

NO DIG *Equipment*

The Trenchless Technology Specialists

VM850

Vacuum Excavation System



**Directional Boring Mud Slurry Clean-Up
Potholing to Locate Buried Utilities
Valve Box, Catch Basin, Manway Cleanout**

Owner's Manual

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Important

Read all safety precautions and instructions carefully before operating this equipment. Refer to specific instructions on how to tow, set up, operate and empty the Vacuum Excavator. The machine must only be operated by an adult person who has both the physical and mental capacity to do so.

Ensure that the machine is shutdown prior to trying to perform any maintenance tasks on it.

Whilst this machine has a wide variety of capacities it is not intended to be used for any of the following purposes: -

- Water blasting or vacuum excavation of any strongly acidic or alkaline solids or liquids;
- Vacuum excavation of materials such as asbestos fibres or other similar hazardous materials;
- Vacuuming of any flammable or combustible liquid or solid where the mixture of a high quantity of air may lead to either a combustible or explosive atmosphere;
- Vacuuming of "contaminated wastes" such as human or animal effluent, food grease traps etc. as the machine is not designed to be licensed to perform such tasks;
- Water blasting of people or animals, or water blasting near where people or animals are likely to walk or stand.

Warranty coverage for the machine is in accordance with the Australian Consumer Guarantee under the Competition and Consumer Act 2010 (the "Act"). As such, no warranty cover is provided to damage caused to the machine by operator error or omission or from incorrect towing or vehicular accident. Refer to correct operating instructions detailed in this manual.

With correct operation, maintenance and care, the VM850 Vacuum Excavator is designed for many hours of operating use. If it does not function correctly, please consult the troubleshooting guide for potential causes and remedies. If that fails to resolve the issue, please contact our maintenance department for assistance.

Model No:	VM850
Serial Number:	_____
Purchase Date:	____ / ____ / 20__
Original Purchaser:	_____

Vacuum Tank
Hazard Level to AS4343

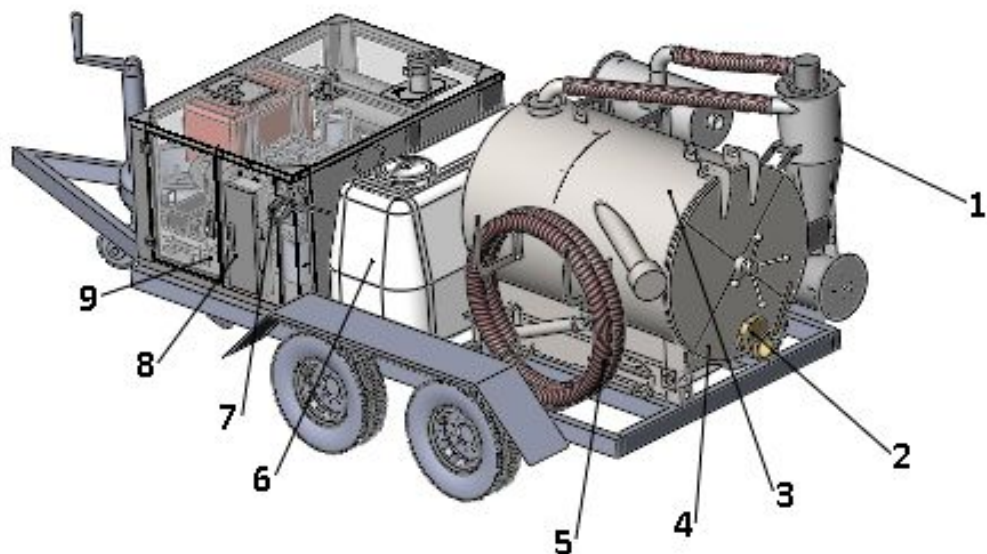
Hazard level "E" - No
design verification or
inspection required for
Australian standard
compliance.

Safety Precautions – Summary

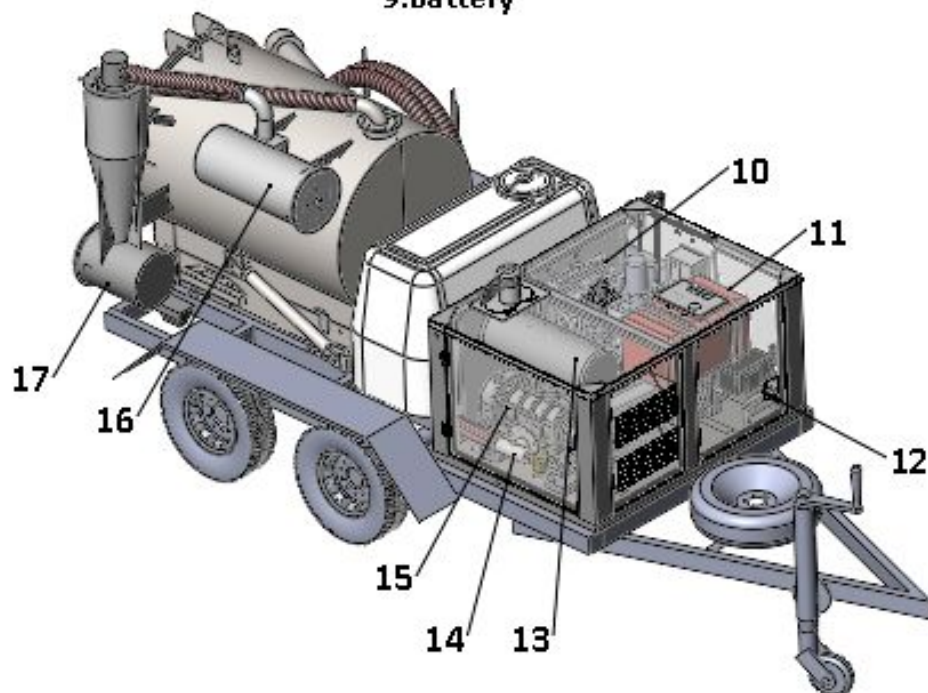
The following safety precautions must be observed with the VM850 Vacuum Excavator:

Towing The towing vehicle must have: - • 3.5 tonne towing capacity • 50mm tow ball / ring hitch • Standard trailer electrical plug • Electric Brakes fitted Maximum Towing Speeds: - • 80 km/hr on sealed roads • 60 km/hr on unsealed / rough roads Before driving off: • Attach safety chains • Raise and stow trailer jockey wheel • Release handbrake & stow wheel chocks	Parking & Set-up When parking and setting up: - • Do not park on a tilt angle greater than 25 degrees lean angle in any trailer direction • Apply the trailer and if attached, the vehicle park brake • Lower the trailer jockey wheel • Install wheel chocks Do not park in a situation that will: - • Cause a traffic hazard • Interfere with other workplace machines • Be hazardous to pedestrians
Operating Environment The exhaust gases from the machine engine are toxic. Hence: - • Do not operate in a fully or partially enclosed building such as a warehouse or building basement, unless sufficient fresh air is available The noise from the operating machine is high. Hence: - • Do not operate in areas at time where noise restrictions apply	Operating Water Blaster Whilst water blasting, do not blast: - • Any person or animal with the water blast • Too close or at an angle to the ground in a manner that produces a lot of blow back Do wear: - ✓ Fully enclosed footwear ✓ Long trousers ✓ Sealed safety glasses or goggles
Operating Vacuum Sucker Whilst vacuum sucking, do not: - • Bring the end of the suction nozzle into contact with a person's skin • Plunge suck into either a liquid or solids as the suction action will stop • Collect acidic, alkaline, flammable or combustible materials or controlled waste. Do: - • Suck up material dislodged by the water blaster • At a maximum, only half cover the end of the suction hose nozzle	Emptying Spoil Tank Prepare for spoil tank emptying by: - • Positioning trailer in suitable dump location • Positioning the vehicle on flat ground • Drain liquids first by drain valve Open the dump door by: • Unlocking the door whilst the vacuum pump is still on • Stand clear and turn off vacuum pump- door will swing open by itself • Wash out tank with water blaster

Machine Overview



- | | |
|--------------------|-------------------------|
| 1.Cyclonic Filter | 10.Kohler Diesel Engine |
| 2.Drain Valve | 11.Fuel tank |
| 3.Vacuum Tank | 12.Water Pump |
| 4.Vacuum Tank Door | 13.Silencer |
| 5.Suction Hose | 14.Relief Valve |
| 6.Water Tank | 15.Blower |
| 7.Water lance | 16.Filter Housing |
| 8.Control Panel | 17.Dust Collector |
| 9.battery | |



Operating Principles

The Vacuum Excavator works on the principle of air velocity in order to produce suction at the end of the suction hose nozzle. Therefore, if the end of the suction hose is fully plunged into either a solid or liquid no air flow will occur and there will be no suction.

The vacuum system uses a 3 stage filtration system in order to filter dirt from the air stream. Firstly, solid or liquid material is drawn into the air stream at the end of the suction hose and travels to the spoil tank. Due to a sudden change in volume in the tank, the air speed dramatically drops and the solid or liquid material falls out of the air stream into the spoil tank.

Second filtration is by cyclone to remove any coarse dust particles.

Then the third and final stage removes dust from the air stream via a cartridge type air filter.

Air flow through the whole air circuit is important to ensure that suction is maintained. It is critical not to overload the filters in the air stream circuit. This is best achieved by not sucking dry material into the machine. Therefore always use water to break up the ground to be sucked away by using the in-built water blaster.

The “No-Dig” action of the machine is achieved by firstly wetting, loosening and breaking up tight hard ground with the water blaster and then sucking away the loosened ground with the vacuum hose. The machine is primarily designed as a two person operation where one person is performing the water blasting operation whilst the other is vacuuming away the loosened material.

The primary design intent of the machine is to loosen and suck away ground and small rocks around buried services or in tight work areas.

The machine is not designed or intended for vacuuming toxic or hazardous material. In case of accidental contact with toxic or hazardous material use appropriate dumping and clean out procedures.

Operating Instructions

Towing the Vacuum Excavator

Task	Step	Key Points
Trailer inspection	Complete a trailer inspection using the checklist on the right.	 ACTIVITY Check the following items on the trailer: - • Any obvious damage to the trailer structure. • The tyres are correctly inflated. • The wheel nuts are tight. • The handbrake is operational. • The safety chains are in good order. • All trailer lights are in good condition. • The wheel chocks are available.
		 DANGER!! Do not tow the trailer if any faults are found.
Towing vehicle inspection	Complete a towing vehicle inspection using the checklist on the right.	 ACTIVITY Check for the following items on the towing vehicle: - • Minimum towing capacity 3.5T. • 50mm tow ball hitch or ring hitch with safety chain connection rings. • Electric Trailer Braking System. • Correct vehicle tow height for the trailer.
		 DANGER!! Do not tow the trailer with an undersized towing capacity vehicle. DANGER!! Do not tow trailer if vehicle does not have electric brakes fitted.
Connect Trailer to towing vehicle	Raise the trailer tow hitch to above the height of the vehicle tow ball.	Wind the jockey wheel handle in order to raise the trailer hitch to be just slightly higher than the trailer tow ball.
	Position tow ball under the trailer tow hitch.	Either back the vehicle or move the trailer into the correct position. Be aware that the trailer is very heavy and difficult to move. Apply hand brake on towing vehicle.

Task	Step	Key Points
	Lower the trailer hitch onto the vehicle tow ball.	Wind the jockey wheel handle in order to lower the trailer hitch onto the towing vehicle tow ball. Remember to open the trailer tow ball hitch to allow the ball to fully engage with the hitch. Secure tow ball hitch and lock out.
	Stow the jockey wheel.	With the trailer correctly connected to the trailer, release the jockey wheel clamp and swing the jockey wheel 90° to ensure it is clear of the road.
	Connect the safety chains.	Connect the safety chains on the trailer to the connection links on the towing vehicle tow hitch.
	Connect the electrical connections.	Connect the trailer electrical connections to the towing vehicle and check for correct brake light and indicator light operation.
	Stow wheel chocks.	Collect the wheel chocks from the ground and stow in brackets on the trailer.
	Release the trailer handbrake.	Operate the trailer handbrake lever and ensure that the brakes are released.
		 DANGER!! Ensure that the reversing arm is returned to open position to enable the trailer brakes to auto operate.
Towing Trailer	Test vehicle / trailer brakes.	If possible, on a flat good road surface test that the towing vehicle can brake and hold the trailer.
		 DANGER!! If the towing vehicle is having trouble being able to brake with the load of the Vacuum machine trailer then do not tow further.
	Tow at a safe road speed.	 NOTE The Vacuum Excavator and trailer have poor aerodynamics and when the drum has contents in it, it has a high centre of gravity. Only tow the VM850 Vacuum Machine trailer at the following maximum speeds: - • 80 km/hr on good sealed roads. • 60 km/hr on unsealed or poor condition sealed roads. If strong cross winds or slippery roads, reduce speed accordingly.

Task	Step	Key Points
	Trailer auto-brakes will assist in braking the trailer.	 REMEMBER! The trailer is fitted with electric brakes that will assist in the overall braking effort. Some adjustment may be required.

Parking and Set-Up

Task	Step	Key Points
Positioning the Trailer for operation	Position trailer with towing vehicle.	Use the towing vehicle to position the Vacuum Machine in the correct location.
	Check for reasonably level surface. No greater than 25° lean angle.	Both the engine and the blower have lubricating oil sumps in them. If the trailer is parked at an angle of greater than 25° then oil starvation and equipment damage can occur.
	Apply towing vehicle and trailer park brake.	Apply towing vehicle handbrake from inside the vehicle and then apply the trailer hand brake.
	Install trailer wheel chocks	Collect trailer wheel chocks from the trailer and position under the trailer wheels in the direction of most likely trailer movement.
	Lower jockey wheel.	If detaching the towing vehicle from the trailer, release the jockey wheel bracket, swing down 90°. Wind down jockey wheel until it is touching the ground.
	Disconnect the trailer from the towing vehicle if required.	The Vacuum Machine trailer can remain attached to the towing vehicle or detached if required.  ACTIVITY If you wish to detach the towing vehicle then: - ● Disconnect the electrical connection. ● Disconnect the safety chains. ● Release tow ball on trailer tow hitch. ● Wind up jockey wheel until the tow hitch clears the tow ball. ● Drive towing vehicle away.

Operating Environment

Task	Step	Key Points
Check for adequate fresh air in operational area	Check that the operating area has adequate fresh air.	 DANGER!! DO NOT operate the Vacuum Machine in an enclosed or mostly enclosed building, tank or underground basement without providing adequate fresh air to the operator's position.
	 Note: The engine exhaust gases are toxic.	 ACTIVITY If used in an operating area where fan forced fresh air is provided to the operator's, ensure that they also wear a gas monitor for: - • High levels of Carbon Monoxide and Carbon Dioxide; • Low levels of Oxygen.
Operating Noise	Both the engine and blower make loud industrial noise.	Consider the impact of the operating noise of the Vacuum Machine if used in an area near residential, office or shopping areas. Also some planned work locations may have night time noise restrictions.

Operating Vacuum Excavator

Task	Step	Key Points
Perform a pre-start check	Perform pre-start check of the trailer engine and blower.	 ACTIVITY Complete the Engine and Blower pre-start check list section of the Vacuum Excavator
Lay out suction hose	Set up the suction hose and connect to the spoil tank.	Unroll the suction hose from the machine and lay it out on the ground. Ensure that it is not forced around tight corners that will damage the hose. Attach the suction hose to the spoil tank using the Camlock fittings.
		 REMEMBER! The suction hose is heavy duty and quite heavy to lift. Best performed as a two person operation.

Task	Step	Key Points
Start the engine	Start the engine in order to provide power to drive the blower.	 ACTIVITY Start the trailer engine by: - • Turn the battery isolator on. • Rotate Emergency Stop to off (out) position • Check for adequate fuel and turn fuel lever to half. • If petrol engine set the choke if the engine is cold. • Turn and hold the ignition key in the "on" position until the engine starts. Let go of the key. • If the engine is cold, allow it to warm up for several minutes. • When the engine is warm, bring the operating speed up to full speed.
Vacuum Excavation	Wear correct Personal Protective Equipment (PPE).  Two person operation.	The combined operation of water blasting and vacuum excavation can generate blow back of high velocity particles. The operator and persons nearby must wear: - • Face shield; • Ear plugs or muffs; • Industrial clothing or disposable overalls; • Closed in footwear.  NOTE The removal of ground material using the Vacuum Excavator is best performed as a two person team. One person operates the water blaster, whilst the other the vacuum hose / nozzle.
	Initial ground breaking.	First operate the water blaster from a distance to wet the ground or completely wet it with a garden hose. This will minimise dust generation. As the ground becomes wetter, bring the water blaster nozzle closer to the ground surface, but not too close to cause extensive splash back. When loose ground is produced by the water blaster, vacuum it away with the vacuum hose nozzle with a maximum of 50% of the nozzle in the material. DO NOT plunge the nozzle completely into the ground as this will result in loss of vacuum and thus no material removal.

Task	Step	Key Points
		 REMEMBER! DO NOT suck dry dusty ground material, otherwise the machine dust filters will quickly become clogged resulting in reduced or no suction.
	Working the exposed face.	When the initial section of material has been removed, it will form an edge. It is best for the water blaster operator to blast and break away the exposed edge whilst the vacuum hose operator sucks away the loosened material.
Reduced suction	Operator notices reduced or no suction.	 ACTIVITY If reduced suction is noticed, check the following: - • Suction nozzle is completely covered. Remove whatever is covering the nozzle. DO NOT plunge the complete nozzle in solids or liquids. • Blocked suction hose. A large object may have lodged in the suction hose and a blockage has built up around it. Shut down the engine, remove the suction hose and remove blockage. • Engine speed has dropped or stopped. Check if the engine has run out of fuel. • Full spoil tank. Empty the drum. • Blocked filter. Shut down the machine, remove and clean the filter. • Added length of suction hose. Reduce suction hose length to standard supplied length.
Shutting down the Vacuum Excavator	Shut down water blaster.	Switch off the water pump on the control panel in order to stop the water blaster.
	Empty the suction line.	Lay the suction hose down with the nozzle completely open to allow any material in the suction hose to be sucked into the spoil tank.
	Shut down engine. (Leave it on if material discharge is going to occur at current work location)	Lower the engine speed to idle. After 10 seconds at idle, turn the ignition key to the 'off' position.
Emptying the spoil tank	Choose the discharge location.	The material spoil tank can be emptied at the work location or towed to a different location.

