Installation and Service Manual:

For use with Mast Motorsports Airboat engines

It is advised to read this Installation and Service Manual THOROUGHLY before proceeding with installation!!

Engine Serial Number: _____
ECM Serial Number: _____

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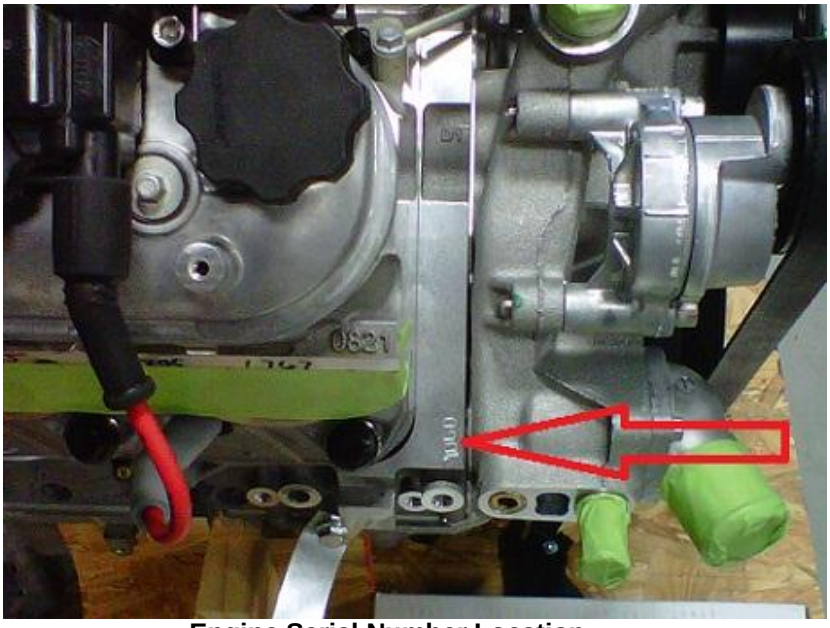
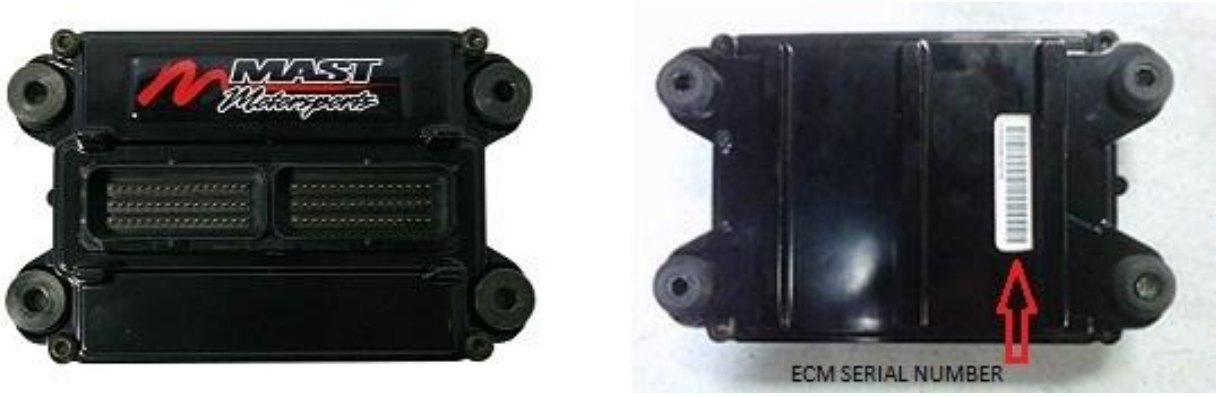
Serial Number Location



Engine Serial Number Location



ECM Serial Number located on Back of M-90 WBO2 ECM

Please fill in the engine and ECM serial number on the cover page of this manual and on page 44 in the warranty section of this manual. These numbers are required for any service or warranty work.

Overview

Congratulations on the purchase of your Mast Motorsports Airboat Engine! Now that you have the parts in hand, it is time to begin the installation process so that you may enjoy your project.

The following information listed in this manual was in effect at the time of printing. Due to continued improvements, Mast Motorsports reserves the right to change any specification or design without notice or obligation.

Before we begin, Mast Motorsports suggests some practices that you may want to employ during the installation process. In order to have your boat running reliably for years to come, it is necessary to ensure that the quality of wiring craftsmanship not be compromised throughout the installation. Spending extra time to ensure that a wiring job has the integrity enough to withstand years of service can potentially save great amounts of time down the road. This is a situation where two minutes can literally save two days of troubleshooting.

Fuel System Requirements

Your Mast Motorsports engine boasts the latest in fuel injection technology. It is supplied with a complete Mast Motorsports Universal Fuel System Kit (**Figure 1**). This kit contains a pump, high pressure fuel filter/regulator, and multiple fittings for proper connection. In order for your engine to operate properly, it must have the appropriate fuel volume and pressure supplied to the fuel rail. Mast Motorsports Engines are required to have 58.5 psi gauge pressure to the fuel rail at all times of operation. Proper fuel pressure (58.5 psi) must be verified at the fuel rail Schrader valve by a mechanical gauge. ***SUPPLYING IMPROPER FUEL PRESSURE TO YOUR ENGINE CAN RESULT IN CATASTROPHIC ENGINE FAILURE AND WILL NOT BE COVERED UNDER WARRANTY!!!*** Mast Motorsports suggests using the Fuel System Plumbing Diagram located in Appendix B as a general outline. The supplied Mast Motorsports Universal Fuel System Kit is designed to keep your engine running at the proper 58.5 psi of fuel pressure. This fuel system closely models the configuration shown in Appendix B. After the fuel system installation, ensure that the fuel system lines and components are away from excessive heat, sharp edges, and vibration.

Figure 1: Universal Fuel System Kit

Gasoline Requirements

WARRANTY NOTICE: Damage caused to the engine through the use of improper gasoline, gasoline with an octane rating below the minimum requirements listed below, or low-quality gasoline, is considered misuse of the engine. Such damage is not covered by the Mast Motorsports Engines warranty.

NOTICE: Mast Motorsports Typhoon and Cyclone engines are calibrated to operate on 91-93 octane (R+M)/2 fuel. Maximum performance and reliability is obtained when using this fuel. If a slight pinging is heard during acceleration and the proper octane fuel is being used, it is considered normal. If a constant, heavy knock occurs, the engine should be evaluated by Mast Motorsports. The use of 87 octane fuel is permissible, ***but only in an emergency.***
The engine should never be operated at full throttle/full load or high RPM while using 87 octane fuel.

Oil Requirements

Motor oil has had several significant changes in the last ten years. In 2004, a decision was made to reduce the sulfur and the zinc-phosphorus compounds (ZDDP). The ZDDP is used as the primary anti-wear agent for internal engine components. Beginning with the 2004 model of new vehicles, the Federal Government has asked auto manufacturers to warranty catalytic converters for 120,000-miles. Most catalytic converters eventually fail from harmful gases emitted thru the exhaust, and two of these are the phosphorous and sulfur which were a prevalent make-up of our older motor oils. All engines will consume some oil thru the exhaust! While in most cases this is only a very small amount, the automakers decided it was time to change the chemistry of motor oil rather than adding to the cost of catalytic converters. This change in engine oil has had a significant impact on the performance engine world, specifically engines with forged pistons and/or flat tappet camshafts. The lack of the zinc phosphorus compounds has been a primary cause of premature failure in flat tappet camshafts and lifters. Current oils for gasoline engines have the ZDDP compounds reduced by 20% or more. We have seen an overwhelming increase in piston scuff and premature ring wear. We have torn down performance engines with less than 1500-miles and seen piston scuff and ring wear that looked as if the engine had 100,000-miles! This caused by super low viscosity oils with poor anti-wear characteristics and a lack of following proper break-in procedures. We have taken every precaution to coat the cylinder walls, pistons, and rings with an anti-wear agent. However, it is imperative that you choose engine oil with a significant amount of ZDDP. For Mast Motorsports Typhoon and Cyclone engines, we suggest an engine oil with a minimum ZDDP content of the following:
Approximate Percentage by Weight
Zinc – 0.120, Phosphorus – 0.115

Suggested Oils:

Valvoline VR1 Racing Oil 20W-50 (normal ambient operating temperatures above 32°F)
Valvoline VR1 Racing Oil 10W-30 (normal ambient operating temperatures below 32°F)

Engine Installation

Engine Mounting

The engine stringer and bed system in a vessel is the single most important structural component. It must be designed to withstand not only the weight of the engine, but also the thrust of the propeller, propeller torque reaction, and the stresses caused by the pitching and rolling of the vessel in the harshest of environmental conditions. Correctly constructed, the engine stringers and engine bed should absorb all of the vessel strain and stress, and not transfer it to the engine. The mounting system must be constructed so

the supporting structure deflections do not overstress the engine castings! The engine must have sufficient clearance to prevent damage from physical contact between the engine components and adjoining vessel structures. Static installation angle of the engine in a vessel must be between 0° and 5° "front up". Steel or stainless steel bolts should be used for all fasteners relating to the mounting system. Mast Motorsports recommends the use of fasteners that are SAE Grade 8 or equivalent. CAUTION: Failure to use proper mounts, support brackets, and hardware could result in premature failure of the mounts, which could result in damage to the engine. **Figure 2** below shows motor mount attaching locations.

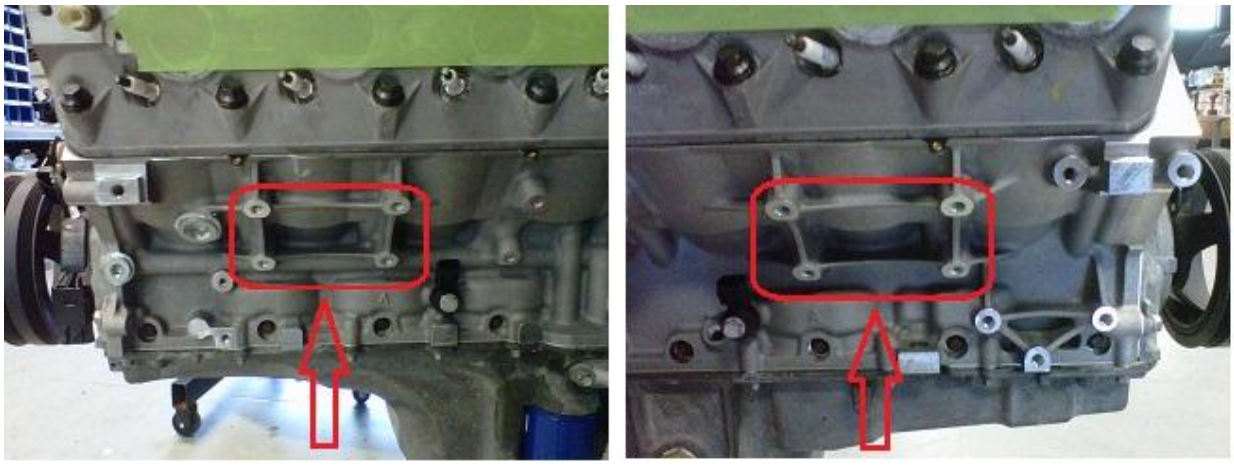


Figure 2: Engine Mounting Locations

Oil Cooling System

Mast Motorsports engines require an air to engine oil cooler. A sample air to oil cooler is shown in **Figure 3**. This is mandatory for proper engine operation and reliability. The air to engine oil cooler should be mounted to a solid structure and in an area that will allow proper air flow through the cooler. It is recommended that the cooler installation be in front of the engine coolant radiator and positioned so that the length of oil lines will be as short as possible. Proper sizing for the cooler should be based on the horse power of the engine. Please refer to the oil cooler manufacturer's recommendations. **Figure 4** below shows the oil line connections.

