Vanguard
Equipment,
Inc.

049-08OP-001B
2018-04

Operation and Maintenance Manual

Vacuum Lifter (VL): VL10, VL12, VL16
Vacuum Lifter Pipe (VLP) attachments: VLP

S/N 049050010021 – UP (VL10)
S/N 049050020021 – UP (VL12)
S/N 049050030021 – UP (VL16)

To be used with the host-carrier vehicle's Operation and Maintenance Manual

VANGUARD EQUIPMENT, INC.
15627 EAST PINE ST
TULSA, OKLAHOMA
74116, USA
☎/🖷: 918.437.1796

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Foreword

Literature Information

This manual should be stored in the Manual Canister in the Vacuum Lifter (VL) which is located on non-operator side doors, inside the Vacuum Lifter (VL). The Manual Canister is accessible after opening non-operator side doors.

049-08-08-001A


049-08-08-002A

Figure 1: Manual Canister placement

This manual contains safety information, operation instructions, transportation information, lubrication information and maintenance information.

Some photographs or illustrations in this publication show details or attachments that can be different from your machine. Guards and covers might have been removed for illustrative purposes.

Continuing improvement and advancement of product design might have caused changes to your machine which are not included in this publication. The latest version of this publication is available for downloaded from the internet at http://vanguardequip.com/. Read, study and keep this manual with the machine.

Whenever a question arises regarding your machine, or this publication, please consult Vanguard Equipment for the latest available information.

Machine Description

Vanguard's Vacuum Lifter system is a Below The Hook Lifting device, specifically a Powered Vacuum Lifter as defined in the American National Standard ASME B30.20. Vanguard's Vacuum Lifter system is a Lifting Device, specifically a Non-self-priming Vacuum Lifter as defined in the Australian Standard AS 4991. Vanguard's Vacuum Lifter system is a non-fixed load lifting attachment, specifically a non-self priming Vacuum Lifter as defined in the European Standard EN 13155. Vanguard's Vacuum Lifter system consists of a main structural supporting unit—the Vacuum Lifter Beam—referred to as the Vacuum Lifter (VL) which houses a self-contained vacuum power pack and vacuum-reservoir, and various interchangeable attachment pads referred to as the Vacuum Lifter Pipe (VLP) attachment pads that are specifically sized and shaped to match the intended loads to be lifted.

The Vacuum Lifter (VL) is available in three different model designations—VL 10, VL 12, VL 16—each with different rated lifting capacities/Working Load Limits (WLL). The Vacuum Lifter Pipe (VLP) attachment pads are available in differing size ranges as specified by their VLP size-designation, each with a unique vacuum-load rating characteristic. See the Product Information Section of this manual for complete specifications.

Vanguard's Vacuum Lifter system is intended to be used with various types of host-carrier machines including: excavators, forklifts, pipelayers, cranes, wheel and track loaders, knuckle- and telescopic booms, telehandlers, backhoes, etc. The primary use of this attachment is to lift and move non-porous construction related material in and around industrial or construction sites. It is not intended to be used inside buildings and its use inside building area is prohibited. It is intended to be used in settings where persons are excluded from the working area during normal operation.

The operator should read, understand, and follow both the hoisting/host-carrier-vehicle's, and the Vanguard Lifter's operating and maintenance instructions. The operator must comply with all local, state, and national construction procedures, regulations, and safety precautions.

This equipment is to be operated by qualified personnel only.

This equipment is to be serviced and maintained by qualified personnel only.

The daily service/inspection procedure should be performed before start-up.

The Vanguard Lifter uses the host-carrier-vehicle's controls for operation. Operate the appropriate controls before commencing actual work until familiar with the Vanguard Lifter's operation.

Safety

The safety sections list basic safety precautions. In addition, these sections identify the text and locations of warning signs and labels used on the machine.

Read and understand the basic precautions listed in the safety sections before operating or performing lubrication, maintenance and repair on this machine.

This equipment is to be operated and serviced by qualified personnel only. To become familiar with the basic safety precautions and warning sign locations and wording, at a minimum they must read and understand the safety section before operating or performing lubrication, maintenance and repair on this equipment.

Do not attempt to bypass any of the safety equipment or instrumentation on this equipment.

Do not attempt to operate this equipment with any of the safety equipment or instrumentation bypassed.

Certain conditions and precautions are peculiar to pipeline construction operations. The following represents the minimum considerations for safe operation of this equipment.

Operation

The operation section is a reference for the new operator and a refresher for the experienced operator. This section includes a discussion of machine controls, and transportation information.

Photographs and illustrations guide the operator through correct procedures of checking, starting, operating, and stopping the equipment.

Maintenance

The maintenance section is provided for quick, general reference only.

The maintenance sections are guides to equipment care. The Maintenance Interval Schedules (MIS) list the items to be maintained at a specific service interval. Items without specific intervals are listed under the "When Required" service interval.

Maintenance Intervals

Use the Vacuum Lifter (VL)'s service hour meter to determine servicing intervals. Calendar intervals shown (daily, weekly, monthly, etc.) can be used instead of service hour meter intervals if they provide more convenient servicing schedules and approximate the indicated service hour meter reading. Recommended service should always be performed at the interval that occurs first.

Under extremely severe, dusty or wet operating conditions, more frequent lubrication than is specified in the maintenance intervals charts might be necessary.

Perform service on items at multiples of the original requirement. For example, at every 500 service hours or 3 months, also service those items listed under every 250 service hours or monthly and every 10 service hours or daily.

California Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

Battery posts, terminals and related accessories contain lead and lead compounds. Wash hands after handling.

Certified Engine Maintenance

Proper maintenance and repair is essential to keep the engine and machine systems operating correctly. As the nonroad diesel engine owner, you are responsible for the performance of the required maintenance listed in the Owner Manual, Operation and Maintenance Manual, and Service Manual.

It is prohibited for any person engaged in the business of repairing, servicing, selling, leasing, or trading engines or machines to remove, alter, or render inoperative any emission related device or element of design installed on or in an engine or machine that is in compliance with the regulations (40 CFR Part 89). Certain elements of the machine and engine such as the exhaust system, fuel system, electrical system, intake air system and cooling system may be emission related and

should not be altered unless approved by the engine OEM. Follow the engine OEM procedures and service requirements to maintain exhaust emission compliance with the regulations as outlined by various regulatory authorities, such as—the California Air Resources Board (CARB), Environment Canada, Environmental Protection Agency (EPA), European Union Non-Road mobile machinery (EU NRMM), Technische Anleitung zur Reinhaltung der Luft (TA Luft), etc.—as specified by the engine OEM. Maintaining the engine systems to be in compliance with the various regulations is the owner's responsibility.

Safety Section

Safety Signs and Labels

There are several specific safety signs on this equipment. The exact location of the hazard and the description are reviewed in this section. Become familiarized with all safety signs.

Make sure that all of the safety signs are legible. Clean or replace the safety signs if you cannot read the words. Replace the illustrations if the illustrations are not visible. Use a cloth, water, and mild soap to clean the safety signs. Do not use solvent, gasoline, or other harsh chemicals to clean the safety signs. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the safety message. Loose adhesive will allow the safety message to fall.

Do not use pressure washers to clean the safety signs.

Replace any safety sign that is damaged, or missing. If a safety sign is attached to a part that is replaced, install a safety sign on the replacement part. Vanguard Equipment can provide new safety signs.

Certain conditions and precautions are peculiar to vacuum lifting operations. The following represents the minimum considerations for safe operations.

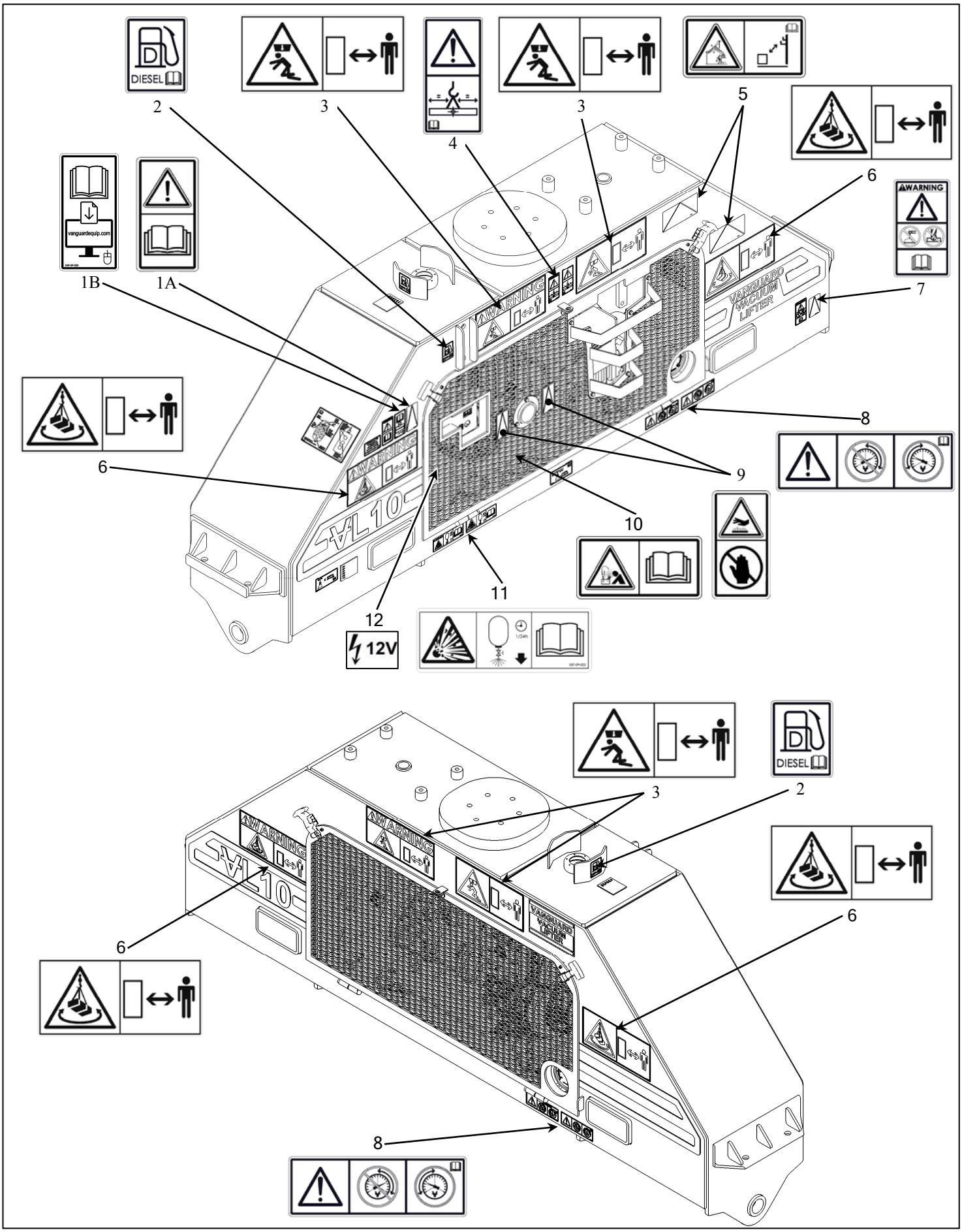


Figure 2: Safety Messages Vacuum Lifter (VL)

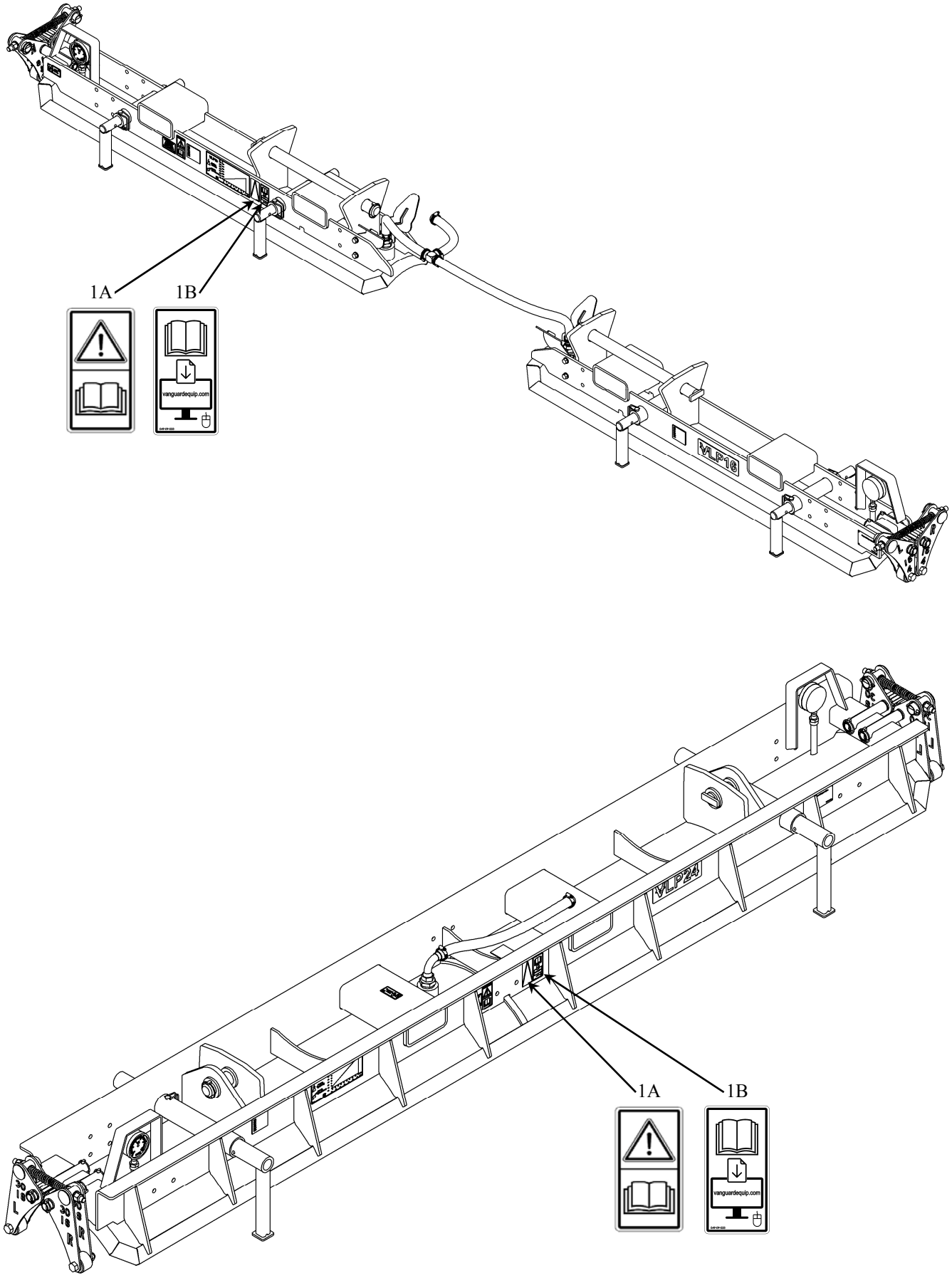


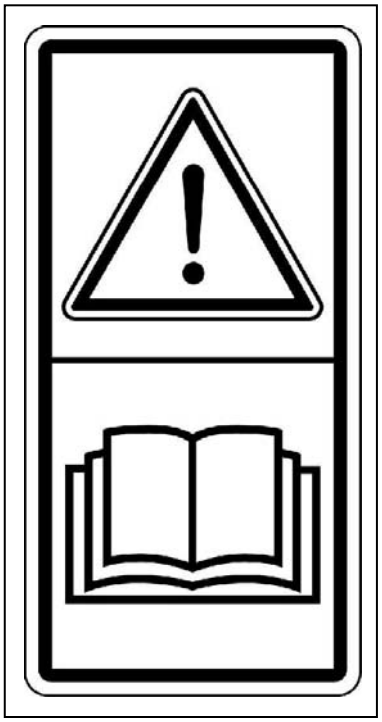
Figure 3: Safety Messages Vacuum Lifter Pads (VLP)

Do Not Operate (1A)

WARNING

WARNING! Do not operate or work on this machine unless you have read and understand the instructions and warnings in the Operation and Maintenance Manuals. Failure to follow the instructions or heed the warnings could result in injury or death. Contact your dealer for replacement manuals or download from vanguardequip.com. Proper care is your responsibility.

Safety message (1A) is located on the Vacuum Lifter (VL), on the operator side (fuel level gauge side) to the left of the fuel



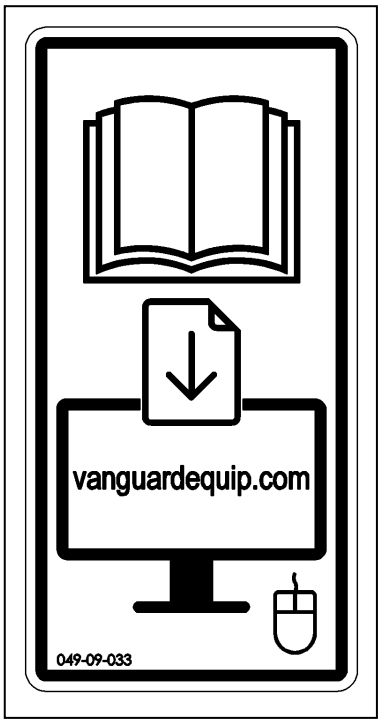
level gauge, above engine control panel.

Figure 4: Do not operate (1A)

Download the Operation and Maintenance Manual (1B)

The most recent copy of Operation and Maintenance Manual can be downloaded from vanguardequip.com. Proper care is your responsibility.

Information message (1B) is located on the Vacuum Lifter (VL), on the operator side (fuel level gauge side) to the left of the



engine control panel.

Figure 5: Download the Operation and Maintenance Manual (1B)

Use Diesel Fuel Only (2)

Notice

The vacuum pump's engine uses diesel fuel only. Use only clean, fresh, commercial-grade diesel fuel. Refer to the Operation and Maintenance Manual, maintenance section for recommended fuel specifications.

⚠ WARNING

Explosion hazard! Explosive fuel vapors can cause severe injury or death. Vaporized fuels are highly explosive. Use extreme care when handling and storing fuels. Store fuels in a well-ventilated area away from spark producing equipment and out of the reach of children. Never add fuel to the tank while the engine is running because spilled fuel may ignite on contact with hot parts or from sparks. Do not smoke or permit flames or sparks to occur near sources of spilled fuel or fuel vapors. Keep the fuel lines and connections tight and in good condition.

Information message (2) is located on the Vacuum Lifter (VL), on the operator side (fuel level gauge side) to the left of the fuel level gauge. Information message (2) is also located on the Vacuum Lifter (VL), at the fuel filler, on the outer fuel filler guard plate.

Figure 6: Diesel fuel only (2)

Do not work under load (3)

WARNING

Overhead Crushing Hazard! Stay back a safe distance. Keep clear of load. Do not work under load. Do not walk under load. Do not lift a suspended load over people. Severe injury or death from crushing could occur.

Safety message (3) is located on the Vacuum Lifter (VL), on the operator side (fuel level gauge side) to the left and right of the center, below the lifting attachment point. Safety message (3) is also located on the Vacuum Lifter (VL), on the front side (opposite side from fuel level gauge) in the center, below the lifting attachment point.

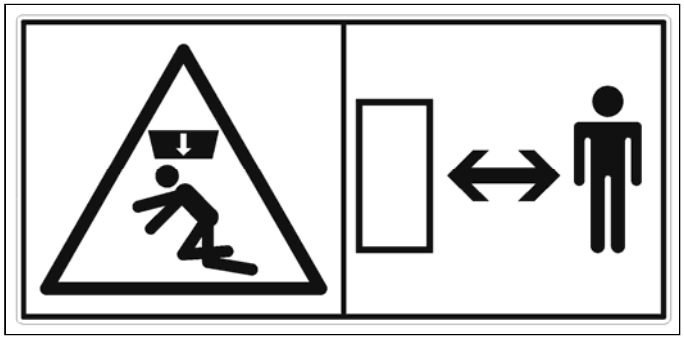


Figure 7: Do not work under load (3)

Position load correctly (4)

WARNING

Load Dropping Hazard! Position load correctly. Lift the load so that the vacuum pads are positioned evenly about center of gravity of the load, and the load is balanced. Do not attempt to lift the load while the vacuum pads are incorrectly positioned on the load. Refer to the Operation and Maintenance Manual for the correct load-handling procedures. Severe injury or death could occur.

Safety message (4) is located on the Vacuum Lifter (VL), on the operator side (fuel level gauge side) in the center, below the lifting attachment point.

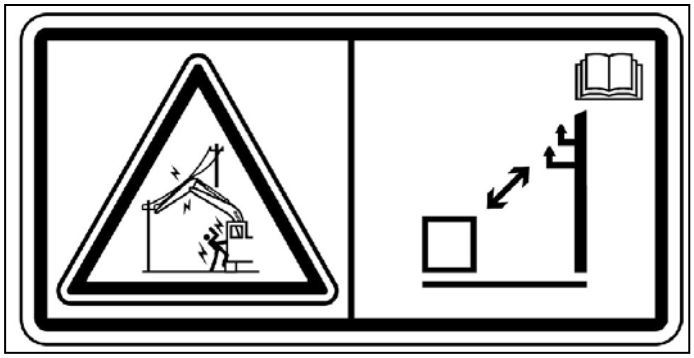
Figure 8: Position load correctly (4)

Electrical Power Lines (5)

DANGER

Electrocution Hazard! Keep the machine and attachments a safe distance from electrical power. Stay clear 3 M (10 ft) plus twice the line insulator length. Read and understand the instructions and warnings in the Operation and Maintenance Manual. Failure to follow the instructions and warnings will cause serious injury or death. Refer to, and follow the instructions contained in the host-carrier-vehicle's Operation and Maintenance Manual.

Safety message (5) is located on Vacuum Lifter (VL), on the operator side (fuel level gauge side), on the upper right, below



the vacuum status bacons.

Figure 9: Electrical power lines (5)

Do not work under rotating load (6)

WARNING

Overhead Rotating Load Hazard! Overhead load may rotate. Do not work under load or rotation zone, keep clear of load and rotation zone. Stay back a safe distance. Do not lift or rotate a suspended load over people. Severe injury or death from crushing could occur.

Safety message (6) is located on the Vacuum Lifter (VL), on the operator side (fuel level gauge side) to the left of the engine control panel and on the right of the Vacuum Lifter (VL) on the same level. Safety message (6) is also located on the Vacuum Lifter (VL), on the front side (opposite side from fuel level gauge) on the left and right sides of the Vacuum Lifter (VL).

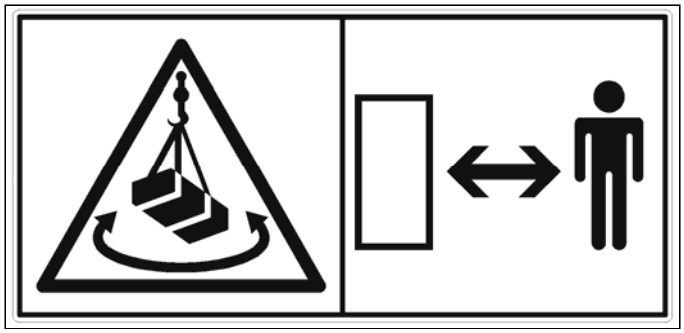


Figure 10: Do not work under rotating load (6)

Do Not Modify (7)

WARNING

Modification hazard! Do not weld, do not drill. Any modifications or alterations to the device could cause injury or death. Structural damage, modification, alteration, or improper repair can impair this structures load capability thereby voiding the loading certification. Do not weld on or drill holes in the structure, this will void the certifications. Consult operators manual.

Safety message (7) is located on the Vacuum Lifter (VL), on the operator side (fuel level gauge side), on the far right, bottom side.

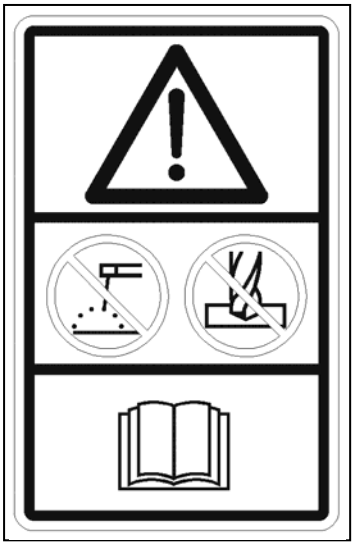


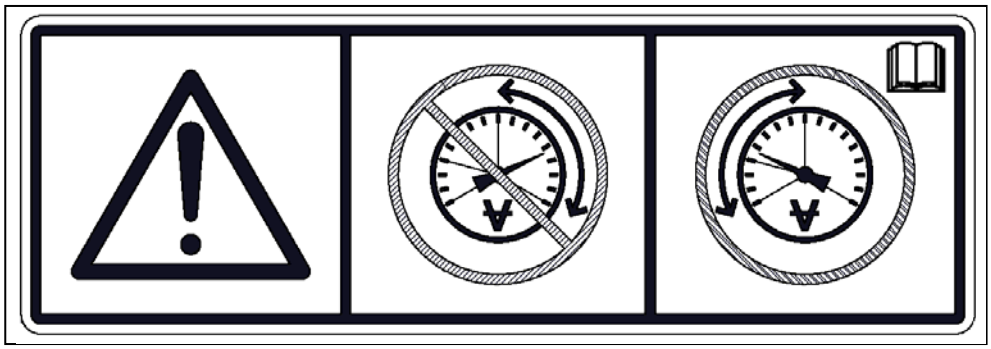
Figure 11: Do not modify (7)

Inadequate Vacuum (8)

⚠ WARNING

Dropping hazard! Do not operate with inadequate vacuum. Do not operate when vacuum gauges are in red area. Attempting to lift or support a load with inadequate vacuum could cause the load to drop without warning and result in serious injury or death. Do not operate the Vacuum Lifter (VL) unless adequate vacuum to support the load can be achieved, between -15 inHg and -30 inHg (-51 kPa and -101 kPa) depending on the weight of the load. Consult operators manual.

