SERVICE MANUAL

2013 HD-OBD Diagnostic Reference Manual

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TABLE OF CONTENTS

FOREWORD

Navistar, Inc. is committed to continuous research and development to improve products and introduce technological advances. Procedures, specifications, and parts defined in published technical service literature may be altered.

Technical service literature is revised periodically. If a technical publication is ordered, the latest revision will be supplied.

NOTE – To order technical service literature, contact your International dealer.

SAFETY INFORMATION

This manual provides general and specific maintenance procedures essential for reliable engine operation and your safety. Since many variations in procedures, tools, and service parts are involved, advice for all possible safety conditions and hazards cannot be stated.

Read safety instructions before doing any service and test procedures for the engine or vehicle. See related application manuals for more information.

Disregard for Safety Instructions, Warnings, Cautions, and Notes in this manual can lead to injury, death or damage to the engine or vehicle.

Safety Terminology

Three terms are used to stress your safety and safe operation of the engine: Warning, Caution, and Note.

Warning: A warning describes actions necessary to prevent or eliminate conditions, hazards, and unsafe practices that can cause personal injury or death.

Caution: A caution describes actions necessary to prevent or eliminate conditions that can cause damage to the engine or vehicle.

Note: A note describes actions necessary for correct, efficient engine or vehicle operation.

Safety Instructions

Work Area

- Keep work area clean, dry, and organized.
- Keep tools and parts off the floor.
- Make sure the work area is ventilated and well lit.
- Make sure a first aid kit is available.

Safety Equipment

- Use correct lifting devices.
- Use safety blocks and stands.

Protective Measures

- Wear protective safety glasses and shoes.
- Wear correct hearing protection.
- Wear cotton work clothing.
- Wear sleeved heat protective gloves.
- Do not wear rings, watches or other jewelry.
- Restrain long hair.

Vehicle

- Make sure the vehicle is in neutral, the parking brake is set, and the wheels are blocked before servicing engine or vehicle.
- Clear the area before starting the engine.

Engine

- The engine and vehicle should be operated or serviced only by qualified individuals.
- Provide necessary ventilation when operating engine in a closed area.
- Keep combustible material away from engine exhaust system and exhaust manifolds.
- Install all shields, guards, and access covers before operating engine or vehicle.
- Do not run engine with unprotected air inlets or exhaust openings. If unavoidable for service reasons, put protective screens over all openings before servicing engine.
- Shut engine off and relieve all pressure in the system before removing panels, housing covers, and caps.
- If an engine, or vehicle, is not safe to operate, tag the ignition key.

Fire Prevention

- Make sure charged fire extinguishers are in the work area.

NOTE – Check the classification of each fire extinguisher to ensure that the following fire types can be extinguished.

1. Type A - Wood, paper, textiles, and rubbish
2. Type B - Flammable liquids
3. Type C - Electrical equipment

Batteries

- Always disconnect the main negative battery cable first.
- Always connect the main negative battery cable last.
- Avoid leaning over batteries.
- Protect your eyes.
- Do not expose batteries to open flames or sparks.
- Do not smoke in workplace.

Compressed Air

- Use an OSHA approved blow gun rated at 30 psi (207 kPa).
- Limit shop air pressure to 30 psi (207 kPa).
- Wear safety glasses or goggles.
- Wear hearing protection.
- Use shielding to protect others in the work area.
- Do not direct compressed air at face or body.

Tools

- Make sure all tools are in good condition.
- Make sure all standard electrical tools are grounded.
- Check for frayed power cords before using power tools.

Fluids Under Pressure

- Use extreme caution when working on systems under pressure.
- Follow approved procedures only.

Fuel

- Do not over fill the fuel tank. Over fill creates a fire hazard.
- Do not smoke in the work area.
- Do not refuel the tank when the engine is running.

Removal of Tools, Parts, and Equipment

- Reinstall all safety guards, shields, and covers after servicing the engine or vehicle.
- Make sure all tools, parts, and service equipment are removed from the engine and vehicle after all work is done.

ON BOARD DIAGNOSTICS (OBD) OVERVIEW

The On Board Diagnostic (OBD) system monitors engine and exhaust aftertreatment emissions control system functionality and will sent faults when Environmental Protection Agency (EPA) exhaust emissions limits are exceeded to aid in fault diagnostics.

"Enable Conditions" are operating conditions that must be met so an OBD monitor can run.