Task	Step	Key Points	
	Empty spoil tank.	 NOTE If the trailer is going to be towed to a different location for emptying, always following the towing instructions detailed earlier in this manual. Also stow water blasting and suction hoses as detailed below.	
		 ACTIVITY • Ensure that the engine is at full speed in order to achieve full suction. • Move to the rear of the spoil tank and unscrew the central door handle until it is completely released. As long as suction is being maintained, the door will remain closed. • Whilst no person is standing in front of the door, return to the engine, reduce the speed to idle then switch it off. • The tank door should open by itself and the material should discharge. • Raise tank by hydraulic tipping to empty the bowl content.	
	Washing the inside of the spoil tank.	Use the water blaster to wash out any remaining material.	
		 NOTE Do not water blast the rubber seal at the end of the tank, otherwise the seal can become damaged and prevent correct vacuum seal for the next operation.	
		 DANGER!! Do not enter the spoil tank without following Confined Space entry procedures.	
	Leave spoil tank door open to allow to dry out.	If desired the tank door can be left open to allow it to dry out.	
		 DANGER!! Ensure that no member of the public can access the open tank.	
		 DANGER!! Be aware of the pinch point area between the door and spoil tank. Keep all hands and fingers clear of this area.	
		When the locking screw is engaged, the door can be fully closed by winding the locking handle in until it is tight.	

Task	Step	Key Points
Packing up hosing.	Disconnect and pack away suction hose.	Disconnect the suction nozzle from the suction hose and stow it. The suction hose can remain connected to the tank and coil up hose on the provided hook.
	Disconnect and pack away water blaster.	 REMEMBER! The suction hose is heavy duty and heavy to lift. Best performed as a two person operation. Disconnect the water blaster gun from the hose and stow it. Wind up the water blaster hose onto the hose holding area.

Operating Water Blaster

Task	Step	Key Points
Perform a pre-start check.	Perform pre-start check of the water blaster.	 ACTIVITY Complete the Water Blaster pre-start check list section of the Vacuum Excavator
Lay out pressure hose and attach water gun	Set up water pressure hose and gun.	Uncoil water pressure hose from the machine and lay it out on the ground. Ensure that no kinks are present in the hose. Attach the water gun to the end of the hose using the quick connect fittings.
Start the trailer engine.	Start the engine in order to provide power to drive the high pressure water pump.	Start the trailer engine as detailed in the "Vacuum Excavation" operating instructions. Allow the engine to warm up for several minutes. Bring engine up to full speed.
Water Blasting	Wear correct Personal Protective Equipment (PPE).	The operation of water blasting can generate blow back of high velocity particles. The operator and persons nearby must wear: - • Face shield; • Ear plugs or muffs; • Industrial clothing or disposable overalls; • Closed in footwear.
	Engage the water pump via	Engage the water pump clutch by

Task	Step	Key Points
	the control panel.	switching the electric clutch to the “On” position on the control panel.
	Operate the trigger on the water gun.	Operate the trigger on the water gun to commence blasting operations.
	Water blast at the correct angle to exposed face.	The water blasting action will work best if performed at a slight angle from the vertical and “biting” away slowly from the exposed face.
	DO NOT water blast people or animals.	 DANGER!! Water blasting can cause injury to persons and animals. DO NOT water blast any part of a person's body or use it to wash.
	Do not run water pump dry.	Always ensure that there is adequate water in the water tank prior to operation of the water blaster. Damage will occur to the water pump if it is run dry.
Completed Water Blasting	Shut down water pump when water blasting has been completed.	If no further water blasting is going to occur for a period exceeding 1 minute, shut down the water pump by switching the electric clutch to the “Off” position. Damage will occur to the water pump if no flow occurs for an extended period of time.
	Switch off water pump.	When all water blasting has been completed, switch water pump to the “Off” position.
	Disconnect water Lance	Disconnect the water blasting gun from the hose using the quick connect coupling. Stow water blasting gun on trailer.
	Stow water blasting hose.	Wind up and stow the water blasting hose on the trailer. Ensure the hose is not kinked whilst stowing it.

End of Day (Shift) Servicing of the Vacuum Machine

Task	Step	Key Points	
End of day (shift) servicing.	Shutdown and if required isolate the engine, using battery isolator.		DANGER!! The machine drive engine must be shut down. If required by your worksite, switch off battery isolator and lock it out prior to performing any servicing tasks.
	Clean the blower pre-filters.	The blower is protected by a cyclone pre-filter and final cartridge filter.	
	Cleaning cyclone filter.	Remove the cover door & place to one side. The chamber may have some collected dust. Sweep the dust out with a brush. If this chamber has a lot of dust in it, the suction work has been performed "too dry". Next time use more water. Replace the cover door.	
	Cleaning filter cartridge.	Remove cover door & place to one side. Remove the cartridge filter and at a separate location either blow it clean with compressed air (max pressure 100 kPa) or wash it with a garden hose. Do not use the water blaster. If washed allow the filter to dry before reinstalling.	
			NOTE DO NOT bang filter cartridge on ground to clean it, as it will damage the filter and potentially cause damage to the blower.
	Reinstall filter cartridge.	When the filter cartridge is clean and dry, reinstall into the chamber and replace the cover door.	
	Refill the water tank.	For most work tasks the water tank has sufficient quantity of water to last one waste tank fill. Refill the tank with water as required. Only use clean water to fill the tank and do not add any detergents etc. Check and if necessary clean the water filter.	
	Refill engine fuel tank.	For most work tasks the fuel tank has enough fuel to last one day or shift. Refill the fuel tank with the correct fuel at the end of the working day.	
	Conduct a general condition check.	Conduct a general condition check of the machine looking for oil leaks, damaged hoses, flat tyres etc.	

Trouble Shooting Guide

If your Vacuum Machine fails to function correctly, refer to the following table for potential issues and solutions.

Symptom	Cause	Solution
Engine does not turn over	a) Low or dead battery b) Corroded or bad connections c) Faulty ignition switch d) Faulty starter motor e) Seized blower	a) Charge or replace battery b) Clean or replace connections c) Replace ignition switch d) Replace starter motor e) Clean out or replace blower.
Engine does not start	a) Emergency Stop pressed in b) Battery Isolator c) Empty fuel tank d) Fuel line disconnected e) Dirty fuel filter f) Faulty fuel pump g) Faulty spark / glow plugs h) Faulty ignition coil	a) Release Emergency Stop b) Open Battery Isolator switch c) Refill fuel tank d) Connect fuel line e) Replace fuel filter f) Replace fuel pump g) Replace spark / glow plugs h) Replace ignition coil
Engine lugs or stalls	a) Empty fuel tank b) Engine speed too low c) Vacuum relief blocked or set too high d) Air filter blocked	a) Refill fuel tank b) Increase engine speed to 3600 RPM c) Clean relief area or readjust relief setting d) Clean or replace air filter
No water pressure	a) Water pump not switched on b) Water tank empty c) Water filter blocked d) Water nozzle blocked e) Air in water system f) Water pump not turning g) Blocked water supply hose h) Faulty water pump	a) Switch on water pump b) Refill water tank c) Clean or replace water filter d) Clean or replace nozzle e) See below (air in water system) f) See below (water pump) g) Clean or replace hose h) Replace water pump
Low water pressure	a) Water filter partially blocked b) Air in the water system c) Leak in the water system d) Water pump turning too slow e) Incorrect nozzle size or worn out nozzle	a) Clean or replace water filter b) See below (air in water system) c) Repair leak d) See below (water pump) e) Replace with correct or new nozzle
Water pressure fluctuates up and down	a) Air in the water system b) Leak in the water system c) Water filter partially blocked	a) See below (air in water system) b) Repair leak c) Clean or replace water filter
Water pump not turning or turning too slowly	a) Engine speed too low b) Water pump frozen c) Faulty water pump	a) Increase engine speed to 3600 RPM b) Thaw out pump c) Replace water pump
Air in water system	a) Cracked filter housing b) Loose fitting(s) c) O-ring missing or damaged in water filter	a) Replace filter housing b) Tighten fittings c) Replace O-ring

For further assistance, please call No Dig Equipment Service Department on **(08) 9493 0642**.

Our technician will be pleased to assist you with your questions

Alternatively call into our Service Department at:

**NO DIG Equipment
15 Wildfire Road
Maddington WA 6109**

Daily (Shift) Pre-Start Checklist

The following two-page checklist should be used at the start of each working day (shift) relevant to the area(s) of the Vacuum Machine that will be used during the working day. A relevant section of the checklist may be filled out just prior to that area of the machine being used.

Vacuum Machine Location _____ Date: _____

Pre-Start - Towing

#	Pre-Start Check Requirement	Initials
1	Check general condition of the trailer – no damage or protruding items – spoil tank door closed.	
2	Check tyres are correctly inflated and no visual damage to them.	
3	Check wheel nut tightness – Tight turning the heavy trailer can cause the wheel nuts to loosen.	
4	Check that the towing vehicle has a minimum of 3.5 tonne towing capacity with electric brakes.	
5	Check that towing vehicle has a standard diameter 50mm tow ball or pintle hook for ring hitch	
6	Connect trailer to vehicle – Check safety chains are secured and electrical connections made.	
7	Check for correct operation of all trailer lights.	
8	With vehicle handbrake applied, check that trailer handbrake is released.	
9	Stow jockey wheel and wheel chocks correctly.	

Pre-Start – Operational Set-Up

#	Pre-Start Check Requirement	Initials
1	Check that trailer handbrake is applied and wheel chocks installed.	
2	Ensure that trailer operation angle does not exceed 25 degrees in any direction.	
3	Check that the operational environment is not in an enclosed or partially enclosed building.	
4	Plan where the removed material will be dumped.	
5	Check that the planned material to be removed is not acidic, caustic, combustible, flammable, toxic or hazardous material such as asbestos etc.	

Pre-Start – Water Blaster

#	Pre-Start Check Requirement	Initials
1	Check that the water tank has sufficient water in it.	
2	Check for correct oil level on the water pump – look at sight glass.	
3	Check the condition of the water pressure hose – no damage or kinks	
4	Check the condition of the water blaster lance & nozzle. Do not inspect whilst connected to hose.	
5	Check that the quick connect functions correctly.	
6	Visual checks for water leaks in hoses from water tank to pump.	
7	Clean water filter if required.	
8	Operator is competent to use the water blaster.	

Pre-Start – Vacuum Excavation

#	Pre-Start Check Requirement	Initials
1	Check that the cartridge filter is correctly installed – lower damage can occur if not fitted.	
2	Check that the spoil tank door is correctly closed.	
3	Check that the spoil tank door valve is closed.	
4	Check that the blower has correct oil level – Refer to sight glass on blower.	
5	Check that the engine has sufficient engine oil – Use dip stick.	
6	Check that the fuel tank has sufficient fuel and correct fuel type.	
7	Check condition of suction hose, nozzle and cam lock.	
8	Determine if noise restricted area during certain times of the day.	
9	Operator has sufficient physical strength to hold the suction hose and nozzle.	
10	Operator is competent to use the vacuum excavating machine.	

Pre-Start – Spoil Tank Emptying

#	Pre-Start Check Requirement	Initials
1	Check that dump location is suitable for material release.	
2	Determine if liquid or solid material is to be released first. Refer to operating instructions.	
3	Check that the tank door can swing open when the vacuum is turned off.	
4	Do not blast rubber door seal when washing out the inside of the spoil tank.	
5	Do not enter the spoil tank without a Confined Space permit.	
6	Operator or two person team have sufficient physical strength to close the spoil tank door.	

Service and Maintenance Check List

Plant #	Hours	Number Plate	Service Person	Date

Maintenance Schedule (hrs)	10	25	100	200	500
Blower - Greatech G100V					
Check Oil Level (½ way up sight glass) add if req.					
First oil change after 100 hours (one time)					
Change oil – Carter EP 220 enclosed gear oil					
Check belt tension					
Check relief valve to ensure it is working properly					
Inspect vacuum lines for leaks and breaks.					
Water Pump - Garpen 1814B					
Check Oil Level (½ way up sight glass) add if req.					
Change oil – engine oil 10W40					
Check clutch screws, tighten if req.					
Check belt tension					
Check operating pressure re set to 3000 Psi if req					
Trailer John Papas trailer, at minimum check every 6 month.					
Check trailer plug and lights- repair if faulty					
Check tyres & rims for splits or cracks					
Check wheel nuts for adjustment					
Check tyre pressure 60 Psi					
Check brake cable tension adjust if required					
Check disc rotors and pads replace if required.					
Grease all grease points hitch, jockey wheel, suspension.					
Check, inspect & grease wheel bearings if required					
Hydraulic Power Unit					
Check oil level and top up if required with ISO 32 hydraulic oil					
Check fittings and hoses for oil leaks					



Service to be completed every 'x' hours

Plant #	Hours	Number Plate	Service Person	Date

ORDINARY MAINTENANCE: After the first 50 working hrs, replace engine oil and oil filter.

Kohler Engine KDW 1404: Extraordinary maintenance		FREQUENCY (X) HOURS						
		<i>Note</i>	10	250	500	1000	5000	10000
CHECK	Engine oil level							
	Coolant level							
	Air filter (dry-type)	***						
	Radiator exchange surface	**						
	Valve clearance adjustment	**						
	Fan/alternator belt stretch	*						
	Cooling liquid hoses	*						
	Setting and injectors cleaning	**						
	Fuel pipes							
	Rubber intake hose (air filter and intake manifold)							
	Interior radiator cleaning							
	Alternator and starting monitor							
REPLACEMENT	Engine oil (Diesel E-Oil 10W40)	*						
	Oil filter	*						
	Fuel filter	*						
	Alternator belt	**						
	Coolant	**						
	Filter element panel air filter	***						
	Fuel pipes	**						
	Cooling liquid hoses	**						
	Rubber intake hose (air filter and intake manifold)	**						
	Timing belt	^	Every 4000 hours					
	Dry air cleaner external cartridge	***	After 6 checks with cleaning					
OVERHAUL	Partial							
	Total							

Please note:

- * In case of low use- every year
- ** In case of low use- every 2 years
- *** Air filter must be cleaned and replaced more frequently in dusty conditions
- ^ Once removed, the timing belt should be replaced even if its scheduled motion period is not over.



Service to be completed every 'x' hours

Operational Risk Assessment

A number of Occupational, Workplace Health and Safety and Mining Safety Acts or Regulations require an operational risk assessment to be supplied by the equipment provider to the end user.

Detailed on the following pages is an operational risk assessment for the towing, set up, operational use and cleaning of the Vacuum Excavator including water blasting and vacuum excavating. The risk assessment is strictly operational and as such does not include any non-operational maintenance tasks that may need to be performed on the machine from time to time. For example, engine oil change etc.

The Risk Assessment assumes that the operator will become competent in the operation of the machine via reading and following the operating instructions detailed in this Operating Manual. Any deviation from the operational instructions or misuse of the machine either deliberately or inadvertently will potentially leave the operator or nearby persons at risk of injury or harm to their health.

It is essential that the operating person(s) need to have both the physical strength and mental capacity to safely operate the machine. As such, the machine shall only be operated by adult persons who have the required capacities.

Furthermore, it is essential that the vacuum system does not remove any material that due to the combination of the large quantity of air could lead to the creation of either an explosive or flammable environment in the spoil tank.

It is also essential that all operators review this risk assessment and use it as a basis of performing their own “on the job” hazard assessment and control as required by relevant occupational, workplace or mining operations health and safety laws.

Safe Work Method Statement (SWMS)

Equipment:

Category: Vacuum Excavation Plant
Equipment Type: Vacuum Excavator (Truck or Trailer)
Equipment Make Model: No Dig Equipment VM400/850/2000/3000/4000/4500

Risk Ranking Matrix

Consequence Likelihood	Low (C1) Low level impact Environmental impact small localised and contained; Possible first aid	Minor (C2) FAI most probable outcome; Environmental impact, contained impact, requiring minor remedial action.	Moderate (C3) MTI or LTI most probable outcome; Environmental impact, medium term contained impact requiring considerable remedial action.	Major (C4) LTI most probable outcome; Environmental contamination off-site, considerable remediation required	Critical (C5) A fatality(s) most probable outcome; irreparable environmental contamination.
Rare (L1) Consequences may occur under exceptional circumstances	L2	L3	L4	M5	M6
Unlikely (L2) Consequence may occur at some time	L3	L4	M5	M6	H7
Possible (L3) Consequence could occur at some time	L4	M5	M6	H7	H8
Likely (L4) Consequence will probably occur at some time	M5	M6	H7	H8	E9
Almost certain (L5) Consequences expected to occur in most circumstances	M6	H7	H8	E9	E10

Minimum Requirement for operating Vacuum Excavation Equipment

Mandatory PPE	Pre-start checks / maintenance required	Specific Personnel Qualifications and Training
• Appropriate Clothing / Gloves / Safety Boots • Eye Protection / Face Shield • Hearing Protection	• Daily pre start of the equipment • Plant pre start checklist • Regular equipment maintenance	• Operator must be competent and trained in the use of the machinery • Project and site specific training • Work Safely in the Construction Industry

Assessment of: Vacuum Excavator (Truck / Trailer)										
Risk Assessment						Treatment				
Activity Sub Hazard / Aspect Activity			Inherent Risk			Description of Control	Responsible Person	Residual		
			L	C	S			L	C	S
Obtain relevant Licenses, PPE and Site Inductions, prior to traveling to site	Unsafe work practices due to insufficient general or site specific safety training	Personal injury	3	3	6	Ensure operator has appropriate truck license onsite, Induction prior to start of work. Ensure correct PPE is worn at all times without exception; Safety glasses , ear plugs, long sleeves shirt and pants, steel cap boots, hi-visibility shirt/vest, UV sunscreen, Sufficient drinking water & breaks in heat stress Environments. Recommended PPE : long sleeves and pants, gloves, chaps, high-impact face shield, hearing protection.	Supervisor/Work Team	2	2	L4
Travel to work site	Vehicle accidents and breakdowns	Personal injury and plant damage	3	3	6	Ensure to complete ‘Daily Plant & Equipment Checklist’ prior to driving to site. Ensure vehicle is roadworthy. All employees MUST not be under the influence of drugs and/or alcohol. Ensure the appropriate driver’s license for the type of vehicle to be driven. Ensure Vehicle is rated to tow trailer ie. 2T, 3.5T with electric brakes etc	Supervisor/Work Team	2	3	M5
	Attaching Vacuum Excavator to Towing Vehicle (trailer only)	Personal injury and plant damage	3	3	6	Secure cable to the tow vehicle hitch, leave slack in cable to allow for the turning radius of the trailer. Check Trailer Breaking system Pull out the cable switch on trailer with electric brakes. Pull the surge brake lever forward on surge brake trailers. Pull the trailer forward with the tow vehicle. The brakes of the trailer should be engaged and provide resistance to motion. Install the cable switch. Connect the trailer electrical connector. Familiarise yourself with the hazard alert decals on the vacuum excavator. ie (80 km /hr) Make sure all components are stored & secured properly Close all valves and doors	Work Team	2	2	L4