Safety message (8) is located on the Vacuum Lifter (VL), on the operator side (fuel level gauge side), at the bottom right, below the vacuum gauge. Safety message (8) is also located on the Vacuum Lifter (VL), on the front side (opposite side



from fuel level gauge), at the bottom right, below the vacuum gauge.

Figure 12: Do not operate with inadequate vacuum (8)

Hot Surface (9)

WARNING

WARNING! Hot parts or hot components can cause burns or personal injury. Do not allow hot parts or components to contact your skin. Use protective clothing or protective equipment to protect your skin. Keep away from hot surfaces.

Safety message (9) is located on the Vacuum Lifter (VL), on the operator side (fuel level gauge side) to the left and to the right of the exhaust outlet in the protective door guarding.

Figure 13: Hot surface (9)

Improper Connections for Jump Start Cables (10)

WARNING

Explosion Hazard! Improper jumper cable connections can cause an explosion resulting in serious injury or death. Batteries may be located in separate compartments. Refer to the Operation and Maintenance Manual for the correct jump starting procedure.

Safety message (10) is located on the Vacuum Lifter (VL), on the operator side (fuel level gauge side) to the left of the engine control panel.

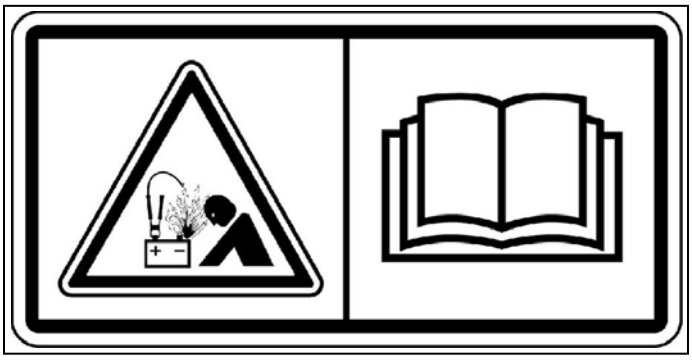


Figure 14: Improper Connections for Jump Start Cables (10)

Drain Vacuum Lifter (VL) Tank Daily (11)

⚠ WARNING

Warning! Explosion Hazard! Drain Vacuum Lifter (VL) tank daily, at the end of work for the day or once every 24 hours (1/24h). Failure to drain Vacuum Lifter (VL) tank can cause serious injury or death. Never leave the vacuum tank charged when unattended for long periods. Never attempt to service Vacuum Lifter (VL) with tank not fully drained. Refer to the Operation and Maintenance Manual for the correct Vacuum Lifter (VL) tank drain procedure.

Safety message (8) is located on the Vacuum Lifter (VL), on the operator side (fuel level gauge side), at the bottom left, below the operator controls.

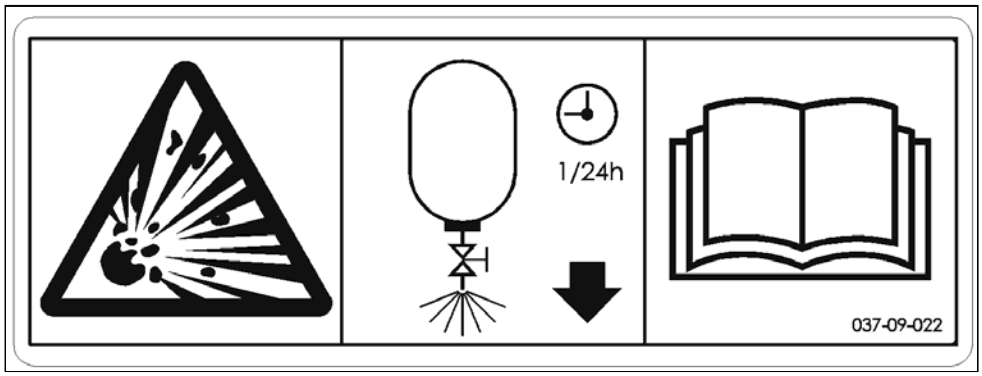


Figure 15: Drain Vacuum Lifter (VL) tank daily (11)

12 Volt DC system (12)

Notice

The Vacuum Lifter (VL) operates on a 12 Volt DC electric system. This includes the batteries, charging, starter-motor, and control system. Do not attempt to connect to another system that operates on a different voltage than 12 Volts DC. Read and understand the instructions and warnings in the Operation and Maintenance Manual. Failure to follow the instructions or heed the warnings could cause serious injury, or could seriously damage the Vacuum Lifter (VL).

Information message (12) is located inside the vacuum power-pack compartment, on the left bulkhead, above the battery and below the control panel.

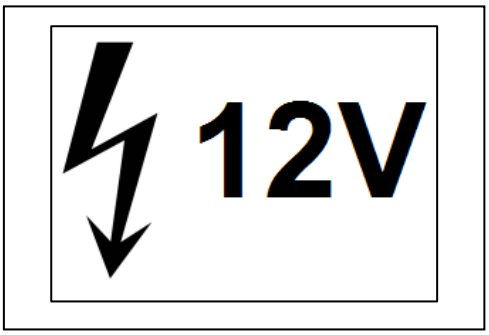


Figure 16: 12 Volt DC system (12)

General Hazard Information

Before you service the equipment or before you repair the equipment, attach a “Do Not Operate” tag or similar tag to the start switch or controls.

Know the width of your equipment in order to maintain proper clearance near fences, boundary obstacles, etc.

This attachment extends significantly beyond the host-carrier increasing the overall length and/or width, be especially aware of the additional length and/or width when turning and maneuvering the host-carrier-vehicle.

Follow all safety regulations, procedures and precautions that govern the work site, including: wearing a hard hat, protective glasses and other protective equipment in order to accommodate job conditions.

Do not wear loose clothing or jewelry that can catch on controls or other parts of the equipment.

Keep all equipment free from foreign material. Remove debris, oil, tools and other items.

Know the appropriate work site hand signals. Also, know the personnel that are authorized to give the hand signals. Accept signals from one person only.

Never put maintenance fluids into glass containers. Drain all liquids into a suitable container.

When you discard liquids, obey all local regulations.

Use all cleaning solutions with care.

Report all necessary repairs.

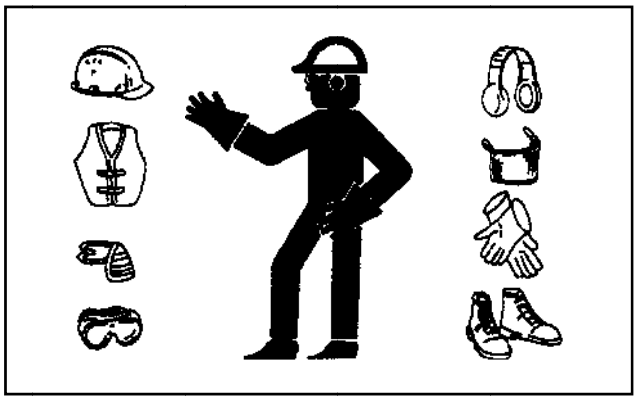
Do not allow unauthorized personnel on the machine.

Perform the maintenance with the host-carrier parked on level ground as per the manufacturer's instructions

Pressure Air and water

Pressurized air and/or water can cause debris and/or hot water to be blown out. The debris and/or hot water could result in personal injury.

When pressurized air and/or pressurized water is used for cleaning, wear protective clothing, protective shoes, and eye



protection. Eye protection includes goggles or a protective face shield.

The maximum air pressure for cleaning purposes must be reduced to 205 kPa (30 psi) when the nozzle is deadheaded and the nozzle is used with an effective chip deflector and personal protective equipment. The maximum water pressure for cleaning purposes must be below 275 kPa (40 psi).

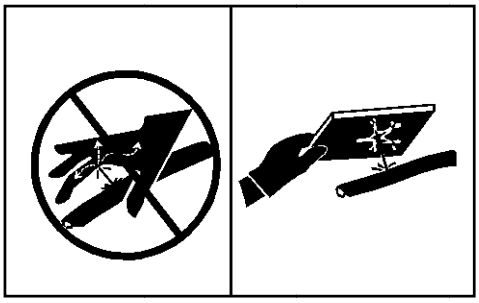
Trapped Pressure

Pressure can be trapped in a hydraulic system. Trapped pressure can cause sudden equipment movement. Use caution if you disconnect hydraulic lines or fittings. High pressure oil that is released can cause a hose to whip. High pressure oil that is released can cause oil to spray. Fluid penetration can cause serious injury and possible death.

Fluid Penetration

Pressure can be trapped in the hydraulic circuit long after the engine has been stopped. The pressure can cause hydraulic fluid or items such as pipe plugs to escape rapidly if the pressure is not relieved correctly.

Do not remove any hydraulic components or parts until pressure has been relieved or personal injury may occur. Do not disassemble any hydraulic components or parts until pressure has been relieved or personal injury may occur. Refer to the hoisting/host-carrier-vehicle's Operation and Maintenance Manual for any procedures that are required to relieve the hydraulic pressure.



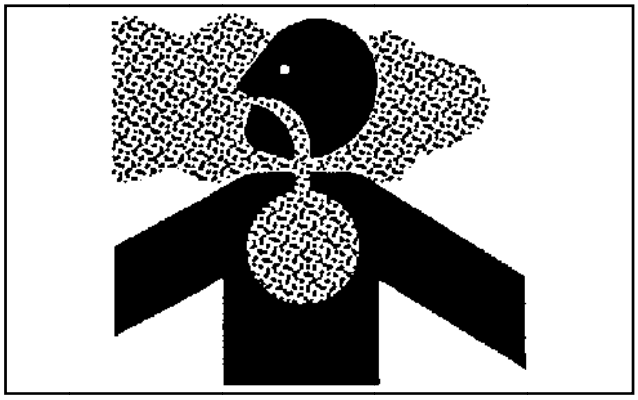
When you check for a leak, use a board or cardboard. Leaking fluid that is under pressure can penetrate body tissue. Fluid penetration can cause serious injury and possible death. A pin hole leak can cause severe injury. If fluid is injected into your skin, you must obtain treatment immediately. Seek treatment from a doctor that is familiar with this type of injury.

Containing Fluid Spillage

Care must be taken in order to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the equipment. Prepare to collect the fluid with suitable containers before opening any compartment or disassembling any component that contains fluids.

Obey all local regulations for the disposal of liquids.

Inhalation



Exhaust

Use caution. Exhaust fumes can be hazardous to your health. If you operate the machine in an enclosed area, adequate ventilation is necessary.

Asbestos Information

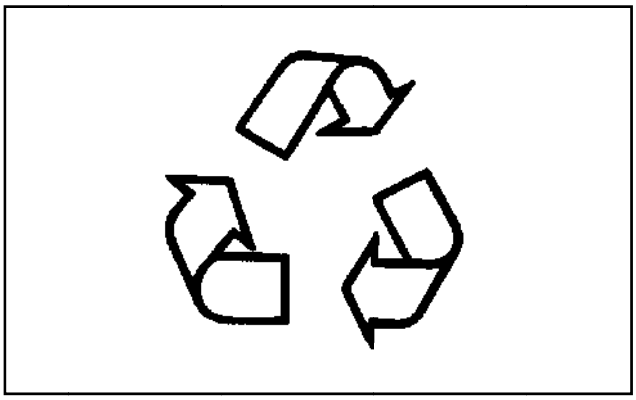
Equipment and replacement parts that are shipped from Vanguard are asbestos free. Use only genuine OEM replacement parts. If any replacement parts that contain asbestos are used, follow the manufacturer's handling guidelines and procedures as outlined in their instruction documentation.

Obey environmental regulations for the disposal of asbestos.

Stay away from areas that might have asbestos particles in the air.

Dispose of Waste Properly

Improperly disposing of waste can threaten the environment. Potentially harmful fluids or materials should be disposed of or recycled according to local regulations.



Always use leak proof containers when you drain fluids. Do not pour waste onto the ground, down a drain, or into any source of water.

Burn Prevention

Do not touch any part of an operating engine. Do not touch any part of an operating vacuum pump. Allow machine systems to cool before any maintenance is performed. Relieve all vacuum-pressure in the air system, in the oil system, in the lubrication system, in the fuel system, or in the cooling system before any lines, fittings, or related items are disconnected.

Crushing Prevention and Cutting Prevention

Support the equipment properly before you perform any work or maintenance beneath that equipment. Do not depend on hydraulic cylinders to hold up the equipment. Equipment can fall if a control is moved, or if a hydraulic line breaks.

Unless you are instructed otherwise, never attempt adjustments while the machine is moving or while the engine is running.

Whenever there are equipment control linkages the clearance in the linkage area will change with the movement of the equipment or the machine. Stay clear of areas that may have a sudden change in clearance with machine movement or equipment movement.

Stay clear of all rotating and moving parts.

If it is necessary to remove guards in order to perform maintenance, always install the guards after the maintenance is performed.

When you strike a retainer pin with force, the retainer pin can fly out. The loose retainer pin can injure personnel. Make sure that the area is clear of people when you strike a retainer pin. To avoid injury to your eyes, wear protective glasses when you strike a retainer pin.

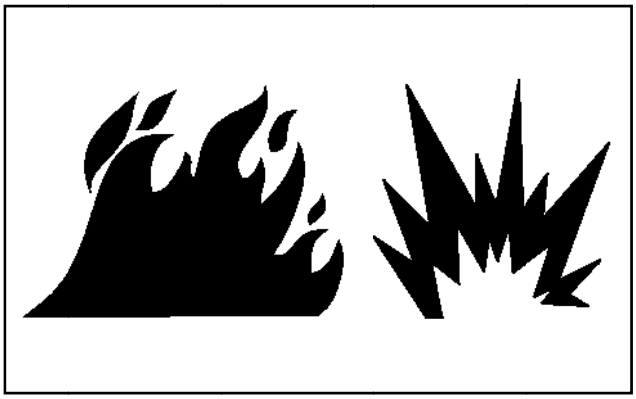
Chips or other debris can fly off an object when you strike the object. Make sure that no one can be injured by flying debris before striking any object.

Oils

Hot oil and hot components can cause personal injury. Do not allow hot oil to contact the skin. Also, do not allow hot components to contact the skin.

Batteries

Electrolyte is an acid. Electrolyte can cause personal injury. Do not allow electrolyte to contact the skin or the eyes. Always wear protective glasses for servicing batteries. Wash hands after touching the batteries and connectors. Use of gloves is recommended.



Fire Prevention and Explosion Prevention

General

All fuels, most lubricants, and some coolant mixtures are flammable.

To minimize the risk of fire or explosion, the following actions are recommended.

Always perform a Walk-Around Inspection, which may help you identify a fire hazard. Do not operate a machine when a fire hazard exists. Contact your dealer for service.

Do not operate a machine with a fluid leak. Repair leaks and clean up fluids before resuming machine operation. Fluids that are leaking or spilled onto hot surfaces or onto electrical components can cause a fire. A fire may cause personal injury or death.

Remove flammable material such as leaves, twigs, papers, trash, and so on. These items may accumulate around hot areas and hot parts on the machine.

Clean all flammable materials such as fuel, oil, debris, etc. from the machine.

Do not operate the machine close to flames.

Do not modify the Vacuum Lifter (VL). Do not weld or flame cut on tanks or lines that contain flammable fluids or flammable material. Empty and purge the lines and tanks. Then clean the lines and tanks with a nonflammable solvent prior to welding or flame cutting. Ensure that the components are properly grounded in order to avoid unwanted arcs.

Dust that is generated from repairing nonmetallic components may be flammable and/or explosive. Repair such components in a ventilated area away from open flames or sparks. Use suitable Personal Protection Equipment (PPE).

Inspect all lines and hoses for wear or deterioration. Replace damaged lines and hoses. The lines and the hoses should have adequate support and secure clamps. Tighten all connections to the recommended torque. Damage to the protective cover or insulation may provide fuel for fires.

Store fuels and lubricants in properly marked containers away from unauthorized personnel. Store oily rags and flammable materials in protective containers. Do not smoke in areas that are used for storing flammable materials.

Use caution when you are fueling a machine. Do not smoke while you are fueling a machine. Do not fuel a machine near open flames or sparks. Always stop the engine before fueling. Fill the fuel tank outdoors. Properly clean areas of spillage.

Never store flammable fluids in the operator compartment of the host-carrier-vehicle.

Battery and Battery Cables

⚠ WARNING

Fire on a machine can result in personal injury or death. Exposed battery cables that come into contact with a grounded connection can result in fires. Replace cables and related parts that show signs of wear or damage. Contact your dealer.

The following actions are recommended to minimize the risk of fire or an explosion related to the battery.

Do not operate a machine if battery cables or related parts show signs of wear or damage. Contact your dealer for service.

Follow safe procedures for starting the engine, Refer to Operation and Maintenance Manual, *Operation Section* for specific instructions.

Follow safe procedures for engine starting with jump-start cables. Improper jumper cable connections can cause an explosion that may result in injury. Refer to Operation and Maintenance Manual, “Engine Starting with Jump Start Cables” for specific instructions.

Do not charge a frozen battery. This action may cause an explosion.

Gases from a battery can explode. Keep any open flames or sparks away from the top of a battery. Do not smoke in battery charging areas.

Never check the battery charge by placing a metal object across the terminal posts. Use a voltmeter in order to check the battery charge.

Daily inspect battery cables that are in areas that are visible. Inspect cables, clips, straps, and other restraints for damage. Replace any damaged parts. Check for signs of the following, which can occur over time due to use and environmental factors:

- Fraying
- Abrasion
- Cracking
- Discoloration
- Cuts on the insulation of the cable
- Fouling

- Corroded terminals, damaged terminals, and loose terminals

Replace damaged battery cable(s) and replace any related parts. Eliminate any fouling, which may have caused insulation failure or related component damage or wear. Ensure that all components are reinstalled correctly.

An exposed wire on the battery cable may cause a short to ground if the exposed area comes into contact with a grounded surface. A battery cable short produces heat from the battery current, which may be a fire hazard.

Repair components or replace components before servicing the machine.

Wiring

Check electrical wires daily. If any of the following conditions exist, replace parts before you operate the machine.

- Fraying
- Signs of abrasion or wear
- Cracking
- Discoloration
- Cuts on insulation
- Other damage

Make sure that all clamps, guards, clips, and straps are reinstalled correctly. This action will help to prevent vibration, rubbing against other parts, and excessive heat during machine operation.

Attaching electrical wiring to hoses and tubes that contain flammable fluids or combustible fluids should be avoided.

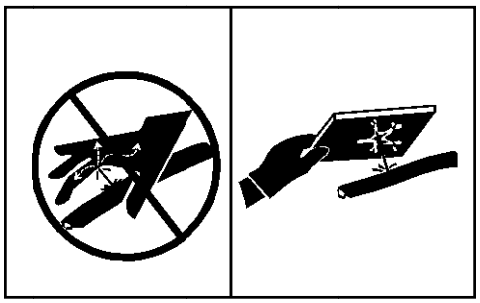
Consult your dealer for repair or for replacement parts.

Keep wiring and electrical connections free of debris.

Lines, Tubes and Hoses

Do not bend high pressure lines. Do not strike high pressure lines. Do not install bent lines, bent tubes, or bent hoses. Do not install damaged lines, damaged tubes, or damaged hoses.

Repair loose lines, loose tubes, and loose hoses. Repair damaged lines, damaged tubes, and damaged hoses. Use the appropriate backup wrenches in order to tighten all connections to the recommended torque. Leaks can cause fires. Contact



Vanguard Equipment for replacement parts.

Check lines, tubes and hoses carefully. Wear Personal Protection Equipment (PPE) in order to check for leaks. Do not use your bare hands to check for leaks. Always use a board or cardboard to check for leaks. Leaking fluid that is under pressure can penetrate body tissue. Fluid penetration can cause serious injury and possible death. A pin hole leak can cause severe injury. If fluid is injected into your skin, you must get treatment immediately. Seek treatment from a doctor that is familiar with this type of injury.

Replace the affected parts if any of the following conditions are present:

- End fittings are damaged or leaking.
- Outer coverings are chafed or cut.
- Wires are exposed.
- Outer coverings are swelling or ballooning.

- Flexible parts of the hoses are kinked or crushed.
- Outer covers have exposed embedded armoring.
- End fittings are displaced.

Make sure that all clamps, guards, and heat shields are installed correctly. During machine operation, this action will help to prevent vibration, rubbing against other parts, excessive heat, and failure of lines, tubes, and hoses.

Do not operate a machine when a fire hazard exists. Repair any lines that are corroded, loose, or damaged. Leaks may provide fuel for fires. Consult your dealer for repair or for replacement parts. Use genuine OEM parts or the equivalent, for capabilities of both the pressure limit and temperature limit.

Starting Fluid Aids (Ether)

⚠ WARNING

To reduce the possibility of personal injury and property damage, never use starting fluid (Ether, etc.) with the Vacuum Lifter (VL) engine. Starting fluid, which contains ether, can cause an explosion.

The Vacuum Lifter (VL) engine is equipped with glow plugs to warm the combustion chamber to assist with starting the engine in cold weather. Starting fluid aids, such as ether, etc., should not be used. Use only the electrical glow plugs during cold starting of the engine. Refer to Operation and Maintenance Manual, "Engine Starting Cold Weather Starting" for specific instructions.

Fire Extinguisher

A fire extinguisher is typically carried on the host-carrier-vehicle.

Be familiar with the operation of the fire extinguisher. Inspect the fire extinguisher and service the fire extinguisher regularly. Obey the recommendations on the fire extinguisher's instruction-plate.

Fire Safety

Note: Locate fire extinguishers and how to use a fire extinguisher before you operate the machine.

Follow the instructions covering Fire Safety outlined in the host-carrier-vehicle's Operation and Maintenance Manual, and/or the Vacuum Lifter (VL)'s Operation and Maintenance Manual.

If you find that you are involved in a machine fire, your safety and that of others on site is the top priority. The following actions should only be performed if the actions do not present a danger or risk to you and any nearby people. At all times you should assess the risk of personal injury and move away to a safe distance as soon as you feel unsafe.

Move the machine away from nearby combustible material such as fuel/oil stations, structures, trash, mulch and timber.

Lower any implements and turn off the engine as soon as possible. If you leave the engine running, the engine will continue to feed a fire. The fire will be fed from any damaged hoses that are attached to the engine or pumps.

If possible, turn the battery disconnect switch to the OFF position. Disconnecting the battery will remove the ignition source in the event of an electrical short. Disconnecting the battery will eliminate a second ignition source if electrical wiring is damaged by the fire, resulting in a short circuit.

Notify emergency personnel of the fire and your location.

Use the on-board fire extinguisher, per the instructions on the fire extinguisher's instruction-plate, use the following procedure:

1. Pull the pin.
2. Aim the extinguisher or nozzle at the base of the fire.
3. Squeeze the handle and release the extinguishing agent.
4. Sweep the extinguisher from side to side across the base of the fire until the fire is out.

Remember, if you are unable to do anything else, shut off the machine before exiting. By shutting off the machine, fuels will not continue to be pumped into the fire.

If the fire grows out of control, be aware of the following risks:

- Tires on wheeled machines pose a risk of explosion as tires burn. Hot shrapnel and debris can be thrown great distances in an explosion.
- Tanks, accumulators, hoses, and fittings can rupture in a fire, spraying fuels and shrapnel over a large area.
- Remember that nearly all of the fluids on the machine are flammable, including coolant and oils. Additionally, plastics, rubbers, fabrics, and resins in fiberglass panels are also flammable.

Fire Extinguisher Location

Make sure that a fire extinguisher is available. Be familiar with the operation of the fire extinguisher. Inspect the fire extinguisher and service the fire extinguisher. Obey the recommendations on the instruction plate.

Mount the fire extinguisher in the accepted location per local regulations.

Electrical cables and wire-harnesses

Do not bend electrical cables or wire-harnesses to a tighter radius than already installed. Do not strike electrical cables or wire-harnesses. Do not kink electrical cables or wire-harnesses. Do not install kinked electrical cables or wire-harnesses. Do not install damaged electrical cables or wire-harnesses.

Note: Only qualified personnel should work on electrical equipment, including electrical cables or wire-harnesses. Follow established safety procedures when working on electrical equipment, including locking out operator controls as described in the "General Hazard Information" section above.

Replace electrical cables or wire-harnesses with the same electrical rating, properties, and specifications as the original. Contact your dealer or Vanguard for replacement parts.

Replace electrical cables or wire-harnesses if any of the following conditions are present:

- The outer covering is chafed or cut.
- The insulation is chafed, cut, or damaged in any way.
- Signs of burning or arcing through the outer covering/insulation are present.
- The electrical cable or wire-harness has been crushed by a heavy object.

Make sure that all clamps and guards are installed correctly. During operation, this will help prevent vibration and rubbing against other parts.

Before Operating Equipment

Clear all personnel from the equipment and from the area.

Check for obvious signs of damage, lose bolts, lose equipment, and foreign objects or debris on and around the equipment.

Before Starting Engine

Start the Vacuum Lifter (VL) engine only from the operator's controls. Do not short across the battery terminals and do not short across the batteries.

Make sure that the host-carrier-vehicle is equipped with a lighting system that is adequate for the job conditions. Make sure that all lights are working properly.

Follow the instructions in the host-carrier-vehicle operation and maintenance manual before you start the host-carrier machine engine or before you move the machine. Make sure that no one is working on the machine, working underneath the machine or working close to the machine. Make sure that the area is free of personnel.

Engine Starting

If a warning tag is attached to the start switch or attached to the controls, do not start the engine. Also, do not move any controls.

Diesel engine exhaust contains products of combustion. These products can be harmful to your health. Always start the engine and always operate the engine in a ventilated area. If you are in an enclosed area, vent the exhaust to the outside.

Check for the presence of bystanders or maintenance personnel. Ensure that all personnel are clear of the machine.

