

Premium Diesel:  
Good for Engines, Economics, and Environment

*Haulage and Loading - 2023*



- Crown is 30-year-old specialty chemical company: HQ Gillette, WY.
  - Rebranded in fall of 2021
  - Highlights our historical AND ongoing commitment to efficiency and ESG
- Products Improve Operational Efficiencies and Reliability
  - Dust Control (road and material handling)
  - Coal Anti-Oxidant (steam & metallurgical, Barges and Rail)
  - Underground Road Stabilization
  - Mine Water Treatment (pH control, flocculants)
  - CRT® Fuel Catalyst
- Markets Served:
  - Hard Rock & Coal Mining
  - Oilfield

Gallons of Diesel Treated

1 2 6 5 5 8 8 0 9

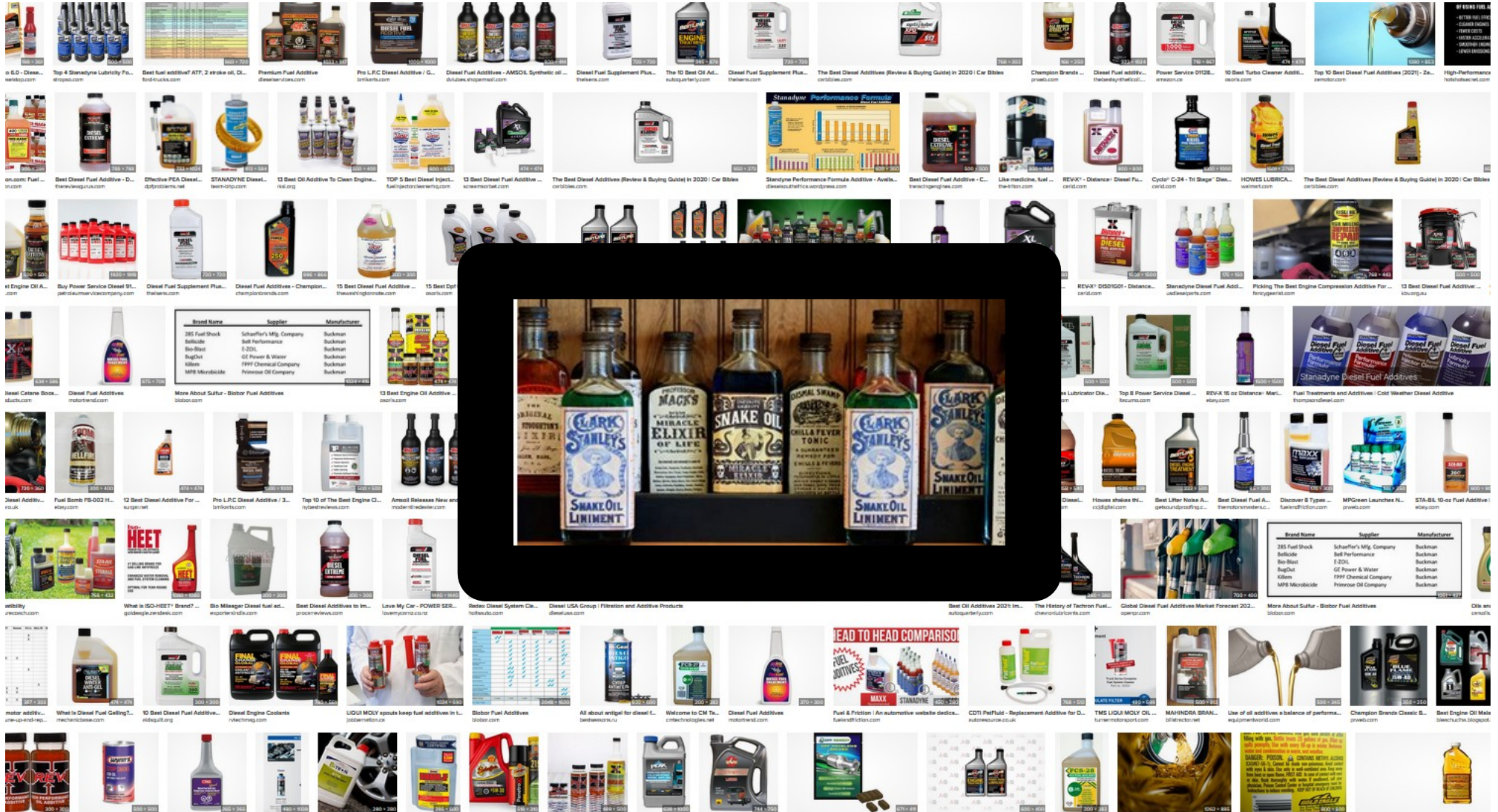
Gallons of Fuel Saved

1 0 1 2 4 7 0 4

Tons of CO2 Prevented

1 1 3 3 9 7







# Fuel Additives

- Diesel must meet ASTM D975 & OEM Specs.
  - Consumer pressure drives compliance to a minimum
- Diesel feedstocks dictate:
  - API/density
  - Cetane
  - Lubricity
  - Distillation, etc.
- Premium Diesel can be achieved

Flash Point	D93	° Celsius
Water & Sediment	D2709	% by vol.
Distillation - 90% recovered	D86 / D7345	° Celsius
Distillation - Init boiling point	D7345	° Celsius
Distillation - 10% recovered	D7345	° Celsius
Distillation - 50% recovered	D7345	° Celsius
Distillation - Final	D7345	
<b>Viscosity @ 40°C.</b>	<b>D445</b>	<b>mm<sup>2</sup> / sec.</b>
Ash Content	D482	% by mass
Sulfur Content	D5453	mg/kg (ppm)
Copper Strip Corrosion, 50C, 3hrs	D130	Rating
<b>*Cetane Number</b>	<b>D613</b>	<b>Cetane #</b>
Cetane Index w/ API Gravity	D976	Cetane Index
**Hydrocarbon Types by FIA	D1319	% by vol.
Cloud Point	D2500	° Celsius
Carbon Residue, 10% bottoms	D524	% by mass
<b>Lubricity by HFRR</b>	<b>D6079</b>	<b>Microns</b>
