

# Production Analysis Report

March 2010

## Cat® D9R Mirengo C-Max On vs. Off



### Study Purpose

- The purpose of the study was to conduct economic analysis of dozer production capability, as well as determine the performance differences and fuel savings between a Cat D9R with Mirencó's C-Max turned on and a Cat D9R with Mirencó's C-Max turned off.

### Study Date

- March 16th, 2010 – March 19th, 2010

### Field Data by

- Braden Weisheit – Whayne Supply
- Edwin Downer – Whayne Supply
- Dale Hikes – Whayne Supply
- KJ Jones – Whayne Supply
- Andrew Gallusser – Whayne Supply (Operator)

### Location

- Whayne Supply Corporate Proving Grounds – Louisville, Ky

### Written by

- Braden Weisheit – Whayne Supply

### Weather Conditions

- Temperatures ranged from 40°F to 70°F. At the time of study month to date rainfall was .31 inches.

### Tested Units

- Caterpillar D9R (Whayne Owned)
- Mirencó C-Max (Whayne Owned)

### Material

- Loam - 60% Silt 30% Clay 10% Sand

### Surveying Tools

- Trimble TSC2 with Survey Controller SCS900
- Trimble SPS-851 Base Station

### Business Unit

- This study was completed by Whayne Supply Company's Technology Division and Production Analysis Team.

## Key Findings

- No noticeable difference in D9R responsiveness was reported by operator with Mirengo C-Max turned on.
- C-Max visibly reduced the amount diesel particulate matter (DPM) during initial cut, blade load and carry, and blade dump and return.
- Mirengo’s C-Max unit resulted in a 8% fuel savings advantage or a 11.12% fuel efficiency advantage (bcy/hr ÷ gal/hr)

6. Fuel Savings		
Annual Dozer Operating Hours	4000	4000
Average Production Rate (bcy/hr)	300	300
Total Volume per year (bcy)	1,200,000	1,200,000
Fuel Efficiency (bcy/gal)	24.75	22.28
Gallons consumed per year	48,479	53,871
Fuel cost per gallon (\$/gal)	2.20	2.20
Total Fuel Expense per year (\$)	\$ 106,653	\$ 118,516
Mirengo C-Max Savings	\$ 11,863	
Tractor Ownership (year) 10	\$ 118,634	

## Executive Summary

During the course of the study two different production dozing slots were studied. The study was composed of one test in which data was recorded for the following parameters:

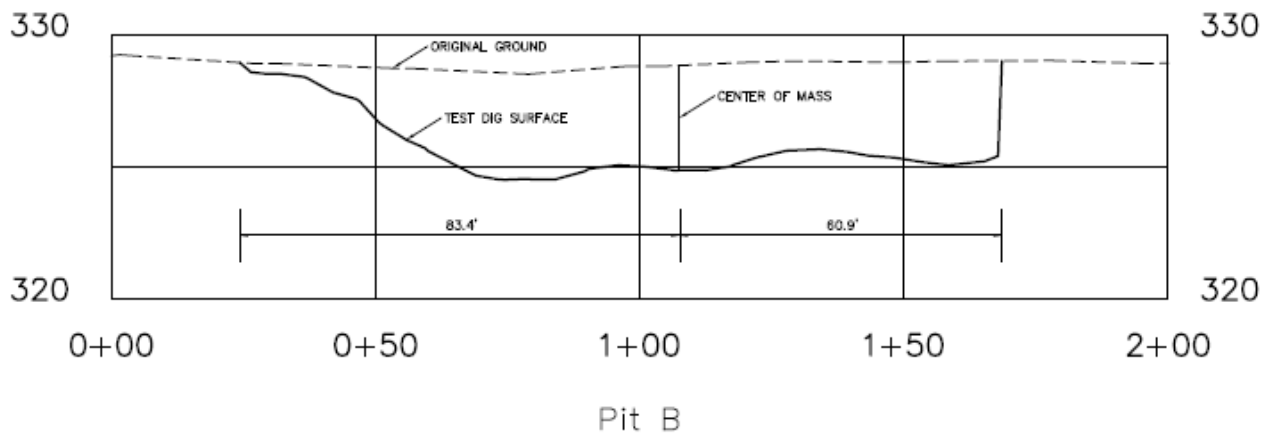
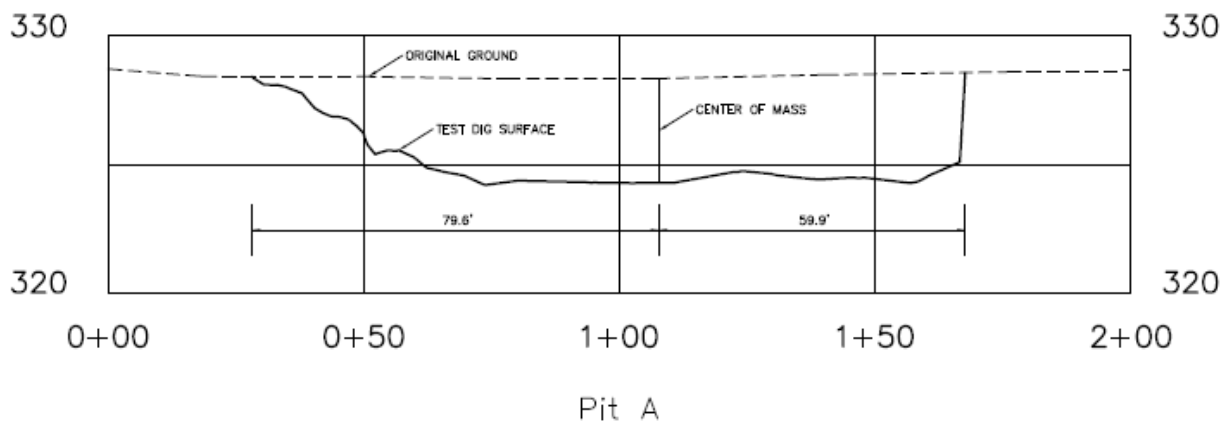
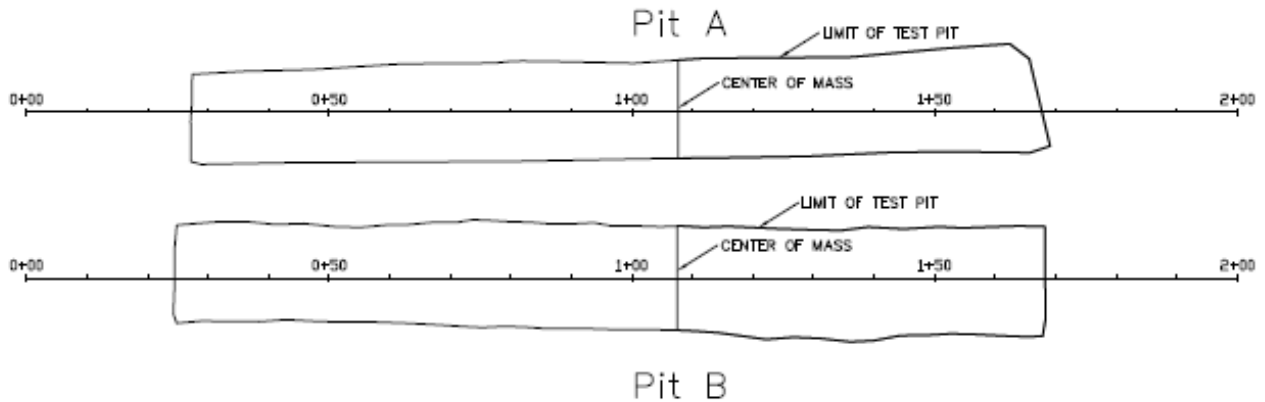
- Fuel Consumption
- Cycle Times
- Pit Dimensions
- Blade Load
- Bank Cubic Yards (BCY) Moved

For this study fuel consumption data has been reported in BCY of material moved per gallon of fuel burned. The dozer production was captured in identical material located within feet of each other. The final data analysis showed a 11.21% BCY/Gal advantage for the Cat D9R with the Mirengo C-Max turned On. The D9R was operated by the same individual during the entire study.



