ZENITH
POWER PRODUCTS

Heavy Duty Engine

Operator Manual

and Maintenance Log

ZPP NA665, NA690, TA690, & TA6120

Stationary & Constant-Speed Mobile Industrial Engines

⚠ WARNING ⚠

This product may contain a chemical known to the state of California to cause cancer, or birth defects, or other reproductive harm. For more information go to www.P65Warnings.ca.gov.

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⚠ California Prop 65 Warning

Engine exhaust from this product, some of its constituents, along with certain machine components contain or emit chemicals known to the State of California to cause cancer and birth defects or other reproductive harm. In addition, certain fluids contained in the machine and certain products of component wear contain or emit chemicals known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov.

Service Parts

To ensure that your engine continues to run reliably and efficiently for as long as possible, use only genuine Zenith Power Products (ZPP) parts.

For genuine ZPP service parts for your engine, or for technical assistance in servicing your engine, call:

1-715-453-9317

Hours:

Monday-Friday: 8:00 – 4:00 Central Time

Maintenance Providers

Maintenance and repair services may be performed by you or any qualified engine service provider that you choose. However, your engine warranty does not cover damage or failure caused by improper maintenance or repairs.

Operators Manual & Maintenance Log Storage & Use

Store this Operators Manual and Maintenance Log in a safe, visible place by your engine. The maintenance log must be updated whenever your engine is serviced.

Disclaimer

All information and specifications in this manual are based on the latest data available at the time of the publication. Zenith Power Products reserves the right to make changes or improvements at any time without notice.

For additional information, see:
www.ZenithPP.com

U.S. EPA Legal Requirements

The ZPP NA665, NA690, TA690, and TA6120K Natural Gas and LPG prime engines have been certified by the U.S. Environmental Protection Agency (EPA) for stationary and mobile constant-speed applications. The TA6120R Natural Gas emergency standby engine has been certified by the U.S. EPA for only stationary applications. It is illegal to operate these engines in a variable-speed (foot pedal
speed control) application.

To ensure emissions compliance, the U.S. EPA requires you to do one of the following two options:

1. Operate and maintain your engine as specified in this Operators Manual. In addition, you are required by law to keep detailed maintenance records.

2. If you do not operate and maintain your engine as specified in this Operators Manual, your engine will be considered a non-certified engine.

   In this case, you must:

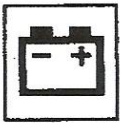
   - Keep a maintenance plan and records of conducted maintenance.
   - To the extent practicable, maintain and operate the engine in a manner consistent with good air pollution control practice for minimizing emissions.
   - Conduct an initial performance test within 1 year of engine startup to demonstrate compliance. Contact your regional EPA office for instructions on how to conduct an initial performance test.

Per section 113 of the U.S. Clean Air Act, failure to abide by these legal requirements can result in fines up to $49,342 per day.

A maintenance plan and log are provided at the back of this manual for you to record your engine maintenance. Update the log each time you service your engine.

SAFETY SYMBOLS

This section identifies the ISO 8999 symbols that may be used in this manual.



Battery

Electrical hazards

Engine coolant fill level

Engine coolant temperature

Engine oil fill level

Engine oil pressure

Hot surface warning

Warning

Read the handbook

No Smoking or Flame

SAFETY PRECAUTIONS - STARTING

WARNING

Starting an engine incorrectly may cause injury to the operator and/or cause damage to the engine. Engine operators must be instructed in the correct procedures before attempting to start any engine.

Before Starting

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- Inspect the engine, intake, exhaust, cooling system, and drivetrain to verify that the engine is fully assembled and not in the process of being serviced.
- Ensure the engine is free to turn without obstruction.
- Check that all safety guards are in their correct position and secure.
- Check that the coolant level in the radiator
- Check that the oil level on the dipstick is between "Add" and "Full".
- Check that the fuel supply is connected, shut-off valves are open, and there are no leaks.
- If a LPG fuel system is being used, verify that there is fuel in the tank.
- If a natural gas fuel system is being used, verify that the correct fuel supply pressure is being supplied to the engine.
- Check that the battery is connected and charged.
- When possible, disengage any driven equipment while starting.

SAFETY PRECAUTIONS – ELECTRICAL



The battery produces flammable and explosive hydrogen gas. The battery electrolyte contains poisonous and corrosive sulfuric acid. The precautions listed below must be followed to ensure operator safety.

- Do not smoke or allow any flame near the battery.
- With the engine stopped and the ignition switch in the OFF position, disconnect the negative battery cable from the battery before working on the engine.
- Be careful not to short circuit battery positive to ground with tools when working on the engine.
- Avoid getting battery electrolyte in your eyes or on your skin or clothes. If electrolyte gets in your eyes, flush with clean water immediately and get medical help. If electrolyte gets on your skin, wash immediately with soap and water and get medical help if you feel pain or burning. Remove and wash any clothing that is exposed to electrolyte.
- Never remove any electrical cables while the battery is connected in the circuit.
- Be careful to not short-circuit or cross battery positive and negative.
- Never ‘flash’ any connection to check the current flow.
- The battery and alternator must be disconnected before commencing any electric welding when a pole strap is directly or indirectly connected to the engine.
- When charging the battery, only do a slow charge (5 A or less), and ensure there is good ventilation.

FUELS

Gasoline, Natural Gas and LPG are highly combustible fuels, and can be explosive if leaked and contained in a confined area. Keep cigarettes and all other flame sources away from these areas.

If you can hear or smell a fuel leak, shut off the fuel supply at the source immediately and fix the leak or have it serviced. Check the entire fuel supply line from the cylinder/tank to the engine for leaks with a soapy water bubble mixture anytime a cylinder/tank is changed, or the fuel supply line is worked on. Fuel leaks should also be checked as part of the regular engine maintenance.

Depending on your engine and fuel system configuration, your engine is designed to run on natural gas and/or vapor LPG. The fuel requirements for each are discussed below. See the "SPECIFICATIONS" section for the required fuel supply pressures for each fuel.

Natural Gas

Your engine is certified to run on "pipeline-quality natural gas". EPA defines pipeline-quality natural gas as being composed of at least 70% methane by volume or having a heating value of 950-1100 BTUs per cubic foot. In addition, pipeline-quality natural gas must be provided by a supplier through a pipeline. If your natural gas supply does not meet these specifications, your engine is considered to be being operated as a non-certified engine. See "U.S. EPA Legal Requirements" at the front of this manual.

LPG

In order to maintain emissions compliance and your engine warranty, use commercial-grade HD-10 or better LPG.

A liquid withdrawal system is recommended when there is insufficient LPG vapor generated in the storage tank to supply the engine sufficient fuel to maintain maximum power at the ambient temperature the engine is operating in. (see engine data sheet) In a liquid withdrawal system Liquid LPG is drawn off of the bottom side of a LPG tank and it remains a liquid until it has passed through the vaporizer/regulator, at which point it is vaporized to a gas. If you connect vapor LPG to a liquid LPG fuel system, you may starve the engine for fuel, causing it to produce low power and excessive emissions.

In a vapor withdrawal LPG system, LPG is drawn off of the top side of a LPG tank and is a gas from the tank through to the engine intake. If you connect liquid LPG to a vapor LPG fuel system the fuel will not vaporize properly, causing the engine to run rich, produce low power and excessive emissions.

STARTING, RUNNING, & STOPPING THE ENGINE

Observe the safety precautions listed in "SAFETY PRECAUTIONS - STARTING" before starting the engine.

Starting the engine

- Turn the key switch to the ON position and verify that the MIL is illuminated. If not determine why the lamp is not working.
- Turn the key switch to the START position and hold until the engine has started.
- Release the key promptly after the engine starts to avoid grinding the starter.
- Do not crank the engine for more than 15 seconds at a time.
- Allow at least 30 seconds between cranking attempts.
- If the engine does not start after 3 starting attempts, review the "Before Starting" checklist.

Running the engine

- Do not race or fully load the engine during the first 3 minutes of operation.
- Verify that the "CHECK ENGINE" light is off while the engine is running. If it is on, refer to the DIAGNOSTICS section.
- Verify that there are no fuel, coolant, or oil leaks while the engine is running. If there are leaks, stop the engine and fix them or have the engine serviced.
- Listen to the engine. If you hear an abnormal noise while the engine is running, turn it off and correct the problem or have the engine serviced.
- No adjustments are necessary to the fuel or ignition systems.

Stopping the engine

- If the engine has been running under load and is hot, run the engine at no load for 3 minutes to allow the engine to cool before stopping the engine.
- Stop the engine by turning the key switch to the OFF position. The engine may run-on for 1-5 seconds while the fuel is depleted from the carburetor and the air/fuel mixture is depleted from the intake manifold.
- Exception: Unless the engine is used in “Emergency Standby” operation.

ENGINE MAINTENANCE

You should properly maintain your engine for the following reasons.

- You are legally required to maintain your engine and keep maintenance records to ensure emissions compliance. See "U.S. EPA Legal Requirements" at the front of this manual.

- Your engine warranty will be void if the engine is not properly maintained.

- Keeping your engine properly maintained will ensure the best engine life, power, and fuel economy.

Scheduled Maintenance

A schedule of the required engine maintenance tasks is listed on the following page. The scheduled maintenance should be performed when the engine reaches the specified operating hours or the specified months have elapsed, whichever comes first.

