

# 688C Excavator

## Table of Contents

| DIVISION/SECTION  | SECTION NO. | FORM-NO |
|---|-------------|---------|
| <b>1 GENERAL</b>  |             |         |
| Sectional Index   |             | 7-32410 |
| Safety, General Information and Torque Specifications.....        | 1001 *      | 8-86530 |
| Specifications.....   | 1002        | 7-32351 |
| <b>2 ENGINE</b>   |             |         |
| Sectional Index   |             | 7-32420 |
| Engine Removal and Installation.....                              | 2000        | 8-89000 |
| Radiator and Oil Cooler.....                                      | 2001        | 8-89010 |
| Specifications Details.....                                       | 2402        | 8-24163 |
| Cylinder Head and Valve Train.....                                | 2415        | 8-24173 |
| Cylinder Block.....   | 2425        | 8-24183 |
| Lubrication System.....   | 2445        | 8-24193 |
| Cooling System.....   | 2455        | 8-24203 |
| Turbocharger.....   | 2465        | 8-25550 |
| Turbocharger Failure Analysis.....                                | 2565        | 9-78235 |
| <b>3 FUEL SYSTEM</b>  |             |         |
| Sectional Index   |             | 7-32430 |
| Fuel System and Filters.....                                      | 3410        | 8-24212 |
| Fuel Injection Pump and Drive Gear.....                           | 3412        | 8-27080 |
| Fuel Injectors.....   | 3413        | 8-24233 |
| <b>4 ELECTRICAL</b>   |             |         |
| Sectional Index   |             | 7-32440 |
| Electrical Schematics and Troubleshooting.....                    | 4001 *      | 8-89021 |
| Battery Testing, Maintenance and Booster Battery Connections..... | 4002        | 7-32080 |
| Starter Motor.....  | 4003        | 8-89040 |
| Alternator.....   | 4004        | 8-89050 |
| <b>5 TRACK</b>  |             |         |
| Sectional Index   |             | 7-32470 |
| Tracks, Rollers and Idlers.....                                   | 5002        | 7-32130 |
| Track Troubleshooting.....  | 5502        | 7-33730 |
| <b>6 POWER TRAIN</b>  |             |         |
| Sectional Index   |             | 7-32450 |
| Drive Motor and Final Drive Transmission.....                     | 6002        | 7-32290 |
| Swing Motor and Reduction Gears.....                              | 6003        | 7-32230 |

\* Schematic Set Sections

THIS TABLE OF CONTENTS REPLACES LEP 8-88992

| DIVISION/SECTION                          | SECTION NO. | FORM-NO |
|---|-------------|---------|
| <b>8 HYDRAULICS</b>                       |             |         |
| Sectional Index                           |             | 7-32461 |
| Hydraulic Troubleshooting.....            | 8001 *      | 8-89093 |
| Low Pressure Pump.....                    | 8002        | 8-89100 |
| High Pressure Pump and Regulator.....     | 8003        | 8-89110 |
| Attachment Valve Bank.....                | 8004        | 8-89130 |
| Drive Control Valve.....                  | 8005        | 7-32120 |
| Option Control Valve.....                 | 8006        | 7-32150 |
| Counter Rotation Valve.....               | 8007        | 8-89150 |
| Swing Brake Release Valve.....            | 8008        | 7-32170 |
| Swing Control Valve.....                  | 8009        | 7-32250 |
| Anti-surge Valve.....                     | 8010        | 8-89160 |
| Hydraulic Swivel.....                     | 8011        | 7-32110 |
| Drive Speed Limiter.....                  | 8012        | 8-89200 |
| Drive Brake Release Valve.....            | 8013        | 7-32190 |
| Hand and Foot Control Valve.....          | 8015        | 8-89170 |
| Hydraulic Oil Tank.....                   | 8016        | 8-89080 |
| Attachment Cylinders.....                 | 8018        | 7-33600 |
| Hydraulic Pick Hammer Control Valve.....  | 8222        | 7-34230 |
| <b>9 MOUNTED EQUIPMENT</b>                |             |         |
| Sectional Index                           |             | 7-32471 |
| Upperstructure and Turntable Bearing..... | 9001        | 8-89140 |
| Boom, Dipper and Bucket.....              | 9002        | 7-32620 |
| Servicing the Cab.....                    | 9004        | 7-32060 |

\* Schematic Set Sections

## Sectional Index

|   | SECTION NO. |
|---|-------------|
| <b>1 GENERAL</b>                                    |             |
| <b>C Capacities</b> .....                           | 1002        |
| <b>D Dimensions</b> .....                           | 1002        |
| Drawbar Pull .....                                  | 1002        |
| Drive Speed .....                                   | 1002        |
| <b>E Electrical System Specifications</b> .....     | 1002        |
| Engine Cooling System Specifications .....          | 1002        |
| Engine Lubricant Specifications .....               | 1002        |
| Engine Lubricating System Specifications .....      | 1002        |
| Engine Special Torques .....                        | 1002        |
| Engine Specifications .....                         | 1002        |
| <b>F Fluids and Lubricants Specifications</b> ..... | 1002        |
| Fuel Specifications .....                           | 1002        |
| Fuel System Specifications .....                    | 1002        |
| <b>G General Dimensions</b> .....                   | 1002        |
| General Information .....                           | 1001        |
| <b>H Hydraulic Systems Specifications</b> .....     | 1002        |
| <b>R Run-in Instructions</b> .....                  | 1002        |
| <b>S Safety Warnings</b> .....                      | 1001        |
| <b>T Torque Data</b>                                |             |
| Engine Special Torques .....                        | 1002        |
| Hydraulic Fittings Special Torques .....            | 1001        |
| Standard Nut and Bolt Torques .....                 | 1001        |
| Track, Rollers and Idlers Specifications .....      | 1002        |
| Transport Dimensions .....                          | 1002        |
| <b>W Weights</b> .....                              | 1002        |



**Thanks very much for your reading,  
Want to get more information,  
Please click here, Then get the complete  
manual**