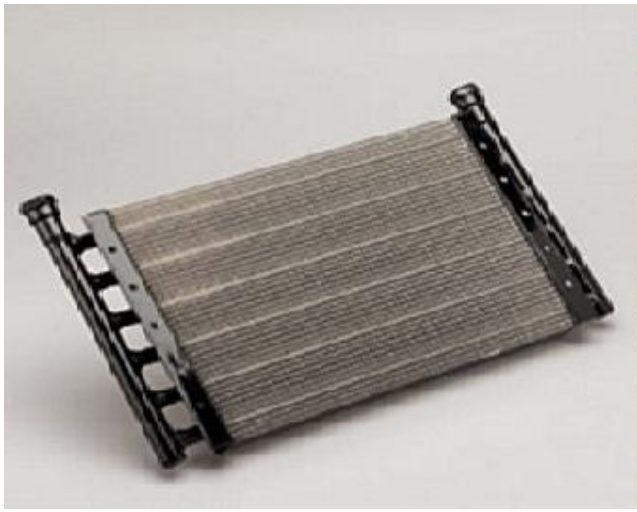


Figure 3: Oil Cooler Example

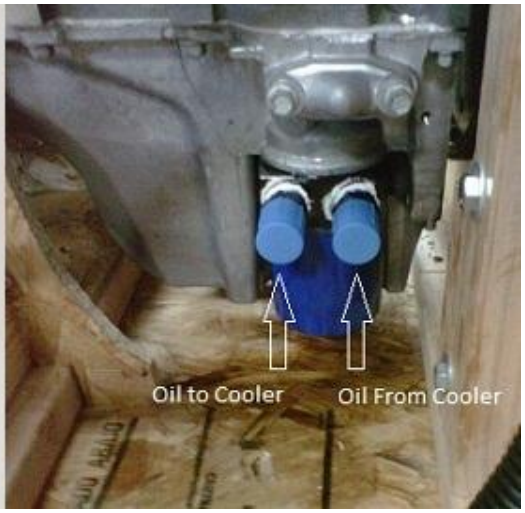


Figure 4: Oil Line Connections

Cooling System

Mast Motorsports engines require the addition of a radiator. Mast Motorsports airboat engines require the engine coolant system to be plumbed as a "closed-loop" system. This will enable proper engine performance and reliability. Proper sizing for a radiator varies depending on application, installation and horse power. Please refer to the radiator manufacturers recommendations for proper sizing. **Figure 5** below shows the proper connections and plumbing of the cooling system.

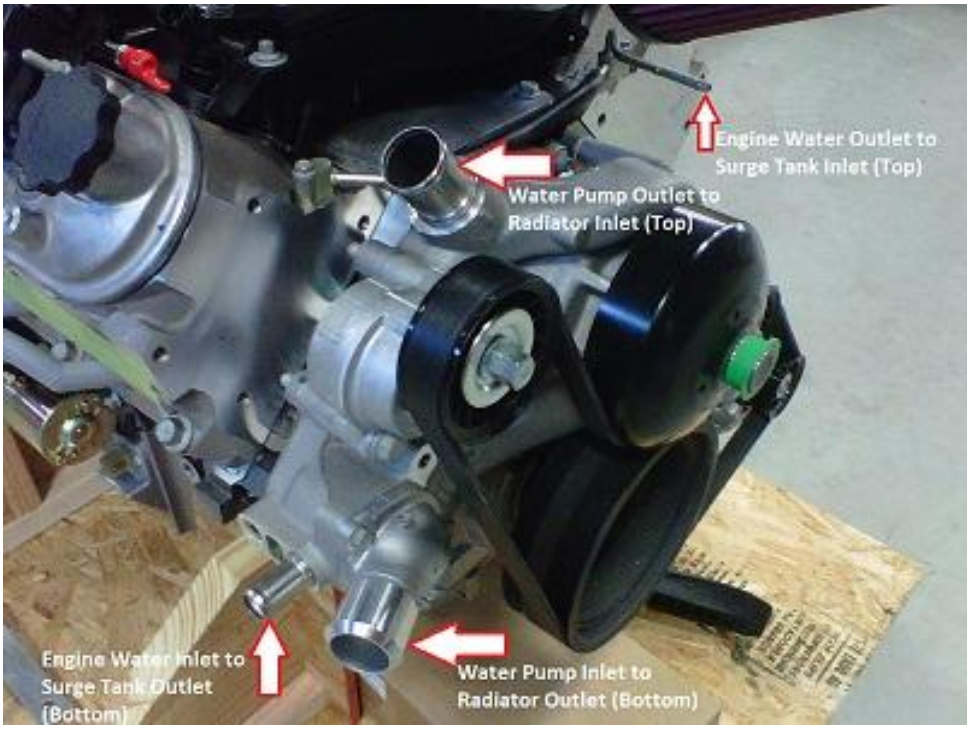


Figure 5: Cooling System Plumbing Diagram

Fuel System

Mast Motorsports suggests using the Fuel System Plumbing Diagram located in Appendix B as a general outline. The supplied Mast Motorsports Universal Fuel System Kit is designed to keep your engine running at the proper 58.5 psi of fuel pressure. This fuel system kit closely models the configuration shown in Appendix B. The fuel pump and filter/regulator should be mounted to a rigid structure using the supplied mounting kit. The fuel pump should be mounted below the lowest point of the fuel tank. If this is not possible, it is recommended to install a High Volume Low Pressure fuel pump between the fuel tank and the high pressure fuel pump. Failure to install a high volume low pressure fuel pump will cause poor engine performance and/or fuel system failure, that could result in engine damage.

All fuel lines should be approved for fuel injected applications and be rated to a minimum working pressure of 100 psi. Fuel lines to the pump, filter/regulator, and fuel rail should be a minimum of 3/8" ID. The return fuel line, from the filter/regulator to the tank, should be a minimum of 5/16" ID. After the fuel system installation, ensure that the fuel system lines and components are away from excessive heat, sharp edges, and vibration, and that all of the fittings and clamps are tight.

It is imperative that you make every effort to have your fuel system in proper working order prior to engine start-up. Inspection of the supply lines, return lines, filters, regulators, and fuel pressure are the responsibility of the boat owner and/or installer. Improper fuel plumbing can lead to an over-rich or over-lean condition which will result in engine failure and void the warranty. It is extremely crucial that you only use the ECM delivered with the engine, as it is calibrated specifically for that engine.

Wiring Installation

Preferred Wiring Procedure

The best way to ensure trouble-free wire connections is with the purchase of a Weather Pack wiring kit and their corresponding crimpers. When used correctly with the appropriate crimpers, Weather Pack connectors can make OEM quality wire connections that will last the life of the installation. They are available in multi-pin configurations and their quick connect nature makes for easy disassembly should it ever be required. A 1-pin as well as a 3-pin Weather Pack connector is shown in **Figures 6 and 7** below.

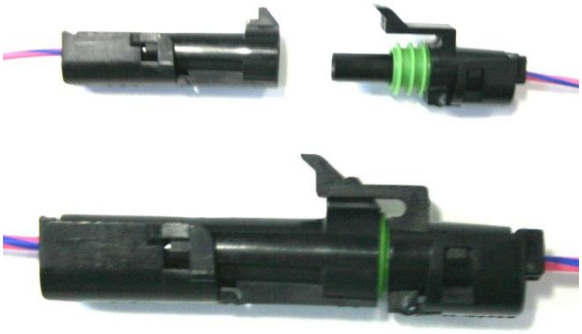


Figure 6: One Pin Weather Pack Connector Apart and Assembled

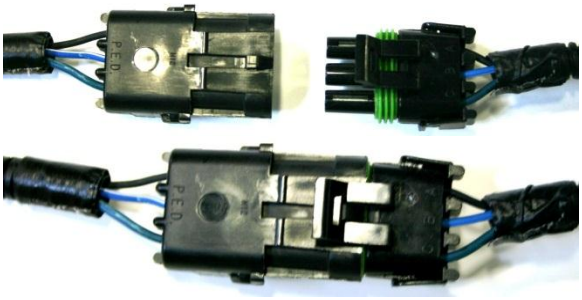


Figure 7: Three Pin Weather Pack Connector Apart and Assembled

Alternative Wiring Procedure

If Weather Pack connectors are not an option, a soldered splice can be made to work. Mast Motorsports recommends using a butt splice (if applicable) that has been soldered to ensure connection integrity. *BE SURE NOT TO GET THE WIRE TOO HOT WHILE SOLDERING!!!* Excessive heat to the wire will lead to eventual brittle fracture. After soldering is complete, the splice should be covered with heat shrink tubing. It is good practice to protect the splice connection from excessive movement and vibration to prevent fatigue fracturing. After the wiring job has been completed, secure the wiring in an area that is free of heat, sharp objects, and moving objects.

M-90 ECM and WBO2 Wiring Harness

While the M-90 ECM and wiring harness are very robust, it is good practice to protect electrical components from excessive heat, vibration, and the elements of weather. This will ensure many years of a smooth running electrical system. It is acceptable to mount the ECM and fuse block in the engine compartment, however, as stated earlier, it should be mounted *AWAY FROM EXCESSIVE HEAT, SHARP EDGES, VIBRATION, AND THE ELEMENTS OF WEATHER!*

Once the engine is mounted, it is recommended to make certain that the harness and all of the connectors are away from excessive heat, sharp edges, vibration and the elements of weather. The M-90 ECM Package wiring harness and components can be seen below in **Figure 8**.

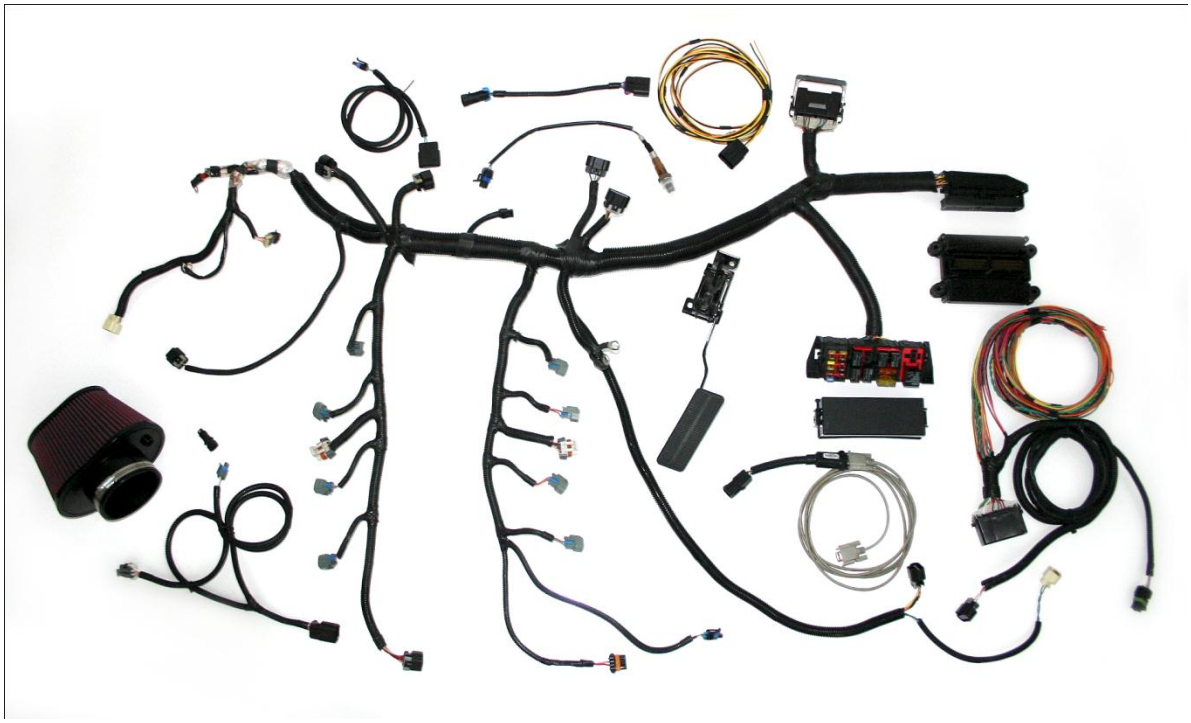


Figure 8: M-90 ECM/Wiring Harness Package

It can be seen that the ECM and fuse block run out of the harness on the port/left side of the engine. Other than the Injector/Ignition banks, Knock Sensors, and engine start wire, the connectors on this harness will not fit the wrong sensor.

