680CK SERIES E LOADER BACKHOE
TABLE OF CONTENTS

[Reprinted]

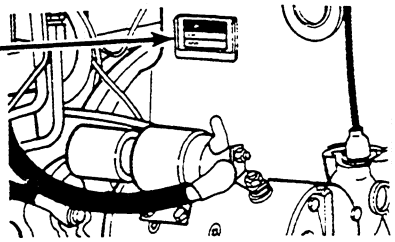
Printed in U.S.A.

Section 1010

GENERAL ENGINE SPECIFICATIONS

680 CK Series E Loaders

THE MODEL AND ENGINE SERIAL NUMBER PLATE IS LOCATED ON THE RIGHT HAND SIDE OF THE ENGINE ABOVE THE CRANKING MOTOR.



DIESEL ENGINES

General

Type	4 Cylinder, 4 Stroke Cycle, Valve-in-Head
Firing Order	1-3-4-2
Bore	4-5/8 Inches
Stroke	5 Inches
Piston Displacement	336 Cubic Inches
Compression Ratio	16.5 to 1
No Load Governed Speed	2330 to 2370 RPM
Rated Engine Speed	2200 RPM
Engine Idling Speed	700 to 750 RPM
*Valve Tappet Clearance (Exhaust)	(Hot) .020 Inch ... (Cold) .025 Inch
(Intake)	(Hot and Cold) .015 Inch

*Hot Settings Are Made After The Engine Has Operated At Thermostat Controlled Temperature For At Least Fifteen Minutes.

Piston and Connecting Rods

Rings per Piston	3
Number of Compression Rings	2
Number of Oil Rings	1
Type Pins	Full Floating Type
Type Bearing	Replaceable Precision, Steel Back, Copper-Lead Alloy Liners

Main Bearings

Number of Bearings	5
Type Bearings	Replaceable Precision, Steel Back, Copper-Lead Alloy Liners

Engine Lubricating System

Oil Pressure	45 to 60 Pounds with Engine Warm and Operating at Rated Engine Speed
Type System	Pressure and Spray Circulation
Oil Pump	Gear Type
Oil Filter	Full Flow Spin on Type
Oil Capacity With Filter	11 U.S. Quarts
Without Filter	10 U.S. Quarts

Fuel System

Fuel Injection Pump	Robert Bosch, Type PES Multiple Plunger
Pump Timing	34 Degrees Before Top Dead Center (Port Closing)
Fuel Injectors	Pencil Type (Opening Pressure 3200 PSI)
Fuel Transfer Pump	Plunger Type, Integral Part of Injection Pump
Governor	Variable Speed, Fly-Weight Centrifugal Type, Integral Part of Injection Pump
1st Stage Fuel Filter	Full Flow Spin on Type
2nd Stage Fuel Filter	Full Flow Spin on Type

Section 1050

MAINTENANCE

AND

LUBRICATION

CASE CORPORATION

Burl. Form 9-73496 June 1976 PRINTED IN U.S.A.

FUEL, FLUIDS AND LUBRICANTS

COMPONENT	CAPACITY U.S.	CAPACITY Metric	SPECIFICATIONS
Fuel tank	30 gallons	113.5 liters	
Engine crankcase oil			
With filter change	11 quarts	10.4 liters	Engine oil: Case HDM oil (CD Commercial class D) MIL-L-45199B Above 32° F (0° C). . . . . SAE 30 10° to 50° F (-12° to 10° C) SAE 20W Below 40° F (4° C). . . . . SAE 10W
Without filter change	10 quarts	9.5 liters	
Hydraulic system			
Total	35 gallons	133 liters	Case TCH Fluid Alternate oils Engine oil - SD - Service class D or CA - Commercial class A Above 32° F (0° C). . . . SAE 10W Below 32° F. (0° C) . . . SAE 5W Type C-2 Transmission and hydraulic fluid such as Tenneco Hytrans Fluid.
Reservoir refill	13.8 gallons	52.2 liters	
Forward/Reverse transmission refill	12 quarts	11.4 liters	Case TCH Fluid
Synchromesh transmission	6.4 pints	3.0 liters	Case FDL Multipurpose Gear Lubricant or (SAE 90, API-GL-4, MIL-L-2105B)
Rear Axle			Hypoid Gear Oil, API-GL-5 SAE 90 or SAE 80W/90 - -15° F. (-26° C) and above SAE 80W - -15° F. (-26° C) to +70° F. (+21° C) SAE 75W - -40° F. (-40° C) to +35° F. (+2° C)
Center bowl	13.5 quarts	12.8 liters	
Planetaries - each	3 pints	1.4 liters	
Cooling System	32 quarts	30.2 liters	Ethylene glycol type antifreeze and water should be mixed for prevailing temperatures. Follow manufacturer's specifications.
Alcohol evaporator	1 pint	0.5 liters	Clean wood alcohol
Batteries	As required		Add colorless, odorless drinking water.
Grease fittings	As required		No. 2 moly disulfide grease Alternate grease: Multipurpose lithium-soap base grease.
Wheel bearings	As required		Number 2 wheel bearing grease.

RUN-IN MAINTENANCE CHART

NOTE: The following charts are based on maximum intervals. If the machine operates in severe conditions, service more often.

NOTE: See page 1050-2 for a listing of fluids and lubricants.

INTERVAL	SERVICE	INSTRUCTIONS
Every Two Hours Until Stabilized	Check wheel nut and bolt torque. Front - 170 foot-pounds torque. Rear - 220-240 foot-pounds torque.	
	Check rear axle mounting bolts. 320-420 foot-pounds torque.	
	Check swing cylinder plate mounting bolts. 500 foot-pounds torque.	Section 9012.
	Check upper swing tower pivot pin nut. 1000 foot-pounds torque.	Section 9012.
After First 20 Hours	Change engine crankcase oil.	
	Replace engine oil filter.	Section 2047.
	Check drive belt tension.	Section 8016.
	Service fuel system.	Section 3010.

SCHEDULED MAINTENANCE CHART

INTERVAL	SERVICE	INSTRUCTIONS
Every 10 Hours or Daily Whichever Occurs First	Grease loader and backhoe pivot points.	
	Check engine crankcase oil level.	
	Check hydraulic oil level.	
	Check radiator coolant level.	
	Drain moisture from air reservoir.	Section 7011.
	Grease inner Extendahoe dipper.	
	Grease front axle pivots.	
	Check machine and ground under it for leaks.	
	Check fuel sediment bowl for water or sediment. If found, drain bowl, 1st stage filter and fuel tank.	Section 3010.