Before Operation

Clear all personnel from the machine and from the area.

Follow the instructions in the host-carrier-vehicle operation and maintenance manual before you operator the host-carrier machine.

Visibility Information

Before you start the machine, perform a walk-around inspection in order to ensure that there are no hazards around the machine.

While the machine is in operation, constantly survey the area around the machine in order to identify potential hazards as hazards become visible around the machine.

This attachment, and the supported loads, extends significantly beyond the host-carrier increasing the overall width and/or length, be especially aware of the additional width and/or when turning and maneuvering the host-carrier-vehicle. Supported loads may restrict vision, and it may not be possible to provide direct visibility to all areas around the machine. Appropriate job site organization is required in order to minimize hazards that are caused by restricted visibility. Job site organization is a collection of rules and procedures that coordinates machines and people that work together in the same area. Examples of job site organization include the following:

- Safety instructions
- Controlled patterns of machine movement and vehicle movement
- Workers that direct traffic to move when it is safe
- Restricted areas
- Operator training
- Warning symbols or warning signs on machines or on vehicles
- A system of communication
- Communication between workers and operators prior to approaching the machine
- A responsible person—such as signal-person, or someone familiar with the lifting operations and capable of communicating the actions and motions required to accomplish the operation—having appropriate means of communication to guide the operator if the operator of lifting equipment cannot observe the full path of the load either directly or by means of auxiliary devices
- Measures to prevent the load striking anything or any person

Operation

Engine Starting with Jump Start Cables

WARNING

Warning! Explosion Hazard! Batteries give off flammable fumes that can explode resulting in personal injury.

Prevent sparks near the batteries; they could cause vapors to explode. Do not allow the jump start cable ends to contact each other or the machine.

Do not smoke when checking battery electrolyte levels.

Electrolyte is an acid and can cause personal injury if it contacts skin or eyes.

Always wear eye protection when starting a machine with jump start cables.

Improper jump start procedures can cause an explosion resulting in personal injury.

Always connect the battery positive (+) to battery positive (+), and battery negative (-) to battery negative (-).

Jump start only with an energy source with the same voltage as the stalled machine.

Notice

When starting from another machine, make sure that the machines do not touch. This could prevent damage to the engine bearings and electrical circuits.

Severely discharged maintenance-free batteries, like the one supplied with the Vacuum Lifter, do not fully recharge from the alternator after jump starting. These batteries must be charged to the proper voltage with a battery charger.

This machine has a 12-volt starting system. Use only the same voltage for jump starting. Use of a higher voltage could damage the electrical system.

Use of Jump Start Cables

1. Determine the cause of engine start failure. If batteries are discharged, a jump start may be necessary.
2. Turn the Engine Stop/Run/Start Switch to the Stop position. Turn off any accessories.
3. Turn on the Battery Disconnect Switch.
4. The battery on this machine is located inside the Vacuum Lifter (VL) on the operator side (fuel level gauge side), behind the engine.
5. Move the machines together in order for the jumper cables to reach. **DO NOT ALLOW THE MACHINES TO CONTACT OR TOUCH EACH OTHER.**
6. Stop the engine on the machine that is the electrical source. When you use an auxiliary power source, turn off the charging system.
7. Check the battery caps for correct placement and for correct tightness. Make these checks on both machines. Make sure the batteries in the stalled machine are not frozen. Check the batteries for low electrolyte.
8. Connect the positive jump start cable to the positive cable terminal of the discharged battery.
9. Batteries in series may be in separate compartments. Use the terminal that is connected to the starter solenoid. Trace this cable in order to make sure that the cable is connected to the starter.
10. Connect the positive jump start cable to the positive terminal of the electrical source. Use the procedure from step 9 in order to determine the correct terminal.
11. Connect one end of the negative jump start cable to the negative terminal of the electrical source.
12. Make the final connection. Connect the negative cable to the frame of the stalled machine, on an unpainted clean bare metal grounding point. Make this connection away from the battery, the fuel, the hydraulic lines, or moving parts.
13. Start the engine on the machine that is the electrical source, or energize the charging system on the auxiliary power source.

14. Allow the electrical source to charge the batteries for two minutes.
15. Attempt to start the stalled engine. Refer to the *Engine Stop/Run/Start Switch* section in this manual.
16. Immediately after the stalled engine starts, disconnect the jump start cables in reverse order.
17. Conclude with a failure analysis on the starting charging system. Check the stalled machine, as required. Check the machine when the engine is running and the charging system is in operation.

Machine Operating Temperature Range

When using the correct hydraulic oil weight, as specified by the host-carrier-vehicle, and the correct oil weights for the vacuum pump and gear reducer as specified in the Maintenance and Lubrication Section the Vacuum Lifter (VL) is intended for use within an ambient temperature range 14°F (-10°C) to 122°F (50°C). Consult the host-carrier-vehicle's Operation and Maintenance Manual for additional information on special configurations. See Operation and Maintenance Manual *Maintenance and Lubrication* Section for correct Lubricant Viscosities for Ambient Temperatures.

Machine Operation

Follow the Operation instructions of the host-carrier-vehicle.

Before you move the machine, make sure that no one will be endangered.

Check for proper operation of all controls and protective devices while you operate the machine slowly in an open area.

Report any needed repairs that were noted during operation.

Be careful to avoid any condition which could cause the machine to tip. Follow the procedures and instructions in the host-carrier machine operation and maintenance manual.

Do not go close to the edge of a cliff, an excavation, or an overhang.

Keep the machine under control. Do not overload the machine beyond capacity.

Know the maximum dimensions of your machine, including the supported load.

Lifting Capacities

Maintain control of the host-carrier-vehicle and Vacuum Lifter (VL).

Do not overload the machine beyond the host-carrier-vehicle's load capacity. Do not overload the Vacuum Lifter (VL) beyond the lifter's load capacity. Do not overload the lifting pads beyond their load capacity. Do not overload the lifting yoke, if fitted, beyond the yoke's load capacity.

Make special note of the yoke-pin size being used with the host-carrier machine, and do not overload the yoke-pin beyond its load capacity.

Ensure that the correct load capacity indication film is referenced: host-carrier-vehicle, Vacuum Lifter (VL), lifting pad(s), lifting yoke, or the yoke-pin. Use the lesser value of these indications to determine the maximum load that can be safely lifted.

The combined host-carrier-vehicle's supported load includes: the load being lifted, the lifting pads, the Vacuum Lifter (VL), the yoke and yoke-pin. The combined host-carrier-vehicle's supported load must be within the capabilities of the host-carrier-vehicle to ensure that the host-carrier-vehicle does not become unstable. See Operation and Maintenance Manual, "Lifting Capacities" for the load capacity of the Vacuum Lifter (VL), the lifting pads, and for the yoke and yoke-pin combinations.

Do not use the Vacuum Lifter (VL) system to drag loads. There is a risk, where lifting equipment is used to drag loads, that the load could become snagged on an obstacle which could destabilize the lifting equipment, exceed its Rated Lifting Capacity/Working Load Limit (WLL), or place an excessive load on particular elements or components.

Limitations on Lifting Loads That Exceed the Working Range

Do not load the Vacuum Lifter (VL) beyond the indicated maximum load capacity.

Do not load the Vacuum Lifter (VL) beyond the maximum load capacity indicated on Yoke (excavator attachment), if present, for the on pin size being used.

Do not load the Vacuum Lifter Pipe (VLP) attachment beyond the indicated maximum load capacity.

Do not load the host-carrier-vehicle beyond its load-capability or load-capacity, refer to the Operation instructions of the host-carrier-vehicle.

Do not lift a load that is covered with snow, ice, dust, etc.

Always check condition of seal for signs of excessive damage, gaps or excessive abrasion. Replace the suspect sections of seal if in doubt.

Electrical Power Lines

⚠ WARNING

Serious injury or death by electrocution can result if the machine or attachments are not kept the proper distance from electrical power lines.

Use the following chart as a reference to determine the minimum safe distance from high voltage wires. Refer also to the host-carrier-vehicle's Operation and Maintenance Manual (OMM) and follow the recommendations outlined there. If the distances specified in the host-carrier's OMM are greater than those listed here, follow the host-carrier's recommendations. Take into account the length of the load being lifted and keep the load clear.

Use the following chart as a reference to determine the minimum safe distance from high voltage wires during these conditions:

- machine operation
- machine transportation

When Operating Near High Voltage Power Lines	
Normal Voltage (Phase to Phase)	**Minimum Clearance Required**
0 Volts to 50 kVolts	3.05 Meters (10 Feet)
Over 50 kVolts to 200 kVolts	4.60 Meters (15 Feet)
Over 200 kVolts to 350 kVolts	6.10 Meters (20 Feet)
Over 350 kVolts to 500 kVolts	7.62 Meters (25 Feet)
Over 500 kVolts to 750 kVolts	10.67 Meters (35 Feet)
Over 750 kVolts to 1000 kVolts	13.72 Meters (45 Feet)
While in Transit Near High Voltage Power Lines	
Normal Voltage (Phase to Phase)	**Minimum Clearance Required**
0 Volts to 0.75 kVolts	1.22 Meters (4 Feet)
Over 0.75 kVolts to 50 kVolts	1.83 Meters (6 Feet)
Over 50 kVolts to 345 kVolts	3.05 Meters (10 Feet)
Over 345 kVolts to 750 kVolts	6.10 Meters (20 Feet)
Over 750 kVolts to 1000 kVolts	7.62 Meters (25 Feet)

Table 1: Power lines, minimum clearance

Machine Parking

Refer to the host-carrier's Operation and Maintenance Manual for specific machine parking instructions. Refer to the *Machine Parking* section in the Operation and Maintenance Manual for Vacuum Lifter (VL) instructions.

Engine Stopping

Do not stop the engine immediately after the machine has been operated under load. This can cause overheating and accelerated wear of engine components.

After the load has been lowered and released, and the host-carrier machine is parked and the parking brake is engaged, allow the Vacuum Lifter (VL) engine to run for two to three minutes before shutdown. This allows hot areas of the engine to cool gradually.

Equipment Lowering with Engine Stopped

Before lowering any equipment with the Vacuum Lifter (VL) engine stopped, ensure that the area around the equipment is clear of all personnel. When in "as new" condition, under optimum lifting conditions—clean, dry, non-porous load; new pad-seals; no leaks; etc.—the Vacuum Lifter (VL) so that the level not decrease by more than 10% in 4 minutes once the Vacuum Lifter (VL) engine has stopped in a vacuum-power-off condition. While lifting or supporting a load, as soon as the Vacuum Lifter (VL) engine stops, or when the low vacuum level alarm is triggered, quickly and safely lower the supported load to the ground in a controlled manner, while the reserve vacuum capacity remains. Investigate and correct the cause of the problem before recommencing lifting.

Sound Level Information

Hearing protection may be needed when the machine is operated with an open operator station and an open cab for extended periods or in a noisy environment. Hearing protection may be needed when the machine is operated with a cab that is not properly maintained, or when the doors and windows are open for extended periods or in a noisy environment.

Guards (Operator Protection)

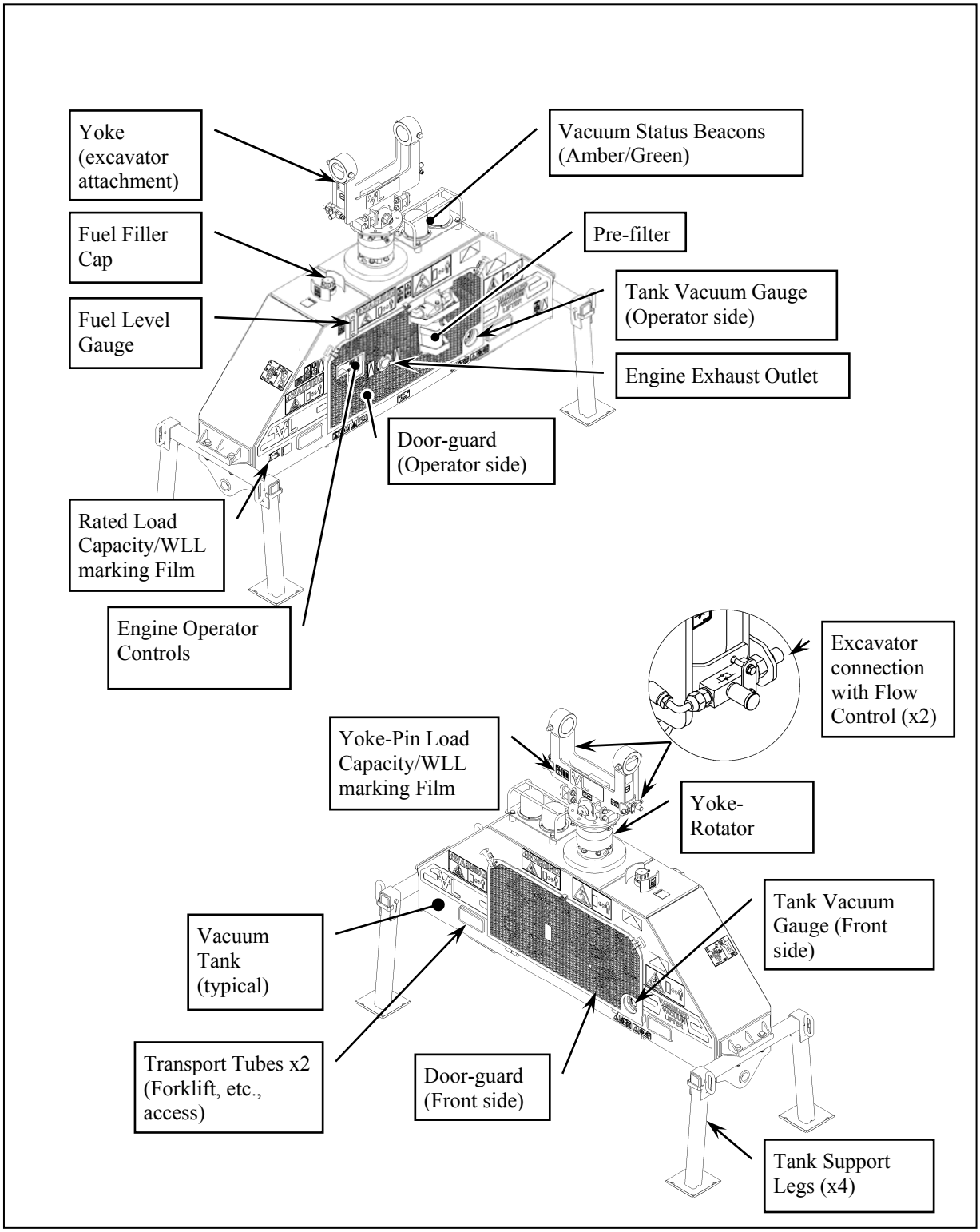
There are two door-type guards on either side of the Vacuum Lifter (VL) that enclose the vacuum pump and engine and control equipment. Always ensure that both door-guards in place whenever the equipment is in operation. If the equipment must be operated for service or maintenance with the door-guards opened or removed, ensure that extreme care is exercised to avoid contact with hot surfaces or electrical voltage. In addition to the door-guards, coupling guards are integrated into the pump-gearbox-engine drive system; never operate the equipment without the coupling guards in place.

Both the operator and personnel on the ground in the vicinity of the work area become exposed to a hazardous situation if the machine is used improperly or if poor operating techniques are used. This situation can occur even though a machine is equipped with an appropriate protective guard. Follow the established operating procedures that are recommended for your machine.

Product Information Section

General Information

Equipment Information Section



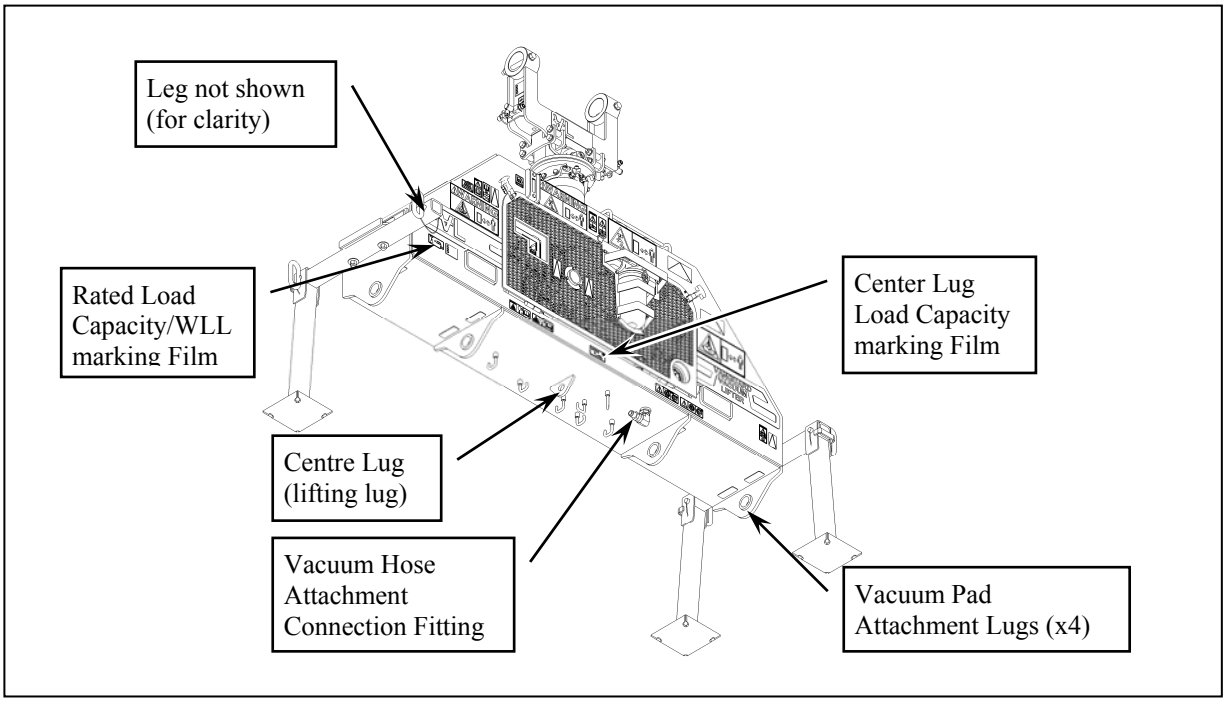


Figure 17: Vacuum Lifter (VL) - components (Optional equipment shown)

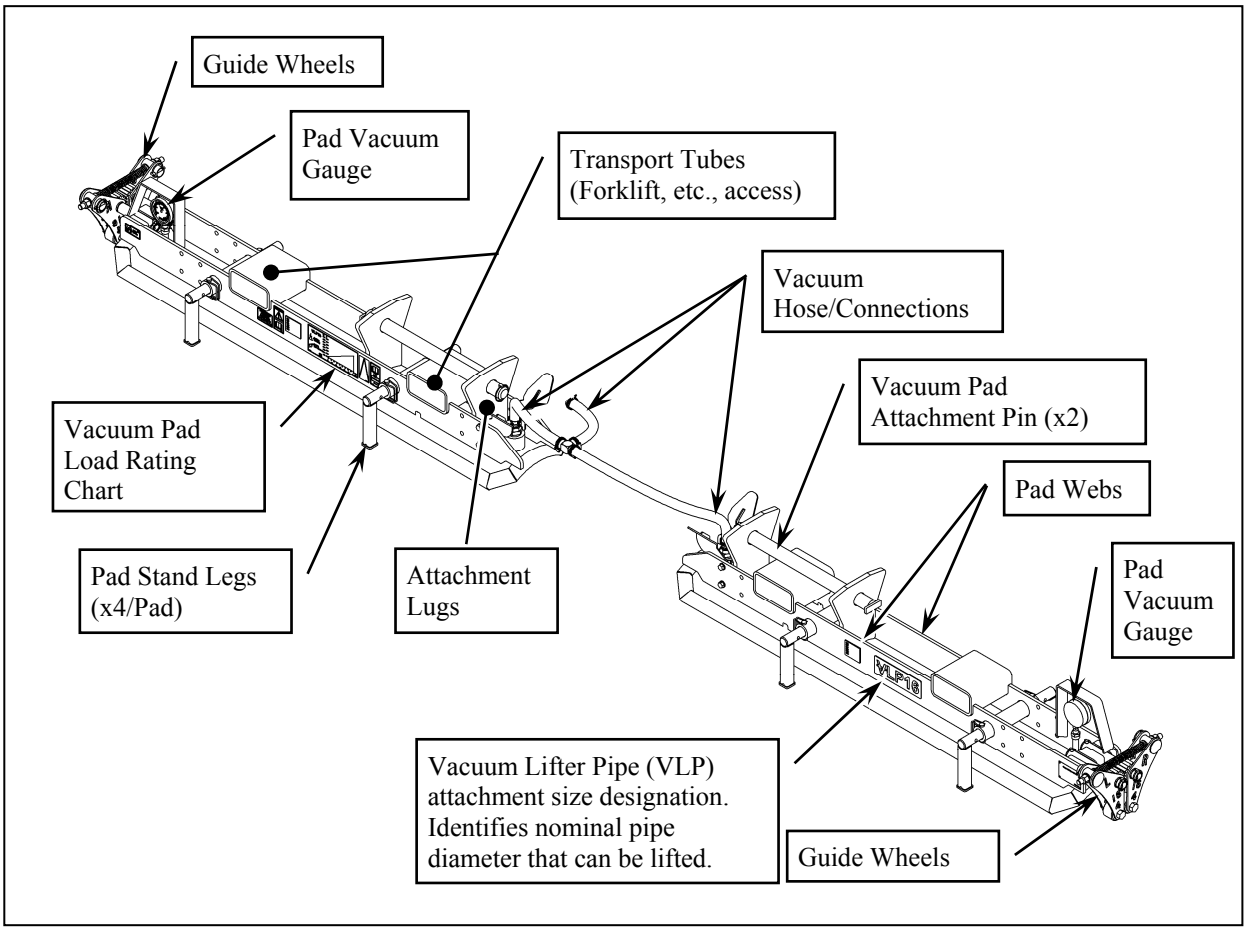


Figure 18: Pair Pads (sizes 4-in through 20-in) - components

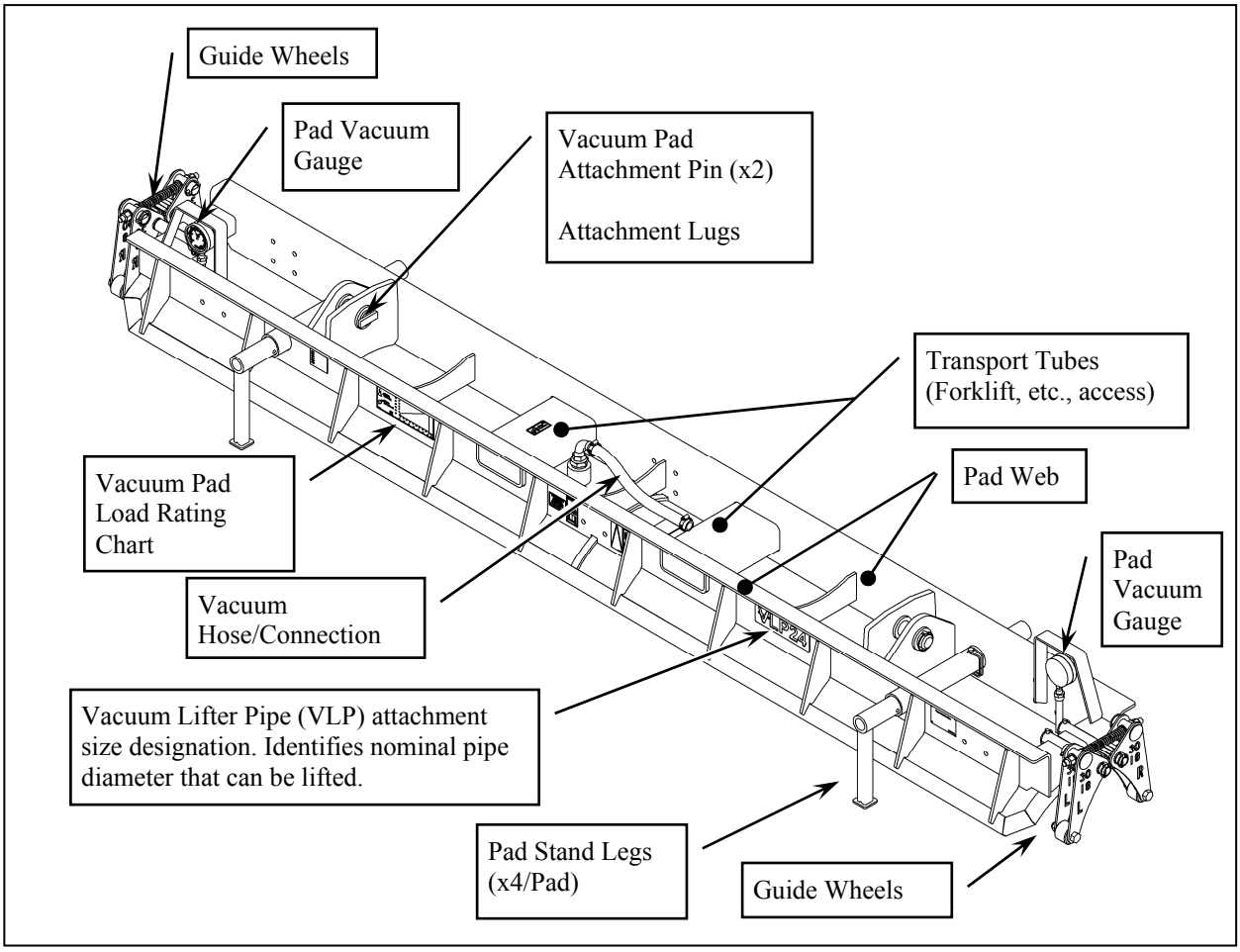
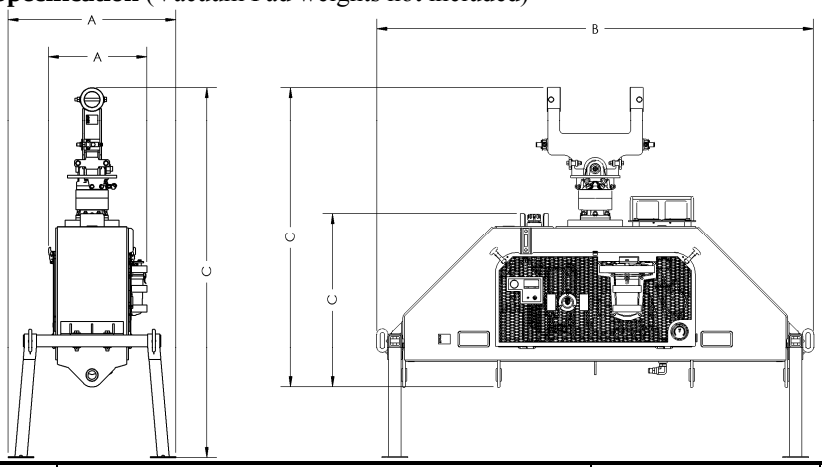