Electrical Conductivity	D2624	pS / meter
FAME Biodiesel Content	D7371M	% by vol.
API at 60C	D4052	
Cold Filter Plugging Point	D6371	
Pour Point	D7346	° Celsius

# Premium Diesel:

- Reduces Fuel Consumption and Net Cost
  - Gallons per ton mile, GPH, Gallons per LB, etc.
  - Lower CO<sub>2e</sub> per unit of work
- Extends Engine Life
  - Cleaner Oil
  - Improved fuel component life
- Lowers Scope Emissions
  - EIA.gov -> 22.4# CO2/gallon diesel
  - ESG scorecard lists carbon intensity by fuel type
  - Improves ESG



- Cetane indicates ignition properties of fuel
  - Increased Cetane Improves Efficiency, Emissions
  - OEMs set minimums for Cetane: 40 CI
  - Premium diesel raises cetane 3-6#

## Workings [\[edit\]](#)

Due to its chemical composition, a Cetane Improver additive has the faculty to decompose itself at lower temperature than Diesel fuel. The additive's [exothermic](#) decomposition leads to successive fuel reactions that result in the start of the combustion at low temperature.<sup>[2]</sup>

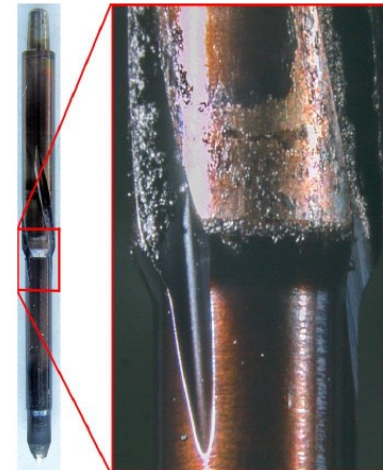
## Advantages [\[edit\]](#)

By reducing ignition time, Cetane Improver additives affect engine emissions,<sup>[10]</sup> and guarantee:<sup>[11]</sup>

- **Lower fuel consumption:** as the fuel takes longer to burn completely, less fuel needs to be injected for the same performance
- **Quicker start-up with less smoke:** easier and faster combustion affects smoke emissions, especially on the long term
- **Better cold start:** fuel ignites more easily
- **Less engine knock and noise:** as the fuel is quick to ignite, it also burns longer, which allows the pressure to rise more smoothly in the chamber
- **Wear reduction:** better combustion leads to minimum deposits and lower engine wear