INTERVAL	SERVICE	INSTRUCTIONS
Every 50 Hours or Weekly, Whichever Occurs First	Grease steering king pins.	
	Grease driveshaft universals and slip spline.	
	Check battery electrolyte level.	
	Check Forward/Reverse transmission oil level.	Section 6014.
	Grease brake shafts and slack adjusters.	Section 7013.
	Check tire pressures.	Section 5011.
Every 150 Hours	Change engine oil.	
Every 250 Hours	Check rear axle oil level.	Section 6020.
	Check synchromesh transmission oil level.	Section 6018.
	Clean alcohol evaporator filter.	Section 7020.
	Grease seat post.	
	Lubricate shuttle control lever.	
	Grease loader and backhoe control lever grease fittings.	
Every 300 Hours	Replace engine oil filter.	Section 2047.
Every 500 Hours	Drain deposits from fuel tank.	
	Check drive belt tension.	Sections 7014, 8016
	Change fuel filters.	Section 3010.
	Check ROPS as indicated.	Section 9019.
	Repack front wheel bearings.	Section 5017.
Every 1000 Hours or Yearly, Whichever Occurs First	Change hydraulic reservoir oil.	
	Replace hydraulic oil filter.	
	Clean hydraulic filter by-pass screen.	
	Change forward/reverse transmission oil.	Section 6014.
	Clean forward/reverse transmission suction screen.	Section 6014.

INTERVAL	SERVICE	INSTRUCTIONS
Every 1000 Hours or Yearly, Whichever Occurs First (Cont'd)	Change synchromesh transmission oil.	Section 6018.
	Change rear axle oil.	Section 6020.
	Clean air compressor cylinder head (by dealer only).	Section 7014.
Every 2000 Hours or Yearly, Whichever Occurs First	Disassemble and clean alcohol evaporator (by dealer only).	Section 7020.
	Drain, flush and refill cooling system.	
Every 3000 Hours	Rebuild or replace air compressor (by dealer only).	Section 7014.
As Required	Service air cleaner element when restriction indicator shows red band.	Section 2051.
	After wheel has been removed for service and reinstalled, check wheel nut/bolt torque every two hours until stabilized.	
	Replace fire extinguisher shell.	
	Fill alcohol evaporator with clean wood alcohol.	
	Check the over-the-center boom stop pad for deterioration. Replace as required. The pad bolt torque is 9 foot-pounds.	Section 9012.

Section 1051

TORQUE CHART

CASE CORPORATION

Burl. Form 9-73495 April 1974

PRINTED IN U.S.A.

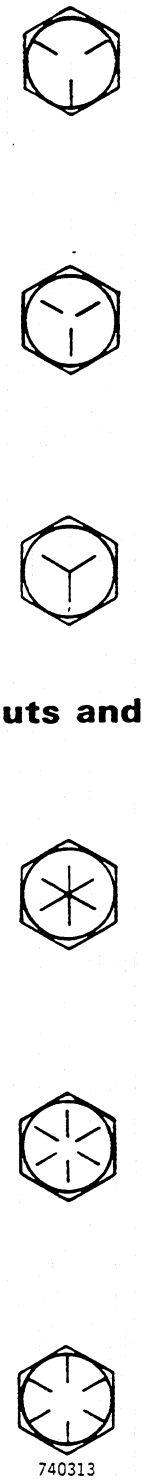
U.S. AND METRIC TORQUE SPECIFICATIONS

Grade 5 Bolts, Nuts and Studs (Dry Threads)

Thread size	Ft-lbs	N m	Thread size	Ft-lbs	N m
1/4"-20 NC	5-10	7-13	3/4"-10 NC	235-285	319-386
1/4"-28 NF	10-15	13-20	3/4"-16 NF	270-330	366-447
5/16"-18 NC	15-20	20-27	7/8"-9 NC	360-440	488-597
5/16"-24 NF	15-20	20-27	7/8"-14 NF	395-490	536-664
3/8"-16 NC	25-35	34-47	1"-8 NC	520-640	705-867
3/8"-24 NF	30-40	41-54	1"-12 NF	575-705	780-955
7/16"-14 NC	45-55	61-74	1-1/8"-7 NC	720-820	976-1111
7/16"-20 NF	50-60	68-81	1-1/8"-12 NF	790-970	1071-1315
1/2"-13 NC	65-85	88-115	1-1/4"-7 NC	1010-1240	1370-1681
1/2"-20 NF	80-100	109-135	1-1/4"-12 NF	1115-1365	1512-1850
9/16"-12 NC	100-120	135-163	1-3/8"-6 NC	1315-1610	1783-2182
9/16"-18 NF	110-130	149-176	1-3/8"-12 NF	1510-1850	2047-2508
5/8"-11 NC	135-165	183-223	1-1/2"-6 NC	1745-2135	2366-2894
5/8"-18 NF	160-200	216-271	1-1/2"-12 NF	1880-2420	2549-3281

Grade 8 Bolts, Nuts and Studs (Dry Threads)

Thread size	Ft-lbs	N m	Thread size	Ft-lbs	N m
1/4"-20 NC	10-15	13-20	3/4"-10 NC	340-420	461-569
1/4"-28 NF	15-20	20-27	3/4"-16 NF	380-460	515-623
5/16"-18 NC	20-30	27-40	7/8"-9 NC	540-660	732-894
5/16"-24 NF	25-30	34-40	7/8"-14 NF	595-725	807-982
3/8"-16 NC	40-50	54-67	1"-8 NC	810-990	1098-1342
3/8"-24 NF	45-55	61-74	1"-12" NF	900-1100	1220-1491
7/16"-14 NC	60-80	82-102	1-1/8"-7 NC	1150-1400	1559-1898
7/16"-20 NF	70-90	95-122	1-1/8"-12 NF	1295-1585	1756-2148
1/2"-13 NC	100-120	136-162	1-1/4"-7 NC	1640-2000	2224-2711
1/2"-20 NF	110-130	149-176	1-1/4"-12 NF	1800-2200	2440-2982
9/16"-12 NC	135-165	183-223	1-3/8"-6 NC	2140-2620	2901-3552
9/16"-18 NF	155-190	210-257	1-3/8"-12 NF	2450-3000	3322-4067
5/8"-11 NC	200-240	271-325	1-1/2"-6 NC	2845-3475	3857-4711
5/8"-18 NF	215-265	292-359	1-1/2"-12 NF	3200-3900	4339-4880



740313

U.S. AND METRIC TORQUE SPECIFICATIONS

Hydraulic Fittings (Steel)