Assessment of: Vacuum Excavator (Truck / Trailer)										
Risk Assessment						Treatment				
Activity Sub Hazard / Aspect Activity			Inherent Risk			Description of Control	Responsible Person	Residual		
			L	C	S			L	C	S
Park vehicle and/or machinery onsite	Hit by traffic onsite	Personal injury, and plant damage	3	4	7	Use a Spotter when possible, especially when reversing. Ensure that the parking of vehicles does not place anyone at risk of being hit by a passing vehicle or backed into.	Supervisor/Work Team	2	4	M6
Arrival onsite	Incorrect works undertaken, and unaware of site specific hazards	Personal injury	3	3	6	On arrival, contact Site Supervisor to discuss scope and location of works Attend site Toolbox Meeting & complete pre-start checks	Supervisor/Work Team	2	2	L4
	On-site Pre-Start	Unaware of site specific hazards and inadequate communication with others working nearby	3	3	6	Conduct Onsite Pre-Start Check – Discuss site-specific hazards at a Pre-Start Meeting; make sure all sub-contractors and people in vicinity are aware of them	Supervisor/Work Team	2	2	L4
	Prepare work area to start work	Slips, trips and falls Personal injury – Sprains and strains	3	3	6	Step down (don’t jump) from truck, enter excavated areas safely using 3 points of contact (e.g.: 2 hands and 1 foot) Address all risks and hazards from Pre-Start Meeting; remain familiar with work zone. Housekeeping – remove any hazards lying around site. Check surrounding work area for hazards such as long grass covering holes, loose gravel & stones, rubbish.	Work Team	2	2	L4
		Sharps – Needle stick injury Vermin – Snakes, spiders, bees etc.	3	4	7	Ensure work area is clear of any sharps, and if found place into the on-site sharps kits using tongs, and returned to Site Supervisor for safe disposal. Use torch if necessary to look for other sharp objects such as glass, metal, and vermin such as snakes, spiders, rats or bees. Stop work if hazards cannot be cleared & escalate to your supervisor	Supervisor/Work Team	2	4	M6
Prepare equipment to start work	Lifting of equipment	Personal injury – Sprains and strain	3	3	6	When lifting items, e.g. from vehicle, always use all correct manual handling techniques including; bend knees, keep back straight, position load, lift with leg muscles, do not twist as you lift. Confirm equipment is in same condition as when checked during ‘Daily Plant & Equipment Checklist’	Work Team	2	2	L4

Assessment of: Vacuum Excavator (Truck / Trailer)										
Risk Assessment						Treatment				
Activity Sub Hazard / Aspect Activity			Inherent Risk			Description of Control	Responsible Person	Residual		
			L	C	S			L	C	S
	Allow Traffic Control (TC) to setup as per the TCP	Collision /incident with vehicles or pedestrians	3	4	7	Have Traffic Control Plans in place. If necessary, acquire legible Traffic Control Plans, and ensure setup as per onsite TC Plans. Temporary Road Closure Cert, and Permit from Traffic Control (TC) may be required, do not plan or begin works until all permits are approved and Traffic Control is accurately set up as per TCP	Supervisor	2	4	M6
	Uncontrolled pedestrian access		3	4	7	Never have pedestrians walk out onto road, between parked vehicles, or near excavation to get past the work area. As per WHS Reg (2011) a barricade or hoarding at least 900mm must be erected around an excavation Ensure redirection and correct pedestrian controls are in place	Supervisor/Work Team	2	4	M6
Acquire Dial Before You Dig (DBYD) plans before commencing works	Underground utilities	Personal injury – Electrical shock, electrocution Damage to services	3	4	7	DBYD plans MUST be on-site before starting When close to services proceed with caution using non-destructive vacuum excavation.	Supervisor	2	4	M6
Safely position Vacuum Excavation Unit	Reversing/collision	Personal injury and plant damage	3	3	6	Use a Spotter, proceed slowly with caution. Ensure no obstructions or overhead utilities prior to operation. Stay inside Traffic Control area as per onsite TC Plans.	Supervisor/Work Team	2	2	L4
Start Vacuum Excavator	Manual handling, slips, trips and falls	Personal injury – Strains, sprains, brakes	3	3	6	Always start work at furthest excavation first, working progressively closer to Truck, to reduce exposure to slips/trips/falls. Ensure to walk calmly and never run onsite. Stay aware of ground level hazards & maintain site tidiness Ensure unused equipment stored out of work zone.	Supervisor/Work Team	2	2	L4
Remain alert to existing & developing hazards in vac excavation work-zone	Flying Debris and spread of fuels and oil.	Personal injury. Environmental damage	3	3	6	Use correct PPE and manual handling lifting techniques Ensure adequate lighting. Clean job site, remove any rubbish or excess materials from site.	Supervisor/Work Team	2	2	L4

Assessment of: Vacuum Excavator (Truck / Trailer)										
Risk Assessment						Treatment				
Activity Sub Hazard / Aspect Activity			Inherent Risk			Description of Control	Responsible Person	Residual		
			L	C	S			L	C	S
	Excavation collapse, or objects / people falling into excavation	Personal and public injury	3	3	6	As per WHS Reg (2011) a barricade or hoarding at least 900mm must be erected around an excavation, unless it is not practicable or no persons are likely to be in the area of excavation.	Supervisor/Work Team	2	2	L4
	Trench collapse, or objects / people falling into excavation	Personal injury – Strains, sprains, broken bones and spinal injury	3	4	7	As per WHS Reg (2011), where a trench is at least 1m deep, erect a barricade at least 900mm high, unless it is not practicable or only persons involved with the trench will be in the work area, or another form of barrier exists (eg: excavated materials near trench)	Supervisor/Work Team	2	4	M6
	Hitting existing underground utilities	Personal injury – Electrical shock, electrocution Damage to service	3	4	7	Utilise DBYD plans to identify underground services. Use trained operators for safe vacuum excavation	Supervisor/Work Team	2	4	M6
	Contact With High Pressure Water	Personal injury	3	3	6	Utilise DBYD plans to identify underground services. Use trained operators for safe vacuum excavation	Supervisor/Work Team	2	2	L4
	Asbestos & Other Contaminants	Personal injury	3	4	8	Equipment is rated for use with contaminated substances. DO NOT collect Asbestos, acidic, alkaline, flammable or combustible materials or controlled waste. Use trained operators for safe vacuum excavation .	Supervisor/Work Team	2	3	M5
Backfilling / Re-instatement of excavated area	Re-instated Surface collapse	Personal and public injury	3	3	6	Ensure sand is placed around all services washed in with water and compacted in 200mm increments. Place lean mix in between 150mm and 450mm below surface. Allow min 150mm for asphalt, use vibratory plate compactor for even finish. For concrete in footpath area endeavor to match existing surface finish with cast in-situ concrete / cold mix.	Supervisor/Work Team	2	2	L4
Open pit or man hole	Pedestrians or workers falling into hole.	Personal injury	3	3	6	Only use approved pit key with safety locks, As per WHS Reg (2011) a barricade or hoarding at least 900mm must be erected around an excavation, unless it is not practicable or no persons are likely to be in the area of excavation. Use of guards, barricading and fences. Use appropriate manual handling techniques, get assistance if required, remove any potential hazards.	Supervisor/Work Team	2	3	M5

Assessment of: Vacuum Excavator (Truck / Trailer)										
Risk Assessment						Treatment				
Activity Sub Hazard / Aspect Activity			Inherent Risk			Description of Control	Responsible Person	Residual		
			L	C	S			L	C	S
Confined Space Entry	Exposure to toxic gases / low oxygen levels	Personal injury – Asphyxiation, unconsciousness	3	4	7	Employees must be certified in confined space and meet the requirements as per state regulations. NO unauthorised person is to enter the confined space.	Supervisor/Work Team	2	4	M6
Turn on jetter tap	Uncontrolled jet hose flying around under pressure (like a snake)	Personal injury	3	3	6	Mark 1m hose depth indicator (use tape/ paint) before start. Hold hose when turning on tap, make sure controller is off.	Supervisor/Work Team	2	5	M5
Insert jetter head into duct before turning controller on	Jetter head coming out unintentionally	Personal injury	3	3	6	Insert hose at least 1m then switch on with remote control Keep unrolled hose safely within barricaded work area.	Supervisor/Work Team	2	2	L4
Pull hose back slowly and turn jetter off	Removing hose too far and jet hose flying around (like a snake)	Personal injury	3	3	6	Only pull hose back to 1m distance indicator then turn off Roll up jet hose and vac up any water or waste in pit	Supervisor/Work Team	2	2	M4
Close manhole/pit	Hitting existing services	Damage to services inside pit/manhole	3	3	6	Utilise Dial Before You Dig plans to identify underground services. Use trained operators for safe vacuum excavation.	Supervisor/Work Team	2	2	L4
Clean-up site and wash-down of roadways and paths	Slips, trips, falls	Personal injury – strains, sprains	3	3	6	Step down (don't jump) from truck, enter excavated areas Safely using 3 points of contact (eg: 2 hands and 1 foot) Ensure adequate lighting Clean site – remove any rubbish or excess materials	Work Team	2	2	L4
	Spread of fuels and oil	Environmental damage	3	3	6	Collect onsite silt socks from all drains, if used. All vac trucks on site have spill kits in them. Contact Fire Dept. for major spills 000 or 112 from mobiles.	Work Team	2	2	L4
Leave Site	Vehicle accidents	Personal injury, plant and equipment injury	3	3	6	Use Spotter, always use strobe lights & reversing beepers.	Work Team	2	2	M5

Assessment of: Vacuum Excavator (Truck / Trailer)

Risk Assessment						Treatment				
Activity Sub Hazard / Aspect Activity			Inherent Risk			Description of Control	Responsible Person	Residual		
								L	C	S
Disposal of uncontaminated spoil material at Authorised Waste Facility	Splash and flying debris Emptying vac truck	Personal injury	3	3	6	Ensure safety glasses are worn. Walk the course and check location if operating alone, or use a spotter if available. Stand well clear of load while emptying unit Maintain a safe distance when opening the hatch. Be aware of pinch points when closing door If work needs to be undertaken under the tanks, factory fitted braces are to be used	Supervisor/Work Team	2	2	L4
Refill equipment with fuel	Fire, Explosion	Personal injury – Burns	3	3	6	Shut down engine/no smoking. Wear all appropriate PPE whilst refuelling Wait until engine cools (as per manufacturers specs) Follow SDS and ensure if spills occur they are cleaned up correctly as per SDS Use appropriate containers & spout. Ensure no leaks.	Supervisor/Work Team	2	3	M5
	Working around Assets	Damage to assets	3	4	7	Ensure correct pressure is used	Work Team	2	2	L4

No Dig Equipment Warranty Policy

Vacuum Excavator Limited Warranty Policy

Note: At the first sign of a suspected warranty problem after using the trouble-shooting guide in the Owner's Manual, we ask that you contact our service department on 08 9493 0642. Our service technicians are often able to diagnose and correct problems over the phone with minimal cost and disruption of service.

Product Limited Warranty

We warrant to our customer that each new *Vacuum Excavator* system manufactured and sold by us will be free from manufacturing defects in materials or workmanship in normal service for a period of one (1) year from date of purchase or the time which the system is put into service by our customer provided it is operated and maintained in accordance with No Dig Equipment's instructions and manuals. Specifically excluded from this warranty are vehicles on which systems are installed, which are covered under their own manufacturer's warranty.

The purchaser (owner) is responsible for the proper use and maintenance of the *Vacuum Excavator*. No Dig Equipment recommends that accurate records covering the performance of regular maintenance be retained in case questions arise. For your convenience there is a Maintenance Schedule Log located in this manual.

A *Vacuum Excavator* is intended to be used for vacuuming slurry (mixture of liquids and solids), liquids only, or wet solids into the unit's spoil tank. Use of the *Vacuum Excavator* for other than the above stated intended use or in a manner contrary to the recommendations in the owner's manual is at the purchaser's own risk and shall void the provisions of this warranty.

The *Vacuum Excavator* is not designed for or warranted for vacuuming toxic or hazardous material and shall not be deemed defective by reason of failure to do so. Purchasers shall have no claim whatsoever against No Dig Equipment therefore, nor for other problems resulting from such use.

Under no circumstances is the *Vacuum Excavator* to be used to vacuum dry and/or dusty material. This may overload and possibly collapse the filter cartridge which will subsequently damage or destroy the positive displacement blower. The *Vacuum Excavator* is not warranted for vacuuming dry and/or dusty material and shall not be deemed defective by reason of failure to do so. Purchasers shall have no claim whatsoever against No Dig Equipment therefore, nor for other problems resulting from such use.

No Dig Equipment will provide free replacement parts to the original purchaser for any part which has a defect in material or workmanship within the warranty period. Defects will be determined by an inspection of the part by No Dig Equipment or its authorised distributor, or an authorised service facility.

Original purchaser of the product must present the product to No Dig Equipment, an authorised distributor or an authorised service facility for inspection within 30-days of the date the product fails. No Dig Equipment will provide the location of its nearest authorised distributor or an authorised service facility upon inquiry. No Dig Equipment reserves the right to supply re-manufactured replacement parts as it deems appropriate. Authorised distributors or authorised service facilities will be reimbursed for their labour required to

inspect and/or repair products at their published labour rates only if authorised beforehand in writing by No Dig Equipment.

The Engine, Blower and water pump are additionally (for your further protection) subject to the warranties of the respective manufacturers. The owner's manuals, operation and maintenance instructions, and warranty registrations (when necessary) for these components are included in, and form part of, the No Dig Equipment owner's manual. All components used on No Dig Equipment's products have been selected:

- first, on the basis of quality, and
- second, because of the number and locations of their service facilities.

No Dig Equipment under this warranty is expressly limited, at our option, to the replacement or repair at No Dig Equipment, 15 Wildfire Road, Maddington, Western Australia or at a service facility designated by us, of parts of the *Vacuum Excavator* as inspection shall disclose to have been actually defective.

Specifically Excluded from Product Limited Warranty are:

The warranty does not apply to defects, damages or injuries caused by: casualty, unreasonable use, misuse, abuse, neglect, improper maintenance, alteration, faulty repairs or malfunction due to the installation or use of add-on or modified parts.

- Uses other than those for which No Dig Equipment's products are intended;
- Transportation charges related to repair, replacement or inspection of *Vacuum Excavator*;
- All defects, damages, or injuries caused by improper training, operation or servicing of *Vacuum Excavator* in a manner inconsistent with manufacturer's recommendations. This information is in the Owner's Manual. It is the owner's responsibility to perpetuate the information to all operators of a *Vacuum Excavator*;
- Vehicles on which No Dig Equipment's systems are installed, engines, engine accessories, compressors, blowers which are covered by original manufacturer's warranties. Tyres, belts and other parts, which may be subject to another manufacturer's warranty, which will be made available to the purchaser.

The warranty does not cover:

- a) Repair or replacement required for any of the reasons detailed above;
- b) Loss of time, inconvenience, loss of use of the equipment, costs of diagnosis and inspection that do not result in eligible warranty work; or
- c) Other special, indirect, incidental or consequential damages of any kind.

Please Note (Extremely Important) ...

No Dig Equipment does not assign to anyone the right of warranty on its behalf.

This warranty and the remedies hereunder are expressly limited to the duration of this limited warranty.

This warranty is an express warranty in lieu of all other warranties whatsoever, express implied and statutory, including without limitation, the implied warranties of merchantability and fitness for a particular purpose.

If the products are purchased for commercial purposes as defined by the uniform commercial code, then there are no warranties which extend beyond the face hereof and

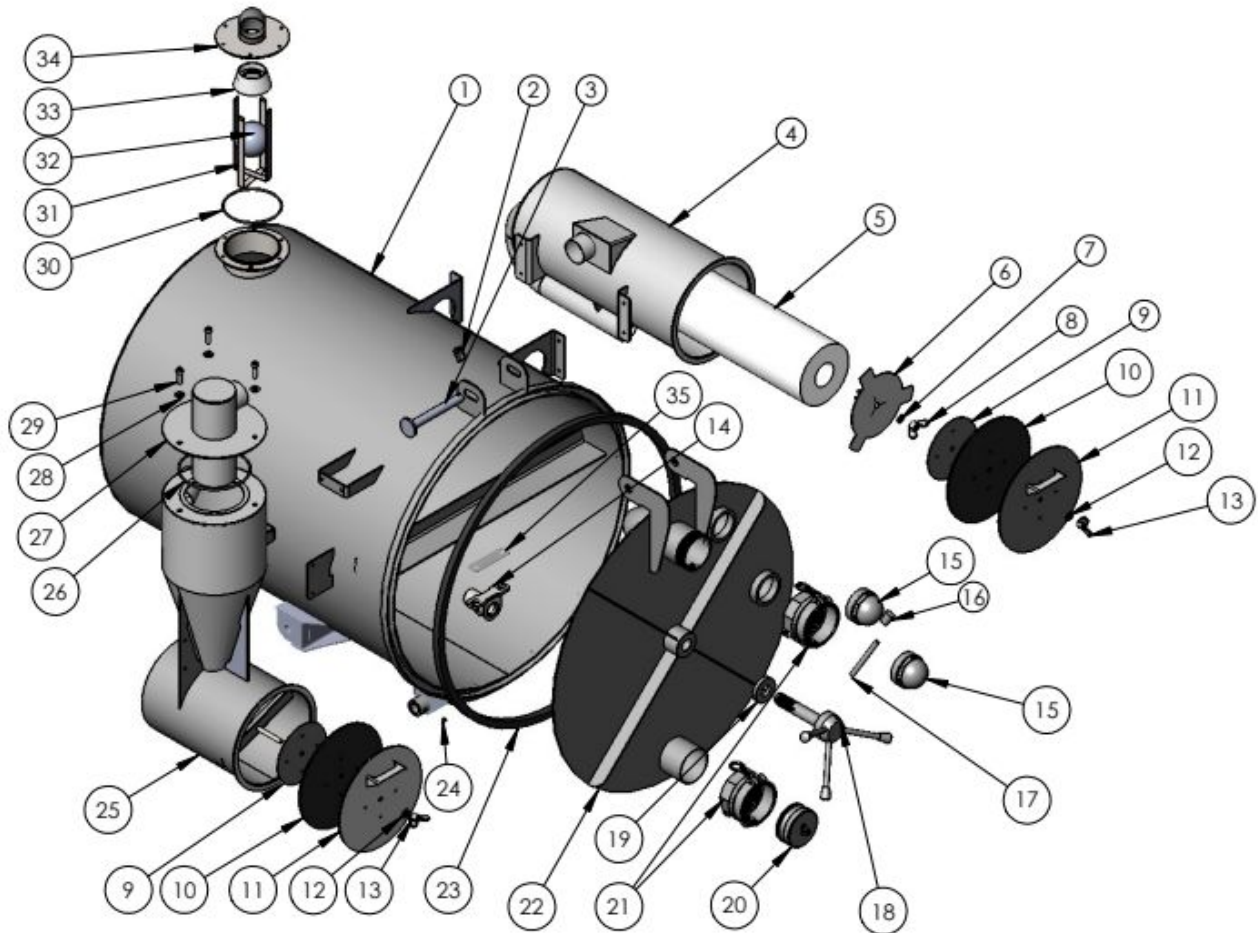
there are no implied warranties of any kind which extend to a commercial buyer. All other provisions of this limited warranty apply including the duties imposed.