# Deposit Control & Removal

- Rack/Pipeline fuel
  - No set ASTM requirement
  - Applied at minimum levels
- Multi-functional detergents maintain and restore lost power
  - Improved injector spray pattern
- 1-2% fuel efficiency gains can be attributed to restored injector performance



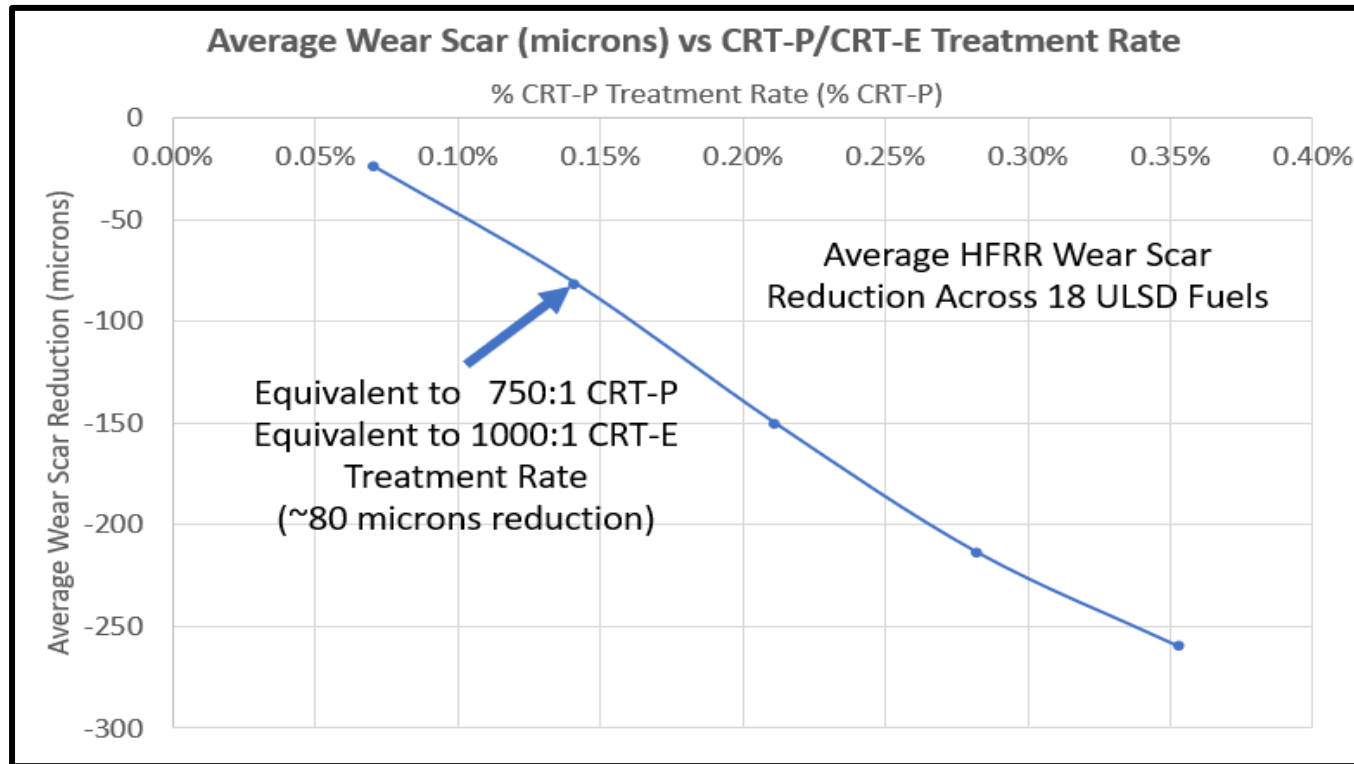
Internal Deposits

External Deposits





# Lubricity Improvement



**60 micron improvement reduces injector failure >70%**



- Tier II vs Tier IV Emissions Reductions
  - Injection timing, frequency, pressure
  - Increased after treatment, engineering controls
    - DOC - Diesel Oxidation Catalyst
    - SCR - Selective Catalyst Reduction
    - DPF - Diesel Particulate Filter
    - EGR - Exhaust Gas Recirculation
    - Results in lower PM, NO<sub>x</sub>, CO, VOCs
  - Catalysts in exhaust system reduce emissions
    - Do they lower fuel consumption? (not really)
- **What about Fuel Borne Catalysts?**

