EMISSIONS AND FUEL ECONOMY TEST
FINAL REPORT (OAE-APSI-4)
Locomotive EMD Engine
FITCH FUEL CATALYST

Prepared by : **OceanAir Environmental, LLC**

PO Box 1318

Somis, CA 93066

(805) 386-1882, Fax (805)504-1618

Mahesh@oceanairllc.com, www.oceanairllcc.com

Prepared for: Advanced Power Systems International, Inc.(APSI)

558 Lime Rock Rd. Lakeville, CT 06039

April 14, 2006

Approved:

Mahesh Talwar

Mahesh Talwar, President

Background: Ocean Air Environmental LLC (OAE) was retained to evaluate the impact of the Fitch Fuel Catalyst on an in service locomotive operated on off-road diesel fuel purchased in the State of California at the time of the evaluations, July 2005 and March 2006.

Advanced Power Systems International, Inc. (APSI) the manufacturer of the product describes the product in product literature as follows:

"The Fitch Fuel Catalyst is a polymetalic alloy housed in a canister and connected into an engines fuel system between the fuel tank and the engine after the fuel filter and before the fuel pump. Its purpose is to reformulate fuel on board the vehicle prior to combustion. It performs its function at the temperatures experienced by vehicles in normal service.

The Fitch Fuel Catalyst is not a fuel additive. It is a special alloy that does not dissolve in fuel. The fuel is reformulated by the alloy catalyst to a state where it is capable of a more complete combustion. As a result, an engine converts the chemical energy in the fuel to mechanical energy in a more efficient manner. The engine power is increased as a result and the toxic exhaust emissions are decreased."

The unit used for the test was supplied by APSI and installed by OceanAir mechanics on site.

Purpose of the Program: To evaluate the effect of Fitch Fuel Catalyst on emission of NOx, CO, HC, PM, and fuel economy.

Test Set Up: A SW1200 locomotive operated by Ventura County Rail Road was used for evaluation. The locomotive is used for switching operation in Oxnard, California. The SW1200 has a single EMD 12-567CE engine. The locomotive was baseline tested using the procedures outlined in Exhibit A. After the baseline test, the locomotive was equipped with a Fitch Fuel Catalyst installed in the fuel supply line to the engine. The test was repeated after approx 3 months of revenue service.

Testing Location: Testing was done at Ventura County Rail Road yard in Oxnard, California.

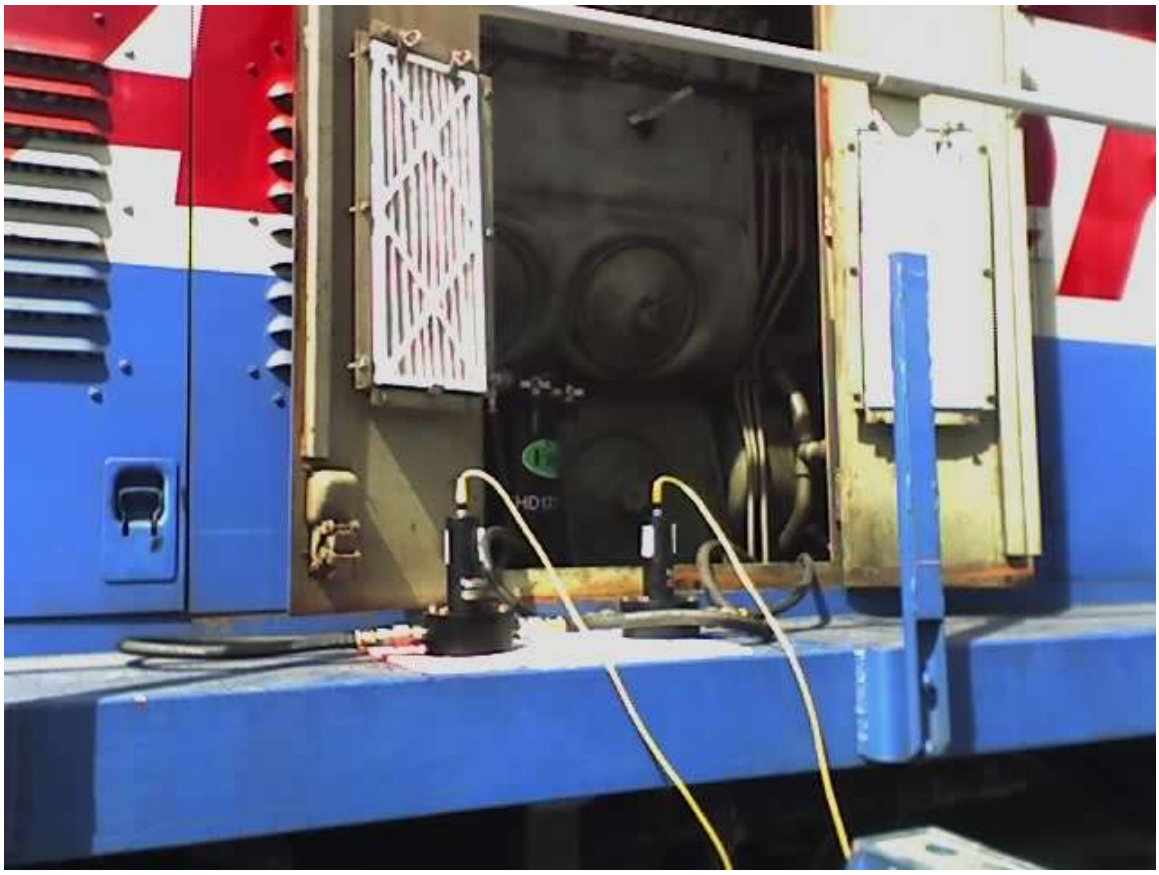
Test Equipment: See Exhibit A Test Procedure

