# EVALUATION OF CV 100 FUEL COMBUSTION CATALYST ONBOARD THE TUGBOAT BRAHMA

Prepared for Tidewater Marine
by UHI Corporation
in cooperation with
Tidewater Marine

August 17, 1982

## INTRODUCTION

Arrangements were made between Tidewater Marine and UHI Corporation to conduct an exhaust gas analysis and engine performance (fuel economy) study onboard an inshore tug. The purpose of the study was to document the changes in exhaust gas composition and in fuel economy resulting from the addition of CV 100 Fuel Combustion Catalyst to the No. 2 diesel fueling a boat's main engines.

The Brahma was selected as a test boat, representative of the inshore tug fleet. A UHI technician with analytical equipment boarded the Brahma on July 23, 1982, and collected engine performance data (exhaust emissions) using untreated fuel. On August 13, 1982, duplicate procedures were followed and data collected with treated fuel.

Analytical Equipment: Sun Electric MGA-90 Multiple Gas Analyzer

Vessel Specification:

| | |
|---|---|
| Name: Brahma | Main Engines: 2 GM Model V871 |
| Class: 600 HP Twin Screw Supply Tug | Maximum HP: 700 @ 2300 RPM |
| Length: 70 feet | Continuous HP: 460 @ 1800 RPM |
| Beam: 26 feet | Gears: Twin Disc 4.5:1 |
| Load Draft: 6 feet | Propellers: 54" Dia x 34"-Pitch Blade |
| Light Draft: 5 feet | Speed: 9 MPH |
| Fuel Consumption: 30 Gal/Hr. | |

## METHODOLOGY

Tom Medynski and Dan Gaiennie, engineers for Tidewater Marine, and Craig Flinders, UHI Technician, conducted baseline testing onboard the tugboat Brahma on July 23, 1982. Using the Sun Electric MGA-90 four gas analyzer, baseline exhaust gas levels of carbon monoxide (CO), carbon dioxide ($CO_2$), unburned hydrocarbons (HC) and oxygen ($O_2$), were recorded using the following procedure.

1) Starboard and port main engines brought up to temperature.

2) Exhaust readings taken at 1700, 1500 and 1200 RPM's while pushing against the dock to simulate load of working conditions.

3) Exhaust readings taken at 1700, 1500 and 1200 RPM's while traveling downriver to simulate load of cruise conditions.

4) Exhaust readings taken at 1700, 1500 and 1200 RPM's while traveling upriver to simulate load of cruise conditions against the current.

After the baseline readings were taken, number one and two fuel tanks, and the day tank were treated with CV 100 at a ratio of one gallon of CV 100 to 1600 gallons of fuel. The Brahma ran for 107 hours with treated fuel before Tidewater and UHI personnel returned to record test data. Readings (with CV 100) were then taken using the same procedures as baseline. Baseline data was read from the MGA-90 meters by both Tidewater and UHI personnel. The "treated" portion of the tests was recorded by Dan Gaiennie of Tidewater.

It should be noted that the MGA-90 analyzers are intended for use with gasoline engines. Application to measuring diesel engine exhaust could introduce some error due to the low scale readings observed and possible particulate interference.

DATA ANALYSIS

The emissions data may be used to determine relative efficiency values using a carbon balance for a given engine if certain assumptions are made. If it is assumed that the steady state engine operating point, (torque and speed), and ambient conditions remain unchanged from one test to another, then exhaust emissions data can be used to indicate an efficiency change due to modifications.

Since the exhaust mass flow is not available in a field test of this kind, absolute values of fuel efficiency cannot be determined using the carbon balance technique. Therefore, a "performance factor" can be calculated for each test which is based on the above assumptions and is related to fuel efficiency.

The performance factor may be calculated according to the following relation:

$$\text{Performance Factor} = \frac{2553.5}{[0.86\ (\text{ppmHC}) + 0.429\ (\text{Vol\%CO}) + 0.273\ (\text{Vol\%CO}_2)]}$$

## OBSERVATIONS

### FILTERS

The MGA-90 is equipped with two outside filters that collect particulates which prevents blockage of hoses, filters, and analyzers inside the unit. UHI technicians added an additional 25 micron filter to the sampling hose to assist the other 49 micron filters. During the baseline tests, one on-line filter (previously used in other testing) was plugged by particulates. A new filter was installed, replacing the plugged filter; mid-way through the rest of the baseline testing, this filter plugged also. The baseline was finished without a filter on the sampling hose.

During the CV 100 tests a new filter was installed and used throughout the balance of the study. Unlike the baseline tests, it remained free of carbon particulate plugging and "black discoloration".

### EXHAUST PLUME

UHI and Tidewater Marine engineers, observed a heavy black exhaust plume during baseline evaluations. Accompanying those exhaust emissions, was a black particulate that blew into the atmosphere, falling to rest on the ship as well as surrounding areas.

Followup testing showed drastic reductions in visual exhaust content upon completion of a 107 hour test using CV 100. The particulate observed during the baseline was greatly diminished along with a reduction in harmful exhaust emissions.

The heavy black exhaust plume had diminished with CV 100 to a grey, less dense cloud.

## CONCLUSIONS

The carbon balance technique used in this report is recognized as one of the most accurate methods of assessing fuel economy when applied under controlled conditions. It is based upon changes in exhaust emissions concentrations at a specific load and with a certain fuel type. The specific reductions in carbon containing exhaust constituents, as recorded by Tidewater Marine engineers, demonstrates an improvement in fuel consumption in the two 8V-71 engines powering the Brahma while using CV 100.

The performance factors, (with qualifying assumptions), also indicate an improvement in fuel economy with CV 100. The percentage change in fuel consumption of CV 100 treated fuel over untreated fuel is in excess of thirty percent with uncertainty at all RPM levels. This unusually high fuel economy improvement may, to some extent, be a result of variables in load that occur in field testing, and a normal drift with NDIR analyzers, (MGA-90), could have occurred. Also, the HC and CO concentrations from the diesel were measured on the extreme low end of the analyzer scales which could give rise to both recording and detector errors. These uncertainties have not been quantified, so absolute accuracies cannot be determined. It is likely that the mechanical and calculated results show a real trend in improved fuel economy with CV 100.

The levels of all harmful emissions were reduced; unburned hydrocarbons and carbon monoxide were reduced to nearly half of untreated levels with CV 100. Smoke and particulates were also reduced, based on visual observations made by UHI and Tidewater personnel.

The performance factors may be scaled to be closer to actual MPG values by a common factor which is based on dynamometer exhaust flow and temperatures data and fuel specific gravity and carbon to hydrogen ratio. Each performance factor was scaled by the same coefficient for a given test type so that percentage changes were unaffected.

Table 1 summarizes the emissions data from the tugboat field tests work in the calculations for relative efficiency. Dynamometer data for the 8V-71 Detroit Diesel are shown in Table 2; from which the constant scaling factor was determined. The scaled performance factors for each RPM and test type with and without CV 100 are listed on Table 3.