No Dig Equipment's products have been tested to deliver acceptable performance in most conditions. This does not imply they will deliver acceptable performance in all conditions. Therefore, to ensure suitability, products should be operated under anticipated working conditions prior to purchase if there is any question or doubt by the purchaser.

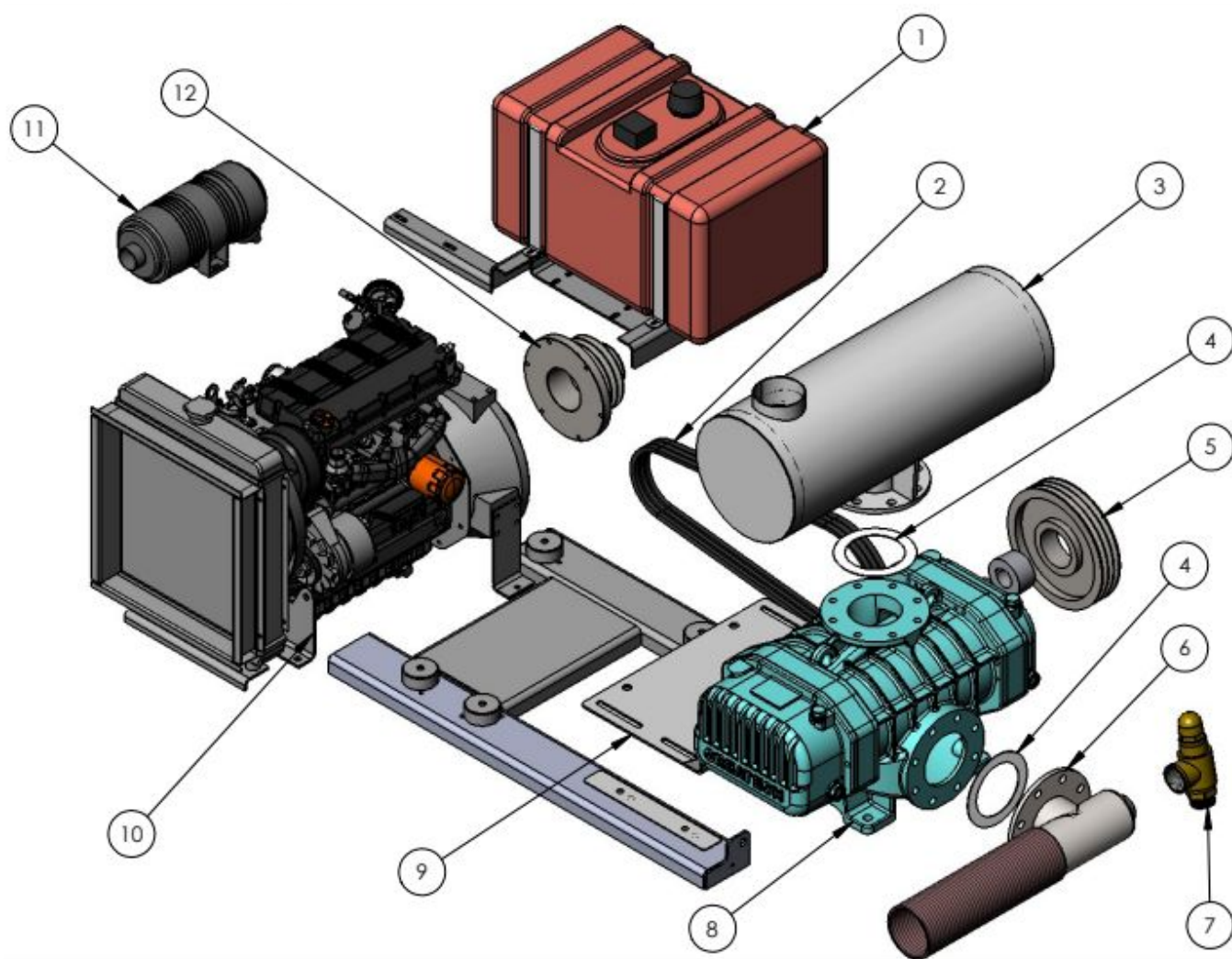
For information regarding this limited warranty contact

No Dig Equipment
15 Wildfire Road
Maddington
Western Australia
Ph: (08) 9493 0642

Appendix 1: VM850 Parts List

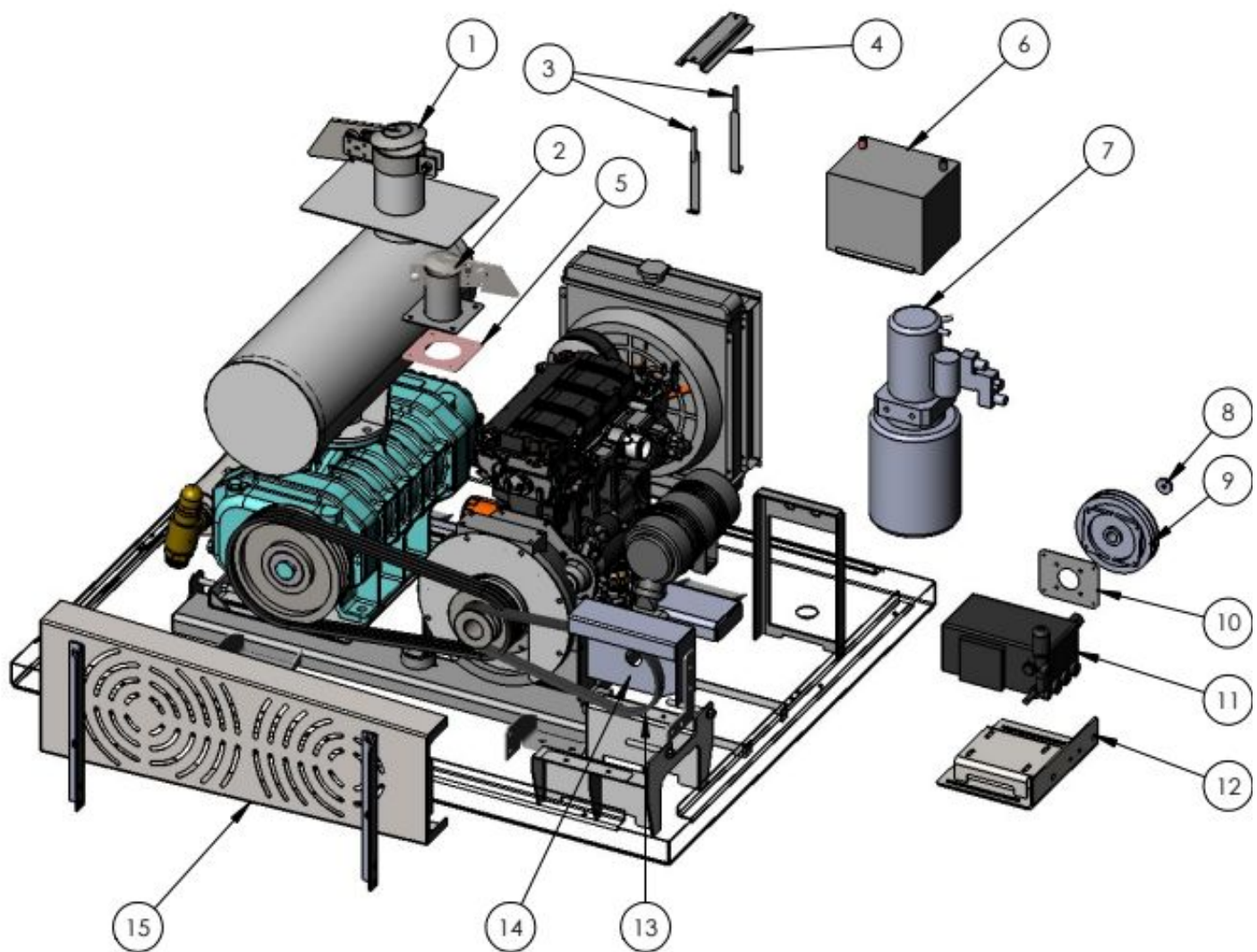


VM850 TANK ASSEMBLY		18	Vac door handle
1	Spoil tank	19	Door handle nylon seal
2	Lynch pin	20	Camlock cap 4" DP
3	Door hinges pin	21	Camlock 4" Type D (x2)
4	Vacuum filter housing	22	Vacuum tank door
5	Vacuum filter	23	Vacuum tank door seal
6	Filter cover plate	24	Grease nipple (x2)
7	Washer	25	Cyclone filter
8	Wing nut M16	26	O-ring seal
9	Gasket retainer plate (x2)	27	Cyclone top cap
10	Gasket (x2)	28	Washer (x3)
11	Filter housing door (x2)	29	Cap screw (x3)
12	Washer	30	O-ring shut off valve
13	Wing nut M12 (x2)	31	Ball cage
14	Inner door threaded bush	32	Float ball
15	Sight glass 3" (x2)	33	Ball cone seal
16	Ball knob	34	Shut off valve top plate
17	Door handle spoke	35	Shim

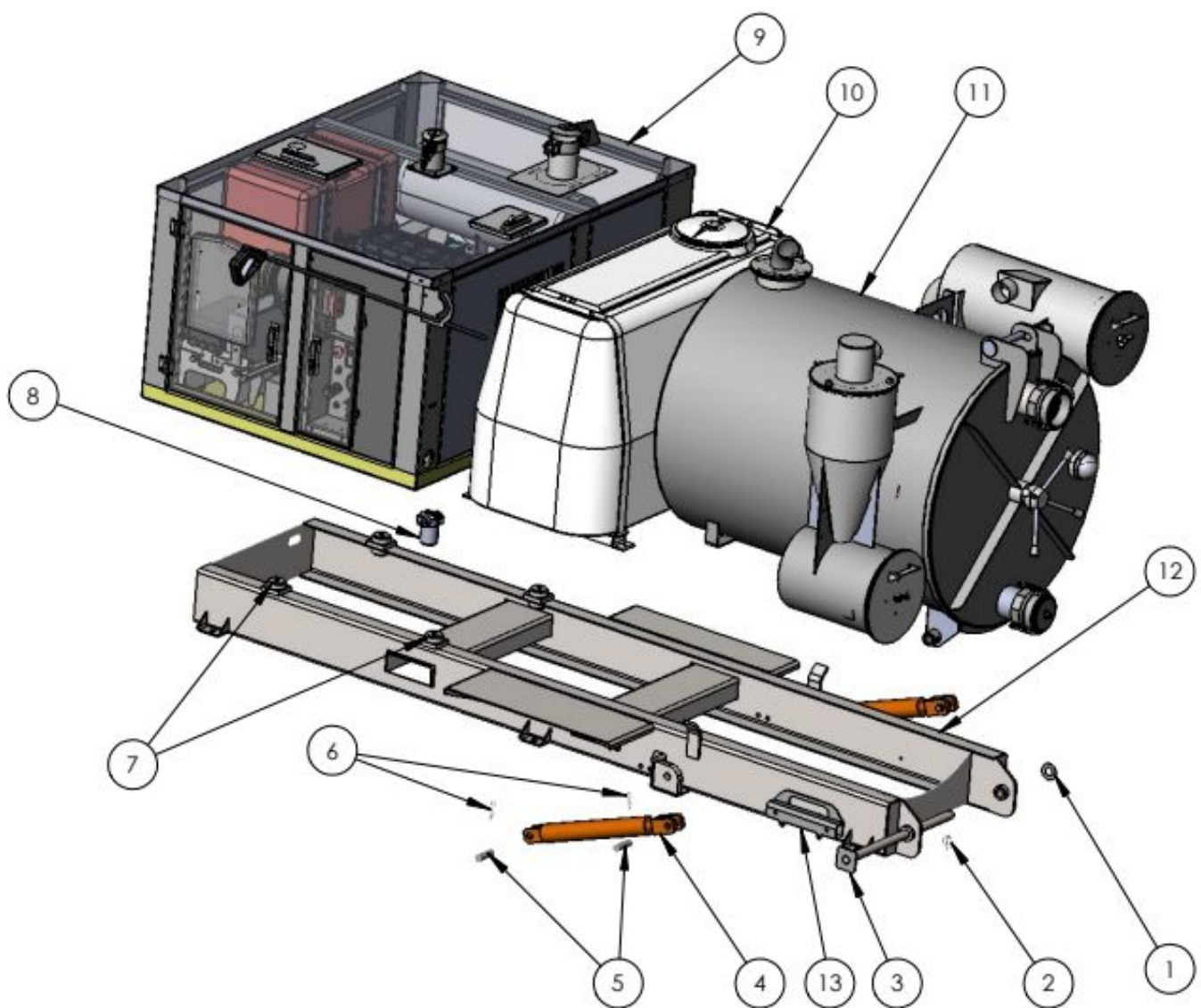


ENGINE BLOWER ASSEMBLY

1	Fuel tank	7	Blower relief valve
2	Blower belts (x3)	8	Blower G100V
3	Silencer	9	Blower adjustment plate
4	Gasket (x2)	10	Diesel engine
5	Blower pulley	11	Engine air cleaner
6	Suction inlet tee	12	Drive pulley



WATER PUMP AND HPU ASSEMBLY			
1	Rain cap 4"	9	Electromagnetic clutch
2	Rain cap 3"	10	Adaptor plate
3	Battery clamp	11	High pressure water pump
4	Battery clamp	12	Pump adjustment bracket
5	Gasket	13	Water pump belt
6	Battery	14	Water pump pulley guard
7	Hydraulic power unit	15	Blower pulley guard
8	Washer		

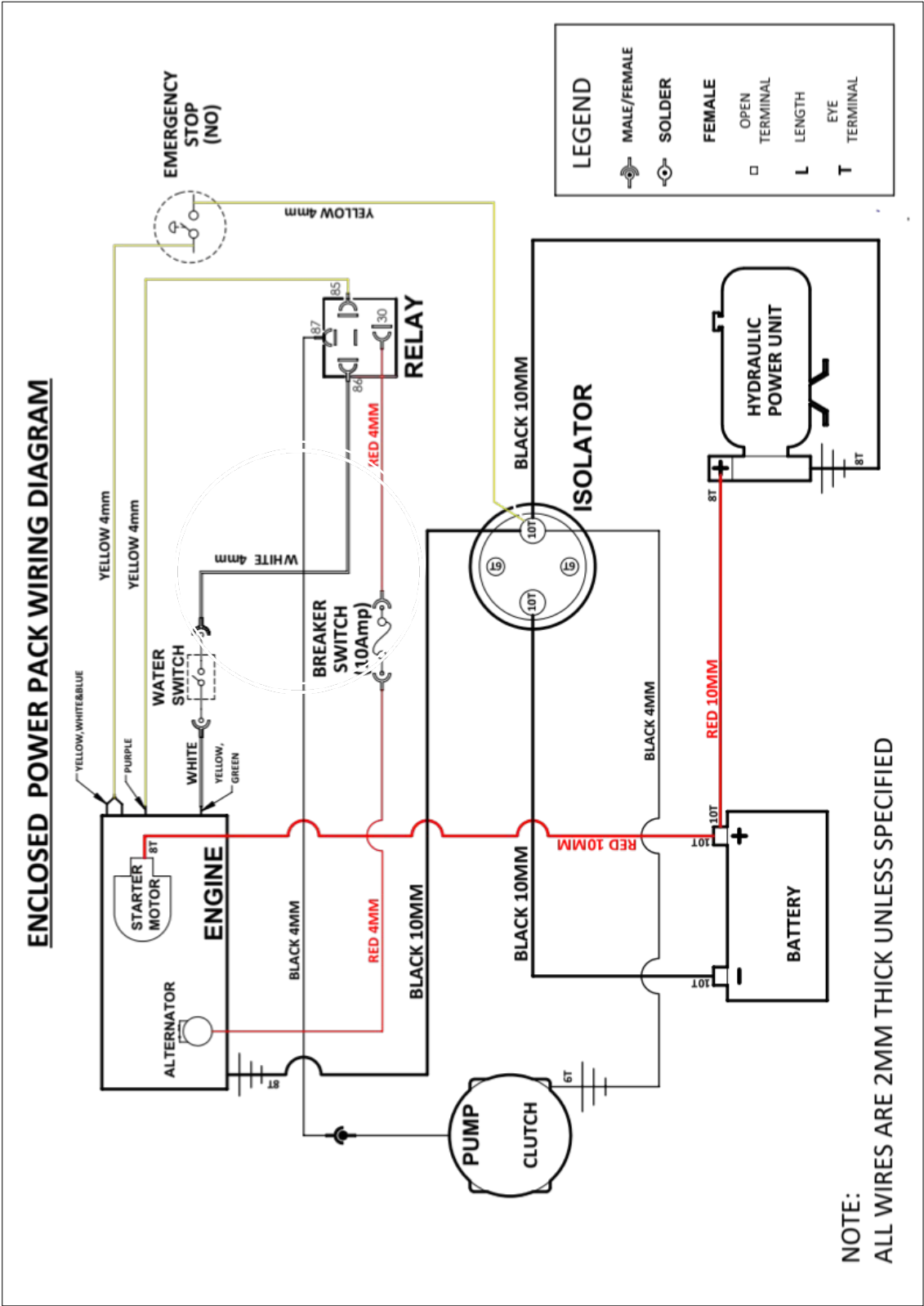


SKID ASSEMBLY

1	Washer	8	Water filter
2	Lynch pin	9	Power unit
3	Hinge pin	10	Water tank
4	Tilt cylinder (x2)	11	Spoil tank
5	Pin (x4)	12	Skid
6	R-clip (x4)	13	Cylinder safety bracket
7	Engine mount (x4)		