**JustClickHere** 

**NOTE:**

**If there is no response to click on the link above,  
please download the PDF document first, and then  
click on it.**

**Have any questions please write to me:  
[admin@servicemanualperfect.com](mailto:admin@servicemanualperfect.com)**

## Sectional Index

|          |  | SECTION NO. |
|----------|--|-------------|
| <b>2</b> | <b>ENGINE</b>                            |             |
| <b>B</b> | Bearings .....                           | 2425        |
|          | Belt Tensioner .....                     | 2455        |
| <b>C</b> | Camshaft .....                           | 2425        |
|          | Cooling System (Engine)                  |             |
|          | Air Removal .....                        | 2001        |
|          | Cleaning and Maintenance .....           | 2455        |
|          | Radiator .....                           | 2001        |
|          | Specifications .....                     | 2001        |
|          | Cooling System (Hydraulic Oil)           |             |
|          | Oil Cooler .....                         | 2001        |
|          | Crankcase Pressure Check (Blow By) ..... | 2425        |
|          | Crankshaft .....                         | 2425        |
|          | Cylinder Block .....                     | 2425        |
|          | Cylinder Head .....                      | 2415        |
| <b>E</b> | Engine                                   |             |
|          | Installation .....                       | 2000        |
|          | Removal .....                            | 2000        |
|          | Engine to Pump Drive Assembly .....      | 2000        |
|          | Expansion Plug Replacement               |             |
|          | Cylinder Block .....                     | 2425        |
|          | Cylinder Head .....                      | 2415        |
| <b>F</b> | Fan Pulley .....                         | 2455        |
|          | Flywheel .....                           | 2425        |
| <b>L</b> | Lubrication System .....                 | 2445        |
| <b>O</b> | Oil Cooler (Engine Oil) .....            | 2445        |
|          | Oil Cooler (Hydraulic Oil) .....         | 2001        |
|          | Oil Filter Housing .....                 | 2445        |
|          | Oil Pan .....                            | 2445        |
|          | Oil Pressure Relief Valve .....          | 2445        |
|          | Oil Pump .....                           | 2445        |
|          | Oil Seals .....                          | 2425        |
| <b>P</b> | Pistons .....                            | 2425        |
| <b>R</b> | Radiator .....                           | 2001        |
|          | Rocker Arms .....                        | 2415        |
|          | Rods .....                               | 2425        |
| <b>S</b> | Sleeves .....                            | 2425        |

SECTION NO.

|   |                                       |      |
|---|---------------------------------------|------|
| T | Thermostat .....                      | 2455 |
|   | Top Dead Centre (How to Locate) ..... | 2415 |
|   | Turbocharger .....                    | 2465 |
|   | Turbocharger Failure Analysis .....   | 2565 |
| V | Valve Guide Replacement .....         | 2415 |
|   | Valves                                |      |
|   | Intake and Exhaust .....              | 2415 |
|   | Dye Pattern Analysis .....            | 2415 |
|   | Valve Seats .....                     | 2415 |
|   | Valve Train .....                     | 2415 |
| W | Water Pump .....                      | 2455 |

