EMISSIONS AND FUEL ECONOMY TEST
FINAL REPORT
Locomotive EMD Engine
RESULTS EXTRAPOLATED FOR MARINE TEST CYCLE
FITCH FUEL CATALYST

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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 evaluation, July 2005 and March 2006. Marine vessels use the same EMD engine for propulsion. OceanAir has used the test data from the locomotive test to calculate the results using a marine 4-mode test cycle.

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 prior to 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."

Unit used for the test were 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. 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:

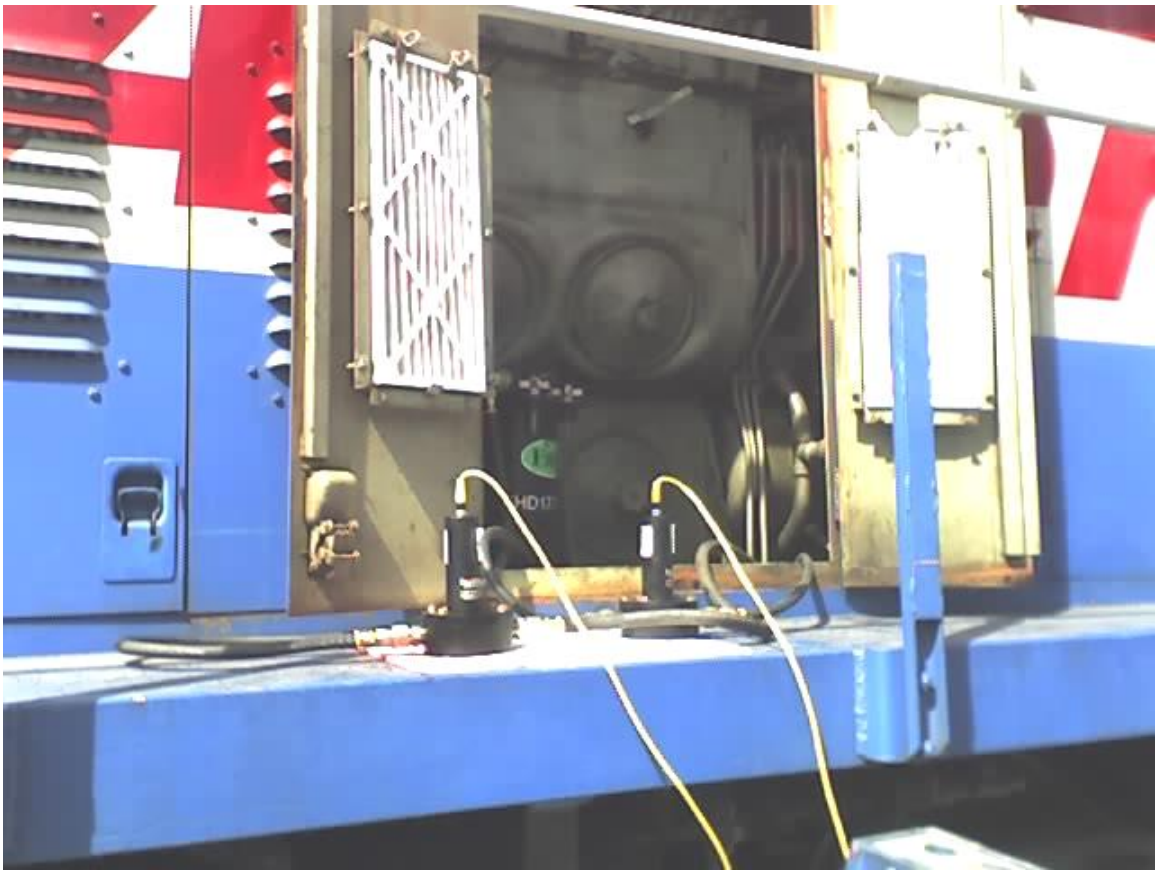
See Exhibit A

Job Site Pictures

A. Load Bank

b. Fitch catalyst installation

c. Fuel meters



Test Team

Mahesh Talwar and Kevin Talwar – OceanAir Environmental
Robert Ward, Kevin Wahl, and Mike from Quinn Caterpillar (under contract with OceanAir)

Test Procedure

See Exhibit A

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

Baseline Data

4- mode weighted results:

Maximum horsepower achievable = 1,315
Bsfc: 0.0595 gal/bhp-hr
NOx + THC: 9.67 gms/bhp-hr
CO: 15.33 gms/bhp-hr
PM10: 2.4125 mg/filter (based on 10 lit/min exhaust flow to PM collection system for five minutes on the filter at each mode)

Retrofit – with Fitch Data

4- mode weighted results:

Maximum horsepower achievable 1,312
Bsfc: 0.0533 gal/bhp-hr
NOx + THC: 7.67 gms/bhp-hr
CO: 12.85 gms/bhp-hr
PM10: 1.725 mg/filter (based on 10 lit/min exhaust flow to PM collection system for five minutes on the filter at each mode)

Discussion of Results

Effect of Fitch Catalyst

All emissions 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) = 20.68% reduction
PM10 = 28.5% reduction
CO = 16.2% decrease
4-mode weighted fuel economy = 10.42% 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.

Dynamometer: Fuelcom was calibrated by Quinn Caterpillar.

Test Fuel:

Fuel to be used in all tests will be commercially available off-road diesel.

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:

	Mode1	Mode2	Mode3	Mode4	Mode5	Mode6	Mode7	Mode8	Mode9
	0.598	0.124	0.123	0.058	0.036	0.036	0.015	0.002	0.008

Majority of the locomotives are powered by older EMD 12-645 or 16-645 engines.

Marine test cycle used for calculations is as follows:

Marine vessels are tested along E-3 test cycle. E-3 test cycle consists of four speed-load points along the propeller curve.

	Mode 1	Mode 2	Mode 3	Mode 4
Load %	100	75	50	25
RPM %	100	91	80	63
Weighting factor	0.2	0.5	0.15	0.15