINE MODEL	=	EMD 16-645-E
TEST NUMBER	=	6/11			
SwRI FUEL CODE	=	EM-3137A-F	FUEL H/C RATIO	=	1.79
BAROMETER	=	29.29 (in. Hg)	ENGINE INTAKE AIR	=	72.(°F)
DRY BULB TEMP	=	71. (°F)	WET BULB TEMP	=	68. (°F)
ABS HUMIDITY	=	100.55 (GR/LB)	RELATIVE HUMIDITY	=	86. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	8.3
TRACTION MOTOR BLOWER HP	=	14.1
INERTIAL SEPERATOR BLOWER HP	=	2.1
RADIATOR FAN HP	=	6.5
TOTAL ACCESSORY HP	=	35.0

FUEL RATE (OBS) = 177.0 (LB/HR)
ALT. VOLTS = 397. ALT. AMPS = 689. ALT. EFF. = .937
FLYWHEEL HP = 425.0 OBS. SFC = .4165 AAR CORR. SFC = .4189 (LB/HP-HR)
CALCULATED A/F = 89.87 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	288.6	.68	83.PPMC
CO	633.6	1.49	92. PPM
NOX	2386.7	5.62	211. PPM (D)
NOX,CORR	2538.3	5.97	
CO2		597.	2.34 PCT
O2			17.30 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= 1.0635	NOX-KH	= 1.0519	NOX-KT	= 1.0000
WET EXH HC CF=	.9748	AIR TEMP CF	= .9946	BAROM CF	= 1.0037
FUEL TEMP CF =	.9850	FUEL S.G. CF =	.9988	FUEL HHV CF	= 1.0074

PARTICULATE INFORMATION
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FILTER PAIR I.D. NUMBER	2743.0-57
FILTER PAIR WEIGHT GAIN (mg)	4.828
SAMPLE VOLUME (scf)	39.628
DILUTE PM CONCENTRATION (mg/scf)	.122
CO2-BASED DILUTION FACTOR	5.679
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	.692
PARTICULATE MASS EMISSION RATE (g/hr)	148.1
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.348

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-10152-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2297	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	N4	TEST CONFIGURATION	=	2°BTDC
TEST DATE	=	10/ 4/ 3	ENGINE MODEL	=	EMD 16-645-E
TEST NUMBER	=	7/11			
SwRI FUEL CODE	=	EM-3137A-F	FUEL H/C RATIO	=	1.79
BAROMETER	=	29.29 (in. Hg)	ENGINE INTAKE AIR	=	72.(°F)
DRY BULB TEMP	=	71. (°F)	WET BULB TEMP	=	68. (°F)
ABS HUMIDITY	=	100.92 (GR/LB)	RELATIVE HUMIDITY	=	86. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	9.4
TRACTION MOTOR BLOWER HP	=	20.6
INERTIAL SEPERATOR BLOWER HP	=	3.1
RADIATOR FAN HP	=	9.5
TOTAL ACCESSORY HP	=	46.6

FUEL RATE (OBS) = 312.0 (LB/HR)
ALT. VOLTS = 568. ALT. AMPS = 978. ALT. EFF. = .937
FLYWHEEL HP = 840.1 OBS. SFC = .3714 AAR CORR. SFC = .3735 (LB/HP-HR)
CALCULATED A/F = 59.62 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	267.3	.32	65.PPMC
CO	521.8	.62	65. PPM
NOX	5815.5	6.92	441. PPM (D)
NOX,CORR	6186.3	7.36	
CO2		535.	3.56 PCT
O2			15.50 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= 1.0638	NOX-KH	= 1.0521	NOX-KT	= 1.0000
WET EXH HC CF=	.9645	AIR TEMP CF =	.9946	BAROM CF	= 1.0037
FUEL TEMP CF =	.9845	FUEL S.G. CF =	.9988	FUEL HHV CF	= 1.0074

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	2744.0-58
FILTER PAIR WEIGHT GAIN (mg)	9.252
SAMPLE VOLUME (scf)	37.757
DILUTE PM CONCENTRATION (mg/scf)	.245
CO2-BASED DILUTION FACTOR	5.302
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	1.299
PARTICULATE MASS EMISSION RATE (g/hr)	327.0
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.389