The main wiring harness is the nervous system of the engine which sends and receives signals from various locations on the engine. Our main wiring harness uses only marine grade TXL wire and ultrasonic welds for OEM quality connections. The main wiring harness connects our 90 pin M-90 ECM to all the various engine sensors, fuse/relay box, and auxiliary wiring harnesses.

The Mast Motorsports main wiring harness comes with a complete fuse/relay box (**Figure 9**). This is not the three relays and four fuses that most aftermarket fuel injection systems supply with their wiring harnesses. The fuse/relay box is populated with nine mini fuses, three maxi fuses, four 35 amp relays, and two 50 amp relays for complete circuit control and protection. The relays control the fuel pump, starter, electric fan, ignition power, AC compressor (not used in airboat applications) and Variable Valve Timing (VVT) camshaft phaser. This makes for a full stand alone engine wiring system that allows less wiring than normally necessary.

Figure 9: Fuse/Relay Panel

Figure 10 below shows the M-90 ECM. The M-90 is mounted on vibration damping mounts. In order to ensure that these mounts achieve their intended purpose, it is imperative that the M-90 be mounted rigidly to a solid structure. This will help avoid problems and/or damage to the ECM.

Figure 10: M-90 WBO2 ECM

MAP/IAT Harness

The MAP/IAT harness (**Figure 12**) allows for various means of calculating the fuel flow into the engine. The method used on our engines is Speed Density. The ECM uses engine speed, intake air temperature, and manifold air pressure to calculate the amount of fuel going into the engine. The connection for this harness is at the rear of the engine in the main wiring harness. The IAT sensor is mounted in the air filter (**Figure 11**). The MAP sensor is located on top of the intake manifold (**Figure 11**). **Failure to have the IAT and/or MAP sensor connected, will lead to poor engine performance.**

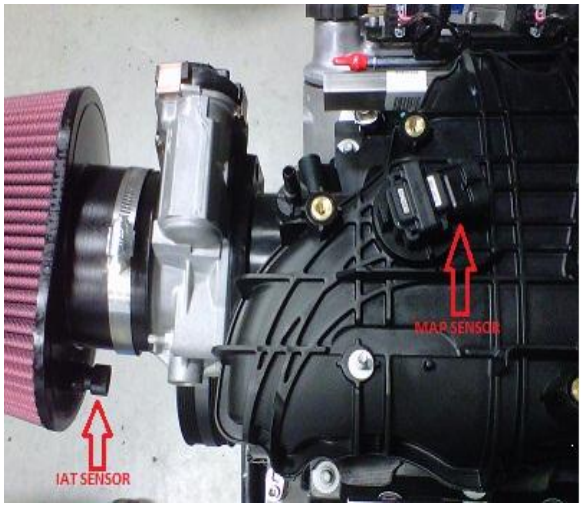


Figure 11: MAP/IAT Sensor Location

Figure 12: MAP/IAT Harness

Fuel Pump Harness

The fuel pump harness (**Figure 13**) utilizes 14 gauge yellow/red and a black wire going to a six terminal connector. The connection is made between the fuel pump harness and the main wiring harness on the driver side of the engine at the rear of the engine. The yellow/red and black wires are simply connected to the fuel pump and the circuit is controlled by the ECM through a 35 amp relay.

Figure 13: Fuel Harness

Dash Harness

The dash harness (**Figure 14**) connects to the main wiring harness using a 38 pin connector. The dash harness was built to allow the end user to use as many or as few of our ECM features as they wish. In order to run the engine, only three connections are needed: ignition power, start, and valet ground. The dash harness encompasses many other features that can be wired in at the end users wishes. It is also pre-wired for future features of our ECM. The dash harness has pre installed connectors for the ECM serial interface, Foot Pedal, and Mast Motorsports CAN Dongle. The dash harness has flying lead wires for all other features. The harness will allow for up to 32 separate Mast Motorsports CAN gauges to be connected that pull information off the M-90 CAN network such as: *engine hours, RPM, battery voltage, engine coolant temperature, oil pressure, fuel level, intake air temperature, throttle position, road speed, DTC's, and odometer*. The dash harness also has connections for analog gauges. These include Tachometer, Engine Coolant Temperature, Oil Pressure, and a configurable gauge driver. The ECM actually uses the engine's existing sensors to provide gauge signals. This eliminates buying, mounting, and plumbing bulky sending units that would normally have to be placed on the engine. This is a great feature to use with Autometer or similar aftermarket gauges. The Malfunction Indicator Lamp (MIL) output and the A/C switch input are also on the dash harness. The dash harness also contains wiring for the future option of Cruise Control with Engage/Resume and Increase/Decrease buttons. ***ALL FLYING LEAD WIRE ENDS NOT BEING USED SHOULD BE PROPERLY TERMINATED AND INSULATED BY THE INSTALLER TO AVOID A POTENTIAL SHORT CIRCUIT!!!***

Figure 14: Dash Harness

Drive-By-Wire Foot Pedal Installation

Drive-By-Wire (DBW) throttle actuation requires that a DBW foot pedal be installed. The foot pedal should be rigidly mounted to a sufficient structure. This will ensure that the driver has reliable and predictable control of the throttle at all times. The connector simply plugs into the Dash Harness. Failure to properly connect the pedal to the Dash Harness will cause poor engine performance. **Figure 15** below shows the DBW foot pedal securely attached to solid floor structure.

Figure 15: DBW Foot Pedal Installed

Getting System Power

Getting system power on a Mast Motorsports Airboat Engine and ECM Package is very straightforward. Below is the procedure for connecting your package to your boat's 12V DC battery power. ***DO NOT APPLY BATTERY POWER TO THE SYSTEM UNTIL THE INSTALLATION IS COMPLETE!!!*** Applying battery power before installation is complete could potentially cause damage to components and void the warranty. The ECM and fuse block get their power from the large, red (RD) battery cable ring terminal located near the starter motor.

Positive Battery Power

- Ensure the large ring terminal on the wiring harness is connected to the starter post (**Figure 16**).
- Run a battery cable from the battery location to the starter post. Do not connect this cable to the battery. You should only connect the cable to the starter post at this time.
- If running your alternator wire directly to the battery you can connect this cable now.
- If you are running your alternator wire directly from the alternator to the starter post, connect the terminal to the starter post at this point. (NOTE: Connecting the alternator directly to the starter

post will cause the engine to run off of the alternator, independent of the battery. For safety, the alternator cable should be run to a battery cutoff switch first, and then to the starter.)

- Secure all cables to the starter post (**Figure 16**) using the supplied nut.

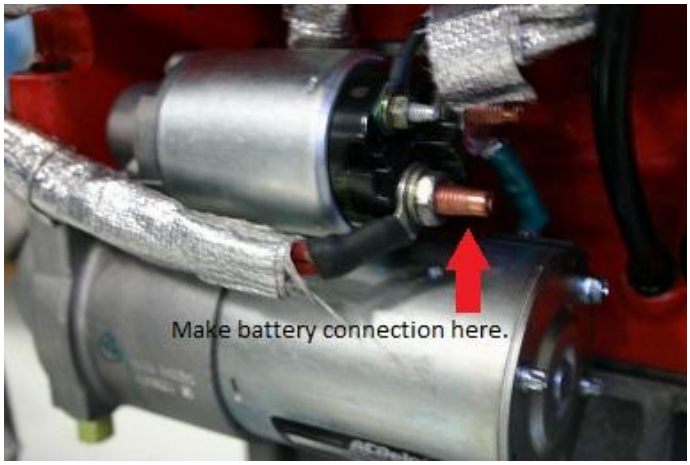


Figure 16: M-90 Power Terminal Installation

Battery Ground

The ECM and fuse block grounds are the two large ring terminals with black (BK) cables that run to the front, driver's side of the engine. They are secured with an M10x1.5 bolt on the side of the engine, located directly behind the alternator. **See Figure 17**.

- Run a cable with ring terminal from the negative side of the battery to the front driver's side of the engine.
- Run a second cable with ring terminal from the vessel ground to the front driver's side of the engine.
- Secure both ring terminals to the side of the engine in the same location as the ECM and fuse block grounds (**Figure 17**).

Figure 17: M-90 ECM and Fuse Block Ground Terminal Installation

NOTE: ALL GROUND CONNECTIONS SHOULD BE CLEAN, FREE OF PAINT, AND SECURED SUFFICIENTLY!!! This will eliminate potential hours of troubleshooting throughout the build process.

Now your ECM/Wiring Harness is grounded to the engine and the engine is also grounded to the chassis. On most installations, this should make for a common ground for the entire vessel.

Ignition Switch Wiring

There are many different configurations that may be used for wiring the ignition/start switch. The most commonly used configuration is a tumbler style ignition switch that is found on road cars. These switches commonly have four posts/connections. The functions of these posts are: 12V Power, Ignition Power, Starter Activation, and Accessory Power. Table 1 shown below describes the wire in the Mast Motorsports Dash Harness that corresponds to each of the posts/connectors.

Ignition Switch Wiring Table

Ignition Switch Post	*Wire Function*	*Mast Motorsports Wire Color*	*Mast Motorsports Dash Harness Cavity* ***(Figure 18)***
12V Power	Supplies 12V to Ignition Switch	RD/BK	A4
Switched Ignition Power	Supplies 12V to ECM and Other Connected Subsystems	PK/D-BU	C6
Starter Activation Wire	Activates Starter Motor	Y/RD	B7
Accessory Power	12V Output for Chassis Accessories (if applicable)	NONE	NONE
Chassis Ground	Valet Ground	WH/PK	B8

Table 1: Mast Motorsports Ignition Power Wire Connection Chart

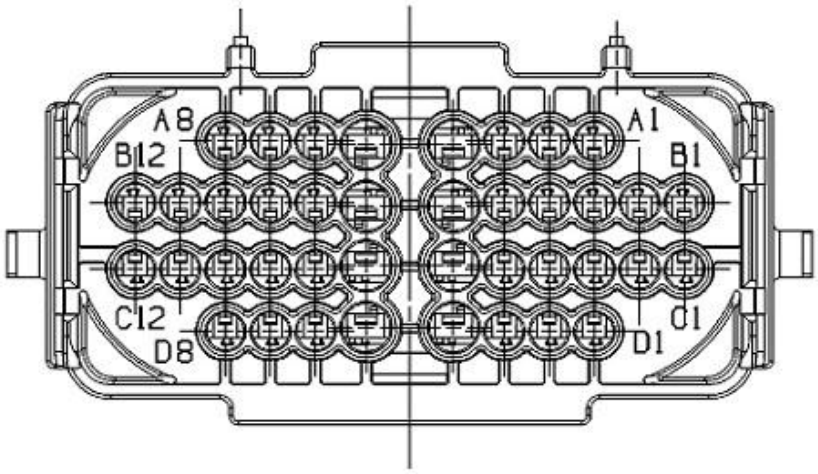


Figure 18: Wiring Cavity Location

Valet Ground Wiring

The White and Pink (WH/PK) Valet Ground Wire is a safety feature integrated into the M-90 ECM/Wiring Harness Package, located in Cavity B8 (**Figure 18**). This disables the user from activating the starter motor unless this wire is grounded. This wire should be placed on a switch that grounds whenever activated. If it is not possible to install a Valet Ground Wire switch in the vessel, the wire may simply be attached to a permanent ground. However, Mast Motorsports highly recommends that a Valet Ground Wire switch be fitted to the vessel in the interest of safety. Wire the (WH/PK) Valet Ground wire to one side of the switch and the other side of the switch to a ground. Now you are ready for safe vessel operation.

Fuel Pump Wiring

The fuel pump wiring harness (**Figure 13**) connects to an 8-pin connector on the main harness. This connector is located on the driver's side rear of the engine. There are two wires in the fuel pump harness. They are to be run directly to the fuel pump. The Yellow/Red (Y/RD) wire goes to the positive side of the fuel pump and the Black (BK) wire goes the ground or negative side of the fuel pump. The fuel pump fuse and relay are integrated into the Mast Motorsports Wiring Harness. The fuel pump is programmed to prime the fuel system for 5 seconds at key on, and is turned on continuously as soon as the starter relay is triggered by the end user's ignition switch. The fuel pump will also stop whenever the engine is stopped for safety and convenience reasons. The fuel system prime feature ensures easy starting and the convenience of not needing a separated switch for the fuel pump. If the end user needs the ignition switch on for lights, radio, or accessories, the fuel pump will not run continuously.