# Section 1002

1002

## SPECIFICATIONS

For 688 Crawler Excavators

DON 7-32351 REPLACES DON 7-32350

J I Case

Don 7-32351

Printed in England  
May 1990



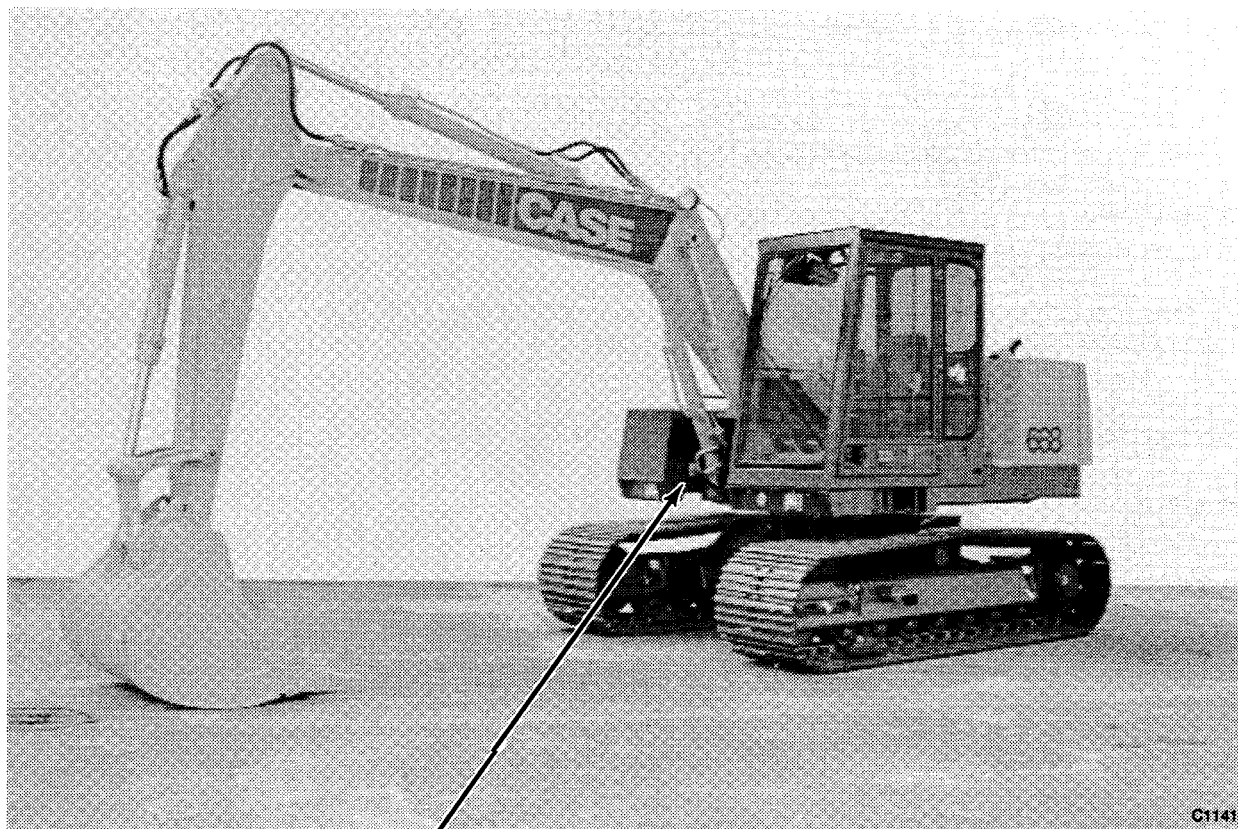
## TABLE OF CONTENTS

|  |           |
|--|-----------|
| MODEL AND PIN NUMBER .....   | 3         |
| <b>GENERAL SPECIFICATIONS</b>  |           |
| Capacities .....   | 4         |
| Drawbar Pull .....   | 4         |
| Drive Speed .....  | 4         |
| Electrical System .....  | 4         |
| Fluids and Lubricants .....  | 5         |
| Fuel .....   | 5         |
| Hydraulic System .....   | 6         |
| Tracks, Rollers and Idlers .....   | 7         |
| Weights .....  | 7         |
| <b>ENGINE SPECIFICATIONS</b>   |           |
| <b>IMPORTANT:</b> <i>This engine was made using the metric measurement system. All measurements and checks must be made with metric tools to make sure of an accurate reading when inspecting parts.</i> |           |
| Run-In Instructions .....  | 8         |
| Engine Cooling System .....  | 9         |
| Engine Lubrication .....   | 9         |
| General Engine Specifications  |           |
| General .....  | 10        |
| Pistons and Connecting Rods .....  | 10        |
| Main Bearings .....  | 10        |
| Engine Lubricating System .....  | 10        |
| Fuel System .....  | 11        |
| Detailed Engine Specifications   |           |
| Cylinder Block .....   | 12        |
| Service Cylinder Sleeves .....   | 12        |
| Pistons .....  | 12        |
| Piston Pins .....  | 12        |
| Piston Rings .....   | 13        |
| Cylinder Head .....  | 13        |
| Lifters .....  | 13        |
| Connecting Rods .....  | 13        |
| Crankshaft .....   | 14        |
| Camshaft .....   | 15        |
| Turbocharger .....   | 15        |
| Gear Train .....   | 15        |
| Rocker Arm Assembly .....  | 15        |
| Intake Valves .....  | 16        |
| Exhaust Valves .....   | 16        |
| Valve Springs .....  | 16        |
| Special Torques .....  | 17        |
| <b>GENERAL DIMENSIONS</b> .....  | <b>20</b> |
| <b>TRANSPORT DIMENSIONS</b> .....  | <b>21</b> |

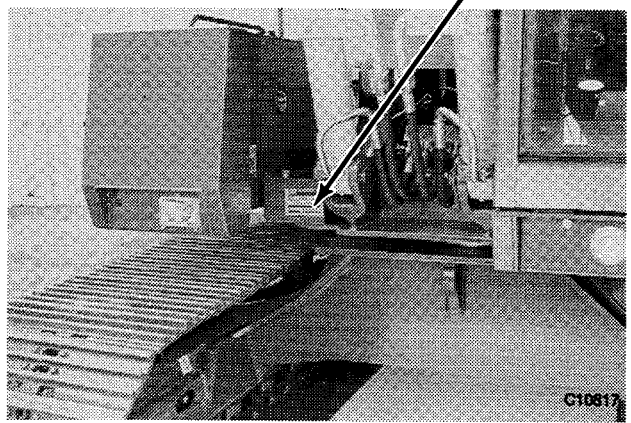
# MODEL AND PIN NUMBERS

When ordering parts or when requesting information or assistance, always give the identification numbers of your machine.

Write the model and PIN numbers of your machine on the lines below.



C11414



C10617

Machine Model Number \_\_\_\_\_

Machine PIN Number \_\_\_\_\_

Engine Serial Number \_\_\_\_\_

High Pressure Pump Serial Number \_\_\_\_\_

Low Pressure Pump Serial Number \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Final Drive Serial Number:

Right Hand Side \_\_\_\_\_

Left Hand Side \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## GENERAL SPECIFICATIONS

### Capacities

|   |             |                 |
|---|-------------|-----------------|
| Engine Oil Capacity (with filter change) .....      | 10.5 litres | 2.77 US gallons |
| Engine Cooling System (with cab heater) .....       | 14 litres   | 3.7 US gallons  |
| Fuel Tank .....                                     | 247 litres  | 65 US gallons   |
| Hydraulic Oil Tank Capacity .....                   | 100 litres  | 26.3 US gallons |
| Total Hydraulic System Capacity .....               | 155 litres  | 40.9 US gallons |
| Final Drive Transmission Capacity (each side) ..... | 1.5 litres  | 1.6 US quarts   |
| Swing Reduction Gear Capacity .....                 | 3.5 litres  | 3.7 US quarts   |
| Track Front Idlers .....                            | 0.25 litres | 0.26 US quarts  |
| Track Lower Rollers .....                           | 0.26 litres | 0.28 US quarts  |

**NOTE:** These capacities are only a guide to the quantities. Always use the dipstick, sight gauge or level plug to make sure that fluid levels are correct.