Daily Maintenance

In addition to the scheduled maintenance, daily checks are required to keep your engine running properly. These checks are listed in the "SAFETY PRECAUTIONS - STARTING" and "STARTING, RUNNING, & STOPPING THE ENGINE" sections.

Maintenance Log

Keep a record of your engine's scheduled maintenance in the Maintenance Log at the back of this manual.

WHEN USING THE ENGINE ONLY DURING A PARTICULAR PERIOD OF THE YEAR

When the engine is to be used only in a particular period of the year, such as summer or winter, the service life of the engine will be determined by how it is maintained during the out-of-use period. Follow the procedures below when preparing the engine.

During in-use period

Follow the normal handling procedures during this period.

During out-of-use period

During the out-of-use period, perform the following maintenance procedures for the engine.

1. Perform loaded operation once a month.
    - Run the engine and perform basic engine checks.
    - Apply a load in excess of 50% of the rated load to the engine, and operate it for more than 10 minutes. Make sure that no abnormal noise or vibration is produced.
2. Perform the following inspection and adjustment before placing the engine in use period.
    - Drain sediment from the fuel system (fuel filter and fuel tank).
    - Change engine oil and oil filter element.
    - Check and adjust fan belt tension.
    - Check battery electrolyte level and specific gravity.
    - Change air cleaner element.
    -  Check antifreeze protection and level.

48 AND 70 PIN ECM's

For the 2022 model year, only the NA665 engine uses the 48-pin ECM. The NA690, TA690, and TA6120 engines use the 70-pin ECM.

It is important to know which ECM you have on your engine, as the ECM determines the control system voltage, the type of pre-cat oxygen sensor, and knock sensing. The ECM's, voltages, and pre-cat oxygen sensors are not interchangeable or upgradeable. Using the wrong ECM, voltage, or pre-cat oxygen sensor may damage your engine's control system. ***See Figure 1***

Please see **Common Parts** (***Figure 2***) for associated service part numbers.

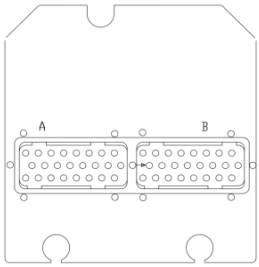
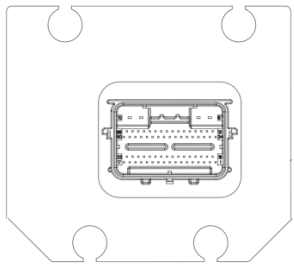
	48-pin ECM: 201407	**70-pin ECM**: 204204
		
Starting & Charging Voltage	12 VDC	24 VDC
Control System Voltage	12 VDC	24 VDC
Knock sensors for TA690 & TA6120	No	Yes

Figure 1

Engine Maintenance Schedule

Procedure	Daily	Months / Hours	4 / 250	13 / 750	25 / 1500	38 / 2250	50 / 3000	63 / 3750	76 / 4500	88 / 5250
Engine Oil Level	I									
Coolant Level	I									
Engine Oil & Filters			R (a)	R	R	R	R	R	R	R
Crankcase Ventilation Filter			I	I	I	I	I	I	I	I
Air Filter Element				I	I	I	I	I	I	I
Accessory Drive Belts	I			I	I	I	I	I	I	I
Clean Debris from Radiator Core (Inspect Daily)	I		C	C	C	C	C	C	C	C
Coolant Hoses for Cracks Swelling or Deterioration			I	I	I	I	I	I	I	I
Charge Cooler Pipes and Connections			I	I	I	I	I	I	I	I
Engine Coolant Filter (NA/TA690)				I	R	I	R	I	I	R
Engine Coolant				I	I	I	R	I	I	R
Fuel Filter (If Equipped)			I	C	C	R	C	C	R	C
Check Fuel System for Leaks	I		I	I	I	I	I	I	I	I
Valve Clearance (b)			I & A	I & A	I & A	I & A	I & A	I & A	I & A	I & A
Spark Plugs				I	R	I	R	I	R	I
Spark Plug Wires				I	I	I	I	I	I	I
Electrical Connections				I	I	I	I	I	I	I
Exhaust System for Cracks or Leaks			I / T	I / T	I / T	I / T	I / T	I / T	I / T	I / T
Exhaust Catalyst for Leaks, Cracks or Plugging			I		I		I		I	

Abbreviations:	Notes:	(a)	We recommend that oil samples be analyzed after the second oil change. The data may indicate that the oil change period may be extended after consultation with ZPP.
I = Inspection & Replacement if Necessary			
R = Replace			
A = Adjust			
C = Clean		(b)	See Clearances under "Engine Specifications"
D = Drain			After the first adjustment at 250 hrs., adjust again at 500 hrs.
T = Retighten			After consultation with ZPP adjustment period may be increased beyond 750 hour increments.

AIR FILTER

Engine	Element	Part Number
NA665/NA690	Primary	200469
	Secondary	200289
TA690	Primary	202186
	Secondary	201050
TA6120	Primary	202519

Inspection

1. Remove air filter element from enclosure.
2. Tap filter to knock off loose dirt.
3. Visually check filter.
4. If filter is clean, reinstall old filter.
   If filter is dirty, replace with a new filter.

BATTERY



The battery produces flammable and explosive hydrogen gas. The battery electrolyte contains poisonous and corrosive sulfuric acid. Review the safety precautions in "SAFETY PRECAUTIONS - ELECTRICAL" before working on the battery.

Battery Specifications: 690 & 6120	
Nominal Voltage:	24 V
Cranking Amps:	1200
Cold Cranking Amps:	1000
Battery voltage during alternator charging:	28.6 V
Fully charged battery with key off @ 20° C (68° F):	27.2 V
Amp Hours (AH)	180

Battery Specifications: 665	
Nominal Voltage:	12 V
Cranking Amps:	1200
Cold Cranking Amps:	1000
Battery voltage during alternator charging:	14.0-15.0 V
Fully charged battery with key off @ 20° C (68° F):	12.5-13.0 V
Amp Hours (AH)	180

See "System Voltages" (Control System and Starting/Charging System) in "Engine Specifications" Pages 19-20.

Battery electrolyte inspection

1. Check electrolyte level.
2. If low, top off with distilled water. Do not overfill.

Battery corrosion inspection

1. Check battery posts and clamps for corrosion.
2. If corroded, remove negative cable first, then positive.
3. Clean both posts and both clamps with a small wire brush.
4. Reconnect cables, positive cable first.

If the engine is cranking slowly or not at all:

1. Remove the battery negative lead from the battery.
2. Remove the positive lead from the battery.
3. Clean the battery posts and cables with a small wire brush.
4. Replace leads, positive lead first.

If the engine is still cranking slowly or not at all:

1. Remove the battery negative leads.
2. Recharge the battery in a well-ventilated area.
3. Reinstall the battery.

If the engine is still cranking slowly or not at all:

Replace the battery.

CCV SYSTEM:

NA665, NA690, & TA690 Engines

Cartridge Part Number: **200584**

TA6120 Engine

Cartridge Part Number: **202541**

The crankcase ventilation system processes the crankcase blow-by gases and oils in the filtration system. Gases are delivered to the intake air to be combusted in the engine. Oils which have been separated from the blow-by gases are returned to the oil pan.

Service the CCV system at the intervals prescribed in the Maintenance schedule (page 11), or more frequently in freezing temperatures.

During Cold weather operation CCV system can become plugged with freezing condensation and emulsion from crankcase blow-by. Preventative measures in addition to frequent inspection are necessary to avoid damage to engine and fuel system components.

ENGINE COOLANT, RADIATOR, AND COOLING SYSTEM



To avoid being scalded or burned, never remove the radiator cap unless the engine is off and coolant has fully cooled. The coolant in the radiator is pressurized when hot and may boil over when the radiator cap is loosened.

When using antifreeze coolant, mix the antifreeze coolant with water, observing instructions attached to antifreeze container. Use only antifreeze approved for aluminum components in a 50/50 mixture ratio.

Clean radiator outside

Clean outside of radiator with dry compressed air.

Inspect cooling system, hoses and connections

Check hoses and fittings for loose connections or for any sign of oil deterioration or soft spots in the hoses. Retighten connections or replace hoses if needed.

Check coolant level. If low, top off coolant with a premixed 50/50 mixture of antifreeze and water.

Engine Coolant Replacement

1. Open Degas tank cap.
2. Drain old coolant.
3. Flush system with fresh, clean water.
4. Slowly refill system with premixed 50/50 antifreeze/water mixture.
5. Idle engine with radiator cap off to allow air to escape.
6. Stop engine.
7. Replace radiator cap and close overflow bottle cap.

ACCESSORY DRIVE BELTS

Engine	Belt P/N	# per Engine
NA665	202334	1
NA/TA690	200577	1
TA6120	202544 - Alt/WP 202545 - Fan	2

Inspection

Check the belt for visible cracks, missing chunks, and fraying. Small cracks on the inside of the belt are OK. Replace the belt if cracks are visible on the outside of the belt, chunks are missing from the inside of the belt, or the belt is frayed.

Belt Tension

Measure the belt tension midway between the alternator and water pump pulley as specified by the arrow in the left figure above. Use a tensioning tool such as the one shown in the right figure above (OTC 6673LG or equivalent).