Gauge Wiring and Setup

Electric Gauge Wiring

Mast Motorsports M-90 ECM has the ability to drive duty cycle or resistance electric gauges. It drives gauges using a Duty-Cycle PWM signal. This eliminates the need to have a separate sender to provide gauge signals.

In the absence of gauge manufacturer's calibration data, a custom gauge calibration must be created. This process consists of correlating the values on the Mast Motorsports Calibration Software to the value shown on the gauge. This process is explained in detail below as well as in the Mast Motorsports Calibration Manual. It should be noted that custom calibration of the gauge drivers requires the purchase of a communications cable and software. (Mast Motorsports P/N: 302-102)

Tachometer Gauge (Tach) Wiring

Mast Motorsports ECM/Wiring Harness Packages have an integrated tachometer signal eliminating the need to acquire a tachometer signal through other means. This signal comes from the ECM and is transmitted through the Red and Dark Green (RD/D-GN) wire in cavity C11 (**Figure 18**) of the dash harness. This tachometer driver uses a 4 pulses per revolution signal and is not custom configurable. A 4 pulse per revolution tachometer or a tachometer that has a selectable pulse per revolution must be used.

Oil Pressure Gauge Wiring

Most oil pressure gauges will have a three wire connection. These wires are for switched ignition power, oil pressure signal, and ground. In order to take advantage of the oil pressure gauge driver, follow the gauge manufacturer's wiring instructions. When hooking up the oil pressure signal wire, use the Black and Dark Green (BK/D-GN) wire in cavity C9 (**Figure 18**) of the Dash Harness. The process of calibrating the gauge is explained in the *Electric Gauge Calibration* section on page 19.

Engine Coolant Temperature (ECT) Gauge Wiring

Most engine coolant temperature gauges will have a three wire connection. These wires are for switched ignition power, ECT signal, and ground. In order to take advantage of the ECT gauge driver, follow the gauge manufacturer's wiring instructions. When hooking up the ECT signal wire, use the Light Green and Dark Green (L-GN/D-GN) wire in cavity C10 (**Figure 18**) of the Dash Harness. The process of calibrating the gauge is explained in the *Electric Gauge Calibration* section on page 19.

Malfunction Indicator Lamp (MIL) Wiring

The M-90 has the ability to power a MIL light so that the user can be notified of a potential engine problem. Many lights can be used and in some cases, an OEM light can be used. The MIL wire is Orange (OR) and is located in cavity C12 (**Figure 18**) of the Dash Harness. This wire will provide a ground when the ECM sees a Diagnostic Trouble Code (DTC). When wiring the MIL light, hook the wire up to the ground side of the MIL light. The terminal on the light should have switched ignition power.

Fit and Finish of Installation

During final installation, make sure that all wires are away from heat sources, sharp edges, and moving parts. This is especially true for the heat shielded wires that run to the Main Power on the Starter Post, Ground Wires, Knock Sensors, and Crankshaft Position Sensor that run toward the bottom of the engine. These wires should be fastened back away from the exhaust system using a "P-Clip" or other reliable solution. **Figures 19, 20, and 21** below show a great strategy for using P-Clips to retain wires away from exhaust heat.

FAILURE TO KEEP WIRES AWAY FROM HEAT AND MOVING PARTS COULD RESULT IN CATASTROPHIC ENGINE DAMAGE AND IS NOT COVERED BY WARRANTY!!!

Figure 19: Passenger Side P-Clip Installation

Figure 20: Driver's Side Front P-Clip Installation

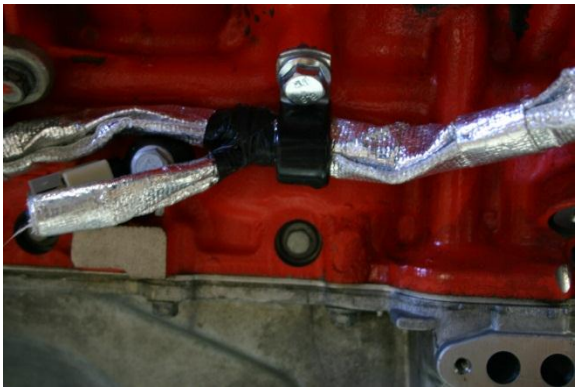


Figure 21: Driver's Side Rear P-Clip Installation

Electric Gauge Calibration

Oil Pressure and Engine Coolant Temperature (ECT) Gauge Calibration

The Mast Motorsports M-90 ECM contains the unique capability of fully calibratable Oil Pressure and ECT gauge drivers. This allows customers to use virtually any electric gauge they choose without using a specific sending unit. The ECM simply streams the information across the Oil Pressure and ECT signal wires. To perform the following calibration, a Mast Motorsports communication software package (PN: 302-102) and password are required. These are available from Mast Motorsports. Please have the ECM serial number available when contacting Mast Motorsports.

Step 1

To start the calibration process you must be in the Mast Display under Page>GaugeDrive (**Figure 22)**. Verify that your Display shows "connected" in the upper left hand corner of the software.

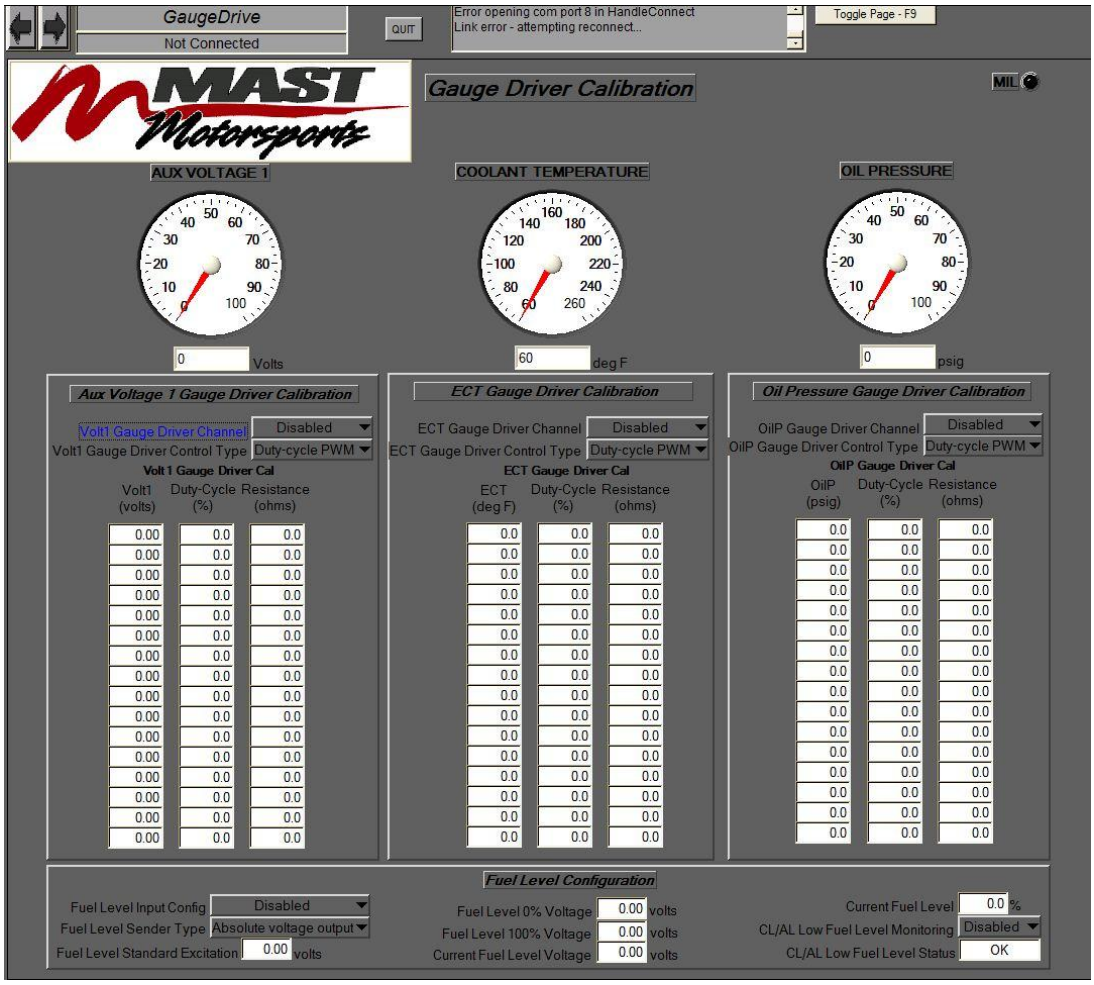


Figure 22: Mast Gauge Driver Calibration Screen

Step 2

To begin the calibration process, start with the engine coolant temperature section (ECT Gauge Driver Calibration) (**Figure 22**). Enter 100 in the highlighted area under the Duty-Cycle column, shown in **Figure 23** (This area will be red on your screen) and press "enter" while watching to see if your coolant gauge moves. If your gauge moves you have a successful connection and can continue to step 3. If it does not move, please verify wiring is connected correctly.

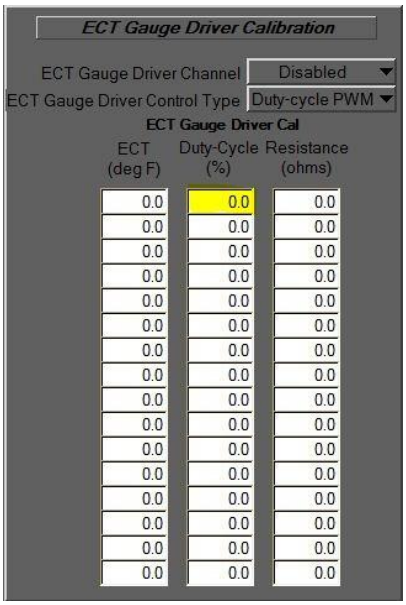


Figure 23 Entry Field

Step 3

Notate the number in the highlighted area in **Figure 24** below. This is the number we want to start with. Enter different values from 0-100 in the highlighted area in **Figure 23** until your gauge reads the value in **Figure 24**.

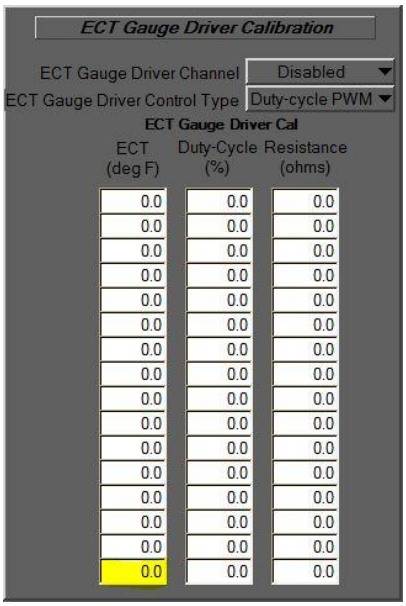


Figure 24 Gauge Value

Step 4

After getting the correct value in the entry field (**Figure 23**) enter this value in the highlighted area under the Duty Cycle column, shown in **Figure 25.** Continue repeating steps 1-4 until you have entered values into each cell under Duty-Cycle (%).

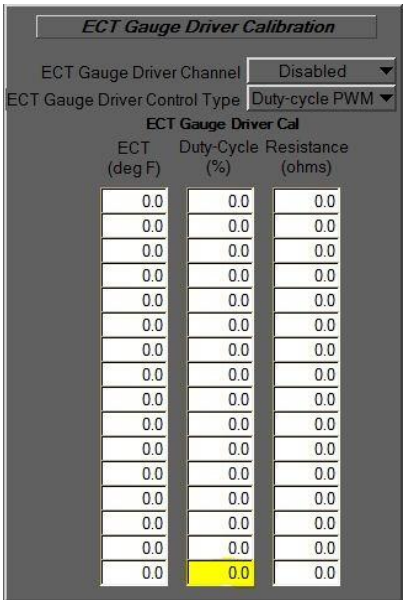


Figure 25 Result Field

After you have entered values into each cell under Duty-Cycle (%) you have successfully calibrated your coolant gauge. Follow these same steps to calibrate your Oil Pressure Gauge.