### Drawbar Pull

|                    |          |          |
|--------------------|----------|----------|
| Drawbar Pull ..... | 101080 N | 22725 lb |
|--------------------|----------|----------|

### Drive Speed

|                   |         |          |
|-------------------|---------|----------|
| Drive Speed ..... | 3.5 kph | 2.17 mph |
|-------------------|---------|----------|

### Electrical System

|                      |                           |
|----------------------|---------------------------|
| Type of System ..... | 24 volts, negative ground |
|----------------------|---------------------------|

#### Alternator

|                                    |                        |
|------------------------------------|------------------------|
| Manufacturer .....                 | Bosch                  |
| Output .....                       | 28 volts at 45 amperes |
| Resistance of rotor winding .....  | 9.0 ohms               |
| Resistance of stator winding ..... | 0.22 ohms              |
| Minimum brush length .....         | 14 mm (0.55 inch)      |

#### Batteries

|   |             |
|---|-------------|
| Number of batteries required .....          | 2           |
| Voltage of each battery .....               | 12 volts    |
| Reserve capacity .....                      | 160 minutes |
| Cold cranking capacity at -17°C (0°F) ..... | 800 amperes |
| Load for capacity (load) test .....         | 400 amperes |

#### Starter Motor

|                             |                                     |
|-----------------------------|-------------------------------------|
| Manufacturer .....          | Bosch                               |
| No load test at 27°C (80°F) |                                     |
| volts .....                 | 23 volts                            |
| current draw .....          | 85 amperes maximum                  |
| armature speed .....        | 7000 rpm minimum                    |
| Brush length .....          | 8.5 mm (0.3125 inch) minimum        |
| Armature run-out .....      | 0.03 mm (0.001 inch) maximum        |
| Commutator diameter .....   | 42.5 mm (1.74 inch) minimum         |
| Armature end play .....     | 0.05 to 0.4 mm (0.002 to 0.15 inch) |

## Hydraulic System

### Low Pressure Pump

Comprises one body with a fixed flow for the servo-steering hydraulic circuits,

|                                 |          |            |
|---------------------------------|----------|------------|
| Maximum flow at 2000 rpm: ..... | 24 l/min | 6.3 US gpm |
| Operating pressure .....        | 28 Bar   | 406 psi    |

### Flow Setting Times

|                 |                    |
|-----------------|--------------------|
| Boom Up .....   | 3.3 to 3.5 seconds |
| Dipper In ..... | 4.7 to 4.9 seconds |
| Bucket In ..... | 3.3 to 3.5 seconds |

### Flow Setting Valve Rates (cylinder large chamber):

|   |                  |                     |
|---|------------------|---------------------|
| Boom raising .....                                | 148 to 155 l/min | 36.7 to 38.4 US gpm |
| Boom lowering .....                               | 28 to 45 l/min   | 6.9 to 11.1 US gpm  |
| Bucket opening .....                              | 75 to 100 l/min  | 18.6 to 24.8 US gpm |
| Bucket closing .....                              | 95 to 105 l/min  | 23.5 to 26 US gpm   |
| Dipper extension .....                            | 110 to 125 l/min | 27.2 to 31 US gpm   |
| Dipper retraction .....                           | 122 to 130 l/min | 30.2 to 32.2 US gpm |
| Right-hand travel in forward drive .....          | 88 to 95 l/min   | 23.2 to 25 US gpm   |
| Left-hand travel in forward drive .....           | 88 to 95 l/min   | 23.2 to 25 US gpm   |
| Right and left-hand travel in forward drive ..... | 176 to 190 l/min | 46.5 to 50.1 US gpm |
| Offset backhoe .....                              | 25 to 35 l/min   | 6.6 to 9.2 US gpm   |

|                                      |      |       |
|--------------------------------------|------|-------|
| Hydraulic Oil Test Temperature ..... | 50°C | 120°F |
|--------------------------------------|------|-------|

### Pressure Settings

|  |                |                  |
|--|----------------|------------------|
| Attachment Flow Cut-off Valve (LS1) .....                        | 360 to 370 Bar | 5221 to 5366 psi |
| Attachment Valve Bank Main Relief Valve .....                    | 435 to 445 Bar | 6309 to 6454 psi |
| Regulator  |                |                  |
| Torque Regulator Valve,  |                |                  |
| 97 l/min (25.6 US gpm) engine speed 2020 rpm at a pressure of .. | 275 Bar        | 3988 psi         |
| Load Sensing Valve (LS) .....                                    | 18 to 20 bar   | 261 to 290 psi   |
| Travel Flow Cut-off Valve (LS2) .....                            | 405 to 415 Bar | 5874 to 6019 psi |

### Circuit Relief Valves:

|   |                |                  |
|---|----------------|------------------|
| Boom : raising .....                        | 380 to 405 Bar | 5511 to 5874 psi |
| Boom : lowering .....                       | 400 to 435 Bar | 5801 to 6309 psi |
| Bucket : opening, closing .....             | 380 to 405 Bar | 5511 to 5874 psi |
| Dipper : extension, retracting .....        | 380 to 405 Bar | 5511 to 5874 psi |
| Swing : right, left .....                   | 320 to 330 Bar | 4641 to 4786 psi |
| Travel : forward drive, reverse drive ..... | 420 to 435 Bar | 6091 to 6309 psi |
| Boom and Dipper Anti-Drift Valve .....      | 390 to 410 Bar | 5656 to 5946 psi |
| Boom and Dipper Safety Valve .....          | 390 to 410 Bar | 5656 to 5946 psi |
| Low Flow (Clamshell Swing) .....            | 130 to 150 Bar | 1885 to 2175 psi |
| Offset boom .....                           | 180 to 200 Bar | 2610 to 2900 psi |

|                                       |              |                |
|---------------------------------------|--------------|----------------|
| Counter Rotation Valve                |              |                |
| Reduction Pressure (A2) .....         | 19 to 20 Bar | 275 to 290 psi |
| Selector Sequence Pressure (A3) ..... | 14 to 15 Bar | 203 to 217 psi |
| Thermostat Controlled Valve           |              |                |
| Starts to Close .....                 | 40°C         | 104°F          |
| Fully Closed.....                     | 50°C         | 122°F          |
| Track Speed                           |              |                |
| 7 Revolutions.....                    |              | 60 seconds     |

## Tracks, Rollers and Idlers

|  |               |                   |
|--|---------------|-------------------|
| Track Tension .....                                | 260 to 280 mm | 10.2 to 11.1 inch |
| Maximum Pin and Bushing Wear Over Four Links ..... | 703 mm        | 27.7 inch         |
| Maximum Link Wear (ITRAC Link) .....               | 86.6 mm       | 3.41 inch         |
| Maximum Track Shoe Wear .....                      | 12 mm         | 0.47 inch         |
| Maximum Spacer Wear .....                          | 46.5 mm       | 1.83 inch         |
| Maximum Idler Wear .....                           | 35 mm         | 1.37 inch         |
| Minimum Diameter on Track Roller .....             | 137 mm        | 5.39 inch         |