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-10152-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2297	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	N5	TEST CONFIGURATION	=	2°BTDC
TEST DATE	=	10/ 4/ 3	ENGINE MODEL	=	EMD 16-645-E
TEST NUMBER	=	8/11			
SwRI FUEL CODE	=	EM-3137A-F	FUEL H/C RATIO	=	1.79
BAROMETER	=	29.30 (in. Hg)	ENGINE INTAKE AIR	=	74.(°F)
DRY BULB TEMP	=	72. (°F)	WET BULB TEMP	=	68. (°F)
ABS HUMIDITY	=	100.95 (GR/LB)	RELATIVE HUMIDITY	=	85. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	10.9
TRACTION MOTOR BLOWER HP	=	32.3
INERTIAL SEPERATOR BLOWER HP	=	4.9
RADIATOR FAN HP	=	15.0
TOTAL ACCESSORY HP	=	67.1

FUEL RATE (OBS) = 444.0 (LB/HR)
ALT. VOLTS = 670. ALT. AMPS = 1186. ALT. EFF. = .937
FLYWHEEL HP = 1202.6 OBS. SFC = .3692 AAR CORR. SFC = .3710 (LB/HP-HR)
CALCULATED A/F = 48.25 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	273.4	.23	58.PPMC
CO	553.5	.46	60. PPM
NOX	10161.4	8.45	672. PPM (D)
NOX,CORR	10808.5	8.99	
CO2		532.	4.42 PCT
O2			14.30 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= 1.0637	NOX-KH	= 1.0521	NOX-KT	= 1.0000
WET EXH HC CF=	.9573	AIR TEMP CF	= .9937	BAROM CF	= 1.0038
FUEL TEMP CF =	.9850	FUEL S.G. CF =	.9988	FUEL HHV CF	= 1.0074

PARTICULATE INFORMATION
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FILTER PAIR I.D. NUMBER	2745.0-59
FILTER PAIR WEIGHT GAIN (mg)	7.536
SAMPLE VOLUME (scf)	37.294
DILUTE PM CONCENTRATION (mg/scf)	.202
CO2-BASED DILUTION FACTOR	6.670
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	1.348
PARTICULATE MASS EMISSION RATE (g/hr)	392.2
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.326

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-10152-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2297	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	N6	TEST CONFIGURATION	=	2°BTDC
TEST DATE	=	10/ 4/ 3	ENGINE MODEL	=	EMD 16-645-E
TEST NUMBER	=	9/11			
SwRI FUEL CODE	=	EM-3137A-F	FUEL H/C RATIO	=	1.79
BAROMETER	=	29.30 (in. Hg)	ENGINE INTAKE AIR	=	74.(°F)
DRY BULB TEMP	=	72. (°F)	WET BULB TEMP	=	69. (°F)
ABS HUMIDITY	=	102.08 (GR/LB)	RELATIVE HUMIDITY	=	85. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	12.1
TRACTION MOTOR BLOWER HP	=	43.3
INERTIAL SEPERATOR BLOWER HP	=	6.5
RADIATOR FAN HP	=	40.0
TOTAL ACCESSORY HP	=	105.9

FUEL RATE (OBS) = 537.0 (LB/HR)
ALT. VOLTS = 729. ALT. AMPS = 1254. ALT. EFF. = .937
FLYWHEEL HP = 1411.6 OBS. SFC = .3804 AAR CORR. SFC = .3823 (LB/HP-HR)
CALCULATED A/F = 42.42 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	304.2	.22	60.PPMC
CO	753.1	.53	77. PPM
NOX	12335.4	8.74	769. PPM (D)
NOX,CORR	13155.5	9.32	
CO2		548.	5.04 PCT
O2			13.80 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= 1.0665	NOX-KH	= 1.0544	NOX-KT	= 1.0000
WET EXH HC CF=	.9522	AIR TEMP CF	= .9937	BAROM CF	= 1.0038
FUEL TEMP CF =	.9850	FUEL S.G. CF =	.9988	FUEL HHV CF	= 1.0074

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	2746.0-60
FILTER PAIR WEIGHT GAIN (mg)	7.539
SAMPLE VOLUME (scf)	39.154
DILUTE PM CONCENTRATION (mg/scf)	.193
CO2-BASED DILUTION FACTOR	7.010
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	1.350
PARTICULATE MASS EMISSION RATE (g/hr)	418.9
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.297