Dash Size	Tube O.D. Hose I.D.	Thread Size	37° Flare Torque		Straight Thread O-ring Torque	
			Ft-lbs	N m	Ft-lbs	N m
4	1/4"	7/16"-20	6-12	8-16	12-19	16-25
5	5/16"	1/2"-20	8-16	11-21	16-25	22-33
6	3/8"	9/16"-18	10-25	14-33	25-40	34-54
8	1/2"	3/4"-16	15-42	20-56	42-67	57-90
10	5/8"	7/8"-14	25-58	34-78	58-92	79-124
12	3/4"	1-1/16"-12	40-80	54-108	80-128	108-174
14	7/8"	1-3/16"-12	60-100	81-135	100-160	136-216
16	1"	1-5/16"-12	75-117	102-158	117-187	159-253
20	1-1/4"	1-5/8"-12	125-165	169-223	165-264	224-357
24	1-1/2"	1-7/8"-12	210-250	258-338	250-400	339-542

Split Flange Mounting Bolts (Grade 5, Dry Threads)

Flange Size	Thread Size	Torque	
		Ft-lbs	N m
1/2"	5/16"-18 NC	15-20	20-25
3/4"	3/8"-16 NC	20-25	26-33
1"	3/8"-16 NC	20-25	26-33
1-1/4"	7/16"-14 NC	35-45	47-61
1-1/2"	1/2"-13 NC	45-55	61-74
2"	1/2"-13 NC	55-65	74-88
2-1/2"	1/2"-13 NC	80-90	104-122
3"	5/8"-11 NC	140-150	190-203

740314

Section 2001

ENGINE DIAGNOSIS

CASE CORPORATION

Rac. 9-76365

PRINTED IN U.S.A

GENERAL INFORMATION

Before making any repairs or adjustments on an engine, a mechanic or technician must properly diagnose the trouble.

Locating the trouble and repairing it is only part of the job, a technician must find and eliminate the cause of the trouble as well. Too many repairs are made with no thought to removing the causes that made the repair necessary.

For any engine to start or perform properly, three main requirements must be present.

1. FUEL
2. COMPRESSION
3. IGNITION

When any of these requirements are not present or limited by some mechanical reason the engine will not start or fails to operate properly throughout the power range.

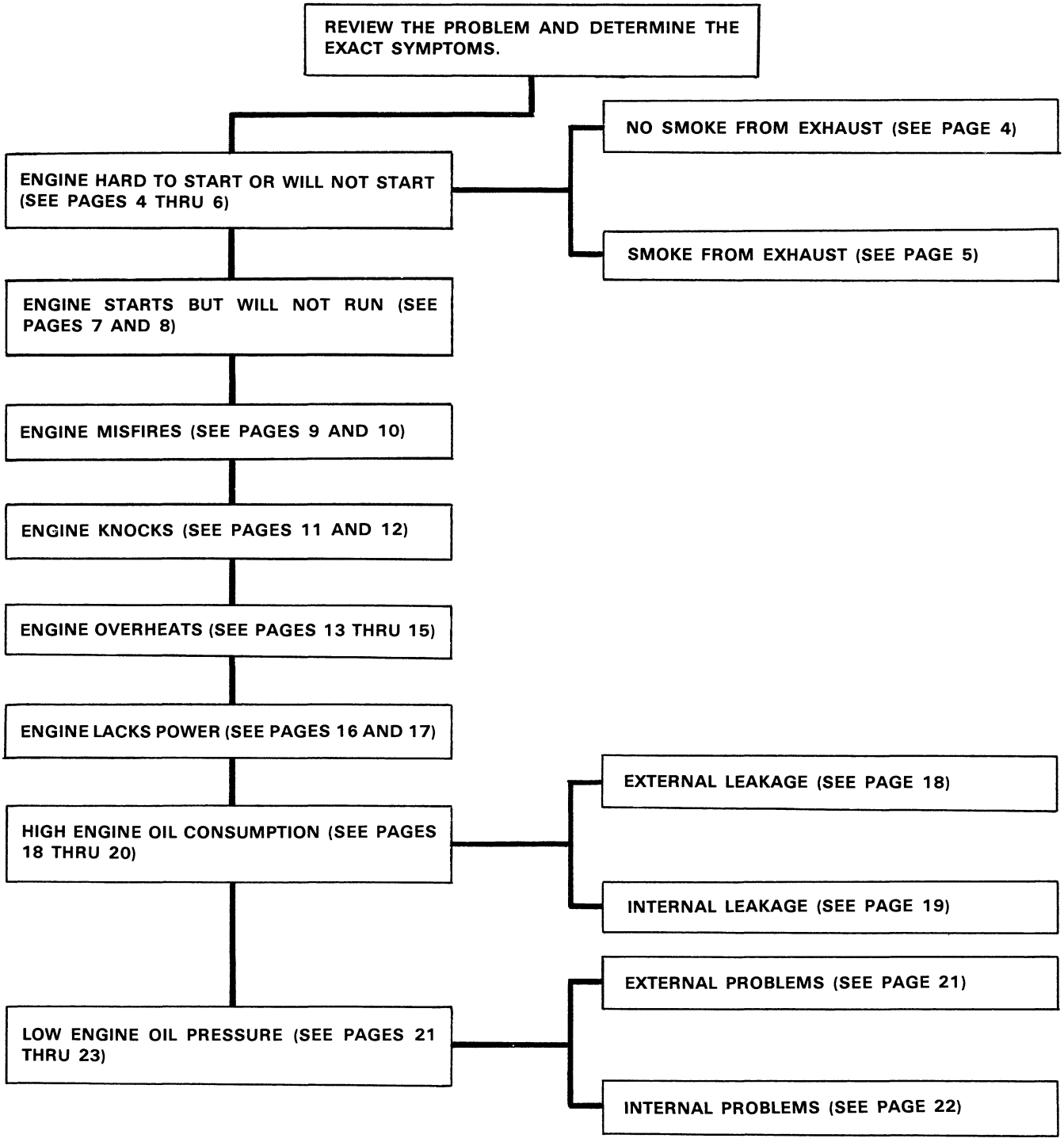
1. FUEL. Fuel system problems can be present anywhere from the fuel tank, through the filters and injection pump as well as the injectors. Correct injection pump timing is important in the overall fuel system performance.

2. COMPRESSION. Compression on an engine is related to the "breathing function". Proper compression is affected by the air cleaner condition, muffler restriction, valve condition and operation including proper valve adjustment, cylinder head gaskets condition of sleeves, rings, pistons, camshaft, and camshaft timing.

3. IGNITION. Ignition is the result of adequate compression to develop enough heat in the air charge on the compression stroke to fire the fuel being injected into the engine cylinders. Proper spray pattern and atomization of the fuel by the injector is very important. Timing the fuel injection pump to the engine to a precise degree BTDC is a vital requirement for proper ignition.