## Study Procedures

The study was conducted using a production slot dozing technique. The pits were set up to ensure that neither Mirengo On nor Mirengo Off had an advantage due to soil conditions. A total of two pits were measured and laid out as shown in figures below.



The D9R was filled with fuel to a predetermined point on the neck of the fuel tank. Fuel was added at the beginning of each pit study to ensure the D9R was completely full. The D9R was driven approx ¼ mile from the fueling station to the testing area in second gear. The D9R then performed the slot production study 1<sup>st</sup> gear forward 2<sup>nd</sup> gear reverse. Post study the D9R was driven back ¼ mile to the fueling station. The machine was allowed to cool to avoid thermal error in fuel data. Post study the D9R was fueled to the predetermined point on the neck of the fuel tank.



## Slot Dozing

Each pit was laid out to be 17 ft in width and 200 ft in length. The pits were dug to a depth of one blade height and a width of one blade. Each pit was limited to 1<sup>st</sup> gear forward and 2<sup>nd</sup> gear reverse. Upon leaving the “in-pit” area the material was carried into a stockpile. The dump portion of the test was recorded, but deducted in the results to provide an “in-pit” study time and to eliminate any differences in push distances beyond the designated test area. The return portion of the test was conducted in 2nd gear as well. Times for doze, carry and return were recorded and are provided in the results. After completion of the study, the pits were surveyed using Trimble Survey Controller to calculate the volume moved.



## Mirenco C-Max Product Description

The Mirenco C-Max system increases fuel efficiency, reduces emissions, and extends the engine life of diesel vehicles. The C-Max system prevents excess, unburned diesel fuel from spewing out the tailpipe as soot, by delivering only as much fuel as the engine needs. C-Max accomplishes this through a solid state, electronic throttle delay and throttle stop that can easily be programmed with a hand-held computer.

### Installation Versatility:

- Majority of equipment types, manufacturers, and models
- Universal to all grades of diesel fuel
- Supports new and old equipment
- No loss of horsepower



<http://mirenco.whayne.com>

## Test Results

	Mirencó On	Mirencó Off
<b>1. Cycle Times</b>		
Doze Time (min.)	20.62	23.31
Return Time (min.)	15.62	15.38
In-Pit Time (min.)	36.24	38.69
Out of Pit Time (min.)	32.70	23.37
Tram to Study Area (min.)	4.00	4.00
Total Study Time (including Tram)	72.94	66.06
Total # of Cycles	36.00	37.00
Avg. Doze Time (min.)	0.57	0.63
Avg. Return Time (min.)	0.43	0.42
Avg. Cycle Time	1.01	1.05

<b>2. Pit Volume (bcy)</b>		
Pit Volume (bcy)	252.49	267.05
Total # of Cycles	36.00	37.00
Avg. Blade Load (bcy)	7.01	7.22

<b>3. Dozer Production (bcy)</b>		
Pit Volume (bcy)	252.49	267.05
Total In Pit Time (min)	36.24	38.69
Dozer Production (bcy/hr)	418	414

or....