## Weights

|   |          |          |
|---|----------|----------|
| Operating Weight .....  | 13200 kg | 29040 lb |
| Counterweight .....   | 2900 kg  | 6395 lb  |
| Turntable Bearing .....                                       | 135 kg   | 300 lb   |
| Attachments   |          |          |
| 4.30 (169 inch) Boom with Dipper Cylinder .....               | 830 kg   | 18261 lb |
| 210 cm (83 inch) Dipper with Links and Bucket Cylinder .....  | 485 kg   | 1067 lb  |
| 235 cm (106 inch) Dipper with Links and Bucket Cylinder ..... | 505 kg   | 1113 lb  |
| Buckets   |          |          |
| 60 cm (24 inch) Bucket .....                                  | 360 kg   | 790 lb   |
| 75 cm (30 inch) Bucket .....                                  | 405 kg   | 890 lb   |
| 85 cm (34 inch) Bucket .....                                  | 430 kg   | 945 lb   |
| 95 cm (37 inch) Bucket .....                                  | 460 kg   | 1010 lb  |
| 105 cm (42 inch) Bucket .....                                 | 495 kg   | 1090 lb  |
| 120 cm (47 inch) Bucket .....                                 | 515 kg   | 1133 lb  |
| Cylinders   |          |          |
| Boom Cylinder (each) .....                                    | 95 kg    | 209 lb   |
| Dipper Cylinder .....   | 107 kg   | 235 lb   |
| Bucket Cylinder .....   | 85 kg    | 187 lb   |

## RUN-IN INSTRUCTIONS

### Engine Lubrication

Fill the engine crankcase with CD service classification oil that has the correct viscosity rating for the ambient air temperature. Refer to Engine Lubrication on page 8. Install new oil filters, after the engine has been rebuilt.

### Run-In Procedure For Rebuilt Engine

- STEP 1** Disconnect the wire to the electric shut-off on the injection pump so that the engine will not start. Crank the engine for 30 seconds until there is oil pressure, then reconnect the wire.
- STEP 2** Remove the air from the cooling system at the temperature sending unit.
- STEP 3** Run the engine at 1000 rpm minimum load for 5 minutes and check for oil leaks.
- STEP 4** During the Run-In, continue to check the oil pressure, coolant level, and coolant temperature.

### Run-In Procedure For Rebuilt Engine (With A Dynamometer)

The following procedure must be followed when using a PTO dynamometer to Run-In the engine. The dynamometer will control the engine load at each speed and will remove stress on new parts during Run-In.

During the Run-In, continue to check the oil pressure, coolant level and coolant temperature.

| STEP | TIME      | ENGINE SPEED | DYNAMOMETER SCALE LOAD |
|------|-----------|--------------|------------------------|
| 1    | 5 Minutes | 1000 rpm     | 50                     |
| 2    | 5 Minutes | 1100 rpm     | 1/2                    |
| 3    | 5 Minutes | 2200 rpm     | Full                   |

### Run-In Procedure For Rebuilt Engines (Without A Dynamometer)

| STEP | TIME      | ENGINE SPEED | LOAD       |
|------|-----------|--------------|------------|
| 1    | 5 Minutes | 1000 rpm     | No Load    |
| 2    | 5 Minutes | 1100 rpm     | Light Load |
| 3    | 5 Minutes | 2200 rpm     | Full       |

### Run-In Procedure

For the first 8 hours, operate the engine at full throttle maintaining a normal load. DO NOT "baby" the engine, but avoid converter or hydraulic stall. The engine must not be "lugged" below the rated engine rpm (Do not stall the engine more than 10 seconds).

## Engine Cooling System

Coolant Solution ..... Ethylene Glycol

**IMPORTANT:** When using ethylene glycol coolant solutions, always have a minimum of 50% ethylene glycol coolant in the system. Do not put more than 50% ethylene glycol in the cooling system unless the ambient air temperature will be less than -36°C (-34°F). More than 50% decreases heat transfer and will cause the engine surface temperature to be higher than normal.

Thermostat ..... Starts to open at 82°C (180°F)

Fully open at 94°C (201°F)

Radiator Cap ..... 1.03 Bar (15 psi)

## Engine Lubrication

### Engine Oil Type

Case IH No. 1 engine oil is recommended for use in the Case engine. Case IH engine oil will lubricate the engine under all operating conditions. If Case IH No.1 Multi-Viscosity engine oil is not available, Case IH No. 1 Single Grade engine oil can be used.

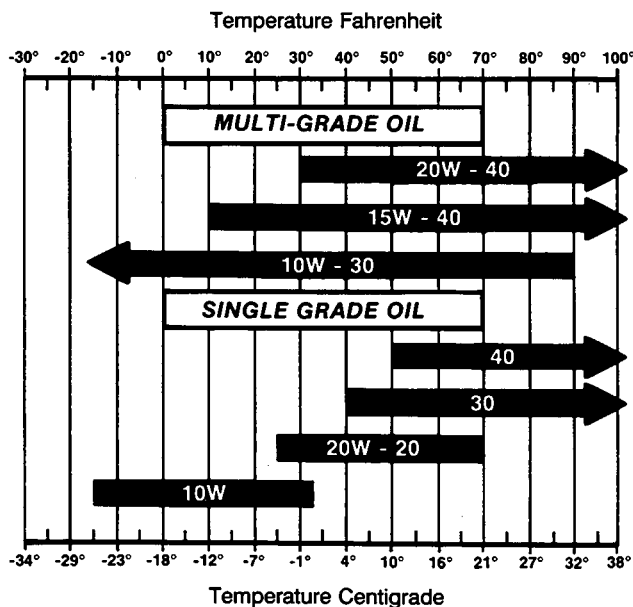
If Case IH No. 1 Multi-Viscosity or Single Grade engine oil is not available, use only oil meeting API engine oil service category CD.