Appendix 2: Electrical System Schematic and Control Panel

ELECTRICAL SYSTEM SCHEMATIC DIAGRAM



CONTROL DISPLAY PANEL



1	Hydraulic tilt switch
2	Emergency stop button
3	Water pump switch
4	Engine throttle
5	Key panel
6	Water pressure gauge
7	Battery isolator
8	Serial number



Key panel symbols and meaning:

a		Fuel indicator	f		Warning
b		Engine ok	g		Glow plug indicator
c		Oil pressure	h		Air filter obstruction
d		Coolant temperature	i		Emergency stop/hazard
e		Battery/alternator			

Appendix 3: Blowers Operator's Manual

Belt Driven Type Roots Blower 550CFM

GREATECH

Operation Manual



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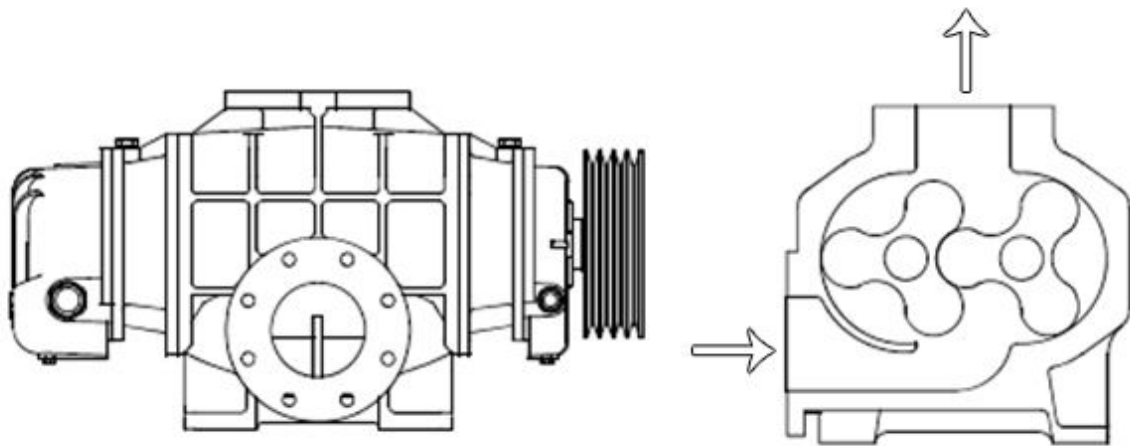
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PRINCIPLE OF ROOTS BLOWER

A Roots Blower is a positive displacement machine which acts like a vacuum pump and can be used for sucking air.

There are two lobes fixed on a set of synchronised gears, the gap between two lobes and the gap between lobes and the cylinder are very small. Since they do not touch each other, they do not need lubrication. Therefore, the transported air won't be polluted. Another advantage of no touch point is that the blower can run at high speeds and draw more air.

Our product is very precise, and only bearings and gears need to be lubricated. Periodic maintenance can reduce the damage of bearing and gear and helps to maintain blower's life cycle.



Roots Blower diagram, and cross section displaying lobes

OPERATION AND MAINTENANCE

- Ensure that cylinder is clean without any obstructions before operation.
- Ensure that installation and direction is correct (page 41)
- Inlet temperature should be under 50°C.
- Ensure that gear oil level is at ½ way mark
- Please use proper oil for lubrication (page 45)
- Make sure safety relief valve is work correctly
- Please refer to page 46 for all types of bearing
- To order parts, please see page 48

INSTALLATION

Movement

Please prevent damage by collision or by shaking during the delivery. After moving, please check if the blower and its accessories are complete. The following check up is for your reference.

1. Check specification is same as purchase order when blower is arrived.
2. Check blower and screws are in good condition- without damage or loose.
3. Rotate shafts by hand to ensure they can rotate smoothly.
4. Please lift / move blower with eye bolts which are on the blower.

Installation and Adjustment

1. Before blower is installed on the machine, please ensure both surfaces (blower bottom and frame) are not greasy, so that the blower can be fixed well.
2. Before plumbing, please seal the inlet port and outlet port of blower well, so that foreign matter will not fall into the blower.
3. After blower and its accessories are placed between equipment and foundation, the pads shall be placed at two sides of anchor bolts and the heavier part. Then, reserve the space for filling cement. The final step is to use pad (or spring washer) and level meter to do the horizontal checkout, the maximum tolerance is less than 2mm per meter.
4. To install on top of the old cement foundation, please smooth the surface and install the equipment on the new surface.

Plumbing

When plumbing, please pay attention to the followings to ensure the blower operates smoothly in the future.

- ✓ Please do not press pipes on the blower directly, so blower will not change its shape due to heavy piping. The pipe which is near the blower should be supported with suitable metal hanger ring or supporter. The centre of the pipe should be matched with centre of blower, please do not tighten them off. Ideally, a flexible joint should be added- this can reduce the stress by deformed pipe and different temperature from piping.
- ✓ When the blower's inlet is opened, please put a filter to prevent anything to drop inside blower. Once they fall into the air cylinder, it will cause serious damages. When it is placed outdoor, please have a rain cover. Please add silencer on the inlet, outlet ports or pipe to reduce the noise. While conveyed air contains steam, it might congeal liquid during the process. Therefore, please have a drain hole at the bottom of plumbing.

Pulley and Belt

When blower has arrived for installation, please ensure that the end surface of two belt pulleys are at the same level, and ensure that belt tension is in normal condition. Refer to 'Belt tension and alignment adjustment' (page 42).

Parallel inspection

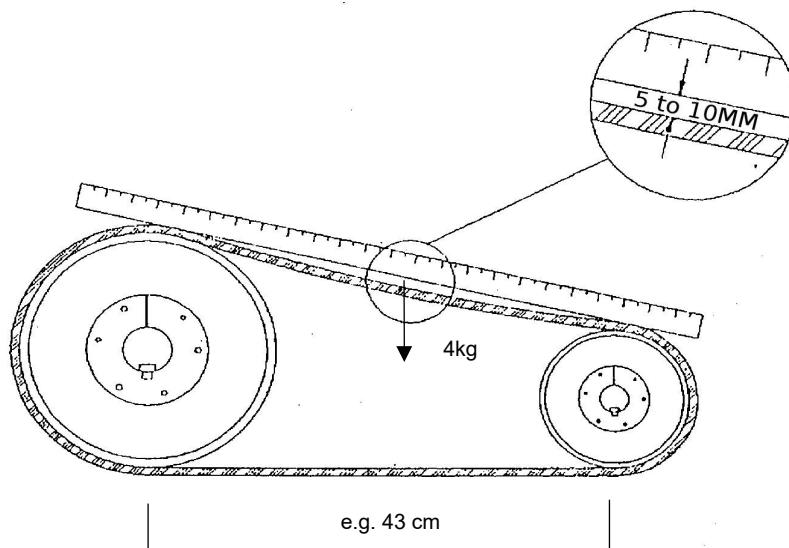
1. Ensure that pulleys are in correct position
2. Measure with ruler or auxiliary line to ensure that the end face of blower pulley and motor pulley are on same level. Motor shaft and blower shaft should be on a parallel position, V-belt and shaft should be on a right. If position is inaccurate, please loosen screws on motor base to adjust it. After adjustment, tighten screws again.
3. Before turning on the blower, ensure the rotating direction is correct first, then operate at full speed.

Belt tension and alignment adjustment

Ensure belt alignment between blower and engine belt. Sheaves on both motor and blower shafts should be as close to the shaft bearings as possible. Blower sheave should not exceed $\frac{1}{4}$ in. (6.5mm) from the blower drive end cover, or damage may be caused to the blower shaft.

Optimum belt tension adjustment is to get the minimum tension without slipping while operating at high horsepower, or causing damage to the drive shaft. When first using a new belt, check the tension frequently and ensure it does not slip (instructions below). After initial checks, adjustment should be done at intervals according to service and maintenance checklist (page 18). While using several belts at the same time, the lengths of all belts should be the same and all of them renewed at the same time.

To check the belt tension – industry guidelines recommend 0.157mm of deflection per centimetre of span when ~4kg of force is applied to the centre of the belt. If deflection is less than this and belt tension is too tight, there is a higher risk of damage to engine shaft. Refer to example below.



CHECK BELT TENSION PERIODICALLY AND TIGHTEN BELTS SHOULD BELT DEFLECTION EXCEED 10MM OR IF BELT SLIPPAGE IS SUSPECTED

1. Measure distance between shafts- in this case, 43cm
2. Therefore, $0.157 \times 43 = \sim 7\text{mm}$ recommended deflection
3. Apply approx. 4kg force to centre of belt- tighten belt until calculated belt deflection is achieved.

OPERATING INSTRUCTIONS

Preparation

1. Rotate the shaft by hand to see whether it can. If there is any difficulty, check the blower to see if it is out of shape by external force.
 - Checking sequence: loosening the flange screws, loosening the screws at the bottom of blower to adjust the position of itself, accessories and plumbing.
 - Meanwhile, check for any foreign material in the air cylinder.
2. Refer to the manual to check the level of lubricating oil
3. Check all the accessories are in the correct position and direction
4. Open the control valve at inlet and outlet ports of the blower. The blower cannot be turned on while the valve is closed. There shall be the safety valves at inlet or outlet ports to protect the system and prevent the damages caused by wrong operation or blockages of the system.

**Special notice: Please check if the stop plate has been removed between the flange of inlet and outlet.*

Operation trial

When you take operation trial, please ensure inlet pressure or outlet pressure is the same.

If pressure needs to be changed, please adjust safety Inlet temperature must be kept within safety range (The highest inlet temperature of our standard roots blower is 50°C), if the inlet temperature is higher than 50°C, please contact us.

Please check the following items one by one while taking operation trial:

- ✓ Is rotating direction of the blower correct?
- ✓ Is there any unusual noise?
- ✓ Is there excessive vibration of the blower?
- ✓ Is the temperature of blower's outer case too high?
- ✓ After operation trial, turn off the power to see if the blower can stop naturally.

After it stops, rotate the shaft by hand and check if it can rotate easily.

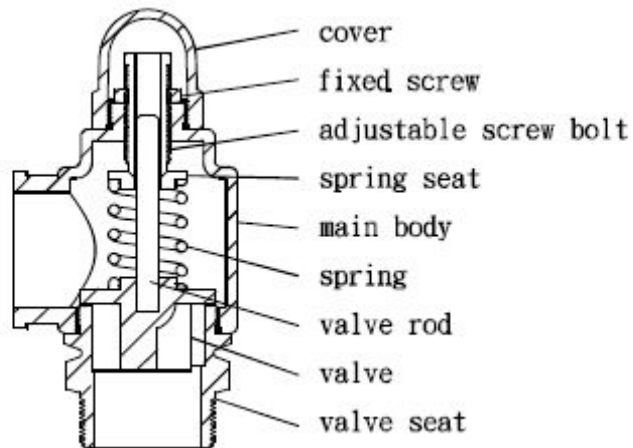
If all above items are OK, standard operation can be arranged. At normal operation, minimal maintenance is required, but attention must be given to bearings, lubrication of gears and belt tension adjustments.

Air volume adjustment

Roots blower is a positive displacement machine. Do not use outlet valve or inlet valve to control air flow, this will not be effective- it is better to change the rotation speed of the blower as this is more economic and efficient.

Safety valve adjustment

The safety valve has been adjusted according to 14" of Hg. To ensure safety of blower and motor, double check the safety valve and its releasing pressure. If the safety valve is not working at designed pressure, adjust safety valve accordingly.



Valve adjustment diagram

The adjustment steps are shown as following

1. Remove valve cover
2. Loosen the fixed screw nut
3. Adjust by operation pressure
 - Reducing the operation pressure: screw on
 - Increasing the operation pressure: screw off
4. Accuracy test: if the safety valve releases the pressure at specific pressure
5. Tighten the fixed screw nut
6. Tighten the cover of safety valve
7. Double test the accuracy of safety valve for pressure release

MAINTENANCE

Shaft seal: We use labyrinth type shaft seal for all our standard roots blowers, this shaft seal does not impact / touch directly the rotary shaft, so it is not necessary to maintenance, particularly when blower is in normal operation.

Lubrication

1. Gear oil changing time

Replace gear oil (drain old gear oil in advance, then fill up new gear oil)

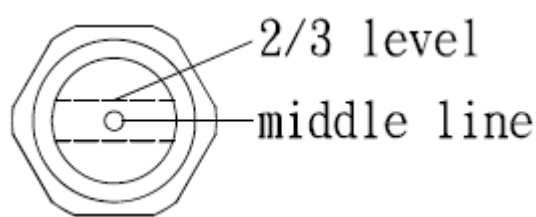
First time: after 100 hours operation

Second time: after 500 hours operation

After that, change the oil every 2200 hours

2. Volume of lubrication

Please refer to the following oil volume and check oil gauge on side oil box- the best volume is at middle line of oil gauge (no higher than 2/3 level) when blower is not running.



Model	Front oil box	Back oil Box	Model	Front oil box	Back oil box
G40	125ml	250ml	G200 G250	200 ml	700ml
G50 G65	400ml	800ml	G300	500ml	1000ml
G80 G100	700ml	1300ml	G350ml	700ml	1500ml
G125 G150	950 ml	2750ml			

3. Lubricating oil

It is suggested to use Shell Omala /Castrol/ Bp / (or same level) circulation oil #150 (use for suction temperature less than 50 °C).

If power is over than 75Hp, please use #220. Replace oil every three months.

INSPECTION

Daily

- Pressure of suction port and discharge port
- Temperature of bearing
- Temperature of gear box
- Noise levels
- Oil level

Monthly

- Belt tension and abrasion is normal
- Clean suction filter
- Vibration is normal
- Lubrication oil and leakage

Semi yearly

- Run shaft by hand when machine is stopped, to make sure bearing, gear and lobes are in normal condition
- Repair and replacement
- With normal maintenance, the blower's life- In order to keep blower's life longer, some parts are requested to repair or replacement in time when parts are damaged.

Gear

- Make appropriate marks when disassembling- to ensure the parts can be recovered to the right angle and position as original when re assembling and to prevent lobes impacting on each other
- If possible, send damaged parts and blower for repair, because the synchronisation of gear and lobes are higher technical working.

Bearing

- In case of damaged gear and lobes, please replace with new bearing if it is in abnormal condition.

Bearing type for blower models			
Blower model	Bearing model	Blower model	Bearing model
G40	6204Z	G200 – 0250	Depends on usage situations
050 - 065	6207Z	0300	Depends on usage situations
080 - 0100	6309Z	0350 – 0400	Depends on usage situations
0125 - 0123	6312Z		

Note: Replacing lubrication oil timely can extend operating life longer.

Belt

- Every half year to a year, the belt must be completely changed. Please refer to belt tension section and do timely adjustments.

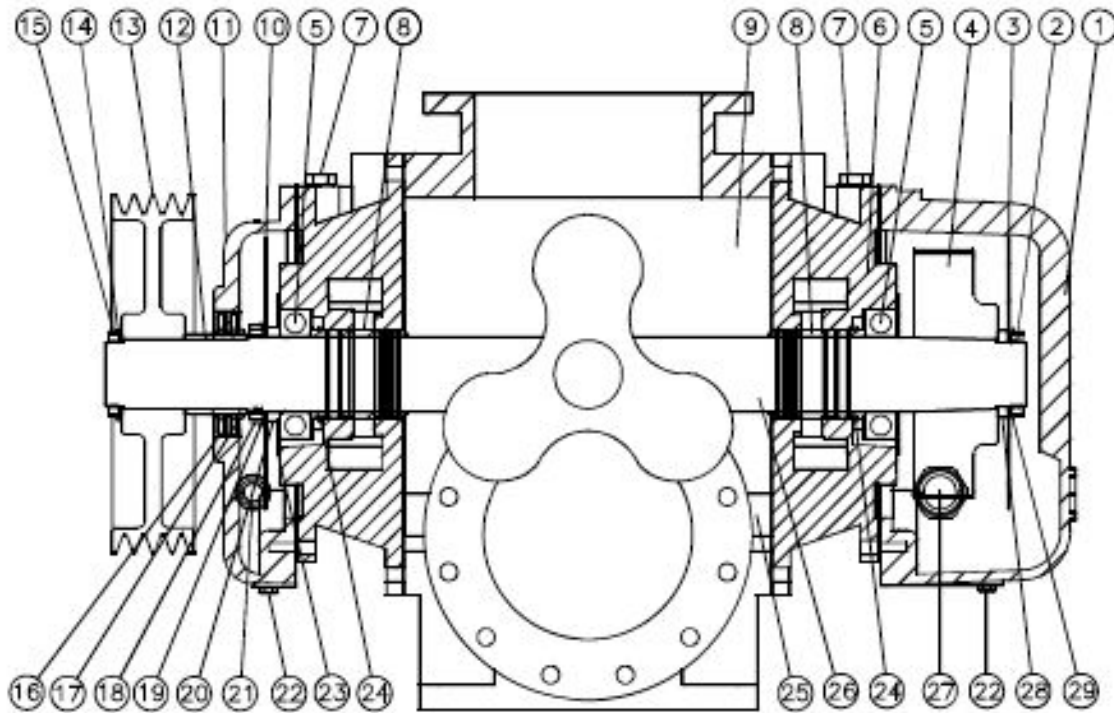
Shaft Seal

- Replace shaft seal every one year, or longer depending on operating situation.

