

# ALPHA

## SEISMIC COMPRESSORS

Offshore Rentals | Air Source Solutions



## ASC 100D Operator Manual

*Direct Drive Diesel Powered High Pressure Air Compressor*

*Version 3.0 Created on 03/29/2013*

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## **A. Introduction**

The ASC 100D Direct Drive Diesel Air Compressor is comprised of several components, two of which are the CompAir 5437 air compressor and the John Deere 4045 engine. This manual will focus on the ASC 100D machine as a whole detailing what is required prior to operation, during and post operation. For in-depth information on each of the major components refer to the following links:

***CompAir Compressor:***

[ASC\\_100D\\_CompAir\\_5437\\_Air\\_Compressor\\_Operator\\_Handbook.pdf](#)

***John Deer Engine:***

[ASC\\_100D\\_John\\_Deere\\_4045\\_Operators\\_Manual.pdf](#)

Throughout this manual, when applicable, references to the above manuals will also be included along with page numbers.

Battery Switch, pg.  
17

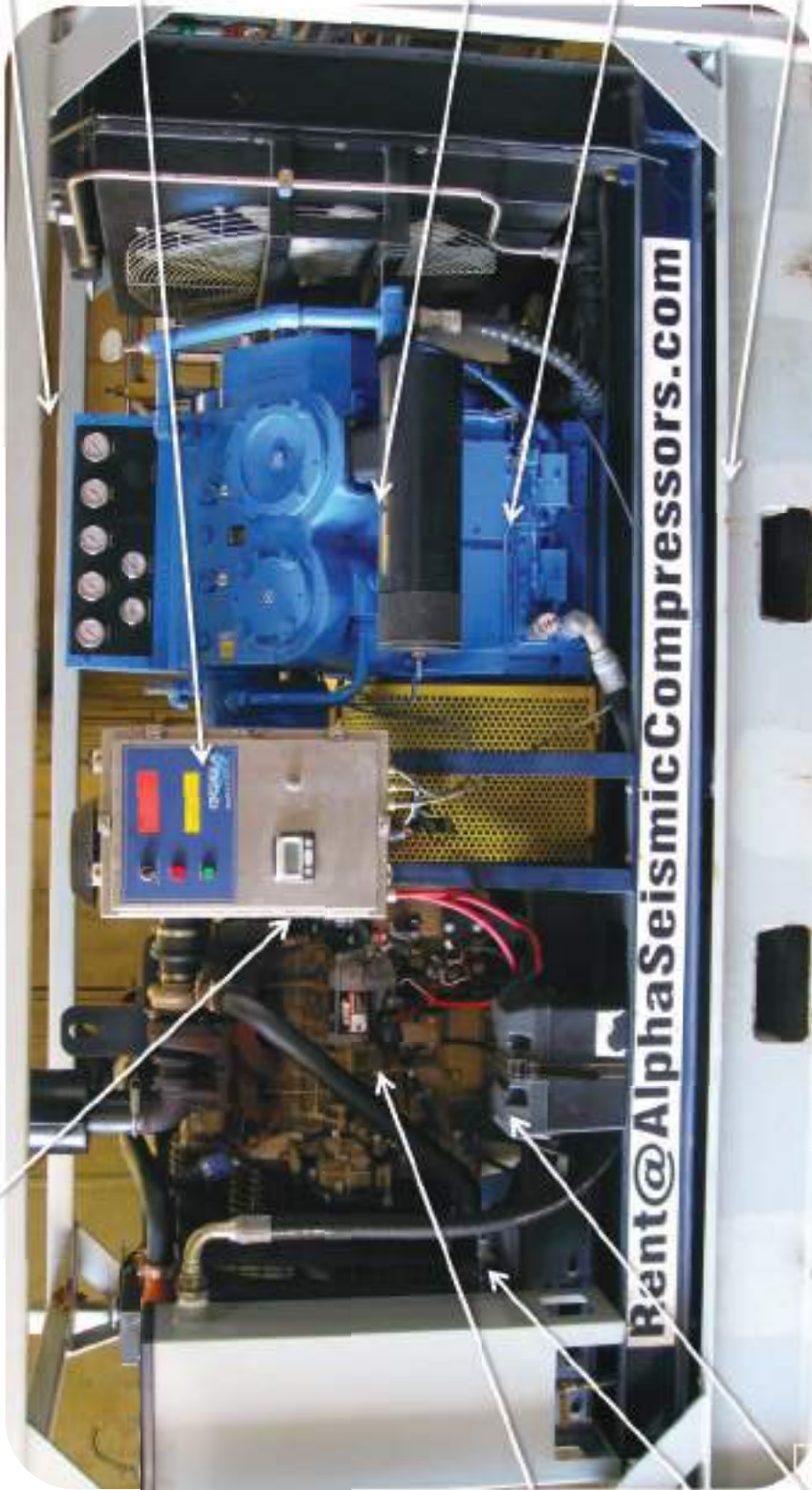
Air  
Compressor  
Gauges, pg.  
11

Main  
Control  
Panel  
discussed  
on pg. 17

Air  
Compressor  
Intake Filter  
**Inspect  
weekly**

Auto Drain  
Assembly

Forklift  
Capability



Fuel Tank  
has a 95-  
gallon  
capacity or  
a 12-hour  
run time

Fuel gauge  
location

Battery

Figure 1: ASC 100D Front View

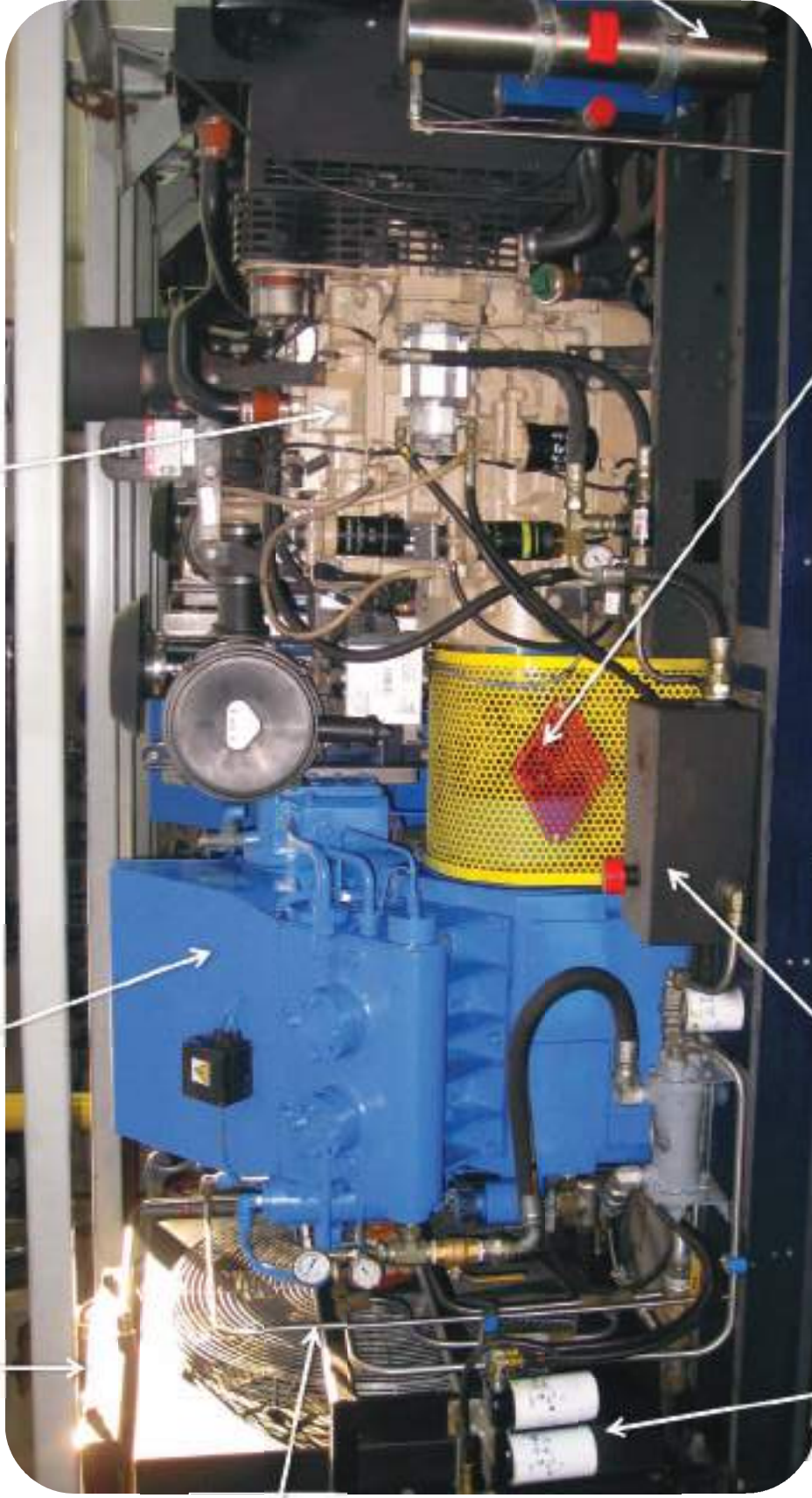


Check Coolant level,  
cap located above  
fan

CompAir  
compressor

John Deer 4.5 Liter  
Engine Tier 3  
Emissions

Coolant  
Pressure  
Gauges



Air  
Discharge  
Valve.  
Drained  
daily

Figure 2: ASC 100D Back View

Standard Universal  
Drive Shaft

Hydraulic reservoir  
Check weekly!

Oil Filters, page 26



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Read and understand all WARNINGS, CAUTION AND MANDATORY LABELS on the unit before operating or carrying out maintenance or servicing.

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RISK OF DANGER



RISK OF HIGH PRESSURE



RISK OF GAS EXHAUST



RISK OF ELECTRIC SHOCK



RISK OF HOT SURFACE



CONSULT MANUAL

## D. Gauges

The ASC 100D was built with several fail-safe features in place. However, monitoring the gauges often is recommended and required to ensure optimum performance. The recommended interval is hourly. Each gauge and its recommended range is discussed below:

**Location:** Front of unit on top of compressor.

**Use:** Compressor coolant outlet ambient temperature.



Important

When documenting this gauge's reading compare it to the intake coolant temperature (Figure 4 below). The difference between the two should NOT exceed 20 PSI for long periods. Monitor the difference closely to ensure it is leveling and not continuously rising.