Test Team
Mahesh Talwar and Kevin Talwar – OceanAir Environmental
Robert Ward, Kevin Wahl, and Mike - Quinn Caterpillar (under contract to OceanAir)

Job site image
A. Load Bank

Job site image
B. Fitch Fuel Catalyst installation

Job site image
C. Fuel Meters



Test Results Discussions: The results of testing are as follows:

Baseline Data

Nine mode weighted results:

Maximum horsepower achievable = 1,315
Bsfc: 0.0664 gal/bhp-hr
NOx + THC: 8.70 gms/bhp-hr
CO: 3.06 gms/bhp-hr
PM10: 0.8452 mg/filter (based on 10 lit/min exhaust flow to
PM collection system for five minutes on the filter at each mode)

At Baseline the engine achieved the Tier 1emissions levels

Retrofit – with Fitch Data

Nine mode weighted results:

Maximum horsepower achievable 1,312
Bsfc: 0.0585 gal/bhp-hr
NOx + THC: 7.59 gms/bhp-hr
CO: 4.05 gms/bhp-hr
PM10: 0.821 mg/filter (based on 10 lit/min exhaust flow to
PM collection system for five minutes on the filter at each mode)

At retrofit the engine achieved Tier 2 emissions levels except for CO

Discussion of Results

Effect of Fitch Catalyst

All emissions but CO were reduced and fuel economy improved as a result of the installation of the Fitch Fuel Catalyst on board the test vehicle.

NOx + THC (ozone precursors) = 12.75% reduction
PM10 = 2.86% reduction
CO = 32.3% increase
Nine mode weighted fuel economy = 11.83% improvement

EXHIBIT A

Test Instruments

The following instruments are used by OAE for emissions testing and performance verification:

Fuel Meter: Fuelcom flow meters used for measurement of supply and return fuel flow rate.

Smoke Meter: An opacity meter is generally used for this purpose.

Emissions Analyzer: An Andors 6241 analyzer supplied by DJ Gas is used. The emissions analyzer is capable of measuring NOx, CO, HC, CO2, and oxygen. The sample conditioning system includes a drier (silica gel) which is capable of drying samples up to 20% moisture content to a 50 deg F dew point level. The dry exhaust gas is then introduced to sensors to measure concentration. Filter housing at the probe tip filters out particulate matter.

PM Analyzer: Total particulate matter sampling is done by the filter weighing method. A pre-weighed dry filter is inserted into the holder close to the exhaust stack to collect the particulate sample. Exhaust gases are sent to the filter through a vacuum pump connected to a gas flow meter. The sampled filter is then baked in the oven at 105 deg C to exclude the moisture from the analysis.

USEPA approved factors are applied to the analyzed total particulate matter to derive PM10 fraction or PM2.5 fractions.