TROUBLESHOOTING

Blower is not running	
<u>Possible reasons for failure</u>	<u>Solution</u>
Electrical wiring / lines error	Haul the electrical wiring / line
Motor is defective	Overhaul the motor
Foreign matter falls into the cylinder	Clean foreign matter away
Rusted rotor	Clean rust away
Gear is stuck by foreign matter	Clean foreign matter away
Inlet / outlet pipeline is clogged by foreign matter	Clean foreign matter away or open inlet / outlet
Outlet temperature is over heating	
<u>Possible reasons for failure</u>	<u>Solution</u>
Gear oil level is over	Discharge oil to appropriate level
Filter is dirty	Clean or change a new filter
Pressure difference is too large	Reduce pressure difference
Ambient temperature is too high	Cool temperature down
Indoor air is poor circulation	Open the door or window
Rotor clearance is eccentric	Send to plant to adjust rotor clearance
Bearing temperature is too high	
<u>Possible reasons for failure</u>	<u>Solution</u>
Oil level is too high	Discharge oil to standard level
Inappropriate lubricating oil	Change appropriate oil
Operating pressure is too over	Adjust pressure
Inlet gas is changed	Find out the reason and improve it
Bearing is worn	Sent to plant to change a new one
Bearing shaft is worn	Sent to plant to change a new one
Belt is loose	Adjust belt tension
Rotor temperature rise	Find out the reason and improve it
Gear oil temperature is too high	
<u>Possible reasons for failure</u>	<u>Solution</u>
Lubricating oil volume is over or less	Fill or discharge oil to appropriate level
Inappropriate lubricant viscosity	Change appropriate oil
Gear is worn	Sent to plant to change a new one
Gear clearance is too over	Sent to plant to change a new one
Current is overload	
<u>Possible reasons for failure</u>	<u>Solution</u>
The anti-pipeline group of inlet/outlet is increased, to cause large pressure difference	Find out the reason and improve it
Blower speed is increased	Reduce Blower speed
Motor breakdown	Overhaul the motor
Rotor gets rusted	Clean the rust away
Foreign matter fall into the cylinder	Clean the foreign matter
Rotors impact each other	Send to plant for adjusting gap
Rotor and cylinder wall impact each other	Send to plant for adjusting gap
Unnatural Noise	
<u>Possible reasons for failure</u>	<u>Solution</u>
Rotor and rotor impact each other	Sent to plant for adjusting gap
Rotor and Cylinder wall impact each other	Sent to plant for adjusting gap
Gear is worn or jammed by foreign matter	Sent to plant to clean foreign matter away
Foreign matter falls into the cylinder	Clean foreign matter away
Belt is loose or touches the belt cover	Re-adjust belt tension
Bearing is Worn	Send to plant to change new Bearing

CONSTRUCTION DRAWING AND SPARE PARTS



No.	Description	Qty	No.	Description	Qty
1	Gear Case	1	16	Oil Seal	2
2	Nut	2	17	O'ring	1
3	Oil slinger	1	18	Tab Washer	2
4	Gear	2	19	Nut	2
5	Bearings	4	20	Nut	1
6	Bearing case	2	21	Oil level sight glass	1
7	Oil plug	2	22	Drain plug	2
8	Labyrinth seal	4	23	Planer	4
9	Rotor	2	24	O'ring	4
10	Oil slinger	1	25	Cylinder	1
11	Oil cover	1	26	Shaft	2
12	Oil seat bush	1	27	Oil level sight glass	1
13	Pulley	1	28	Tab Washer	2
14	Tab washer	1	29	Tab Washer	2
15	Nut	1			

Appendix 4: Pump Operator's Manual

Pressure Washer

Professional Power Equipment

Operation Manual



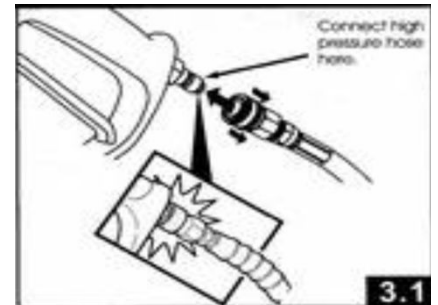
This manual contains:

IMPORTANT WARNING and INSTRUCTIONS: READ AND RETAIN FOR
REFERENCE

BEFORE USE

1. Attaching high pressure hose to spray gun

- Pull slip ring on female quick-disconnect fitting of high pressure hose back (refer to figure 3.1)
- Insert male quick-disconnect fitting on spray gun into female quick-disconnect on high pressure hose
- Release slip ring on female quick-disconnect and twist. Listen for 'click' to ensure both quick-disconnects are coupled
- Pull high pressure hose and spray gun in opposite direction to ensure they do not separate



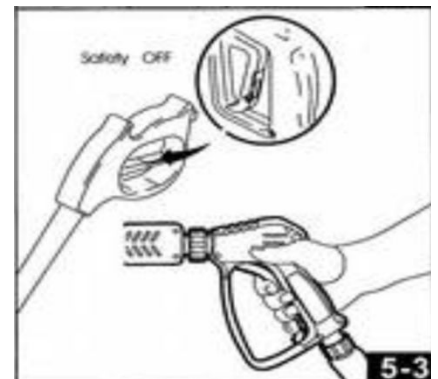
2. Check inlet filter

- Examine the screen on the pump water inlet. If the screen appears damaged, replace. Ensure the filter is clean and O-ring is in place.

IMPORTANT: DO NOT siphon standing water for the water supply. Use ONLY cold water (less than 100°F/37.8°C)

3. Connect hose and water supply to pump

- Connect hose (not to exceed 50 feet/16.24 metres in length and with the ID no less than 13mm) to the water inlet.
- May be pre-connected on to board water tank.



WARNING!

Risk of eye injury

Spray can splash back or propel objects

Jet can lacerate skin and clothing

- Always wear correct Personal Protective Equipment (PPE) when using this equipment or in vicinity of where it is in use
- Before starting pressure washer, ensure you are wearing adequate safety goggles or face shield – NEVER substitute safety glasses for safety goggles



4. Check pressure hose reel

- Lay out hose
- Check hose condition, and ensure there are no holes or tears
- Maximum working temperature at 90°C
- Maximum pressure 5000psi/345bar
- Inlet/outlet 3/8" M x F quick connect
- Hose capacity 3/8" x 15m



MAINTENANCE

General recommendations

Regular maintenance will improve the performance and extend life of the pressure washer.

The pressure washer's warranty does not cover items that have been subjected to operator abuse or negligence. To receive full value from the warranty, the operator must maintain the pressure washer as instructed in this manual and in the engine manual, including proper storage as detailed in Winter Storage and Long Term Storage.

NOTE: Should you have questions about replacing components on your pressure washer, please contact dealer for assistance.

- Some adjustments will need to be made periodically to properly maintain your pressure washer. Check the spray and extension wand assembly for wear.
- All maintenance in this manual and the engine operator's manual should be made at least once each season.

Pressure washer maintenance

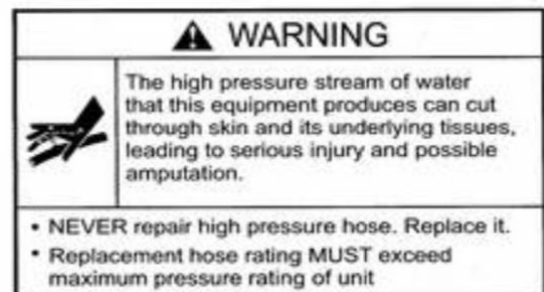
NOTE: Improper treatment of pressure washer can damage it and shorten its life.

Check and clean inlet filter

Examine the screen on the pump water inlet.
Clean it if the screen is clogged or replace it if screen is damaged.

Check high pressure hose

The high pressure hose can develop leaks from wear, kinking, or abuse. Inspect the hose each time before using it. Check for cuts, leaks, abrasions or bulging of cover, damage or movement of couplings. If any of these conditions exist, replace the hose immediately.



Check gun

Examine the hose connection to the spray gun and make sure it is secure, and make sure the "Safety Lock" is present on the trigger. Replace spray gun immediately if the "Safety Lock" is damaged or does not work.

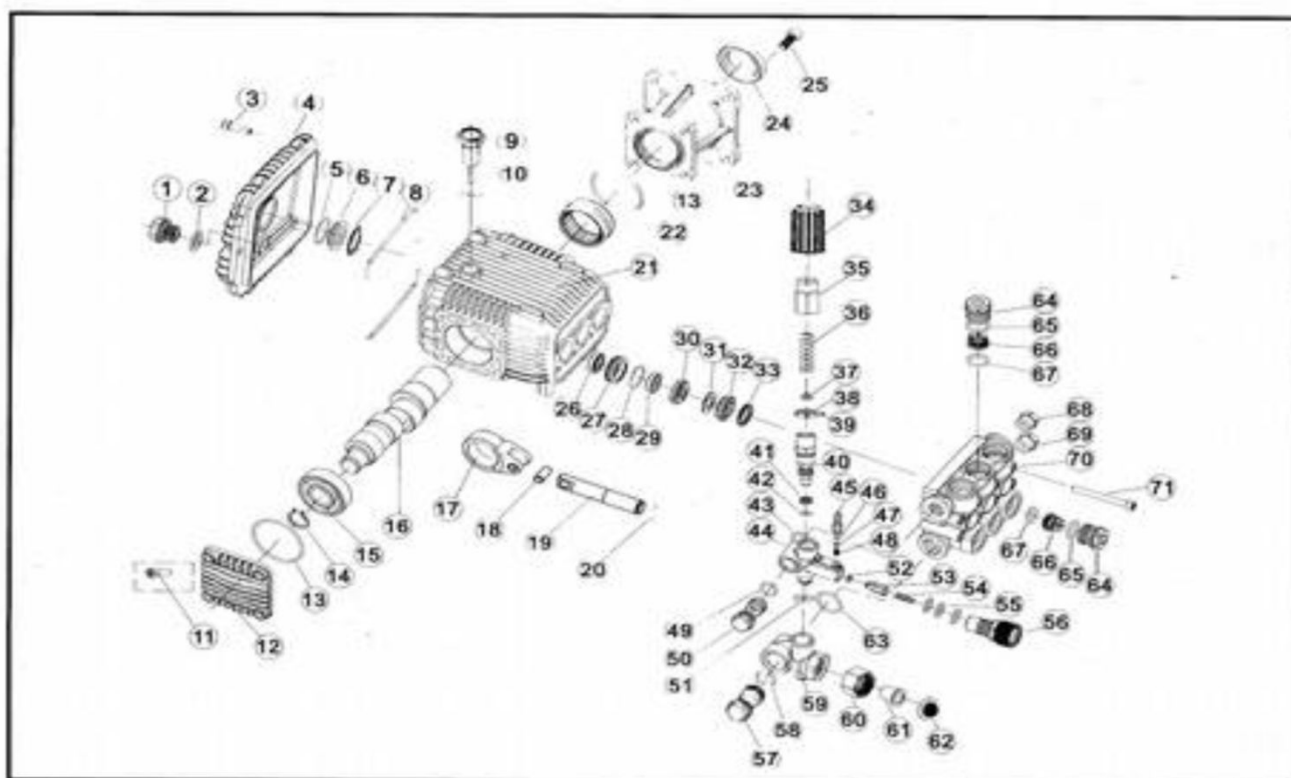
Check spray wand

Occasionally, the spray wand can become clogged with foreign materials such as dirt. When this happens, excessive pressure can develop. Whenever the pressure nozzle becomes partially clogged, the pump pressure will pulsate. It should be immediately cleaned.

TROUBLE SHOOTING GUIDE

Problem	Possible cause	Solution
No pressure or low pressure	a) Spray wand not set to high pressure b) Lower water supply c) Hose fitting leaks during high pressure d) Nozzle obstructed e) Water filter screen obstructed f) Defective thermal relief valve g) Air in hose	a) See "Using Spray Wand" section b) Tighten hose fitting. Use thread sealant tape if necessary c) Clear nozzle obstruction d) Remove and clean filter e) Call customer service f) Stop engine and water source. Disconnect water source from pump inlet and turn water source to ON to remove all air from hose. When steady stream of water is present, turn water source to OFF. Re-connect water source to pump inlet and turn on water source. Squeeze trigger to remove remaining air.
No or low pressure (after period of normal use)	a) Worn seal or packing b) Worn or obstructed valves c) Worn unloader piston	Have parts cleaned or replaced by an authorised dealer.
Water leaking at spray gun connection	a) Worn or broken O-ring b) Loose hose connection	a) Check and replace O-ring b) Tighten hose connection
Water leaking at pump	a) Loose connections b) Piston packing worn c) Worn or broken O-rings d) Pump head or tubes damaged from freezing	a) Check and replace O-ring a) Tighten connections b) Tighten hose connection b) Have parts cleaned or replaced by authorised dealer c) Have parts cleaned or replaced by authorised dealer d) Have parts cleaned or replaced by authorised dealer
Oil leaking at pump	a) Oil seals worn b) Loose drain plug c) Worn drain plug O-ring d) Worn fill plug O-ring e) Pump overfilled f) Incorrect oil used g) Vent plug clogged	a) Have parts cleaned or replaced by authorised dealer b) Tighten drain plug c) Inspect and replace O-ring d) Inspect and replace O-ring e) Check for correct amount f) Drain and refill with correct type and amount of oil g) Clean vent plug. Use air hose to free it of blockage. If problem persists, replace vent bag.
Pump pulsates	a) Nozzle obstructed	a) See "Use Spray Wand" section

PUMP EXPLODED VIEW AND PARTS LIST



No	Description	No.	Description	No.	Description
1	Drain plug	25	Bolt	49	O-ring
2	Gasket	26	Oil seal	50	Output banjo bolt
3	Screw	27	Retainer ring	51	O-ring
4	Crankcase cover	28	O-ring	52	O-ring
5	O-ring	29	Low pressure seal	53	Checking valve
6	Side glass	30	Seal compaction ring	54	Spring
7	Fix clip	31	Seal compaction flake	55	O-ring
8	O-ring	32	High-pressure seal	56	Outlet quick connector
9	Vented oil plug	33	Supporting ring	57	Inlet banjo bolt
10	O-ring	34	Plastic cup	58	O-ring
11	Bolt	35	Knob	59	By-pass housing
12	Crankshaft cover	36	Spring	60	Swivel nut
13	O-ring	37	Spring seat	61	Inlet connector
14	Snap ring	38	Jam nut	62	Inlet water filter
15	Ball bearing	39	Fix screw	63	O-ring
16	Crankshaft	40	Unloader valve	64	Valve plug
17	Connecting rod	41	Valve seat	65	O-ring
18	Fix pin	42	O-ring	66	Checking valve assy
19	Ceramic plunger	43	O-ring	67	O-ring
20	O-ring	44	Valve housing	68	Outlet plug
21	Crankcase	45	Soap suction nozzle	69	Inlet plug
22	Needle bearing	46	O-ring	70	Manifold head
23	Flange	47	Steel ball	71	Bolt
24	Oil seal	48	Spring		

Appendix 5: Clutch Operator's Manual

Electromagnetic Clutch

Operation Manual



INSTALLATION OF MOBILE CLUTCHES

INSTALLATION PROCEDURE

1. This installation assumes the most common form of mounting, mounting to a pump bracket or direct mounting to a pump face. The pump can be hydraulic, water, a vacuum, or a compressor. These clutches consist of two major sub-assemblies: the field and the rotor/armature assembly.
2. Attach the field to the customer-supplied mounting bracket or pump face. Use the four ¼" cap screws supplied with the clutch. Tighten each screw to 8ft-lbs, taking care not to strip the heads. The flange should be perpendicular to the pump shaft within 0.003" TIR at a 6" diameter.
3. Install the customer-supplied key into the pump shaft key way.
4. Mount the rotor/armature assembly onto the shaft.
 - A. Straight-bore type: First, establish the required clearance between the end of the armature hub and the face of the field mounting flange. Some models have these two aligned, in which case no clearance is required. Check the part drawing for the appropriate specification. A shaft step or a spacer will be required to set this proper clearance. Then, slide the rotor/armature assembly onto the pump shaft.
 - B. Taper-bore or set-screw type: Slide the rotor/armature assembly onto the pump shaft, taking care to properly align both the shaft and hub key ways.
5. Secure the rotor/armature assembly.
 - A. Centre-bolt type: Install and securely tighten the centre bolt and washer supplied with most models (recommended torque: 20~30ft-lbs).
 - B. Set-screw type: The set screws can be accessed through openings in the field mounting flange. If there is no shaft step or spacer to position the hub, slide the rotor/armature assembly onto the shaft until it contacts the field. Then back off the assembly approximately 0.1" and tighten the set screws.
6. After installing the assembly, turn the pulley by hand to verify that there is no contact between the pulley and the field. If contact is noticed, reinstall the rotor/armature assembly or refer to the Noisy Clutch section of the Troubleshooting guide online.
7. Connect the lead wire(s) to the electric circuit. Check the lead wire polarity if the clutch coil has a diode (only possible on two-wire fields). All single-wire fields are

grounded at the factory. If the field support is not properly grounded, it is a good practice to attach a wire from the ground terminal on the field to the equipment to provide a sure ground. Possible interference with proper grounding is a painted surface in the connection.

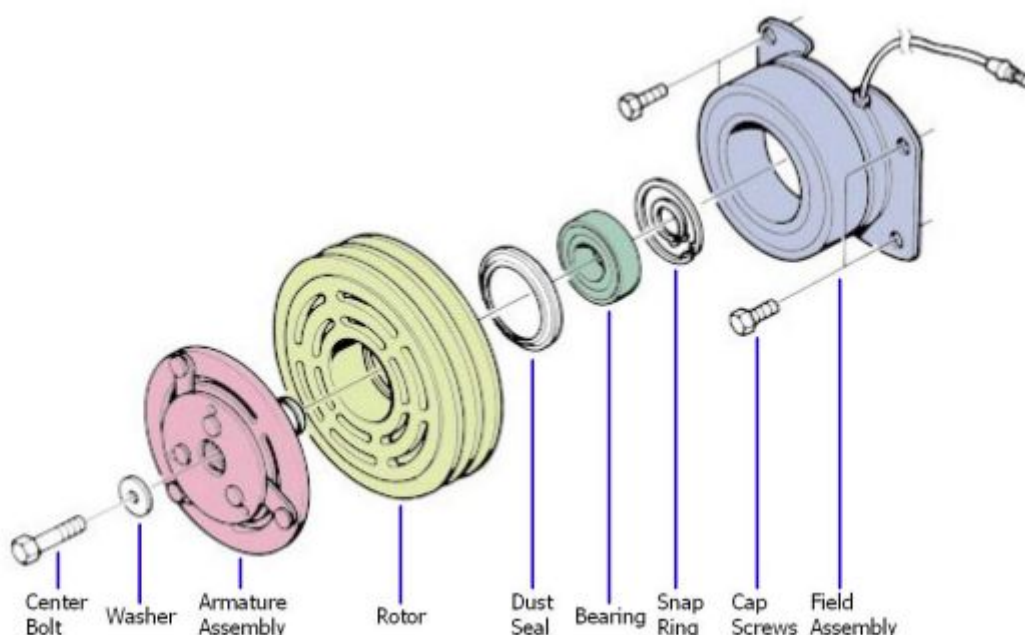
8. Engage and disengage the clutch several times while manually rotating the pulley to ensure it is functioning properly. If full torque is required immediately, the clutch should be burnished. This involves cycling the clutch at a reduced speed not more than 4 times per minute so the surfaces can mate together. In most applications, 20~50 cycles are required for burnishing.