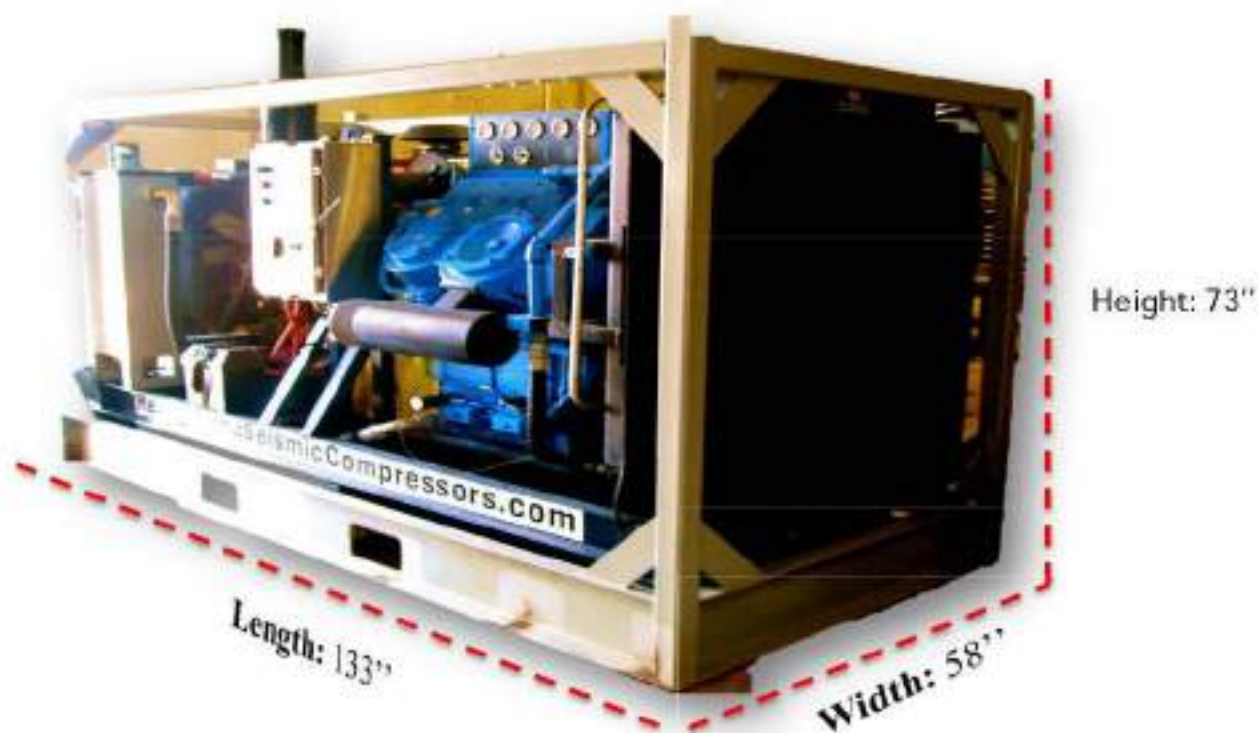
Figure 3: Coolant Outlet Temp. Gauge



Coolant Outlet Temp.  
Gauge Close-up



## B. Specifications



### CompAir Compressor

Type	High Pressure Reciprocating
Make/Model	CompAir 5437ia
Medium	Air
Cooling Method	Liquid
Maximum Working Pressure	5000psi
Compressor Speed	1800 Rpm
Absorbed Power	100 HP
Direction Of Rotation (Facing Flywheel)	Counter Clockwise
Number Of Stages	4
1st Stage Running Pressure	35-50 PSI
2nd Stage Running Pressure	200-270 PSI
3rd Stage Running Pressure	800-1200 PSI
Final Stage Relief Valve Setting	5500 PSI
Interstage Drain System	Automatic Diaphragm
Pressure Maintaining Valve Setting	1700 PSI

### John Deere Engine

Type	Open Industrial Diesel Engine
Make/Model	John Deere 4045hf285
Operating Range	1700-2400 RPM
Number And Configuration Of Cylinders	Inline 4 Cylinder
Power Rating	140 HP
Displacement	4.5 Liter
Rotation	CCW
Electrical System	12 VDC
Emissions Standards	Tier 3

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## Package Features

Drive Type	Direct Drive Centrifugal Clutch
Storage Cylinders/Accumulators	None
Outlet Connections	1/2 Inch FNPT
Control System Voltage	12 VDC
Cooling Fan Drive	Hydraulic
Lifting	Forklift Tines/ 4 Point Overhead

## Capacities

Fuel	95 Gallons
Compressor Oil	7 Gallons
Engine Oil	4 Gallons
Coolant	15 Gallons
Hydraulic Fluid	5 Gallons
Waste Water/Oil	10 Gallons
Dry Weight	8480 LBS
Weight With Fluids (No Fuel)	8580 LBS

## Fluids

Compressor Oil	Ultrachem 751
Engine Oil	Shell Rotella T 5w30
Hydraulic Fluid	Shell Type R&O
Coolant	Dura Cool 50/50

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## C. Precautions

Prior to operation of the unit the following considerations should be reviewed:

- a. It is recommended the fuel to be filled to the 95-gallon capacity prior to shift commencement.

[Refer to section 10-1 on page 25 for detailed Fuel guidelines.](#)

### Diesel Fuel

Consult your local fuel distributor for properties of the diesel fuel available in your area.

In general, diesel fuels are blended to satisfy the low temperature requirements of the geographical area in which they are marketed.

Diesel fuels specified to EN 590 or ASTM D975 are recommended. Renewable diesel fuel produced by hydrotreating animal fats and vegetable oils is basically identical to petroleum diesel fuel. Renewable diesel that meets EN 590 or ASTM D975 is acceptable for use at all percentage mixture levels.

#### Required Fuel Properties

In all cases, the fuel shall meet the following properties:

**Cetane number of 45 minimum.** Cetane number greater than 50 is preferred, especially for temperatures below -20°C (-4°F) or elevations above 1500 m (5000 ft).

**Cold Filter Plugging Point (CFPP)** should be at least 5°C (9°F) below the expected lowest temperature or **Cloud Point** below the expected lowest ambient temperature.

**Fuel lubricity** should pass a maximum scar diameter of 0.45 mm as measured by ASTM D6079 or ISO 12156-1.

#### Sulfur Content for Interim Tier 4 and EU Stage IIIB Engines

- Diesel fuel quality and fuel sulfur content must comply with all existing emissions regulations for the area in which the engine operates.
- Use ONLY ultra low sulfur diesel (ULSD) fuel with a maximum of 0.0015% (15 ppm) sulfur content.

#### Sulfur Content for Other Engines

- Diesel fuel quality and fuel sulfur content must comply with all existing emissions regulations for the area in which the engine operates.
- Use of diesel fuel with sulfur content less than 0.10% (1000 ppm) is STRONGLY recommended.
- Use of diesel fuel with sulfur content 0.10% (1000 ppm) to 0.50% (5000 ppm) may result in REDUCED oil and filter change intervals. Refer to table in Diesel Engine Oil and Filter Service Intervals.
- BEFORE using diesel fuel with sulfur content greater than 0.50% (5000 ppm), contact your John Deere dealer.

**IMPORTANT: Do not mix used diesel engine oil or any other type of lubricating oil with diesel fuel.**

**Improper fuel additive usage may cause damage on fuel injection equipment of diesel engines.**

DKFUEL1-16-20APR09-01

### Lubricity of Diesel Fuel

Most diesel fuels manufactured in the United States, Canada, and the European Union have adequate lubricity to ensure proper operation and durability of fuel injection system components. However, diesel fuels manufactured in some areas of the world may lack the necessary lubricity.

**IMPORTANT: Make sure the diesel fuel used in your machine demonstrates good lubricity characteristics.**

Fuel lubricity should pass a maximum scar diameter of 0.45 mm as measured by ASTM D6079 or ISO 12156-1.

If fuel of low or unknown lubricity is used, add John Deere PREMIUM DIESEL FUEL CONDITIONER (or equivalent) at the specified concentration.

#### Lubricity of Biodiesel Fuel

Significant improvement in lubricity can occur with biodiesel blends up to B20. The gain in lubricity above a 20% blend is limited.

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- b. Keep the unit clear of any other objects; do not lay anything on it or in close proximity.
- c. Check pressure gauges hourly to proactively identify any possible issues.
- d. Walk around the unit to ensure no wires are loose or appear damaged.



- e. Ensure no water or oil leaks are visible.
- f. Check engine oil via the dipstick for proper level.

#### Daily Prestarting Checks

Do the following **BEFORE STARTING THE ENGINE** for the first time each day:

**IMPORTANT: DO NOT** add makeup oil until the oil level is **BELOW** the crosshatch marks on the dipstick.

1. Check engine oil level on dipstick. Add as required, using seasonal viscosity grade oil. (See **DIESEL ENGINE OIL** in Fuels, Lubricants, and Coolant Section for oil specifications.)

Depending on application, oil may be added at left (A) or right (B) side oil filler cap and rocker arm cover filler cap (C) locations.

**IMPORTANT: DO NOT** fill above the top mark on the dipstick. Oil levels anywhere within crosshatch (D) are considered in the acceptable operating range.

A—Left Side Oil Filler Cap      C—Cover Oil Filler Cap  
B—Right Side Oil Filler Cap      D—Crosshatch On Dipstick



Left Side Oil Filler Cap



Right Side Oil Filler Cap



Rocker Arm Cover Filler Cap



Crosshatch on Dipstick

- g. Check compressor oil level.
- h. Check coolant level at the top of the unit above the fan.



**Location:** Back of unit behind compressor.

**Use:** Compressor coolant Intake ambient temperature.



Figure 4: Coolant Intake Temp Gauge



Coolant Intake Temp. Bottom  
Close-Up



Coolant Intake Temp. Top  
Close-Up



**Note**

It is important for the life and safety of the machine not to exceed the maximum operating temperatures.