LOCOMOTIVE EMISSIONS SwRI PROJECT NO. 03-10152-001

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2297	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	N7	TEST CONFIGURATION	=	2°BTDC
TEST DATE	=	10/ 4/ 3	ENGINE MODEL	=	EMD 16-645-E
TEST NUMBER	=	10/11			
SwRI FUEL CODE	=	EM-3137A-F	FUEL H/C RATIO	=	1.79
BAROMETER	=	29.29 (in. Hg)	ENGINE INTAKE AIR	=	72.(°F)
DRY BULB TEMP	=	73. (°F)	WET BULB TEMP	=	69. (°F)
ABS HUMIDITY	=	102.95 (GR/LB)	RELATIVE HUMIDITY	=	83. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	13.8
TRACTION MOTOR BLOWER HP	=	65.4
INERTIAL SEPERATOR BLOWER HP	=	9.8
RADIATOR FAN HP	=	60.5
TOTAL ACCESSORY HP	=	153.5

FUEL RATE (OBS) = 697.2 (LB/HR)
ALT. VOLTS = 816. ALT. AMPS = 1391. ALT. EFF. = .937
FLYWHEEL HP = 1773.9 OBS. SFC = .3930 AAR CORR. SFC = .3953 (LB/HP-HR)
CALCULATED A/F = 36.75 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	457.6	.26	80.PPMC
CO	1652.3	.93	151. PPM
NOX	16083.6	9.07	894. PPM (D)
NOX,CORR	17187.9	9.69	
CO2		565.	5.83 PCT
O2			13.00 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= 1.0687	NOX-KH	= 1.0561	NOX-KT	= 1.0000
WET EXH HC CF=	.9457	AIR TEMP CF =	.9946	BAROM CF	= 1.0037
FUEL TEMP CF =	.9845	FUEL S.G. CF =	.9988	FUEL HHV CF	= 1.0074

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	2700.0-38
FILTER PAIR WEIGHT GAIN (mg)	7.076
SAMPLE VOLUME (scf)	36.509
DILUTE PM CONCENTRATION (mg/scf)	.194
CO2-BASED DILUTION FACTOR	8.512
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	1.650
PARTICULATE MASS EMISSION RATE (g/hr)	577.9
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.326

LOCOMOTIVE EMISSIONS *SwRI PROJECT NO. 03-10152-001*

LOCOMOTIVE MODEL	=	EMD GP38	TEST LOCATION	=	SwRI SA,TX
LOCOMOTIVE UNIT #	=	BNSF 2297	COMPUTER PROGRAM	=	EPA.FOR
THROTTLE NOTCH	=	Notch 8	TEST CONFIGURATION	=	2°BTDC
TEST DATE	=	10/ 4/ 3	ENGINE MODEL	=	EMD 16-645-E
TEST NUMBER	=	11/11			
SwRI FUEL CODE	=	EM-3137A-F	FUEL H/C RATIO	=	1.79
BAROMETER	=	29.29 (in. Hg)	ENGINE INTAKE AIR	=	73.(°F)
DRY BULB TEMP	=	73. (°F)	WET BULB TEMP	=	69. (°F)
ABS HUMIDITY	=	102.95 (GR/LB)	RELATIVE HUMIDITY	=	83. (%)

ENGINE PERFORMANCE SUMMARY:

ACCESSORY HORSEPOWER:

AUXILLARY GENERATOR HP	=	4.0
AIR COMPRESSOR HP	=	15.0
TRACTION MOTOR BLOWER HP	=	82.8
INERTIAL SEPERATOR BLOWER HP	=	12.4
RADIATOR FAN HP	=	76.6
TOTAL ACCESSORY HP	=	190.7

FUEL RATE (OBS) = 810.0 (LB/HR)

ALT. VOLTS = 861. ALT. AMPS = 1448. ALT. EFF. = .937

FLYWHEEL HP = 1971.5 OBS. SFC = .4108 AAR CORR. SFC = .4130 (LB/HP-HR)

CALCULATED A/F = 34.69 (LB DRY AIR/LB FUEL)

EMISSIONS	G/HR	G/HP-HR	CONC.
HC	722.6	.37	115.PPMC
CO	3505.3	1.78	292. PPM
NOX	18103.5	9.18	919. PPM (D)
NOX,CORR	19346.3	9.81	
CO2		590.	6.17 PCT
O2			12.40 PCT