Deflection:

A second method of measuring belt tension is to apply a force of 50N (5kg, 11lb), and measure the deflection between the alternator and Crankshaft pulley. If the belt tension is not as specified, adjust it.

DEFLECTION
10 ~ 20 mm (0.390 ~ 0.780 in.)

NOTE:

"New belt" *refers to a belt which has been used less than 5 minutes on a running engine.*

"Used belt" *refers to a belt which has been used on a running engine for 5 minutes or more. After installing a belt, check that it fits properly in the ribbed grooves. Check with your hand to confirm that the belt has not slipped out of the groove on the bottom of the pulley. After installing a new belt, run the engine for about 5 minutes and recheck the belt tension.*

Belt Replacement

1. Release all tension from the old belt.
2. Remove the old belt.
3. Install the new belt.
4. Apply tension to the belt as specified in "Belt Tension".
5. Recheck tension after 1 hour of operation.

ELECTRICAL CONNECTIONS

1. Visually inspect the electrical connections in the wiring harness for loose connections.

2. If you see a loose connection, or suspect a loose connection for other reasons, take the connection apart.

3. Visually inspect the pins in the male connector and the sockets in the female connector.

4. If any pins or sockets are bent, recessed, or corroded, repair the connector.

5. Remake the connection. Verify that the connection is fully made and is snug and secure.

ENGINE OIL AND FILTERS REPLACEMENT

Oil Grade:	See “SELECTION OF ENGINE OIL”	
API Certification:	SJ or better	
NA665 Engine		
Filter:	201989	
Oil Capacity		
- Without filter	18 US Quarts	17.0 Liters
- With filter	19 US Quarts	17.9 Liters
NA690 & TA690 Engines		
Filter:	201372	
Oil Capacity		
- Without filter	20.5 US Quarts	19.4 Liters
- With filter	22.0 US Quarts	20.8 Liters
TA6120 Engine		
Filter:	202542 (2 per engine)	
Oil Capacity		
- Without filter	10.8 US gallons	41 Liters
- With filters	11.8 US gallons	45 Liters

DRAIN THE ENGINE OIL

1. Remove the oil filler cap.
2. Remove the oil drain plug and drain the oil into a container.

REPLACE THE OIL FILTER

1. Remove the oil filter.
2. Check and clean the oil filter installation surface.
3. Check that the part number of the new oil filter is correct.
4. Apply clean engine oil to the gasket of the new oil filter and screw on until finger tight.
5. Tighten it an additional 1/4 turn.

REFILL WITH ENGINE OIL

1. Clean and install the oil drain plug with a new gasket.
2. Fill with fresh engine oil. Do not overfill.
3. Install the oil filler cap.
4. Start engine and check for oil leaks.
5. Recheck the engine oil level.

Dispose of used oil at your local oil recycling center.

SELECTION OF ENGINE OIL

API SERVICE GRADE CERTIFIED

Use engine oil that is API Service Grade Certified. Standard engine oil identification notations have been adapted to aid in the proper selection of engine oil. The identifying notations are located on the label of engine oil plastic bottles and the top of engine oil cans.

API recommendation: SJ or above

NOTE: This applies to all automotive/industrial applications regardless of the fuel selection, i.e., LPG or natural gas.

SAE VISCOSITY

Use **SAE 15W-40** multiple viscosity engine oil. When choosing engine oil, consider the range of temperatures the engine will be operated in before the next oil change. Select engine oil that is best suited to your area's particular ambient temperature range and variation. For engines operating below 20° F, **SAE 10W-30** is recommended.

CHECKING FOR GAS LEAKS

Natural gas and LPG are combustible gases, and can be explosive if leaked and contained in a confined area. Keep cigarettes and all other flame sources away from these areas.

Inspection

1. If you can hear or smell a fuel leak, shut off the fuel supply at the source immediately and fix the leak or have it serviced.

2. If there are no leaks detected, start the engine.

3. Check the entire fuel supply line from the source to the engine with a soapy water mixture. A stream of bubbles indicates leak sources.

4. Tighten fittings and clamps as needed to eliminate slow leaks.

5. If any fuel line components (hoses, pipe, fittings, etc.) need to be replaced, first bleed the fuel out of the line by shutting off the gas supply at the source with the engine running at idle. Wait for the engine to stop before disassembling the fuel line.

NATURAL GAS & LPG FUEL LOCK-OFF VALVES

Due to the many variances of Fuel Lock-Off valves, if replacement is necessary, please contact ZPP Parts Sales to assure proper application and fitment.

The fuel lock-off valve is located between the final stage regulator and NG fuel supply line or LPG supply. The Engine Control Module (ECM) opens the fuel lock-off when the ECM detects engine speed from the CRANK sensor during cranking. The ECM turns off the fuel lock-off when the key switch is turned off or the ECM shuts down the engine for low oil pressure, low coolant level or engine overheat.

PRE- AND POST-CATALYST OXYGEN SENSORS

For the 2024 model year, only the NA665 engine uses the 48-pin ECM. The NA690, TA690, and TA6120 engines use the 70-pin ECM.

The switching type (HEGO) used by the 48 pin and the wide-range (UEGO) sensors used by the 70 pin use different connectors. **NOTE: These sensors are not interchangeable**.

ZPP Part Numbers:

*See Common Components in ***Figure 2***, pg 35, for proper part number for your application.

Sensor Locations:

On Naturally Aspirated (NA) engines, the pre-cat O2 sensor is located between the exhaust manifold and the catalyst.

On Turbocharged and Aftercooled (TA) engines, the pre-cat O2 sensor is located between the turbocharger's exhaust outlet and the catalyst.

On both NA and TA engines, the post catalyst oxygen sensor is located in the outlet of the catalyst.

SPARK PLUGS & WIRES

Ignition System Part Specifications			
	NA665	**TA6120**	**NA690 & TA690**
Spark Plugs	200613	200613	201004
Socket Size	14 mm	14 mm	5/8 in
Spark plug gap	.025 in .0635 mm	0.013 in 0.330 mm	0.020 in 0.508 mm
Spark plug wire set	200614	202543	201071
Ignition Coils	*See Common Components		

Spark plug inspection

1. Remove one plug.
2. Inspect plugs for fouling and erosion.
3. Clean or replace plugs if needed.

Ignition wires inspection

1. Visually check ignition wires.
   - Look for spark arcing while the engine is running.
   - Check for cracks in the wire insulation.

2. If arcing and/or cracked insulation is evident, *replace the entire set of ignition wires.*

DIAGNOSTICS

How to manage and retrieve fault codes

A MIL (malfunction indicator lamp) is provided to notify the engine operator of potential problems with the emissions control system. With the key ON and engine OFF the MIL will illuminate to indicate it is functioning properly. If the key switch is ON and the engine is OFF and the MIL is not illuminated there is a problem with the MIL circuit. Diagnose and repair this problem before proceeding.

If the key is ON and an active fault exists, the MIL will automatically flash. The flashing sequence indicates the DTC that occurred. DTC's are 3 digit codes. Count the flashes to determine which DTC is set.

If the engine is stopped the MIL flashes a '12' code before and after an active fault that might exist. If the engine is running it will flash just the fault code. Refer to the following table to determine which fault(s) is set.

Faults can also be viewed through the CAN Gauge, if so equipped. Faults are located near the end of the *Live Data* group. Faults can be viewed and cleared with the CAN Gauge, simply follow the steps when prompted.

Faults can also be viewed through the use of a PC tool with the appropriate software and communications cable. The PC is most often used by the service technician when more detailed diagnostic information is required.

The action taken when a fault occurs can be different for each fault. The engine manufacturer (MOR) assigns these actions based on the specific application of the engine. Fault actions include illumination of the MIL, power limiting, engine shutdown, delayed engine shutdown, cut throttle, and disable closed-loop fuel control.

A DTC normally requires a service technician to diagnose and repair the problem. If the MIL is illuminated it is recommended that the engine be stopped and repaired immediately to avoid potential damage to the engine or non-compliance.

If the fault condition disappears on its own, the MIL will stay illuminated for three (3) consecutive engine starts subsequent to the fault condition no longer existing, after which the MIL will turn off by itself. Refer to Service Manual or call your authorized service center for additional diagnostic and service information.