# TABLE 1
## Emissions Data

| DATA PAGE | MODE | RPM | CV 100 | $CO_2$% | $O_2$% | CO% | HC ppm |
|---|---|---|---|---|---|---|---|
| 1 | Pushing Starbd | 1700 | No | 4.73 | 12 | 0.053 | 21.5 |
| 2 | Pushing Port | 1700 | No | 4.33 | 12.2 | 0.188 | 19 |
| 3 | Pushing Starbd | 1700 | Yes | 3.0 | 13.4 | 0.06 | 14.33 |
| 3 | Pushing Port | 1700 | Yes | 2.9 | 13.4 | 0.143 | 14 |
| 4 | Pushing Starbd | 1500 | No | 3.17 | 15.0 | 0.023 | 20 |
| 5 | Pushing Port | 1500 | No | 2.97 | 15.3 | 0.015 | 20 |
| 6 | Pushing Starbd | 1500 | Yes | 1.93 | 15.3 | 0 | 15 |
| 6 | Pushing Port | 1500 | Yes | 1.83 | 15.3 | 0 | 15 |
| 7 | Pushing Starbd | 1200 | No | 2.33 | 16.8 | 0.01 | 19.3 |
| 7 | Pushing Port | 1200 | No | 2.0 | 17.3 | 0.01 | 19.0 |
| 8 | Pushing Starbd | 1200 | Yes | 1.08 | 17.9 | 0 | 12.8 |
| 8 | Pushing Port | 1200 | Yes | 1.1 | 17.8 | 0 | 13.2 |
| 9 | Upriver Port | 1700 | No | 3.22 | 14.97 | 0 | 20 |
| 9 | Upriver Starbd | 1700 | No | 3.04 | 15.1 | 0 | 20 |
| 10 | Upriver Port | 1700 | Yes | 1.51 | 17.3 | 0 | 11.3 |
| 10 | Upriver Starbd | 1700 | Yes | 1.2 | 18.1 | 0 | 11.2 |
| 11 | Upriver Port | 1500 | No | 2.06 | 16.5 | 0 | 20 |
| 11 | Upriver Starbd | 1500 | No | 1.9 | 17.3 | 0 | 20 |
| 12 | Upriver Port | 1500 | Yes | 0.94 | 18.8 | 0 | 11 |
| 12 | Upriver Starbd | 1500 | Yes | 0.8 | 19.2 | 0 | 11 |
| 13 | Upriver Port | 1200 | No | 1.35 | 18.0 | 0 | 19.5 |
| 13 | Upriver Starbd | 1200 | No | 1.42 | 17.75 | 0 | 20.0 |
|  | Upriver | 1200 | Yes | NO DATA |  |  |  |
|  | Upriver | 1200 | Yes | NO DATA |  |  |  |
| 14 | Downriver Port | 1700 | No | 2.9 | 15.4 | 0 | 20 |
| 14 | Downriver Starbd | 1700 | No | 2.79 | 15.5 | 0 | 20 |
| 15 | Downriver Port | 1700 | Yes | 1.53 | 17.3 | 0 | 11 |
| 15 | Downriver Starbd | 1700 | Yes | 1.29 | 17.8 | 0 | 11 |
| 16 | Downriver Port | 1500 | No | 2.3 | 16.5 | 0 | 19 |
| 16 | Downriver Starbd | 1500 | No | 2.25 | 16.4 | 0 | 19.5 |
| 17 | Downriver Port | 1500 | Yes | 1.1 | 18.6 | 0 | 10.9 |
| 17 | Downriver Starbd | 1500 | Yes | 0.86 | 18.9 | 0 | 10.8 |
| 18 | Downriver Port | 1200 | No | 1.56 | 17.6 | 0 | 19 |
| 18 | Downriver Starbd | 1200 | No | 1.66 | 17.3 | 0 | 18.2 |
| 19 | Downriver Port | 1200 | Yes | 0.71 | 19.3 | 0 | 11.3 |
| 19 | Downriver Starbd | 1200 | Yes | 0.6 | 19.5 | 0 | 11.0 |

## TABLE II

### Detroit Diesel Dynamometer Studies Under Load
### 8V-71 Exhaust Flow and Temperature Data

| | 1200 RPM | 1500 RPM | 1700 RPM |
|---|---|---|---|
| Exhaust Temperature | 760° F | 770° F | 775° F |
| Intake Airflow | 510 CFM | 630 CFM | 710 CFM |
| Exhaust Flow | 1140 CFM | 1420 CFM | 1610 CFM |

Cubic Inch Displacement - 568

TABLE III

Scaled Performance Factors

| Mode | RPM | CV 100 | Performance Factor* | |
|---|---|---|---|---|
| PS | 1700 | No | 1.24 | 35% |
| PS | 1700 | Yes | 1.92 | |
| PP | 1700 | No | 1.34 | 30% |
| PP | 1700 | Yes | 1.94 | |
| PS | 1500 | No | 1.72 | 35% |
| PS | 1500 | Yes | 2.64 | |
| PP | 1500 | No | 1.80 | 34% |
| PP | 1500 | Yes | 2.72 | |
| PS | 1200 | No | 2.20 | 35% |
| PS | 1200 | Yes | 3.41 | |
| PP | 1200 | No | 2.43 | 39% |
| PP | 1200 | Yes | 3.97 | |
| US | 1700 | No | 1.74 | 55% |
| US | 1700 | Yes | 3.86 | |
| UP | 1700 | No | 1.68 | 50% |
| UP | 1700 | Yes | 3.35 | |
| US | 1500 | No | 2.36 | 52% |
| US | 1500 | Yes | 4.91 | |
| UP | 1500 | No | 2.26 | 50% |
| UP | 1500 | Yes | 4.54 | |
| DS | 1700 | No | 1.84 | 50% |
| DS | 1700 | Yes | 3.72 | |
| DP | 1700 | No | 1.80 | 46% |
| DP | 1700 | Yes | 3.35 | |
| DS | 1500 | No | 2.17 | 54% |
| DS | 1500 | Yes | 4.79 | |
| DP | 1500 | No | 2.16 | 48% |
| DP | 1500 | Yes | 4.19 | |
| DS | 1200 | No | 2.75 | 52% |
| DS | 1200 | Yes | 5.79 | |
| DP | 1200 | No | 2.78 | 47% |
| DP | 1200 | Yes | 5.30 | |

* Performance Factor is roughly same as miles/gallon. See list of assumptions for further information.

APPENDIX A

SUMMARY REVIEW - EFFECT OF
CV 100 IN INTERNAL COMBUSTION ENGINES

## Background

The combustion related efficiency of an internal combustion engine may be increased in two independent ways. First, the hydrocarbon fuel may be more completely burned in the combustion chamber, with a theoretical exhaust gas consisting of carbon dioxide, water vapor and nitrogen. Actual engine exhaust contains small concentrations of carbon monoxide and unburned hydrocarbons as well as other products of incomplete combustion and molecular dissociation. For a typical engine, the conversion of carbon monoxide to carbon dioxide, and conversion of unburned fuel to water vapor and carbon dioxide, represents a potential improvement in combustion efficiency of up to approximately 3%.

Second, the combustion process may occur completely when the piston is at or just past top dead center, corresponding to minimum combustion chamber volume in a spark ignition engine. Thus, the combustion energy is released to obtain maximum combustion pressure rise for greatest contribution to crankshaft torque. (The ideal cycle theorizes combustion heat release at constant pressure as the piston moves downward, due to the interval during which fuel is injected into the combustion chamber.) Because combustion requires a finite time period for preflame reactions, ignition and flame propagation, the actual combustion related engine efficiency is reduced from the hypothetical ideal case which models these processes as occurring instantaneously. A reduction in combustion losses without destructive rates of pressure rise results in improved efficiency as the engine operates more closely to the ideal Otto (spark ignition) or Diesel thermodynamic cycle.

## CV 100 Effect

The presence of CV 100 in a hydrocarbon fuel seems to affect both the completeness of combustion and the time required for combustion. While detailed combustion studies with CV 100 have not been conducted to date, a model of the CV 100 mode of action which fits observed data may be formulated.

CV 100 has an affect on the amount of fuel which can be burned in a given time period in an engine cylinder. Thermal decomposition of the ferrous picrate molecules in CV 100 in the combustion chamber provides catalytic iron surfaces and picrate molecules which become available to act as localized ignition sources. Assuming that the CV 100 is uniformly dispersed in the fuel/air mixture, the mixture becomes subject to a multitude of ignition sources after the initial expanding flame kernel begins to propagate from the spark plug tip.