TROUBLESHOOTING

For problems during installation or operation, please refer to the troubleshooting section on the website (<https://ogura-clutch.com/troubleshooting.php>). If you still have questions, please contact us directly for assistance.

CONTAMINATION

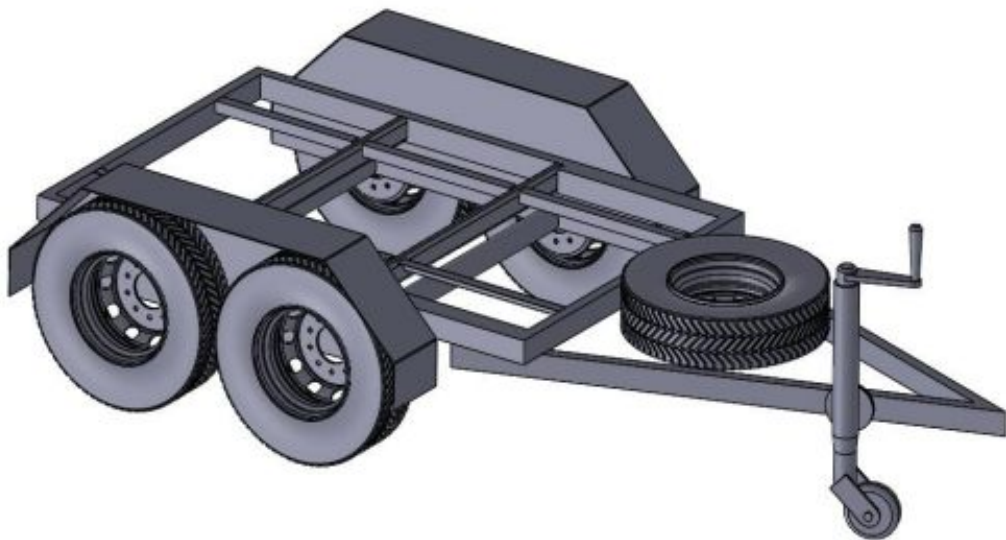
Care should be taken so that contaminants such as oil, grease, etc. do not come in contact with the working faces of the unit. In some cases it may be necessary to provide a cover or baffle to prevent this. Oil and grease on the friction surfaces should be removed by wiping with a small amount of environmentally friendly grease solvent. However, depending on the permeability of the grease or oil, it may be impossible to remove completely, so if the unit shows signs of slippage it needs to be replaced.



Appendix 6: Trailer Owner's Manual

Custom Trailer

John Papas Trailers (Australia) Pty Ltd
Operation Manual



MAINTENANCE

Every 10 000 km or 6 months of use;

1. Wheel bearings

Wheel bearings should be checked for adjustment. Any noise when spinning the wheel should be tended to-

- NOTE: no bearing noise should be heard. Bearings can also be inspected by removing then cleaning them checking for small pit marks or the bearings of the bearing cone holders
- NOTE: any noise or marking on the cups and cones should be replaced.

2. Trailers with mechanical disk breaks

Trailers with mechanical disc brackets rotors should be inspected for gauging marks. Brake pads should be checked for excessive wear.

- Correct adjustment should be made on the brake caliper. Front cable should be adjusted correctly.

3. Trailers with hydraulic breaks

The master cylinder should have the correct fluid level. Break pads should be checked for excessive wear.

- Correct adjustment should be made on the brake adjuster. Hand brake adjuster bolt to be adjusted correctly.

4. Trailers fitted with hydraulic tipping rams

Check hydraulic ram and hoses for any leaks, check fluid level in the tank, and check battery charge.

5. Tyres on the trailer

Check tyre pressure, check for any splits or cracks on the tires, and check wheel nuts for adjustment.

6. Miscellaneous

- Grease all the grease nipples on the trailer
- Check lights and the plug on the trailer
- Check trailer for any broken welds or cracks

TERMS AND CONDITIONS OF TRADE

John Papas Trailers (Australia) Pty Ltd – Terms & Conditions of Trade

- 1. Definitions**
- 1.1 "Seller" shall mean John Papas Trailers (Australia) Pty Ltd its successors and assigns or any person acting on behalf of and with the authority of John Papas Trailers (Australia) Pty Ltd.
- 1.2 "Customer" shall mean the Customer (or any person acting on behalf of and with the authority of the Customer) as described on any quotation, work authorisation or other form as provided by the Seller to the Customer.
- 1.3 "Guarantor" means that person (or persons), or entity, who agrees to be liable for the debts of the Customer on a principal debtor basis.
- 1.4 "Goods" shall mean Goods supplied by the Seller to the Customer (and where the context so permits shall include any supply of Services as hereinafter defined) and are as described on the invoice, quotation, work authorisation or any other forms as provided by the Seller to the Customer.
- 1.5 "Services" shall mean all Services supplied by the Seller to the Customer and includes any advice or recommendations (and where the context so permits shall include any supply of Goods as defined above).
- 1.6 "Price" shall mean the price payable for the Goods as agreed between the Seller and the Customer in accordance with clause 4 of this contract.
- 2. The Commonwealth Trade Practices Act 1974 ("TPA") and Fair Trading Acts ("FTA") and application of these terms and conditions to consumers**
- 2.1 Nothing in this agreement is intended to have the effect of contracting out of any applicable provisions of the TPA or the FTA in each of the States and Territories of Australia, except to the extent permitted by those Acts where applicable.
- 2.2 Clause 8 (Defects), and clause 9 (Warranty) may NOT apply to the Customer where the Customer is purchasing Goods or Services not for resale or hire where the Price of the Goods or Services does not exceed \$40,000, or where the Price of the Goods or Services does exceed \$40,000 and are of a kind ordinarily acquired for personal, domestic or household use or consumption, or where the Customer is in any other way a consumer within the meaning of the TPA or the FTA of the relevant state or territories of Australia.
- 3. Acceptance**
- 3.1 Any instructions received by the Seller from the Customer for the supply of Goods and/or the Customer's acceptance of Goods supplied by the Seller shall constitute acceptance of the terms and conditions contained herein.
- 3.2 Where more than one Customer has entered into this agreement, the Customers shall be jointly and severally liable for all payments due to the Seller.
- 3.3 Upon acceptance of these terms and conditions by the Customer the terms and conditions are binding and can only be amended with the written consent of the Seller.
- 3.4 The Customer shall give the Seller not less than fourteen (14) days prior written notice of any proposed change of ownership of the Customer or any change in the Customer's name and/or any other change in the Customer's details (including but not limited to, changes in the Customer's address, facsimile number, or business practice). The Customer shall be liable for any loss incurred by the Seller as a result of the Customer's failure to comply with this clause.
- 3.5 Goods are supplied by the Seller only on the terms and conditions of trade herein to the exclusion of anything to the contrary in the terms of the Customer's order notwithstanding that any such order is placed on terms that purport to override these terms and conditions of trade.
- 4. Price And Payment**
- 4.1 At the Seller's sole discretion the Price shall be either:
- (a) as indicated on invoices provided by the Seller to the Customer in respect of Goods supplied; or
- (b) the Seller's quoted Price (subject to clause 4.2) which shall be binding upon the Seller provided that the Customer shall accept the Seller's quotation in writing within thirty (30) days.
- 4.2 The Seller reserves the right to change the Price in the event of a variation to the Seller's quotation.
- 4.3 At the Seller's sole discretion a non refundable deposit may be required.
- 4.4 At the Seller's sole discretion:
- (a) payment shall be due on delivery of the Goods; or
- (b) payment for approved Customers shall be due thirty (30) days following the end of the month in which a statement is posted to the Customer's address or address for notices.
- 4.5 Time for payment for the Goods shall be of the essence and will be stated on the invoice or any other forms. If no time is stated then payment shall be due seven (7) days following the date of the invoice.
- 4.6 Payment will be made by cash, or by cheque, or by bank cheque, or by credit card (plus a surcharge of up to two percent (2%) of the Price), or by direct credit, or by any other method as agreed to between the Customer and the Seller.
- 4.7 GST and other taxes and duties that may be applicable shall be added to the Price except when they are expressly included in the Price.
- 5. Delivery Of Goods**
- 5.1 At the Seller's sole discretion delivery of the Goods shall take place when:
- (a) the Customer takes possession of the Goods at the Seller's address; or
- (b) the Customer takes possession of the Goods at the Customer's nominated address (in the event that the Goods are delivered by the Seller or the Seller's nominated carrier).
- 5.2 At the Seller's sole discretion the costs of delivery are:
- (a) in addition to the Price; or
- (b) for the Customer's account.
- 5.3 The Customer shall make all arrangements necessary to take delivery of the Goods whenever they are tendered for delivery. In the event that the Customer is unable to take delivery of the Goods as arranged then the Seller shall be entitled to charge a reasonable fee for redelivery.
- 5.4 Delivery of the Goods to a third party nominated by the Customer is deemed to be delivery to the Customer for the purposes of this agreement.
- 5.5 The failure of the Seller to deliver shall not entitle either party to treat this contract as repudiated.
- 5.6 The Seller shall not be liable for any loss or damage whatsoever due to failure by the Seller to deliver the Goods (or any of them) promptly or at all where due to circumstances beyond the control of the Seller.
- 6. Risk**
- 6.1 If the Seller retains ownership of the Goods nonetheless, all risk for the Goods passes to the Customer on delivery.
- 6.2 If any of the Goods are damaged or destroyed following delivery but prior to ownership passing to the Customer, the Seller is entitled to receive all insurance proceeds payable for the Goods. The production of these terms and conditions by the Seller is sufficient evidence of the Seller's rights to receive the insurance proceeds without the need for any person dealing with the Seller to make further enquiries.
- 6.3 Where the Customer expressly requests the Seller to leave Goods outside the Seller's premises for collection or to deliver the Goods to an unattended location then such Goods shall be left at the Customer's sole risk and it shall be the Customer's responsibility to ensure the Goods are insured adequately or at all.
- 7. Title**
- 7.1 The Seller and the Customer agree that ownership of the Goods shall not pass until:
- (a) the Customer has paid the Seller all amounts due for the particular Goods; and
- (b) the Customer has met all other obligations due by the Customer to the Seller in respect of all contracts between the Seller and the Customer.
- 7.2 Receipt by the Seller of any form of payment other than cash shall not be deemed to be payment until that form of payment has been honoured, cleared or recognised and until then the Seller's ownership or rights in respect of the Goods shall continue.
- 7.3 It is further agreed that:
- (a) where practicable the Goods shall be kept separate and identifiable until the Seller shall have received payment and all other obligations of the Customer are met; and
- (b) until such time as ownership of the Goods shall pass from the Seller to the Customer the Seller may give notice in writing to the Customer to return the Goods or any of them to the Seller. Upon such notice the rights of the Customer to obtain ownership or any other interest in the Goods shall cease; and
- (c) the Seller shall have the right of stopping the Goods in transit whether or not delivery has been made; and
- (d) if the Customer fails to return the Goods to the Seller then the Seller or the Seller's agent may enter upon and into land and premises owned, occupied or used by the Customer, or any premises as the invitee of the Customer, where the Goods are situated and take possession of the Goods; and
- (e) the Customer is only a bailee of the Goods and until such time as the Seller has received payment in full for the Goods then the Customer shall hold any proceeds from the sale or disposal of the Goods, up to and including the amount the Customer owes to the Seller for the Goods, on trust for the Seller; and
- (f) the Customer shall not deal with the money of the Seller in any way which may be adverse to the Seller; and
- (g) the Customer shall not charge the Goods in any way nor grant nor otherwise give any interest in the Goods while they remain the property of the Seller; and
- (h) the Seller can issue proceedings to recover the Price of the Goods notwithstanding that ownership of the Goods may not have passed to the Customer; and
- (i) until such time that ownership in the Goods passes to the Customer, if the Goods are converted into other products, the parties agree that the Seller will be the owner of the end products.
- 8. Defects**
- 8.1 The Customer shall inspect the Goods on delivery and shall within three (3) days of delivery (time being of the essence) notify the Seller of any alleged defect, shortage in quantity, damage or failure to comply with the description or quote. The Customer shall afford the Seller an opportunity to inspect the Goods within a reasonable time following delivery. If the Customer believes the Goods are defective in any way, if the Customer shall fail to comply with these provisions the Goods shall be presumed to be free from any defect or damage. For defective Goods, which the Seller has agreed in writing that the Customer is entitled to reject, the Seller's liability is limited to either (at the Seller's discretion) replacing the Goods or repairing the Goods except where the Customer has acquired Goods as a consumer within the meaning of the Trade Practices Act 1974 (Cwth) or the Fair Trading Acts of the relevant state or territories of Australia, and is therefore also entitled to, at the consumer's discretion either a refund of the purchase price of the Goods, or repair of the Goods, or replacement of the Goods.
- 8.2 Goods will not be accepted for return other than in accordance with 8.1 above.
- 9. Warranty**
- 9.1 Subject to the conditions of warranty set out in clause 9.2 the Seller warrants that if any defect in any workmanship of the Seller becomes apparent and is reported to the Seller within six (6) months of the date of delivery (time being of the essence) then the Seller will either (at the Seller's sole discretion) replace or remedy the workmanship.
- 9.2 The conditions applicable to the warranty given by clause 9.1 are:
- (a) the warranty shall not cover any defect or damage which may be caused or partly caused by or arise through:
- (i) failure on the part of the Customer to properly maintain any Goods; or
- (ii) failure on the part of the Customer to follow any instructions or guidelines provided by the Seller; or
- (iii) any use of any Goods otherwise than for any application specified on a quote or order form; or the continued use of any Goods after any defect becomes apparent or would have become apparent to a reasonably prudent operator or user; or
- (iv) fair wear and tear, any accident or act of God;
- (b) the Customer shall return the Goods to the Seller premises to allow the Seller the opportunity to inspect the Goods and assess the alleged defect or damage.
- (c) the warranty shall cease and the Seller shall thereafter in no circumstances be liable under the terms of the warranty if the workmanship is repaired, altered or overhauled without the Seller's consent.
- (d) in respect of all claims the Seller shall not be liable to compensate the Customer for any delay in either replacing or remedying the workmanship or in properly assessing the Customer's claim.
- 9.3 For Goods not manufactured by the Seller, the warranty shall be the current warranty provided by the manufacturer of the Goods. The Seller shall not be bound by nor be responsible for any term, condition, representation or warranty other than that which is given by the manufacturer of the Goods.
- 9.4 A two (2) year warranty (that is subject to the conditions set out in clause 9.2) is offered to the Customer when the Goods have been serviced (subject to the Seller's service fee) by the Seller after each six (6) month period or after the Goods have travelled ten thousand kilometres (10000km), whichever occurs first.
- 10. Default & Consequences of Default**
- 10.1 Interest on overdue invoices shall accrue daily from the date when payment becomes due, until the date of payment, at a rate of two and one half percent (2.5%) per calendar month (and at the Seller's sole discretion such interest shall compound monthly at such a rate) after as well as before any judgment.
- 10.2 In the event that the Customer's payment is dishonoured for any reason the Customer shall be liable for any dishonour fees incurred by the Seller.
- 10.3 If the Customer defaults in payment of any invoice when due, the Customer shall indemnify the Seller from and against all costs and disbursements incurred by the Seller in pursuing the debt including legal costs on a solicitor and own client basis and the Seller's collection agency costs.
- 10.4 Without prejudice to any other remedies the Seller may have, if at any time the Customer is in breach of any obligation (including those relating to payment), the Seller may suspend or terminate the supply of Goods to the Customer and any of its other obligations under the terms and conditions. The Seller will not be liable to the Customer for any loss or damage the Customer suffers because the Seller has exercised its rights under this clause.
- 10.5 If any account remains overdue after thirty (30) days then an amount of the greater of twenty dollars (\$20.00) or ten percent (10%) of the amount overdue (up to a maximum of two hundred dollars (\$200.00)) shall be levied for administration fees which sum shall become immediately due and payable.
- 10.6 Without prejudice to the Seller's other remedies at law the Seller shall be entitled to cancel all or any part of any order of the Customer which remains unfilled and all amounts owing to the Seller shall, whether or not due for payment, become immediately payable in the event that:
- (a) any money payable to the Seller becomes overdue; or
- (b) the Customer becomes insolvent, convenes a meeting with its creditors or proposes or enters into an arrangement with creditors, or makes an assignment for the benefit of its creditors; or
- (c) a receiver, manager or liquidator (provisional or otherwise) or similar person is appointed in respect of the Customer or any asset of the Customer.
- 11. Security And Charge**
- 11.1 Despite anything to the contrary contained herein or any other rights which the Seller may have howsoever:
- (a) where the Customer and the Guarantor (if any) is the owner of land, realty or any other asset capable of being charged, both the Customer and/or the Guarantor agree to mortgage and/or charge all of their joint and/or several interest in the said land, realty or any other asset to the Seller or the Seller's nominee to secure all amounts and other monetary obligations payable under these terms and conditions. The Customer and/or the Guarantor acknowledge and agree that the Seller (or the Seller's nominee) shall be entitled to lodge where appropriate a caveat, which caveat shall be withdrawn once all payments and other monetary obligations payable hereunder have been met.
- (b) in the event that the Customer elects to proceed in any manner in accordance with this clause and/or its sub-clauses, the Customer and/or Guarantor shall indemnify the Seller from and against all the Seller's costs and disbursements including legal costs on a solicitor and own client basis.
- (c) the Customer and/or the Guarantor (if any) agree to irrevocably nominate constitute and appoint the Seller or the Seller's nominee as the Customer's and/or Guarantor's true and lawful attorney to perform all necessary acts to give effect to the provisions of this clause 11.1.
- 12. Cancellation**
- 12.1 The Seller may cancel any contract to which these terms and conditions apply or cancel delivery of Goods at any time before the Goods are delivered by giving written notice to the Customer. On giving such notice the Seller shall repay to the Customer any sums paid in respect of the Price. The Seller shall not be liable for any loss or damage whatsoever arising from such cancellation.
- 12.2 In the event that the Customer cancels delivery of Goods the Customer shall be liable for any loss incurred by the Seller (including, but not limited to, any loss of profits) up to the time of cancellation.
- 12.3 Cancellation of orders for Goods made to the Customer's specifications or non-stockist items will definitely not be accepted, once production has commenced.
- 13. Privacy Act 1988**
- 13.1 The Customer and/or the Guarantor agree for the Seller to obtain from a credit reporting agency a credit report containing personal credit information about the Customer and Guarantor/s in relation to credit provided by the Seller.
- 13.2 The Customer and/or the Guarantor agree that the Seller may exchange information about the Customer and the Guarantor with those credit providers either named as trade referees by the Customer or named in a consumer credit report issued by a credit reporting agency for the following purposes:
- (a) to assess an application by Customer; and/or
- (b) to notify other credit providers of a default by the Customer; and/or
- (c) to exchange information with other credit providers as to the status of this credit account, where the Customer is in default with other credit providers; and/or
- (d) to assess the credit worthiness of Customer and/or Guarantor/s.
- 13.3 The Customer consents to the Seller being given a consumer credit report to collect overdue payment on commercial credit (Section 18k(1)(h) Privacy Act 1988).
- 13.4 The Customer agrees that personal credit information provided may be used and retained by the Seller for the following purposes and for other purposes as shall be agreed between the Customer and Seller or required by law from time to time:
- (a) provision of Goods; and/or
- (b) marketing of Goods by the Seller, its agents or distributors in relation to the Goods; and/or
- (c) analysing, verifying and/or checking the Customer's credit, payment and/or status in relation to provision of Goods; and/or
- (d) processing of any payment instructions, direct debit facilities and/or credit facilities requested by Customer; and/or
- (e) enabling the daily operation of Customer's account and/or the collection of amounts outstanding in the Customer's account in relation to the Goods.
- 13.5 The Seller may give information about the Customer to a credit reporting agency for the following purposes:
- (a) to obtain a consumer credit report about the Customer; and/or
- (b) allow the credit reporting agency to create or maintain a credit information file containing information about the Customer.
- 14. Unpaid Seller's Rights**
- 14.1 Where the Customer has left any item with the Seller for repair, modification, exchange or for the Seller to perform any other Service in relation to the item and the Seller has not received or been tendered the whole of the Price, or the payment has been dishonoured, the Seller shall have:
- (a) a lien on the item;
- (b) the right to retain the item for the Price while the Seller is in possession of the item;
- (c) a right to sell the item.
- 14.2 The right of the Seller shall continue despite the commencement of proceedings, or judgment for the Price having been obtained.
- 15. General**
- 15.1 If any provision of these terms and conditions shall be invalid, void, illegal or unenforceable the validity, existence, legality and enforceability of the remaining provisions shall not be affected, prejudiced or impaired.
- 15.2 These terms and conditions and any contract to which they apply shall be governed by the laws of Western Australia and are subject to the jurisdiction of the courts of Western Australia.
- 15.3 The Seller shall be under no liability whatsoever to the Customer for any indirect and/or consequential loss and/or expense (including loss of profit) suffered by the Customer arising out of a breach by the Seller of these terms and conditions.
- 15.4 In the event of any breach of this contract by the Seller the remedies of the Customer shall be limited to damages which under no circumstances shall exceed the Price of the Goods.
- 15.5 The Customer shall not be entitled to set off against, or deduct from the Price, any sums owed or claimed to be owed to the Customer by the Seller nor to withhold payment of any invoice because part of that invoice is in dispute.
- 15.6 The Seller may license or sub-contract all or any part of its rights and obligations without the Customer's consent.
- 15.7 The Customer agrees that the Seller may review these terms and conditions at any time. If, following any such review, there is to be any change to these terms and conditions, then that change will take effect from the date on which the Seller notifies the Customer of such change.
- 15.8 Neither party shall be liable for any default due to any act of God, war, terrorism, strike, lock-out, industrial action, fire, flood, storm or other event beyond the reasonable control of either party.
- 15.9 The failure by the Seller to enforce any provision of these terms and conditions shall not be treated as a waiver of that provision, nor shall it affect the Seller's right to subsequently enforce that provision.