Horsepower: Engine power is measured through the resistive load bank Resistive load bank measures the locomotive engine generator output. Mechanically driven accessories are not included in the generator output. Engine manufacturer, EMD, supplied accessories load was then added to the generator horsepower to derive total engine output. One variable that cannot be controlled by the test equipment hooked up to the engine is the starting and stopping of cooling fan in engine compartment of locomotive. Cooling fan horsepower was either added to the total or not added depending upon the fact whether the cooling fan was on or off. .

Engine RPM: A portable tachometer is used.

Ambient Temperature, Pressure, and Humidity: A hand-held digital meter is used for this purpose.

Instrument Calibration

Emissions Analyzer: NOx analyzer was calibrated using a high and low range gas. Analyzer output is then checked against a known concentration of mixtures of all gases, before and after the test.

Smoke Meter: Opacity meter is calibrated at 100%, 0%, and mid range opacity.

Fuel Meter: Fuelcom was calibrated by Quinn Caterpillar.

Test Fuel:

Fuel used in all tests was commercially available off-road diesel normally used to fuel this equipment.

Test Procedures (Emissions Test)

Locomotive Testing

Locomotives are tested along the nine mode speed-load test cycle. Mode 2 **through** 9 represents eight notch settings of the locomotive engine. Mode 1 is the idle. This type of in-use testing is possible through a load bank. The load bank KW reading is converted to BHP using engine manufacturer supplied data for parasitic loads and generator efficiency. Fuel flow can be obtained by an actual fuel flow meter or from manufacturer's curve for the notch setting and engine rpm.

Weighting factors for switcher locomotives are:

Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7	Mode 8	Mode 9
0.598	0.124	0.123	0.058	0.036	0.036	0.015	0.002	0.008

A majority of the locomotives are powered by EMD 12-645 or 16-645 engines.

Emissions standards for Locomotives gms/bhr-hr

Duty Cycle	HC*	CO	NOx	PM
Tier 0 (1973 - 2001)				
Line-haul	1	5	9.5	0.6
Switch	2.1	8	14	0.72
Tier 1(2002 - 2004)				
Line-haul	0.55	2.2	7.4	0.45
Switch	1.2	2.5	11	0.54
Tier 2(2005 and later)				
Line-haul	0.3	1.5	5.5	0.2
Switch	0.6	2.4	8.1	0.24
Non-Regulated Locomotives(1997 estimates)				
Line-haul	0.5	1.5	13.5	0.34
Switch	1.1	2.4	19.8	0.41

Data Sheet for Fuel Consumption and Horsepower

VCRR 1200
Baseline 07/21/05

		KVA	H.P.	H.P.	RPM	Fuel	Fuel	Fuel Wt Avg
			w/o aux	w/ aux		Gal/hr	gal/bhp-hr	gal/bhp-hr
Mode 1	Fan on	0	0	129	265	8.7	0.0674	0.0403
Mode 2	Fan on	21	30	159	244	11.8	0.0742	0.0092
Mode 3	Fan on	94	134	263	326	16.8	0.0638	0.0078
Mode 4	Fan on	193	276	405	380	23.8	0.0588	0.0034
Mode 5	Fan on	342	489	618	454	31.7	0.0513	0.0018
Mode 6	Fan on	472	674	803	560	49.9	0.0621	0.0022
Mode 7	Fan on	611	873	1,002	634	58.8	0.0587	0.0009
Mode 8	Fan on	721	1,030	1,159	693	69.7	0.0601	0.0001
Mode 9	Fan on	830	1,186	1,315	770	79.9	0.0608	0.0005
	Weighted Fuel		Locomotive 9-Mode					0.0664
	Weighted Fuel		Marine 4-Mode					0.0595

Post Fitch 03/24/06

Mode 1	Fan off	0	0	53	260	3.58	0.0675	0.0404
Mode 2	Fan off	50	71	124	258	4.81	0.0388	0.0048
Mode 3	Fan off	94	134	187	320	9.3	0.0497	0.0061
Mode 4	Fan on	199	284	413	394	17.22	0.0417	0.0024
Mode 5	Fan on	302	431	560	458	25.15	0.0449	0.0016
Mode 6	Fan on	467	667	796	563	39.97	0.0502	0.0018
Mode 7	Fan on	598	854	983	645	52.04	0.0529	0.0008
Mode 8	Fan on	701	1,001	1,130	696	60.94	0.0539	0.0001
Mode 9	Fan on	828	1,183	1,312	772	73.73	0.0562	0.0004
	Weighted Fuel		Locomotive 9-Mode					0.0585
	Weighted Fuel		Marine 4-Mode					0.0533