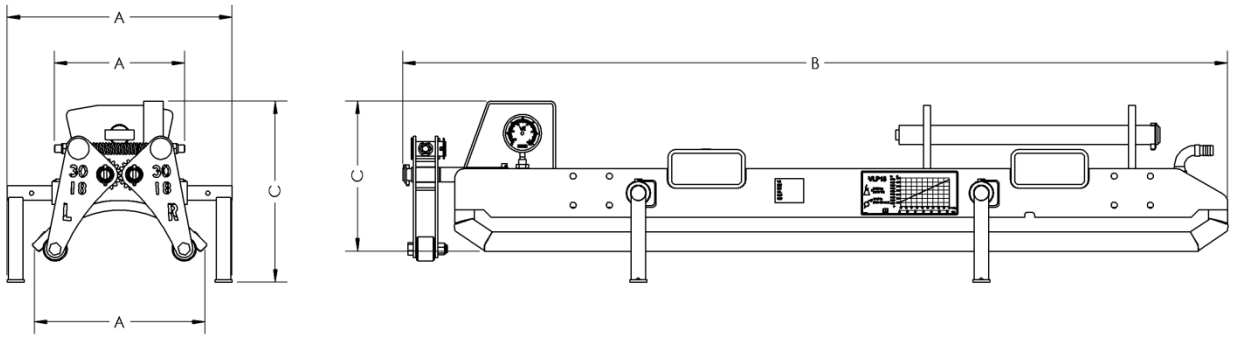
Figure 19: Single Pads (sizes 22-in and up) - components

Vacuum Lifter (VL) Specification (Vacuum Pad weights not included)



(A) Vacuum Lifter (VL) Width	Legs installed, extended or folded	47 in	1094 mm
	Legs removed (minimum obtainable)	25.1 in	638 mm
(B) Vacuum Lifter (VL) Length	Legs installed, extended or folded	112 in	2845 mm
	Legs removed (minimum obtainable)	106.6 in	2707 mm
(C) Vacuum Lifter (VL) Height	**VL 10**		
	With Yoke, with Legs installed and extended	94.3 in	2394 mm
	With Yoke, with Legs folded or removed	76.5 in	1944 mm
	No Yoke, Status Beacons removed, Legs folded or removed (minimum obtainable)	44.4 in	1128 mm
	VL 12		
	With Yoke, with Legs installed and extended	91.2 in	2317 mm
	With Yoke, with Legs folded or removed	73.5 in	1866 mm
	No Yoke, Status Beacons removed, Legs folded or removed (minimum obtainable)	44.4 in	1128 mm
	VL 16		
	With Yoke, with Legs installed and extended	92.2 in	2342 mm
	With Yoke, with Legs folded or removed	74.5 in	1891 mm
	No Yoke, Status Beacons removed, Legs folded or removed (minimum obtainable)	44.4 in	1128 mm
	No Yoke and Status Beacons removed, Legs folded or removed (minimum obtainable)	195 in	4953 mm
	Canopy Fully Raised	194.89 in	4950 mm
	Canopy Fully Lowered	177.36 in	4505 mm
Weight Vacuum Lifter (VL)	**VL 10**		
	Tare weight (no Yoke, no fuel no tank legs)	2340 lb	1060 kg
	Maximum shipping weight (Lifter, Yoke, tank legs, 100% fuel)	2950 lb	1338 kg
	Yoke + Rotator (no attachment pin, etc.)	365 lb	166 kg
	VL 12		
	Tare weight (no Yoke, no fuel)	2315 lb	1050 kg
	Maximum operating/shipping weight (Lifter, Yoke, tank legs, 100% fuel)	2976 lb	1350 kg
	Yoke + Rotator (no attachment pin, etc.)	420 lb	190b kg
	VL 16		
	Tare weight, no Yoke, no fuel	2315 lb	1050 kg
	Maximum operating/shipping weight (Lifter, Yoke, tank legs, 100% fuel)	3021 lb	1370 kg
	Yoke + Rotator (no attachment pin, etc.)	465 lb	211 kg

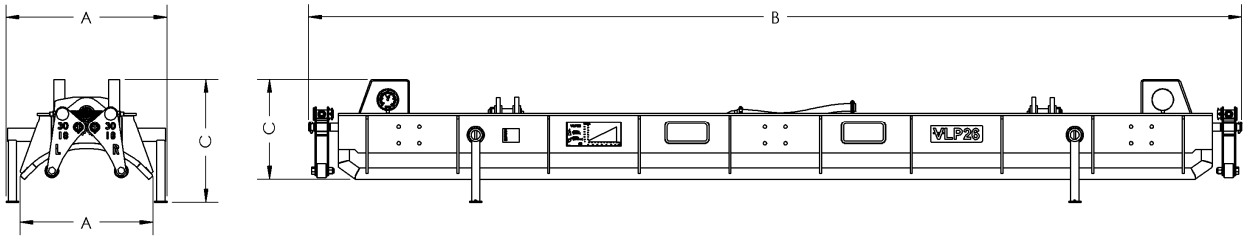
Vacuum Lifter Pipe (VLP) attachment Specification (Pair Pads)



VLP 4 (2 pads required for lifting)	Lifting diameter range	Ø3 - Ø5 in	Ø76 - Ø127 mm
(A) Pad Width	Guide Wheel Width	16.5 in	419 mm
	Legs and Guide Wheels removed (minimum)	8.07 in	205 mm
(B) Pad Length		79.4 in	2016 mm
(C) Pad Height	Legs extended	16.4 in	418 mm
	Legs folded (Guides wheels removed)	13.6 in	344 mm
VLP Load handling and Shipping weight (with legs and seal installed)		275 lb	125 kg
VLP 6 (2 pads required for lifting)	Lifting diameter range	Ø5 - Ø7 in	Ø127 - Ø178 mm
(A) Pad Width	Guide Wheel Width	13.1 in	332 mm
	Legs and Guide Wheels removed (minimum)	10.0 in	254 mm
(B) Pad Length		79.4 in	2016 mm
(C) Pad Height	Legs extended	16.4 in	418 mm
	Legs folded (Guides wheels removed)	13.3 in	339 mm
VLP Load handling and Shipping weight (with legs and seal installed)		275 lb	125 kg
VLP 8 (2 pads required for lifting)	Lifting diameter range	Ø7 - Ø9 in	Ø178 - Ø229 mm
(A) Pad Width	Legs extended	15.1 in	382 mm
	Legs folded (Guide Wheel Width)	16.5 in	419 mm
	Legs and Guide Wheels removed (minimum)	9.0 in	229 mm
(B) Pad Length		79.4 in	2016 mm
(C) Pad Height	Legs extended	16.4 in	418 mm
	Legs folded (Guides wheels removed)	13.5 in	342 mm
VLP Load handling and Shipping weight (with legs and seal installed)		285 lb	129 kg
VLP 10 (2 pads required for lifting)	Lifting diameter range	Ø9 - Ø11 in	Ø229 - Ø279 mm
(A) Pad Width	Legs extended	15.1 in	382 mm
	Legs folded (Guide Wheel Width)	16.5 in	419 mm
	Legs and Guide Wheels removed (minimum)	11.13 in	283 mm
(B) Pad Length		79.4 in	2016 mm
(C) Pad Height	Legs extended	16.4 in	418 mm
	Legs folded (Guides wheels removed)	13.9 in	353 mm
VLP Load handling and Shipping weight (with legs and seal installed)		300 lb	136 kg
VLP 12 (2 pads required for lifting)	Lifting diameter range	Ø11 - Ø13 in	Ø279 - Ø330 mm
(A) Pad Width	Legs extended	18.6 in	471 mm
	Legs folded (Guide Wheel Width)	16.5 in	419 mm
	Legs and Guide Wheels removed (minimum)	12.4 in	316 mm
(B) Pad Length		79.88 in	2029 mm
(C) Pad Height	Legs extended	17.3 in	439 mm
	Legs folded (Guides wheels removed)	14.2 in	360 mm

VLP Load handling and Shipping weight (with legs and seal installed)		345 lb	156 kg
VLP 14 (2 pads required for lifting)	Lifting diameter range	Ø13 - Ø15 in	Ø330 - Ø381 mm
(A) Pad Width	Legs extended	18.6 in	471 mm
	Legs folded (Guide Wheel Width)	16.5 in	419 mm
	Legs and Guide Wheels removed (minimum)	13.76 in	349 mm
(B) Pad Length		79.88 in	2029 mm
(C) Pad Height	Legs extended	17.2 in	437 mm
	Legs folded (Guides wheels removed)	14.4 in	366 mm
VLP Load handling and Shipping weight (with legs and seal installed)		355 lb	161 kg
VLP 16 (2 pads required for lifting)	Lifting diameter range	Ø15 - Ø17 in	Ø381 - Ø432 mm
(A) Pad Width	Legs extended	18.6 in	471 mm
	Legs folded (Guide Wheel Width)	16.5 in	419 mm
	Legs and Guide Wheels removed (minimum)	14.9 in	379 mm
(B) Pad Length		85.88 in	2181 mm
(C) Pad Height	Legs extended	17.2 in	437 mm
	Legs folded (Guides wheels removed)	14.63 in	372 mm
VLP Load handling and Shipping weight (with legs and seal installed)		375 lb	170 kg
VLP 18 (2 pads required for lifting)	Lifting diameter range	Ø17 - Ø19 in	Ø432 - Ø483 mm
(A) Pad Width	Legs extended	23.3 in	590 mm
	Legs folded (minimum)	18.1 in	458 mm
(B) Pad Length		85.38 in	2169 mm
(C) Pad Height	Legs extended	18.68 in	474 mm
	Legs folded (Guides wheels removed)	15.5 in	393 mm
VLP Load handling and Shipping weight (with legs and seal installed)		430 lb	195 kg
VLP 20 (2 pads required for lifting)	Lifting diameter range	Ø19 - Ø21 in	Ø483 - Ø533 mm
(A) Pad Width	Legs extended	23.3 in	590 mm
	Legs folded (minimum)	19 in	483 mm
(B) Pad Length		85.38 in	2169 mm
(C) Pad Height	Legs extended	18.58 in	472 mm
	Legs folded (Guides wheels removed)	15.55 in	395 mm
VLP Load handling and Shipping weight (with legs and seal installed)		435 lb	197 kg

Vacuum Lifter Pipe (VLP) attachment Specification (Single Pads)



VLP 22 (1 pad required for lifting)	Lifting diameter range	Ø21 - Ø23 in	Ø533 - Ø584 mm
(A) Pad Width	Legs extended	29.25 in	743 mm
	Legs folded	21.25 in	540 mm
	Legs removed (minimum)	20.68 in	525 mm
(B) Pad Length		169.75 in	4312 mm
(C) Pad Height	Legs extended	22.5 in	572 mm
	Legs folded	18.1 in	459 mm
VLP Load handling and Shipping weight (with legs and seal installed)		1085 lb	492 kg
VLP 24 (1 pad required for lifting)	Lifting diameter range	Ø23 - Ø25 in	Ø584 - Ø635 mm
(A) Pad Width	Legs extended	29.25 in	743 mm
	Legs folded (minimum)	23 in	583 mm
(B) Pad Length		169.75 in	4312 mm
(C) Pad Height	Legs extended	22.5 in	572 mm
	Legs folded	18.1 in	459 mm
VLP Load handling and Shipping weight (with legs and seal installed)		1135 lb	515 kg
VLP 26 (1 pad required for lifting)	Lifting diameter range	Ø25 - Ø27 in	Ø635 - Ø686 mm
(A) Pad Width	Legs extended	29.25 in	743 mm
	Legs folded (minimum)	24.15 in	613.4 mm
(B) Pad Length		169.75 in	4312 mm
(C) Pad Height	Legs extended	22.37 in	568.4 mm
	Legs folded	18.2 in	462 mm
VLP Load handling and Shipping weight (with legs and seal installed)		1160 lb	526 kg
VLP 28 (1 pad required for lifting)	Lifting diameter range	Ø27 - Ø29 in	Ø686 - Ø737 mm
(A) Pad Width	Legs extended	35.5 in	902 mm
	Legs folded	30.5 in	775 mm
	Legs removed (minimum)	25.63 in	651 mm
(B) Pad Length		169.75 in	4312 mm
(C) Pad Height	Legs extended	24.8 in	629 mm
	Legs folded	18.58 in	472 mm
VLP Load handling and Shipping weight (with legs and seal installed)		1215 lb	551 kg
VLP 30 (1 pad required for lifting)	Lifting diameter range	Ø29 - Ø31 in	Ø737 - Ø787 mm
(A) Pad Width	Legs extended	35.5 in	902 mm
	Legs folded	30.5 in	775 mm
	Legs removed (minimum)	27.6 in	701 mm
(B) Pad Length		169.75 in	4312 mm
(C) Pad Height	Legs extended	24.8 in	629 mm
	Legs folded	19.22 in	488 mm
VLP Load handling and Shipping weight (with legs and seal installed)		1260 lb	572 kg
VLP 32 (1 pad required for lifting)	Lifting diameter range	Ø31 - Ø33 in	Ø787 - Ø838 mm
(A) Pad Width	Legs extended	35.5 in	902 mm
	Legs folded (Guide Wheel Width)	34 in	863 mm
	Legs and Guide Wheels removed (minimum)	29.9 in	759.5 mm
(B) Pad Length		181.5 in	4610 mm

(C) Pad Height	Legs extended	24.6 in	625 mm
	Legs folded (Guides wheels removed)	18.5 in	470 mm
VLP Load handling and Shipping weight (with legs and seal installed)		1480 lb	671 kg
VLP 34 (1 pad required for lifting)	Lifting diameter range	Ø33 - Ø35 in	Ø838 - Ø889 mm
(A) Pad Width	Legs extended	35.5 in	902 mm
	Legs folded (Guide Wheel Width)	34.28 in	871 mm
	Legs and Guide Wheels removed (minimum)	29.9 in	759.5 mm
(B) Pad Length		181.5 in	4610 mm
(C) Pad Height	Legs extended	24.5 in	622 mm
	Legs folded (Guides wheels removed)	18.33 in	466 mm
VLP Load handling and Shipping weight (with legs and seal installed)		1490 lb	676 kg
VLP 36 (1 pad required for lifting)	Lifting diameter range	Ø35 - Ø37 in	Ø889 - Ø940 mm
(A) Pad Width	Legs extended	35.5 in	902 mm
	Legs folded (Guide Wheel Width)	34.8 in	885 mm
	Legs and Guide Wheels removed (minimum)	29.9 in	759.5 mm
(B) Pad Length		181.5 in	4610 mm
(C) Pad Height	Legs extended	24.4 in	621 mm
	Legs folded (Guides wheels removed)	18.17 in	461 mm
VLP Load handling and Shipping weight (with legs and seal installed)		1500 lb	680 kg

Intended Use

The Vacuum Lifter (VL) system is a Below The Hook Lifting device as described in the Machine Description of the Foreword section of this manual. The primary use of the Vacuum Lifter (VL) equipment with the Vacuum Lifter Pipe (VLP) attachment pads is to lift, handle, and move pipe sections. The Vacuum Lifter (VL) system is not intended as a permanent or semi-permanent supporting structure. For use inside buildings, the Vacuum Lifter (VL) system requires additional optional components, contact your dealer or Vanguard Equipment for additional details. The Vacuum Lifter (VL) system is not intended to be used in proximity to people. Never use the Vacuum Lifter (VL) or any attachment pads, etc., to lift or transport people.

Certifications

The Vacuum Lifter (VL) system is designed, manufactured, and tested in accordance with:

- American National Standard Institute (ANSI) and The American Society of Mechanical Engineers (ASME) ASME B30.20, Below-the-Hook Lifting Devices.
- American National Standard Institute (ANSI) and The American Society of Mechanical Engineers (ASME) ASME BTH-1, Design of Below-the-Hook Lifting Devices

Load Capacity/WLL

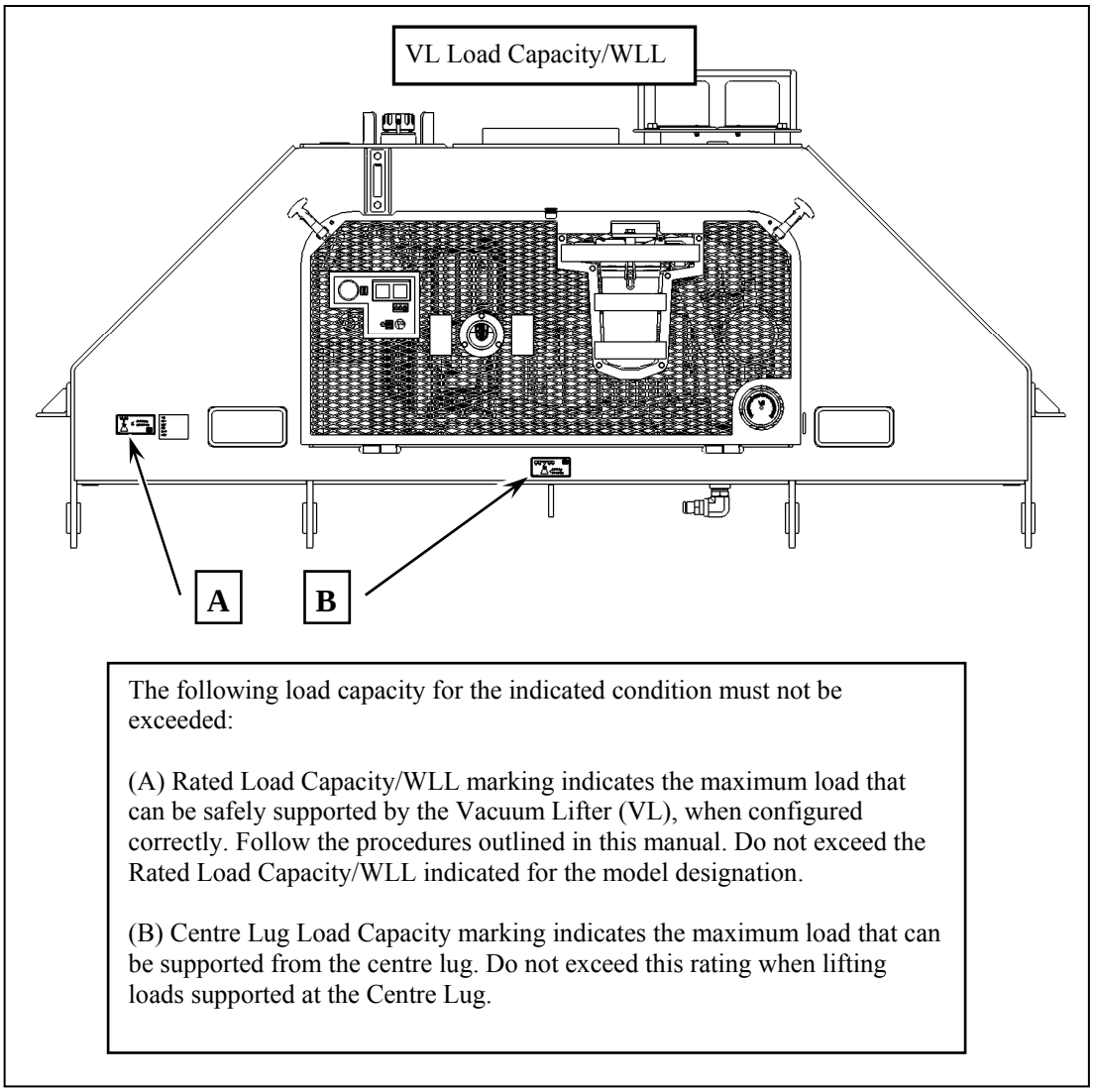
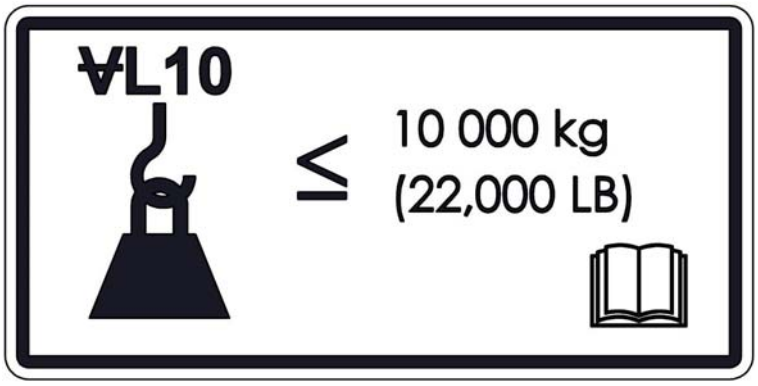
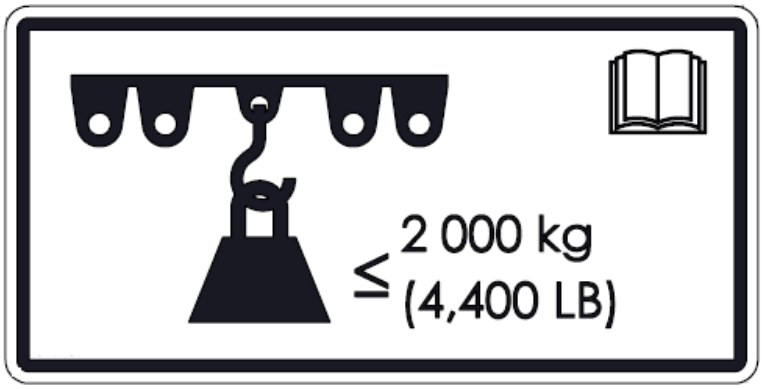


Figure 20: Vacuum Lifter (VL) Load Capacity

VL10 Load Capacity/WLL

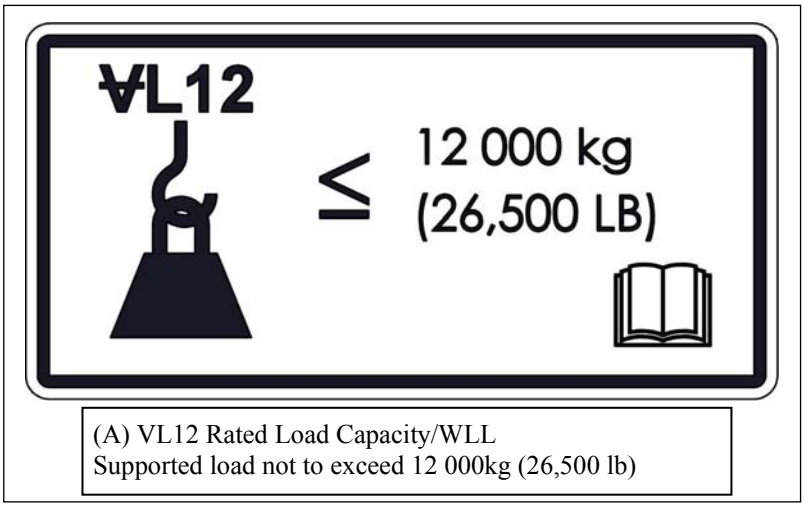


(A) VL 10 Rated Load Capacity/WLL
Supported load not to exceed 10 000kg (22,000 lb)

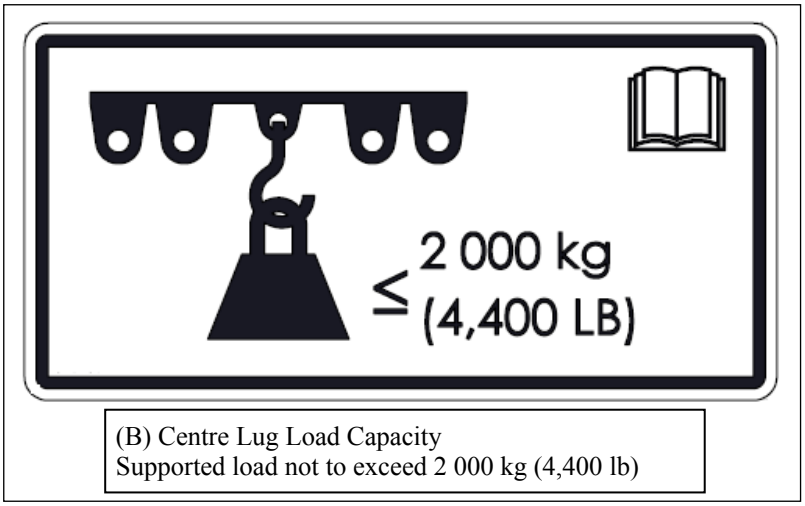


(B) Centre Lug Load Capacity
Supported load not to exceed 2 000 kg (4,400 lb)