See the chart below for recommended viscosity at ambient air temperature ranges.

**NOTE:** DO NOT put performance additives or other oil additive products into the engine crankcase.

### Engine Lubrication Oil Viscosity

AMBIENT AIR TEMPERATURE RANGES



0217Z

## GENERAL ENGINE SPECIFICATIONS

### General

|                              |   |
|------------------------------|---|
| Make and Model .....         | JI Case, 4T-390                         |
| Type .....                   | 4 cylinder, turbocharged 4 stroke cycle |
| Horsepower .....             | 92 at 2000 rpm      68.6 kw at 2000 rpm |
| Firing Order .....           | 1, 3, 4, 2                              |
| Bore and Stroke .....        | 102 mm x 102 mm                         |
| Piston Displacement .....    | 3920 cm <sup>3</sup>                    |
| Compression Ratio .....      | 17 to 1                                 |
| Valve Tappet Clearance       |   |
| Exhaust (Cold) .....         | 0.508 mm                                |
| Intake (Cold) .....          | 0.254 mm                                |
| Engine Speeds                |   |
| No Load Governed Speed ..... | 2080 to 2200 rpm                        |
| Rated Engine Speed .....     | 2040 to 2070rpm                         |
| Engine Idle Speed .....      | 850 to 900 rpm                          |

### Pistons and Connecting Rods

|                                       |                          |
|---------------------------------------|--------------------------|
| Rings per Piston .....                | 3                        |
| Number of Compression Rings .....     | 2                        |
| Number of Oil Rings (two piece) ..... | 1                        |
| Type of Pins .....                    | Full Float               |
| Type of Bearings .....                | Steel Back Leaded Bronze |

### Main Bearings

|                          |             |
|--------------------------|-------------|
| Number of Bearings ..... | 5           |
| Type of Bearings .....   | Replaceable |

### Engine Lubricating System

|  |                                    |
|--|------------------------------------|
| Type of System .....   | Pressure and Spray Lubrication     |
| Oil Pressure (when engine warm and operating at rated speed) ..... | 2.07 to 3.45 Bar      30 to 50 psi |
| Oil Pump .....   | Rotor Type                         |
| Oil Filter .....   | Full Flow Turn-on Type             |
| Oil Capacity   |                                    |
| (with filter change) .....   | 15.4 litres      16 US quarts      |
| (without filter change) .....                                      | 14.4 litres      15 US quarts      |



## Fuel System

|                                   |  |                  |
|-----------------------------------|--|------------------|
| Fuel Injection Pump .....         |  | Bosch            |
| Pump Timing .....                 |  | Top Dead Center  |
| Fuel Injectors .....              |  | Bosch 17 mm      |
| Opening Pressure (New) .....      | 231 to 253 Bar                             | 3350 to 3670 psi |
| Opening Pressure (Used) .....     | 221 to 250 Bar                             | 3200 to 3625 psi |
| Maximum Pressure Difference ..... | 10.34 Bar                                  | 150 psi          |
| Number of Orifices .....          |  | 4                |
| Spray Orifice Size .....          |  | 0.29 mm          |
| Governor .....                    | Variable Speed, Part of the Injection Pump |                  |
| First Stage Fuel Filter .....     |  | Turn-on Type     |
| Second Stage Fuel Filter .....    |  | Turn-on Type     |
| Lift Pump .....                   | 0.34 to 0.48 Bar                           | 5 to 7 psi       |

## DETAILED ENGINE SPECIFICATIONS

### Cylinder Block

|                                       |                     |
|---------------------------------------|---------------------|
| Type .....                            | Non-Sleeved         |
| Material .....                        | Cast Iron           |
| ID of Cylinder .....                  | 102.00 to 102.04 mm |
| Maximum Service Limit .....           | 102.116 mm          |
| Cylinder Out of Round (Maximum) ..... | 0.038 mm            |
| Cylinder Taper (Maximum) .....        | 0.076 mm            |
| 0.5 mm Oversize Piston                |                     |
| Machine Cylinder Bore to .....        | 102.40 to 102.44 mm |
| 1.00 mm Oversize Piston               |                     |
| Machine Cylinder Bore to .....        | 103.00 to 103.04 mm |

### Service Cylinder Sleeves

|                                      |                       |
|--------------------------------------|-----------------------|
| Type .....                           | Dry, Can Be Replaced  |
| Material .....                       | Cast Iron             |
| Machine Cylinder Block Bore to ..... | 104.500 to 104.515 mm |
| Installation .....                   | Press Fit             |
| Machine Sleeve Bore to .....         | 102.00 to 102.04 mm   |

### Pistons

|   |                       |
|---|-----------------------|
| Type .....  | Cam Ground            |
| Material .....  | Aluminium alloy       |
| OD at 12 mm From the Bottom, 90 Degrees From Piston Pin |                       |
| Standard Size Piston .....                              | 101.873 to 101.887 mm |
| Minimum Service Limit .....                             | 101.823 mm            |
| 0.5 Oversize Piston .....                               | 102.373 to 102.387 mm |
| Minimum Service Limit .....                             | 102.323 mm            |
| 1.00 Oversize Piston .....                              | 102.873 to 102.887 mm |
| Minimum Service Limit .....                             | 102.823 mm            |
| ID of Piston Pin Bore .....                             | 40.006 to 40.012 mm   |
| Maximum Service Limit .....                             | 40.025 mm             |
| Width of 1st Ring Groove (Top) .....                    | 2.465 to 2.485 mm     |
| Width of 2nd Ring Groove (Intermediate) .....           | 2.425 to 2.445 mm     |
| Width of 3rd Ring Groove (Oil Ring) .....               | 4.040 to 4.060 mm     |
| Protrusion Above Cylinder Block (Maximum) .....         | 0.660 mm              |

### Piston Pins

|                             |                     |
|-----------------------------|---------------------|
| Type .....                  | Full Float          |
| OD of Pin .....             | 39.997 to 40.003 mm |
| Minimum Service Limit ..... | 39.990 mm           |