Fuel economy gains	11.83%	Locomotive 9-Mode
Fuel economy gains	10.53%	Marine 4-Mode

ENGINE EXHAUST EMISSIONS TEST RESULTS
Switcher Locomotive Test Cycle
Baseline

Testing Firm:	OAE
Test Cycle 9 mode locomotive switcher	USEPA Switcher test cycle for lcomotives
Test Date: 7/21/2005	Lcomotive VCRR1200
Fuel Type: D2	
Engine Type:	EMD12-567CE Er12CE66140
Aspiration:	Blower
Engine Rating:	H.P. 1200
Test Purpose	Test the efffectiveness of Fitch Fuel Catalyst
Client	APSI

A. ENGINE PERFORMANCE DATA		**Mode 1**	**Mode 2**	**Mode 3**	**Mode 4**	**Mode 5**	**Mode 6**	**Mode 7**	**Mode 8**	**Mode 9**
Engine Torque (ft-lb)		NM	NM	NM	NM	NM	NM	NM	NM	NM
Engine Power (hp))		129.00	159.00	263.00	405.00	618.00	803.00	1,002.00	1,159.00	1,315.00
Engine power (kw)		92	114	188	290	443	575	718	830	942
Fuel Flow (kg/hr)		28.02	38.00	54.11	76.65	102.09	160.71	189.37	224.47	257.32
Intake Air (dry kg/hr)		5651	3396	3391	3827	3926	5397	5771	6127	7252
Exhaust flow (dry kg/hr)		5679	3434	3445	3904	4028	5558	5961	6352	7509
Engine RPM		265	244	326	380	454	560	634	593	770
Engine RPM % of Rated		NM	NM	NM	NM	NM	NM	NM	NM	NM
Engine Load % of Rated		NM	NM	NM	NM	NM	NM	NM	NM	NM
Fuel Flow (gal/hr)		8.7	11.8	16.8	23.8	31.7	49.9	58.8	69.7	79.9
Exhaust Gas Temp. (deg F)		NM	NM	NM	NM	NM	NM	NM	NM	NM
BSFC	gal/bhp-hr	0.0674	0.0742138	0.0638	0.0588	0.0513	0.0621	0.05869	0.06014	0.06077
B. GASEOUS EMISSIONS										
NOx (dry ppmv)		133	226	368	519	703	816	851	845	728
CO (dry ppmv)		20	20	100	100	200	700	1300	2900	4100
O2 (%)		19.5	17.8	16.5	15.4	13.8	12.8	12	11	11.3
CO2 (%)		1.19	2.34	3.22	4.61	5.01	5.7	6.14	6.76	6.15
HC (dry ppmv)		5	7	5	6	8	11	17	23	13
C. EXHAUST EMISSIONS ANALYSIS										
Mode Weighting Factors		0.598	0.124	0.123	0.058	0.036	0.036	0.015	0.002	0.008
Weighted Specific NOx (gms/kw-hr)		4.29	0.91	1.48	1.12	0.97	1.55	0.72	0.10	0.42
Weighted Specific CO (gms/kw-hr)		0.39	0.05	0.25	0.13	0.17	0.81	0.67	0.21	1.42
Weighted Specific HC (gms/kw-hr)		0.06	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00
Weighted Specific CO2 (gms/kw-hr)		367.33	90.58	124.02	94.89	66.04	103.67	49.90	7.81	33.58
Weighted Specific Fuel (gal/kw-hr)		0.0541	0.0123	0.0105	0.0046	0.0025	0.0030	0.0012	0.0002	0.0007

D. RESULTS

			Tier 1	Tier 2	gms/bhp-hr
Total Mode Weighted NOx	**11.57 gms/kw-hr**	**8.63 gms/bhp-hr**		11	8.1
Total Mode Weighted CO	**4.11 gms/kw-hr**	**3.06 gms/bhp-hr**		2.5	2.4
Total Mode Weighted HC	**0.10 gms/kw-hr**	**0.07 gms/bhp-hr**		1.2	0.6
Total Mode Weighted CO2	**937.83 gms/kw-hr**	**699.62 gms/bhp-hr**			
Total Mode Weighted BSFC	**0.0890 gal/kw-hr**	**0.0664 gal/bhp-hr**			