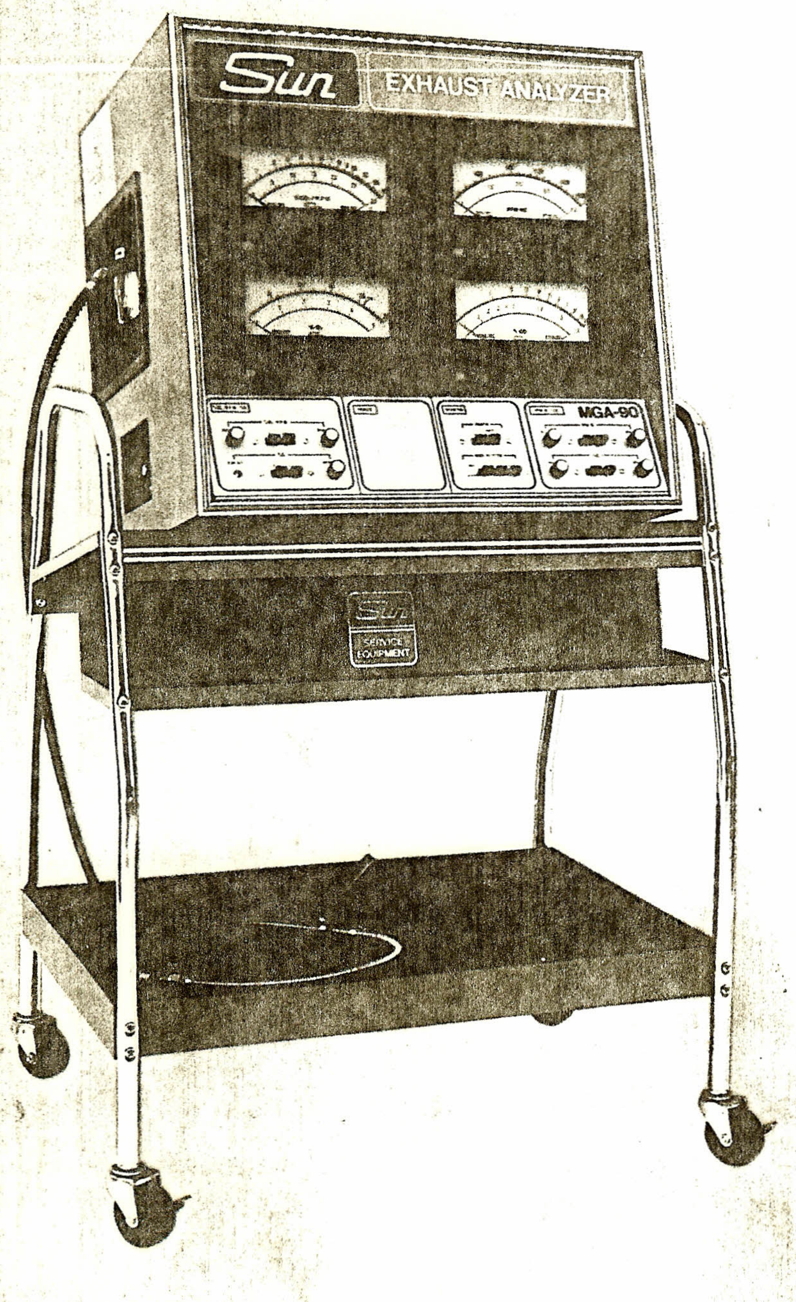
The resulting inflammation is more uniform than that produced by a single propagating flame front, thus increasing the amount of fuel burning when the piston is near top dead center. This effectively decreases the time required for combustion of all the fuel in the compressed mixture, which increases the energy conversion efficiency of the processes.

The consistent reduction in carbon monoxide emissions with CV 100 in automobiles, an effect which is expected with the ferrous form of the iron ion in CV 100, indicated a potentially measurable increase in combustion efficiency. The unburned hydrocarbon fuel may be reduced only slightly with CV 100 but combustion efficiency can still increase due to a strong dependence on carbon monoxide conversion to carbon dioxide,

APPENDIX B

Sun.

# MULTIPLE GAS ANALYZER




## MGA-90

THE DIAGNOSTIC FUTURE

# BID DESCRIPTION

The MGA-90 Multiple Gas Analyzer is a solid-state, non-dispersive infrared exhaust analyzer with four (4) 8-inch (20 cm) analog meters. This power sampling system is designed to measure hydrocarbons (HC), carbon monoxide (CO), oxygen ($O_2$) and carbon dioxide ($CO_2$) in the exhaust of gasoline-driven internal combustion engines. It also provides an analog read-out of rpm from 0-3000 rpm in 10 rpm increments. Gas calibrated with automated leak detection. The MGA-90 includes a PTS-33 test stand. It can also be mounted overhead from a rail using an optional head suspension kit.

California Bureau of Automotive Repair approved.

Specify MGA-90 Multiple Gas Analyzer or equivalent.

# SPECIFICATIONS

**Meters** — Four, 8-inch (20 cm), fluorescent back-lighted, D'Arsonval-jeweled bearing movement, tamper-proof with 400% overload protection. All scales have indicator lights.

**%$O_2$ Meter** — Two scales: 0-5%; 0-25%.

**PPM HC Meter** — Two scales: 0-400 ppm; 0-2000 ppm.

**%CO Meter** — Two scales: 0-2%; 0-10%.

**%$CO_2$/RPM Meter** — Two scales: 0-16% $CO_2$; 0-3000 rpm.

**Tester Controls** — Color-coded pushbutton, switch and potentiometer controls for total front panel control of all functions.

**Warm-Up** — 15 minutes @ 70°-110°F; 20 minutes @ 35°F for total system readiness.

**System Accurac'** HC, CO, $O_2$ & $CO_2$: ± 3% of full scale.

**Temperature Range** — 35° to 120° F operating; -20° to 130°F storage.

**Relative Humidity** — Up to 85% non-condensing.

**Interference Effects** — Less than ± 10 ppm HC or ± .05% CO of full scale (low range).

**System Response Time** — 8 seconds for 90% response of full scale.

**Drift** — ± 3% of full scale in one hour.

**Repeatability** — Less than ± 2% of full scale.

**Power** — 115V ac, 60 Hz @ 4.5 A.

**Circuit Protection** — Circuit breaker protection provided for the main console and infrared.

**Dimensions** — 24.5"Lx30.5"Hx18"D (62x77x46 cm)

**Weight** — 100 lbs. (45 kg).

**Construction** — All metal housing painted with blue textured and Sun Red enamel, resistant to oil, gasoline, chipping and scratching.

# ACCESSORIES INCLUDED

Stainless steel exhaust pickup probe and 25 feet (8m) of sample hose.

Anti-Dilution probe adapter.

Standard test lead with clamp-on tachometer connector.

Calibration gas bottle and mounting.

Literature including Operators Manual and Quick Reference Guide.

693-1118 (1830)

SUN ELECTRIC CORPORATION
ONE SUN PARKWAY•C TAL LAKE, ILLINOIS 60014•(815) 459-7700

Printed in U.S.A.