# CRT Catalytic Action

- **Chemically stable** – in solution rather than in suspension as oxide
- **Storage** not prone to separation / sedimentation
- **Tolerant** of environmental extremes
- **Small particle size (sub-nanometer)** - enhanced blending with diesel fuel

Solution

Ion

- **High thermal transfer** – enhances diesel fuel vaporization and distribution in-cylinder
- Reactions begin at **lower temperatures and continue** over a wider temperature range
- **Readily accessible Ion form** promotes immediate anion interaction

- **Catalyzation** effects continue through combustion phases to provide enhanced combustion and emissions reduction
- **Oxide** formed in combustion - works synergistically
- **Catalyst** as an efficient oxygen carrier
- **Redox reactions** - allow sustained catalytic action lowering NOx
- **Combustion Enhancement:** Emissions

Oxide State



# CRT Catalyst Highlights

## 6-12% Diesel Fuel Reduction Technology

- Fuel savings typically exceeds cost of product by 2 times (2x ROE)
- No capital cost, rapid deployment, and readily scalable

## Quantifiable ESG Improvement Technology

- Less Fuel Burned = less CO<sub>2</sub>
- All harmful emissions, including GHGs, are reduced with no trade-off emissions
- CO<sub>2</sub> reductions at a net savings

## Safe for Use in All Diesel Engines

- Compliant with all major OEM fuel specifications and ASTM D975
- Improves oil properties, reduces injector failures, and extends asset life

## CRT<sup>®</sup> Fuel Borne Catalyst Component Contribution

### **1. Fuel Borne Combustion Catalyst (+3-6% efficiency)**

- Significantly accelerates overall combustion of fuel *in cylinder*
- *Increases* oxidation of soot, hydrocarbons, CO, etc.
- Lowers Carbon Oxidation Temperature

### **2. Cetane Improver (+2-4% efficiency)**

- Lowers ignition pressure/temperature for combustion
- Works synergistically with catalyst ion to advance timing of combustion

### **3. Detergent & Lubricant (+1-2% efficiency)**

- Restores Injector Spray pattern
- Improves fuel lubricity 10-20%

**Added Bonus: Healthier Engine Components (Oil, Injectors)**



# CRT<sup>®</sup> Offerings to Upgrade Diesel

## CRT<sup>®</sup> - E Endurance 1000:1

- Maximum fuel efficiency for straight diesel engines
- Plus Premium Maintenance benefits and Lowered Emissions

## CRT<sup>®</sup> - PM Premium Maintenance 2000:1

- Premium soot reduction, Improved Lubricity, and Detergent
- Very good fuel efficiency and emissions reduction
















## CRT<sup>®</sup> - Clear 1000:1

- On-Road EPA listed formulation
- Very good soot reduction, Improved DPF Regeneration

## CRT<sup>®</sup> - P Premium 750:1

- Formulated for Dual Fuel engines (diesel and natural gas)
- Maximum fuel efficiency and emissions reduction

# SOOT Oxidation Test

	CRT Premium	CRT Endurance	CRT-Clear Catalyst	Competitor CB, L, D	Soot Only (Control)
450C					
500C					
550C					



# Reduced Visible Emissions with CRT P



Before  
2/21/2022

19 ea Tier II Cat 3512  
powered frac pumps



After  
3/8/2022



# Tier IV 2015 Cummins Oil after CRT



• 2K Miles since oil change



• 4K Miles since oil change



• 9K Miles since oil change



- 2015 Tier IV Cummins
- 180,000 miles
- CRT-E splash blended



# Surface Mine 3: Oil Property Improvement 7 months CRT Catalyst Use (5.2022)

- Oil: Chevron 15W-40

Engine Type	# of Samples		Soot		Iron		Silica		Lead		Copper	
	Baseline	CRT	Baseline	CRT	Baseline	CRT	Baseline	CRT	Baseline	CRT	Baseline	CRT
<b>CAT Avgs</b>	962	271	9.62	5.79	13.52	11.71	4.90	4.79	0.89	0.70	27.78	6.00
<b>% Difference</b>			-40%		-13%		-2%		-21%		-78%	
<b>Cummins Avgs</b>	149	49	11.72	8.27	6.06	5.76	3.84	3.27	1.44	0.33	4.08	0.35
<b>% Difference</b>			-29%		-5%		-15%		-77%		-91%	