ENGINE EXHAUST EMISSIONS TEST RESULTS
Switcher Locomotive Test Cycle
Retrofit - Post Fitch

Testing Firm:	OAE
Test Cycle 9 mode locomotive switcher	USEPA Switcher test cycle for locomotives
Test Date: 3/24/2006	Lcomotive VCRR120(
Fuel Type: D2	
Engine Type:	EMD12-567CE Er12CE66140
Aspiration:	Blower
Engine Rating:	H.P. 1200
Test Purpose	Test the efffectiveness of Fitch Fuel Catalyst
Client	APSI

A. ENGINE PERFORMANCE DATA		**Mode 1**	**Mode 2**	**Mode 3**	**Mode 4**	**Mode 5**	**Mode 6**	**Mode 7**	**Mode 8**	**Mode 9**
Engine Torque (ft-lb)		NM	NM	NM	NM	NM	NM	NM	NM	NM
Engine Power (hp))		53.00	124.00	187.00	413.00	560.00	796.00	983.00	1,130.00	1,312.00
Engine power (kw)		38	89	134	296	401	570	704	809	940
Fuel Flow (kg/hr)		11.53	15.49	29.95	55.46	81.00	128.73	167.60	196.26	237.45
Intake Air (dry kg/hr)		1913	1957	2592	3558	4121	5506	6540	6763	8515
Exhaust flow (dry kg/hr)		1924	1973	2622	3613	4202	5635	6707	6960	8753
Engine RPM		260	258	320	394	458	563	645	696	772
Engine RPM % of Rated		NM	NM	NM	NM	NM	NM	NM	NM	NM
Engine Load % of Rated		NM	NM	NM	NM	NM	NM	NM	NM	NM
Fuel Flow (gal/hr)		3.58	4.81	9.3	17.22	25.15	39.97	52.04	60.94	73.73
Exhaust Gas Temp. (deg F)		NM	NM	NM	NM	NM	NM	NM	NM	NM
BSFC	gal/bhp-hr	0.0675	0.0387903	0.0497	0.0417	0.0449	0.0502	0.0529	0.05391	0.0562
B. GASEOUS EMISSIONS										
NOx (dry ppmv)		120	159	266	451	620	797	880	981	832
CO (dry ppmv)		20	100	200	200	300	600	1100	1900	3300
O2 (%)		19.2	18.7	17.7	16.6	15.5	14.5	13.9	13	13.3
CO2 (%)		0.81	1.15	2.21	3.24	3.97	4.67	5.2	5.9	5.58
HC (dry ppmv)		14	13	14	17	18	20	20	23	23
C. EXHAUST EMISSIONS ANALYSIS										
Mode Weighting Factors		0.598	0.124	0.123	0.058	0.036	0.036	0.015	0.002	0.008
Weighted Specific NOx (gms/kw-hr)		1.79	0.50	1.11	1.22	1.21	2.09	1.14	0.18	0.75
Weighted Specific CO (gms/kw-hr)		0.18	0.19	0.51	0.33	0.36	0.96	0.87	0.21	1.82
Weighted Specific HC (gms/kw-hr)		0.07	0.01	0.02	0.02	0.01	0.02	0.01	0.00	0.01
Weighted Specific CO2 (gms/kw-hr)		115.26	34.78	88.14	83.96	74.26	117.14	64.69	10.15	48.31
Weighted Specific Fuel (gal/kw-hr)		0.0541	0.0064	0.0082	0.0032	0.0022	0.0024	0.0011	0.0001	0.0006

D. RESULTS

				Tier 1	Tier 2	gms/bhp-hr
Total Mode Weighted NOx	**10.00 gms/kw-hr**	**7.46 gms/bhp-hr**		11	8.1	
Total Mode Weighted CO	**5.42 gms/kw-hr**	**4.05 gms/bhp-hr**		2.5	2.4	
Total Mode Weighted HC	**0.17 gms/kw-hr**	**0.13 gms/bhp-hr**		1.2	0.6	
Total Mode Weighted CO2	**636.69 gms/kw-hr**	**474.97 gms/bhp-hr**				
Total Mode Weighted BSFC	**0.0784 gal/kw-hr**	**0.0585 gal/bhp-hr**				