Compressor Speed	1180 rpm	1500 rpm	1800 rpm
1st Stage Delivery	131°C	148°C	159°C
2nd Stage Suction	28°C	32°C	40°C
2nd Stage Delivery	163°C	175°C	180°C
3rd Stage Suction	33°C	38°C	40°C
3rd Stage Delivery	175°C	180°C	185°C
3rd Stage Temperature Controller	158°C	164°C	170°C
3rd Stage Temperature Controller Maximum	200°C	200°C	200°C
4th Stage Suction	22°C	24°C	27°C
4th Stage Delivery	170°C	175°C	184°C
Final Delivery	16.5°C	17°C	18°C



**Location:** Front of unit, above compressor.

**Use:**

**Oil Pressure** – When the compressor first starts the oil pressure may spike due to the viscosity of the oil, but should level off to approximately 45 PSI once it starts heating.

**Oil Pressure should be greater than 30 PSI, if pressure drops below 10 PSI the compressor will shut down to prevent damage.**



Oil Pressure Gauge Close-Up

**1<sup>st</sup> Stage-** Should read between 35- 50 PSI.



1<sup>st</sup> Stage Gauge Close-Up

**2<sup>nd</sup> Stage-** Should read between 200-270 PSI.



2<sup>nd</sup> Stage Gauge Close-Up



**3<sup>rd</sup> Stage** - Should read between 800-1200 PSI



3<sup>rd</sup> Stage Gauge Close-Up

**4<sup>th</sup> Stage** - Should read between 1200-5000 PSI

For additional information regarding the 4 stages refer to the [CompAir](#) manual, page 19, section 4.2.



4<sup>th</sup> Stage Gauge Close-Up



**Location:** (facing the back of the unit) it is located on the right hand side of the unit.

**Use:** Pressure regulator valve; used to maintain a minimum of 1800 PSI while compressor is running. Configured according to customer specification, max of 5000 PSI.



Pressure Regulation Valve



Figure 5: Pressure Regulation Valve

## E. Operation

The Main controller panel is at the front of the unit and discussed in detail below.

### Engine Diagnostic Gauge:

This panel may be used to view engine information such as RPM, Engine hours, Oil Pressure, Fuel consumption, etc. It is not used to configure the ASC 100D. To learn more about this panel refer to the [John Deere manual, section 15-3 on page 40](#).

### Using Diagnostic Gauge to Access Engine Information

The diagnostic gauge (A) allows the operator to view readouts of engine functions and trouble codes (DTCs). The gauge is linked to the electronic control system and its sensors. This allows the operator to monitor engine functions and to troubleshoot the engine systems when needed.

Press the menu key (B) to access the various engine functions in sequence. The displays can be selected as either customary English or metric units.

- A- Diagnostic Gauge
- B- Menu Key
- C- Arrow Keys
- D- Enter Key
- E- Red "STOP ENGINE" Indicator Light
- F- Amber "WARNING" Indicator Light

The following menu of engine parameters can be displayed on the diagnostic gauge window:

- Engine hours
- Engine rpm
- System voltage
- Percent engine load at the current rpm
- Coolant temperature
- Oil pressure
- Throttle position
- Intake manifold temperature
- Current fuel consumption
- Active service (diagnostic) codes
- Stored service (diagnostic) codes from the engine
- Set the units for display
- View the engine configuration parameters

**NOTE:** Engine parameters which can be accessed will vary with the engine application. The diagnostic gauge includes a graphical backlit Liquid Crystal Display (LCD) screen. The display can show either a single parameter or a quadrant display showing four parameters simultaneously. The diagnostic gauge uses two arrow keys (C) for scrolling through the engine parameter list and viewing the menu list and an enter key (D) for selecting highlighted items. The red (E) and amber (F) lights are used to signal active trouble code received by the diagnostic gauge.



Figure 7 Main Control Panel



## E.1 Starting the ASC 100D

1. Ensure the Compressor dial is set to the OFF position as shown below.



Figure 8: Main Controller Up-close

2. Turn the Battery switch to the ON position by turning the dial towards you.



Figure 9: Main Control Panel's Battery Switch



3. Once on, the green light on the main controller will glow green indicating power to the controller is received.



Figure10: Battery ON Indicator

4. Turn the Key half a click to the right until the Engine Diagnostic Gauge is green.



Figure 11 : Diagnostic Gauge ON Position

5. When a reading appears, it is safe to turn the key fully to the right to start the engine.



Figure12: Diagnostic Gauge Ready to Start Engine

6. The Engine's RPM will start climbing and will appear in the Diagnostic Gauge.



Figure13: Diagnostic Gauge Ready to Start Compressor



7. Once the Engine has ramped up, approximately 1 minute, turn the Compressor dial to the right to the ON position.



Figure14: Diagnostic Gauge Compressor Started

8. The Compressor will turn on and both the RED Alarm and the GREEN High PSI buttons will turn on briefly and should immediately stop glowing.
9. Notice the Gauges above the Compressor will begin reacting; compare those readings with the acceptable limits discussed in [section D on page 8](#).



Figure15: Compressor Gauges While Running

## **E.2 Stopping the ASC 100D**

To stop the operation of the unit do the following:

1. Turn the Compressor dial to the OFF position as shown in Figure 8.
2. Turn the Engine Key to the left to stop the Engine.
3. Turn the Battery dial to the OFF position as shown in Figure 9.

## **E.3 Control Panel Alarm button**

Need details on this button's use.

## **E.4 Control Panel High PSI button**

Need details on this button's use.

## F. Maintenance



**BEFORE PROCEEDING WITH MAINTENANCE ON THE COMPRESSOR IT MUST BE STOPPED, ISOLATED ELECTRICALLY AND MECHANICALLY AND VISIBLE WARNING NOTICES DISPLAYED. ADDITIONALLY, ALL INTERNAL PRESSURE MUST BE RELEASED WITH THE UNIT ISOLATED FROM THE STORAGE RESERVOIR AND THE WATER SUPPLY SHUT OFF.**

*NOTE: A safety valve opening indicates excessive pressure and under NO CIRCUMSTANCES must a safety valve be screwed down to accommodate excessive pressure. THIS IS DANGEROUS. If safety valve opens or appears faulty shut down compressor immediately and investigate. If fault appears immediately or shortly after a service, first examine those parts disturbed during the service.*

### F.1 General

It is useful to record stage pressure, temperatures, oil used in a log against hour's run, as this builds up a detailed record of machine condition. It can also provide a trend and indication of a possible problem. □ Do not re-use O rings, seals and joints – fit new!

Grease O-rings used for all 'dry' joints in contact air. Use a liberal smear of silicone for all O-rings used in possible contact with the cooling water. I.e. cooler assemblies, 1<sup>st</sup> and 2<sup>nd</sup> stage 'wet' cylinder liners. □ Flush out water passages either with high-pressure water or steam cleaning.

Clean thoroughly all oil-ways and carefully blow clean using compressed air. □ Lightly grease or oil all surfaces of ferrous components after cleaning to prevent rusting. □ Where practical, remove carbon deposits by gently tapping and scraping, taking care not to remove metal.

#### Daily Checks

Check oil level in crankcase and top up as necessary. Check stage pressures, oil pressure and temperatures.

#### Weekly Checks

Check bursting disc for signs of cracking. □ Check for oil, air or water leaks; rectify as necessary. □ Examine oil in crankcase and ensure that it is not contaminated with condensate. Depending on the degree of contamination, the oil may appear emulsified (creamy in colour) especially if the recommended lubricant is not used. If emulsification takes place the oil must be changed and the crankcase cleaned. □ This condition is usually visible through the sight glass, oil level indicator and must be rectified immediately. Trace cause of contamination, rectify, and fit new oil filter and refill crankcase with recommended oil. □ If

moisture forms without emulsification, as two separate liquids, condensate may be drained from below the oil by means on the drain plug. The oil level should be replenished accordingly with clean oil. Crankcase oil contamination is often accompanied by increase in sight glass oil level, due to oil being supported by condensate fluid. □ Check correct operation of all controls.

**Note**

Refer to Appendix <<pending>> for a daily/weekly Data Collection forms.



## F.2 Parts

	Component	Part Number	Notes	How To
Compressor	1 <sup>st</sup> Stage Valve	98650.1519	It is recommended to change the whole valve and not just a sub-component.	Refer to Appendix C: <a href="#">Valve Replacement</a> section on page 43. And <a href="#">Appendix D</a> on page 44.
	2 <sup>nd</sup> Stage Valve	98659.1039	It is recommended to change the whole valve and not just a sub-component.	Refer to Appendix C: <a href="#">Valve Replacement</a> section on page 43. And <a href="#">Appendix E</a> on page 46.
	3 <sup>rd</sup> Stage Valve	98650.1049	It is recommended to change the whole valve and not just a sub-component.	Refer to Appendix C: <a href="#">Valve Replacement</a> section on page 43. And <a href="#">Appendix F</a> on page 48.
	4 <sup>th</sup> Stage Valve	98650.2037	It is recommended to change the whole valve and not just a sub-component.	Refer to Appendix C: <a href="#">Valve Replacement</a> section on page 43. And <a href="#">Appendix G</a> on page 50.
	Oil Filter	NAPA 1551 NAPA 1607	Should be replaced every 500 hours.	Refer to <a href="#">Replacing Oil Filter</a> on page 26.
	Air Intake Filter		Should be replaced every 500 hours.	Refer to <a href="#">Replacing Intake Filter</a> on page 26.
	Oil	UC800	Should be replaced every 500 hours.	Drain the oil completely from compressor whilst the oil remains warm. Drain sump, replace oil filter, clean sump & refill with recommended synthetic oil.
	Coolant	50/50 ethylene glycol coolant?	How often?	

Engine	Engine Oil	• ACEA Oil Sequence E7 • ACEA Oil Sequence E6 ??	John Deere PLUS-50™ oil is preferred. Oil type will vary depending on air temperature.	Refer to the <a href="#">John Deere Manual</a> and locate section 10-5 on page 29 for details.  Refer to section <a href="#">F.5</a> on page 27.
	Engine Coolant	John Deere COOL-GARD™ II Premix Coolant	How often?	
	Engine Oil Filter		Should be replaced every 500 hours.	Refer to section <a href="#">F.5</a> on page 27.
	Crank Case Vent System		If working in dusty environment check often.	Refer to section <a href="#">F.6</a> on page 29.
	Air Vent System		Should be replaced every 500 hours.	Refer to section <a href="#">F.7</a> on page 29.
	Fuel Filter	RE529643	Should be replaced every 500 hours.	Refer to section <a href="#">F.8</a> on page 30.
	Cooling System is every 5000 hours, wouldn't that be done between rentals or should it be included here?			