Vehicle "Drive Cycles" are conditions and values that must be met before a monitor will execute. Drive cycles may range from starting the engine, to a heavy pull.

Drive cycles are important for the OBD system to evaluate control system thresholds to determine if "Malfunction Criteria" exists to either illuminate, or extinguish the Malfunction Indicator Lamp (MIL) and make a PASS or FAIL determination. When the MIL illuminates, a Diagnostic Trouble Code (DTC) will be stored in the engines computer. DTCs are stored as Pending, Active, Healing, Previously Active, and Permanent.

DIAGNOSTIC TROUBLE CODE OVERVIEW

Many DTCs are "Pending" when that fault is detected during one drive cycle, an example is when a monitor records values outside of expected values (Setting Criteria) for one drive cycle, but values outside of expected values have not yet been detected on two or more drive cycles. The Malfunction Indicator Lamp (MIL) remains OFF for "Pending" DTCs.

Many DTCs are "Active" if the monitor detects the same fault values (Setting Criteria) twice within three drive cycles, the MIL often turned ON.

Many DTCs are "Healing" when Setting Criteria has not been detected for two consecutive drive cycles. While a DTC is Healing, if the same fault is not detected after three consecutive drive cycles, the fault becomes "Previously Active" and the MIL is turned OFF. If the fault is detected within three consecutive "Healing" drive cycles, the fault returns to "Active" and the MIL stays ON.

Many DTCs will remain "Previously Active" and the MIL will stay OFF as long as the fault is no longer detected. But, if the same fault is detected within three drive cycles while it is still "Healing," the fault returns to "Active," and the MIL turns "ON."

A "Permanent" DTC is a fault that was detected by an OBD monitor when the Setting Criteria was met and a DTC was stored as "Active." Permanent DTCs are stored and cannot be cleared. Permanent faults are cleared when the monitor that set the code PASSES on three consecutive drive cycles. Permanent DTCs should not be treated as a current problem with the control system.

WARRANTY INFORMATION

5.1. DRIVE CYCLES

Road Testing is not covered by warranty, see the CTS-1100 Warranty and Procedure Manual for more Information.

During a "Drive Cycle," the intent is to satisfy the enable criteria to enable that monitor to run.

Drive Cycle	Description	Condition
1	Ambient Condition (COLD SOAK)	Temperature values need to be checked after 8 hours or more of cold soak. • Sit (engine Off) for 8 hours • Temperature 20°F to 130°F (-7°C to 55°C) • Barometric Pressure -2200 to 6400 (80 to 110 kPa)
2	Low Idle	Key-On Engine-Running for 5 minutes
3	Parked Regen	Manual regeneration of the exhaust aftertreatment
4	City Cycle	Drive for 20 - 30 minutes in city
5	Highway Cycle	Drive for 20 - 30 minutes on highway
6	System	Key-On Engine-Off

DRIVE CYCLES

6.1. MAXXFORCE® 11 AND 13 (EPA 10) WITH HD-OBD

During a "Drive Cycle," the intent is to satisfy the enable criteria to enable that monitor to run.

Drive Cycle	Condition
1	Using Electronic Service Tool (EST) with ServiceMaxx™ do a parked aftertreatment regeneration. Shut the engine Off and allow Engine Control Module (ECM) housekeeping to complete.
2	Turn key to ON position and wait 1 minute. Start engine and allow to low idle (600 - 750 rpm) for 5 minutes. Shut the engine Off and allow the Engine Control Module (ECM) housekeeping to complete.
3	Steady driving for 30 seconds at 35 - 40 mph and at 40 - 50 mph.
4	Steady accelerations for 30 seconds, from 0 - 45 mph (engine speed > 1200 rpm) @ 100% throttle. Perform 5 times.
5	Steady driving at 45 - 55 mph for 60 seconds @ 1200 - 1300 rpm and @ 50% pedal.
6	Steady driving @ 1500 rpm and @ 50% pedal for 4 min.
7	Steady driving @ 1700 - 2000 rpm @ 100% pedal for 60 seconds.
8	Coast downs from 55 mph @ 0% throttle for 30 - 60 seconds. Perform 5 times.
9	Engine Coolant Temperature (ECT) > 140°F (60°C). Shut the engine Off and allow Engine Control Module (ECM) housekeeping to complete.
10	8 hours (engine Off) cold soak.
11	Hold engine at > 50% torque at > 1500 RPM for > 60 seconds.
12	With ECT < 50°F (10°C). Key-On Engine-Off (KOEO), allow wait to start lamp to flash. Start engine and allow cold start assist to operate at low idle (600-750 rpm) for 2 minutes.
13	Key-ON Engine-Running (KOER), bring engine speed to 1500 RPM, and hold for 2 minutes. Shut the engine Off and allow Engine Control Module (ECM) housekeeping to complete.
14	Hold engine speed > 50% load and >1500 RPM for > 60 seconds.
15	KOER, hold engine speed @ high idle for 30 seconds with Diesel Particulate Filter (DPF) inlet temperature between 392 - 752°F (200 - 400°C). Shut the engine Off and allow the Engine Control Module (ECM) housekeeping to complete.
16	Hold engine torque at > 75% load and engine speed > 1500 RPM for > 60 seconds.
17	Engine Coolant Temperature (ECT) < 125°F (52°C), ambient temperature > 50°F (10°C). Steady driving maintaining > 35 MPH for 2 minutes.