## Piston Rings

|                                      |                                |
|--------------------------------------|--------------------------------|
| No. 1 Compression (4T-390 ) .....    | Key Stone Type (Barrel Face)   |
| End Gap in 102.02 ID .....           | 0.40 to 0.70 mm                |
| No. 1 Compression 6-590 Engine ..... | Rectangular Type (Barrel Face) |
| End Gap in 102.02 ID .....           | 0.25 to 0.55 mm                |
| Maximum Service Limit .....          | 0.806 mm                       |
| Side Clearance .....                 | 0.075 to 0.120 mm              |
| Maximum Service Limit .....          | 0.15 mm                        |
| No. 2 Compression .....              | Rectangular Type (Taper Face)  |
| End Gap in 102.02 ID .....           | 0.25 to 0.55 mm                |
| Maximum Service Limit .....          | 0.806 mm                       |
| Side Clearance .....                 | 0.075 to 0.120 mm              |
| Maximum Service Limit .....          | 0.15 mm                        |
| No. 3 Oil Control Rings .....        | Two Piece                      |
| End Gap in 102.02 ID .....           | 0.25 to 0.55 mm                |
| Maximum Service Limit .....          | 0.806 mm                       |
| Side Clearance .....                 | 0.130 mm                       |

## Cylinder Head

|                         |         |
|-------------------------|---------|
| Warpage (Maximum) ..... | 0.20 mm |
|-------------------------|---------|

## Lifters

|                              |                     |
|------------------------------|---------------------|
| Material .....               | Hardened Iron       |
| OD of Lifter .....           | 15.961 to 15.977 mm |
| Minimum Service Limit .....  | 15.960 mm           |
| Bore Diameter in Block ..... | 16.000 to 16.030 mm |
| Maximum Service Limit .....  | 16.055 mm           |

## Connecting Rods

|   |                            |
|---|----------------------------|
| Bushing .....                             | Steel Backed Leaded Bronze |
| Bushing ID Installed (Ream to Size) ..... | 40.053 to 40.067 mm        |
| Maximum Service Limit .....               | 40.092 mm                  |
| Bearing Liners .....                      | Replaceable                |
| Journal ID Without Bearing Liners .....   | 72.987 to 73.013 mm        |
| Bearing Oil Clearance .....               | 0.038 to 0.116 mm          |
| Maximum Service Limit .....               | 0.129 mm                   |
| Side Clearance .....                      | 0.100 to 0.300 mm          |
| Maximum Service Limit .....               | 0.330 mm                   |
| Connecting Rod Bend (Maximum)             |                            |
| Without Bushing .....                     | 0.200 mm                   |
| With Bushing .....                        | 0.150 mm                   |
| Connecting Rod Twist (Maximum)            |                            |
| Without Bushing .....                     | 0.500 mm                   |
| With Bushing .....                        | 0.300 mm                   |

## Crankshaft

|  |                              |
|--|------------------------------|
| Type .....   | Hardened Steel, Balanced     |
| Main Bearing Liners .....                          | Replaceable                  |
| Crankshaft End Clearance .....                     | 0.041 to 0.119 mm            |
| Center Main Bearing Thrust Surface Thickness ..... | 2.50 mm                      |
| Connecting Rod Journal                             |                              |
| OD, Standard .....                                 | 68.987 to 69.013 mm          |
| Maximum Service Limit .....                        | 68.962 mm                    |
| 0.25 mm OD Undersize, Grind to .....               | 68.737 to 68.763 mm          |
| Maximum Service Limit .....                        | 68.712 mm                    |
| 0.50 mm OD Undersize, Grind to .....               | 68.487 to 68.513 mm          |
| Maximum Service Limit .....                        | 68.462 mm                    |
| 0.75 mm OD Undersize, Grind to .....               | 68.237 to 68.263 mm          |
| Maximum Service Limit .....                        | 68.212 mm                    |
| 1.00 mm OD Undersize, Grind to .....               | 67.987 to 68.013 mm          |
| Maximum Service Limit .....                        | 67.962 mm                    |
| Connecting Rod Journal Maximum Taper .....         | 0.013 mm                     |
| Journals Out of Round Maximum .....                | 0.050 mm                     |
| Undersize Main Bearing Liners For Service .....    | 0.25, 0.50, 0.75 and 1.00 mm |
| Main Bearing Oil Clearance .....                   | 0.041 to 0.119 mm            |
| Maximum Service Limit .....                        | 0.140 mm                     |
| Main Bearing Journal                               |                              |
| OD, Standard .....                                 | 82.987 to 83.013 mm          |
| Maximum Service Limit .....                        | 82.962 mm                    |
| 0.25 mm OD Undersize, Grind to .....               | 82.737 to 82.763 mm          |
| Maximum Service Limit .....                        | 82.712 mm                    |
| 0.50 mm OD Undersize, Grind to .....               | 82.487 to 82.513 mm          |
| Maximum Service Limit .....                        | 82.462 mm                    |
| 0.75 mm OD Undersize, Grind to .....               | 82.237 to 82.263 mm          |
| Maximum Service Limit .....                        | 82.212 mm                    |
| 1.00 mm OD Undersize, Grind to .....               | 81.987 to 82.013 mm          |
| Maximum Service Limit .....                        | 81.962 mm                    |
| Main Bearing Journal Bore ID No Liners .....       | 87.982 to 88.018 mm          |
| Maximum Service Limit .....                        | 88.031 mm                    |
| Main Journal Width                                 |                              |
| 1st, 2nd, 3rd, 5th and 6th .....                   | 37.424 to 37.576 mm          |
| 4th .....  | 37.475 to 37.525 mm          |
| Connecting Rod Journals Width .....                | 38.950 to 39.050 mm          |