Avg. Blade Load (bcy)	7.01	7.22
Cycles / Hour	59.60	57.38
Dozer Production (bcy/hr)	418	414

Dozer Production (bcy/hr)	418	414
Distance leave pit line to Centroid (ft)	60.9	59.9
Reference Centroid	60.4	60.4
Adjusted Production (bcy/hr)	421	411
Production Difference	3%	



<b>4. Fuel Consumption</b>		
<b>Total Fuel Consumed (gallons)</b>	20.70	20.30
<b>Running Time of Dozer (min)</b>	72.94	66.06
<b>Fuel Consumption (gallons/hr)</b>	17.03	18.44
<b>Fuel Difference</b>		8%

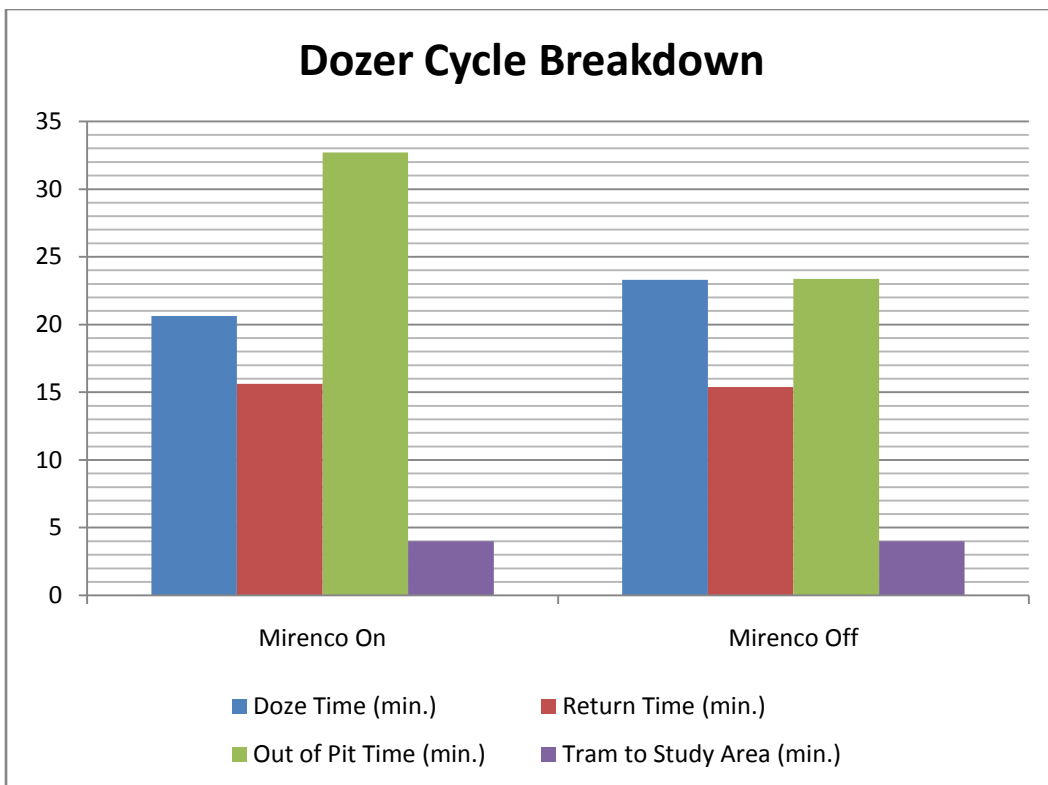
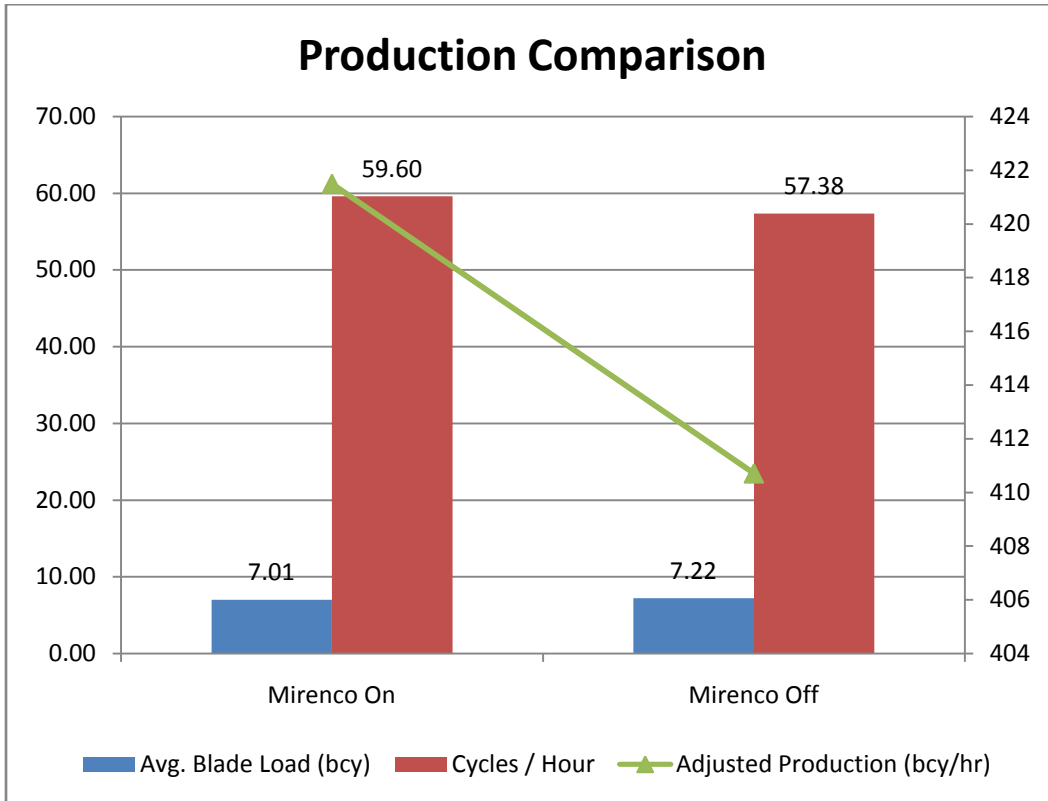
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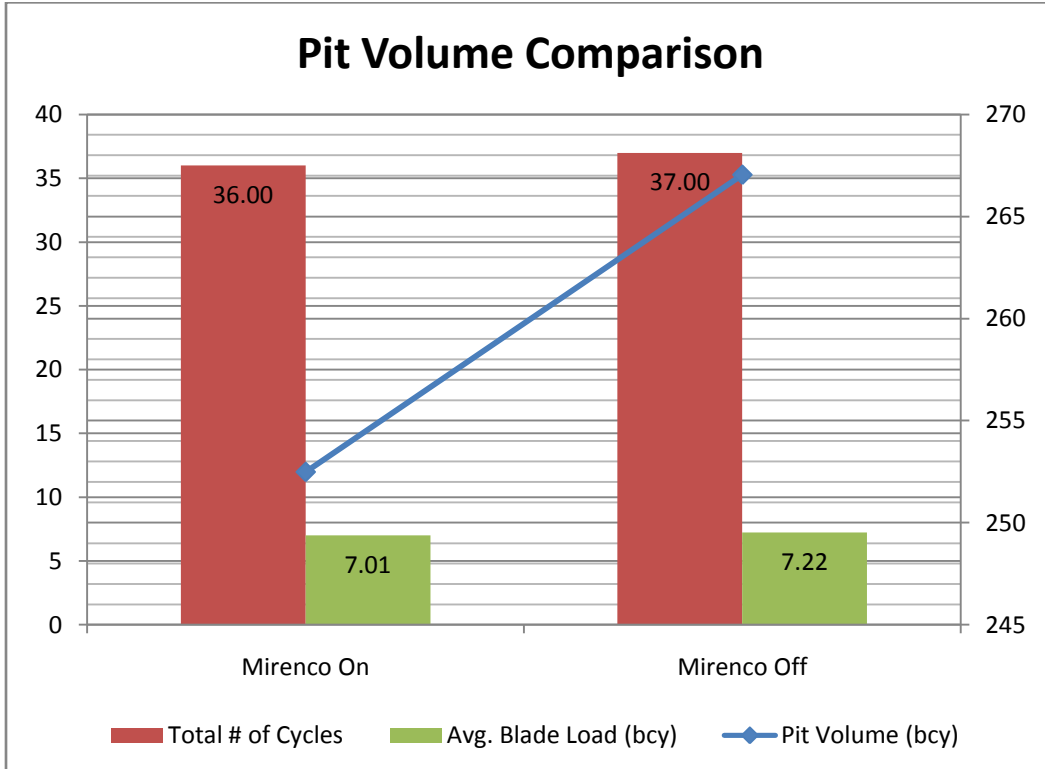
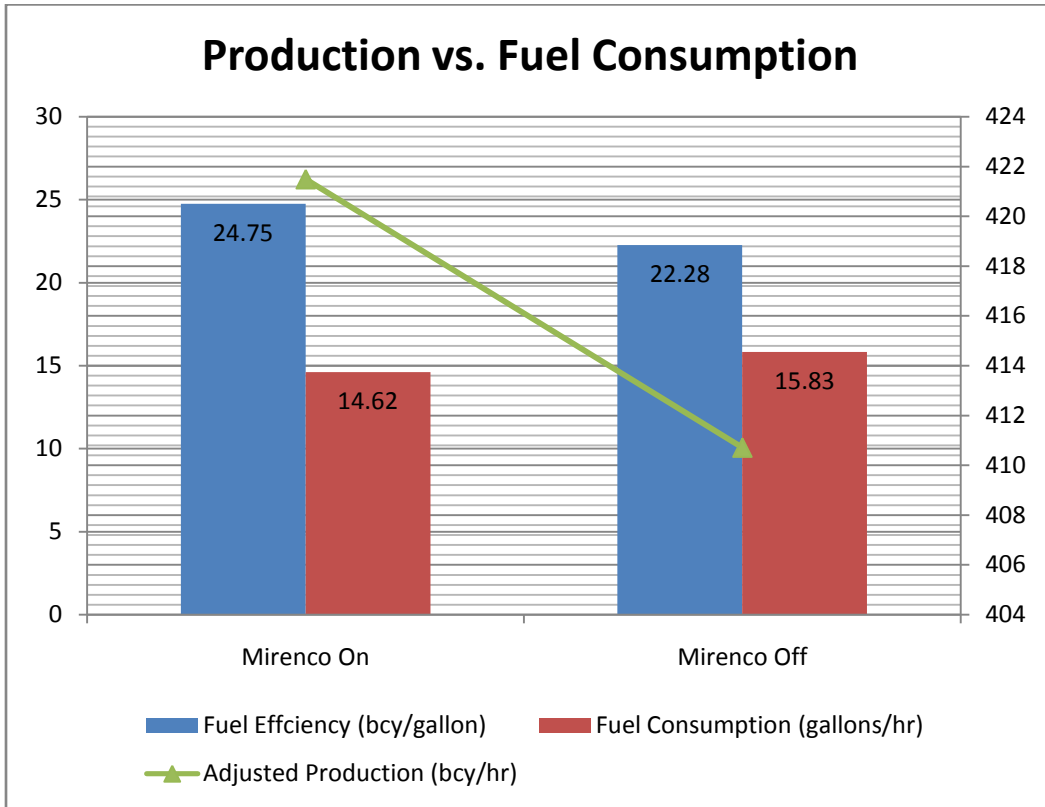
<b>D9R ECM gallons before study</b>	162,958	162,999
<b>D9R ECM gallons after study</b>	162,977	163,018
<b>Gallons consumed</b>	19	19
<b>Hour Meter reading before study</b>	7.9	10.80
<b>Hour Meter reading after study</b>	9.2	12.00
<b>Running Time of Dozer (min)</b>	1.3	1.20
<b>Fuel Consumption (gallons/hr)</b>	14.62	15.83
<b>Fuel Difference</b>		8%