Controller Area Network (CAN)

CAN is a means of data transfer that is commonly used in modern vehicle OEM, marine, and industrial applications. This allows the transfer of large amounts of data over just two wires. Taking advantage of this technology can greatly reduce the amount of wiring that is required to monitor certain parameters of an engine. CAN also transmits data from the M-90 ECM to operate other devices, such as gauges and data loggers.

Mast Motorsports CAN Gauge Wiring

Mast Motorsports offers a Livorsi CAN Gauge Package (**Figure 26**) that allows the data transmission of multiple engine parameters across two wires. There is a master tachometer gauge and multiple slave gauges in this setup. The master tachometer contains all the major electronic circuitry. The slave gauges are completely plug and play into the master gauge with the supplied 3-wire slave harness. A master gauge will come with a 12 wire master harness to operate the gauges. Only six of these wires will need to be connected to the Mast Motorsports Dash Harness. **Table 2** shows the wire connections for Mast Motorsports CAN Gauges. The remaining wires are connected to the supplied control pod to operate multiple functions of the master tachometer.

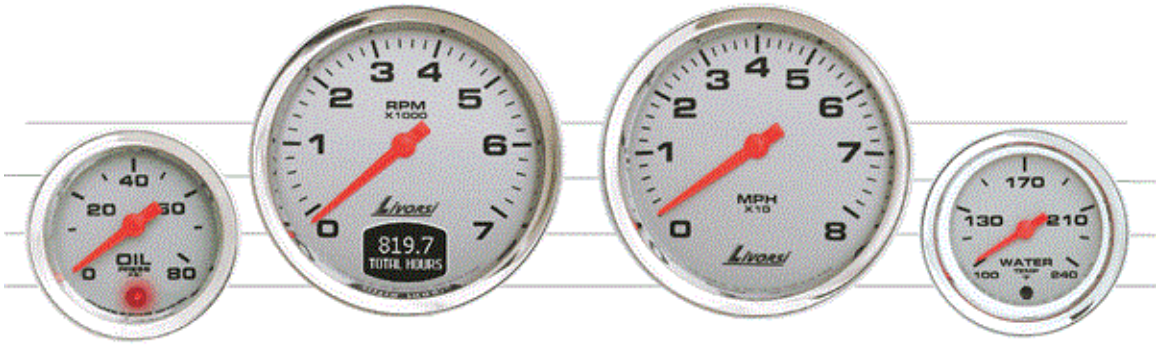


Figure 26: Livorsi CAN Gauges

With the master Gauge wired, the satellite gauges are a plug and play installation. Plug them into the master gauge using the slave harnesses supplied with the gauge package. Full instructions for connection of the CAN gauges are supplied with the Livorsi CAN Gauge Kit.

Mast Motorsports CAN Gauge Wiring Table			
Wire Function	*CAN Gauge Wire Number*	*Mast Motorsports Wire Color*	*Mast Motorsports Dash Harness Cavity*
12V Power Supply	6	LT-BU/RD	A5
Ground	2	BK	C7
CAN1 High	4	LT-BU/BK	D1
CAN1 Low	3	LT-BU/WH	D2
Illumination	5	Connect to Light Switch Power Source	
Ignition	1	PK/D-BU	C6

Table 2: Mast Motorsports CAN Gauge Wire Connection Chart

Operating Instructions

Engine Starting Checklist

Before your engine is started, it is essential that the following checklist be completed.

- ___ Proper engine oil added to correct level.
- ___ Engine cooling system: filled and bled of air, plumbed correctly, hose clamps tightened.
- ___ Fuel system: provides 58.5 psi and checked to ensure no leakage.
- ___ Air filter installed, secured, and IAT sensor connected.
- ___ Starter connections correct and tight.
- ___ Accessory drive belt installed and secured.
- ___ Exhaust system installed and secured.
- ___ Wires connected, secured, and placed away from heat, sharp edges, and moving parts.
- ___ Ensure flying lead wires not being used are insulated to prevent electrical shorting.
- ___ Battery cables properly connected to battery.

Engine Break-in

Your engine is a high performance engine and requires special care during the break-in period and beyond. Every airboat engine at Mast Motorsports goes through a thorough start-up procedure and dyno run before the engine is shipped. Special care was taken during the initial start-up and dyno run to ensure the engine is performing properly.

Use only the recommended engine oil for the temperature for which the vessel will be operated. The engine oil level and coolant level should be checked frequently during this period. It is important to watch all gauges while performing this break-in. If at any time the temperatures or pressures deviate from the normal operating parameters, the engine must be stopped to determine the cause of the problem. Refer to the ***Troubleshooting*** section of this manual if a problem occurs. Mast Motorsports recommends a two hour break-in period, during which, maximum RPM should never be sustained for more than two minutes. During this break-in period, it is recommended to operate the engine at varied RPM levels between 2200 RPM and 5800 RPM. Avoid operating the engine at a constant RPM, including idling, for extended periods of time during this period. This procedure will help promote piston ring sealing.

Mast Motorsports Typhoon and Cyclone engines have forged pistons. It is imperative that you always use the oil recommended by Mast Motorsports or oil with sufficient ZDDP for the entire life of the engine! Mast Motorsports does not recommend the use of synthetic oil. This will ensure proper ring seating. Mast Motorsports does not warranty any application with the use of power adders, such as turbochargers, superchargers or nitrous. If it is determined that premature ring wear, ring sealing, piston scuffing, and/or engine failure, is the result of improper tuning, incorrect oil, improper installation, and/or the use of power adders, all repairs, parts, materials, shipping expenses, and labor will be the sole responsibility of the purchaser.

> **NOTE: It must be understood that every internal combustion engine will use a certain amount of oil during operation to act as a lubricating and cooling agent, especially during the break-in period. Oil consumption should decrease and become stabilized after approximately 100 hours of operation.**

PCV Systems

The LS-Series engines are prone to excessive crank case pressure build-up resulting in oil blow-by, oil consumption, and oil wetting of the intake manifold. One of the first changes from GM to help resolve this issue was the bay-to-bay "windows" placed in the main webs of the blocks. Any increase in cubic inch displacement over stock, places more demand on the PCV system, regardless of the engine type. Operating the engine with the improper oil viscosity, or below normal oil temperature, will increase engine blow-by and lead to abnormal oil consumption. Use only the specified oil for the temperature range for which the engine will be operated. See ***Normal Operating Parameters and Requirements.***

Mast Motorsports Airboat Engines are supplied with a PCV Breather Tank (**Figure 27**). This tank should be mounted to a rigid structure, at a level higher than the breather fittings on the engine. The fitting on the side should be plumbed directly to the valve cover breather located next to the oil fill cap (**Figure 28**). The tank should be drained of any excess oil every 50 hours.

Figure 27: PCV Breather Tank

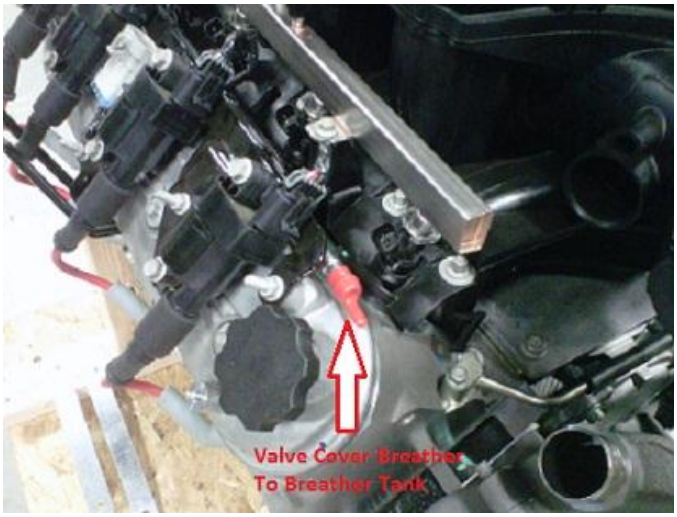


Figure 28: Valve Cover Breather Location

Power Reduction Mode

The Mast Motorsports M-90 ECM monitors engine oil temperature and engine coolant temperature (ECT) whenever the engine is running. When the ECT or oil temperature is out of the normal operating parameters, the system will go into "Power Reduction" mode. This is a feature that will help protect the engine during abnormal temperature conditions. When operating in "Power Reduction" mode, the ECM will default to a "load limit" condition. Refer to **Table 3** for Power Reduction Mode conditions. While operating in power reduction mode, the ECM will only allow limited engine performance. Once the engine has returned to normal operating temperatures, normal engine operation is restored, until the engine exceeds the temperature parameters again. This feature still allows maneuverability of the boat while removing the possibility of high engine speed operation until the problem is corrected.

NOTICE: For continued reliability of your Mast Motorsports engine, the cause of the Power Reduction Mode fault must be determined and corrected. Please refer to the *Troubleshooting Section* of this manual. Engine failure due to symptoms of Power Reduction Mode faults, will not be covered under warranty!

ECT	*Load-Limit*
(degF)	*(%)*
0.0	60.0
40.0	70.0
80.0	85.0
120.0	100.0
160.0	100.0
200.0	100.0
210.0	80.0
220.0	40.0

Oil Temperature	*Load-Limit*
(deg F)	*(%)*
-40.0	60.0
0.0	100.0
40.0	100.0
200.0	100.0
220.0	100.0
250.0	100.0
260.0	80.0
280.0	40.0

Table 3: Power Reduction Mode Parameters

Service

Replacement Parts

Use of replacement parts (i.e. automotive, after-market, etc.) in the electrical, ignition and fuel systems, which are not Mast Motorsports approved, could cause a fire or explosion hazard and void the warranty, and should be avoided. Always use Mast Motorsports approved replacement parts in any repairs or maintenance being performed on your engine(s).

Accessory Drive Belt and Pulleys

Inspect the drive belt for excessive wear, shredding or missing sections. **Excessive dirt, oil, coolant, or other substances on the belt and pulleys can cause abnormal belt noise and will affect the drive belt life and operation. Figure 29** shows the proper belt routing. If a problem is found, replace the belt after inspecting the following items:

- All pulleys and tensioners for signs of misalignment, rust, or other damage.
- Excessive debris embedded in pulleys.
- Tight or worn bearings in pulleys, engine water circulation pump, and alternator.

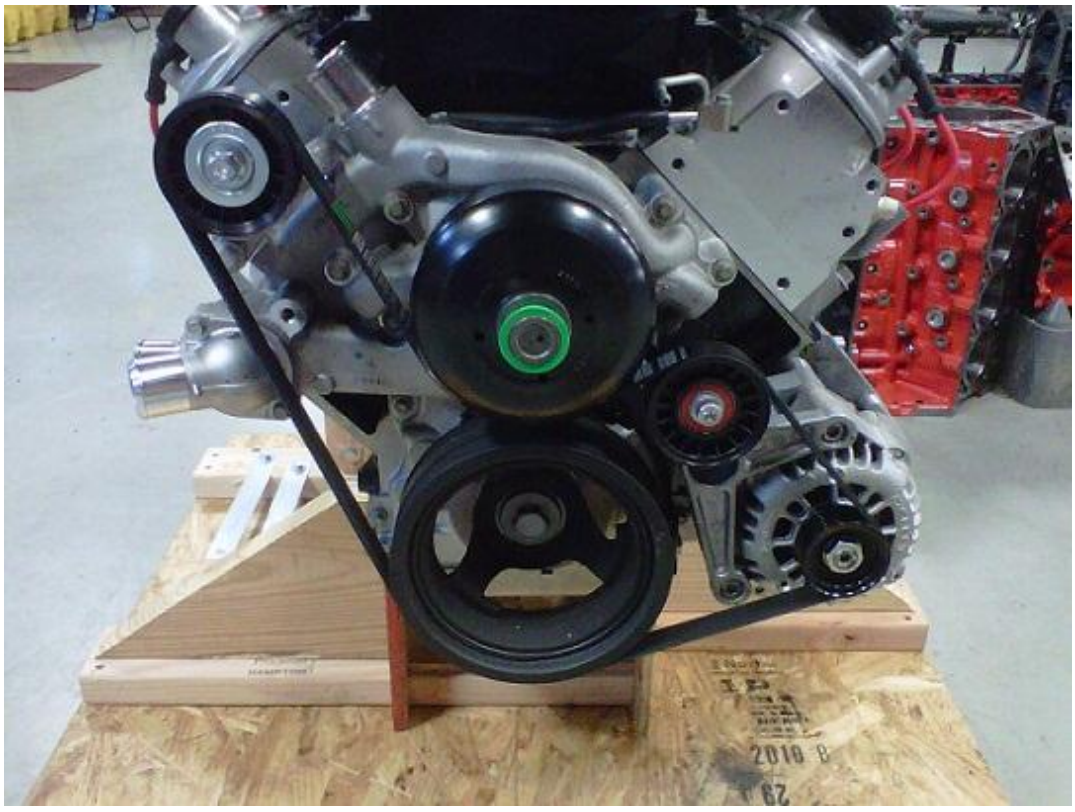


Figure 29: Proper Belt Routing

Changing Oil

Refer to the MAINTENANCE SCHEDULE for oil change intervals. The engine oil should be changed prior to placing the engine into storage. **IMPORTANT:** Change the engine oil when the engine is warm from operation. Warm oil flows more freely, and allows more foreign material and impurities to be removed.