The engine diagnosis contained in the following pages covers many trouble symptoms, the causes, and what will be necessary to repair or eliminate the problem. Under each symptom are listed the most common and reoccuring problems progressively to the not so common problems. Locate your problem symptom in the diagnosis chart and refer to the pages listed for the probable causes and remedies.

ENGINE DIAGNOSIS CHART



ENGINE HARD TO START OR WILL NOT START

NO SMOKE FROM EXHAUST

1. Fuel Shut-Off Not Open Completely.

Improper cable adjustment, damaged cable, cable slipping in clamps, misadjusted or inoperative solenoid will not completely return fuel shut-off lever to open position. Check lever to be sure it is opening completely. A partially opened lever limits the amount of fuel to the injection pump and results in low engine horsepower.

2. Final Air Filter Plugged

A dirty filter will cause rich fuel mixture and low engine power. Check filter restriction indicator and service final air filter if required.

3. Slow Cranking Speed

Starter must crank engine 200 to 300 RPM in order to ignite the diesel fuel. Check engine RPM while cranking. If cranking is slow, check starter amperage draw to help determine the following defective areas: batteries, cables, solenoid, and starting motor.

Slow cranking speed can be caused by the following internal and external engine defects: scuffing and scoring of pistons and sleeves, improper crankshaft or camshaft end play, defective rod or crank bearings, oil pump, air compressor, water pump or hydraulic pump.

4. Fuel Supply Shut Off or No Fuel

Check that fuel tank shutoff valve is open. Check fuel supply in tank.

5. Air In Fuel System

Bleed fuel system until fuel flows steadily with no bubbles. Check for air leaks at fittings between tank and fuel pump.

6. Camshaft Damaged

A sheared key in the cam drive gear or a broken cam shaft will throw valve timing out of sequence affecting engine operation. Remove cylinder head cover and check valve timing in reference to crankshaft timing marks with a dial indicator.

7. Fuel Injection Nozzle Not Seated In Head.

A nozzle that is not seated in the cylinder head will let compression leak by and not produce enough heat to fire the injected fuel. Check for damaged nozzle gasket or seals, lose nozzle, or broken stud.

8. Fuel Line Plugged

A fuel line plugged with dirt will not let fuel through to the injection pump. Remove line at fuel filters and check for fuel flow through line.

9. Clogged Fuel Filter

Check and service fuel filters.

10. Wrong Fuel or Contaminated Fuel

Wrong fuel or contaminated fuel can cause the unit not to run, or to have preignition and detonation causing serious damage to the engine. Drain fuel tank and refill with correct fuel.

11. Sticking Rack Control

A sticking rack control will not let the fuel injection pump accept any fuel. Remove cap from front of injection pump to see if rack moves when throttle lever is moved.

12. Piston Rings Worn

As piston rings become worn, they lose tension and ability to seal and wipe lubrication oil off cylinder walls. Take a compression test to determine piston ring condition. If readings are low, squirt a small amount of oil into the cylinder and retest. If compression comes up because the oil helps the rings seal, it will be necessary to install new piston rings and possibly sleeve and pistons.

13. Injection Pump Malfunction

A malfunctioning injection pump will usually under-fuel the engine. Adjust or replace the injection pump.

ENGINE HARD TO START OR WILL NOT START

SMOKE FROM EXHAUST

1. Slow Cranking Speed

Starter must crank engine 200 to 300 RPM in order to ignite the diesel fuel. Check engine RPM while cranking. If cranking is slow, check starter amperage draw to help determine the following problem areas: batteries, cables, solenoid, and starting motor.

Slow cranking speed can be caused by the following internal and external engine defects: scuffing and scoring of pistons and sleeves, improper crankshaft or camshaft end play, worn rod or crank bearings, oil pump, air compressor, water pump or hydraulic pump.

2. Fuel Shut-Off Not Open Completely.

Improper cable adjustment, damaged cable, cable slipping in clamps, misadjusted or inoperative solenoid will not completely return fuel shut-off lever to open position. Check lever to be sure it is opening completely. A partially opened lever limits the amount of fuel to the injection pump and results in low engine horsepower.

3. Low Compression

Low compression on several cylinders makes the engine hard to start and also does not generate enough heat to properly fire on all cylinders and continue running. Make a compression check on the engine.

4. Final Air Filter Plugged

A dirty filter will cause rich fuel mixtures and low engine power. Check filter restriction indicator and service final air filter if required.

5. Fuel Injection Nozzles Malfunctioning

Low cracking pressure, improper spray pattern, or plugged spray orifice will affect proper combustion in engine cylinders. Remove and test the fuel injection nozzles.

6. Engine Timing Incorrect

Combustion will not occur in the cylinder at the correct moment (degrees BTDC) if the engine timing is incorrect. This can cause preignition or detonation and serious damage to the engine. Check for proper engine timing.

7. Piston Rings Worn

As piston rings become worn, they lose tension and ability to seal and wipe lubricating oil off cylinder walls. Take a compression test to determine piston ring condition. If readings are low, squirt a small amount of oil into the cylinder and retest. If compression comes up because the oil helps the rings seal, it will be necessary to install new piston rings and possibly sleeve and pistons.

8. Valve Push Rods Bent

Bent push rods will affect valve operation and not allow cylinders to get a full charge of fuel and air, or not exhaust properly. This can usually be distinquished by excessive valve tappet noise. Remove cylinder covers and check for bent push rods.

9. Clogged Fuel Filter

Check and service fuel filters.

10. Fuel Injection Nozzle Not Seated In Head

A nozzle that is not seated in the cylinder head will let compression leak by and not produce enough heat to fire the injected fuel. Check for damaged nozzle gasket or seals, lose nozzle, or broken stud.

11. Tune-up Specifications Wrong

Check engine and unit serial number plates for correct specifications when performing engine tune-up.

12. Piston and Sleeves Scuffed and Scored

Scuffing starts as a very small surface disturbance of torn out metal particle. This helps break down lubrication which increases heat and spreads the scuffing to adjacent areas. Scuffing and scoring are caused by malfunctioning of the lubrication system or cooling system, incorrect timing, detonation, preignition, lugging or overloading, improperly fitted parts, and improper break-in procedure. Remove piston assemblies and inspect.

ENGINE HARD TO START OR WILL NOT START

SMOKE FROM EXHAUST (Cont'd)

13. Cylinder Head Gasket Blown

A blown cylinder head gasket will cause one or two cylinders to lose power and cause an engine miss. It can also cause cooling system pressure to rise and blow engine coolant out the radiator overflow. Take a compression test to help determine a defective head gasket or, remove thermostats and fan belts, run engine, and check for gas bubbles rising in coolant in the water manifold.