6.2. N13 WITH SCR (EPA 10) WITH HD-OBD

During a "Drive Cycle," the intent is to satisfy the enable criteria to enable that monitor to run.

Drive Cycle	Condition
1	Using Electronic Service Tool (EST) with ServiceMaxx™ do a parked aftertreatment regeneration. Shut the engine Off and allow Engine Control Module (ECM) housekeeping to complete.
2	Turn key to ON position and wait 1 minute. Start engine and allow to low idle (600 - 750 rpm) for 5 minutes. Shut the engine Off and allow the Engine Control Module (ECM) housekeeping to complete.
3	Steady driving for 30 seconds, at 35 - 40 mph, and at 40 - 50 mph.
4	Steady accelerations for 30 seconds, from 0 to 45 mph (engine speed > 1200 rpm) at 100% throttle. Perform 5 times.
5	Steady driving at 45 - 55 mph for 60 seconds @ 1200 - 1300 rpm and at 50% pedal.
6	Steady driving at 1500 rpm and @ 50% pedal for 4 minutes.
7	Steady driving at 1700 - 2000 rpm @ 100% pedal for 60 seconds.
8	Coast downs from 55 mph @ 0% throttle for 30 - 60 seconds. Perform 5 times.
9	After attaining Engine Coolant Temperature (ECT) > 140°F (60°C). Shut the engine Off and allow Engine Control Module (ECM) housekeeping to complete.
10	8 hours (engine Off) cold soak.
11	Hold engine at > 50% torque at > 1500 RPM for > 60 seconds.
12	With Engine Coolant Temperature (ECT) < 50°F (10°C). KOEO, allow wait for cold start system lamp to flash. Start engine, allow cold start assist to operate at low idle (600 - 750 rpm) for 2 minutes.
13	KOER, bring engine speed to 1500 RPM, and hold for 2 minutes. Shut the engine down, and allow Engine Control Module (ECM) housekeeping to complete.
14	Hold engine speed > 50% load and > 1500 RPM for > 60 seconds.
15	KOER, hold engine speed @ high idle for 30 seconds with Diesel Particulate Filter (DPF) inlet temperature between 392 - 752°F (200 - 400°C). Shut the engine Off and allow the Engine Control Module (ECM) housekeeping to complete.
16	Hold engine torque > 75% load and engine speed > 1500 RPM for > 60 seconds.
17	Engine Coolant Temperature (ECT) < 125°F (52°C), ambient temperature > 50°F (10°C). Steady driving maintaining > 35 MPH for 2 minutes.
18	Selective Catalyst Reduction (SCR) catalyst inlet temp below (380°F (193°C) .
19	With (SCR) catalyst inlet temp below 380°F (193°C), let idle for 15 minutes.
20	With Diesel Oxidation Catalyst Inlet Temperature (DOCIT) maintained above 325°F (163°C). Run engine for 10 minutes.
21	With (SCR) catalyst outlet temperature maintained above 325°F (163°C). Run engine for 10 minutes.
22	Using Electronic Service Tool (EST) with ServiceMaxx™, do Tests > KOEO Aftertreatment Test > run AFT Fuel Shutoff Valve and AFT Fuel Injector test.