<b>5. Fuel Efficiency</b>		
<b>Dozer Production (bcy/hr)</b>	421	411
<b>Fuel Consumption (gallons/hr)</b>	17.03	18.44
<b>Fuel Efficiency (bcy/gallon)</b>	24.75	22.28
<b>Fuel Efficiency difference</b>	11%	

<b>6. Fuel Savings</b>		
<b>Annual Dozer Operating Hours</b>	4000	4000
<b>Average Production Rate (bcy/hr)</b>	300	300
<b>Total Volume per year (bcy)</b>	1,200,000	1,200,000
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<b>Fuel cost per gallon (\$/gal)</b>	2.20	2.20
<b>Total Fuel Expense per year (\$)</b>	\$ 106,653	\$ 118,516
<b>Mirencó C-Max Savings</b>	\$ 11,863	
<b>Tractor Ownership (year) 10</b>	\$ 118,634	







# MIRENCO – MDEP BASELINE

Wayne Supply Engine Lab (Louisville)

Evaluation Date: 7/23/2009



Equipment # ABK0649

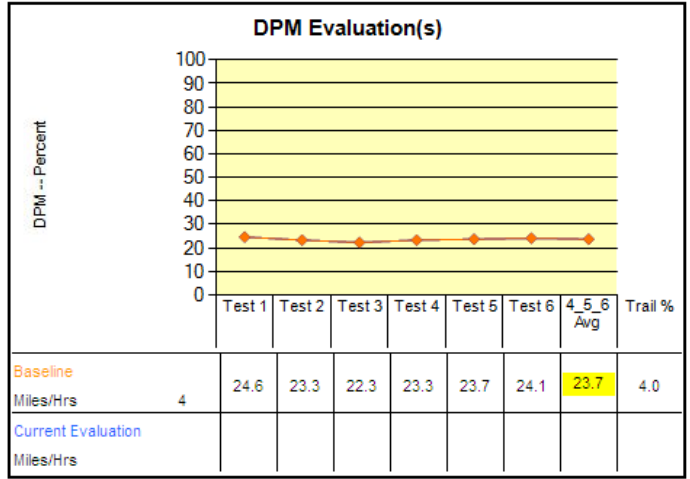
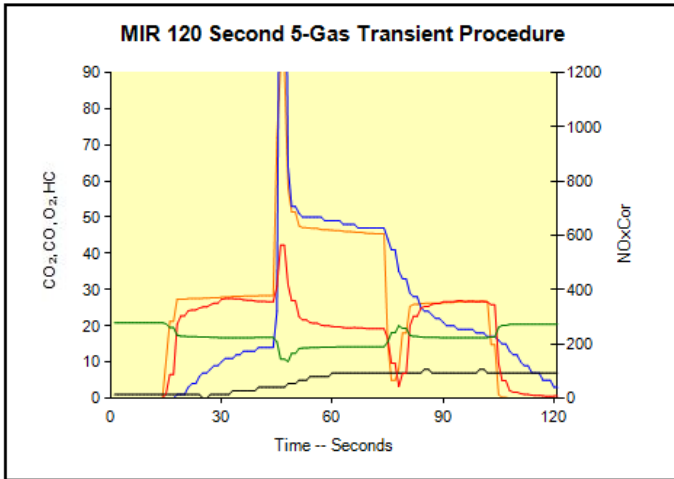
Equipment Reference #

Evaluation Type: Baseline

Year:	2001	Engine mfr:	Caterpillar
Vehicle type:	Dozer	Engine model:	3408
Vehicle model:	D9R	Injection type:	E
OEM SN:		Fuel type:	No data
Stack position:	Single	Engine position:	Single

Annual fuel consumption (gal):		90,000
Average DPM Density (%):	Baseline	23.7
Calculated fuel loss (gal):	7/23/2009	4,267
Calculated DPM produced (lbs.):		1,728
Average DPM Density (%):	Current Evaluation	23.7
Calculated fuel loss (gal):	7/23/2009	4,267
Calculated DPM produced (lbs.):		1,728

CO <sub>2</sub> % X 10	HC ppm	O <sub>2</sub> %
CO % X 1000	NO <sub>x</sub> Corr ppm	



**Recommendations:**

Evaluation results indicate the engine is injecting more fuel than it can burn during engine acceleration. Recommend installing C-Max to reduce fuel loss.