14. Piston Ring Installation Faulty or Broken Rings

Many times piston rings are installed wrong, upside down, wrong size, or expanders are cut-off on three piece oil rings and overlapping the expander. Be sure to carefully read instructions before installing piston rings. Damaged rings can cause scoring of the pistons and sleeves and cause the engine to use oil.

15. Valves sticking

Sticking valves can be caused by improper replacement of valve guides, no lubrication, rust vapors, bent valves, or carbon. A sticking valve will cause an engine miss and the valve could also hit the piston causing internal damage.

16. Wrong Fuel or Contaminated Fuel

Wrong fuel or contaminated fuel can cause the unit not to run or to have preignition and detonation causing serious damage to the engine. Drain fuel tank and refill with correct fuel.

17. Injection Pump Malfunction

A malfunctioning injection pump will usually under-fuel the engine. Adjust or replace the injection pump.

18. Fuel Injection Line Cracked.

A cracked, chaffed or damaged fuel injector line will allow the fuel to escape externally and not inject fuel into the cylinder. This will cause an engine miss and low horsepower. Leaking fuel from a damaged injector line can easily be seen.

ENGINE STARTS BUT WILL NOT RUN

1. Fuel Shut-Off Not Open Completely

Improper cable adjustment, damaged cable, cable slipping in clamps, misadjusted or inoperative solenoid will not completely return fuel shut-off lever to open position. Check lever to be sure it is opening completely. A partially opened lever limits the amount of fuel to the injection pump and results in low engine horsepower.

2. Final Air Filter Plugged

A dirty filter will cause rich fuel mixtures and low engine power. Check filter restriction indicator and service final air filter if required.

3. Air In Fuel System

Bleed fuel system until fuel flows steady with no air bubbles. Check for air leaks at fittings between fuel tank and injection pump.

4. Low Fuel Supply

Check fuel supply in tank and refill if necessary.

5. Injection Pump Rack Control Sticking

A sticking rack control will not allow the fuel injection pump to accept any fuel. Remove cap from front of pump and check that rack moves when throttle lever is moved.

6. Low Compression

Low compression on several cylinders makes the engine hard to start and also does not generate enough heat to properly fire on all cylinders and continue running. Make a compression check on the engine.

7. Valve Push Rods Bent

Bent push rods will affect valve operation and not allow cylinders to get a full charge of fuel and air, or not exhaust properly. This can usually be distinguished by excessive valve tappet noise. Remove cylinder covers and check for bent push rods.

8. Camshaft Damaged

A sheared key in the cam drive gear or a broken camshaft will throw valve timing out of sequence, affecting engine operation. Remove cylinder cover and check valve timing in reference to crankshaft timing marks with a dial indicator.

9. Wrong Fuel or Contaminated Fuel

Wrong fuel or contaminated fuel can cause the unit not to run or to have preignition and detonation causing serious damage to the engine. Drain fuel tank and refill with correct fuel.

10. Clogged Fuel Filter

Check and service fuel filters.

11. Fuel Injection Nozzles Malfunctioning

Low cracking pressure, improper spray pattern, or plugged spray orifice will affect proper combustion in engine cylinders. Remove and test the fuel injection nozzles.

12. Cylinder Head Gasket Blown

A blown cylinder head gasket will cause one or two cylinders to lose power and cause an engine miss. It can also cause cooling system pressure to rise and blow engine coolant out the radiator overflow. Take a compression test to help determine a defective head gasket or, remove thermostats and fan belts, run engine, and check for gas bubbles rising in coolant in the water manifold.

13. Piston Rings Worn

As piston rings become worn, they lose tension and ability to seal and wipe lubricating oil off cylinder walls. Take a compression test to determine piston ring condition. If readings are low, squirt a small amount of oil into the cylinder and retest. If compression comes up because the oil helps the rings seal, it will be necessary to install new piston rings and possibly sleeve and pistons.

ENGINE STARTS BUT WILL NOT RUN (Cont'd)

14. Valves Sticking

Sticking valves can be caused by improper replacement of valve guides, no lubrication, rust vapors, bent valves, or carbon. A sticking valve will cause an engine miss and the valve could also hit the piston causing internal damage.

15. Injection Pump Malfunction

A malfunctioning injection pump will usually under-fuel the engine. Adjust or replace the injection pump.

16. Fuel Injector Line Cracked

A cracked, chaffed or damaged fuel injector line will allow the fuel to escape externally and not inject fuel into the cylinder. This will cause an engine miss and low horsepower. Leaking fuel from a damaged injector line can easily be seen.

17. Injection Pump Timing Incorrect

A fuel injection pump timed at wrong degrees, wrong stroke, or marks moved on pulley, will inject fuel into the cylinders at the wrong time, causing rough running, detonation, preignition, low horsepower and other damage to the engine. Check for proper pump timing.

ENGINE MISFIRES

LOW AND HIGH RPM

1. Wrong Fuel or Contaminated Fuel

Wrong fuel or contaminated fuel can cause the unit not to run or to have preignition and detonation causing serious damage to the engine. Drain fuel tank and refill with correct fuel.

2. Valve Push Rods Bent

Bent push rods will affect valve operation and not allow cylinders to get a full charge of fuel and air, or not exhaust properly. This can usually be distinquished by excessive valve tappet noise. Remove cylinder covers and check for bent push rods.

3. Fuel Injection Nozzles Malfunctioning

Low cracking pressure, improper spray pattern or plugged orifice will affect proper combustion in engine cylinders. Isolate faulty injector nozzle and remove.

4. Fuel Injection Nozzle Not Seated in Head

A fuel injection nozzle that is not seated in the cylinder head will let compression leak by and the cylinder does not produce enough heat to fire the injected diesel fuel. A damaged nozzle gasket or seals, lose nozzle, or broken stud can cause the nozzle not to be seated correctly.

5. Cylinder Head Gasket Blown

A blown cylinder head gasket will cause one or two cylinders to lose power and cause engine miss. It can also cause cooling system pressure to rise and blow engine coolant out the radiator overflow. Take a compression test to help determine a defective head gasket or, remove thermostats and fan belts, run engine, and check for gas bubbles rising in coolant in the water manifold.

6. Low Compression

Low compression on several cylinders makes the engine hard to start and also does not generate enough heat to properly fire on all cylinders and continue running. Make a compression check on the engine.

7. Fuel Injection Line Cracked

A cracked, chaffed or damaged fuel injector line will allow fuel to escape externally and inject fuel into the cylinder. This will cause an engine miss and low horsepower. Leaking fuel from a damaged injector line can easily be seen.