Appendix 7: Engine Operator's Manual

KDW – 1404 Diesel Engine

Diesel Engine Operation Manual
Kohler Engines



REFER TO KOHLER OEM MANUAL FOR DETAILS

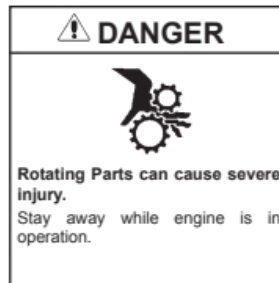
This manual contains pertinent information regarding the repair of Kohler water-cooled, indirect injection Diesel engines type **KDW 702-1003-1404**: updated 20/06/2012.

SAFETY INFORMATION



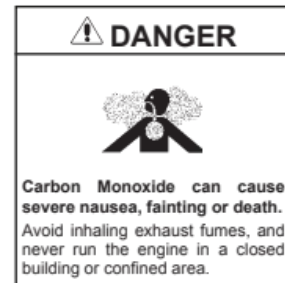
Accidental Starts!

Disabling engine. Accidental starting can cause severe injury or death. Before working on the engine or equipment, disable the engine as follows: 1) Disconnect negative (-) battery cable from battery.



Rotating Parts!

Keep hands, feet, hair, and clothing away from all moving parts to prevent injury. Never operate the engine with covers, shrouds, or guards removed.



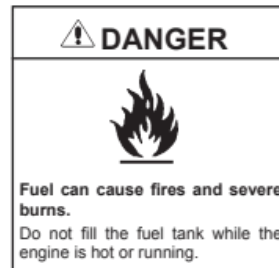
Lethal Exhaust Gases!

Engine exhaust gases contain poisonous carbon monoxide. Carbon monoxide is odorless, colorless, and can cause death if inhaled. Avoid inhaling exhaust fumes, and never run the engine in a closed building or confined area.



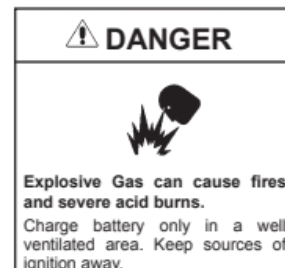
Hot Parts!

Engine components can get extremely hot from operation. To prevent severe burns, do not touch these areas while the engine is running, or immediately after it is turned off. Never operate the engine with heat shields or guards removed.



Explosive Fuel!

Fuel is flammable and its vapors can ignite. Store fuel only in approved containers, in well ventilated, unoccupied buildings. Do not fill the fuel tank while the engine is hot or running, since spilled fuel could ignite if it comes in contact with hot parts or sparks from ignition. Do not start the engine near spilled fuel. Never use fuel as a cleaning agent.



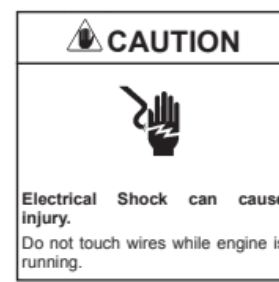
Explosive Gas!

Batteries produce explosive hydrogen gas while being charged. To prevent a fire or explosion, charge batteries only in well ventilated areas. Keep sparks, open flames, and other sources of ignition away from the battery at all times. Keep batteries out of the reach of children. Remove all jewelry when servicing batteries. Before disconnecting the negative (-) ground cable, make sure all switches are OFF. If ON, a spark will occur at the ground cable terminal which could cause an explosion if hydrogen gas or fuel vapors are present.



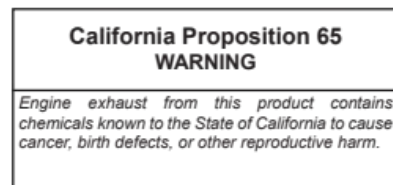
High Pressure Fluid Puncture!

Fuel system is to be serviced only by properly trained personnel wearing protective safety equipment. Fluid puncture injuries are highly toxic and hazardous. If an injury occurs, seek immediate medical attention.

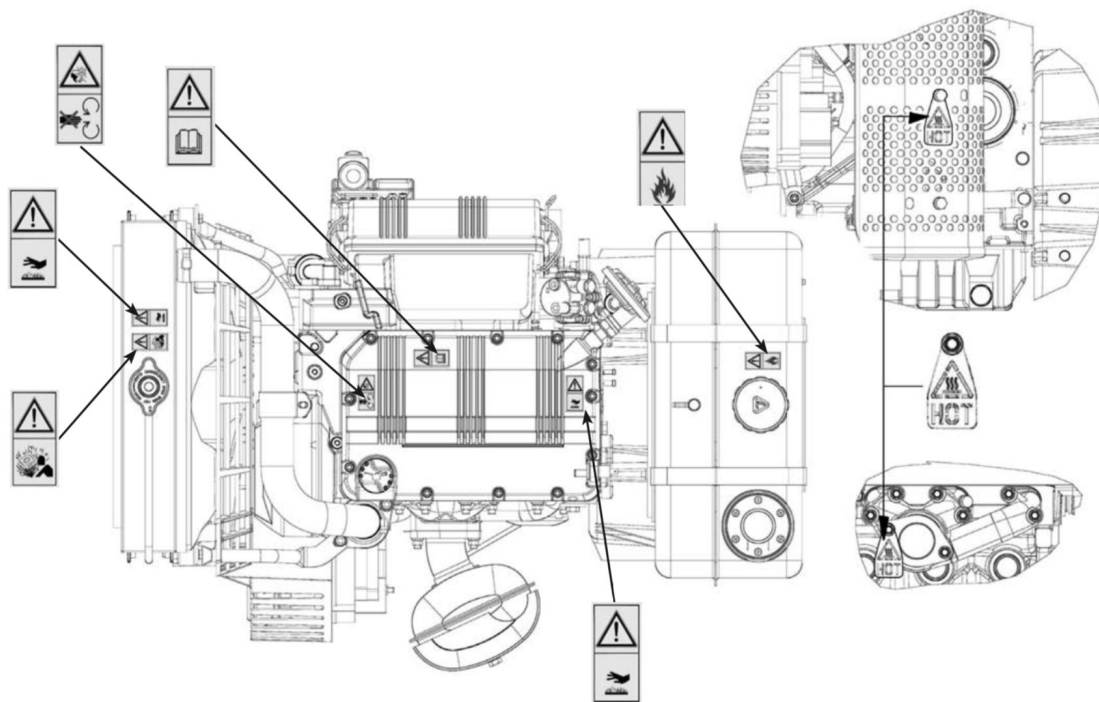


Electrical Shock!

Never touch electrical wires or components while the engine is running. They can be sources of electrical shock.



Below shows the points on the engine where safety pictograms are placed indicating danger.



General Notes

- To start the engine, follow the specific instructions provided in the engine and/or machine operating manual. Do not use auxiliary starting devices not originally installed on the machine (e.g. Startpilot systems which utilise ether etc.)
- Before carrying out any work on the engine, turn it off and allow it to cool down. Do not perform any operation while the engine is running.
- Check that the discharged oil, the oil filter and the oil contained in the oil filter are disposed of in such a way as not to harm the environment.
- Close the fuel tank filler cap carefully after each filling operation. Do not fill the tank right up to the top, but leave sufficient space to allow for any expansion of the fuel.
- Do not smoke or use naked flames while filling.
- Take care when removing the oil filter as it may be hot.
- The operations of checking, filling up and replacing the cooling liquid must be carried out with the engine turned off and cold. Take particular care if liquids containing nitrites are mixed with others not containing these compounds as this may give rise to the formation of nitros-amines which are a health hazard. The cooling liquid is polluting, so dispose of in a manner that does not damage the environment.
- In order to move the engine simultaneously use the eyebolts fitted for this purpose by Kohler. These lifting points are however not suitable for the entire machine, so in this case use the eyebolts fitted by the manufacturer.

TECHNICAL INFORMATION – TROUBLE SHOOTING

Technical Data

ENGINE TYPE		KDW1404
Cylinders	N°	4
Bore	mm	88
Stroke	Mm	90.4
Displacement	Cm ³	2199
Compression ratio		22:1
R.P.M		3000
Power KW	N 80/1269/CEE-ISO 1585-DIN 70020	49.2
	NB ISO 3046 – 1 IFN – DIN 6270	47
	NA ISO 3046 – 1 ICXN – DIN 6270	42.3
Max. torque*	Nm	190
	RPM	@1800
Max. torque 3 rd + 4 th p.t.o	Nm	39.2
	g/KWh	@3000
Oil consumption**	kg/h	0.04
Dry weight	kg	197
Combustion air volume at 3000 r.p.m	l./1'	4200
Cooling air volume at 3000 r.p.m	m ³ /mm	180
Max. permissible driving shaft axial load in both directions	Kg	300
Max. inclination	Max. 60 seconds	α 35°
	Lasting up to 30 seconds	α 25°
	Permanent	α ***
Firing order		1-3-4-2

* Referred to max. N power

** At NA power

*** Depending on the application

The engine must be stopped immediately when:

1. The engine rpms suddenly increase and decrease
2. A sudden unusual noise is heard
3. The colour of the exhaust fumes suddenly darkens
4. The oil pressure indicator light turns on while running

TABLE OF LIKELY ANOMALIES AND THEIR SYMPTOMS

The following table contains the possible causes of some failures which may occur during operation. Always perform these simple checks before removing or replacing any part

POSSIBLE CAUSE		TROUBLE													
		Engine does not start	Engine starts but stops	No acceleration	Non-uniform speed	Black smoke	White smoke	Oil pressure too low	Oil level increase	Excessive oil consumption	Oil and fuel dripping from the exhaust	Engine overheats	Inadequate performance	High noise level	
FUEL CIRCUIT	Clogged fuel pipes														
	Clogged fuel filter														
	Air or water in the fuel circuit														
	Tank cap breather blocked														
	Faulty fuel pump														
	Lack of fuel														
ELECTRIC SYSTEM	Glow plug fuse burned														
	Faulty glow plug control relay														
	Flat battery														
	Unclear or mistaken cable connection														
	Faulty starter switch														
	Faulty starting motor														
	Faulty glow plugs														
MAINTENANCE	Clogged air filter														
	Prolonged operation at idle														
	Incomplete run-in														
	Overloaded engine														
SETTINGS REPAIRS	Excessive valve clearances														
	Absence of valve clearances														
	Incorrect speed governor leverages														
	Speed governor spring broken or disengaged														
	Idle low														
	Worn out or stuck rings														
	Worn out cylinders														
	Worn out valve guides														
	Bad valve seal														
	Bearing shells of bearing cap - piston rod - rocker worn out														
	E.G.R. valve blocked open														
	Governor leverages not running														
	Cylinder head gasket damaged														
	Faulty timing system														
	Supplementary starter spring broken or disengaged														

POSSIBLE CAUSE		TROUBLE													
		Engine does not start	Engine starts but stops	No acceleration	Non-uniform speed	Black smoke	White smoke	Oil pressure too low	Oil level increase	Excessive oil consumption	Oil and fuel dripping from the exhaust	Engine overheats	Inadequate performance	High noise level	
LUBRICATION CIRCUIT	High oil level														
	Low oil level														
	Dirty or blocked pressure regulation valve														
	Worn oil pump														
	Air to the oil suction hose														
	Faulty manometer or pressure switch														
	Oil in sump suction hose blocked														
	Oil in sump drainage pipe blocked														
	Faulty spray nozzles (Turbo engines only)														
INJECTION	Damaged injector														
	Damaged injection pump valve														
	Incorrectly calibrated injector														
	Worn or damaged pumping element														
	Incorrect injection pump delivery setting (delivery equalisation)														
	Hardened pump/injector control rod														
	Cracked or broken pre-combustion chamber														
	Incorrect adjustment of the injection systems (delivery equalisation advance)														
COOLING CIRCUIT	Insufficient refrigerant fluid														
	Defective fan, radiator, or radiator cap														
	Defective thermostatic valve														
	Loss of refrigerant fluid from the radiator, hoses, engine crankshaft or water pump.														
	Inside of radiator or coolant lines obstructed.														
	Defective or worn water pump														
	Alternator fan drive belt loose or torn														
	Heat exchange surface of the radiator clogged														

MAINTENANCE

Routine Engine Maintenance

NOTE: Failure to carry out the operations described in the table may lead to technical damage to the machine and/or system.

Plant #	Hours	Number Plate	Service Person	Date

ORDINARY MAINTENANCE: After the first 50 working hours, replace engine oil and oil filter.

Kohler Engine KDW 1404: EXTRAORDINARY MAINTENANCE		FREQUENCY x HOURS						
		Note	10	250	500	1000	5000	10000
CHECK	Engine oil level							
	Coolant level							
	Air filter (dry-type)	***						
	Radiator exchange surface	**						
	Valve clearance adjustment	**						
	Fan/alternator belt stretch	*						
	Cooling liquid hoses	*						
	Setting and injectors cleaning	**						
	Fuel pipes							
	Rubber intake hose (air filter and intake manifold)							
	Interior radiator cleaning							
	Alternator and starting monitor							
REPLACEMENT	Engine oil (Diesel E-Oil 10W40)	*						
	Oil filter	*						
	Fuel filter	*						
	Alternator belt	**						
	Coolant	**						
	Filter element panel air filter	***						
	Fuel pipes	**						
	Cooling liquid hoses	**						
	Rubber intake hose (air filter and intake manifold)	**						
	Timing belt	^	Every 4000 hours					
	Dry air cleaner external cartridge	***	After 6 checks with cleaning					
OVERHAUL	Partial							
	Total							

Please note:

- * In case of low use- every year
- ** In case of low use- every 2 years
- *** Air filter must be cleaned and replaced more frequently in dusty conditions
- ^ Once removed, the timing belt should be replaced even if its scheduled motion period is not over.



**Service to be completed
every 'x' hours**

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This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

NO DIG *Equipment*

The Trenchless Technology Specialists

Address: 15 Wildfire Rd, Maddington WA 6109

Postal: PO Box 2, Maddington WA 6989

Ph : 08 9493 0642

www.NoDigEquipment.com.au

sales@NoDigEquipment.com