VL12 Load Capacity/WLL

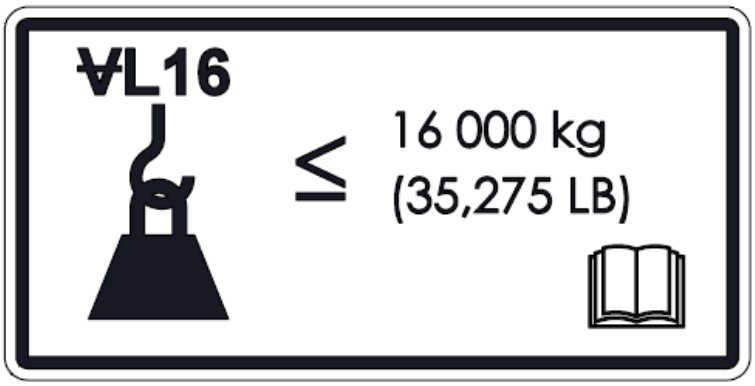


(A) VL12 Rated Load Capacity/WLL
Supported load not to exceed 12 000kg (26,500 lb)

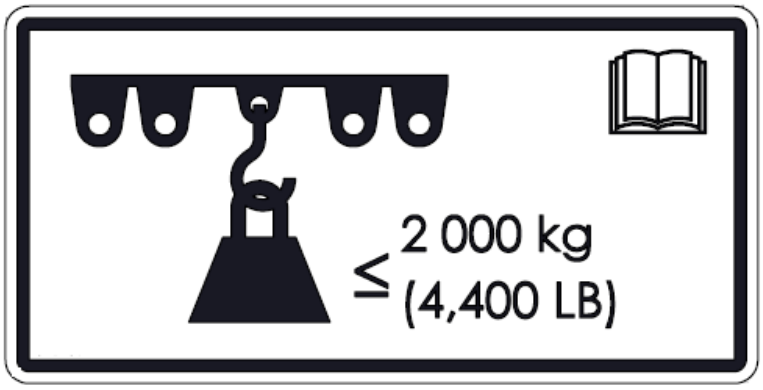


(B) Centre Lug Load Capacity
Supported load not to exceed 2 000 kg (4,400 lb)

VL 16 Load Capacity/WLL



(A) VL16 Rated Load Capacity/WLL
Supported load not to exceed 16 000kg (35,275 lb)



(B) Centre Lug Load Capacity
Supported load not to exceed 2 000 kg (4,400 lb)

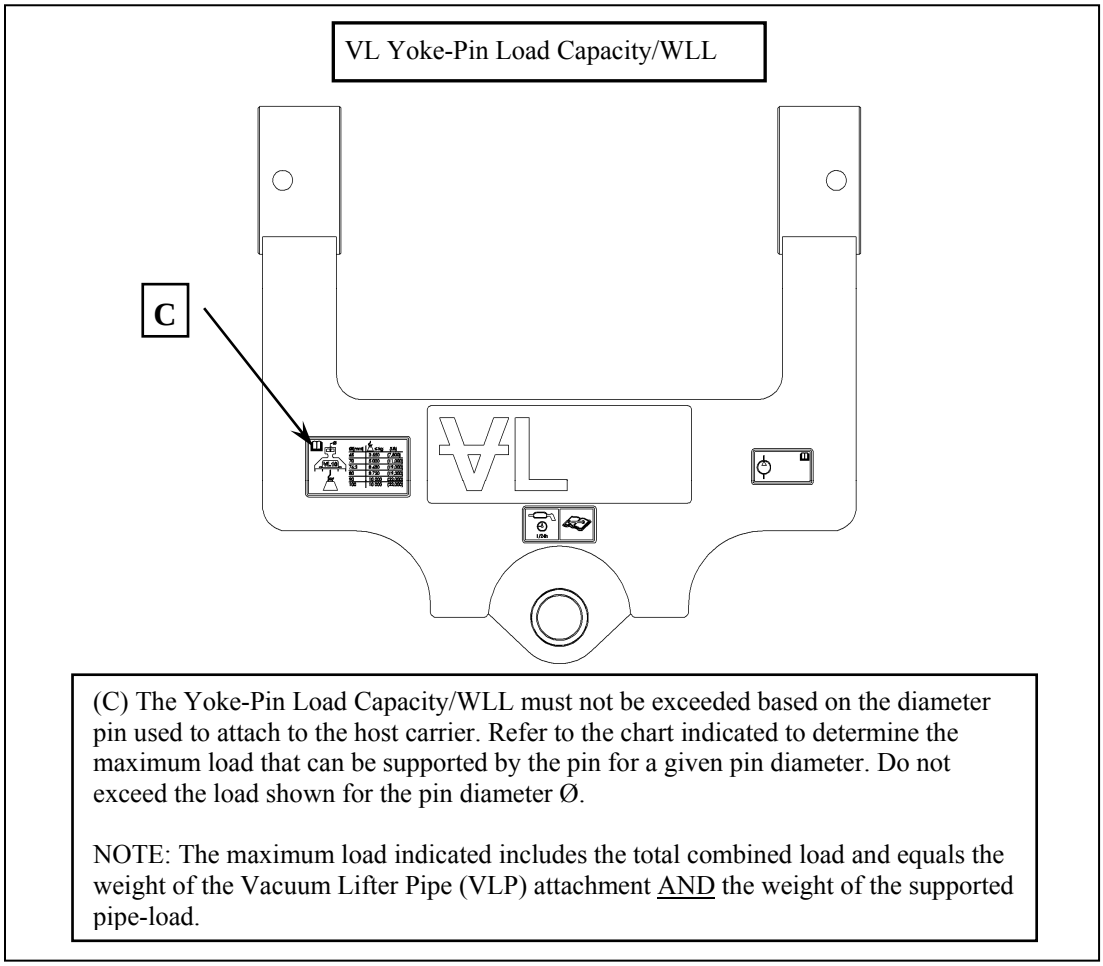
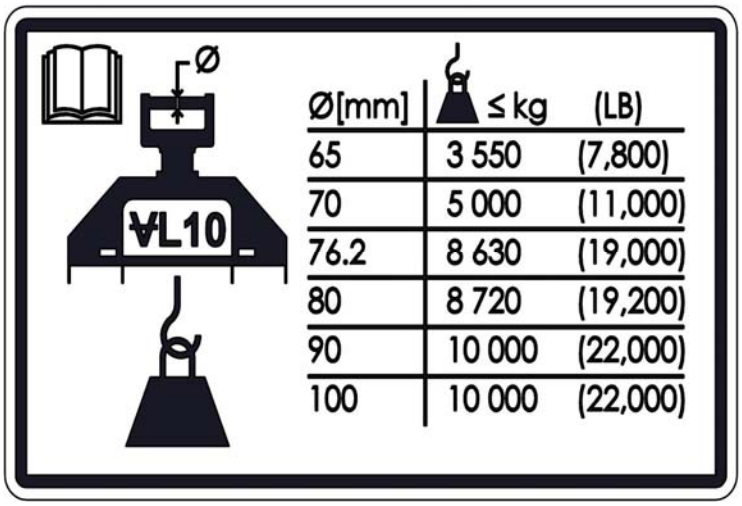


Figure 21: Vacuum Lifter (VL) Load Capacity

VL 10 Yoke-Pin Load Capacity/WLL

NOTE: The maximum load that can be supported is based on the pin diameter (Ø) used to attach to the host carrier machine.

The maximum load indicated includes the total combined load and equals the weight of the Vacuum Lifter Pipe (VLP) attachment AND the weight of the supported pipe-load.



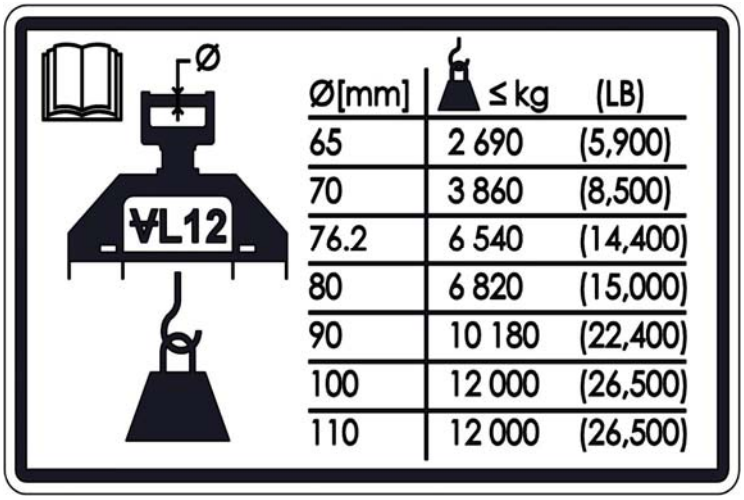
(C) VL 10 Yoke-Pin Load Capacity/WLL

Supported load for given Ø not to exceed value indicated by

VL12 Yoke-Pin Load Capacity/WLL

NOTE: The maximum load that can be supported is based on the pin diameter (Ø) used to attach to the host carrier machine.

The maximum load indicated includes the total combined load and equals the weight of the Vacuum Lifter Pipe (VLP) attachment AND the weight of the supported pipe-load.



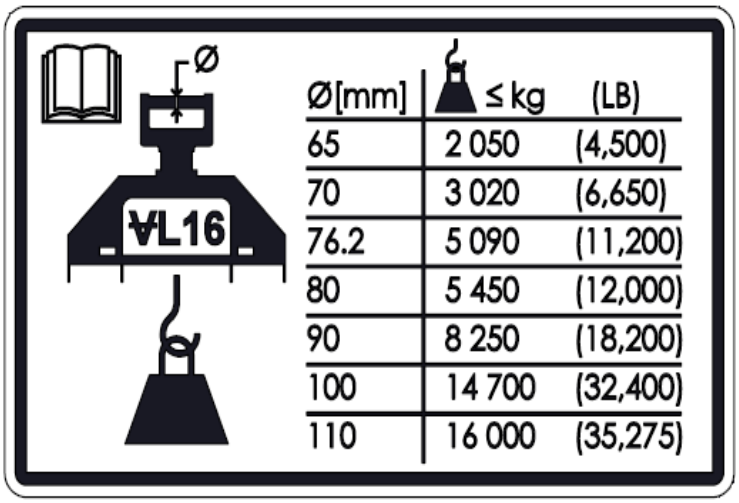
(C) VL12 Yoke-Pin Load Capacity/WLL

Supported load for given Ø not to exceed value indicated by

VL16 Yoke-Pin Load Capacity/WLL

NOTE: The maximum load that can be supported is based on the pin diameter (Ø) used to attach to the host carrier machine.

The maximum load indicated includes the total combined load and equals the weight of the Vacuum Lifter Pipe (VLP) attachment AND the weight of the supported pipe-load.



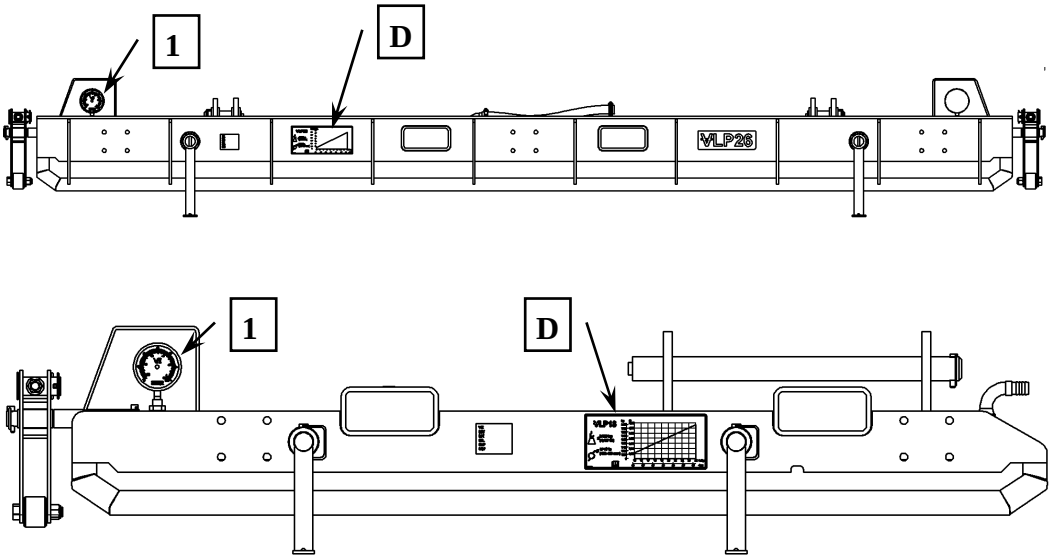
(C) VL16 Yoke-Pin Load Capacity/WLL

Supported load for given Ø not to exceed value indicated by

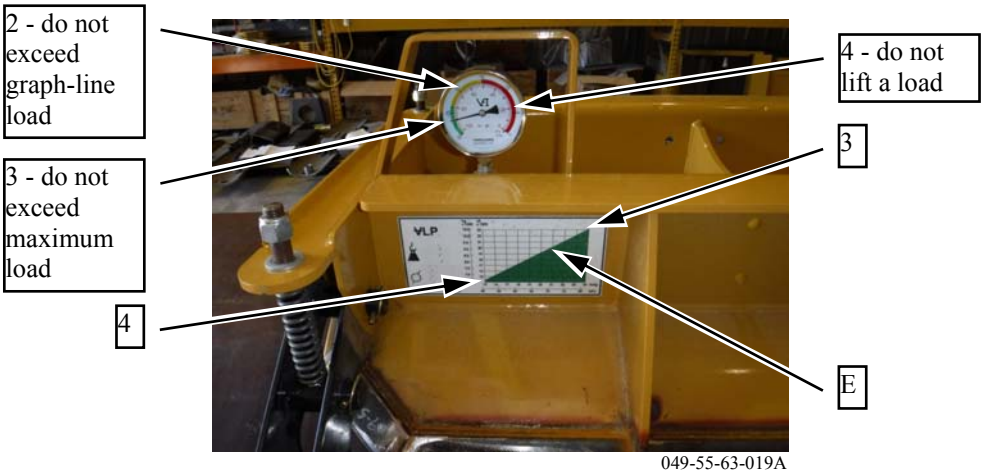
VLP Load Capacity/WLL

(D) The load supported from the VLP cannot exceed the specifications indicated on the Load Capacity/WLL rating. NOTE: The maximum load that can be supported from the VLP is based on the vacuum that can be developed at the attachment when the pad is in full contact with the pipe lifted horizontally. Never attempt to lift the pipe off-center. Do not exceed the load indicated by the graph-line (E) for the vacuum achieved. Do not lift a load when the vacuum is outside the operating range (F).

The VLP can only be used for pipe diameters within the size range as indicated by the "Ø". Do not lift pipes larger or smaller than the indicated Ø range.



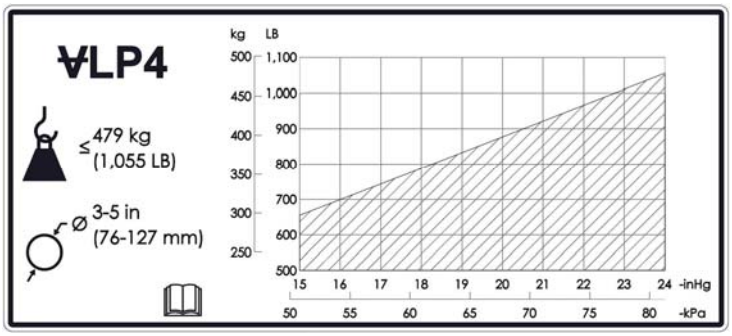
The vacuum level achieved at the attachment pad is shown by attachment pad gauge (1). When the vacuum level achieved is in the YELLOW zone (2) of the gauge (1), the load must not exceed the load indicated by the graph-line (E). When the vacuum level achieved is in the GREEN zone (3) of the gauge (1), the load must not exceed the maximum load specifications for the attachment pad. Do not attempt to lift a load when the vacuum level achieved is in the RED zone (4) of the gauge (1).



049-55-63-019A

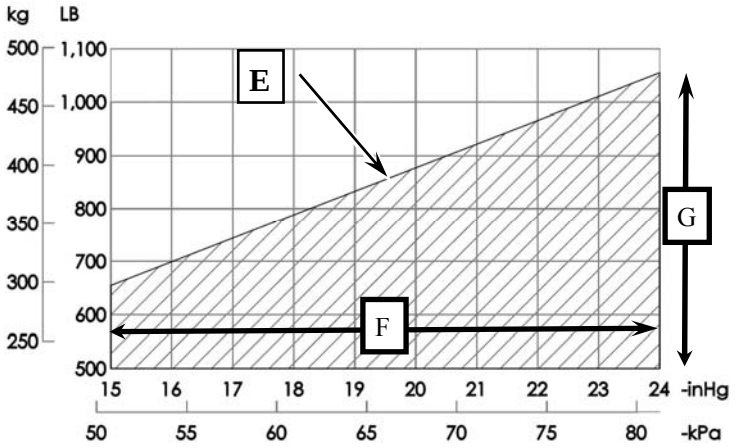
VLP4 Load Capacity/WLL

NOTE: The maximum load that can be supported from the VLP is based on the vacuum that can be developed at the attachment when the pad is in full contact with the pipe and pipe is lifted horizontally. Never attempt to lift the pipe off-center. Do not exceed the load indicated by the graph-line (E) for the vacuum achieved. Do not lift a load when the vacuum is below the range (F). Always ensure that the supported load is within the green shaded region of the chart bounded by (E), (F) and (G).



D) VLP4 Load Capacity/WLL. Do not exceed the maximum load specifications:

- Supported load not to exceed 479 kg (1,055 lb) as indicated by .
- The VLP can only be used for pipe diameters within the size range as indicated by the "Ø". Do not lift pipes larger or smaller than the indicated Ø range.



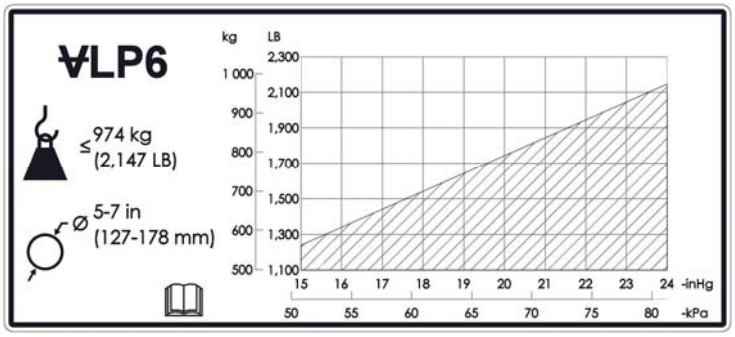
(E) VLP Load Capacity / WLL for vacuum developed with pipe-load

(F) Vacuum operating range

(G) Load operating range

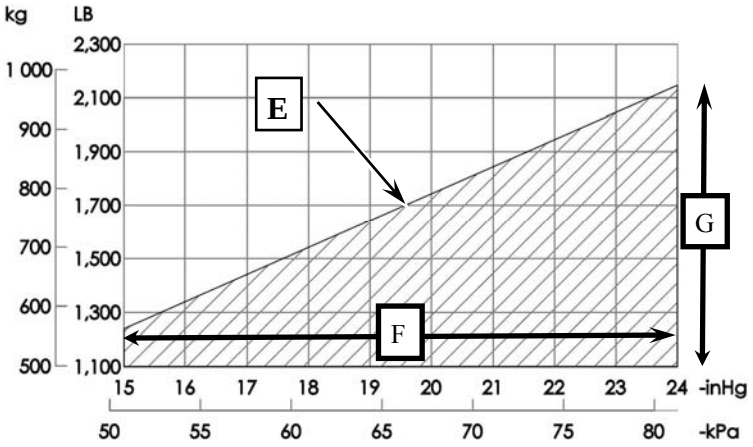
VLP6 Load Capacity/WLL

NOTE: The maximum load that can be supported from the VLP is based on the vacuum that can be developed at the attachment when the pad is in full contact with the pipe and pipe is lifted horizontally. Never attempt to lift the pipe off-center. Do not exceed the load indicated by the graph-line (E) for the vacuum achieved. Do not lift a load when the vacuum is below the range (F). Always ensure that the supported load is within the green shaded region of the chart bounded by (E), (F) and (G).



D) VLP6 Load Capacity/WLL. Do not exceed the maximum load specifications:

- Supported load not to exceed 974 kg (2,147 lb) as indicated by .
- The VLP can only be used for pipe diameters within the size range as indicated by the "Ø". Do not lift pipes larger or smaller than the indicated Ø range.



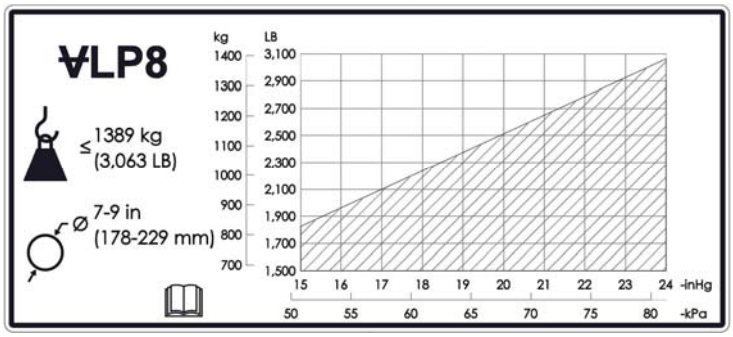
(E) VLP Load Capacity / WLL for vacuum developed with pipe-load

(F) Vacuum operating range

(G) Load operating range

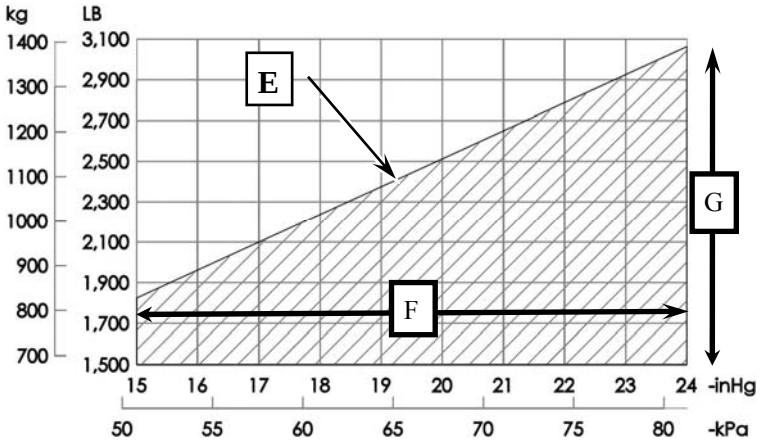
VLP8 Load Capacity/WLL

NOTE: The maximum load that can be supported from the VLP is based on the vacuum that can be developed at the attachment when the pad is in full contact with the pipe and pipe is lifted horizontally. Never attempt to lift the pipe off-center. Do not exceed the load indicated by the graph-line (E) for the vacuum achieved. Do not lift a load when the vacuum is below the range (F). Always ensure that the supported load is within the green shaded region of the chart bounded by (E), (F) and (G).



D) VLP8 Load Capacity/WLL. Do not exceed the maximum load specifications:

- Supported load not to exceed 1389 kg (3,063 lb) as indicated by .
- The VLP can only be used for pipe diameters within the size range as indicated by the "Ø". Do not lift pipes larger or smaller than the indicated Ø range.



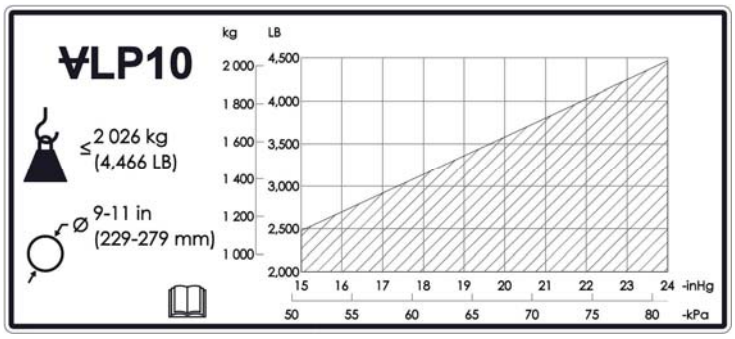
(E) VLP Load Capacity / WLL for vacuum developed with pipe-load

(F) Vacuum operating range

(G) Load operating range

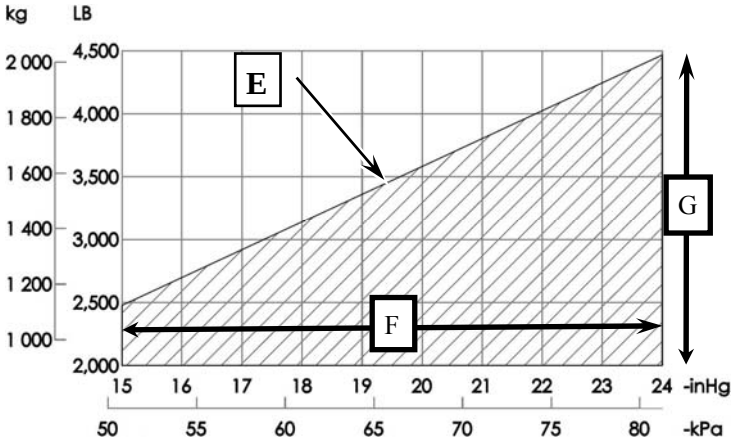
VLP10 Load Capacity/WLL

NOTE: The maximum load that can be supported from the VLP is based on the vacuum that can be developed at the attachment when the pad is in full contact with the pipe and pipe is lifted horizontally. Never attempt to lift the pipe off-center. Do not exceed the load indicated by the graph-line (E) for the vacuum achieved. Do not lift a load when the vacuum is below the range (F). Always ensure that the supported load is within the green shaded region of the chart bounded by (E), (F) and (G).



D) VLP10 Load Capacity/WLL. Do not exceed the maximum load specifications:

- Supported load not to exceed 2 026 kg (4,466 lb) as indicated by .
- The VLP can only be used for pipe diameters within the size range as indicated by the "Ø". Do not lift pipes larger or smaller than the indicated Ø range.