8. Injection Pump Malfunction

A malfunctioning injection pump will usually under-fuel the engine. Adjust or replace the injection pump.

9. Injection Pump Timing Incorrect

A fuel injection pump timed at wrong degrees, wrong stroke, or marks moved on pulley, will inject fuel into the cylinders at the wrong time, causing rough running, detonation, preignition, low horsepower and other damage to the engine. Check for proper pump timing.

10. Intake Manifold Gasket Damaged

A damaged intake manifold gasket on a turbocharged engine can reduce the manifold pressure and cause an insufficient air-fuel mixture in the cylinders and result in low power. A leaking intake manifold gasket on multiple head engines may be caused by failure to align cylinder heads by snugging-up manifold bolts before torquing cylinder head bolts.

11. Cylinder Head or Sleeve Cracked

A cracked head or sleeve will usually let engine coolant into the engine. This will cause an engine miss or pressure rise in the cooling system depending on how bad the leak is. Low coolant level, oil level, engine missing, and blowing water out the exhaust are evidence that coolant is getting into the engine combustion chambers.

ENGINE MISFIRES

LOW AND HIGH RPM (Cont'd)

12. Valves Damaged

Damaged valves are caused by wear, improper grinding, hitting the pistons, wrong adjustment, loose seat, or broken valve spring. Defective valves can usually be heard through the intake or exhaust manifold. A low reading compression test usually indicates defective valves.

13. Valve Spring Worn (High RPM)

Weak valve springs will allow the valves to float at high speed. Broken valve springs will not close valve completely and valve could hit the piston doing internal engine damage. Always check and test valve springs when doing a valve job. Close coils on spring should be assembled against the the cylinder head.

14. Operating Temperature Low

The engine was designed for and will only develop full horsepower within its correct operating temperature range. Low operating temperature can result from a malfunctioning thermostat. Do not remove thermostat during the summer. Maintain 50% of permanent anti-freeze all year for more efficient operation.

15. Engine Preignition

Preignition is the igniting of the fuel before the normal ignition occurs. This causes wild pinging, severe knock, and power loss. High temperature and pressure from preignition usually burns a hole through the center of the piston. The following are causes of preignition:

A. Carbon deposits that remain incandescent.
B. Valves operating at higher than normal temperature because of excessive guide clearance or improper seal with valve seats.
C. Hot spots caused by an inefficient or damaged cooling system.
D. Nozzles set at wrong cracking pressure.
E. Detonation or conditions leading to it.
F. Sharp edges in combustion chamber.
G. Wrong or contaminated fuel.

16. Valves Sticking

Sticking valves can be caused by improper replacement of valve guides, no lubrication, rust vapors, bent valves, or carbon. A sticking valve will cause an engine miss and the valve could also hit the piston causing internal damage.

17. Bent Connecting Rod

A bent connecting rod will cause piston slap from scoring due to misalignment. The engine will run rough because of imcomplete combustion and emit white exhaust smoke from the bad cylinder. Remove engine oil pan and inspect connecting rods for alignment. A comparison of piston heights at Top Dead Center with cylinder heads removed may quickly indicate a bent rod condition. A difference of .020 inch in connecting rod can cause a noticeable miss at low RPM and cold engine conditions.

18. Turbo-Charger Malfunction

A malfunctioning turbo-charger will not supply the required compressed or supercharged air into the intake manifold. The engine will smoke from the rich mixture and a noticeable loss of power will result. Remove intake hose and inspect turbo for wear, lubrication, and determine if compressor wheel will turn freely.

19. Tune-up Specifications Incorrect

Check engine and unit serial number plates for correct specifications when performing engine tune-up.

20. Engine Detonation

Detonation is an explosion or uncontrolled burning of the fuel charge. This sudden release of energy will usually break piston ring lands and cause burning down the sides of the piston. Also, a power loss will be noticeable because the engine cannot absorb the sudden release of energy for even power to the crankshaft. Causes for detonation are:

A. Lean fuel mixtures.
B. Wrong fuel.
C. Timing incorrect.
D. Lugging engine.
E. Excessive carbon deposit on pistons and cylinder heads.
F. Defective injection pump.
G. Deficiencies in cooling system which offsets cylinder head cooling.

ENGINE KNOCKS

LOW AND HIGH RPM

1. Engine Timing Incorrect

Combustion will not occur in the cylinder at the correct moment (degrees BTDC) if the engine timing is incorrect. This can cause preignition or detonation and serious damage to the engine. Check for proper engine timing.

2. Flywheel Loose (Low RPM)

A loose flywheel will chuck or pound at low speed making the engine sound like it has a loose connecting rod. As speed increases, the knock will go away. Replace flywheel if badly worn.

3. Engine Preignition

Preignition is the igniting of the fuel before the normal ignition occurs. This causes wild pinging, severe knock, and power loss. High temperature and pressure from preignition usually burns a hole through the center of the piston. The following are causes of preignition:

A. Carbon deposits that remain incandescent.
B. Valves operating at higher than normal temperature because of excessive guide clearance or improper seal with valve seats.
C. Hot spots caused by an inefficient or damaged cooling system.
D. Nozzles set at wrong cracking pressure.
E. Detonation or conditions leading to it.
F. Sharp edges in combustion chamber.
G. Wrong or contaminated fuel.

4. Engine Detonation

Detonation is an explosion or uncontrolled burning of the fuel charge. This sudden release of energy will usually break piston ring lands and cause burning down the sides of the piston. Also, a power loss will be noticeable because the engine cannot absorb the sudden release of energy for even power to the crankshaft. Causes for detonation are:

A. Lean fuel mixtures.
B. Wrong fuel.
C. Timing Incorrect.
D. Lugging engine.
E. Excessive carbon deposit on pistons and cylinder heads.
F. Defective injection pump.
G. Deficiencies in cooling system which affects cylinder head cooling.

5. Rod Bearing Worn

A rod bearing going bad will have a sharp metallic sound which will increase as RPM increases. When the cylinder with the bad knock is grounded by cracking the injector line, the knock will stop or decrease considerably. Remove the engine oil pan and check rods with plastigauge.

6. Main Bearing Worn

A worn main bearing will have a thudding sound and increased engine vibration. Both symptoms will increase as engine speed increases. By grounding out (cracking injector line) the problem cylinder, the thudding sound will stop or decrease but the vibration will remain. Remove engine oil pan and check main bearing clearance with plastigauge. Also, low oil pressure can be the result of worn main bearings and excessive oil clearance.