Diagnostic Trouble Code (DTC) List

DTC	Fault Description	MIL Flash Code
121	Auto engine crank function exceeded specified number of engine crank attempts without succesful engine start	121
123	Manual engine crank function exceeded specified number of engine cranks without succesful engine start	123
141	Engine Coolant Temperature Sensor voltage is Low. Normally set if the coolant sensor wire has shorted to chassis ground or the sensor has failed.	141
151	Engine Coolant Temperature Sensor voltage is High. Normally set if coolant sensor wire has been disconnected or circuit has opened to the SECM or shorted to power	151
161	Engine Coolant Temperature is High. The sensor has measured an excessive coolant temperature typically due to the engine overheating	161
171	Engine Coolant Temperature not changing as expected	171
191	No CAM signal when engine is known to be rotating, broken CAM sensor leads or defective CAM sensor	191
192	Loss of synchronization on the CAM sensor, normally due to noise on the signal or an intermittent connection on the CAM sensor	192
193	No crankshaft signal when engine is known to be rotating, broken crankshaft sensor leads or defective crank sensor	193
194	Loss of synchronization on the crankshaft sensor, normally due to noise on the signal or an intermittent connection on the crankshaft sensor	194
199	Communication response longer than expected	199
221	TPS1 sensor voltage out of range low, normally set if TPS1 signal has shorted to ground, circuit has opened or sensor has failed	221
222	TPS2 sensor voltage out of range low, normally set if the TPS2 signal has shorted to power, circuit has opened, or sensor has failed	222
231	TPS1 sensor voltage out of range high, normally set if TPS1 signal has shorted to power or ground for the sensor has opened	231
232	TPS2 sensor voltage out of range high, normally set if the TPS2 signal has shorted to power or ground for the sensor has opened	232
241	Learned closed throttle end of TPS1 sensor range lower than expected	241
242	Learned closed throttle end of TPS2 sensor range lower than expected	242
251	Learned WOT end of TPS1 sensor range higher than expected	251
252	Learned WOT end of TPS2 sensor range higher than expected	252
271	Learned WOT end of TPS1 sensor range lower than expected	271
272	Learned WOT end of TPS1 sensor range lower than expected	272
281	Learned closed throttle end of TPS1 sensor range higher than expected	281
282	Learned closed throttle end of TPS1 sensor range higher than expected	282
291	TPS sensors differ by more than expected amount. **NOTE: The TPS is not a serviceable item and can only be repaired by replacing the DV-EV throttle assembly.**	291
292	TPS1 and/or TPS2 is going in and out of range rapidly	292

DTC List (continued)

DTC	Fault Description	MIL Flash Code
331	Manifold Absolute Pressure Sensor Voltage is Low, normally set if the TMAP pressure signal wire has been disconnected or shorted to ground or the circuit has opened to the SECM	331
332	Manifold Absolute Pressure Sensor Voltage is Low, normally set if the TMAP pressure signal wire has been disconnected or shorted to ground or the circuit has opened to the SECM	332
341	Manifold Absolute Pressure Sensor Voltage is High, normally set if the TMAP pressure signal wire has become shorted to power, shorted to the IAT signal, the TMAP has failed or the SECM has failed.	341
342	Manifold Absolute Pressure Sensor Voltage is High, normally set if the TMAP pressure signal wire has become shorted to power, shorted to the MAT signal, the TMAP has failed or the SECM has failed.	342
351	MAP sensor indicates higher pressure than expected	351
352	MAP sensor indicates lower pressure than expected	352
353	MAP sensor not changing as expected	353
354	MAP sensor pressure higher than expected for a specified period of time	354
371	Manifold Air Temperature Sensor Voltage is Low normally set if the MAT temperature sensor wire has shorted to chassis ground or the sensor has failed.	371
381	Manifold Air Temperature Sensor Voltage is High normally set if the MAT temperature sensor wire has been disconnected, the circuit has opened to the SECM, or a short to Vbatt or sensor power has occurred.	381
391	Manifold Air Temperature not changing as expected	391
392	Manifold Air Temperature is too high	392
421	EST1 output open circuit: possible open EST1 signal or defective spark module	421
422	EST2 output open circuit, possible open EST2 signal or defective spark module	422
423	EST3 output open circuit, possible open EST3 signal or defective spark module	423
424	EST4 output open circuit, possible open EST4 signal or defective spark module	424
425	EST5 output open circuit, possible open EST5 signal or defective spark module	425
426	EST6 output open circuit, possible open EST6 signal or defective spark module	426
427	EST7 output open circuit, possible open EST7 signal or defective spark module	427
428	EST8 output open circuit, possible open EST8 signal or defective spark module	428

DTC List (continued)

DTC	Fault Description	MIL Flash Code
431	EST1 output shorted high or low, EST1 signal shorted to ground or power or defective spark module	431
432	EST2 output shorted high or low, EST2 signal shorted to ground or power or defective spark module	432
433	EST3 output shorted high or low, EST3 signal shorted to ground or power or defective spark module	433
434	EST4 output shorted high or low, EST4 signal shorted to ground or power or defective spark module	434
435	EST5 output shorted high or low, EST5 signal shorted to ground or power or defective spark module	435
436	EST6 output shorted high or low, EST6 signal shorted to ground or power or defective spark module	436
437	EST7 output shorted high or low, EST7 signal shorted to ground or power or defective spark module	437
438	EST8 output shorted high or low, EST8 signal shorted to ground or power or defective spark module	438
461	Electronic Throttle Control is Sticking. This can occur if the throttle plate (butterfly valve) inside the throttle bore is sticking. The plate sticking can be due to some type of obstruction, a loose throttle plate, worn components, or sticking shaft bea	461
471	Electronic Throttle Control Driver has failed. Normally set if either of the ETC driver signals have opened or become disconnected, electronic throttle or SECM is defective.	471
481	Electronic Throttle Control Spring Return Test has Failed. The SECM will perform a safety test of the throttle return spring following engine shutdown. If this spring has become weak the throttle will fail the test and set the fault.**NOTE: Throttle assembly**	481
491	(Electronic Throttle Control Driver has Failed)Indeterminate fault on Hbridge driver for Electronic Throttle Control. Possibly either ETC+ or ETC- driver signals have been shorted to ground	491
511	Coolant Level or Oil Level is Low. The coolant level in the radiator tank or the oil level in the oil pan or oiler has fallen below the desired minimum level for safe operation	511
521	Low engine oil pressure	521
522	Oil Pressure sensor voltage out of range low, sensor signal shorted to ground	522
523	Oil Pressure sensor voltage out of range high, sensor signal shorted to power	523
524	Oil Temperature Sensor voltage is Low. Normally set if the sensor wire has shorted to chassis ground or the sensor has failed.	524
525	Oil Temperature Sensor voltage is High. Normally set if sensor wire has been disconnected or circuit has opened to the SECM or shorted to power	525
526	Oil Temperature not changing as expected	526
527	Oil Temperature is too high	527

DTC List (continued)

DTC	Fault Description	MIL Flash Code
528	Pre-Throttle sensor is out of range low, possible short to ground	528
529	Pre-Throttle sensor is out of range high, possible short to power	529
531	+12V or +24V System voltage too low	531
541	+12V or +24V System voltage too high	541
551	+5V Sensor reference voltage XDRP too low	551
561	+5V Sensor reference voltage XDRP too high	561
571	Engine speed has exceeded the third level (3 of 3) of overspeed protection	571
572	Engine speed has exceeded the second level (2 of 3) of overspeed protection	572
573	Engine speed has exceeded first level (1 of 3) of overspeed protection	573
581	Fuel valve sensor voltage out of range low, normally set if signal has shorted to ground, circuit has opened or sensor has failed	581
582	Fuel valve sensor voltage out of range high, normally set if signal has shorted to power or ground for the sensor has opened	582
583	LSeries Fuel Trim Valve Fault, the LSeries monitors its control functions internal to itself, a fault can occur if the actuator doesn't maintain position set point, the position sensor fails, the temperature sensor fails, or over temperature	583
612	Intergal term on the boost control PID is at it's upper limit for a specified amount of time and the desired boost pressure set point has not been reached	612
613	Intergal term on the boost control PID is at it's lower limit for a specified amount of time and the desired boost pressure set point has not been reached	613
631	FSeries or LSeries Throttle Valve Fault, the smart throttle monitors its control functions internal to itself, a fault can occur if the actuator doesn't maintain position set point, the position sensor fails, the temperature sensor fails, or over temperature	631
641	EGT Sensor Voltage is High, normally set if the pessure signal wire has become shorted to power or the SECM input circuit has failed	641
642	EGT Sensor Voltage is Low, normally set if the signal wire has become disconnected or shorted to ground or the input circuit to the SECM is open	642
644	Exhaust Gas Temperature (EGT) has reached the maximum allowable limit for a specified period of time	644
651	Intergal term in the EGR valve control PID reached it's upper limit for a specified amount of time and the desired EGR dP flow set point has not been reached	651
652	Intergal term on the EGR valve control PID is at it's lower limit for a specified amount of time and the desired EGR dP flow set point has not been reached	652
653	EGR dP Sensor Voltage is High, normally set if the pressure signal wire has become shorted to power or the SECM input circuit has failed	653

DTC List (continued)

DTC	Fault Description	MIL Flash Code
654	EGR dP Sensor Voltage is Low, normally set if the pressure signal wire has been disconnected or shorted to ground or the input circuit to the SECM is open	654
655	EGT is to High which caused the Torque Limiting fault action to be enabled	655
666	Emergency shutdown of the engine either manually by the operator or automatically by specified external conditions	666
671	APP1 sensor voltage out of range high, normally set if the APP1 signal has shorted to power or the ground for the sensor has opened	671
672	APP1 sensor voltage out of range low, normally set if the APP1 signal has shorted to ground, circuit has opened or sensor has failed	672
711	Fuel Trim Valve 1 Fault, signal has opened or shorted to ground or power or defective Fuel Trim Valve	711
712	Fuel Trim Valve 2 Fault, signal has opened or shorted to ground or power or defective Fuel Trim Valve	712
713	Post Catalyst O2 Sensor Heater Fault, Heater has opened or shorted to ground or power or defective heater element	713
714	Pre Catalyst O2 Sensor Heater Fault, Heater has opened or shorted to ground or power or defective heater element	714
715	EGR Control Solenoid Fault, control wire is open or shorted to power or ground, or defective Boost Control Solenoid	715
716	Smart Air Throttle Valve Fault, signal has opened or shorted to ground or power or defective Throttle Valve	716
717	Fuel Lock Off Fault on Valve 1, signal has opened or shorted to ground or power or defective Fuel lock off valve	717
718	Malfunction Indicator Lamp Fault, signal has opened or shorted to ground or power or defective MIL lamp	718
719	Boost Control Solenoid Fault, control wire is open or shorted to power or ground, or defective Boost Control Solenoid	719
721	Fuel system had to adapt lean more than expected on Gas 1 in response to a rich operating condition	721
722	Fuel system had to adapt lean more than expected on Gas 2 in response to a rich operating condition	722
727	Fuel Lock Off Fault on Valve 2, signal has opened or shorted to ground or power or defective Fuel lock off valve	727
731	Fuel system had to adapt rich more than expected on Gas 1 in response to a lean operating condition	731
732	Fuel system had to adapt rich more than expected on Gas 2 in response to a lean operating condition	732