### F.3 Replacing Compressor Oil Filter

1. Remove filter, spin-on type, by unscrewing anti-clockwise.
2. Fit new spin-on filter, lightly oil sealing ring before fitting.
3. Tighten - hand tight. □
4. Check for leaks on restart.



Figure 16: Primary and Secondary Oil Filters

### F.4 Replacing Compressor Air Intake Filter/Silencer

1. Remove air filter element from unit. □
2. Replace paper element. □
3. Brush or blow out dust and dirt from suction silencer.
4. Replace air filter element into unit ensuring it sits firmly on the seal.



## F.5 Changing Engine Oil and Replacing Filter

1. Run engine approximately 5 minutes to warm up oil. Shut engine off.
2. Remove oil pan drain plug (B).
3. Drain crankcase oil from engine while warm.
4. Turn filter element (A) using a suitable filter wrench to remove. Discard oil filter element.

**NOTE:** Depending on engine application, oil filter may be located on either side of the engine in a high- or low-mount location.

**IMPORTANT:** Filtration of oils is critical to proper lubrication. Always change filter regularly. Use filter meeting John Deere performance specifications.

5. Apply clean engine oil to the new filter at the inner (B) and outer (C) seals and to filter threads.
6. Wipe both sealing surfaces of the header (D, E) with a clean rag. Ensure notches in dust seal (F) are properly installed in the slots in the housing. Replace dust seal if damaged.

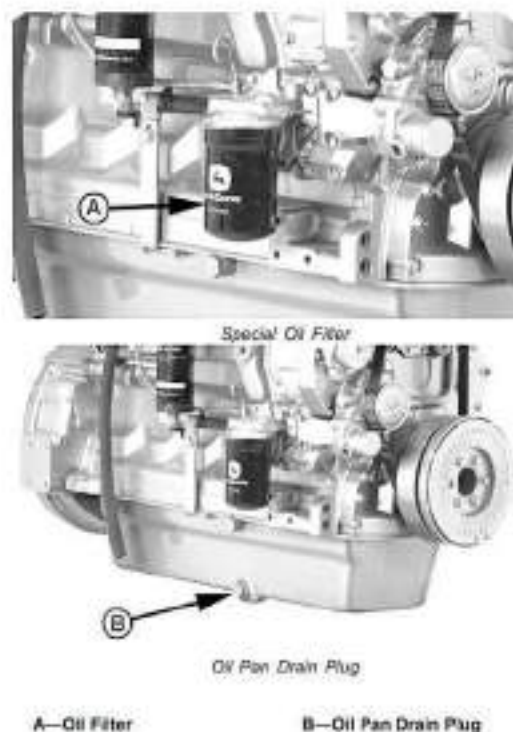


Figure 16: Changing Engine Oil

**IMPORTANT:** When installing filter element, **HAND TIGHTEN** only. A filter wrench may be used for **REMOVAL ONLY**. Be sure notches in dust seal (F) are properly installed in the slots in the housing.

7. Install and tighten oil filter by hand until firmly against dust seal (F). **DO NOT** apply an extra 3/4 to 1-1/4 after gasket contact as done with standard filters.
8. Tighten drain plug to specifications.

9. Fill engine crankcase with correct John Deere engine oil through rocker arm cover oil filler cap (A) or oil filler cap on either side of engine depending on engine application.

**IMPORTANT:** Immediately after completing any oil change, crank engine for 30 seconds without permitting engine to start. This will help insure adequate lubrication to engine components before engine starts.

**NOTE:** Crankcase oil capacity may vary slightly. ALWAYS fill crankcase within crosshatch marks on dipstick. DO NOT overfill.

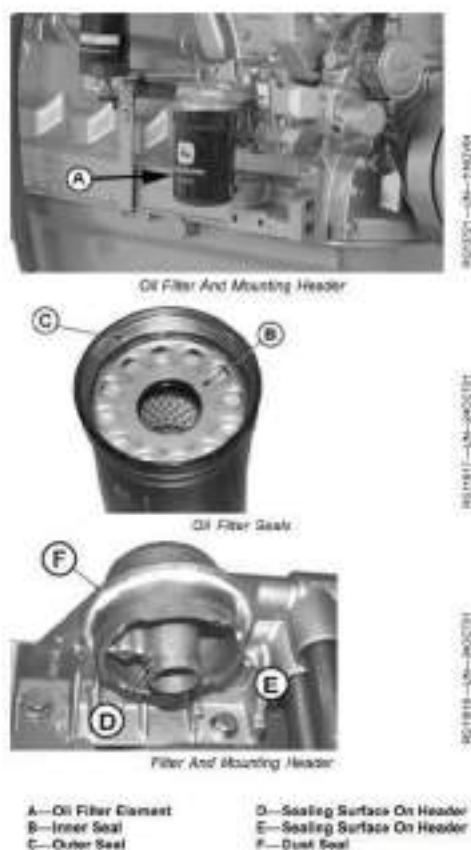


Figure 18: Changing Engine Filter



Figure 19: Oil Filter

10. Start engine and run to check for possible leaks.
11. Stop engine and check oil level after 10 minutes. Oil level reading should be within crosshatch marks (B) on dipstick.

## F.6 Checking Crankcase Vent System

1. Remove and clean crankcase vent tube (A).
2. Install the vent tube. Be sure the O-ring fits correctly in the rocker arm cover for elbow adapter. Tighten hose clamp securely.

A—Crankcase Vent Tube

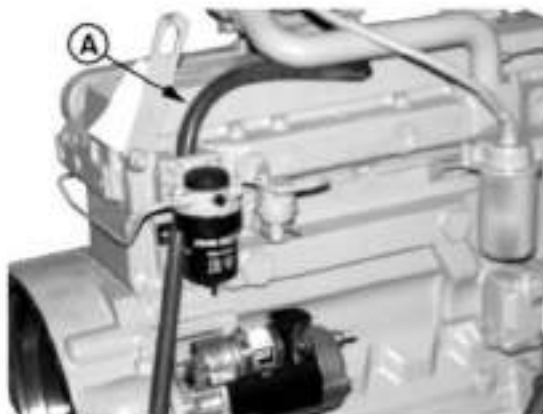
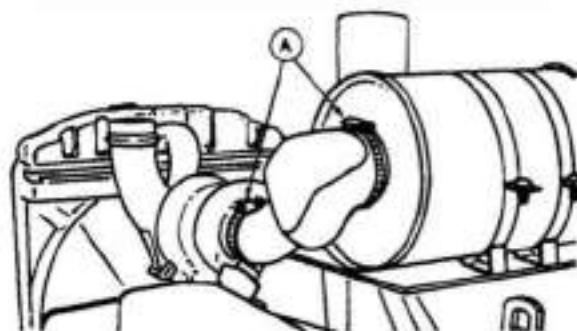


Figure 20: Crank Case Vent Tube

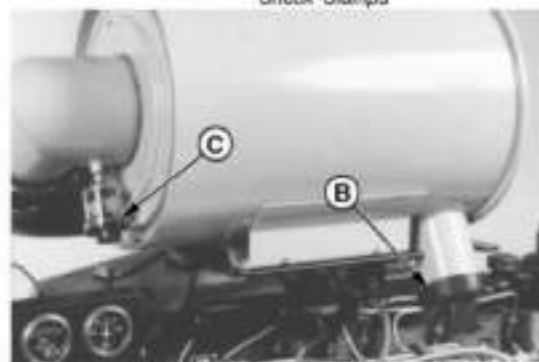
## F.7 Checking Engine Air Intake System

**IMPORTANT:** The air intake system must not leak. Any leak, no matter how small, may result in internal engine damage due to abrasive dirt and dust entering the intake system.

1. Inspect all intake hoses (piping) for cracks. Replace as necessary.
2. Check clamps (A) on piping which connect the air cleaner, engine and, if present, turbocharger. Tighten clamps as necessary. This will help prevent dirt from entering the air intake system through loose connections causing internal engine damage.
3. If engine has a rubber dust unloader valve (B), inspect the valve on bottom of air cleaner for cracks or plugging. Replace as necessary.



Check Clamps



Underloader Valve and Air Restriction Indicator

A—Clamps  
B—Dust Unloader Valve

C—Air Restriction Indicator

Figure 21: Air Intake System

**IMPORTANT:** ALWAYS REPLACE primary air cleaner element when air restriction indicator shows a vacuum of 625 mm (25 in.) H<sub>2</sub>O, is torn, or visibly dirty.

4. Test air restriction indicator (C) for proper operation. Replace indicator as necessary.

**IMPORTANT:** If not equipped with air restriction indicator, replace air cleaner elements at 500 Hours or 12 Months, whichever occurs first.



## F.8 Replacing Fuel Filter Elements

Engines are equipped with a primary fuel filter (F) and a final fuel filter (B). Both filters are replaced at the same 500-hour interval.

**CAUTION:** Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting fuel or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

If any fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result. Doctors unfamiliar with this type of injury may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

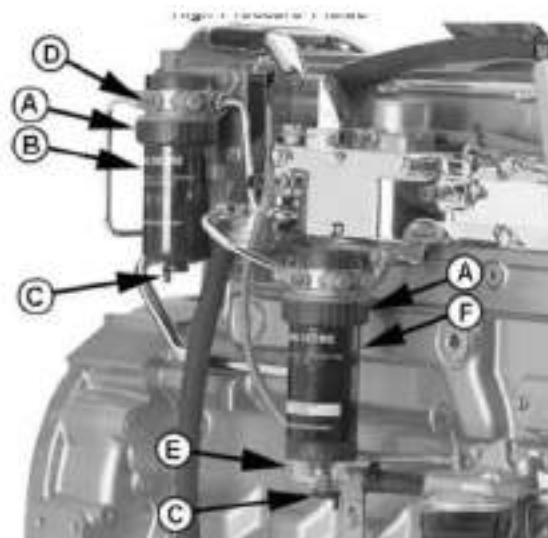
1. Close fuel shut-off valve, if equipped.
2. Thoroughly clean fuel filter assemblies and surrounding areas.
3. Disconnect water sensor wiring (if equipped).
4. Loosen drain plugs (C) and drain fuel into a suitable container.