FIGURE I

## CARBON BALANCE TECHNIQUE

ASSUMPTIONS: $C_8H_{15}$ and SG = 0.78
Time is constant
Load is constant
RPM is constant

DATA:

pf1 = Calculated Performance Factor (Baseline)
pf2 = Calculated Performance Factor (Treated)
PF1 = Performance Factor (adjusted for Baseline exhaust mass)
PF2 = Performance Factor (adjusted for Treated exhaust mass)
T = Temperature (F°)
F = Flow (exhaust CFM)
SG = Specific Gravity
VF = Volume Fraction

$VFCO_2$ = "reading" ÷ 100
$VFO_2$ = "reading" ÷ 100
VFHC = "reading" ÷ 1,000,000
VFCO = "reading" ÷ 100

EQUATIONS:

$$1wt=(VFHC)(86)+(VFCO)(28)+(VFCO_2)(44)+(VFO_2)(32)+[(1-VFHC-VFCO-VFO_2-VFCO_2)(28)]$$

$$\text{pf1 or pf2} = \frac{2952.3 \times Mwt}{86(VFHC)+13.89(VFCO)+13.89(VFCO_2)}$$

$$\text{PF1 or PF2} = \frac{pf \times (T+460)}{F}$$

$$\text{PERCENT INCREASE (OR DECREASE IN FUEL ECONOMY} = \left(\frac{PF_1 - PF_2}{PF_1}\right) \times 100$$

5. The more correct version is based on the mass functions of exhaust constituents which are obtained by assuming that the exhaust is composed entirely of unburned HC, CO, $CO_2$, $O_2$ and $N_2$.

$$\text{mass fraction}_i = \text{volume fraction}_i \left(\frac{\text{molecular weight}}{\text{molecular weight of total mixture}}\right)$$

$$MW_t = \text{Molecular wt. of total mixture} = (\text{volfracHC})(86)+(\text{volfracCO})(28) + (\text{volfracCO}_2)(44)+(\text{volfracO}_2)(32)+(1-VF_{HC}-VF_{CO}-VF_{CO_2}-VF_{O_2})(28)$$

6. The equation becomes:

$$\text{III. P.F.} = \frac{3785\ SG}{(0.0833\ \frac{x}{y}+1)\left[\frac{1}{0.0833\ \frac{x}{y}+1}\left(\frac{86}{MW_t}\right)(\text{ppmHC})+0.429\left(\frac{28}{MW_t}\right)(\text{volfracCO})+0.273\left(\frac{44}{MW_t}\right)(\text{volfracCO}_2\ldots\right.}$$

One only needs to know mass of exhaust per mile to obtain miles per gallon. This may be calculated based on certain assumptions concerning exhaust flow and density. If the mass of exhaust per mile is not calculated, the performance factor is:

$$\text{IV. P.F.} = \frac{(3785\ SG)\ (MW_t)}{(0.0833\ \frac{x}{y}+1)\left[\frac{86}{0.0833\ \frac{x}{y}+1}(\text{ppmHC})+(12.01)\left[(\text{volfracCO})+(\text{volfracCO}_2)\right]\right]}$$

7. As mentioned above:

$$(\text{P.F.}) \times \frac{1}{(\text{Mass exhaust/mi})} = \text{MPG}$$

$$\text{Mass exhaust/mi} = \frac{(\text{velocity exhaust})(\text{area of pipe})(\text{density of exhaust})}{\text{mi.}}$$

miles traveled=(miles/min) (minutes of test)

where miles/min is obtained from equivalent vehicle velocity for a given engine speed.

8. Equation IV. is most technically correct for comparison purposes.

NOTE: Tidewater calculations based on equation II. with $C_8H_{15}$ fuel and SG=0.78. This gives:

$$\text{P.F.} = \frac{2553.5}{0.86\ (\text{ppmHC})+0.429\ (\text{volfracCO})+0.273\ (\text{volfracCO}_2)}$$

NOTE: Time of measurement must be consistent.

Dr. G.J. Germane
January, 1983

# DERIVATION OF CARBON BALANCE
# "PERFORMANCE FACTOR"

1. Based on carbon balance fuel economy:

$$F.E. = \frac{P_{cf}}{M_{ce}/D}$$

Where: $P_{cf}$ is more carbon per volume of fuel (gm/gal)
$M_{ce}$ is mass of carbon in exhaust gas (gm)
D is distance traveled (miles)

2. Assume - mass of carbon in fuel is same as mass of carbon in exhaust, and define fuel composition to be $C_yH_x$

$$F.E. = \frac{\left(\frac{12y}{x + 12y}\right) P_{C_yH_x}}{\frac{12y}{x + 12y} (gm/mi\ HC) + \left(\frac{12}{28}\right) (gm/mi\ CO) + \frac{12}{44} (gm/mi\ CO_2)}$$

Where: $P_{C_yH_x}$ = (fuel specific gravity) x (density of water)

Which equals (3785) (SG of fuel) (gm/gal)

also, $\frac{12y}{x + 12y}$ is written as $\frac{1}{0.0833 \frac{x}{y} + 1}$

3. The working formula for fuel economy then becomes:

$$I.\ F.E. = \frac{3785\ SG}{(0.0833 \frac{x}{y}+1)\left[\frac{1}{0.0833 \frac{x}{y}+1}(gpmHC)+0.429(gpmCO)+0.273(gpmCO_2)\right]}$$

F.E. = miles/gal

4. For our purposes, a fuel specific gravity must be assumed as well as a carbon/hydrogen ratio. Also, grams/mi of exhaust components is unavailable as a direct measurement. The volume fraction of the exhaust constituents is available, however, and a "performance factor" form of the equation may be written in terms of volume percent. A more technically correct form of the equation would be based on mass fraction, which is discussed next.

$$II.\ P.F. = \frac{3785\ SG}{(0.0833 \frac{x}{y}+1)\left[\frac{1}{0.0833 \frac{x}{y}+1}(ppmHC)+0.429(volfracCO)+0.273(volfracCO_2)\right]}$$

(no meaning to units obtained)

Pushing

MGA 90
Emissions Tests Analysis

Baseline Test Date July 22, '82 Treated Test Date ____________

Company Tidewater Marine

Year and Make of Equipment ____________

Company Identification No. Brahma

Engine C.I.D. and Cylinders 2 8V-71 Mains 4-71 N/A Gens

Serial Number ____________

Precombustion [ ] After cooled [ ] Intercooled [ ] Turbo [ ] Natural Asp. [✓]

Baseline Ambient Temperature 82°F Treated Ambient Temperature ____

Catalytic Converter No Scrubber No

Baseline Engine Temperature ____ Treated Engine Temperature ____

Baseline Fuel: Diesel #1____ #2 ✓ #3____ Other ____________

Treated Fuel: Diesel #1____ #2____ #3____ Other ____________

Baseline Fuel: Premium____ Regular____ Unleaded____ Other ____________

Treated Fuel: Premium____ Regular____ Unleaded____ Other ____________

Baseline Engine Hours or Mileage____ Treated Engine Hours or Mileage____

Baseline MGA Calibrated ____________ Treated MGA Calibrated ____________

| ~~RPM~~ RPM 1700 | Port Baseline 1 | Starboard Baseline 2 1700 | Main Baseline 3 ~~Treated 1~~ | Baseline 4 ~~Treated 2~~ 1700 | ~~Treated 2~~ ~~Treated 3~~ |
|---|---|---|---|---|---|
| $CO_2$ | 3.9% | 5.2% | 5% | 4.8% | |
| $O_2$ | 12% | 12% | 12% | 12% | |
| HC | 22 | 22 | 21 | 21 | |
| CO | .050% | .060 | .050 | .050 | |

| RPM____ | Baseline 1 | Starboard Baseline 2 | ~~Gen~~ Main Base 3 ~~Treated 1~~ | Base 4 ~~Treated 2~~ |
|---|---|---|---|---|
| $CO_2$ | | | | |
| $O_2$ | | | | |
| HC | | | | |
| CO | | | | |