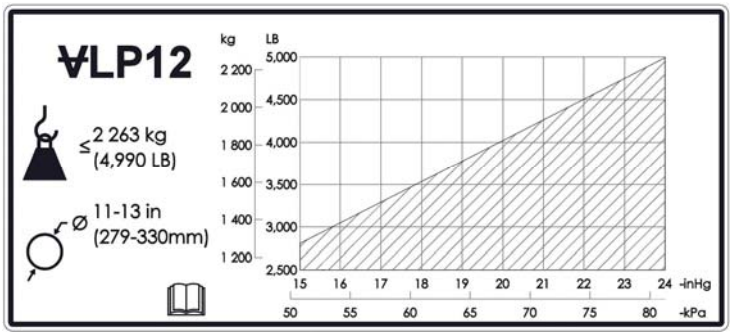
(E) VLP Load Capacity / WLL for vacuum developed with pipe-load

(F) Vacuum operating range

(G) Load operating range

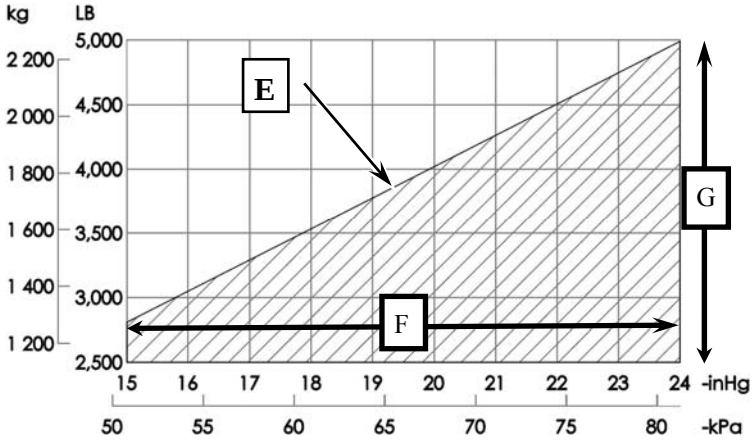
VLP12 Load Capacity/WLL

NOTE: The maximum load that can be supported from the VLP is based on the vacuum that can be developed at the attachment when the pad is in full contact with the pipe and pipe is lifted horizontally. Never attempt to lift the pipe off-center. Do not exceed the load indicated by the graph-line (E) for the vacuum achieved. Do not lift a load when the vacuum is below the range (F). Always ensure that the supported load is within the green shaded region of the chart bounded by (E), (F) and (G).



D) VLP12 Load Capacity/WLL. Do not exceed the maximum load specifications:

- Supported load not to exceed 2 263 kg (4,990 lb) as indicated by .
- The VLP can only be used for pipe diameters within the size range as indicated by the "Ø". Do not lift pipes larger or smaller than the indicated Ø range.



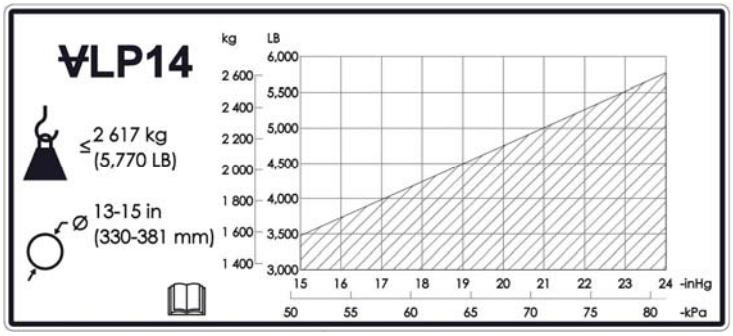
(E) VLP Load Capacity / WLL for vacuum developed with pipe-load

(F) Vacuum operating range

(G) Load operating range

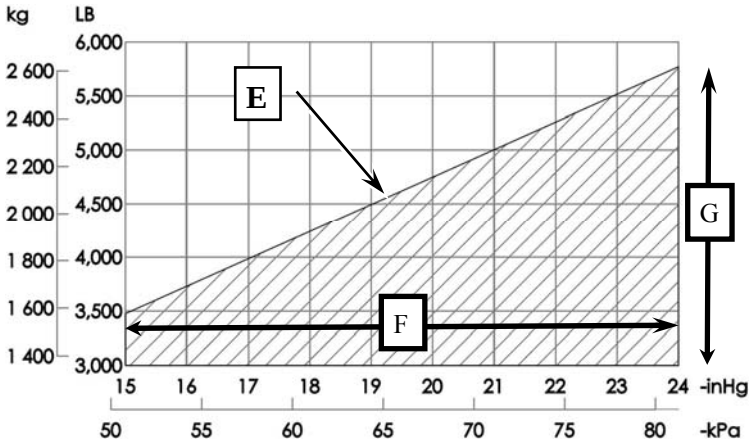
VLP14 Load Capacity/WLL

NOTE: The maximum load that can be supported from the VLP is based on the vacuum that can be developed at the attachment when the pad is in full contact with the pipe and pipe is lifted horizontally. Never attempt to lift the pipe off-center. Do not exceed the load indicated by the graph-line (E) for the vacuum achieved. Do not lift a load when the vacuum is below the range (F). Always ensure that the supported load is within the green shaded region of the chart bounded by (E), (F) and (G).



D) VLP14 Load Capacity/WLL. Do not exceed the maximum load specifications:

- Supported load not to exceed 2 617 kg (5,770 lb) as indicated by .
- The VLP can only be used for pipe diameters within the size range as indicated by the "Ø". Do not lift pipes larger or smaller than the indicated Ø range.



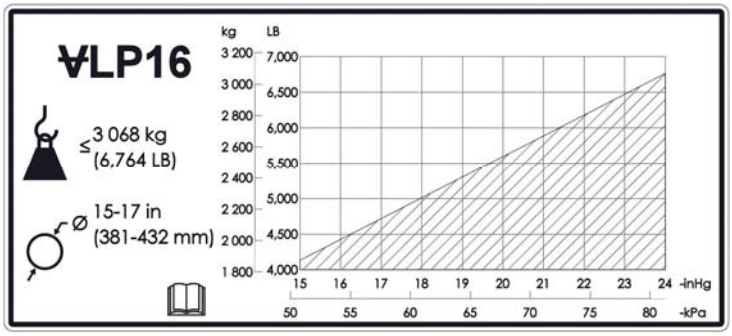
(E) VLP Load Capacity / WLL for vacuum developed with pipe-load

(F) Vacuum operating range

(G) Load operating range

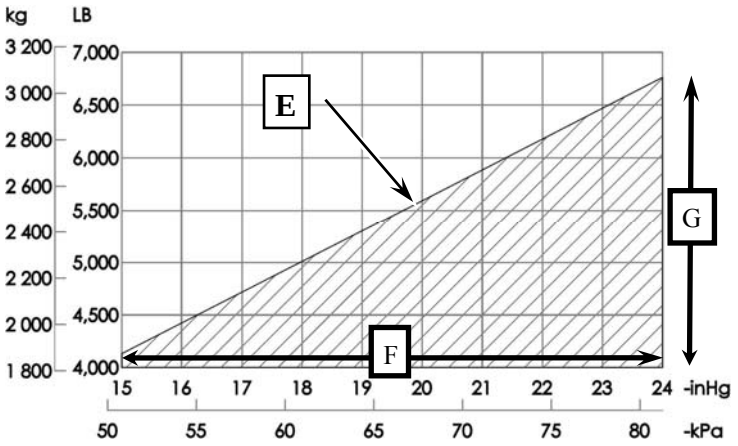
VLP16 Load Capacity/WLL

NOTE: The maximum load that can be supported from the VLP is based on the vacuum that can be developed at the attachment when the pad is in full contact with the pipe and pipe is lifted horizontally. Never attempt to lift the pipe off-center. Do not exceed the load indicated by the graph-line (E) for the vacuum achieved. Do not lift a load when the vacuum is below the range (F). Always ensure that the supported load is within the green shaded region of the chart bounded by (E), (F) and (G).



D) VLP16 Load Capacity/WLL. Do not exceed the maximum load specifications:

- Supported load not to exceed 3 068 kg (6,764 lb) as indicated by .
- The VLP can only be used for pipe diameters within the size range as indicated by the "Ø". Do not lift pipes larger or smaller than the indicated Ø range.



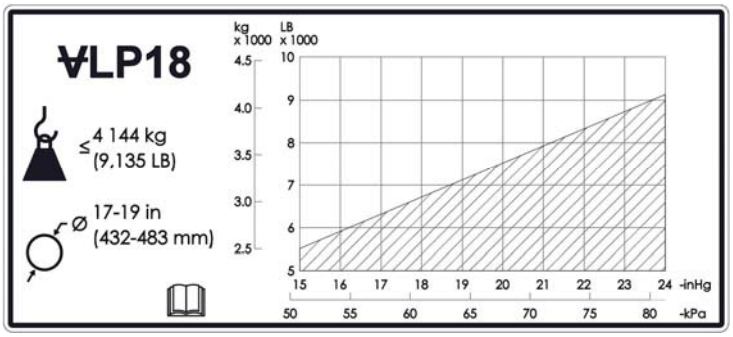
(E) VLP Load Capacity / WLL for vacuum developed with pipe-load

(F) Vacuum operating range

(G) Load operating range

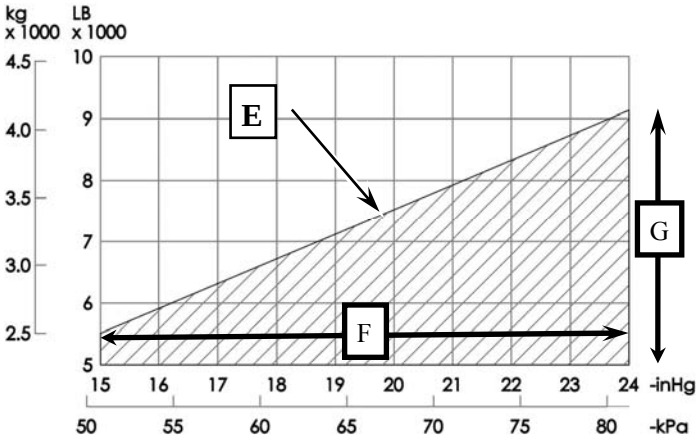
VLP18 Load Capacity/WLL

NOTE: The maximum load that can be supported from the VLP is based on the vacuum that can be developed at the attachment when the pad is in full contact with the pipe and pipe is lifted horizontally. Never attempt to lift the pipe off-center. Do not exceed the load indicated by the graph-line (E) for the vacuum achieved. Do not lift a load when the vacuum is below the range (F). Always ensure that the supported load is within the green shaded region of the chart bounded by (E), (F) and (G).



D) VLP18 Load Capacity/WLL. Do not exceed the maximum load specifications:

- Supported load not to exceed 4 144 kg (9,135 lb) as indicated by .
- The VLP can only be used for pipe diameters within the size range as indicated by the "Ø". Do not lift pipes larger or smaller than the indicated Ø range.



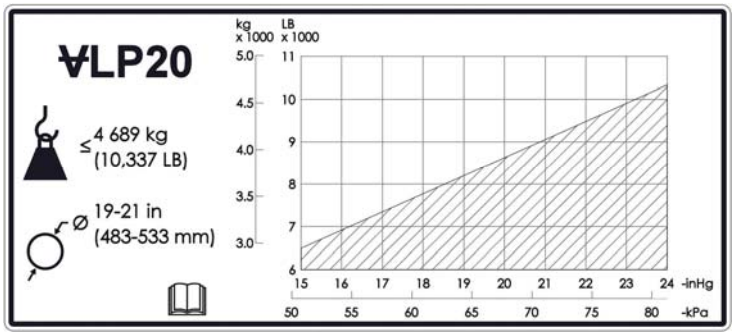
(E) VLP Load Capacity / WLL for vacuum developed with pipe-load

(F) Vacuum operating range

(G) Load operating range

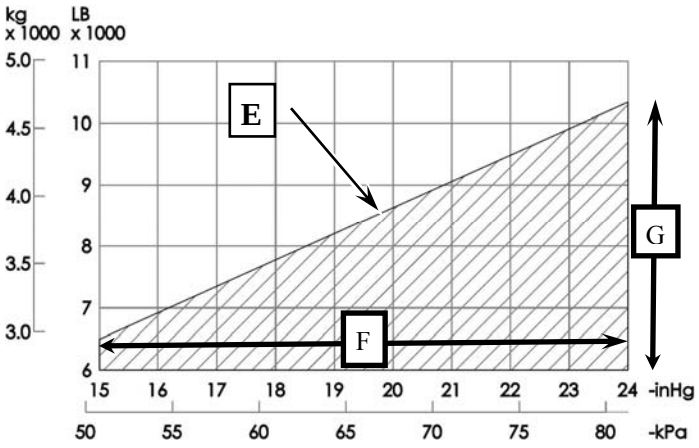
VLP20 Load Capacity/WLL

NOTE: The maximum load that can be supported from the VLP is based on the vacuum that can be developed at the attachment when the pad is in full contact with the pipe and pipe is lifted horizontally. Never attempt to lift the pipe off-center. Do not exceed the load indicated by the graph-line (E) for the vacuum achieved. Do not lift a load when the vacuum is below the range (F). Always ensure that the supported load is within the green shaded region of the chart bounded by (E), (F) and (G).



D) VLP20 Load Capacity/WLL. Do not exceed the maximum load specifications:

- Supported load not to exceed 4 689 kg (10,337 lb) as indicated by .
- The VLP can only be used for pipe diameters within the size range as indicated by the "Ø". Do not lift pipes larger or smaller than the indicated Ø range.



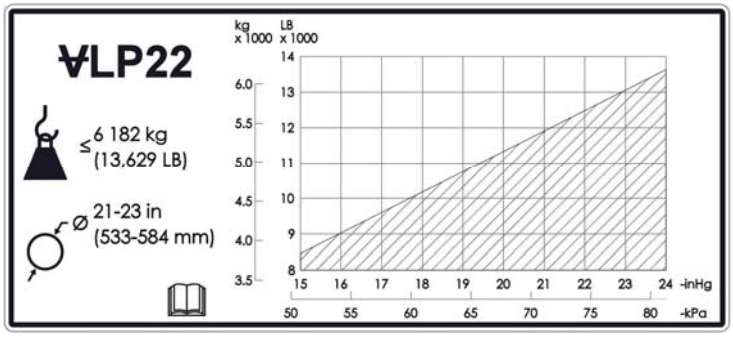
(E) VLP Load Capacity / WLL for vacuum developed with pipe-load

(F) Vacuum operating range

(G) Load operating range

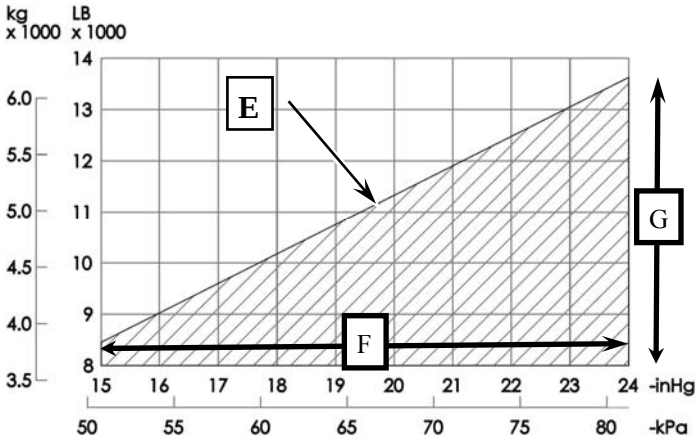
VLP22 Load Capacity/WLL

NOTE: The maximum load that can be supported from the VLP is based on the vacuum that can be developed at the attachment when the pad is in full contact with the pipe and pipe is lifted horizontally. Never attempt to lift the pipe off-center. Do not exceed the load indicated by the graph-line (E) for the vacuum achieved. Do not lift a load when the vacuum is below the range (F). Always ensure that the supported load is within the green shaded region of the chart bounded by (E), (F) and (G).



D) VLP22 Load Capacity/WLL. Do not exceed the maximum load specifications:

- Supported load not to exceed 6 182 kg (13,629 lb) as indicated by .
- The VLP can only be used for pipe diameters within the size range as indicated by the "Ø". Do not lift pipes larger or smaller than the indicated Ø range.



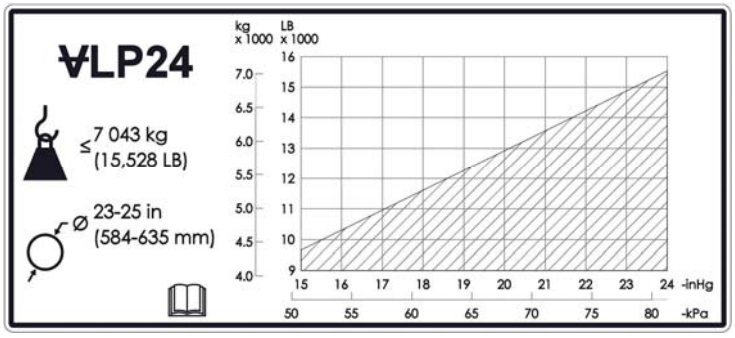
(E) VLP Load Capacity / WLL for vacuum developed with pipe-load

(F) Vacuum operating range

(G) Load operating range

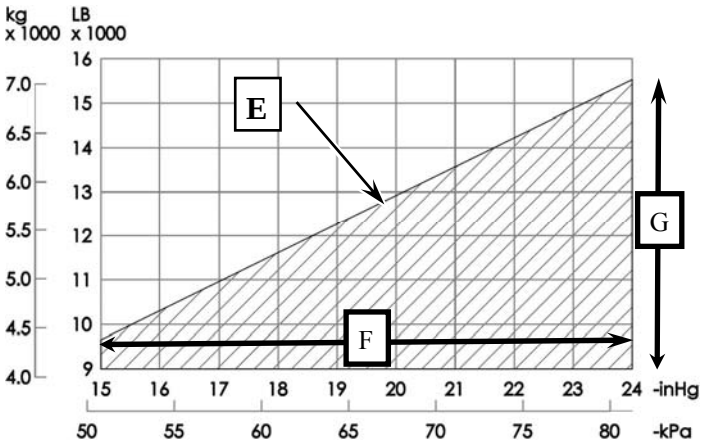
VLP24 Load Capacity/WLL

NOTE: The maximum load that can be supported from the VLP is based on the vacuum that can be developed at the attachment when the pad is in full contact with the pipe and pipe is lifted horizontally. Never attempt to lift the pipe off-center. Do not exceed the load indicated by the graph-line (E) for the vacuum achieved. Do not lift a load when the vacuum is below the range (F). Always ensure that the supported load is within the green shaded region of the chart bounded by (E), (F) and (G).



D) VLP24 Load Capacity/WLL. Do not exceed the maximum load specifications:

- Supported load not to exceed 7 043 kg (15,528 lb) as indicated by .
- The VLP can only be used for pipe diameters within the size range as indicated by the "Ø". Do not lift pipes larger or smaller than the indicated Ø range.



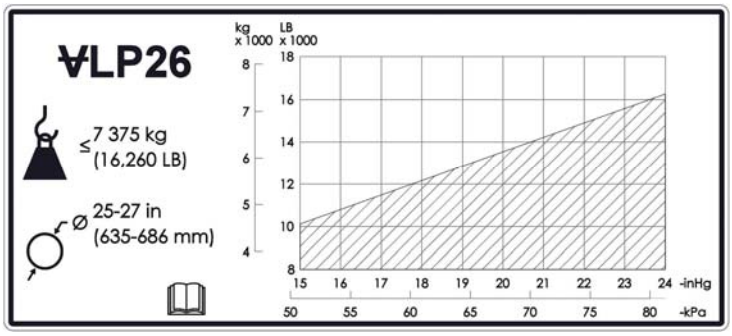
(E) VLP Load Capacity / WLL for vacuum developed with pipe-load

(F) Vacuum operating range

(G) Load operating range

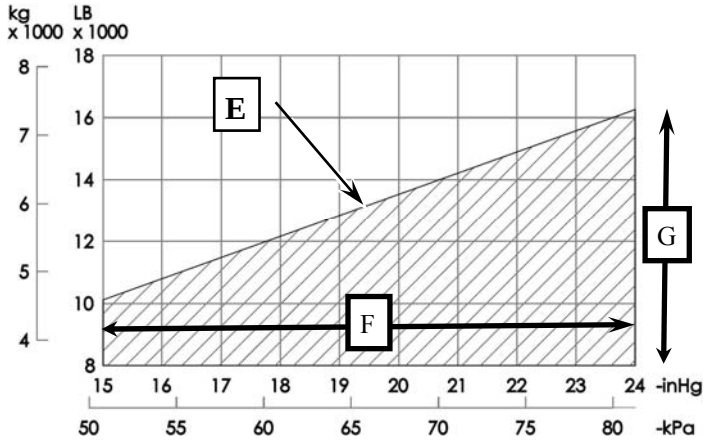
VLP26 Load Capacity/WLL

NOTE: The maximum load that can be supported from the VLP is based on the vacuum that can be developed at the attachment when the pad is in full contact with the pipe and pipe is lifted horizontally. Never attempt to lift the pipe off-center. Do not exceed the load indicated by the graph-line (E) for the vacuum achieved. Do not lift a load when the vacuum is below the range (F). Always ensure that the supported load is within the green shaded region of the chart bounded by (E), (F) and (G).



D) VLP26 Load Capacity/WLL. Do not exceed the maximum load specifications:

- Supported load not to exceed 7 375 kg (16,260 lb) as indicated by .
- The VLP can only be used for pipe diameters within the size range as indicated by the "Ø". Do not lift pipes larger or smaller than the indicated Ø range.



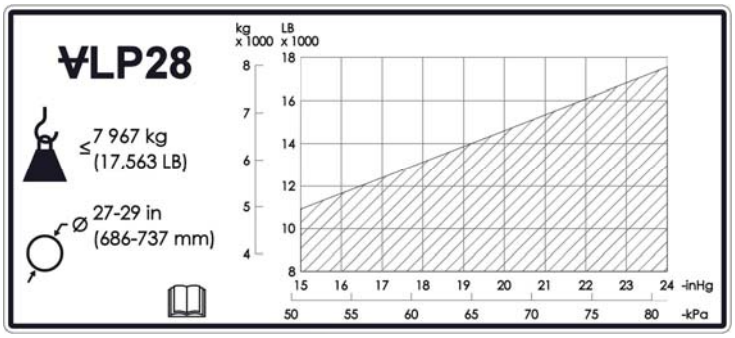
(E) VLP Load Capacity / WLL for vacuum developed with pipe-load

(F) Vacuum operating range

(G) Load operating range

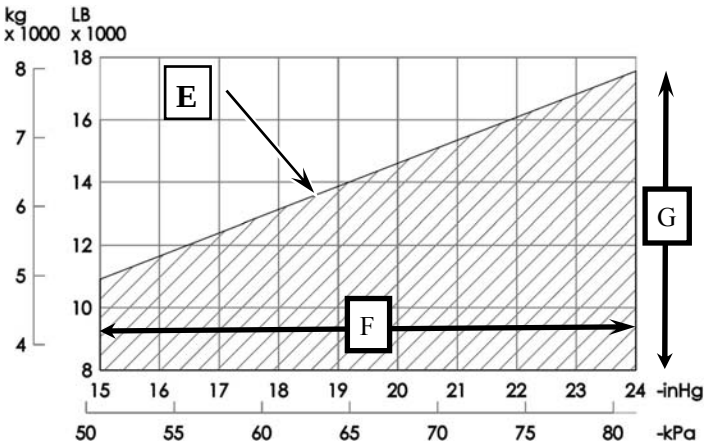
VLP28 Load Capacity/WLL

NOTE: The maximum load that can be supported from the VLP is based on the vacuum that can be developed at the attachment when the pad is in full contact with the pipe and pipe is lifted horizontally. Never attempt to lift the pipe off-center. Do not exceed the load indicated by the graph-line (E) for the vacuum achieved. Do not lift a load when the vacuum is below the range (F). Always ensure that the supported load is within the green shaded region of the chart bounded by (E), (F) and (G).



D) VLP28 Load Capacity/WLL. Do not exceed the maximum load specifications:

- Supported load not to exceed 7 967 kg (17,563 lb) as indicated by .
- The VLP can only be used for pipe diameters within the size range as indicated by the "Ø". Do not lift pipes larger or smaller than the indicated Ø range.



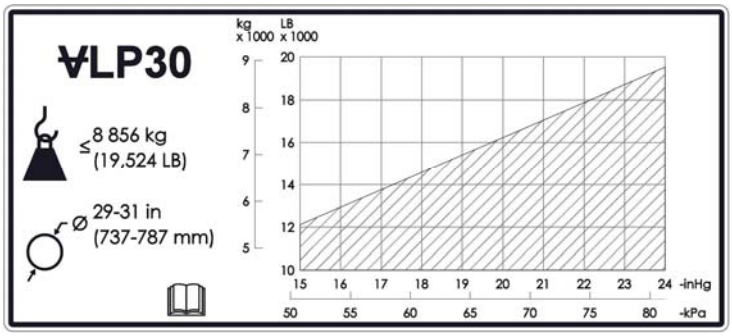
(E) VLP Load Capacity / WLL for vacuum developed with pipe-load

(F) Vacuum operating range

(G) Load operating range

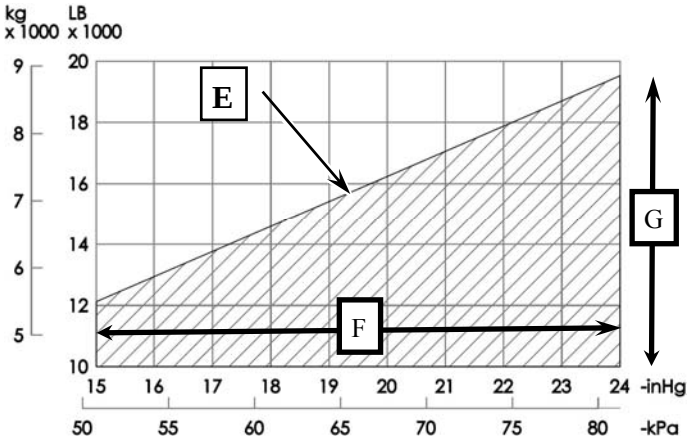
VLP30 Load Capacity/WLL

NOTE: The maximum load that can be supported from the VLP is based on the vacuum that can be developed at the attachment when the pad is in full contact with the pipe and pipe is lifted horizontally. Never attempt to lift the pipe off-center. Do not exceed the load indicated by the graph-line (E) for the vacuum achieved. Do not lift a load when the vacuum is below the range (F). Always ensure that the supported load is within the green shaded region of the chart bounded by (E), (F) and (G).