7. Piston and Sleeves Scuffed and Scored

Scuffing starts as a very small surface disturbance of torn out metal particles. This helps break down lubrication which increases heat and spreads the scuffing to adjacent areas. Scuffing and scoring are caused by malfunctioning of the lubrication system or cooling system, incorrect timing, detonation, preignition, lugging or overloading, improperly fitted parts, and improper break-in procedure. Remove piston assemblies and inspect.

8. Piston Ring Installation Faulty or Broken Rings

Many times piston rings are installed wrong, upside down, wrong size, or expanders are cut off on three piece oil rings and overlapping the expander. Be sure to carefully read instructions before installing piston rings. Damaged rings can cause scoring of the pistons and sleeves and cause the engine to use oil.

ENGINE KNOCKS

LOW AND HIGH RPM (Cont'd)

9. Bent Connecting Rod

A bent connecting rod will cause piston slap from scoring due to misalignment. The engine will run rough because of incomplete combustion and emit white exhaust smoke from the bad cylinder. Remove engine oil pan and inspect connecting rods for alignment. A comparison of piston heights at Top Dead Center with cylinder heads removed may quickly indicate a bent rod condition. A difference of .020 inch in connecting rod can cause a noticeable miss at low RPM and cold engine conditions.

10. Valve Spring Worn

Weak valve springs will allow the valves to float at high speed. Broken valve springs will not close valve completely and valve could hit the piston doing internal engine damage. Always check and test valve springs when doing a valve job. Close coils on spring should be assembled against the cylinder head.

11. Piston Pin or Bushing Worn

Piston pin or bushing knock will increase with speed. When grounding out the cylinder (cracking injector line) the knock will be twice as bad. Due to combustion, every other revolution will keep the piston pin and bushing tight giving no knock. Remove and inspect piston assembly producing the knock.

12. Camshaft Bearing Worn

A camshaft bearing knock is not a very sharp knock. The knock will be only at one-half of crankshaft speed and will not become worse at different engine speeds. By grounding out two or more cylinders at high RPM, the knock usually decreases. Low oil pressure could result from worn bearings and excessive oil clearance from lack of replacing cam bearing at engine overhaul.

13. Crankshaft End Play Excessive

Excessive crankshaft end play will be indicated by one thudding sound when increasing RPM and one thud when decreasing RPM. Due to the angle of the teeth on crank gear and cam gear, as speed changes it pushes the crankshaft back and forth. Check crankshaft end play with a dial indicator.

14. Foreign Material In Cylinders

Foreign material such as pieces of broken valve, bolts, nuts, washers, or pieces of castings, in the cylinder will cause a noise everytime the piston comes to Top Dead Center. The noise will not change by shorting out the cylinder. Due to the metal-to-metal contact, the vibration can be felt on the side of the engine. Remove cylinder heads and inspect.

15. Cylinder Ridge Not Removed

When performing an engine overhaul and installing new rings, the cylinder ridge must be removed. If the ridge was not removed, it would cause the engine to knock on all cylinders as the top piston ring hits the ridge on every stroke. If the top ring continued to hit the ridge, it would cause ring land breakage between top and second ring, causing piston and sleeve scuffing and scoring. Remove heads and check for cylinder ridge.

16. Improper Use of Ether (Low RPM)

Spraying ether into the engine air intake without cranking the engine, will cause one or more cylinders to receive a large amount of ether due to open valves. Then, when the engine is cranked, volatile, uncontrolled explosions will occur in these cylinders breaking ring lands and damaging the piston. Be sure engine is cranking before using ether. Remove cylinder heads and inspect pistons for damage.

17. Camshaft End Play Excessive

Excessive camshaft end play will be indicated by one thudding sound when increasing engine speed and one thud when decreasing speed, but will not be as pronounced as crankshaft end play. Due to the angle of the teeth on crank gear and cam gear, as engine speed changes, it pushes and pulls the camshaft back and forth. Excessive camshaft end play can be caused by worn thrust washer, loose cam gear, or broken or missing camshaft thrust spring. Remove front timing cover and check camshaft end play with a dial indicator.

ENGINE OVERHEATS

1. Fan Belt Loose

Check fan belt for proper tension. Check that the belt is not covered with oil or worn badly and riding very deep in pulley groove. Check for pulley groove wear.

2. Low Coolant Level

Check coolant level in radiator and refill if necessary.

3. Water Pump Malfunction

Remove the radiator cap and observe the coolant to see if there is movement which indicates the water pump is pumping. Move the fan back and forth to check for any defective bearings. Check around the water pump for any signs of coolant leakage indicating a bad water pump seal. Remove water pump and rebuild or replace.

4. Thermostat Inoperative

If there is high coolant temperature and boiling coolant, remove thermostats and test them.

5. Engine Timing Incorrect

Combustion will not occur in the cylinder at the correct moment (degrees BTDC) if the engine timing is incorrect. This can cause preignition or detonation and serious damage to the engine. Check for proper engine timing.

6. Tractor Mechanical Drag

A mechanical drag on a unit can cause low horsepower and engine overheating. Causes of some mechanical drags are defective brakes, bad bearings, or gears in transmission.

7. Radiator Cap Inoperative

Test radiator cap to see that it relieves at the correct pressure. Inspect cap gasket for proper sealing. An inoperative cap can cause water pump cavitation and lower coolant boiling points.

8. Radiator Fins Bent

Bent or damaged fins can cause a cooling system to overheat because of restricted air flow through the radiator core. All of the fin area is needed to dissipate the engine heat from the radiator.

9. Radiator Fins Plugged With Dirt

Radiator fins must be clean so air can flow through the radiator fins and help dissipate the heat of the coolant. Items that affect radiator cooling are: oil and grease on fins, leaves, and attachments covering radiator air inlet.

10. Cylinder Head Gasket Blown

A blown cylinder head gasket will cause one or two cylinders to loose power and cause an engine miss. It can also cause cooling system pressure to rise and blow engine coolant out the radiator overflow. Take a compression test to help determine a defective head gasket or, remove thermostats and fan belts, run engine, and check for gas bubbles rising in coolant in the water manifold.

11. Injection Pump Malfunction

A malfunctioning injection pump will usually under-fuel the engine. Adjust or replace the injection pump.

12. Radiator Baffling Missing

The removal of or non-reinstalling of radiator baffling, whether foam rubber or sheet metal, will cause cooling air flow to escape around the radiator instead of drawing in cool external air through the radiator.

13. Engine Low On Oil

An engine low on oil could loose lubrication to internal parts and start scoring pistons, sleeves and damage engine bearings. Proper oil level is required to help dissipate some of the engine heat. Check engine oil level every eight hours of operation. Low engine oil can also give low oil pressure readings.