MGA 90
Emissions Test Analysis
Page 2

POR MAIN

| RPM ______ | Baseline 1 | Baseline 2 | ~~Treated~~ BASE 1 | ~~Treated~~ BASE 2 |
|---|---|---|---|---|
| RPM 1720 | | 1700 | [illegible] | 1750 |
| $CO_2$ | 2.3 | 5% | 5%. | 5% |
| $O_2$ | 13.5 | 12.2% | 11.5% | 11.5% |
| HC | 17 | 20 | 20 | 19 |
| CO | .20% | .24% | .150% | .190% |

Average______ Average______

Average______ Average______

Average______ Average______

POR GEN

| RPM | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $CO_2$ | 2.3% | | | |
| $O_2$ | 13.5% | | | |
| HC | 17 | | | |
| CO | .2% | | | |

Pursuits

MGA 90
Emissions Tests Analysis

Baseline Test Date ______ Treated Test Date ______

Company Tidewater

Year and Make of Equipment ______

Company Identification No. ______

Engine C.I.D. and Cylinders ______

Serial Number ______

Precombustion [ ] After cooled [ ] Intercooled [ ] Turbo [ ] Natural Asp. [ ]

Baseline Ambient Temperature ______ Treated Ambient Temperature ______

Catalytic Converter ______ Scrubber ______

Baseline Engine Temperature ______ Treated Engine Temperature ______

Baseline Fuel: Diesel #1 ___ #2 ___ #3 ___ Other ______

Treated Fuel: Diesel #1 ___ #2 ___ #3 ___ Other ______

Baseline Fuel: Premium ___ Regular ___ Unleaded ___ Other ______

Treated Fuel: Premium ___ Regular ___ Unleaded ___ Other ______

Baseline Engine Hours or Mileage ______ Treated Engine Hours or Mileage ______

Baseline MGA Calibrated ______ Treated MGA Calibrated ______

STARBOARD MN

| ~~RPM~~ RPM | Baseline 1 | Baseline 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| | 1500 | 1500 | 1500 | |
| $CO_2$ | 3.8% | 2.8% | 2.8% | |
| $O_2$ | 14% | 15.5% | 15.0% | |
| HC | 20 | 20 | 20 | |
| CO | .050 | .010 | .010 | |

STARBOARD GEN

| RPM ______ | Baseline 1 | Baseline 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | | | | |
| $O_2$ | | | | |
| HC | | | | |
| CO | | | | |

MGA 90
Emissions Test Analysis
Page 2

Port Main

| RPM | Baseline 1 | Baseline 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| | 1500 | 1500 | 1500 | |
| $CO_2$ | 3% | 2.8% | 3.1 | |
| $O_2$ | 15.5% | 15.5% | 15% | |
| HC | 20 | 20 | 20 | |
| CO | T | .010 | .020 | |

Average______ Average______

Average______ Average______

Average______ Average______

Port Gen

$CO_2$

$O_2$

HC

CO

Pilsano

MGA 90
Emissions Tests Analysis

Baseline Test Date ______ Treated Test Date ______

Company Tidewater

Year and Make of Equipment ______

Company Identification No. ______

Engine C.I.D. and Cylinders ______

Serial Number ______

Precombustion /_/ After cooled /_/ Intercooled /_/ Turbo /_/ Natural Asp. /_/

Baseline Ambient Temperature ______ Treated Ambient Temperature ______

Catalytic Converter ______ Scrubber ______

Baseline Engine Temperature ______ Treated Engine Temperature ______

Baseline Fuel: Diesel #1 ___ #2 ___ #3 ___ Other ______

Treated Fuel: Diesel #1 ___ #2 ___ #3 ___ Other ______

Baseline Fuel: Premium ___ Regular ___ Unleaded ___ Other ______

Treated Fuel: Premium ___ Regular ___ Unleaded ___ Other ______

Baseline Engine Hours or Mileage ______ Treated Engine Hours or Mileage ______

Baseline MGA Calibrated ______ Treated MGA Calibrated ______

Starboard Main

| RPM ~~1800~~ 1200 | Baseline 1 | Baseline 2 | ~~Treated~~ Base 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 2.2% | 2.4 | 2.4 | |
| $O_2$ | 17% | 16.8 | 16.7 | |
| HC | 18 | 21 | 19 | |
| CO | .010 | .01 | .01 | |

Port M

| RPM ~~1200~~ 1200 | Baseline 1 | Baseline 2 | ~~Treated~~ Base 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 2% | 2.0% | 2.0 | |
| $O_2$ | 17.4% | 17.3 | 17.3 | |
| HC | 20 | 18 | 19 | |
| CO | .010 | .01 | .01 | |

MGA 90
Emissions Tests Analysis

Baseline Test Date ____________ Treated Test Date ____________

Company: TIDEWATER MARINE

Year and Make of Equipment ____________

Company Identification No. BRAHMA

Engine C.I.D. and Cylinders 2 - 8V-71 MAINS 2 - 471 GENS

Serial Number ____________

Precombustion [ ] After cooled [ ] Intercooled [ ] Turbo [ ] Natural Asp. [ ]

Baseline Ambient Temperature ____ Treated Ambient Temperature ____

Catalytic Converter No Scrubber No

Baseline Engine Temperature ____ Treated Engine Temperature ____

Baseline Fuel: Diesel #1 ___ #2 ___ #3 ___ Other ____________

Treated Fuel: Diesel #1 ___ #2 ✓ #3 ___ Other ____________

Baseline Fuel: Premium ___ Regular ___ Unleaded ___ Other ____________

Treated Fuel: Premium ___ Regular ___ Unleaded ___ Other ____________

Baseline Engine Hours or Mileage ____ Treated Engine Hours or Mileage ____

Baseline MGA Calibrated ____________ Treated MGA Calibrated ____________

1700 PUSHING

STARBOARD

| RPM ____ | TREATED (~~Baseline~~) 1 | TREATED (~~Baseline~~) 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 3.0% | 2.98% | 2.9% | |
| $O_2$ | 13.5% | 13.4% | 13.4% | |
| HC | 13.0 | 15.0 | 15.0 | |
| CO | 0.07% | 0.06% | 0.05% | |

PORT

| RPM ____ | TREATED (~~Baseline~~) 1 | TREATED (~~Baseline~~) 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 2.9% | 2.9% | 2.9% | |
| $O_2$ | 13.5% | 13.49% | 13.25% | |
| HC | 12 | 15.0 | 15 | |
| CO | 0.11% | 0.15% | 0.17% | |

MGA 90
Emissions Tests Analysis

Baseline Test Date ________ Treated Test Date ________

Company *TIDEWATER*

Year and Make of Equipment ________

Company Identification No. ________

Engine C.I.D. and Cylinders ________

Serial Number ________

Precombustion ☐ After cooled ☐ Intercooled ☐ Turbo ☐ Natural Asp. ☐

Baseline Ambient Temperature ____ Treated Ambient Temperature ____

Catalytic Converter ________ Scrubber ________

Baseline Engine Temperature ____ Treated Engine Temperature ____

Baseline Fuel: Diesel #1 ___ #2 ___ #3 ___ Other ________

Treated Fuel: Diesel #1 ___ #2 ___ #3 ___ Other ________

Baseline Fuel: Premium ___ Regular ___ Unleaded ___ Other ________

Treated Fuel: Premium ___ Regular ___ Unleaded ___ Other ________

Baseline Engine Hours or Mileage ____ Treated Engine Hours or Mileage ____

Baseline MGA Calibrated ________ Treated MGA Calibrated ________

*1500 PUSHING*

*STARBOARD*

| RPM ____ | *TREATED* ~~Baseline~~ 1 | *TREATED* ~~Baseline~~ 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 2.0% | 1.99% | 1.8% | |
| $O_2$ | 14.9% | 15.01% | 16% | |
| HC | 15.0 | 15 | 15 | |
| CO | 0% | 0% | 0% | |