CORRECTION FACTOR SUMMARY:

EPA NOX CF	= 1.0686	NOX-KH	= 1.0561	NOX-KT	= 1.0000
WET EXH HC CF=	.9430	AIR TEMP CF	= .9941	BAROM CF	= 1.0037
FUEL TEMP CF =	.9850	FUEL S.G. CF =	.9988	FUEL HHV CF	= 1.0074

PARTICULATE INFORMATION

FILTER PAIR I.D. NUMBER	2701.0-39
FILTER PAIR WEIGHT GAIN (mg)	7.773
SAMPLE VOLUME (scf)	36.248
DILUTE PM CONCENTRATION (mg/scf)	.214
CO2-BASED DILUTION FACTOR	8.721
PARTICULATE CONCENTRATION IN RAW EXHAUST (mg/scf)	1.870
PARTICULATE MASS EMISSION RATE (g/hr)	719.4
BRAKE-SPECIFIC PARTICULATE EMISSION RATE (g/hp-hr)	.365

BNSF 2297
04-OCT-2003

VCO + Check @ 2° BTDC

Notch	Barom in. Hg	Ambient Dry Bulb °F	Ambient Wet Bulb °F	Fuel Rate lb/hr	HC ppmC	CO ppm	Raw CO2 %	Dil CO2 %	BG CO2 ppm	Nox ppm	O2 %	Engine Speed (rpm)	# of Fans	Gen Volts	Gen Amps	Fuel Temp °F	Intake Air °F	Intake Manifold °F
Low Idle	29.27	69.3	67.1	23.0	85.2	73.6	0.63	0.1585	495.2	95.3	19.8	241	0	3.9	7.8	93	72	93
Idle	29.27	69.3	67.1	29.3	92.7	82.6	0.64	0.1652	471.7	85.3	19.7	307	0	5.2	10.3	92	71	91
DB-2	29.28	69.7	67.3	36.0	115.2	98.4	0.67	0.2039	566.9	80.2	19.5	367	0	6.3	12.7	91	71	92
Notch 1	29.29	70.1	67.5	38.0	125.2	91.8	0.84	0.2466	518.9	107.8	19.4	307	0	108.8	196.4	91	71	90
Notch 2	29.29	70.2	67.7	116.3	130.2	157.1	2.16	0.5226	495.2	170.5	17.5	367	0	324.3	571.0	90	71	92
Notch 3	29.29	70.9	68.0	177.0	82.6	91.8	2.34	0.4455	518.9	210.5	17.3	497	1	396.5	688.5	90	72	100
Notch 4	29.29	71.0	68.1	312.0	65.1	65.0	3.56	0.6929	518.9	441.0	15.5	564	1	568.1	977.7	91	72	106
Notch 5	29.30	71.6	68.3	444.0	57.6	60.1	4.42	0.6756	448.3	671.6	14.3	656	1	670.3	1,185.8	90	74	119
Notch 6	29.30	71.9	68.6	537.0	60.1	77.1	5.04	0.7288	471.7	768.7	13.8	723	2	729.0	1,253.8	90	74	131
Notch 7	29.29	72.7	69.0	697.2	80.1	150.9	5.83	0.6929	471.7	894.1	13.0	830	2	815.7	1,390.6	91	72	147
Notch 8	29.29	72.7	69.0	810.0	115.2	292.4	6.17	0.7106	448.3	919.2	12.4	898	2	860.7	1,448.3	90	73	163