14. Wrong Fuel or Contaminated Fuel

Wrong fuel or contaminated fuel can cause the unit not to run or to have preignition and detonation causing serious damage to the engine. Drain fuel tank and refill with correct fuel.

ENGINE OVERHEATS (Cont'd)

15. Piston and Sleeves Scuffed and Scored

Scuffing starts as a very small surface disturbance of torn out metal particles. This helps break down lubrication which increases heat and spreads the scuffing to adjacent areas. Scuffing and scoring are caused by malfunctioning of the lubrication system or cooling system, incorrect timing, detonation, preignition, lugging or overloading, improperly fitted parts, and improper break-in procedure. Remove piston assemblies and inspect.

16. Water Pump Hose Worn

Water pump hoses can become worn from age and collapsing, cracking, chaffing against something or fan belts cutting through them. Inspect hoses for coolant leaks.

17. Bad Ground on Gauge or Sending Unit

A bad ground on gauges or sending units can many times be the only problem with a defective gauge. Take a jump wire and ground gauge or sending unit to machine, then recheck gauge. Pipe tape is often used to seal threads on oil sending units which destroys the biggest share of its grounding ability.

18. Cylinder Head or Sleeve Cracked

A cracked cylinder head or sleeve will usually allow engine coolant into the engine, causing engine miss or pressure rise in the cooling system depending upon how bad the leak is. Coolant level low, oil level check, engine missing when first started, and water blowing out the exhaust are indications that coolant is getting into the engine combustion chambers.

19. Lack of Anti-Freeze

To illustrate the importance of having antifreeze in the cooling system year around, consider the following. Any ethylene glycol antifreeze with a 50% mixture and a 7 PSI cap will raise the coolant boiling point to 242 degrees. A 70% mixture will raise the boiling point to 253 degrees. With just water in the above cooling system, it would boil at 233 degrees.

20. Cylinder Sleeve O-Ring Damaged

A pinched, rolled, nicked, or hard sleeve O-ring can cause a coolant leak in the crankcase, contaminating the engine oil. This coolant leaking can go undetected for sometime causing engine heating and crankshaft damage. Remove engine oil pan and observe bottom of sleeves to detect slow coolant leak.

21. Radiator Leaking Externally

Inspect and repair or replace leaking radiator.

22. Tune-up Specifications Wrong

Check engine and unit serial number plates for correct specifications when performing engine tune-up.

23. Engine Detonation

Detonation is an explosion or uncontrolled burning of the fuel charge. This sudden release of energy will usually break piston ring lands and cause burning down the sides of the piston. Also, a power loss will be noticeable because the engine coolant absorb the sudden release of energy for even power to the crankshaft. Causes for detonation are:

A. Lean fuel mixtures.
B. Wrong fuel
C. Timing incorrect
D. Lugging engine.
E. Excessive carbon deposit on pistons and cylinder heads.
F. Defective injection pump.
G. Deficiencies in cooling system which affects cylinder head cooling.

ENGINE OVERHEATS (Cont'd)

24. Engine Preignition

Preignition is the igniting of the fuel before the normal ignition occurs. This causes wild pinging, severe knock, and power loss. High temperature and pressure from preignition usually burns a hole through the center of the piston. The following are causes of preignition:

A. Carbon deposits that remain incandescent.
B. Valves operating at higher than normal temperature because of excessive guide clearance or improper seal with valve seats.
C. Hot spots caused by an inefficient or damaged cooling system.
D. Nozzles set at wrong cracking pressure.
E. Detonation or conditions leading to it.
F. Sharp edges in combustion chamber.
G. Wrong or contaminated fuel.

25. Water Temperature Gauge Malfunction

The water temperature gauge, wiring, resistor or sending bulb could give false or no temperature readings. To diagnose, remove wire at sending unit and ground to tractor. Turn key switch on, if gauge comes up, sending unit is malfunctioning. If gauge does not come up, use voltmeter and ohmeter to check wiring circuit.

ENGINE LACKS POWER

1. Fuel Shut-Off Not Open Completely

Improper cable adjustment, damaged cable, cable slipping in clamps, misadjusted or inoperative solenoid will not completely return fuel shut-off lever to open position. Check lever to be sure it is opening completely. A partially opened lever limits the amount of fuel to the injection pump and results in low engine horsepower.

2. Low Engine RPM

Check engine for correct RPM.

3. Tractor Mechanical Drag

A mechanical drag on a unit can cause low horsepower and engine overheating. Causes of some mechanical drags are damaged brakes, bad bearings, or gears in transmission.

4. Final Air Filter Plugged

A dirty filter will cause rich fuel mixtures and low engine power. Check filter restriction indicator and service final air filter if required.

5. Wrong Fuel or Contaminated Fuel

Wrong fuel or contaminated fuel can cause the unit not to run or to have preignition and detonation causing serious damage to the engine. Drain fuel tank and refill with correct fuel.

6. Operating Temperature Low

The engine was designed for and will only develop full horsepower within a specific temperature range. Low temperature can result from defective thermostats. Do not remove thermostats during summer. Maintain 50% of permanent anti-freeze all year for more efficient operation.

7. Engine Timing Incorrect

Combustion will not occur in the cylinder at the correct moment (degrees BTDC) if the engine timing is incorrect. This can cause preignition or detonation and serious damage to the engine. Check for proper engine timing.

8. Low Compression

Low compression on several cylinders makes the engine hard to start and also does not generate enough heat to properly fire on all cylinders and continue running. Make a compression check on the engine.

9. Turbo-Charger Malfunction

A malfunctioning turbo-charger will not supply the required compressed or super-charged air into the intake manifold. The engine will smoke from the rich fuel mixture and a noticeable loss of power will result. Remove intake hose and inspect turbo for wear, lubrication and wheel turning freely.

10. Fuel Injection Nozzles Malfunctioning

Low cracking pressure, improper spray pattern, or plugged spray orifice will affect proper combustion in engine cylinders. Remove and test the fuel injection nozzles.

11. Clogged Fuel Filter

Check and service fuel filters.

12. Air In Fuel System

Bleed fuel system until fuel flows steady with no air bubbles. Check for air leaks at fittings between fuel tank and injection pump.

13. Camshaft Timed Wrong

A camshaft can be installed one tooth out of time making all valves operate out of normal timing sequence in relation to the crankshaft. This would not allow the engine to develop full power or run smoothly. Valves could hit the pistons causing internal damage.

14. Crankcase Too Full of Oil

An over-full or completely full crankcase can cause a loss of power because the crankshaft is trying to turn in the extra high oil level. High oil level can be caused by coolant or fuel leakage into the crankcase, extra engine oil, or oil transferred from an adjoining compartment.