**NOTE:** Lifting up on retaining ring (A) as it is rotated helps to get it past raised locators.

5. Firmly grasp the retaining ring (A) and rotate it clockwise 1/4 turn (when viewed from the top). Remove ring with filter element (B).
6. Inspect filter-mounting base for cleanliness. Clean as required.

**NOTE:** Raised locators on fuel filter canisters must be indexed properly with slots in mounting base for correct installation.

7. Install new filter elements onto mounting bases. Be sure elements are properly indexed and firmly seated on bases. It may be necessary to rotate filters for correct alignment. If equipped with water separator bowl (E), remove filter element from separator bowl. Drain and clean separator bowl. Dry with compressed air. Install bowl onto new element. Tighten securely.
8. Align keys on filter element with slots in filter base.



A—Retaining Ring  
B—Final Fuel Filter  
C—Drain Plug

D—Bleed Plug  
E—Water Separator Bowl  
F—Primary Fuel Filter

Figure 22: Fuel Filters

9. Install retaining ring onto mounting base making certain dust seal is in place on filter base. Hand tighten ring counterclockwise (about 1/3 turn) until it "snaps" into the detent. DO NOT over tighten retaining ring.

**NOTE:** The proper installation is indicated when a "click" is heard and a release of the retaining ring is felt.

A plug is provided with the new element for plugging the used element.

10. Reconnect water sensor wiring (if equipped).
11. Open fuel shut-off valve and bleed the fuel system. Tighten bleed plug (D).

## G. Data Collection

Alpha Seismic Compressors created three different methods that can be used to collect and track data.

1. Manually using the provided Data Collection sheet
2. Using Alpha Seismic Online Access forms
3. Using Alpha Seismic iPad application

### **G.1 Manual Data Collection**

### **G.2 Online Data Collection**

### **G.3 iPad App Data Collection**

This section is pending Jason... will resume working on this once higher priority spec sheets are complete.

## **H. Appendices**



## Appendix A: Compressor Troubleshooting Guide

Symptom	Fault	Recommendation(s)
<b>7.10.1 SAFETY VALVE(S) BLOWING</b>	? 4 <sup>th</sup> stage relief valve blowing - final pressure switch not cutting out.	✓ Renew final pressure switch or re-adjust top pressure cut-out point.
	? 3 <sup>rd</sup> stage safety valve blowing	✓ Check, 4 <sup>th</sup> stage valve springs and plates or replace 4 <sup>th</sup> stage valve complete. Check safety valve operating pressure.
	? 2 <sup>nd</sup> stage safety valve blowing	✓ Check, 3 <sup>rd</sup> stage valve springs and plates or replace 3 <sup>rd</sup> stage valve complete. Check safety valve operating pressure.
	? 1 <sup>st</sup> stage safety valve blowing	✓ Check, 2 <sup>nd</sup> stage valve springs and plates or replace 2 <sup>nd</sup> stage valve complete. Check safety valve operating pressure.
	? 4 <sup>th</sup> stage relief valve blowing - incorrectly set or re-assembled items.	✓ Check setting of downstream system valves. Check stage safety valve operation.
	? 4 <sup>th</sup> stage relief valve blowing new installations -	✓ Verify pipework bore is large enough, has a minimum of bends at the largest possible radius. Ensure any Uni-directional flow valve is fitted the right way round.
<b>7.10.2 FAILS TO REACH PRESSURE</b>	? Intake air filter dirty or blocked.	✓ Check air intake filter detector – if dirty, renew.
	? Unloader / drain valves not closing.	✓ Check solenoid valve is operating correctly and the DDVs seat properly. ✓ Check that operating air pipework is not damaged (or blocked at 1st stage separator end). ✓ Renew diaphragm and valves in the DDVs.
	? Compressor valve malfunction.	✓ 1st stage air valve, suction valve most likely to need attention, but check for correct assembly and condition or for leak from plates/springs in all stage air valves.
	? Safety valve blowing.	✓ Check safety valve is not faulty and replace if not serviceable. DO NOT ADJUST SAFETY VALVES
	? Electrical fault.	✓ Check pressure switch setting.
<b>7.10.3 LOW COMPRESSOR OUTPUT</b>	? Does not reach pressure.	✓ Check solenoid valve is operating correctly and the DDVs seat properly. ✓ Check that operating air pipework is not damaged (or blocked at 1st stage separator end). ✓ Renew diaphragm and valves in the DDVs. ✓ Check and renew inlet filter element
	? Low output due to cylinder/piston ring wear. 'Blow-by' noted from crankcase breather pipe.	✓ Check for Piston ring leakage – 'blow-by' – check final (4 <sup>th</sup> ) stage piston rings for wear then progressively 3 <sup>rd</sup> , 2 <sup>nd</sup> and 1 <sup>st</sup> .



The Compressor will shut down if there is no oil pressure for 30 seconds OR if oil pressure drops below 14 PSI.

Symptom	Fault	Recommendation(s)
<b>7.10.4 STOPS SUDDENLY</b>	? Low oil pressure switch operating.	<ul style="list-style-type: none"> <li>✓ Check switch.</li> <li>✓ Check oil level - replenish sump oil after removing any condensate in sump.</li> <li>✓ Check &amp; clean oil strainer</li> <li>✓ Renew oil filter.</li> <li>✓ Renew oil pump.</li> <li>✓ Check for bearing wear – replace as necessary</li> </ul>
	? Final High air temperature switch operating.	<ul style="list-style-type: none"> <li>✓ Check switch &amp; setting.</li> <li>✓ Check cooling water exit temperature does not exceed 50°C.</li> <li>✓ Check cooling water temperature rise is 10-12°C.</li> <li>✓ Remove 4th stage cooler coil assembly. Clean interior of cooler body and exterior of coil assembly.</li> </ul>
	? 3 <sup>rd</sup> stage High air temperature switch operating.	<ul style="list-style-type: none"> <li>✓ Check switch &amp; setting.</li> <li>✓ Check cooling water exit temperature does not exceed 50°C.</li> <li>✓ Check cooling water temperature rise is 10-12°C.</li> <li>✓ Remove stage cooler assemblies. Clean interior of cooler body and exterior of cooler assemblies.</li> </ul>
<b>7.10.5 WILL NOT START</b>	? Electrical fault.	<ul style="list-style-type: none"> <li>✓ Check power to starter</li> <li>✓ Check for previous STOP fault condition – high air temperature switches, low oil pressure switch</li> <li>✓ Check via bell-housing inspection cover compressor free to turn by hand</li> <li>✓ Check fuses within starter</li> <li>✓ Check wiring connections to motor terminal</li> <li>✓ Check continuity in motor windings</li> </ul>
<b>7.10.6 OVERHEATING</b>	? Incorrect grade of lubricant.	✓ Drain, clean and refill crankcase with correct grade of lubricant. Check condition of valves and gas passageways.
	? Insufficient water flow, reduced cooling efficiency	✓ Examine condition of water circuit, remove any sludge or scale build-up.
<b>7.10.7 OVERHEATING RADIATOR SET</b>	? Water pump faulty or drive slipping	✓ Renew pump, adjust drive belt tension.
	? Insufficient water flow	✓ Contaminated water, replace and add inhibitor.
	? Incorrect siting, insufficient cooling air flow	✓ Resite unit to give correct cooling air flow.
	? Radiator blocked	✓ Clean matrix and flush out tubes.

Symptom	Fault	Recommendation(s)
<b>7.10.8 LOW OIL PRESSURE</b>	? Oil filter blocked.	✓ Fit new oil filter element.
	? Worn bearings	✓ Check bearing clearances
	? Bearing end plate gasket distorted partially blocking suction port	✓ Examine gasket, replace if necessary, position correctly.
	? Loose pipe connections	✓ Trace and rectify
	? Loose B/E bearing bolts or incorrectly fitted bearings	✓ Examine and re-tighten to correct torque.
<b>7.10.9 CUTS OUT ON START-UP</b>	? Motor overloaded set too low	✓ Consult qualified electrician.
	? Insufficient electrical supply causing low voltage.	✓ Consult qualified electrician.
	? Star/Delta timer	✓ Full speed should be attained by Star before switching to Delta. Extend timer period to suit.
	? Low oil pressure switch operating	✓ See fault 'LOW OIL PRESSURE' or reset timer.
<b>7.10.10 UNUSUAL NOISE (ON LOAD)</b>	? Loose components	✓ Trace and rectify.
	? Aas leaks (usually hissing or whistling)	✓ Trace, stop compressor, depressurise if safe to do so, renew seal.
	? Worn bearings, cylinders and rings- usually heavy knocking, rumbling or slapping.	✓ Check clearances and renew as necessary.
<b>7.10.11 UNUSUAL NOISE (UNLOADED)</b>	? Piston knocking	✓ Check Top Dead Centre clearance.
	? Compressor set-up or pipework system vibration.	✓ Check compressor pipework system is firmly secured, check clearances and alignment of couplings and tension of vee belts.
<b>7.10.12 HIGH OIL CONSUMPTION</b>	? Incorrect grade of lubricant	✓ Change to recommended lubricant.
	? Piston rings/cylinder worn or damaged	✓ Check for wear and renew as necessary.
<b>7.10.13 PREMATURE WEAR</b>	? Faulty pipeline intake filter	✓ Check to ensure filter is not damaged
	? Incorrect grade of lubricant	✓ Change to recommended lubricant.

## Appendix B: Engine Troubleshooting Guide

Symptom	Problem	Solution
<b>Engine cranks but will not start</b>	Incorrect starting procedure.	Verify correct starting procedure.
	No fuel.	Check fuel in tank.
	Exhaust restricted.	Check and correct exhaust restriction.
	Fuel filter plugged or full of water.	Replace fuel filter or drain water from filter.
	Injection pump not getting fuel or air in fuel system.	Check fuel flow at supply pump or bleed fuel system.
	Faulty injection pump or nozzles.	Consult authorized diesel repair station for repair or replacement.
<b>Engine hard to start or will not start</b>	Engine starting under load.	Disengage PTO.
	Improper starting procedure.	Review starting procedure.
	No fuel.	Check fuel tank.
	Air in fuel line.	Bleed fuel line.
	Cold weather.	Use cold weather starting aids.
	Slow starter speed.	See "Starter Cranks Slowly".
	Crankcase oil too heavy.	Use oil of proper viscosity.
	Improper type of fuel.	Consult fuel supplier; use proper type fuel for operating conditions.
	Water, dirt, or air in fuel system.	Drain, flush, fill, and bleed system.
	Clogged fuel filter.	Replace filter element.
<b>Engine knocks</b>	Dirty or faulty electronic fuel injectors.	Have authorized servicing dealer or engine distributor check injectors.
	Electronic fuel system problem (if equipped)	See your John Deere distributor or servicing dealer.
	Low engine oil level.	Add oil to engine crankcase.
	Low coolant temperature.	Remove and check thermostat.
	Engine overheating.	See "Engine Overheats".