*PORT*

| RPM ____ | *TREATED* ~~Baseline~~ 1 | *TREATED* ~~Baseline~~ 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 1.8% | 1.85% | 1.84% | |
| $O_2$ | 15.01% | 15.2% | 15.6% | |
| HC | 15.0 | 15.0 | 15.0 | |
| CO | 0% | 0% | 0% | |

MGA 90

Emissions Tests Analysis

Baseline Test Date ______________ Treated Test Date ______________

Company TIDEWATER

Year and Make of Equipment ______________

Company Identification No. ______________

Engine C.I.D. and Cylinders ______________

Serial Number ______________

Precombustion ☐ After cooled ☐ Intercooled ☐ Turbo ☐ Natural Asp. ☐

Baseline Ambient Temperature ____ Treated Ambient Temperature ____

Catalytic Converter ______________ Scrubber ______________

Baseline Engine Temperature ____ Treated Engine Temperature ____

Baseline Fuel: Diesel #1 ____ #2 ____ #3 ____ Other ______________

Treated Fuel: Diesel #1 ____ #2 ____ #3 ____ Other ______________

Baseline Fuel: Premium ____ Regular ____ Unleaded ____ Other ______________

Treated Fuel: Premium ____ Regular ____ Unleaded ____ Other ______________

Baseline Engine Hours or Mileage ____ Treated Engine Hours or Mileage ____

Baseline MGA Calibrated ______________ Treated MGA Calibrated ______________

1200 PUSHING

STARBOARD

| RPM ____ | TREATED ~~Baseline~~ 1 | TREATED ~~Baseline~~ 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 1.2% | 1.05% | 1.0 | |
| $O_2$ | 17.5% | 18.0% | 18.2 | |
| HC | 12.5 | 13.0 | 13 | |
| CO | 0% | 0% | 0% | |

PORT

| RPM ____ | TREATED ~~Baseline~~ 1 | TREATED ~~Baseline~~ 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 1.1% | 1.1% | 1.09% | |
| $O_2$ | 17.6% | 17.9% | 18% | |
| HC | 14.0 | 12.5 | 13 | |
| CO | 0% | 0 | 0% | |

UPRIVER

MGA 90
Emissions Tests Analysis

Baseline Test Date July 22, 1982 Treated Test Date ____________

Company TIDEWATER MARINE

Year and Make of Equipment ____________

Company Identification No. M/V BRAHMA

Engine C.I.D. and Cylinders ____________

Serial Number ____________

Precombustion [ ] After cooled [ ] Intercooled [ ] Turbo [ ] Natural Asp. [ ]

Baseline Ambient Temperature _____ Treated Ambient Temperature _____

Catalytic Converter ____________ Scrubber ____________

Baseline Engine Temperature _____ Treated Engine Temperature _____

Baseline Fuel: Diesel #1____ #2____ #3____ Other ____________

Treated Fuel: Diesel #1____ #2____ #3____ Other ____________

Baseline Fuel: Premium____ Regular____ Unleaded____ Other ____________

Treated Fuel: Premium____ Regular____ Unleaded____ Other ____________

Baseline Engine Hours or Mileage_____ Treated Engine Hours or Mileage_____

Baseline MGA Calibrated____________ Treated MGA Calibrated____________

PORT

| RPM 1700 | Baseline 1 | Baseline 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 3.25% | 3.2% | | |
| $O_2$ | 14.99% | 14.95% | | |
| HC | 20.0 | 20 | | |
| CO | TRACE | TRACE | | |

STBD

| RPM 1700 | Baseline 1 | Baseline 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 3.1% | 2.99% | | |
| $O_2$ | 15% | 15.1% | | |
| HC | 20 | 20.05 | | |
| CO | TRACE | TRACE | | |

UPRIVER

# MGA 90
## Emissions Tests Analysis

Baseline Test Date AUG 22, 1982 Treated Test Date ____________

Company TIDEWATER MARINE

Year and Make of Equipment ____________

Company Identification No. M/V BRAHMA

Engine C.I.D. and Cylinders ____________

Serial Number ____________

Precombustion ☐ After cooled ☐ Intercooled ☐ Turbo ☐ Natural Asp. ☐

Baseline Ambient Temperature ______ Treated Ambient Temperature ______

Catalytic Converter ____________ Scrubber ____________

Baseline Engine Temperature ______ Treated Engine Temperature ______

Baseline Fuel: Diesel #1____ #2____ #3____ Other ____________

Treated Fuel: Diesel #1____ #2____ #3____ Other ____________

Baseline Fuel: Premium____ Regular____ Unleaded____ Other ____________

Treated Fuel: Premium____ Regular____ Unleaded____ Other ____________

Baseline Engine Hours or Mileage______ Treated Engine Hours or Mileage______

Baseline MGA Calibrated____________ Treated MGA Calibrated____________

PORT

| RPM 1500 | Baseline 1 | Baseline 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 2.21% | 1.99% | | |
| $O_2$ | 16.25% | 16.8% | | |
| HC | 20.0 | 20.0 | | |
| CO | TRACE | TRACE | | |

STBD

| RPM 1500 | Baseline 1 | Baseline 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 1.9 | 1.8% | | |
| $O_2$ | 16.8 | 17.% | | |
| HC | 20.0 | 20.0 | | |
| CO | TRACE | TRACE | | |

MGA 90
Emissions Tests Analysis

Baseline Test Date ______ Treated Test Date Aug 13

Company Tidewater

Year and Make of Equipment ______

Company Identification No. ______

Engine C.I.D. and Cylinders ______

Serial Number ______

Precombustion ☐ After cooled ☐ Intercooled ☐ Turbo ☐ Natural Asp. ☐

Baseline Ambient Temperature ______ Treated Ambient Temperature ______

Catalytic Converter ______ Scrubber ______

Baseline Engine Temperature ______ Treated Engine Temperature ______

Baseline Fuel: Diesel #1 ___ #2 ✓ #3 ___ Other ______

Treated Fuel: Diesel #1 ___ #2 ✓ #3 ___ Other ______

Baseline Fuel: Premium ___ Regular ___ Unleaded ___ Other ______

Treated Fuel: Premium ___ Regular ___ Unleaded ___ Other ______

Baseline Engine Hours or Mileage ______ Treated Engine Hours or Mileage ______

Baseline MGA Calibrated ______ Treated MGA Calibrated ______

1700 warmed

Port

| RPM ___ | ~~Baseline~~ 1 | ~~Baseline~~ 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 1.5% | 1.58 | 1.45% | |
| $O_2$ | 17.4% | 17.2 | 17.4% | |
| HC | 11 | 11 | 12 | |
| CO | 0% | 0 | 0% | |

STBD

| RPM ___ | ~~Baseline~~ 1 | ~~Baseline~~ 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 1.2% | 1.2% | 1.2% | |
| $O_2$ | 18.1% | 18.2% | 18.0% | |
| HC | 11.0 | 11 | 11.5 | |
| CO | 0.0% | 0% | 0% | |