*Baseline January 2019 - February 2021*

*CRT Performance November 2021 - May 2022*

*Outliers removed for fluid hours (< 90 hours and > 1500 hours excluded)*

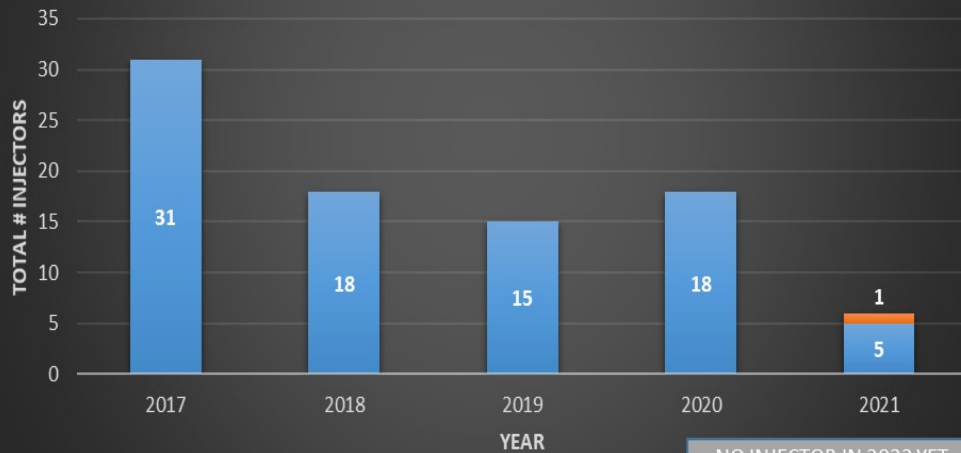
*Samples were taken at 300 hours on average*

## PRB Surface Coal Mine – 11-month case study

### TOTAL # INJECTORS REPLACEMENT - D11

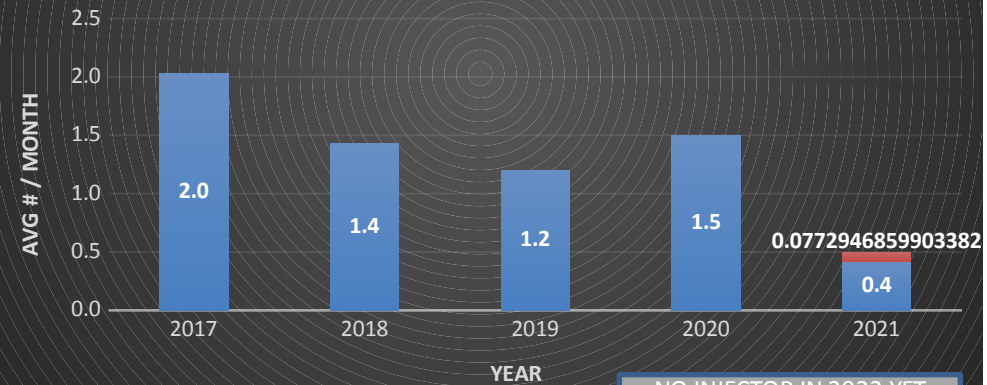
AFTER TREATMENT STARTED MAY 2021  
(Average 9 dozers operating per month)

■ BEFORE TREATMENT ■ AFTER TREATMENT



### AVG # INJECTORS/ MONTH - 830E \*\*\*BASED ON 14 TRUCKS\*\*\* (average 13-14 trucks operating per month)

■ BEFORE TREATMENT ■ AFTER TREATMENT



- Injector replacements have dropped significantly
  - 15 Expected in 2021 – Only 1 replaced (90% reduction)
  - Zero replacements in 2022 YTD