Symptom	Problem	Solution
<b>Engine runs irregularly or stalls frequently</b>	Engine cold	Wrong or defective thermostat. Remove and check thermostat.
	Low coolant temperature.	Remove and check thermostat.
	Clogged fuel filter.	Replace fuel filter element.
	Water, dirt, or air in fuel system.	Drain, flush, fill, and bleed system.
	Dirty or faulty injection nozzles.	Have authorized servicing dealer or engine distributor check injectors.
<b>Below normal engine temperature</b>	Electronic fuel system problem	See your John Deere distributor or servicing dealer.
	Defective thermostat.	Remove and check thermostat.
<b>Lack of power</b>	Defective temperature gauge or sender.	Check gauge, sender, and connections.
	Engine overloaded.	Reduce load.
	Intake air restriction.	Service air cleaner.
	Clogged fuel filter.	Replace filter elements.
	Improper type of fuel.	Use proper fuel.
	Overheated engine.	See "Engine Overheats".
	Below normal engine temperature.	Remove and check thermostat.
	Improper valve clearance.	See your authorized servicing dealer or engine distributor.
	Dirty or faulty injection nozzles.	Have authorized servicing dealer or engine distributor check injectors.
	Injection pump out of time.	See your authorized servicing dealer or engine distributor.
	Electronic fuel system problem	See your John Deere distributor or servicing dealer.
	Turbocharger not functioning. (Turbocharger engines only.)	See your authorized servicing dealer or engine distributor.
	Leaking exhaust manifold gasket.	See your authorized servicing dealer or engine distributor.
	Defective aneroid control line.	See your authorized servicing dealer or engine distributor.

Symptom	Problem	Solution
	Restricted fuel hose.	Clean or replace fuel hose.
	Low fast idle speed.	See your authorized servicing dealer or engine distributor.
<b>Low oil pressure</b>	Low oil level.	Add oil.
	Improper type of oil.	Drain, fill crankcase with oil of proper viscosity and quality.
<b>High oil consumption</b>	Crankcase oil too light.	Use proper viscosity oil.
	Oil leaks.	Check for leaks in lines, gaskets, and drain plug.
	Restricted crankcase vent tube.	Clean vent tube.
	Defective turbocharger.	See your authorized servicing dealer or engine distributor.
<b>Engine emits white smoke</b>	Improper type of fuel.	Use proper fuel.
	Low engine temperature.	Warm up engine to normal operating temperature.
	Defective thermostat.	Remove and check thermostat.
	Defective electronic fuel injectors.	See your authorized servicing dealer or engine distributor.
<b>Engine emits black or gray exhaust smoke</b>	Improper type of fuel.	Use proper fuel.
	Clogged or dirty air cleaner.	Service air cleaner.
	Engine overloaded.	Reduce load.
	Defective electronic fuel injectors.	See your authorized servicing dealer or engine distributor.
	Electronic fuel system problem.	See your authorized servicing dealer or engine distributor.
	Turbocharger not functioning.	See your authorized servicing dealer or engine distributor.
<b>Engine overheats</b>	Engine overloaded.	Reduce load.
	Low coolant level.	Fill radiator to proper level, check radiator and hoses for loose connections or leaks.
	Faulty radiator cap.	Have technician check.

Symptom	Problem	Solution
High fuel consumption	Stretched poly-vee belt or defective belt tensioner.	Check automatic belt tensioner and check belts for stretching. Replace as required.
	Low engine oil level.	Check oil level. Add oil as required.
	Cooling system needs flushing.	Flush cooling system.
	Defective thermostat.	Remove and check thermostat.
	Defective temperature gauge or sender.	Check coolant temperature with thermometer and replace, if necessary.
	Incorrect grade of fuel.	Use correct grade of fuel.
	Improper type of fuel.	Use proper type of fuel.
	Clogged or dirty air cleaner.	Service air cleaner.
	Engine overloaded.	Reduce load.
	Improper valve clearance.	See your authorized servicing dealer or engine distributor.
Undercharged electrical system	Electronic fuel injectors dirty.	See your authorized servicing dealer or engine distributor.
	Electronic fuel system problem	See your authorized servicing dealer or engine distributor.
	Defective turbocharger.	See your authorized servicing dealer or engine distributor.
	Low engine temperature.	Check thermostat.
	Excessive electrical load from added accessories.	Remove accessories or install higher output alternator.
	Excessive engine idling.	Increase engine rpm when heavy electrical load is used.
Battery uses too much water	Poor electrical connections on battery, ground strap, starter, or alternator.	Inspect and clean as necessary.
	Defective battery.	Test battery.
	Defective alternator.	Test charging system.
	Cracked battery case.	Check for moisture and replace as necessary.
	Defective battery.	Test battery.

Symptom	Problem	Solution
<b>Batteries will not charge</b>	Battery charging rate too high.	Test charging system.
	Loose or corroded connections.	Clean and tighten connections.
<b>Starter will not crank</b>	Sulfated or worn-out batteries.	See your authorized servicing dealer or engine distributor.
	Stretched poly-vee belt or defective belt tensioner.	Adjust belt tension or replace belts.
	PTO engaged.	Disengage PTO.
	Loose or corroded connections.	Clean and tighten loose connections.
	Low battery output voltage.	See your authorized servicing dealer or engine distributor.
	Faulty start circuit relay.	See your authorized servicing dealer or engine distributor.
<b>Starter cranks slowly</b>	Blown main system fuse.	Replace fuse. (See Wiring Diagram.)
	Low battery output.	See your authorized servicing dealer or engine distributor.
	Crankcase oil too heavy.	Use proper viscosity oil.
<b>Starter and hour meter functions; rest of electrical system does not function</b>	Loose or corroded connections.	Clean and tighten loose connections.
	Blown fuse on magnetic switch.	Replace fuse.
	Faulty battery connection.	Clean and tighten connections.
	Sulfated or worn-out batteries.	See your authorized servicing dealer or engine distributor.
	Blown main system fuse.	Replace fuse.



## Appendix C: Servicing Compressor

### AFTER THE FIRST 100 HOURS & AFTER MAJOR OVERHAUL

Drain sump, replace oil filter, clean sump & refill with recommended synthetic oil. □ Clean suction and delivery valves. □ *All components on these compressors are compatible with the recommended synthetic oil but as problems may exist with downstream ancillary equipment, the equipment manufacturer should be consulted.* □ METHOD □ Drain the oil completely from compressor whilst the oil remains warm.

#### 1. REMOVE CRANKCASE DOORS AND THOROUGHLY CLEAN INTERIOR OF THE CRANKCASE.

Clean suction strainer. □ Renew oil filter. □ Remove, thoroughly clean and refit all suction and delivery valves. □ When inspecting valves, also remove as far as is possible any carbon deposit in valve pockets, passageway pipes and separators. □ Replace crankcase doors and refill crankcase to correct levels with recommended synthetic oil.

#### 2. ROUTINE CLEANING AND INSPECTION - ALL STAGES □ *Valve maintenance is a simple procedure but the following guidelines should be observed:*

- a. Keep a spare oiled and maintained set of valve units in store for quick compressor servicing.
- b. Carbon may be removed scraping with a soft, blunt instrument, e.g. a piece of wood.
- c. **WARNING:** *Great care should be taken when removing carbon deposits to ensure that the seating faces of the valve components are not damaged.*
- d. *Note: Unless replacement of the springs and plates is intended, the order in which these components are removed should be carefully noted so that the valves may be reassembled with the same seating faces in contact.*
- e. These faces should be clean and bright over their whole area, with no evidence of uneven contact. Renew any plates that are indented, cracked, warped, or have wear grooves which exceed 10% of the plate thickness.
- f. Valve plates and springs must always be replaced at recommended life periods, regardless of appearance, to achieve maximum reliability.
- g. If the valve seats show severe wear or indentations, the complete valve assembly must be renewed. The remaining components should be checked for cracks, distortion or other damage liable to impair the valve operation.

#### 3. ROUTINE VALVE REMOVAL AND SERVICING □ *Valve removal is as follows for all stages.*

Clean all grease and dirt from valve covers and surrounding areas. □ Rotate crankshaft by hand until relevant stage piston is at top dead centre. □ Remove valve cover nuts. □ Use forcing screws to remove valve covers. □ Using the special valve lifting tools, remove valve assemblies. A gentle rocking action pulling at the same time will free the valve from any carbon build up in the pocket. □ Carefully wipe any loose carbon from valve pocket ensuring that no carbon is left in valve pocket or on top of the piston. □ Move valve to a workbench and remove central nut from valve unit. Carefully separate upper and lower bodies and, with unit on a level surface, lift off upper body. □ Remove valve plates and springs, noting very carefully their relative positions to the body and each other if they are to be re-