MGA 90
Emissions Tests Analysis

Baseline Test Date ______ Treated Test Date ______

Company Tidewater

Year and Make of Equipment ______

Company Identification No. ______

Engine C.I.D. and Cylinders ______

Serial Number ______

Precombustion ☐ After cooled ☐ Intercooled ☐ Turbo ☐ Natural Asp. ☐

Baseline Ambient Temperature ______ Treated Ambient Temperature ______

Catalytic Converter ______ Scrubber ______

Baseline Engine Temperature ______ Treated Engine Temperature ______

Baseline Fuel: Diesel #1 ___ #2 ___ #3 ___ Other ______

Treated Fuel: Diesel #1 ___ #2 ___ #3 ___ Other ______

Baseline Fuel: Premium ___ Regular ___ Unleaded ___ Other ______

Treated Fuel: Premium ___ Regular ___ Unleaded ___ Other ______

Baseline Engine Hours or Mileage ______ Treated Engine Hours or Mileage ______

Baseline MGA Calibrated ______ Treated MGA Calibrated ______

1500 unriven

Port

| RPM ______ | Baseline 1 | Baseline 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 0.87% | 1.01% | | |
| $O_2$ | 19.0% | 18.7% | | |
| HC | 11.0 | 11.0 | | |
| CO | 0% | 0% | | |

Stbd

| RPM ______ | Baseline 1 | Baseline 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 0.8% | | | |
| $O_2$ | 19.2% | | | |
| HC | 11.0 | | | |
| CO | 0% | | | |

DOURRIVER

# MGA 90
## Emissions Tests Analysis

Baseline Test Date JULY 22, 1982 Treated Test Date ________

Company TIDEWATER MARINE

Year and Make of Equipment ________

Company Identification No. M/V BRAHMA

Engine C.I.D. and Cylinders ________

Serial Number ________

Precombustion ☐ After cooled ☐ Intercooled ☐ Turbo ☐ Natural Asp. ☐

Baseline Ambient Temperature ____ Treated Ambient Temperature ____

Catalytic Converter ________ Scrubber ________

Baseline Engine Temperature ____ Treated Engine Temperature ____

Baseline Fuel: Diesel #1 ___ #2 ___ #3 ___ Other ________

Treated Fuel: Diesel #1 ___ #2 ___ #3 ___ Other ________

Baseline Fuel: Premium ___ Regular ___ Unleaded ___ Other ________

Treated Fuel: Premium ___ Regular ___ Unleaded ___ Other ________

Baseline Engine Hours or Mileage ____ Treated Engine Hours or Mileage ____

Baseline MGA Calibrated ________ Treated MGA Calibrated ________

PORT

| RPM 1700 | Baseline 1 | Baseline 2 | ~~Treated~~ BASELINE 3 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 2.8% | 3.0% | | |
| $O_2$ | 15.6% | 15.2% | | |
| HC | 20.0 | 20.0 | | |
| CO | TRACE | TRACE | | |

STBD

| RPM 1700 | Baseline 1 | Baseline 2 | ~~Treated~~ BASELINE 3 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 1.6% | 2.96% | | |
| $O_2$ | 15.5% | 15.5% | | |
| HC | 20.0 | 20.0 | | |
| CO | TRACE | TRACE | | |

DOWNRIVER

MGA 90
Emissions Tests Analysis

Baseline Test Date JULY 22, 1982 Treated Test Date ____

Company TIDEWATER MARINE

Year and Make of Equipment ____

Company Identification No. M/V BRAHMA

Engine C.I.D. and Cylinders ____

Serial Number ____

Precombustion ☐ After cooled ☐ Intercooled ☐ Turbo ☐ Natural Asp. ☐

Baseline Ambient Temperature ____ Treated Ambient Temperature ____

Catalytic Converter ____ Scrubber ____

Baseline Engine Temperature ____ Treated Engine Temperature ____

Baseline Fuel: Diesel #1 ____ #2 ____ #3 ____ Other ____

Treated Fuel: Diesel #1 ____ #2 ____ #3 ____ Other ____

Baseline Fuel: Premium ____ Regular ____ Unleaded ____ Other ____

Treated Fuel: Premium ____ Regular ____ Unleaded ____ Other ____

Baseline Engine Hours or Mileage ____ Treated Engine Hours or Mileage ____

Baseline MGA Calibrated ____ Treated MGA Calibrated ____

PORT

| RPM 1500 | Baseline 1 | Baseline 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 2.2% | 2.4% | | |
| $O_2$ | 16.9% | 16.% | | |
| HC | 19.0 | 19.0 | | |
| CO | TRACE | TRACE | | |

STBD

| RPM 1500 | Baseline 1 | Baseline 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 2.1% | 2.4% | | |
| $O_2$ | 16.6% | 16.2% | | |
| HC | 20.0 | 19.0 | | |
| CO | TRACE | TRACE | | |

DOLLARNER

# MGA 90
## Emissions Tests Analysis

Baseline Test Date JULY 22, 1982 Treated Test Date ______

Company TIDEWATER MARINE

Year and Make of Equipment ______

Company Identification No. M/V BRAHMA

Engine C.I.D. and Cylinders ______

Serial Number ______

Precombustion ☐ After cooled ☐ Intercooled ☐ Turbo ☐ Natural Asp. ☐

Baseline Ambient Temperature ______ Treated Ambient Temperature ______

Catalytic Converter ______ Scrubber ______

Baseline Engine Temperature ______ Treated Engine Temperature ______

Baseline Fuel: Diesel #1 ____ #2 ____ #3 ____ Other ______

Treated Fuel: Diesel #1 ____ #2 ____ #3 ____ Other ______

Baseline Fuel: Premium ____ Regular ____ Unleaded ____ Other ______

Treated Fuel: Premium ____ Regular ____ Unleaded ____ Other ______

Baseline Engine Hours or Mileage ____ Treated Engine Hours or Mileage ____

Baseline MGA Calibrated ______ Treated MGA Calibrated ______

PORT

| RPM 1200 | Baseline 1 | Baseline 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 1.61% | 1.5% | | |
| $O_2$ | 17.5% | 17.7% | | |
| HC | 19.0 | 19.0 | | |
| CO | TRACE | TRACE | | |

STBD

| RPM 1200 | Baseline 1 | Baseline 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 1.62% | 1.7% | | |
| $O_2$ | 17.4% | 17.3% | | |
| HC | 18.0 | 18.5 | | |
| CO | TRACE | TRACE | | |

MGA 90
Emissions Tests Analysis

Baseline Test Date ________ Treated Test Date *Aug. 13*

Company *Tidewater*

Year and Make of Equipment ________

Company Identification No. ________

Engine C.I.D. and Cylinders ________

Serial Number ________

Precombustion ☐ After cooled ☐ Intercooled ☐ Turbo ☐ Natural Asp. ☐

Baseline Ambient Temperature ____ Treated Ambient Temperature ____

Catalytic Converter ________ Scrubber ________

Baseline Engine Temperature ____ Treated Engine Temperature ____

Baseline Fuel: Diesel #1___ #2___ #3___ Other ________

Treated Fuel: Diesel #1___ #2___ #3___ Other ________

Baseline Fuel: Premium___ Regular___ Unleaded___ Other________

Treated Fuel: Premium___ Regular___ Unleaded___ Other________

Baseline Engine Hours or Mileage____ Treated Engine Hours or Mileage____

Baseline MGA Calibrated________ Treated MGA Calibrated________

*1700 Downriver*

*Port*

| RPM ____ | *Treated* ~~Baseline~~ 1 | *Treated* ~~Baseline~~ 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 1.59% | 1.5% | 1.5% | |
| $O_2$ | 17.4% | 17.2% | 17.4% | |
| HC | 11.0 | 11.0 | 11.0 | |
| CO | 0% | 0% | 0% | |

*Starboard*

| RPM ____ | *Treated* ~~Baseline~~ 1 | *Treated* ~~Baseline~~ 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 1.3 | 1.28% | 1.3% | |
| $O_2$ | 17.9 | 17.8% | 17.8% | |
| HC | 11.0 | 11.0 | 10.8 | |
| CO | 0 | 0% | 0% | |