D) VLP30 Load Capacity/WLL. Do not exceed the maximum load specifications:

- Supported load not to exceed 8 856 kg (19,524 lb) as indicated by .
- The VLP can only be used for pipe diameters within the size range as indicated by the "Ø". Do not lift pipes larger or smaller than the indicated Ø range.



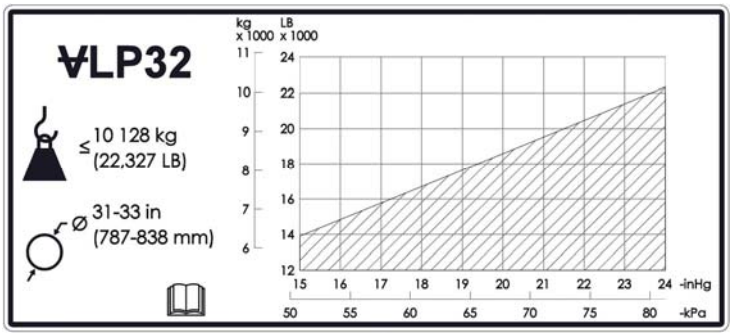
(E) VLP Load Capacity / WLL for vacuum developed with pipe-load

(F) Vacuum operating range

(G) Load operating range

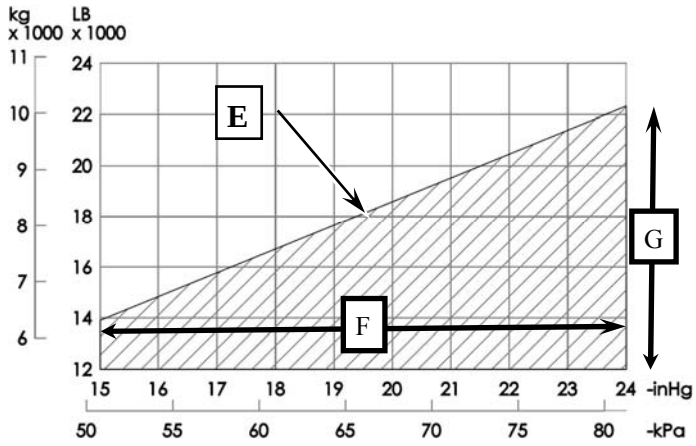
VLP32 Load Capacity/WLL

NOTE: The maximum load that can be supported from the VLP is based on the vacuum that can be developed at the attachment when the pad is in full contact with the pipe and pipe is lifted horizontally. Never attempt to lift the pipe off-center. Do not exceed the load indicated by the graph-line (E) for the vacuum achieved. Do not lift a load when the vacuum is below the range (F). Always ensure that the supported load is within the green shaded region of the chart bounded by (E), (F) and (G).



D) VLP32 Load Capacity/WLL. Do not exceed the maximum load specifications:

- Supported load not to exceed 10 128 kg (22,327 lb) as indicated by .
- The VLP can only be used for pipe diameters within the size range as indicated by the "Ø". Do not lift pipes larger or smaller than the indicated Ø range.



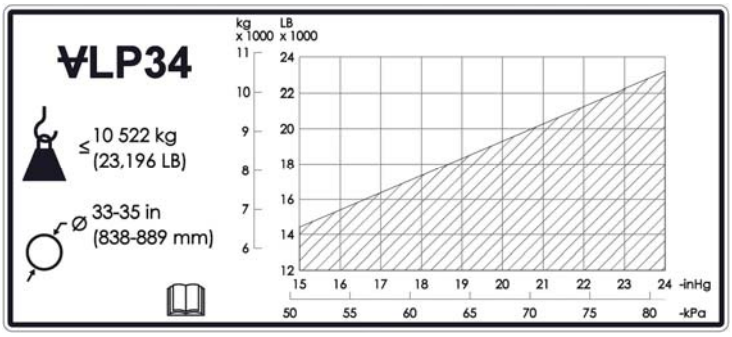
(E) VLP Load Capacity / WLL for vacuum developed with pipe-load

(F) Vacuum operating range

(G) Load operating range

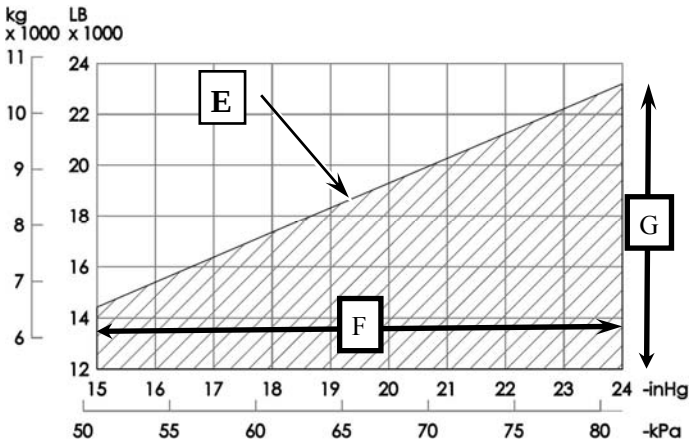
VLP34 Load Capacity/WLL

NOTE: The maximum load that can be supported from the VLP is based on the vacuum that can be developed at the attachment when the pad is in full contact with the pipe and pipe is lifted horizontally. Never attempt to lift the pipe off-center. Do not exceed the load indicated by the graph-line (E) for the vacuum achieved. Do not lift a load when the vacuum is below the range (F). Always ensure that the supported load is within the green shaded region of the chart bounded by (E), (F) and (G).



D) VLP34 Load Capacity/WLL. Do not exceed the maximum load specifications:

- Supported load not to exceed 10 522 kg (23,196 lb) as indicated by .
- The VLP can only be used for pipe diameters within the size range as indicated by the "Ø". Do not lift pipes larger or smaller than the indicated Ø range.



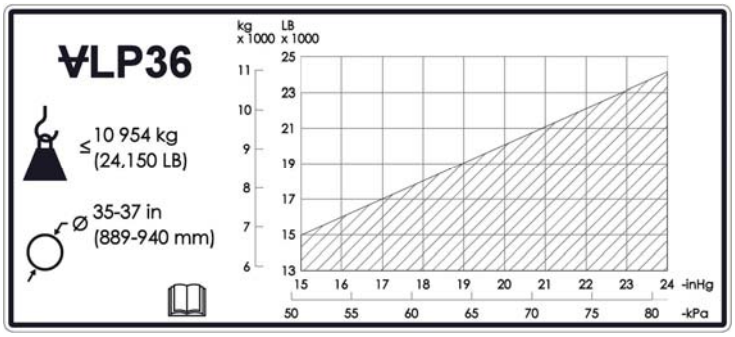
(E) VLP Load Capacity / WLL for vacuum developed with pipe-load

(F) Vacuum operating range

(G) Load operating range

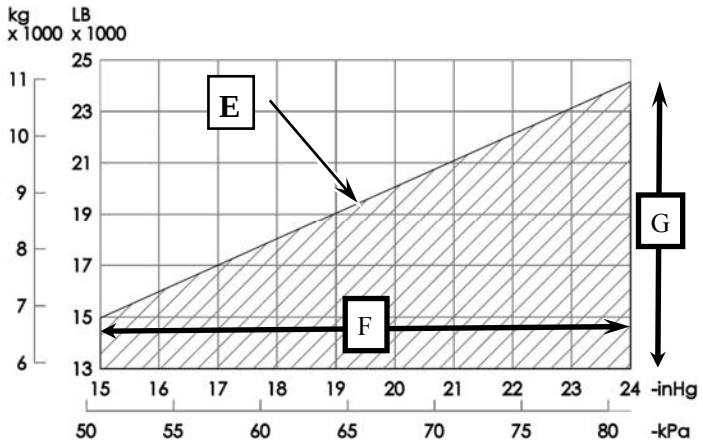
VLP36 Load Capacity/WLL

NOTE: The maximum load that can be supported from the VLP is based on the vacuum that can be developed at the attachment when the pad is in full contact with the pipe and pipe is lifted horizontally. Never attempt to lift the pipe off-center. Do not exceed the load indicated by the graph-line (E) for the vacuum achieved. Do not lift a load when the vacuum is below the range (F). Always ensure that the supported load is within the green shaded region of the chart bounded by (E), (F) and (G).



D) VLP36 Load Capacity/WLL. Do not exceed the maximum load specifications:

- Supported load not to exceed 10 954 kg (24,150 lb) as indicated by .
- The VLP can only be used for pipe diameters within the size range as indicated by the "Ø". Do not lift pipes larger or smaller than the indicated Ø range.



(E) VLP Load Capacity / WLL for vacuum developed with pipe-load

(F) Vacuum operating range

(G) Load operating range

Identification Information

Plate Locations and Film Locations

Vacuum Lifter (VL) Attachment/Component Information plate

The attachment/component information plate is attached to the component to identify the model name/number and the serial number. It is not a Product Information Number (PIN). The attachment/component information plate is located inside the vacuum power-pack compartment, on the right bulkhead, above the vacuum valve-filter, per the illustration below. For quick reference, record this information in the spaces that are provided below:

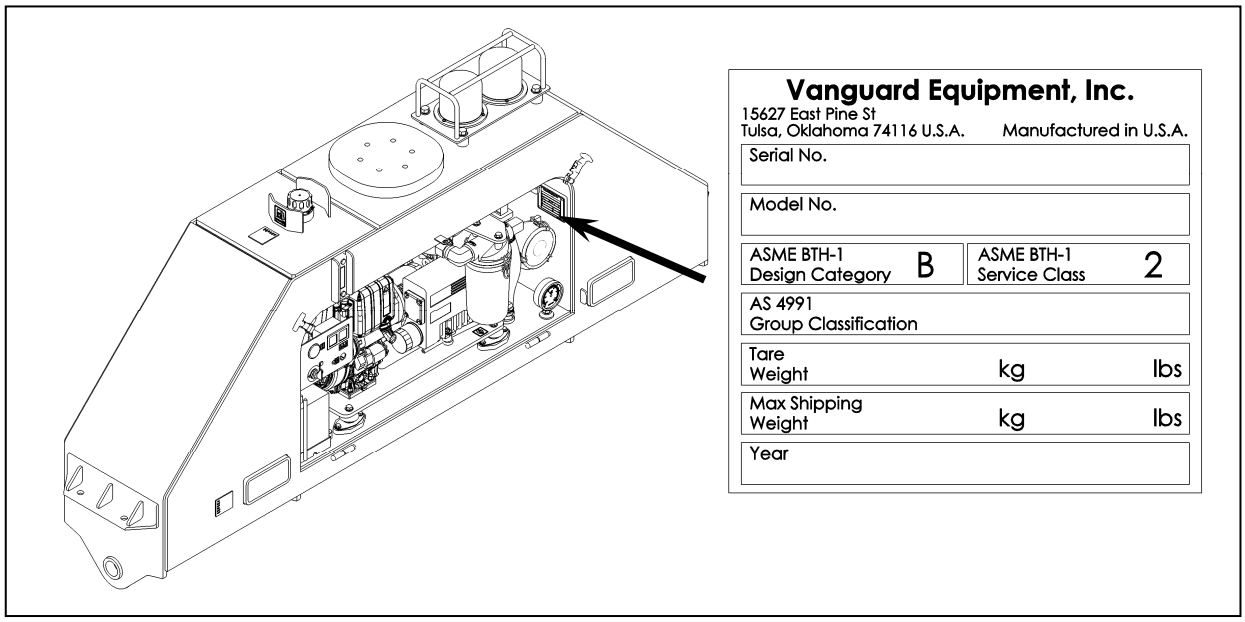
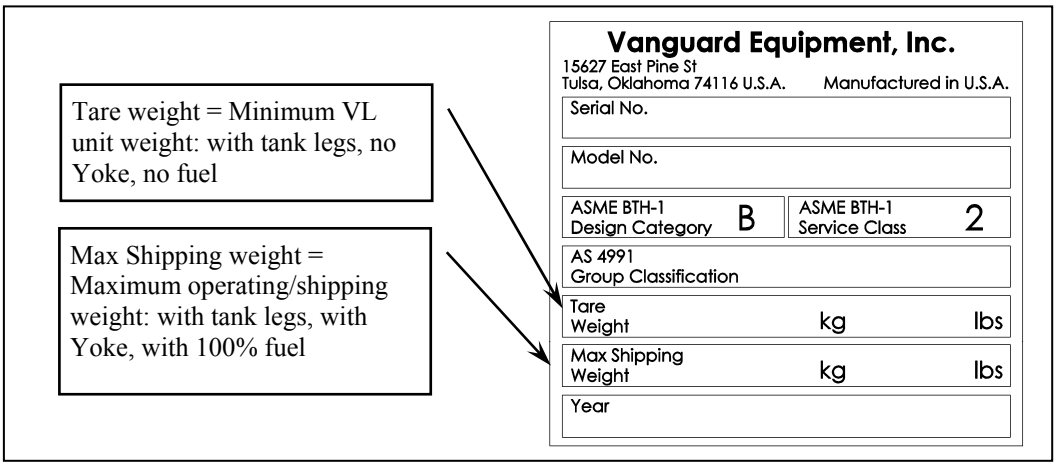


Figure 22: Attachment/component information plate

Serial Number _____ Model Number _____

Year of Manufacture _____

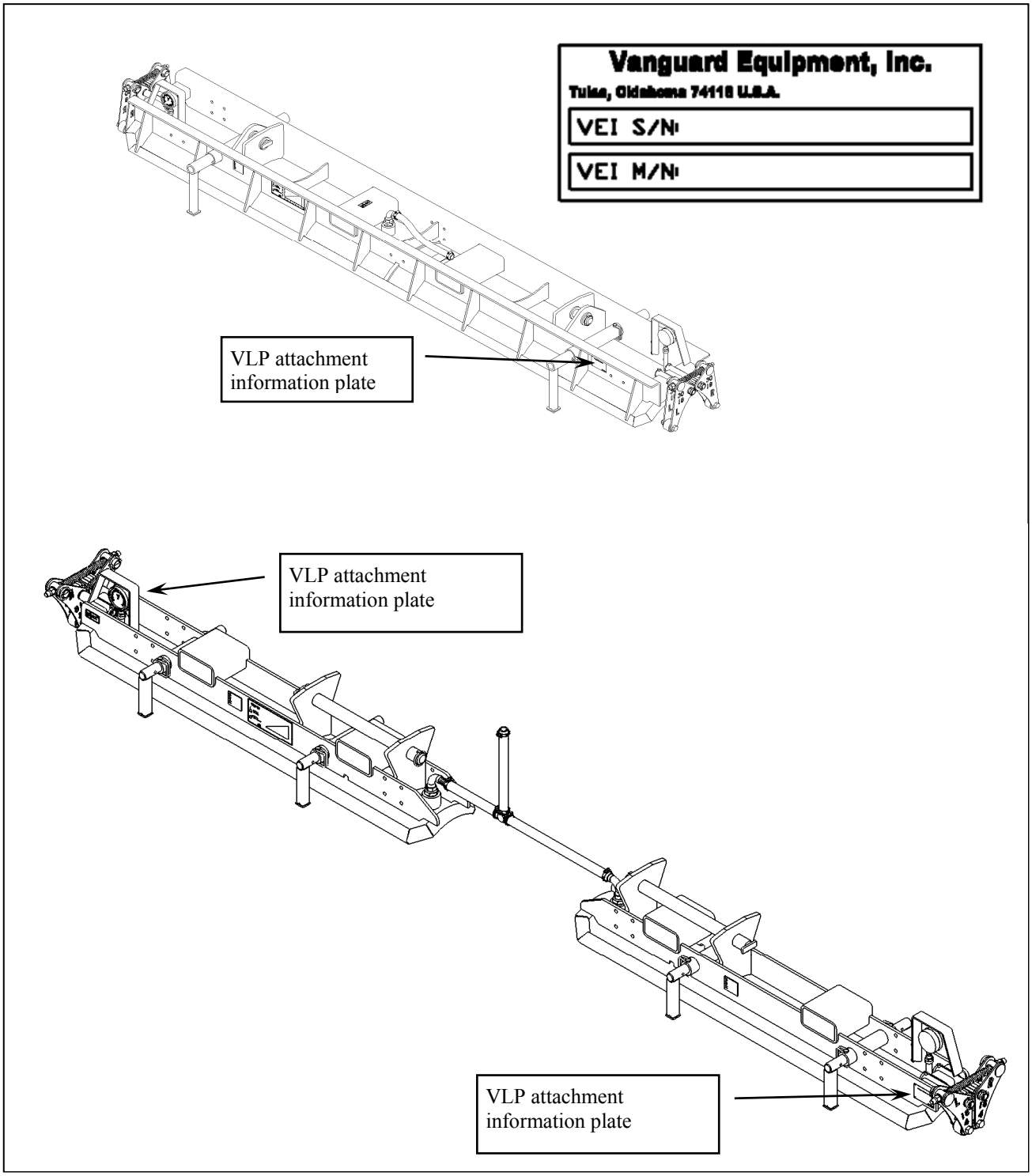
Vacuum Lifter (VL) Weight



The Vacuum Lifter (VL) weights are listed in the Vacuum Lifter (VL) Specification section of this manual.

Vacuum Lifter Pipe (VLP) Attachment Information plate

The VLP attachment pad information plate is attached to the component to identify the model name/number and the serial number. It is not a Product Information Number (PIN). The VLP attachment information plate is located on the outside of the web, on the opposite end from the Vacuum Gauge, close to the Guide Wheels. Note: on Single Pads, VLP attachment information plate is on the opposite end from the Vacuum Hose connection, per the illustration below. For quick reference,



record this information in the spaces that are provided below:

Figure 23: Vacuum Lifter Pipe (VLP) attachment pads information plate

Pad Weight - Load handling and Shipping Weight

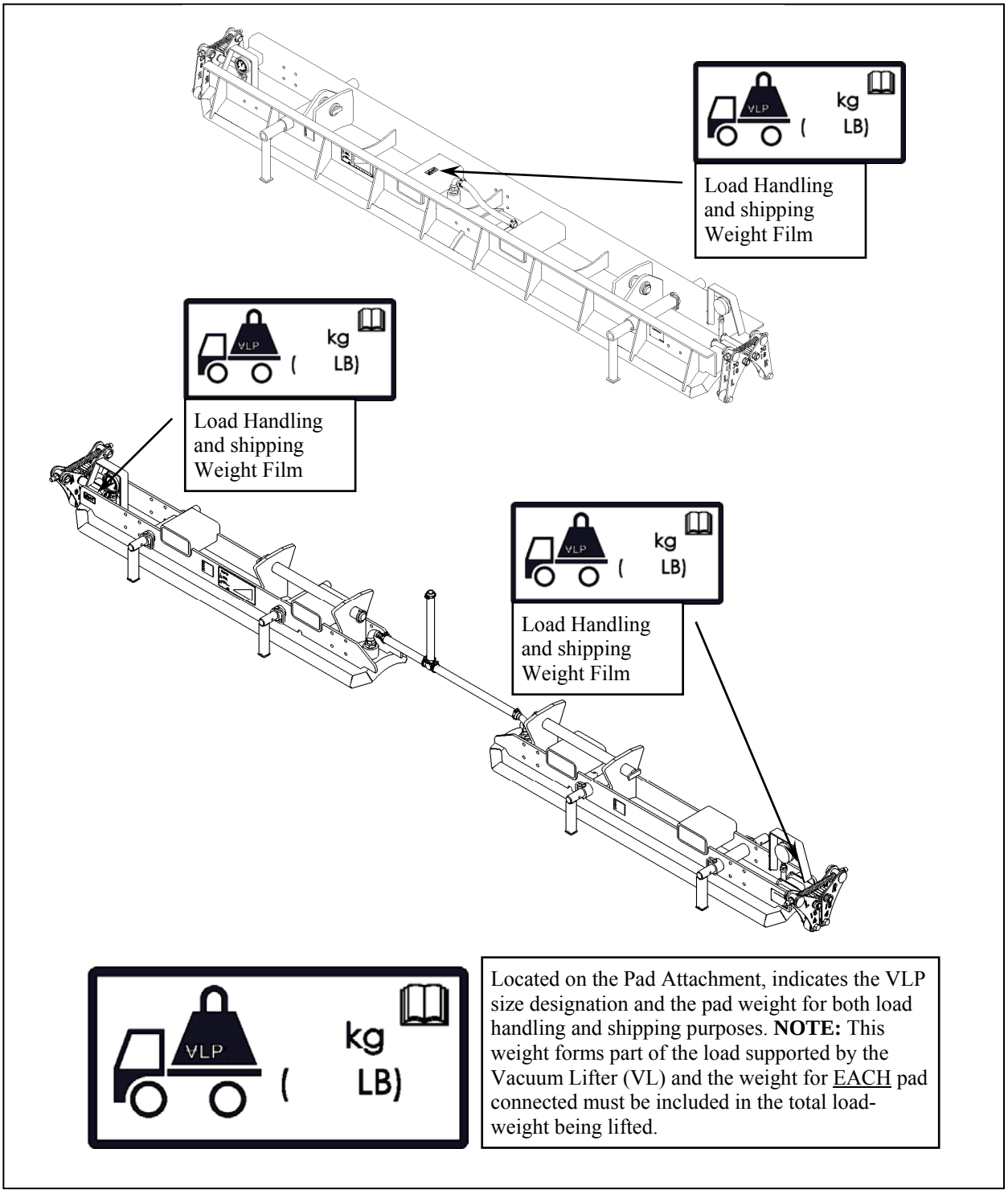


Figure 24: Vacuum Lifter Pipe (VLP) attachment pads Load handling and Shipping weight

The Load Handling and Shipping weights are listed in the Vacuum Lifter Pipe (VLP) attachment Specification section of this manual.

Certification - CE Mark

For Vacuum Lifter (VL) equipment that are compliant to 2006/42/EC "The Machinery Directive" the CE mark and designation of the machinery information is incorporated into the attachment/component information plate.

For Vacuum Lifter Pipe (VLP) attachment pads the CE mark and designation of the machinery information is shown on the VLP's attachment information plate, is located on the outside of the web, on the opposite end from the Vacuum Gauge, close to the Guide Wheels. Note: on Single Pads, VLP attachment information plate is on the opposite end from the Vacuum Hose connection

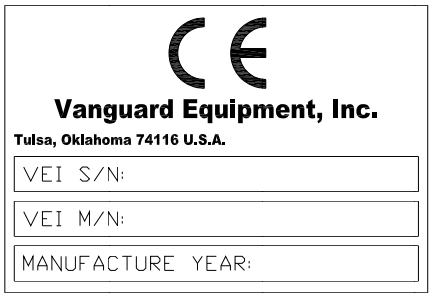


Figure 25: Vacuum Lifter Pipe (VLP) attachment pads CE information plate

ISO Symbols (Model Usage)

The following list contains all of the ISO Symbols that appear in this publication.

	On: To identify the on position of a control.
	Off: To identify the off position of a control.
	Battery Disconnect: To identify the control that disconnects the battery from the electrical system.
	Engine Start: To identify the control used to start the engine.
	Engine Run: To identify the control position that indicates the engine, once started, will continue to operate.
	Engine Stop: To identify the control used to stop the engine.
	To identify the control that activates diesel engine glow plugs to assist in starting the engine at low temperatures.
	Battery charging condition: To identify the display that provides information about the battery charging condition.
	To indicate that the engine oil is low or fails outside of specified parameters. To identify the engine oil gauge. To identify the engine oil filler cap or fill point. To identify the display that provides information about the oil pressure in the engine lubrication system.
	Hour meter: To indicate the number of hours the equipment has operated.
	Electrical Earth/Ground: Indentifies the Earth/Ground terminal connection.

Operation

Before Operation

Refer to the host-carrier-vehicle's Operation and Maintenance Manual for relevant instructions, including safety related issues.

Ensure that the Vacuum Lifter (VL) fuel tank has enough fuel to complete the scheduled work before requiring refueling, refer to the *Maintenance* section of this manual. The Diesel engine powers the vacuum pump. Without adequate fuel, both the engine and vacuum pump will stop causing the vacuum level to fall and eventually drop below the working range. Lifting operations will not be possible as soon as the unit runs out of fuel and the engine stops.

Daily Inspection

To ensure a safe operational condition of the machine, and for maximum service life of the machine, perform a daily walk-around inspection.

Note: Watch closely for leaks, both vacuum and fluid leaks. If leaking is observed, find the source of the leak and correct the leak. If fluid leaking is suspected or fluid leaking is observed, check the fluid levels more frequently.