## Camshaft

|   |                     |
|---|---------------------|
| Type .....  | Hardened Iron       |
| Bushing (Front Only) .....                                | 1, Replaceable      |
| Bushing Lubrication:                                      |                     |
| Front Bushing .....                                       | Pressure Lubricated |
| Intermediate .....  | Pressure Lubricated |
| Rear .....  | Pressure Lubricated |
| Oil Clearance .....                                       | 0.076 to 0.152 mm   |
| ID of No. 1 Bushing (Installed) .....                     | 54.107 to 54.133 mm |
| Maximum Service Limit .....                               | 54.146 mm           |
| ID of No. 1 Oversize (57.24 mm OD) Service Bushing .....  | 54.089 to 54.139 mm |
| Maximum Service Limit .....                               | 54.146 mm           |
| ID of No. 2, 3, 4 and 5 Service Bushing .....             | 54.089 to 54.139 mm |
| Maximum Service Limit .....                               | 54.146 mm           |
| Width of No. 1 Bushing .....                              | 25.15 to 25.65 mm   |
| Width of No. 2, 3, 4 and 5 Service Bushing .....          | 17.75 to 18.25 mm   |
| Camshaft Bushing Journal OD .....                         | 53.987 to 54.013 mm |
| Minimum Serviceable Limit .....                           | 53.962 mm           |
| Camshaft Bore Diameter in Block                           |                     |
| No. 1 Bushing .....                                       | 57.222 to 57.258 mm |
| No. 1 Oversize Bushing, Machine to .....                  | 57.722 to 57.758 mm |
| No. 2, 3, 4 and 5 Less Bushings .....                     | 54.089 to 54.139 mm |
| No. 2, 3, 4 and 5 Oversize for Bushings, Machine to ..... | 57.222 to 57.258 mm |
| Camshaft Thrust Thickness .....                           | 9.42 to 9.58 mm     |
| Minimum Service Limit .....                               | 9.34 mm             |
| Camshaft Thrust Clearance .....                           | 0.130 to 0.340 mm   |
| Maximum Service Limit .....                               | 0.470 mm            |

## Turbocharger

|  |                 |
|--|-----------------|
| Horizontal Travel of Turbine Shaft ..... | 0.10 to 0.16 mm |
|--|-----------------|

## Gear Train

### Backlash:

|   |                 |
|---|-----------------|
| Crankshaft Gear to Camshaft Gear .....  | 0.08 to 0.33 mm |
| Crankshaft Gear to Idler Gear .....     | 0.08 to 0.33 mm |
| Camshaft to Fuel Pump Gear .....        | 0.08 to 0.33 mm |
| Idler Gear to Oil Pump .....            | 0.08 to 0.33 mm |
| Camshaft to Auxiliary .....             | 0.08 to 0.33 mm |
| Maximum Service Limit (All Gears) ..... | 0.45 mm         |

## Rocker Arm Assembly

|                             |                           |
|-----------------------------|---------------------------|
| OD of Shaft .....           | 18.963 to 18.975 mm       |
| Minimum Service Limit ..... | 18.938 mm                 |
| ID of Arm Bore .....        | 19.000 to 19.026 mm       |
| Maximum Service Limit ..... | 19.051 mm                 |
| Lubrication .....           | Pressure From Oil Gallery |

## Intake Valves

|  |                     |
|--|---------------------|
| Tappet Clearance (Cold) .....            | 0.254 mm            |
| Face Angle .....                         | 29 Degrees          |
| Face Run-Out .....                       | 0.038 mm            |
| Valve Head Edge Thickness, Minimum ..... | 1.50 mm             |
| Length .....                             | 128.84 to 129.46 mm |
| OD of Stem .....                         | 7.960 to 7.980 mm   |
| Minimum Service Limit .....              | 7.940 mm            |
| OD of Head .....                         | 44.870 to 45.130 mm |
| Seat Angle .....                         | 30 Degrees          |
| Seat Contact Width .....                 | 1.32 to 1.92 mm     |
| Seat Run-Out .....                       | 0.10 mm             |
| Insert Height .....                      | 6.84 to 6.96 mm     |
| OD of Insert .....                       | 47.063 to 47.089 mm |
| ID of Insert .....                       | Tapered             |
| Valve Recession Below Head Surface ..... | 0.99 to 1.52 mm     |
| Maximum Service Limit .....              | 1.52 mm             |
| ID of Valve Guide Bore .....             | 8.019 to 8.039 mm   |
| Maximum Service Limit .....              | 8.089 mm            |

## Exhaust Valves

|  |                     |
|--|---------------------|
| Tappet Clearance (Cold) .....            | 0.508 mm            |
| Face Angle .....                         | 44 Degrees          |
| Face Run-Out .....                       | 0.038 mm            |
| Valve Head Edge Thickness, Minimum ..... | 1.50 mm             |
| OD of Head .....                         | 41.870 to 42.130 mm |
| OD of Stem .....                         | 7.960 to 7.980 mm   |
| Minimum Service Limit .....              | 7.940 mm            |
| Length .....                             | 128.74 to 129.36 mm |
| Insert Seat Angle .....                  | 45 Degrees          |
| Seat Contact Width .....                 | 1.47 to 2.07 mm     |
| Seat Run-Out .....                       | 0.10 mm             |
| Insert Height .....                      | 6.65 to 6.77 mm     |
| OD of Insert .....                       | 43.713 to 43.739 mm |
| ID of Insert .....                       | Tapered             |
| Valve Recession Below Head Surface ..... | 0.99 to 1.52 mm     |
| Maximum Service Limit .....              | 1.52 mm             |
| ID of Valve Guide Bore .....             | 8.019 to 8.039 mm   |
| Maximum Service Limit .....              | 8.089 mm            |

## Valve Springs

|                              |                             |
|------------------------------|-----------------------------|
| Free Length .....            | 55.63 mm                    |
| Total Coils .....            | 7.25                        |
| Wire Diameter .....          | 4.830 to 4.930 mm           |
| Compressed to 38.53 mm ..... | (Valve Open) 785 to 839 N   |
| Maximum Service Limit .....  | 765 N                       |
| Compressed to 49.25 mm ..... | (Valve Closed) 285 to 321 N |
| Minimum Service Limit .....  | 270 N                       |