DTC List (continued)

DTC	Fault Description	MIL Flash Code
741	Pre-catalyst O2 sensor inactive on Gas 1, may be due to open O2 sensor signal or heater leads, defective O2 sensor	741
743	Post-catalyst fuel control on Gas 1 has sensed the O2 sensor is changing too frequently and too much. Normally, the sensor voltage should be steady. Possible causes for this fault are a faulty sensor, air leak in exhaust sytem or failed catalyst	743
744	Post-catalyst fuel control on Gas 2 has sensed the O2 sensor is changing too frequently and too much. Normally, the sensor voltage should be steady. Possible causes for this fault are a faulty sensor, air leak in exhaust sytem or failed catalyst	744
745	Pre-catalyst O2 sensor inactive on Gas 2, may be due to open O2 sensor signal or heater leads, defective O2 sensor	745
751	Pre-catalyst O2 sensor indicates extended lean operation on Gas 1	751
752	Post-catalyst O2 sensor control has reached rich limit on Gas 1 and sensor still reads too lean. This could be caused by an exhaust leak, catalyst failure, sensor failure, or wiring/relay failure causing the sensor to not be properly heated. If any Pre-O2	752
753	Post-catalyst O2 sensor control has reached rich limit on Gas 2 and sensor still reads too lean. This could be caused by an exhaust leak, catalyst failure, sensor failure, or wiring/relay failure causing the sensor to not be properly heated. If any Pre-O2	753
761	Pre-catalyst O2 sensor indicates extended lean operation on Gas 2	761
762	Post-catalyst O2 sensor control has reached lean limit on Gas 1 and sensor still reads too rich. This could be caused by catalyst failure, sensor failure, or wiring/relay failure causing the sensor to not be properly heated. If any Pre-O2 sensor faults exist, diagnose and repair them first, then check and see if this fault resets.	762
763	Post-catalyst O2 sensor control has reached lean limit on Gas 2 and sensor still reads too rich. This could be caused by catalyst failure, sensor failure, or wiring/relay failure causing the sensor to not be properly heated. If any Pre-O2 sensor faults exist, diagnose and repair them first, then check and see if this fault resets.	763
764	Post-catalyst O2 sensor signal out of range due to disconnected sensor or open circuit	764
771	Pre-catalyst O2 sensor indicates extended rich operation on Gas 1	771
781	Pre-catalyst O2 sensor indicates extended rich operation on Gas 2	781
791	Rotary Fuel Trim Valve 1 Fault, signal has opened or shorted to ground or power or defective Rotary Fuel Trim Valve	791
792	Rotary Fuel Trim Valve 2 Fault, signal has opened or shorted to ground or power or defective Rotary Fuel Trim Valve	792
811	Engine knock multiplier above amplitude defined for Level1 derate	811
812	Engine knock multiplier above amplitude defined for Level2 derate	812

DTC List (continued)

DTC	Fault Description	MIL Flash Code
831	Fuel pressure sensor signal indicates higher pressure than expected	831
832	Fuel pressure sensor signal indicates lower pressure than expected	832
841	Fuel pressure sensor voltage out of range high, normally set if the pessure signal wire has become shorted to power or the SECM input circuit has failed	841
842	Fuel pressure sensor voltage out of range low, normally set if the pessure signal wire has become shorted to ground, disconnected, or the SECM input circuit has failed	842
851	Sensor Air Calibration lower limit reached before calibration achieved	851
852	Sensor Air Calibration correction is has adjusted to it's maximum limit	852
853	Sensor Air Calibration upper limit reached before calibration achieved	853
854	Sensor Heater duty cycle lower limit reached and sensor hasn't reached set point temperature	854
855	Sensor Heater duty cycle upper limit reached and sensor hasn't reached set point temperature	855
856	Sensor Temperature Set Point not reached after a specified period of time	856
911	Pre-catalyst O2 sensor voltage out of range low, sensor signal shorted to ground	911
921	Pre-catalyst O2 sensor voltage out of range high, sensor signal shorted to power	921
951	Trim valve command reached the lower duty cycle limit for the specified time limit, fuel system is unable to reach the desire PHI setpoint, it could be rich or lean depending on trim valve configuration	951
961	Trim valve command reached the upper duty cycle limit for the specified time limit, fuel system is unable to reach the desire PHI setpoint, it could be rich or lean depending on trim valve configuration	961
991	Service Interval 1 has been reached	991
992	Service Interval 2 has been reached	992
993	Service Interval 3 has been reached	993
994	Service Interval 4 has been reached —time to replace HEGO sensors	994
995	Service Interval 5 has been reached —time to replace engine timing belt	995

SPECIFICATIONS for NA665 Engine

Component	NA665
Air Filter Elements:	Primary: 200469 Secondary: 200289
Accessory Drive belts:	202344
Battery:	12 V, 180 Amp Hours 1,200 Cranking Amps, 1,000 Cold Cranking Amps
CCV Cartridge:	200584
Oil:	See “ENGINE OIL AND FILTER REPLACEMENT”
Oil Filter:	201989
Pre-Cat Oxygen Sensor:	*See Common Components
Post-Cat Oxygen Sensor:	*See Common Components
Spark Plugs:	200613
Spark Plug Gap:	0.025 inches (0.635 mm)
Spark Plug wire set:	200614
Ignition Coils	*See Common Components
Cam and Crank Sensor Gap:	Not Adjustable
Valve Lash	Intake .010 in ± .003 (.25 mm ± .08) Exhaust .019 in ± .003 (.50 mm ± .08)
Recommended Natural Gas & Vapor LPG Lock-Off Valve:	Contact ZPP

SPECIFICATIONS for NA690 & TA690 Engines

Component	NA690	TA690
Air Filter Elements:	Primary: 200469 Secondary: 200289	Primary: 202186 Secondary: 201050
Accessory Drive belts:	200577	
Battery:	24 V, 180 Amp Hours 1,200 Cranking Amps, 1,000 Cold Cranking Amps	
CCV Cartridge:	200584	
Oil:	See “ENGINE OIL AND FILTER REPLACEMENT”	
Oil Filter:	201372	
Engine Coolant Filter	200582	
Pre-Cat Oxygen Sensor:	*See Common Components	
Post-Cat Oxygen Sensor:	*See Common Components	
Spark Plugs:	201004	
Spark Plug Gap:	0.020 inches (0.508 mm)	
Spark Plug wire set:	201375	
Ignition Coils	*See Common Components	
Valve Lash	Intake .012 in ± .003 (.30 mm ± .08) Exhaust .019 in ± .003 (.50 mm ± .08)	
Cam and Crank Sensor Gap:	Cam .025~.030 Crank .055~.065	
Recommended Natural Gas & Vapor LPG Lock-Off Valve:	Contact ZPP	

SPECIFICATIONS for TA6120 Engine

Component	TA6120
Air Filter Elements:	202519
Accessory Drive belts: (2)	202544 - Alt/WP 202545 - Fan
Battery:	24 V, 180 Amp Hours 1,200 Cranking Amps 1,000 Cold Cranking Amps
CCV Filter:	202541
Oil:	See “ENGINE OIL AND FILTER REPLACEMENT”
Oil Filter:	202542 (2 per engine)
Pre-Cat Oxygen Sensor:	*See Common Components
Post-Cat Oxygen Sensor:	*See Common Components
Spark Plugs:	200613
Spark Plug Gap:	0.013 inches (0.330 mm)
Spark Plug wire set:	202453
Ignition Coil	*See Common Components
Valve Lash	Intake .015 in ± .003 (.40 mm ± .08) Exhaust .025 in ± .003 (.65 mm ± .08)
Cam and Crank Sensor Gap:	Not Adjustable
Recommended Natural Gas & Vapor LPG Lock-Off Valve:	Contact ZPP

Common Components

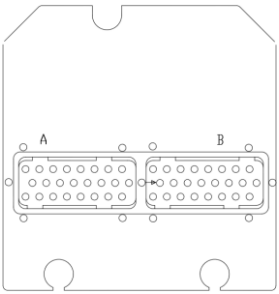
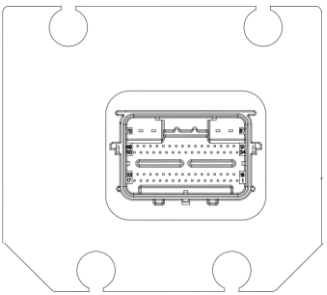
ECU Type	48 Pin ECU: 201407 (12 Volt)	70 Pin ECU: 201408 (24 Volt)
		
Ignition Coils	201375	200452
Pre-Catalyst o2 Sensor	200474	201279
Post-Catalyst 02 Sensor	201280	201280

Figure 2

Note: Please note the type of ECU your engine is equipped with before ordering parts. Selecting the wrong components can cause damage to the engine and/or fuel control system.