1. With the engine at normal operating temperature, place an oil drain pan beneath drain plug on the oil pan. Remove drain plug and let the oil drain completely.

2. Remove the oil filter by turning it counterclockwise. Use an oil filter wrench if necessary. Discard the old filter and sealing gasket.

3. Coat the sealing gasket on the new filter with a light coating of clean engine oil. Install the oil filter securely by hand. **DO NOT** over tighten.

4. Fill the engine with the recommended oil through the oil fill location on the valve cover.

Engine Storage

1. Fill the fuel tanks with gasoline (that does not contain alcohol) and add a sufficient amount of gasoline stabilizer, such as STA-BIL™ Fuel Stabilizer – Marine Formula, to prevent the formation of fuel gum and varnish. Follow the instructions on the container.

   IMPORTANT: If the engine is to be placed into storage with fuel containing alcohol in the fuel tanks, the engine fuel system must be run dry at idle RPM. A fuel conditioner, such as STA-BIL™ Fuel Stabilizer – Marine Formula, should be added to any fuel remaining in the tanks.

2. Run the engine and allow it to reach normal operating temperature. Shut down the engine and change the oil and oil filter (See CHANGING OIL).

3. Remove the air filter. Operate the engine at a fast idle speed (1000-1500 RPM). Using an aerosol type fogging oil, such as STA-BIL™ Fogging Oil, spray a sufficient amount into the throttle body assembly bore to treat internal surfaces of the engine. Do not allow the engine to stop while spraying fogging oil. Short bursts work best. Refer to the instructions on the fogging oil canister. Turn the ignition switch to the OFF position.

4. Cover the throttle body assembly to prevent the possibility of water and debris entering the engine through the throttle body assembly during storage.

5. Close the fuel shut-off valve (if equipped).

Engine Prep after Storage

When re-commissioning the engine after storage, the following items should be checked:

• Check the condition of all cooling system hoses. Be sure they are properly connected and all clamps are tight.

• Install a fully charged battery. Be sure that all the connections are clean and free from corrosion. Coat the battery terminal connections with an anti-corrosion battery terminal spray.

• Refer to the OPERATING INSTRUCTIONS on page 24 and perform all the safety checks before starting the engine.

• Start the engine and closely observe all gauges for proper operating parameters. Allow the engine to reach normal operating temperature. Inspect the engine carefully for fuel, exhaust, oil and coolant leaks.

• Check the steering and throttle controls for proper operation.

Normal Operating Parameters and Requirements

Engine oil	*Temperatures above 32° F* *Valvoline Racing SAE 20W-50* *Temperatures below 32°F* *Valvoline Racing SAE 10W-30*
Fuel Requirement	*91-93 Octane (R+M)/2*
Coolant	*Extended Life Antifreeze/Coolant (50/50 mix)*
Oil Pressure @ 2500 RPM	*25-50 psi with oil at operating temperature*
Minimum Oil Pressure	*10 psi @ idle with oil at operating temperature*
*Oil quantity **	*6 Quarts*
Normal Oil Temperature	*180° - 230°*
Normal Engine Coolant Temperature	*155°-200°*
Voltage	*13.0 – 14.8 volts*
Maximum RPM	*6200 RPM*
Alternator	*105 amp*
Battery CCA	*650 CCA (Minimum)*
Spark plug gap	*.045”*

** Capacities are dependent on installation angle. Oil capacities are approximate. Always verify the correct amount by using the dipstick.*

Service Item List

Component	***Mast Motorsports Part #***
Oil Filter	*89017524*
Spark Plugs	*AC 12621258 or NGK 4091*
High Pressure Fuel Filter/Regulator	*105-006*
Fuel Pump	*WAL-GSL392*
Air Filter	*115-001*
Inlet Air Temperature Sensor (IAT)	*12160244-B*
Spark Plug Wires	*402-002*
Accessory Drive Belt	*GATK060532*
Diagnostic Software and USB Cable	*302-102*
Engine Coolant	*Extended Life Antifreeze/Coolant (50/50 mix)*

General Torque Specifications

Component	***Torque ft-lb***
Spark Plug	*11*
Header Bolts	*15*
Alternator Bolts	*37*
Flywheel Bolts	*74*
Engine Mounts Bolts	*37*
Bell Housing Bolts	*37*
Idler Pulley Bolt	*37*
Coolant Temperature Sensor	*15*
Crankshaft Position Sensor	*18*
Oil Pan Drain Plug	*18*
Oil Pressure Sensor	*26*
Throttle Body Bolts	*7.5*
Intake Manifold Bolts	*7.5*
Other M8 Bolts	*18*
Other M10 Bolts	*37*
Coolant Thermostat Housing Bolts	*11*

Maintenance Schedule

Location & Service	*Check Daily*	*After 1st 25 Hours of Operation*	*Every 50 Hours of Operation*	*Every 100 Hours of Operation*	*Once Each Year*
Check Coolant Level	X				
Check Oil Level – Engine Crankcase	X				
Engine Assembly (Check for obvious leaks, water, oil, fuel and exhaust)	X				
Throttle and Steering System – Check for proper operation	X				
Cooling system – Check condition and tightness of all hose clamps		X	X		X
Exhaust System – Check for leaks at manifold		X	X		
Ignition System and Spark plugs – Clean and inspect condition		X		X	X
Complete Engine Assembly – Check for loose, missing or damaged parts (especially engine mounts, starter and alternator mounting fasteners)		X		X	X
Change Engine Oil and Filter		X	X		X
Drain PCV Breather Tank			X		X
Engine Alignment – Check and adjust if necessary		X			X
Air Filter – Clean or Replace			X		X
Battery – Check electrolyte level and specific gravity. Inspect case for damage. Check cables and connections.		X	X		X
Electrical System – Check for loose or dirty connections and damaged wiring.			X		X
Hoses – Inspect for cracks, swelling, weather checking or other signs of deterioration				X	X
Fuel Filters – Service or replace			X		X
Engine Assembly Exterior Surfaces – Spray with rust-preventative oil (WD 40 Penetration oil or equivalent.)	Fresh water areas – Every 60 Days Salt water areas – Every 15 Days				

Troubleshooting

Malfunction	**Possible Cause**	**Corrective Action**
Engine will not crank with the starter motor, or cranks slowly. ***Note:*** *Battery voltage must be AT or ABOVE 10 volts while engine is cranking.*	Improper Valet Ground Connection.	-Confirm Valet Ground is properly grounded. *Refer to Wiring Installation Section.*
	Blown Ignition Fuse.	-Confirm proper wiring. Refer to *Wiring Installation Section.* Replace the Fuse.
	Loose and/or Dirty Wiring Connections	-Check battery cables and starter circuit wiring. Refer to *Wiring Installation Section.* -Clean and tighten all connections.
	Dead Battery	-Recharge, test and replace if necessary.
Engine Cranks – will not start or is hard starting.	Insufficient Fuel/Low Fuel Pressure	-Verify fuel pressure of 58.5 psi at the fuel rail. -Open fuel shut-off valve. -Check fuel level. -Verify fuel system plumbing. Refer to *Appendix B.* -Plugged fuel filter, plugged or kinked fuel lines or plugged fuel tank vent. Replace or repair as needed. -Fuel pump not functioning. Confirm wiring. Refer to *Wiring Installation Section.*
	Improper Wiring	-Confirm MAP, IAT Sensors and pedal assembly are connected. -Confirm all wiring connectors are connected. Refer to *Wiring Installation Section.*

Troubleshooting Continued:

Malfunction	**Possible Cause**	**Corrective Action**
Engine Cranks – will not start or is hard starting continued.	Contaminated Fuel	-Check for water and other contaminates in fuel. Replace fuel and fuel filters.
	Ignition System Malfunction	-Contact Mast Motorsports.
Engine overheats	Improper Coolant Hose Routing	-Confirm proper hose routing. Refer to ***Figure 4.***
	Incorrect Coolant Gauge Calibration	-Recalibrate gauge. Refer to *Electric Gauge Calibration.*
	Coolant Level Low	- Refill the system. Check cooling system for leaks.
	Loose or Worn Accessory Belt	-Replace Belt.
	Collapsed, Kinked or Leaking Hoses	-Replace hoses.
	Faulty Thermostat	-Replace thermostat.
	Faulty Temperature Gauge or Sending Unit	-Test and replace as necessary.
Engine Oil Pressure Low	Oil Level Low	-Check engine for leaks. Add specified oil.
	Incorrect Oil Pressure Gauge Calibration	-Recalibrate gauge. Refer to *Electric Gauge Calibration.*
	Faulty Oil Pressure Gauge or Sending Unit	-Test and replace as necessary.

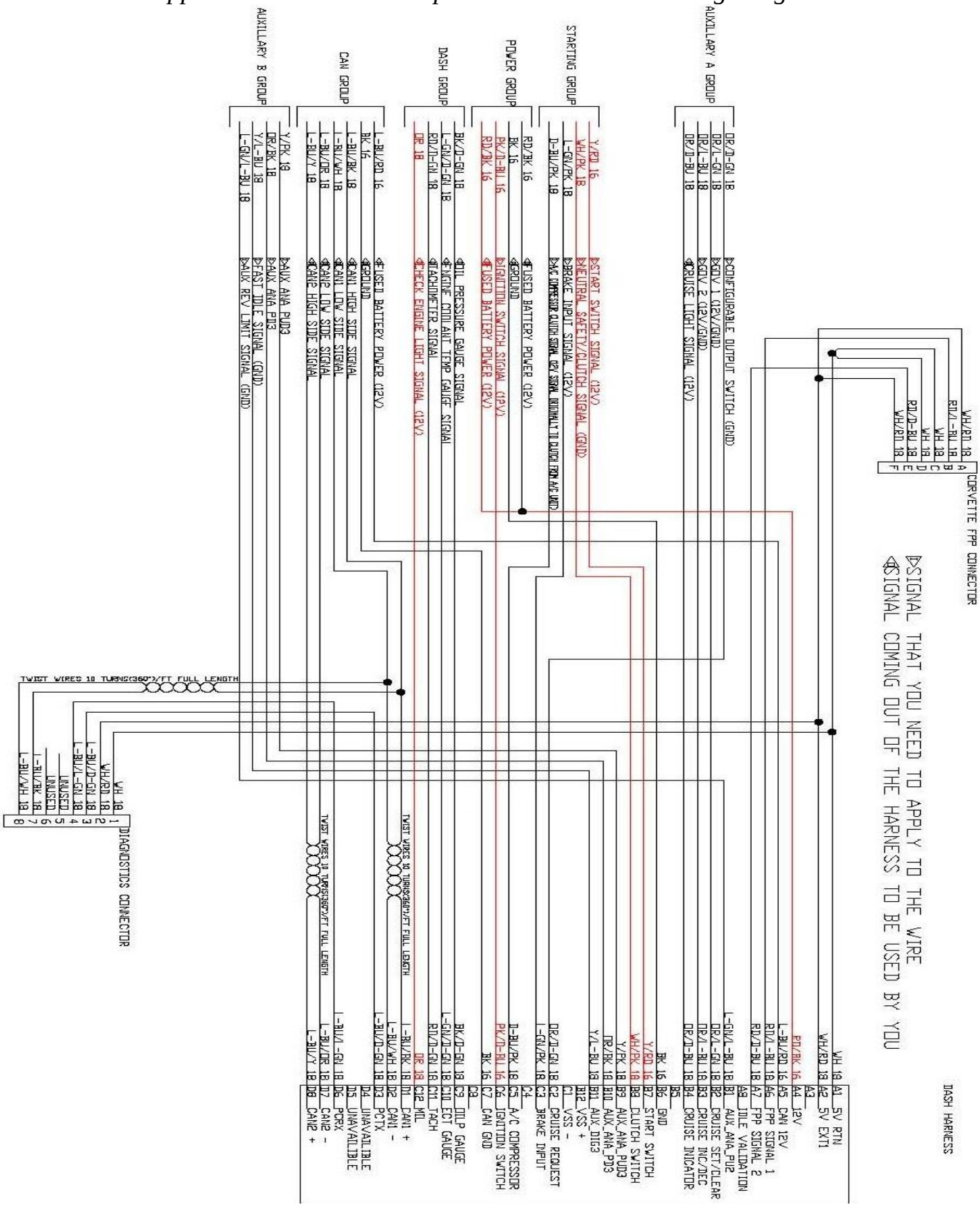
Troubleshooting Continued:

Malfunction	**Possible Cause**	**Corrective Action**
Engine Oil Pressure Low Continued	Engine Oil Overfilled Causing Aeration	- Remove the required amount of oil. Determine the cause of the overfilled condition.
	Diluted or Improper grade/Viscosity of Oil	-Change the oil and filter with proper grade/viscosity Determine the cause of the dilution. (Insufficient engine temperature, excessive idling, etc.)
High Oil Temperature	Incorrect Oil Temperature Gauge Calibration	-Recalibrate gauge. Refer to *Electric Gauge Calibration.*
	Oil Level Low	-Check oil level. Adjust as necessary.
	Incorrect Oil Viscosity	-Replace oil and filter. Refer to *Normal Operating Parameters and Requirements*
	Oil Cooler-Placement/Sizing	-No air flow to oil cooler. Refer to *Oil Cooling System.* -Incorrect size cooler. Refer to *Oil Cooling System.*
Engine Enters Power Reduction Mode	Oil Temperature Sensor and/or ECT Sensor Not Connected	-Confirm connection of oil temperature sensor and/or ECT Sensor.
	High Engine Coolant Temperature	-Refer to *Troubleshooting: Engine Overheats.*
	High Oil Temperature	-Refer to *Troubleshooting: High Oil Temperature.*

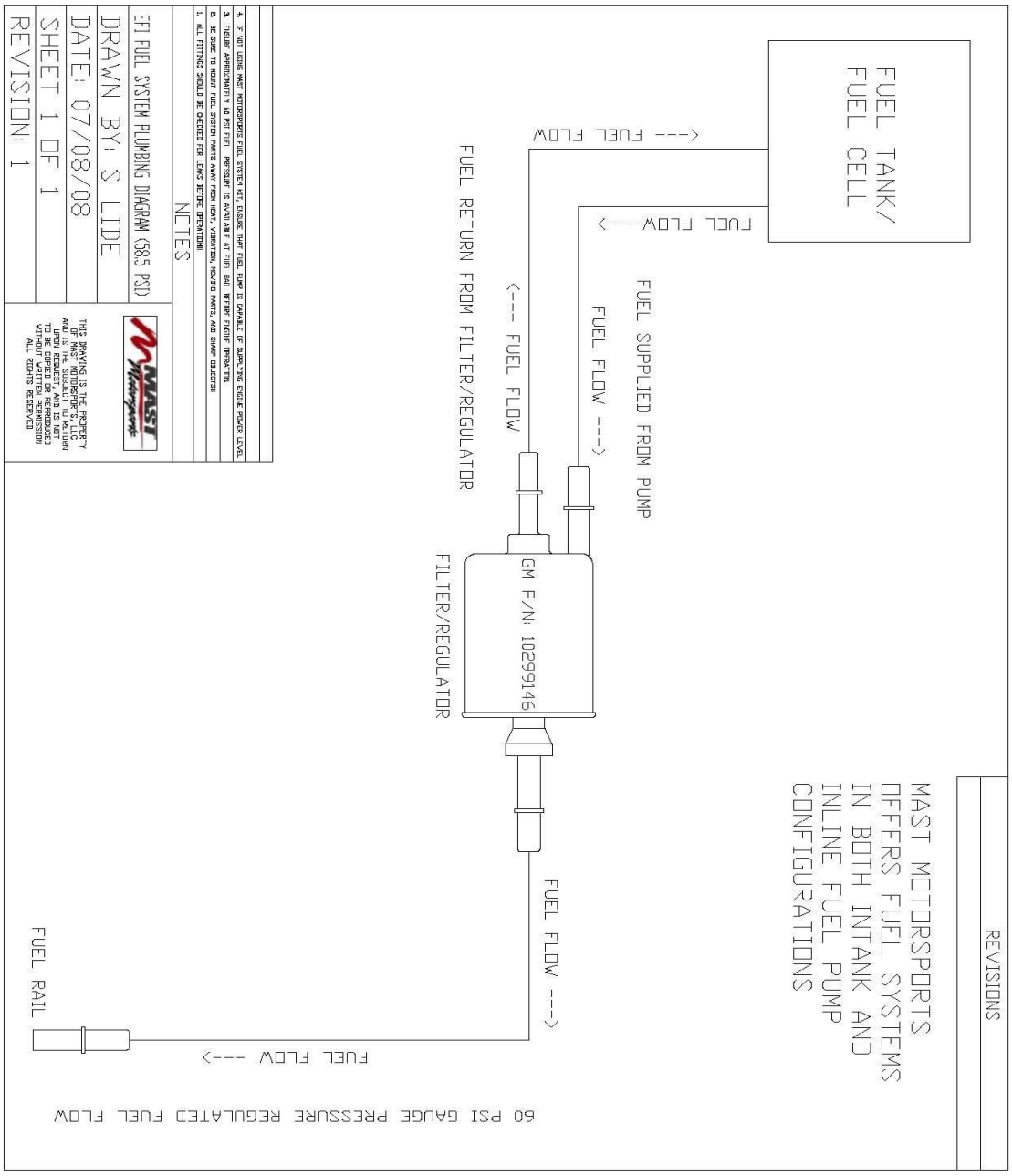
Troubleshooting Continued:

Malfunction	**Possible Cause**	**Corrective Action**
Engine Enters Power Reduction Mode Continued	Low ECT and/or Oil Temperature	-Run engine at high idle speed (1500 RPM) until normal operating temperature is achieved.
Engine Misses, Runs Rough, and/or Backfires	Low Fuel Pressure	-Confirm fuel pressure at fuel rail is 58.5 psi.
	Faulty Wiring	-Confirm all wiring, including MAP Sensor, IAT Sensor, and Pedal Assembly, is connected.
	Plugged fuel filters	-Replace the fuel filters.
	Faulty Fuel Pump	-Replace the fuel pump.
	Plugged or Kinked Fuel Lines or Fuel Tank Vent	-Repair or replace the fuel lines.
	Ignition System Malfunction	-Contact Mast Motorsports

Appendix A: Mast Motorsports Dash Harness Wiring Diagram



Appendix B: Mast Motorsports Suggested Fuel System Plumbing Diagram



Appendix C: Mast Motorsports System Fault Codes

System Fault Code	*Description*		System Fault Code	Description
111	*IAT High Voltage*		411	Injector Driver #1 Open
112	*IAT Low Voltage*		412	Injector Driver #1 Shorted
113	*IAT Higher than Expected 1*		413	Injector Driver #2 Open
114	*IAT Higher than Expected 2*		414	Injector Driver #2 Shorted
115	*Oil Pressure Low*		415	Injector Driver #3 Open
121	*ECT/CHT High Voltage*		416	Injector Driver #3 Shorted
122	*ECT/CHT Low Voltage*		421	Injector Driver #4 Open
123	*ECT Higher than Expected 1*		422	Injector Driver #4 Shorted
124	*ECT Higher than Expected 2*		423	Injector Driver #5 Open
131	*MAP High Pressure*		424	Injector Driver #5 Shorted
132	*MAP Low Voltage*		425	Injector Driver #6 Open
134	*BP High Pressure*		426	Injector Driver #6 Shorted
135	*BP Low Pressure*		431	Injector Driver #7 Open
136	*TIP Voltage High*		432	Injector Driver #7 Shorted
137	*TIP Voltage Low*		433	Injector Driver #8 Open
142	*Crank Sync Noise*		434	Injector Driver #8 Shorted
143	*Never Crank Synced at Start*		511	COP Failure
144	*Camshaft Sensor Loss*		512	Invalid Interrupt
145	*Camshaft Sensor Noise*		513	A/D Loss
212	*HO2S Open/Inactive*		514	RTI 1 Loss
221	*Closed Loop Multiplier High*		515	Flash Checksum Invalid
222	*Closed Loop Multiplier Low*		516	RAM Failure
241	*Adaptive Lean Fault*		521	Shutdown Request
242	*Adaptive Rich Fault*		531	External 5v Reference Lower than Expected
261	*System Voltage High*		532	External 5v Reference Higher than Expected
262	*System Voltage Low*		555	RTI 2 Loss
311	*Coil Driver #1 Open*		556	RTI 3 Loss
312	*Coil Driver #1 Shorted*		611	FPP High Voltage
313	*Coil Driver #2 Open*		612	FPP Low Voltage
314	*Coil Driver #2 Shorted*		613	FPP Higher than IVS Limit
315	*Coil Driver #3 Open*		614	FPP Lower than IVS Limit
316	*Coil Driver #3 Shorted*		631	TPS1 (signal voltage) High
321	*Coil Driver #4 Open*		632	TPS1 (signal voltage) Low
322	*Coil Driver #4 Shorted*		633	TPS2 (signal voltage) High
323	*Coil Driver #5 Open*		634	TPS2 (signal voltage) Low
324	*Coil Driver #5 Shorted*		635	TPS1 Higher than TPS2
325	*Coil Driver #6 Open*		636	TPS2 Higher than TPS1
326	*Coil Driver #6 Shorted*		637	Throttle Unable to Open
331	*Coil Driver #7 Open*		638	Throttle Unable to Close
332	*Coil Driver #7 Shorted*		651	Max Govern Speed Override
333	*Coil Driver #8 Open*		652	Fuel Rev Limit
334	*Coil Driver #8 Shorted*		653	Spark Rev Limit

Engine Maintenance Log

Date	*Maintenance/Repair*	*Engine Hours*

Notes

330 NW Stallings
Nacogdoches, TX 75964

WARRANTY STATEMENT

Congratulations on your purchase of Mast Motorsports Typhoon/Cyclone Engine.
The industries finest Fuel Injected High Performance Airboat Engine.

The following Terms and Conditions of Sale protect the purchaser/owner from defects in materials and workmanship. It is important that the purchaser/owner provide their Engine with a favorable break-in, and good maintenance in order to get the very best performance from this engine.

MAST MOTORSPORTS, LLC CONSUMER TERMS AND CONDITIONS OF SALE

GOVERNING PROVISIONS.

All sales of Airboat engines, and engine parts ("Engines") by Mast Motorsports, LLC ("MMS") to distributors, or consumers are made subject to these MMS Consumer Terms and Conditions of Sale. No additional or different terms shall apply. If you do not agree to all of these Terms and Conditions of Sale, do not place an order of any Mast Motorsports manufactured Engines. Placing an order for Engines from MMS, a MMS distributor, or any entity that sells MMS Engines will confirm that you agree to be bound by all of these MMS Consumer Terms and Conditions of Sale.

LIMITED WARRANTY.