# Haul Truck Case Study – Coal Mining

Equipment	Material	20/21 Avg	2022 Avg	% Diff	Coal Diff	Dirt Diff
830E	Coal	30.3	27.6	-9.0%	<b>-8.2%</b>	<b>-4.8%</b>
MT4400	Coal	39.5	34.7	-12.2%		
793D	Coal (90%)	33.9	32.1	-5.4%		
797B	Dirt	55.9	52.4	-6.2%		
797F	Dirt	55.9	53.9	-3.5%		
<b>Overall</b>		<b>45.7</b>	<b>43.0</b>	<b>-6.0%</b>		

- Baseline: January 2020 - October 2021
- Treated: December 2021 – September 2022
- 3.0% Net fuel savings ( >2:1 Return) on haulage fleet  
– **\$332,000 net savings through September**
- Coal Trucks represent 42% of haulage hours

# Controlled Flow Loop Dyno – Tier IV Diesel

## Testing Procedure

- Tier IV Cat 3512e, 4<sup>th</sup> gear, 1900 rpms
- High accuracy supply & return flow meters
- Kept parasitic loads constant

## Baseline – 5 Hours

- 5 set of Test cycles: 50% and 75% loads for 30 mins

## Conditioning – 30 Hours

## Treated – 5 Hours

- 3 sets of cycles treated with CRT-P at 750:1
- 2 sets of cycles treated with CRT-E at 1000:1

## Conclusions

**CRT-P: 7.4%** reduction in fuel

**CRT-E: 6.1%** reduction in fuel

Reduction in **ALL** harmful emissions



	Emissions		
	Baseline	CRT	% Diff
<b>O2</b>	15.9 %	16.3 %	<b>2.5%</b>
<b>CO</b>	12.9 ppm	8.4 ppm	<b>-34.9%</b>
<b>NO</b>	130 ppm	112 ppm	<b>-13.8%</b>
<b>NO2</b>	3.5 ppm	0.1 ppm	<b>-97.1%</b>
<b>CxHy</b>	410 ppm	324 ppm	<b>-21.0%</b>
<b>CO2</b>	4.6 %	4.3 %	<b>-7.4%</b>



# Deployment is Easy with EZ Add<sup>®</sup>

## EZ Add Auto Dosing System

- Integrates into any bulk storage
- Dispenses on delivery to bulk tank
- No additional personnel on site
- Treats up to 500k+ USG per fill-up
- Remote Access – Verizon
- Double Wall DOT certified tank
- Differentiated offering vs competition



# Economic and ESG Savings Model

Economic Analysis	Diesel Cost per gallon: \$4.00			
	Baseline	6%	7%	8%
Estimated Fuel Consumption	10,000,000	9,400,000	9,300,000	9,200,000
Fuel Spend	\$40,000,000	\$37,600,000	\$37,200,000	\$36,800,000
Fuel Catalyst Cost	\$0	\$1,128,000	\$1,116,000	\$1,104,000
Total Fuel Spend	\$40,000,000	\$38,728,000	\$38,316,000	\$37,904,000
<b>Net Fuel Savings \$</b>	<b>\$0</b>	<b>\$1,272,000</b>	<b>\$1,684,000</b>	<b>\$2,096,000</b>
<b>Net Fuel Savings %</b>	<b>0.0%</b>	<b>3.0%</b>	<b>4.0%</b>	<b>5.0%</b>
<b>ROE</b>	<b>0.0 x</b>	<b>2.1 x</b>	<b>2.5 x</b>	<b>2.9 x</b>
<b>Breakeven Efficiency</b>	<b>0.0%</b>	<b>3.00%</b>	<b>3.00%</b>	<b>3.00%</b>
<b>CO<sub>2</sub> Reduction (tons)</b>	<b>0</b>	<b>6,720</b>	<b>7,840</b>	<b>8,960</b>
<b>\$/ton CO<sub>2</sub> Savings</b>	<b>\$0</b>	<b>-\$189</b>	<b>-\$215</b>	<b>-\$234</b>



# Crown CRT<sup>®</sup> Catalysts: Premium Diesel Upgrade

- Engines
  - Cleaner engine oil benefits asset life
  - Reduced injector failures
- Economics
  - Provides \$2 in fuel savings per \$1 cost (2:1 ROE)
  - Maintenance savings
- Environment
  - 6-12% measurable emissions eliminated (CO<sub>2</sub>e)
  - Plus reduced Soot, CO, Nox, VOCs