If you are uncertain of the ECU Type, please call Zenith Power Products at (715)453-9317 with your engine serial number for assistance.

EMISSION CONTROL WARRANTY STATEMENT FOR ZPP ENGINES

YOUR WARRANTY RIGHTS AND OBLIGATIONS

Zenith Power Products LLC (ZPP) is pleased to explain the **emission control system warranty** on your **2024 model year emission certified ZPP** engine. This emissions warranty statement applies to all of ZPP's certified engines.

New off-road Large Spark-Ignition (LSI) engines must be designed, built and equipped to meet Federal stringent anti-smog standards. ZPP must warrant the emission control system on your engine for the periods of time listed below provided there has been no abuse, or improper maintenance of your engine.

Your emission control system may include parts such as the carburetor, regulator or fuel injection system, ignition system, engine computer unit (ECM), catalytic converter and air induction system. Also included may be sensors and other emission-related assemblies. See below the complete Emissions Warranty Parts List.

Where a warrantable condition exists, ZPP will repair your LSI engine at no cost to you including diagnosis, parts and labor.

MANUFACTURER'S WARRANTY COVERAGE

The warranty period begins on the date the engine or equipment is placed into service. Operating hours will be determined by the Engine Control Module's (ECM's) internal hour meter. If any emission-related part on your engine is defective, the part will be repaired or replaced by ZPP.

Base Warranty Period

Rating	***Months***	***Hours***
Stationary and Constant Speed Mobile	**12**	**2500**
Emergency Standby	**24**	**400**

- *Stationary or Constant Speed Mobile-* Means compressor applications, irrigation applications, or generator sets operating at a constant fixed speed.

- ***Emergency Standby-*** Means engines operated to provide electrical or mechanical work (such as electrical power or pumping water) during an emergency situation and not exceeding 100 hours per calendar year non-emergency service per, EPA **40 CFR 60.4248.**

EMISSION CONTROL WARRANTY STATEMENT (continued)

Standard Emissions-Related Components
3 (three) years or 2,500 hours, whichever comes first, for standard emissions-related components.
See “Standard Emissions Parts” list.

High-Cost Emissions-Related Components:
5 (five) years or 3,500 hours, whichever occurs first, for “high-cost” components. See “High-Cost Emissions Parts” list.

OWNER’S WARRANTY RESPONSIBILITIES:

a) As the off-road LSI engine owner, you are responsible for the performance of the required maintenance listed in your Owner’s Manual. ZPP recommends that you retain all receipts covering maintenance of your off-road engine, but ZPP cannot deny warranty solely for the lack of receipts or for failure to ensure the performance of all scheduled maintenance.

b) As the off-road LSI engine owner, you should however be aware that ZPP may deny your warranty coverage if your off-road engine or a part has failed due to abuse, accidents, neglect, misuse, improper service or maintenance, wrong or contaminated fuel, use of any starting aid, improper cooling concentration or unapproved modifications.

c) Your engine is designed to operate on unleaded gasoline, LPG or pipeline-quality natural gas only. Use of other fuels may result in your engine package no longer operating in compliance with EPA and CARB emissions requirements.

d) You are responsible for initiating the warranty process. EPA and CARB suggest that you present your off-road LSI engine to ZPP or a ZPP-authorized agent as soon as any problem exists. The warranty repairs should be completed by ZPP or a ZPP-authorized agent as expeditiously as possible.

If you have any questions regarding your warranty rights or responsibilities, contact Zenith Power Products LLC at 715-453-9317 or at www.ZenithPP.com.

EMISSION CONTROL WARRANTY STATEMENT (continued)

ZPP's warranty on emissions-related parts is specified as follows:

1) Any part that is not scheduled for replacement as required maintenance in the Owner's Manual shall be warranted for the entire Emissions Control System (Emissions) Warranty Period. If any emissions-related part fails during the Emissions Warranty Period, it will be replaced by ZPP per subsection 4) below. Any emissions-related part repaired or replaced under the Emissions Warranty will be covered for the remainder of the Emissions Warranty Period.

2) Any warranted part that is scheduled only for inspection in the Owner's Manual during the Emissions Warranty Period is covered for the entire Emissions Warranty Period. Any inspected part that is repaired or replaced under this Emissions Warranty is covered until the end of the Emissions Warranty Period.

3) Any warranted part that is scheduled for replacement in the Owner's Manual is covered until the first replacement point for that part. If the emissions-related part fails prior to the first replacement point, it will be repaired or replaced per subsection 4) below. The repaired or replaced part will continue to be covered until the first replacement point.

4) Repair or replacement of any emissions-related part under this Emissions Warranty will be performed at a ZPP authorized service center at ZPP's expense.

5) The owner shall not make any modifications to the engine without ZPP's written consent. Unapproved changes shall void this Emissions Warranty and be sufficient basis for denying an Emissions Warranty claim.

6) Failure of unauthorized replacement parts shall not be covered by this Emissions Warranty.

7) Failure of authorized emission-related parts due to the use of unauthorized replacement parts shall not be covered by this Emissions Warranty.

8) Damage to or failure of emission-related parts caused by fire, flood, acts of God, or other accidents beyond ZPP's control shall not be covered by this Emissions Warranty.

EMISSION CONTROL WARRANTY STATEMENT (continued)

Standard Emissions Parts List Covered under the 2500 hour/3-year Warranty

(1) Fuel Metering System
- Mixer
- Final-stage NG & vapor LPG fuel pressure regulator (NA665, NA690, TA690)
- Final-stage liquid LPG pressure regulator/vaporizer (TA6120)
- Fuel valve (NA665)

(2) Air Induction System
- Intake manifold
- Electronic throttle (All except TA6120)
- Exhaust manifold

(3) Crankcase Ventilation Systems
- Oil/Mist Separator (NA665, NA690, TA690, TA6120)

(4) Ignition Control System
- Ignition coil or coil-pack
- Ignition wires
- Spark plugs (up to first Replace interval at 1500 hours)

(5) Miscellaneous Emissions Control System Components
- CAM sensor
- CRANK sensor
- Engine Control Module (ECM)
- Pre-cat and post-cat oxygen sensors
- Knock sensor(s) (TA690, TA6120)
- TMAP sensor

(6) Exhaust Gas Recirculation System (TA6120 only)
- EGR cooler
- EGR pressure regulator
- EGR 3-way solenoid valve
- EGR flow control valve

High-Cost Emissions Parts List Covered under the 3500 hour/5-year Warranty

- CAC/radiator package
- Catalytic converter
- Electronic throttle (TA6120 only)
- LPG vapor fuel pressure regulator (TA6120 only)
- NG fuel pressure regulator (TA6120 only)
- Fuel valve (all except NA665)
- Turbocharger

Engine Identification

Engine part number _____

Engine serial number _____

Engine application _____

Purchased from _____

In-service date _____

Engine hours at delivery _____

MAINTENANCE LOG

Service Interval: 250 Hours or 4 Months

- ☐ Replace engine oil and filters
- ☐ Clean debris from radiator core
- ☐ Inspect fuel filter
- ☐ Inspect fuel lines, hoses, and fittings for gas leakage
- ☐ Inspect exhaust system for cracks or leaks & tighten
- ☐ Inspect catalyst for cracks, leaks, or plugging

Date:	
Engine Hours:	
Mechanic:	

MAINTENANCE LOG

Service Interval: 750 Hours or 13 Months

- ☐ Replace engine oil and filters
- ☐ Inspect air filter element
- ☐ Inspect accessory drive belts
- ☐ Clean debris from radiator core
- ☐ Inspect coolant hoses for cracks, swelling, and
- ☐ Inspect charge cooler pipes and connections
- ☐ Inspect engine coolant filter
- ☐ Inspect engine coolant
- ☐ Clean fuel filter
- ☐ Inspect fuel lines, hoses, and fittings for gas leakage
- ☐ Inspect valve clearance and adjust if needed
- ☐ Inspect spark plugs
- ☐ Inspect spark plug wires
- ☐ Inspect electrical connections
- ☐ Inspect exhaust system for cracks or leaks & tighten

Date:	
Engine Hours:	
Mechanic:	

MAINTENANCE LOG

Service Interval: 1500 Hours or 25 Months

- ☐ Replace engine oil and filters
- ☐ Inspect crankcase ventilation filter
- ☐ Inspect air filter element
- ☐ Inspect accessory drive belts
- ☐ Clean debris from radiator core
- ☐ Inspect coolant hoses for cracks, swelling, and deterioration
- ☐ Inspect charge cooler pipes and connections
- ☐ Replace engine coolant filter
- ☐ Inspect engine coolant
- ☐ Clean fuel filter
- ☐ Inspect fuel lines, hoses, and fittings for gas leakage
- ☐ Inspect valve clearance and adjust if needed
- ☐ Replace spark plugs
- ☐ Inspect spark plug wires
- ☐ Inspect electrical connections
- ☐ Inspect exhaust system for cracks or leaks & tighten
- ☐ Inspect exhaust catalyst for leaks, cracks, or plugging

Date:	
Engine Hours:	
Mechanic:	