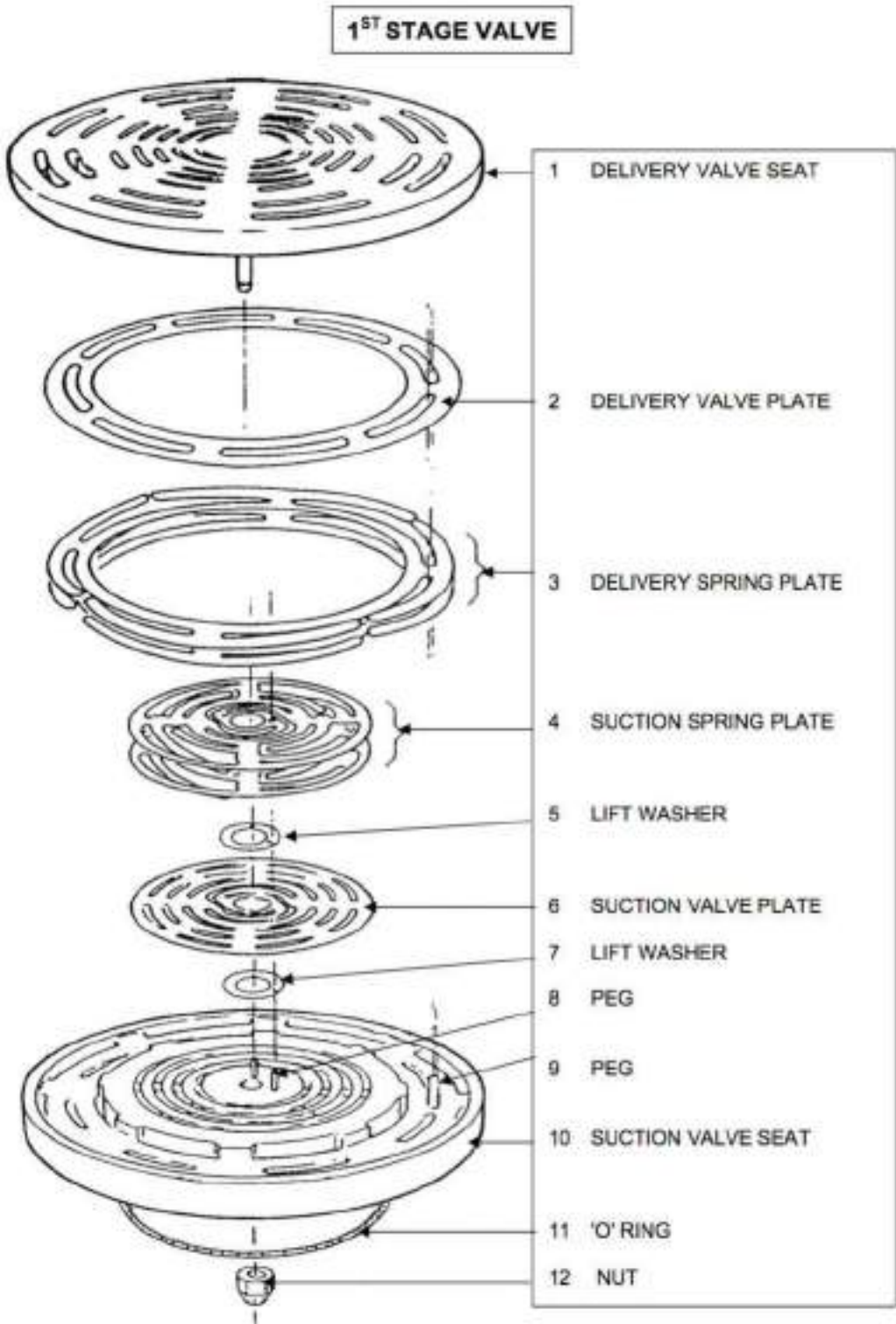
used.

#### **4. ROUTINE VALVE REPLACEMENT**

Recheck that valve / valve pocket, top of piston, and the surrounding area is clean before replacing valve assembly. □ Ensure valve seats properly as a slight misfit will entail loss of gas. □ Check valve cover for cleanliness before assembly.

Renew "O" rings, lightly greasing before fitting. □ There should be at least a 2mm gap between the top of cylinder and bottom of valve cover. Tighten cover-retaining nuts sequentially to the correct torque.

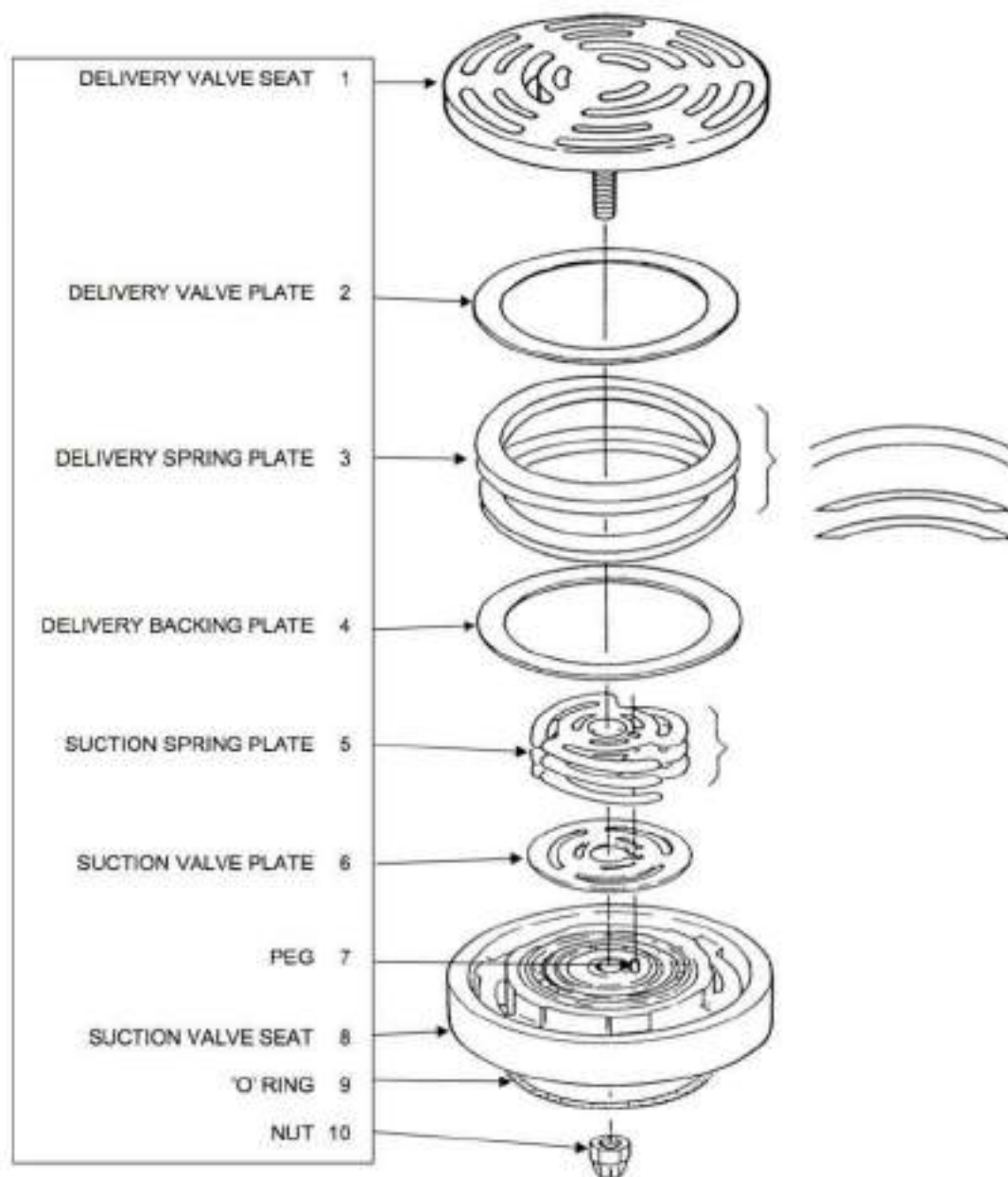
Appendix D: 1<sup>st</sup> Stage Valve Specifics



## FIRST STAGE VALVE REASSEMBLY

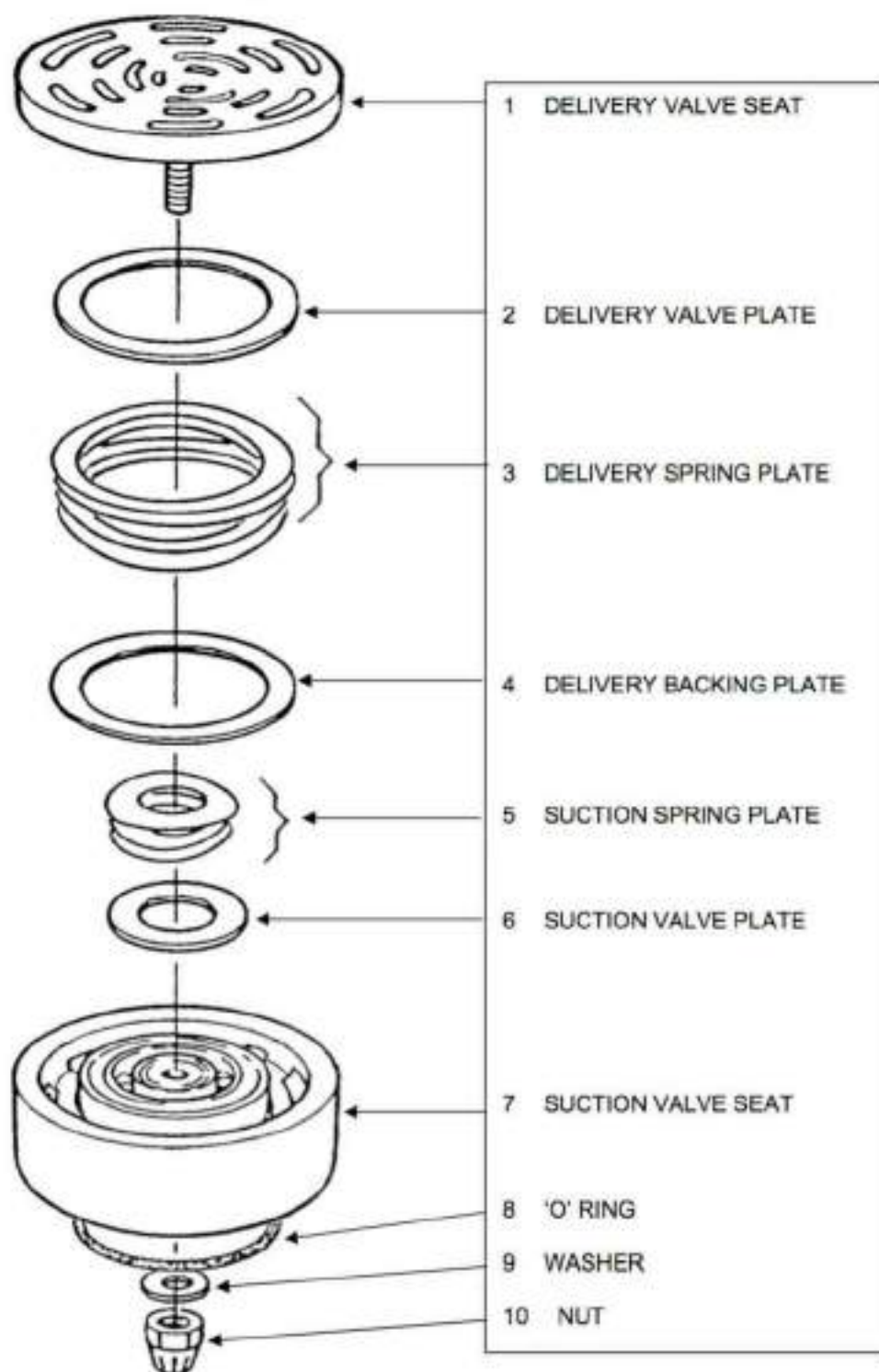
1. Place suction valve seat (10) face downwards on suitable metal ring, or protected open vice jaws with locating pegs uppermost. □ Position spring plates (3) to locate over pegs (9) with bridging strip resting between pegs and springs facing upwards.
2. Place valve plate (2) onto spring plate, located as above, ensuring concentricity with centre hole. Place middle lift washer (7) over hole, locating on pegs (8). □ Place valve plate (6) onto locating pegs (8). □ Place lower lift washer (7) onto locating pegs (8).
3. Place valve spring plates (4) onto locating pegs (8) with springs pointing downwards. □ Place delivery valve seat (1) onto assembly, ensuring inner (8) and outer pegs (9) engage correctly. If assembly has been carried out correctly, upper and lower body faces will contact. □ Screw nut (12) on stud and hand tighten only at this stage. □ Test for correct operation by ensuring free movement of suction and delivery valve plates. This is facilitated by gently pushing a small diameter plastic or nylon rod through the ports in the valve to check plates for freedom. □ If satisfactory tighten to the correct torque. If plates are not free, dismantle, relocate misplaced part and assemble, check again for free movement of plates before tightening to the correct torque. Ensure "O" ring (11) is secure in slot in upper valve body.