23	With Diesel Exhaust Fluid (DEF) tank temperature below 32°F (0°C), ambient temp above -22°F (-30°C), and coolant temp above 70°F (21°C), for 10 minutes.
24	With DEF tank temp between below 32°F (0°C), ambient temp above -22°F (-30°C), and coolant temp above 70°F (21°C), using Electronic Service Tool (EST) with ServiceMaxx™, do Tests > KOEO Aftertreatment Test > run the DEF Tank Heater Test.
25	Under development Using Electronic Service Tool (EST) with ServiceMaxx™, do Tests > KOEO Aftertreatment Test > run DPF reset procedure.
26	Top off Diesel Exhaust Fluid (DEF), and maintain Selective Catalyst Reduction (SCR) catalyst inlet temperature > 400°F (204°C) for 10 minutes.
27	With Diesel Exhaust Fluid (DEF) tank temperature above 35°F (2°C), and ECT1 above 80°F (27°C), using Electronic Service Tool (EST) with ServiceMaxx™, do Tests > KOEO Aftertreatment Test > run the DEF Doser Pump Override Test.
28	Turn key to ON position and wait 1 minute. Start engine and allow engine to low idle at (600 - 750 rpm) for 10 minutes. Shut the engine Off and allow Engine Control Module (ECM) housekeeping to complete.
29	Using Electronic Service Tool (EST) with ServiceMaxx™, do Tests > KOEO Aftertreatment Test > run the DEF Line Heater Test.
30	**NOTE – Do not remove doser nozzle during DEF Doser Pump Override Test.** Using Electronic Service Tool (EST) with ServiceMaxx™, do Tests > KOEO Aftertreatment Test > perform DEF Doser Pump Override Test.
31	KOER, raise engine RPM to high idle and hold for 10 minutes. Then drive with steady load for additional 5 minutes.
32	Under development Using Electronic Service Tool (EST) with ServiceMaxx™, do Tests > satisfy entry conditions and complete DOC Maintenance Reset Procedure.
33	Under development Using Electronic Service Tool (EST) with ServiceMaxx™, do Tests > satisfy entry conditions and complete SCR Performance Test.

FAILURE MODE INDICATOR (FMI) HIERARCHY

A Failure Mode Indicator (FMI) is used with a Suspect Parameter Number (SPN) to provide information to determine what system failed and how a circuit, component, or system is setting a fault code. An FMI indicates the detection method, not the estimated root cause. For example, FMI 3 is a diagnostic fault that becomes active, due to signal Out of Range HIGH or short to PWR. This condition can be caused by more than one possible cause. For this FMI, the control system only detects whether or not the signal or voltage is higher than the diagnostic threshold.

FMI Hierarchy defines the FMI into three categories, Circuit, Component, and System faults. When more than one FMI is present, first diagnose "Circuit" FMIs, secondly, diagnose "Component" FMIs, and finally, diagnose "System" FMIs. Some Component FMIs (2, 13, 14) may need to be diagnosed first. See specific direction in the appropriate Engine Diagnostic Manual.

A. Circuit FMI: 3, 4, 5, and 19. These FMI direct diagnostics to specific circuit failures.

B. Component FMI: 2, 7, 11, 13, and 14. These FMI direct diagnostics towards a monitored system component failure, and other components associated with the operation of a system.

C. System FMI: 0, 1, 10, 15, 16, 17, 18, 20, 21, and 31. These FMI direct diagnostics to a loss of efficiency and performance in the monitored system. Some FMIs are an indication of higher emissions being produced.

Circuit	Component	System
3, 4, 5, and 19	2, 7, 11, 13, and 14	0, 1, 10, 15, 16, 17, 18, 20, 21, and 31
Shorts	Comparison	Efficiency & Performance
Open	Position	Inducement / Strategy
High Resistance	Mechanical	

DEFINITIONS / ACRONYMS

- AFT - Aftertreatment
- CSE - Customer Service Engineer
- DEF - Diesel Exhaust Fluid
- DOC - Diesel Oxidation Catalyst
- DOCIT - Diesel Oxidation Catalyst Inlet Temperature
- DPF - Diesel Particulate Filter
- DTC - Diagnostic Trouble Code
- ECT - Engine Coolant Temperature
- EPA - Environmental Protection Agency
- EST - Electronic Service Tool
- FMI - Failure Mode Indicator
- KOEO - Key-On Engine-Off
- KOER - Key-On Engine-Running
- MIL - Malfunction Indicator Lamp
- OBD - On Board Diagnostic
- PWR - Power (voltage)
- RPM - Revolutions Per Minute
- SCR - Selective Catalyst Reduction
- SCROT - Selective Catalyst Reduction Outlet Temperature
- SPN - Suspect Parameter Number
- SRT - Standard Repair Time
- TSM - Technical Service Manager