MAINTENANCE LOG

Service Interval: 2250 Hours or 38 Months

- ☐ Replace engine oil and filters
- ☐ Inspect air filter element
- ☐ Inspect accessory drive belts
- ☐ Clean debris from radiator core
- ☐ Inspect coolant hoses for cracks, swelling, and
- ☐ Inspect charge cooler pipes and connections
- ☐ Inspect engine coolant filter
- ☐ Inspect engine coolant
- ☐ Replace fuel filter
- ☐ Inspect fuel lines, hoses, and fittings for gas leakage
- ☐ Inspect valve clearance and adjust if needed
- ☐ Inspect spark plugs
- ☐ Inspect spark plug wires
- ☐ Inspect electrical connections
- ☐ Inspect exhaust system for cracks or leaks & tighten

Date:	
Engine Hours:	
Mechanic:	

MAINTENANCE LOG

Service Interval: 3000 Hours or 50 Months

- ☐ Replace engine oil and filters
- ☐ Inspect crankcase ventilation filter
- ☐ Inspect air filter element
- ☐ Inspect accessory drive belts
- ☐ Clean debris from radiator core
- ☐ Inspect coolant hoses for cracks, swelling, and deterioration
- ☐ Inspect charge cooler pipes and connections
- ☐ Replace engine coolant filter
- ☐ Replace engine coolant
- ☐ Clean fuel filter
- ☐ Inspect fuel lines, hoses, and fittings for gas leakage
- ☐ Inspect valve clearance and adjust if needed
- ☐ Replace spark plugs
- ☐ Inspect spark plug wires
- ☐ Inspect electrical connections
- ☐ Inspect exhaust system for cracks or leaks and tighten
- ☐ Inspect catalyst for cracks, leaks, or plugging

Date:	
Engine Hours:	
Mechanic:	

MAINTENANCE LOG

Service Interval: 3750 Hours or 63 Months

- ☐ Replace engine oil and filters
- ☐ Inspect air filter element
- ☐ Inspect accessory drive belts
- ☐ Clean debris from radiator core
- ☐ Inspect coolant hoses for cracks, swelling, and
- ☐ Inspect charge cooler pipes and connections
- ☐ Inspect engine coolant filter
- ☐ Inspect engine coolant
- ☐ Clean fuel filter
- ☐ Inspect fuel lines, hoses, and fittings for gas leakage
- ☐ Inspect valve clearance and adjust if needed
- ☐ Inspect spark plugs
- ☐ Inspect spark plug wires
- ☐ Inspect electrical connections
- ☐ Inspect exhaust system for cracks or leaks and tighten

Date:	
Engine Hours:	
Mechanic:	

MAINTENANCE LOG

Service Interval: 4500 Hours or 76 Months

- ☐ Replace engine oil and filters
- ☐ Inspect crankcase ventilation filter
- ☐ Inspect air filter element
- ☐ Inspect accessory drive belts
- ☐ Clean debris from radiator core
- ☐ Inspect coolant hoses for cracks, swelling, and deterioration
- ☐ Inspect charge cooler pipes and connections
- ☐ Replace engine coolant filter
- ☐ Inspect engine coolant
- ☐ Replace fuel filter
- ☐ Inspect fuel lines, hoses, and fittings for gas leakage
- ☐ Inspect valve clearance and adjust if needed
- ☐ Replace spark plugs
- ☐ Inspect spark plug wires
- ☐ Inspect electrical connections
- ☐ Inspect exhaust system for cracks or leaks and tighten
- ☐ Inspect catalyst for cracks, leaks, or plugging

Date:	
Engine Hours:	
Mechanic:	

MAINTENANCE LOG

Service Interval: 5250 Hours or 88 Months

- ☐ Replace engine oil and filters
- ☐ Inspect air filter element
- ☐ Inspect accessory drive belts
- ☐ Clean debris from radiator core
- ☐ Inspect coolant hoses for cracks, swelling, and
- ☐ Inspect charge cooler pipes and connections
- ☐ Inspect engine coolant filter
- ☐ Inspect engine coolant
- ☐ Clean fuel filter
- ☐ Inspect fuel lines, hoses, and fittings for gas leakage
- ☐ Inspect valve clearance and adjust if needed
- ☐ Inspect spark plugs
- ☐ Inspect spark plug wires
- ☐ Inspect electrical connections
- ☐ Inspect exhaust system for cracks or leaks and tighten

Date:	
Engine Hours:	
Mechanic:	

Engine and Fuel System Installation Guide

NG and LP Vapor Fuel System Installation

- Vapor fuel line should be of sufficient size to prevent fuel pressure drop at full load operation. Vapor fuel pressure regulator should be set at **7-11 inWC**.
- All fuel lines must be a minimum of 12" from exhaust system components, with adequate airflow around pipes, and properly shielded from radiant heat.
- Fuel line used in stationary applications should be of ***Black Malleable Iron*** or ***Steel***. Galvanized steel pipe is not recommended or approved. A flexible line of suitable material, (***steel flex pipe*** or ***braided stainless*** is recommended) should be used between engine's fuel shutoff valve and supply line with a manual shutoff valve. Dual fuel systems must have shutoff valves on both supply lines.
- Fuel supply line fittings must be assembled with O2 sensor safe thread sealant. ***ZPP*** recommends the use of Loctite 592 Thread Sealant, or equivalent.
- All fuel lines should be properly supported and strapped to prevent vibration and undesired motion and free from kinks or bends with the least amount of elbows necessary. ***ZPP*** recommends a maximum of 1, 90° elbow per installation.

The following are guidelines for vapor fuel supply line installation:

Supply Line	NA665	NA690	TA690	TA6120
1"	•	•		
1 ¼"		•	•	
1 ½"			•	•

Fuel Supply Regulator Sizing

Supply fuel pressure regulator should be sized and configured to allow for proper fuel supply pressure during fully loaded operation. The table below is a guide to assist with initial installation.

BTU/HR 1800 RPM Full Load	NA665	NA690	TA690	TA6120
NG	815,000	960,000	2,060,000	2,924,000
LPG	973,150	1,184,143	1,929,077	2,544,832

LPG Liquid Withdrawal Fuel System Installation

- All LPG Liquid Withdrawal systems must utilize a hydrostatic relief valve or a device providing pressure-relieving protection that complies with section 2-4.7 of NFPA 58.
- Relief valve should be installed in each section of piping (including hose), in which liquid LP-Gas can be isolated between shutoff valves, to relieve the pressure that could develop from the trapped liquid, to a safe atmosphere.
- Recommended LPG liquid fuel supply line should be 3/8".

Electronic and Electrical Components

- All electronic components and controls should me mounted to control ***vibration*** to ***3g***'s or less.
- Due to the sensitive nature of electronic components, all electrical emission sources should be considered during product installation. Electrical emissions can cause erratic operation of electronic control devices.
- Electrical and electronic components should be spaced at least 12", if practical from exhaust components and other external heat sources. Proper shielding and airflow should be provided to protect all sensitive components.
- Batteries and battery cables should be sized according to the specifications as outlined in the engines Owners and Operators Manuals.

Cooling and Airflow

Engines should be mounted as to maximize the amount of outside air across the engine and through the radiator while taking measures to prevent heated air from recirculating back through the cooling system. ***ZPP*** recommends the use of an air duct, no smaller than the radiator core, in buildings or enclosure installations, to prevent recirculation. Radiator ***vibration*** should not exceed ***1.5***g.

Engine Environment

Engines should be located and positioned to reduce the effects of wind, weather, temperature, and environmental conditions such as;

- Engine air intake temperature
- Airflow
- Air borne contaminants (Dirt, sawdust, fibers, insects, animal feathers or fur, etc.)
- Moisture
- Snow and Ice

Air inlet temperature should not exceed ambient temperature. Measurements between ambient and manifold temperature sensor should not exceed 130° F.

High air inlet temperatures can cause engine detonation and improper fueling which can lead to poor performance and severe engine damage.
Electrical components and controls should be properly shielded from water. Damage from weather or moisture is not considered a warrantable condition.

Engine Mounting

Engines should be mounted level on a solid surface or frame while reducing vibration to the absolute minimum. Frames should include provisions for securing engine mounting legs to the extent of **all** mounting holes. Engine mounting legs should never be left unsupported.

Failure to follow engine mounting steps may result in severe damage to cooling system components and severe injury to bystanders.

Isolation mounting can be utilized provided that ***proper earth grounds*** are used to insure the reduction of electrical emissions as well as static electricity.

Exhaust System Installation

All fuel system components, wiring, and electronic components should be protected from exhaust heat sources. Catalysts should be mounted horizontally.

If application does not permit, ***ZPP*** will review and have the ultimate decision on the installation.

Catalysts should be mounted with flex pipe and provisions to reduce the ***vibration*** to less that ***3g***s.

Exhaust pipe size should be at least the same size as provided, or recommended by ***ZPP*** in the ***Emissions Related Installation Instructions***, as provided by ***ZPP***.

Exhaust pipe installations requiring additional length or bends will require increasing the I.D. off the pipe proportional to the length to reduce back pressure.

Back pressure should not exceed 1 psig for engines 6.5 liters and larger. Ultimately, back pressure readings with suitable gauge will be the determining factor for all exhaust installations.