SwRI Project No.:03.10152.01.001

LOCOMOTIVE ENGINE TEST SUMMARY

TEST DATE: 10/4/2003

NOTCH		L.Idle	Idle	DB2	N1	N2	N3	N4	N5	N6	N7	N8
HC (ppmC)	RANGE	500	500	500	500	500	500	500	500	500	500	500
	METER DIV.	17	18.5	23	25	26	16.5	13	11.5	12	16	23
	CONC., ppmC	85.2	92.7	115.2	125.2	130.2	82.6	65.1	57.6	60.1	80.1	115.2
CO (ppm)	RANGE	100	100	100	250	250	250	250	250	250	1000	1000
		74	83	98	38	64	38	27	25	32	14	28
	CONC., ppm	73.6	82.6	98.4	91.8	157.1	91.8	65.0	60.1	77.1	150.9	292.4
CO_2 (%)	RANGE	2	2	2	2	6	6	6	6	16	16	16
	METER DIV.	37	37.5	39	47.5	47	50	68	79	52	57	59
	CONC., %	0.63	0.64	0.67	0.84	2.16	2.34	3.56	4.42	5.04	5.83	6.17
NOx (ppm)	RANGE	250	250	250	250	250	1000	1000	1000	2500	2500	2500
	METER DIV.	38	34	32	43	68	21	44	67	30	35	36
	CONC., ppm	95.3	85.3	80.2	107.8	170.5	210.5	441.0	671.6	768.7	894.1	919.2
O_2 (%)	RANGE	25	25	25	25	25	25	25	25	25	25	25
	METER DIV.	79	78.5	78	77.5	70	69	62	57	55	52	49.5
	CONC., %	19.8	19.7	19.5	19.4	17.5	17.3	15.5	14.3	13.8	13.0	12.4
LCO_2 (ppm)	RANGE	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
TUNNEL DILUTE	MTR DIV.	31	32	37.5	43	69	63	80	79	82	80	81
	CONC., ppm	1585.4	1651.8	2038.6	2465.8	5225.8	4455.2	6929.0	6756.0	7287.5	6929.0	7106.1
LCO_2 (ppm)	RANGE	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
BG	MTR DIV.	11.5	11	13	12	11.5	12	12	10.5	11	11	10.5
	CONC., ppm	495.2	471.7	566.9	518.9	495.2	518.9	518.9	448.3	471.7	471.7	448.3

Test Configuration: BNSF 2297 check Inj. 2° BTDC Operator: EJ

LOCOMOTIVE TEST SUMMARY

SwRI project No. 03.10152.01.001 **Test Date** 10-4-03 **Unit Number** BNSF-2297

Notch		Idle Low	Idle/ DB-1	DB-2	1	2	3	4	5	6	7	8
Observed Fuel Rate at X minutes into test point (lb/hr)												
1 min.		22.7	28.9	36.6	38.9	112.5	174	327	446	539	697	803
3 min.		23.1	29.4	36.2	39.0	118.7	176	295	442	540	694	809
5 min.			29.6	36.1	38.8	118.5	180		445	538		806
Averaged Fuel Rate over Time												
Cumulative Fuel Used (lbs)		2.3	3.9	3.6	3.8	12.6	17.7	31.2	44.4	53.7	58.1	67.5
Over X Minutes		6.0	8.0	6.0	6.0	~~7.0~~ 6.5	6.0	6.0	6.0	6.0	5.0	5.0
x 60. = Fuel Rate (lb/hr)		23.0	29.25	36.0	38.0	116.3	177.	312	444.	537.	697.2	810.
Traction Volts/2		----------	----------	----------	53.8	159.8	195.5	278.3	330.8	359.1	402.0	424
MG Volts = xxx X 2.014		----------	----------	----------	108.3	321.8	393.7	560.5	666.2	723.2	809.6	853.9
Current Shunt mV		----------	----------	----------	4.87	14.22	17.33	24.48	28.92	31.29	34.86	36.68
Traction Current = Shunt mV * 40		----------	----------	----------	194.8	568.8	693.2	979.2	1156.8	1251.6	1394.4	1467.2
Baro (in Hg)		29.27	29.27	29.28	29.29	29.29	29.29	29.29	29.29	29.30	29.29	29.29
Dry Bulb Temperature (°F)		69.3	69.3	69.7	70.1	70.2	70.9	71.0	71.6	71.9	72.7	72.7
Wet Bulb Temperature (°F)		67.1	67.1	67.3	67.5	67.7	68.0	68.1	68.3	68.6	69.0	69.0
# of Fans		0	0	0	0	0	1	1	1	2	2	2
LS Run #		2921	2922	2923	2924	2925	2926	2927	2928	2929	2930	2931
SS Smoke, % Opacity		2	2	2	2	8	2	3	3	2	3	—

Notes: 1 - Air compressor locked off. (Form = Loco Test Sum 8-25-03.xls)

Test Configuration: VCO/check 2° BTDC **Operator:** SGF

Smoke File Name 975.prn I = 1880