Appendix E: 2<sup>nd</sup> Stage Valve Specifics**2<sup>ND</sup> STAGE VALVE**

## SECOND STAGE VALVE REASSEMBLY

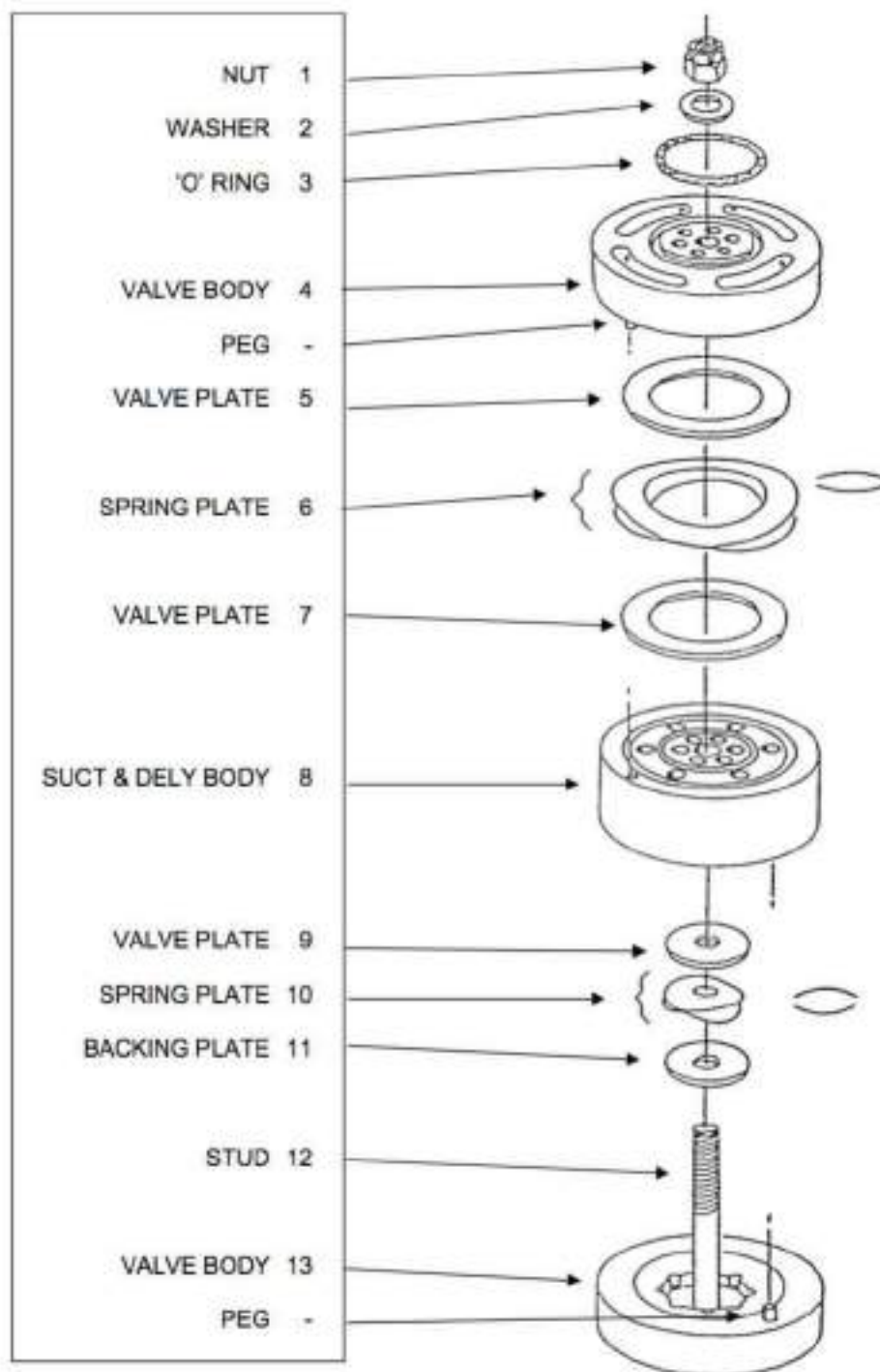
1. Place suction valve seat (8) face downwards on suitable metal ring or protected open vice jaws with locating peg (7) uppermost. □ Position suction valve plate (6) to locate over peg (7). □ Fit suction spring plates (5) onto valve plate, locating them on peg (7), springs facing downwards. Fit delivery valve backing plate (4) into outer recess of valve body.
2. Place delivery valve springs (3) onto backing plate having first positioned them as follows:
3. Assemble the delivery plate springs (3) in pairs, rotating one spring in each pair until the inner and outer circumferences are matched perfectly. □ Hold the two springs together with their concave faces facing each other and then rotate one pair until edges touch all round the outer circumference and there is a constant gap around the inner edge.
4. Place delivery valve plate (2) on spring plates and ensure concentricity. □ Place delivery valve seat (1) onto assembly. If all components are located correctly upper and lower bodies will contact. □ Screw nut (10) on stud and hand tighten only at this stage. □ Test for correct operation by ensuring free movement of suction and delivery valve plates. This is facilitated by gently pushing a small diameter plastic or nylon rod through the ports in the valve to check plates for freedom. □ If satisfactory tighten to the correct torque. If plates are not free, dismantle; relocate misplaced part and reassemble, checking again for free movement of plates before tightening to the correct torque. Ensure "O" ring (9) is secure in slot in upper valve body.

Appendix F: 3<sup>rd</sup> Stage Valve Specifics

### THIRD STAGE VALVE REASSEMBLY

1. Position suction valve seat (7) face downwards on suitable metal ring or open protected vice jaws. Fit delivery valve backing plate (4) into outer recess of valve body. □ Fit delivery valve spring plates (3) onto backing plate having first positioned them as follows: *Assemble the delivery plate springs (3) in pairs, rotating one spring in each pair until the inner and outer circumferences are matched perfectly.*
2. *Hold the two springs together with their concave faces facing each other and then rotate one pair until edges touch all round the outer circumference and there is a constant gap around the inner edge.* □ Place delivery valve plate (2) on spring plates and ensure concentricity.
3. Place suction valve plate (6) onto valve body ensuring concentricity with centre hole. □ Assemble the suction plate springs (5) and place on suction valve plate with springs facing downwards. □ Place delivery valve seat (1) onto assembly. If all components are located correctly upper and lower bodies will contact. □ Press together and ensure edges of upper and lower body contact then fit washer (9) and nut (10), hand tighten only at this stage. □ Test for correct operation by ensuring free movement of suction and delivery valve plates. This is facilitated by gently pushing a small diameter plastic or nylon rod through the ports in the valve to check plates for freedom. If satisfactory tighten to correct torque, however, if plates are not free, dismantle, relocate misplaced part and reassemble, checking for free movement of plates before tightening to the correct torque. □ Ensure "O" ring (8) is secure in slot in upper valve body.



Appendix G: 4<sup>th</sup> Stage Valve Specifics**4<sup>TH</sup> STAGE VALVE**

#### FOURTH STAGE VALVE REASSEMBLY

1. Place lower valve body (13) on a clean flat surface with stud (12) uppermost. □ Fit suction valve backing plate (11) in the valve recess followed by spring plates (10), arranged as shown, and suction valve plate (9). □ Fit central body (8) over stud and lower until locating hole engages with peg in lower body. □
2. Carefully push two valve body sections (8 & 13) together until in full and firm contact. If the sections will not locate correctly: separate and re-align to plates and springs. **DO NOT FORCE TOGETHER.** Invert upper body (4) and hold in a soft jawed vice or similar. □ Fit delivery valve backing plate (5) into recess followed by spring plates (6), arranged as shown, and delivery valve plate (7). □ With the central (8) and lower body (12) held firmly together; turn upside down and pass stud through hole in upper body (4), ensuring that the hole in central body engages with peg in upper body. If center section will not locate correctly with upper body: remove and re-align plates and springs. **DO NOT FORCE.**
3. Ensuring that all components are correctly located and held firmly together, remove from the vice and fit washer (2) and nut (1) and tighten to correct torque. □ When correctly located and tighten and fit new O ring (3).