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 Mirenc0's recommendations should be initiated at the discretion of the vehicle owner.



# MIRENCO – MDEP C-MAX INSTALL

Wayne Supply Engine Lab (Louisville)



Equipment # ABK0649

Evaluation Date: 7/23/2009

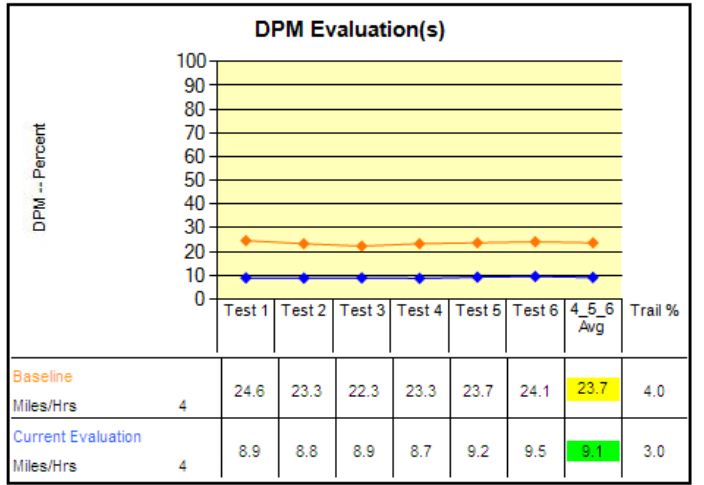
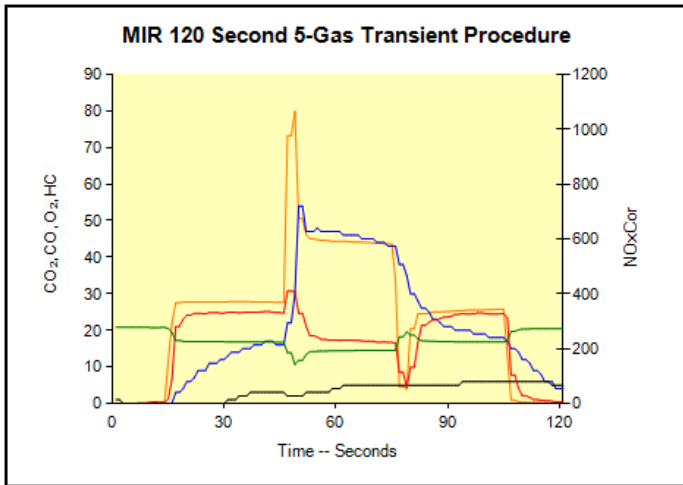
Equipment Reference #

Evaluation Type: Install CMax

Year:	2001	Engine mfr:	Caterpillar
Vehicle type:	Dozer	Engine model:	3408
Vehicle model:	D9R	Injection type:	E
OEM SN:		Fuel type:	No data
Stack position:	Single	Engine position:	Single

Annual fuel consumption (gal):		90,000
Average DPM Density (%):	Baseline	23.7
Calculated fuel loss (gal):	7/23/2009	4,267
Calculated DPM produced (lbs.):		1,728
Average DPM Density (%):	Current Evaluation	9.1
Calculated fuel loss (gal):	7/23/2009	1,646
Calculated DPM produced (lbs.):		667

CO <sub>2</sub> % X 10	HC ppm	O <sub>2</sub> %
CO % X 1000	NO <sub>x</sub> Cor ppm	



**Recommendations:**

No action recommended at this time.

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Mirenc's recommendations should be initiated at the discretion of the vehicle owner.



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