Engine Misfire/Backfire Troubleshooting

- Improper air to fuel ratio
  - Failing oxygen sensor
  - Improper or insufficient fuel pressure
  - Poor fuel quality
- Incorrect spark plug or gap
- Cracked insulator on spark plug
- Damaged or leaking ignition cable
- High resistance in Ignition cable
- Oil in spark plug well
- Failing ignition coil
- Incorrect voltage to ignition coil
- Intermittent voltage loss (electrical connections or splices)
- Poor or improper engine ground
- Improper ignition timing or phasing
- Sync loss between cam and crank sensor
  - Air gap between tooth and sensor
  - Failing camshaft or crankshaft position sensor
  - Debris on tone ring or sensor
  - Electronic or magnetic noise or interference
- Valve not opening or closing
  - Insufficient valve clearance
  - Worn camshaft lobe
  - Broken or bent pushrod
  - Damaged tappet
- Unmetered air entering intake manifold
  - Leaking gasket
  - Missing cap or plug
  - Cracks
- Broken or damaged piston
- Excessive carbon buildup on piston
- Excessive back pressure
  - Plugged catalyst
  - Damaged exhaust pipe
  - Collapsed muffler
- Clogged air filter

Appendix

This supplement is to assist in the operation of ZPP engines equipment equipped with Dynagen TE350 and TG410 controllers.

The following pages will assist you in navigating through the basic controller functions.

TE350

Item	Name
O	Off Button
A	Auto Button
	Run Button
	Up Button
ENTER	Enter Button
	Down Button
	Generator/Engine LED

You can identify which panel by simply looking at the UP and DOWN arrows on the panel.

TG410 has UP and DOWN arrow only

TE350 has the UP Arrow with Rabbit, and the DOWN arrow with Turtle symbol.

TG410

Item	Name
O	Off Button
A	Auto Button
I	Run Button
	Up Button
ENTER	Enter Button
	Down Button
	Generator/Engine LED

Item	Name
O	Off Button
A	Auto Button
I	Run Button
▲	Up Button
ENTER	Enter Button
▼	Down Button
	Generator/Engine LED

OFF BUTTON -> Press OFF while engine is running to activate engine shutdown.

AUTO Button -> While engine is off, Hold AUTO for 3 seconds to activate fuel pump priming, and diagnostic mode for powering ECM. (Activates for 1 hr period max for priming and diagnostic)

RUN Button -> Press RUN button to start and run generator.

UP /DOWN Button -> Used to scroll screens while engine running, for changing parameters in MENU and also for MENU system navigation.

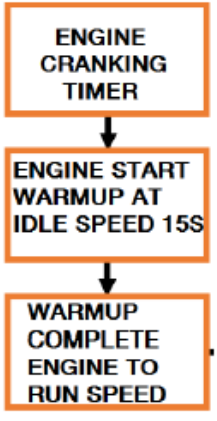
ENTER -> Press for entering menu system (OFF MODE), for locking screen view when engine running (Press ENTER to lock) and for accepting settings in Menu system.

Generator Symbol LED: Green = OK, Amber = Warning, RED = Failure.

Speed Control -> While Engine is running HOLD AUTO, and while holding AUTO use UP and DOWN arrows for speed control.

Engine Starting Sequence

After triggering the RUN button, The Sequence will be as follows:

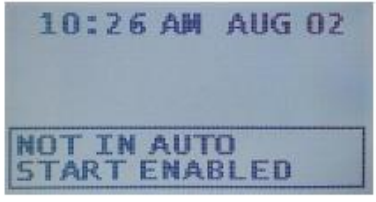


Starter engagement –> Engine Warmup (at IDLE Speed) -> Engine Running at Rated speed (1800RPM)

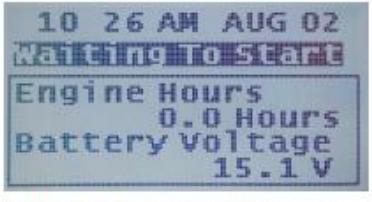
NOTE: The Engine will turn on the starter for a maximum of 10 seconds, at which point it will pause for 15 seconds and reattempt starter engagement for a maximum of 3 cycles.

During the Forced Warmup timer a message will appear indicating "Do Not Load".

OFF Mode

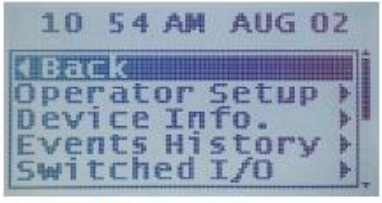


AUTO Mode



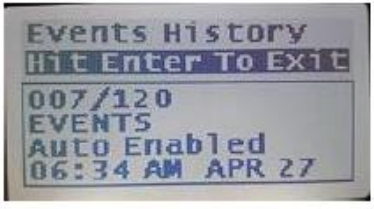
AUTO Mode: Allows view of parameters during AUTO (battery, Engine Hours, Oil PSI, Engine Temp

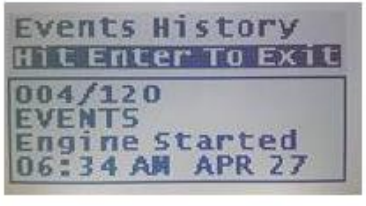
MENU System Mode

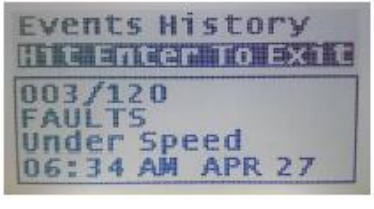


Hit ENTER during OFF mode to enter MENU

LOG / EVENTS History



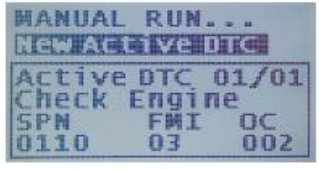




Failure Mode

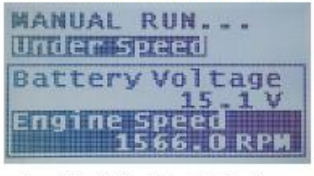
HIT OFF to reset failure.
To view failure after it has been reset, you will need to go to MENU, then to EVENTS History

ECM Trouble Code



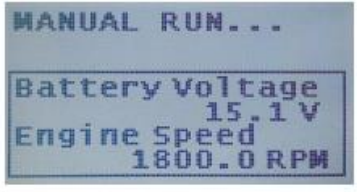
Engine Trouble Code
Refer to Cummins
SPN = Warning Type
FMI = Warning Meaning
SPN 0110 = Eng. Temp
FMI 03 = Above Normal

DYNAGEN Warning



Parameter highlighted during warning

RUN MODE Screens



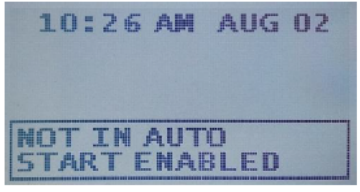
EVENTS HISTORY can provide some valuable insights into any failures that might have occurred as well as the sequence of engine operation which led to the failure. Time, Date, and log event number are recorded, up to 150 events.

ACCESSING EVENTS HISTORY

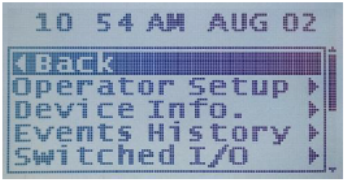
Controller must be in OFF mode, next

1. **Hit ENTER button, you will enter Menu System.**
2. **Scroll down to EVENTS HISTORY and hit ENTER**
3. **The EVENT LOG will allow you to see up to 150 combined events, warnings, failures.**

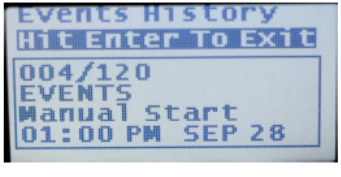
OFF Mode



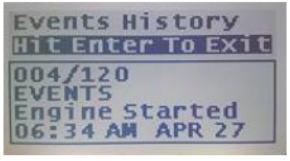
Hit ENTER



Scroll to EVENTS HISTORY and hit ENTER



Engine Started EVENT

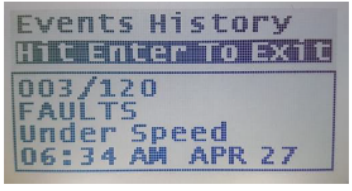


EVENTS HISTORY
004/120 represents the 4th item in the LOG with a total of 120 items

EVENTS is the logged type

ENGINE STARTED: The operator started the engine at 6:34 on April 27.

Engine Failure EVENT



EVENTS HISTORY
003/120 represents the 3rd item in the LOG with a total of 120 items

FAULTS is the logged type (Enging/Genset failure)

ENGINE FAILED: The Engine Failed due to underspeed. (Likely due to overload, out of fuel.)

The Keyswitch on main Panels serves as an ON/OFF for main Power to DYNAGEN panel.

Keyswitch in Ignition position applies power to panel. Use RUN and OFF buttons on DYNAGEN TG410 panel to start and stop Engine normally.

Keyswith Switch OFF powers OFF Panel. It is recommended that Keyswitch be put in OFF position when equipment is not is use to prevent battery drain from the panel. To trigger an EMERGENCY STOP, Press the RED emergency stop button which will immediately shutdown the engine.

NOTES

⚠ WARNING ⚠

This product may contain a chemical known to the state of California to cause cancer, or birth defects, or other reproductive harm. For more information go to www.P65Warnings.ca.gov.