# MGA 90
## Emissions Tests Analysis

Baseline Test Date ______ Treated Test Date Aug 13

Company Tidewater

Year and Make of Equipment ______

Company Identification No. ______

Engine C.I.D. and Cylinders ______

Serial Number ______

Precombustion ☐ After cooled ☐ Intercooled ☐ Turbo ☐ Natural Asp. ☐

Baseline Ambient Temperature ______ Treated Ambient Temperature ______

Catalytic Converter ______ Scrubber ______

Baseline Engine Temperature ______ Treated Engine Temperature ______

Baseline Fuel: Diesel #1 ___ #2 ___ #3 ___ Other ______

Treated Fuel: Diesel #1 ___ #2 ___ #3 ___ Other ______

Baseline Fuel: Premium ___ Regular ___ Unleaded ___ Other ______

Treated Fuel: Premium ___ Regular ___ Unleaded ___ Other ______

Baseline Engine Hours or Mileage ______ Treated Engine Hours or Mileage ______

Baseline MGA Calibrated ______ Treated MGA Calibrated ______

1500 Down River

Port

| RPM ______ | ~~Baseline~~ Treated 1 | ~~Baseline~~ Treated 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 1.0 % | 1.0 % | 1.10 % | |
| $O_2$ | 18.6% | 18.6% | 18.5% | |
| HC | 10.8 | 11.0 | 11.0 | |
| CO | 0 % | 0 % | 0% | |

STBD

| RPM ______ | ~~Baseline~~ Treated 1 | ~~Baseline~~ Treated 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 0.87% | 0.90 | 0.80% | |
| $O_2$ | 19.0% | 18.8 | 19.05% | |
| HC | 11.0 | 10.5 | 11.0 | |
| CO | 0 % | 0% | 0% | |

MGA 90
Emissions Tests Analysis

Baseline Test Date ________ Treated Test Date ________

Company TIDEWATER

Year and Make of Equipment ________

Company Identification No. ________

Engine C.I.D. and Cylinders ________

Serial Number ________

Precombustion ☐ After cooled ☐ Intercooled ☐ Turbo ☐ Natural Asp. ☐

Baseline Ambient Temperature ____ Treated Ambient Temperature ____

Catalytic Converter ________ Scrubber ________

Baseline Engine Temperature ____ Treated Engine Temperature ____

Baseline Fuel: Diesel #1 ___ #2 ___ #3 ___ Other ________

Treated Fuel: Diesel #1 ___ #2 ___ #3 ___ Other ________

Baseline Fuel: Premium ___ Regular ___ Unleaded ___ Other ________

Treated Fuel: Premium ___ Regular ___ Unleaded ___ Other ________

Baseline Engine Hours or Mileage ____ Treated Engine Hours or Mileage ____

Baseline MGA Calibrated ________ Treated MGA Calibrated ________

1200 DOWNRIVER

PORT

| RPM ____ | ~~Baseline~~ TREATED 1 | ~~Baseline~~ TREATED 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 0.7% | 0.72% | 0.79% | |
| $O_2$ | 19.4% | 19.2% | 19.2% | |
| HC | 11.0 | 11.0 | 12.0 | |
| CO | 0 | 0% | 0% | |

STBD

| RPM ____ | ~~Baseline~~ TREATED 1 | ~~Baseline~~ TREATED 2 | Treated 1 | Treated 2 |
|---|---|---|---|---|
| $CO_2$ | 0.6% | 0.6% | 0.6% | |
| $O_2$ | 19.5% | 19.5% | 19.5% | |
| HC | 11.0 | 11.0 | 11 | |
| CO | 0% | 0% | 0% | |

Tidewater Marine Baseline Evaluation

| R.P.M. | Up River Port 1 | Up River Port 2 | Up River Stbd 1 | Up River Stbd 2 | Down River Port 1 | Down River Port 2 | Down River Stbd 1 | Down River Stbd 2 | Pushing Port 1 | Pushing Port 2 | Pushing Port 3 | Pushing Stbd 1 | Pushing Stbd 2 | Pushing Stbd 3 | Generator Stbd / R.P.M. Fixed 1 | Generator Stbd / R.P.M. Fixed 2 | Generator Stbd / R.P.M. Fixed 3 | Emissions Level |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1200 | 1.1 | 1.6 | 1.18 | 1.7 | 1.61 | 1.5 | 1.62 | 1.7 | 2.0 | 2.0 | 2.0 | 2.2 | 2.4 | 2.4 | 1.8 | 1.9 | 1.9 | $CO_2$ |
| | 18.5 | 17.49 | 18.25 | 17.75 | 17.5 | 17.7 | 17.4 | 17.3 | 17.4 | 17.3 | 17.3 | 17 | 16.8 | 16.7 | 17.0 | 17.0 | 17.0 | $O_2$ |
| | 19 | 20 | 20 | 20 | 19. | 19 | 18 | 18.5 | 20 | 18 | 19. | 18 | 21 | 19 | 20.01 | 25 | 25 | HC |
| | Tr | Tr | Tr | Tr | Tr | Tr | Tr | Tr | .010 | .10 | .010 | .01 | .01 | .01 | Tr | Tr | Tr | CO |

| R.P.M. | Up River Port 1 | Up River Port 2 | Up River Stbd 1 | Up River Stbd 2 | Down River Port 1 | Down River Port 2 | Down River Stbd 1 | Down River Stbd 2 | Pushing Port 1 | Pushing Port 2 | Pushing Port 3 | Pushing Stbd 1 | Pushing Stbd 2 | Pushing Stbd 3 | Generator Stbd / R.P.M. Fixed | Emissions Level |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1500 | 2.21 | 1.9 | 1.9 | 1.8 | 2.2 | 2.4 | 2.1 | 2.4 | 3.0 | 2.8 | 3.1 | 3.8 | 2.8 | 2.9 | | $CO_2$ |
| | 16.25 | 16.8 | 16.8 | 17 | 16.9 | 16.1 | 16.6 | 16.2 | 15.5 | 15.5 | 15 | 14 | 15.5 | 15.5 | | $O_2$ |
| | 20 | 20 | 20 | 20 | 19. | 19 | 20 | 19 | 20 | 20 | 20 | 20 | 20 | 20 | | HC |
| | Tr | Tr | Tr | Tr | Tr | Tr | Tr | Tr | Tr | .01 | .02 | .05 | .01 | .01 | | CO |

| R.P.M. | Up River Port 1 | Up River Port 2 | Up River Stbd 1 | Up River Stbd 2 | Down River Port 1 | Down River Port 2 | Down River Stbd 1 | Down River Stbd 2 | Pushing Port 1 | Pushing Port 2 | Pushing Port 3 | Pushing Port 4 | Pushing Stbd 1 | Pushing Stbd 2 | Pushing Stbd 3 | Pushing Stbd 4 | Generator Stbd / R.P.M. Fixed | Emissions Level |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1700 | 3.25 | 3.2 | 3.1 | 2.99 | 2.8 | 3.0 | 1.61 | 2.96 | 2.3 | 5.0 | 5.0 | 5.0 | 3.9 | 5.2 | 5.0 | 4.8 | | $CO_2$ |
| | 14.78 | 14.95 | 15 | 15.1 | 15.6 | 15.2 | 15.5 | 15.5 | 13.5 | 12.2 | 11.5 | 11.5 | 12 | 12 | 12 | 12 | | $O_2$ |
| | 20 | 20 | 20 | 20.05 | 20 | 20 | 20 | 20 | 17 | 20 | 20 | 19 | 22 | 22 | 21 | 21 | | HC |
| | Tr | Tr | Tr | Tr | Tr | Tr | Tr | Tr | .20 | .21 | .15 | .19 | .05 | .06 | .05 | .05 | | CO |

File in
Tidewater
file