MMS warrants, to the original consumer purchaser of each Airboat Engine, the Engine will be free from defects in materials and workmanship, for a period of 12 months or 300 hours, whichever comes first, from the date the Engine was purchased from Mast Motorsports. The limited warranty is not an unconditional warranty against all hazards or failures. This limited warranty shall not apply to defects or conditions caused by misuse, abuse, misapplication, incorrect installation, modification, or accident after you received the Engine. The limited warranty shall not apply to any Engine that has been installed in any application that is used or could be used for competition purposes. The limited warranty shall not cover damages resulting from lack of lubrication, improper oil and/or lube, overheating, oil starvation, oil pressure loss, engine over-speed, excessive oil temperature, contamination from foreign elements, environment, or auxiliary components, failures due to extreme weather conditions, detonation or pre-ignition, including but not limited to melted or broken pistons, broken or scored rings, damaged cylinder heads or gaskets, scoring on cylinder walls or piston heads. The limited warranty shall not cover replacement oil, antifreeze, or other substances used in normal maintenance, tune-ups, replacement of belts, hoses, or routine maintenance items. The limited warranty shall not cover or provide payment or reimbursement for towing charges, transportation charges, lift, dock, or storage fees, or loss of use of vessel time or income. MMS's entire liability, and your exclusive remedy under this limited warranty in the event of a breach during the warranty period, will be for MMS to either repair or replace (at MMS's option and expense) the defective Engine or Engine Components, provided you return the defective Engine or Engine Components to MMS at your expense. To make a claim under this limited warranty, please contact MMS directly for a numbered authorization. Prior authorization is required from MMS before warranty work is begun. You must then return the alleged defective Engine or Engine Components via insured freight carrier. MMS will process your return, and if there has been no violation of the warranty and the claim was made within the warranty period, send a repaired or replacement Engine to you at MMS's expense.

THE LIMITED WARRANTY SET FORTH ABOVE IS IN LIEU OF ALL OTHER EXPRESS WARRANTIES. IN NO EVENT SHALL ANY IMPLIED WARRANTIES, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT, EXTEND BEYOND THE DURATION OF THIS EXPRESS LIMITED WARRANTY. NO ORAL STATEMENTS BY ANY PERSON, DISTRIBUTOR OR SALESMAN MAY MODIFY OR CHANGE THIS LIMITED WARRANTY. NO

TERMS OF ANY PURCHASE ORDER OR OTHER FORM FROM THE PURCHASER OR DISTRIBUTOR/SELLER SHALL MODIFY OR CHANGE THIS LIMITED WARRANTY.

Some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

OWNER OBLIGATIONS AND PROCEDURES

Upon initial startup, ultimate purchaser/owner shall assure that a qualified mechanic inspects your engine. The inspection should include, but is not limited to, a change of oil and oil filter after the first (25) hours. Carefully monitor coolant and oil levels for the first 100 hours as oil consumption may be higher during this period. The owner and/or operator is responsible for checking and maintaining ALL fluid levels before and during operation, and for regularly monitoring gauges during operation. Change engine oil as specified in the Maintenance Schedule of this manual. Maintain a documented maintenance schedule, including the facility performing the services, corresponding receipts, and dates. Use only approved motor oil stated above or equivalent. Allow the engine's coolant and oil to reach operating temperatures before the engine is placed in a high load or high RPM operating condition. DO NOT OPERATE THE ENGINE WITH ABNORMAL OIL PRESSURE OR WATER TEMPERATURE. MMS does not recommend the use of full synthetic oils or non-detergent oils, the use of which shall void this Limited Warranty. Due to the manufacturing techniques, the quality products used in MMS Engines and the initial break in performed at MMS, very few special requirements apply to break-in. Use only the recommended engine oil for the temperature for which the vessel will be operated. The engine oil level and coolant level should be checked frequently during this period. It is important to watch all gauges while performing this break-in. If at any time the temperatures or pressures deviate from the normal operating parameters, the engine must be stopped to determine the cause of the problem. Refer to the ***Troubleshooting*** section of this manual if a problem occurs. Mast Motorsports recommends a two hour break-in period, during which, maximum RPM should never be sustained for more than two minutes. During this break-in period, it is recommended to operate the engine at varied RPM levels between 2200 RPM and 5800 RPM. Avoid operating the engine at a constant RPM, including idling, for extended periods of time during this period. This procedure will help promote piston ring sealing.

All engines should be equipped with gauges or lights to indicate engine RPM, engine coolant temperature and engine oil pressure. Mast Motorsports recommends using 91-93 Premium octane fuel only. In the event that 91-93 octane fuel is not available, a minimum of 87 octane fuel is permitted. **However, the engine should not be operated and full throttle/full load or high RPM while using 87 octane fuel.**

IMPORTANT NOTICE - EFFECT ON OTHER WARRANTIES.

Installation of MMS's Engine to a vessel may void, reduce or otherwise adversely affect any warranties given by the manufacturer or seller of the vessel, engine or other component parts. MMS shall not be liable for any such adverse effect on such other manufacturers' or sellers' warranties.

LIMITATION OF LIABILITY

In no event will MMS be liable to you for any incidental, indirect or consequential damages, including but not limited to any damage to your vessel, engine or any fines or penalties, arising from or out of the installation or use of an MMS product, even if MMS has been advised of the possibility of such damages. In no event will MMS's liability for any claim, whether in contract, tort (including negligence and strict liability) or under any other theory of liability, exceed the amount paid by you for the product. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

RECEIVING.

Please inspect the MMS Engine immediately after receiving your order. Any damages or evidence of tampering on the outer packaging must be noted on the delivery receipt of the driver. ANY DAMAGES MUST BE REPORTED TO MMS WITHIN 48 HOURS of your receiving the item -- no exceptions. Incorrect shipments must be reported within 5 BUSINESS DAYS of receiving the Engine(s), as described in the Incorrect Products Section below -- no exceptions.

INCORRECT PRODUCTS.

MMS make every effort to ship the correct Engine. However, unusual mistakes can happen. If we ship you a MMS Engine you did not order, we will pay for return shipment and replace it with the correct Engine. Please let us know within 5 business days after receipt, if you receive a MMS Engine you did not order. The replacement Engine will not be shipped until the incorrect Engine has been received by MMS. Replacements can only be shipped in the same manner and to the same address as the original order was sent.

RETURNING A PRODUCT.

MMS does not accept any returns for any Engine. All Product sales are final after receipt of payment.

GOVERNING LAW

These MMS Consumer Terms and Conditions of Sale, and all sales of Products by MMS to consumers, shall be governed by the laws of the State of Texas.

The customer will not be entitled to any special or consequential damages, including, but not limited to, freight charges to and from our facility, trip expense, legal expense, or lost time as a result of the engine failure.

THIS IS A LIMITED WARRANTY. MAST MOTORSPORTS MAKES NO WARRANTIES, EXPRESSED OR IMPLED, OTHER THAN WHAT IS STATED ABOVE. STATEMENT MUST BE SIGNED, DATED, AND RETURNED TO MAST MOTORSPORTS TO VALIDATE THIS WARRANTY.

330 NW Stallings
Nacogdoches, TX 75964

WARRANTY POLICY AND PROCEDURES

Customer Name:_____
Date:_____
Engine Type:_____
Engine Serial Number:_____
ECM Serial Number:_____

Mast Motorsports strives to ensure that your Engine performs as intended for its entire life expectancy. In order to achieve this, it is important that certain procedures be followed. These procedures are also required to validate the Mast Motorsports engine package warranty. By following the procedures and precautions stated below, you greatly reduce the chances of an engine failure.

MMS warrants, to the original consumer purchaser of each airboat engine, the engine will be free from defects in materials and workmanship, for a period of 12 months or 300 hours, whichever comes first, from the date the engine was purchased from Mast Motorsports.

Mast Motorsports Typhoon and Cyclone engines are calibrated to operate on 91-93 octane (R+M)/2 fuel. Maximum performance and reliability is obtained when using this fuel. If a slight pinging is heard during acceleration and the proper octane fuel is being used, it is considered normal. If a constant, heavy knock occurs, the engine should be evaluated by Mast Motorsports.
The use of 87 octane fuel is permissible, but only in an emergency.
The engine should never be operated at full throttle/full load or high RPM while using 87 octane fuel.

I hereby agree to accept the responsibility of operating my Mast Motorsports Engine with the proper fuel octane requirement. _____(Initials)

This warranty is only for repair or replacement of failed components. In the event that Mast Motorsports deems it necessary to replace or repair a component, the component must be supplied by ONLY Mast Motorsports. No other component supplier may be used under the terms of the warranty. Any alteration, repairs, or services performed to a component that is not authorized by Mast Motorsports will void any and all warranties. Mast Motorsports reserves the right to waive, or not waive, the labor charge(s) involved with any and all warranty claims. Any and all warranties will be issued at the sole discretion of Mast Motorsports.

I hereby agree to accept the responsibility of not altering or repairing my Mast Motorsports Engine without the authorization of Mast Motorsports. _____(Initials)

The limited warranty is not an unconditional warranty against all hazards or failures. This limited warranty shall not apply to defects or conditions caused by misuse, abuse, misapplication, incorrect installation, modification, or accident after you received the Engine. The limited warranty shall not cover damages resulting from lack of lubrication, improper oil and/or lube, overheating, oil starvation, oil pressure loss, engine over-speed, excessive oil temperature, contamination from foreign elements, environment, or auxiliary components, failures due to extreme weather conditions, detonation or pre-ignition, including but not limited to melted or broken pistons, broken or scored rings, damaged cylinder heads or gaskets, scoring on cylinder walls or piston heads. **_____(Initials)** All of the aforementioned items are at the sole discretion of Mast Motorsports. Mast Motorsports may deem that neglect was the cause of the component failure. In the event of a failure due to negligence, the engine owner assumes responsibility of the failure. If Mast Motorsports deems it necessary to warranty a component, proof of oiling system flush procedure and/or oiling system replacement must be presented to Mast Motorsports. The thoroughness and validity of the flush procedure and/or replacement is at the sole discretion of Mast Motorsports.

The owner and/or operator is responsible for checking and maintaining ALL fluid levels before and during operation, for regularly monitoring gauges during operation, and following the maintenance schedule listed below:

The owner/operator of a Mast Motorsports Engine must, under all conditions, abide by the following maintenance schedule and procedures:

- **Check and monitor engine coolant level and temperature before and during operation.**
- **Check and monitor engine oil level and temperature before and during operation.**
- **Change engine oil as outlined in the *Maintenance Schedule*.**
- **Change fuel filter/pressure regulator as outlined in the *Maintenance Schedule*.**
- **Use only the oil specified in the *Normal Operating Parameters and Requirements* and *Oil Requirements* sections.**
- **Allow engine to come up to operating temperature as listed in the *Normal Operating Parameters and Requirements* before operation.**
- **Allow engine to idle for 30 seconds before shut-down.**
- **Retighten header bolts to 15 Ft.-Lbs. following the first 25 hours of operation.**
- **Check that all nuts and bolts are tight and that all engine components are securely fastened to the engine.**
- **Check that all wiring is not subject to the elements, as well as securely fastened away from heat, vibration, sharp edges, and moving parts.**
- **Run fuel that is minimum 91-93 octane.**
- **Maintain a documented maintenance schedule including the facility performing the services, corresponding receipts, and dates.**

I hereby agree to accept the responsibility of operating and maintaining my Mast Motorsports Engine to the specifications and procedures stated above. _____(Initials)

The customer will not be entitled to any special or consequential damages, including, but not limited to, freight charges to and from our facility, trip expense, legal expense, or loss of time as a result of the engine failure.

I hereby agree that any litigation which may be deemed necessary on behalf of either party involved must and will be filed in Nacogdoches, Nacogdoches County, Texas. _____(Initials)

THIS IS A LIMITED WARRANTY. MAST MOTORSPORTS MAKES NO WARRANTIES, EXPRESSED OR IMPLIED, OTHER THAN WHAT IS STATED ABOVE. STATEMENT MUST BE SIGNED, DATED, AND RETURNED TO MAST MOTORSPORTS TO VALIDATE THIS WARRANTY.

I, _____, (printed name) have read the above warranty statement. I understand and accept the terms and conditions of this warranty statement.
Signature_____ Date:_____
Start Date (Date of engine purchase from Mast Motorsports):_____
End Date (One year from date of engine purchase from Mast Motorsports):_____