Inspect the machine for the following items:

- Inspect the Vacuum Lifter (VL) for any signs of physical damage, such as: cracks, dents, gouges, corrosion, loose or missing bolts and hardware, damaged pins etc.
- Inspect the hydraulic system for leaks. Repair any hydraulic system leaks. Inspect the hoses, the seals, and the flanges.
- Inspect covers and the guards for damage, for loose bolts, and for missing bolts.
- Inspect the vacuum gauges on the Vacuum Lifter (VL) to ensure they are in good condition and replace if damaged or fail to give a readout when the machine is operating under vacuum.
- Inspect the vacuum hoses and connections at the Vacuum Lifter (VL). Ensure there are no nicks, cuts, cracks, frays, or tears in the hoses. Check the vacuum connections for leaks, repair any leaks.
- Inspect the fuel-line hoses between the Vacuum Lifter (VL) fuel tank and the engine-system for leaks. Repair any fuel-line leaks.
- Inspect the Vacuum Lifter Pipe (VLP) attachment for any signs of physical damage, such as: cracks, dents, gouges, corrosion, loose or missing bolts and hardware, damaged pins etc.
- Inspect the vacuum hoses and connections to the Vacuum Lifter Pipe (VLP) attachment pads. Ensure there are no nicks, cuts, cracks, frays, or tears in the hoses. Check the vacuum connections for leaks, repair any leaks.
- Inspect the vacuum gauges on the Vacuum Lifter Pipe (VLP) attachment pads to ensure they are in good condition and replace if damaged or fail to give a readout when the machine is operating under vacuum.
- Inspect the guide wheels on the Vacuum Lifter Pipe (VLP) attachment pads to ensure the guides open freely, and the guide-wheels rotate freely.
- Inspect the vacuum seal on the Vacuum Lifter Pipe (VLP) attachment pads to ensure it is not overly worn, cut, or damaged. Replace damaged sections as required.

Note: Refer to the host-carrier-vehicle's operation manual for detailed information on the specific daily inspection of the host-carrier unit.

Notice

Accumulated grease and oil on a machine is a fire hazard.

Remove debris with steam cleaning or high-pressure water, at the specified interval in the Maintenance Interval Schedule or each time any significant quantity of oil is spilled on the machine.

Daily Checks

After you inspect the machine, perform the daily maintenance that is listed in the maintenance interval schedule. Perform the daily maintenance before you mount the host-carrier-vehicle in order to operate the machine.

Refer to Operation and Maintenance Manual, "Maintenance Interval Schedule" for the correct procedures for the following checks:

- Diesel Fuel Filter - Check
- Vacuum Engine Fuel Level - Check
- Vacuum Engine Oil - Check
- Vacuum Engine Air Cleaner - Check
- Vacuum Pump Oil - Check
- Vacuum Filters - Check
- Yoke Pin - Lubricate
- Guide Wheels - Check
- Operation Controls and Alarm System - Check
- Host-carrier-vehicle Hydraulic System Oil Level – Check
- Hydraulic Hoses and fittings for leaks – Check
- Vacuum Hoses and fittings for leaks – Check
- Electrical cables for signs of damage to insulation - Check, replace if damaged
- Lift Test - Perform
- Yoke Bumpers - Check

Note: Refer to the host-carrier-vehicle's operation manual for detailed information on the specific daily checks of the host-carrier unit.

Operator Controls

Rotation of the Vacuum Lifter (VL) is only possible when the Yoke (excavator attachment) is installed. The hydraulic rotation functions of the Yoke (excavator attachment) are controlled by the host-carrier-vehicle's implement controls. Refer to the specific host-carrier-vehicle's Operation and Maintenance manual for information regarding the type and location of the implement controls. It is recommended to connect the Yoke (excavator attachment) hoses to the bucket cylinder or auxiliary circuit on the excavator. The speed of the rotation will be dependent on the host-carrier-vehicle's engine RPM speed driving the hydraulic implement pump. The faster the engine RPM, the faster the Yoke (excavator attachment) rotation operational speed. The rotation speed can also be limited by flow control valves fitted to the Yoke (excavator attachment). Refer to the *Excavator attachment* section of this manual for connection and adjustment instructions.

Battery Disconnect Switch

The battery disconnect switch is on the Vacuum Lifter (VL) main control panel on the operator's side, behind the door guard enclosure.

049-05-05-013C

049-50-63-015B

Figure 26: Battery Disconnect Switch

I ON — Insert the battery disconnect switch key, and turn the battery disconnect switch key clockwise in order to supply electrical power to the electrical system. The switch must be ON before you start the engine.

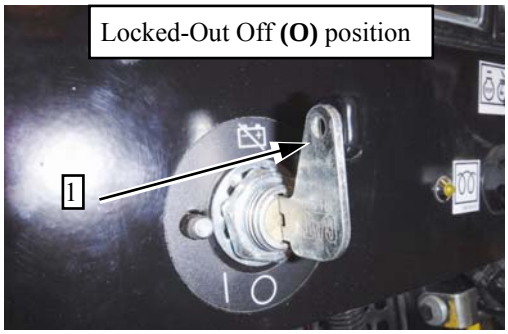
O OFF — Turn the battery disconnect switch key counter clockwise in order to shut off the electrical power supply to the entire electrical system.

The battery disconnect switch and the engine Stop/Run/Start Switch serve different functions. When the battery disconnect switch is turned off, the entire electrical system is disabled. When only the engine start switch is turned off, the battery remains connected to the electrical system.

Turn the battery disconnect switch key to the off **(O)** position and remove the battery disconnect switch key when you service the electrical system or you service any other components on the equipment. See also the General Hazard Information section in this manual.

Turn the battery disconnect switch key to the off **(O)** position and remove the battery disconnect switch key when the equipment is left for an extended period. This procedure will prevent a short circuit from draining the battery. This procedure will also prevent the components from draining the battery. This procedure will also prevent the battery from being drained by vandalism, etc.

The battery disconnect switch can also be placed in the locked-out off **(O)** position (1) with the key left in place. The key can be locked in place to the hasp with a padlock. This locks the machine out so it cannot be used. This is useful for locking the machine out for service or maintenance.



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Engine Stop/Run/Start Switch

The engine stop/run/start switch is located on the Vacuum Lifter (VL) main control panel on the operator's side; it can be accessed with the door guard enclosure in place. Turning the switch to RUN energizes the electrical system, turning on the status-alarm and controls, etc. Turning the switch to STOP de-energizes the electrical system, turning everything off. Note: The battery remains connected to the electrical system, refer to the Battery Disconnect Switch operation.

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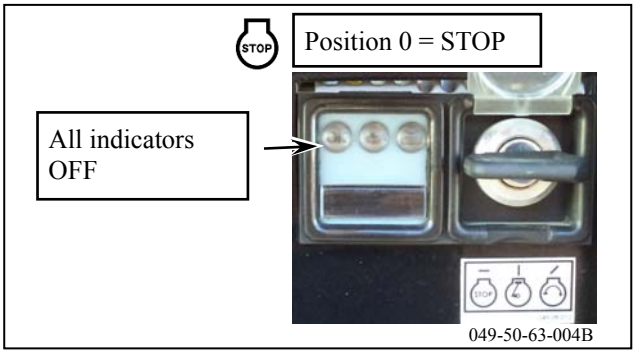
Figure 27: Engine Stop/Run/Stop Switch

STOP—Turn the engine Stop/Run/Start switch to the STOP position (position 0) in order to stop the engine. If the engine won't stop, refer to the troubleshooting section, Engine Won't Start / Manual reset lever in wrong position



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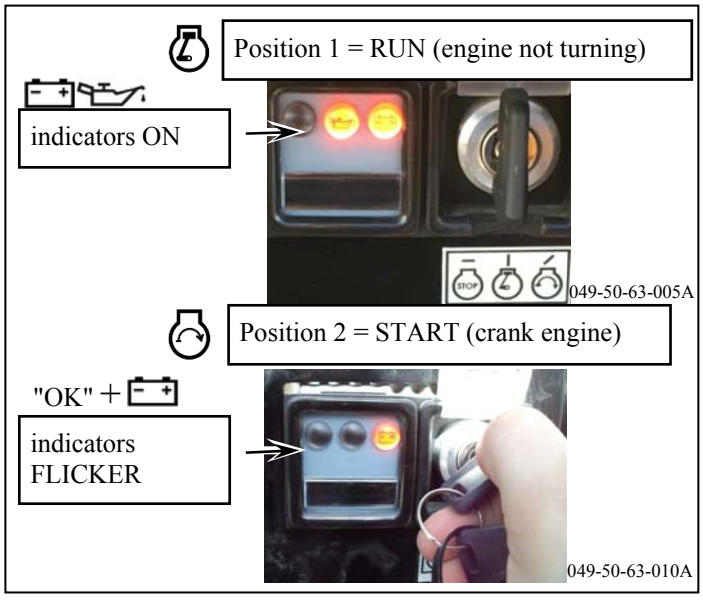
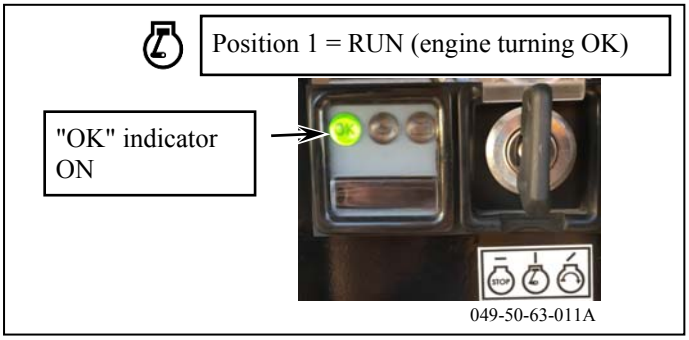
START—Turn the engine Stop/Run/Start switch to position 1, RUN, so that the oil pressure and battery charge lights are on. Then continue to turn the key clockwise to position 2, START, to crank the engine all the way. Crank the Engine until the engine catches. Do not actuate starter switch for more than 20 seconds at a time. If engine does not start, wait 1 minute before repeating attempt. If engine does not start after two attempts, use the *Troubleshooting Guide* in the Engine Manual appendix to find the cause. **Note:** Special cold start precautions must be taken for ambient temperatures below 0 ºC (32 ºF), refer to the *Post Start-up* section below.

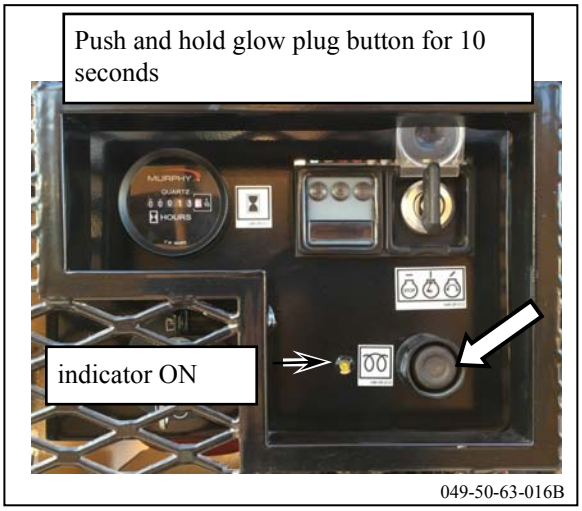


RUN—Return key to 1st position, RUN, when engine is running. **Note:** While the engine is running, all warning lights should be off except the starting panel OK light.



Glow Plug

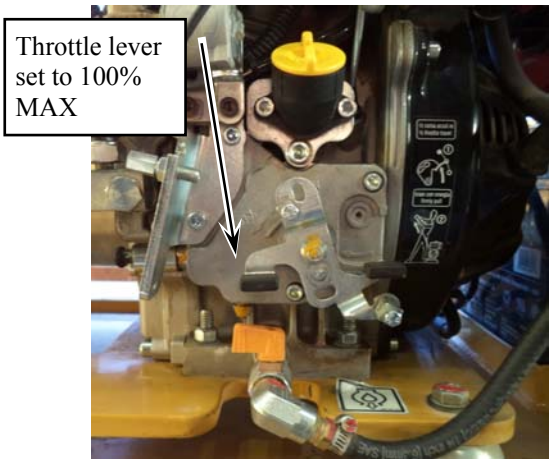
GLOW PLUG—At temperatures below 5°C (41°F), use the glow plug to assist starting the engine. Push and hold the glow plug button for 10 seconds, the glow plug indicator will illuminate. Release the glow plug button, and start the engine.



Post Start-Up (Maximum throttle/Manual throttle Minimum idle/Stop)

Run engine at idle speed according to the table below. Throttle lever will stay in last position. After start-up, move throttle lever to the 100% MAX position.

Temperature	Time
≤ -4°F (-20°C)	5 minutes
-4°F to 14°F (-20°C to -10°C)	2 minutes
14°F to 23°F (-10°C to -5°C)	1 minute
≥ 41°F (5°C)	20 seconds



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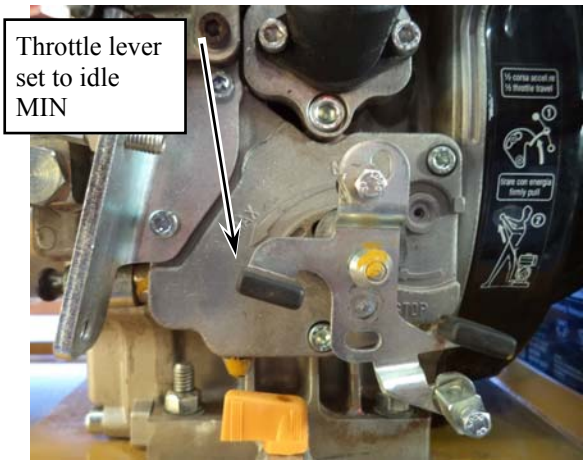

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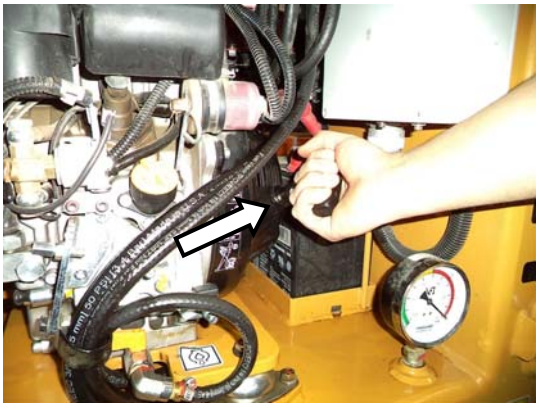
Figure 28: Engine Throttle positions

Engine Recoil Starting

Set the Engine Throttle to idle position. See *Post Start-Up (Maximum throttle/Manual throttle Minimum idle/Stop)* section in this manual for instructions.

Recoil starting rope is accessible from non-operator side of the Vacuum Lifter (VL), on the back of the Engine.

Take the handle and pull the rope softly until it is extended to its full limit. Let the rope rewind completely. Start the Engine by pulling the rope strongly.



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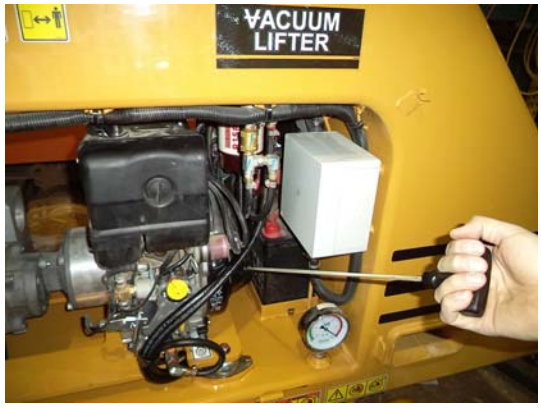

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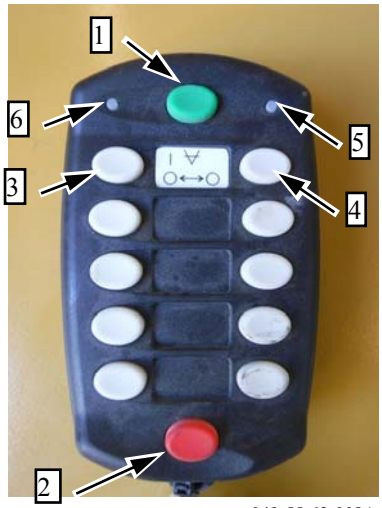
Wireless Remote Transmitter

The Wireless Remote Transmitter comes with strong magnets on its base allowing it to be mounted to any steel surface in the carrier vehicle. The Wireless Remote Transmitter also comes with a flexible lanyard that can be used to secure the control to the operator's wrist. Always position the Wireless Remote Transmitter so that it can be easily reached and operated at all times while working.



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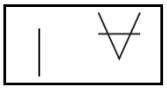
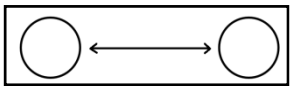
Notice

The Wireless Remote Transmitter must be connected to the Vacuum Lifter (VL) control system in order for the Wireless Remote Transmitter to operate the Vacuum Lifter (VL). See the *Wired Controller Removal (Wireless Remote Transmitter connected)* section below.

1. Wireless Remote Transmitter Power ON: Push Button (1)—GREEN. Turns the Wireless Remote Transmitter on. Pushing the green button does not affect the engine condition. (Note: The transmitter will shut itself off and the receiver will then shut off all outputs—the vacuum valve will hold—after 10 minutes of inactivity as a battery saving feature. Momentarily operating any button on the transmitter, including the green power button, will restart the 10-minute timer).
2. Wireless Remote Transmitter Power OFF: Push Button (2)—RED. Turns the Wireless Remote Transmitter off. Does not affect the engine condition.
3. Pick up/Support load—Vacuum ON: Push Button (3)  to engage the vacuum.
4. Release load—Vacuum OFF: Push Buttons (3) and (4) together  release the vacuum and the load.

Note: To prevent accidental dropping of the load, both buttons (3) and (4) must be pushed together at the same time.

5. Active LED (5): Shows that the remote is on and paired with the receiver. In the event of transmitter and receiver not being paired, refer to the TEST the Transmitter/Receiver Link instructions in the appendix.

6. Battery Low indicator (6): Replace Batteries, low batteries will last approximately 8 hours once the Low Battery light begins to flash.

Wireless Remote Receiver

Refer to Wireless Remote Transmitter/Receiver Operation and Troubleshooting in appendix for setup, diagnostic codes, and Troubleshooting, etc.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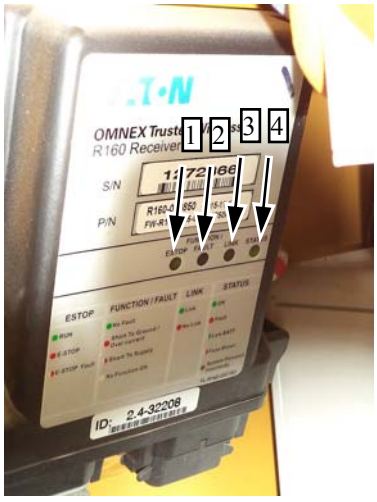

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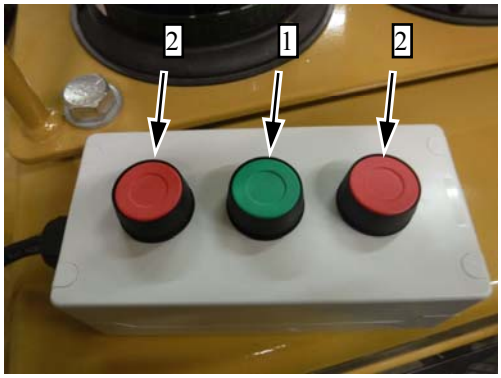
1 = ESTOP
2 = FAULT
3 = LINK
4 = STATUS

Notice

After installing the Wired Controller, always perform the "Operation Controls and Alarm System - Check" outlined in the *Maintenance* section of this manual.

Use the Wired Controller when the Wireless Remote system is not operational, or if job-site conditions do not permit the use of the Wireless Remote system. Refer to the *Wired Controller Installation (Wireless Remote Transmitter disconnected)* section in this manual for cable connection instructions. Once the Wired Controller is connected, there is no need to turn it on or off, this is done through the Battery Disconnect Switch described above. Always position the Wired Controller so that it can be easily reached and operated at all times while in use.



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Thoroughly Inspect the condition of the entire length of cable prior to use, at the beginning of each shift. DO NOT use the wired controller if the cable or insulation is damaged in any way. Replace any damage cable immediately, prior to use.
Ensure the armor guard is positioned correctly, to reduce chaffing of the cable-insulation.

Notice

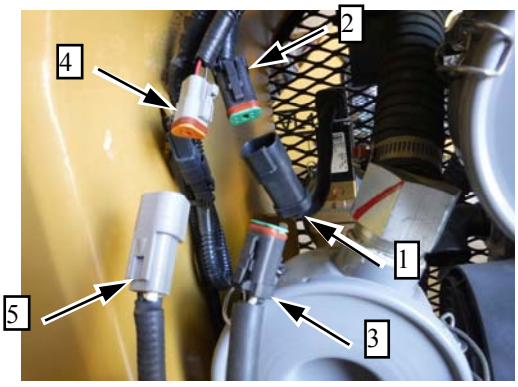
When the Wired Controller is connected to the Vacuum Lifter (VL) control system, the Wireless Remote Transmitter will no longer operate the Vacuum Lifter (VL).

1. Pick up/Support load—Vacuum ON: Push Button (1)—middle GREEN, to engage the vacuum.
2. Release load—Vacuum OFF: Push both Buttons (2) together —outer RED, release the vacuum and the load.

Note: To prevent accidental dropping of the load, both RED buttons (2) must be pushed together at the same time.

Wired Controller Installation (Wireless Remote Transmitter disconnected)

1. Turn the Battery Disconnect Switch key to the off **(O)** position, lockout if required, see the *Battery Disconnect Switch* section in this manual.



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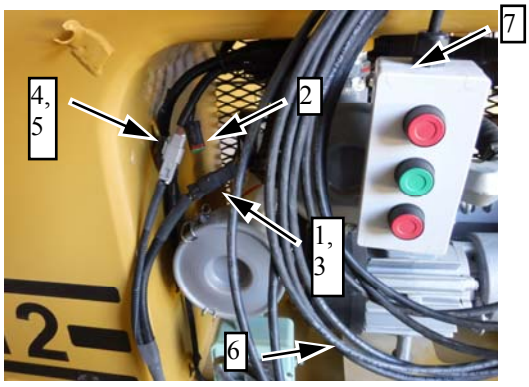

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2. Disconnect the Vacuum Valve Cable (1) and the Vacuum Valve Cable Harness (2).
3. Connect the Vacuum Valve Cable (1) and the Wired Controller Cable (3) together.
4. Remove the Plug Cap (not shown) from the Wired Controller Power Cable (4) and connect to the Wired Controller Cable (5).

5. Route the Wired Controller Cable (6) to operator's cabin along the carrier vehicle's boom, avoid routing the cable in areas that will severely damage the cable. Position the armor guard to protect cable against any pinch-point areas or rubbing areas so the cable does not get damaged or chaffed. Secure the cable in place along the boom, etc., using

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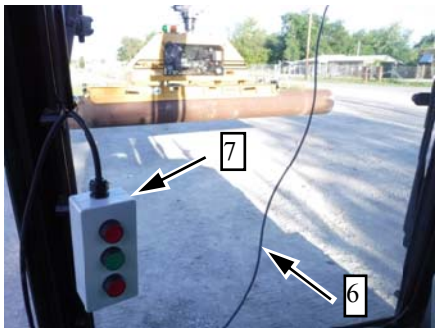

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nylon cable ties or similar.

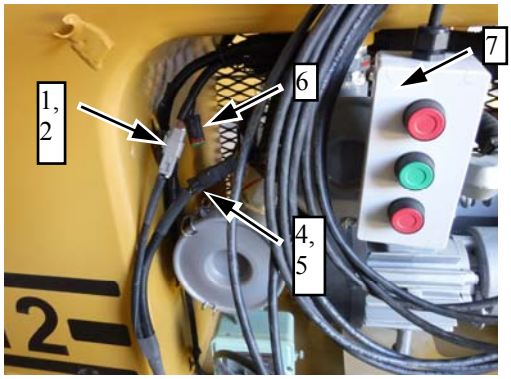
6. Secure the Wired Controller (7) in operator's cabin so that it is easily reachable. Make sure the Wired Controller Cable (6) will not get damaged during operation.
7. Turn Battery Disconnect Switch to on **(I)** position, see the *Battery Disconnect Switch* section in this manual.
8. The Wired Controller (7) is now ready to use, see the *Wired Controller* section in this manual for operating instructions.

Wired Controller Removal (Wireless Remote Transmitter connected)

Notice

After removing the Wired Controller (Wireless Remote connected), always perform the "Operation Controls and Alarm System - Check" outlined in the Maintenance section of this manual.

1. Turn the Battery Disconnect Switch key to the off **(O)** position, lockout if required, see the *Battery Disconnect Switch* section in this manual.



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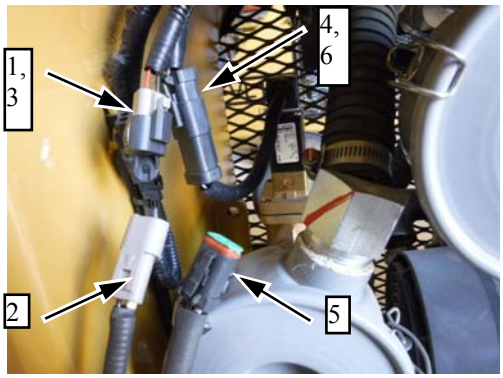

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2. Disconnect the Wired Controller Power Cable (1) from the Wired Controller Cable (2) and place the Plug Cap (3) on the Wired Controller Power Cable (1).
3. Disconnect the Vacuum Valve Cable (4) from the Wired Controller Cable (5).
4. Connect the Vacuum Valve Cable (4) to the Vacuum Valve Cable Harness (6).
5. The Wired Controller (7) is now fully disconnected, and the Wireless Remote Transmitter is now connected.
6. Thoroughly inspect the condition of the entire length of cable. Replace the cable if damaged in any way. Ensure the armor guard is intact on the cable, and is not damaged. Replace the armor guard if damaged or missing.
7. Turn Battery Disconnect Switch to on **(I)** position, see the *Battery Disconnect Switch* section in this manual.

8. The Wireless Remote Transmitter is now connected, see the *Wireless Remote Transmitter* section in this manual for operating instructions.

Yoke Rotator Speed Control Valves

Rotation speed of the Yoke Rotator should be slow enough to ensure safe operation of the VL Vacuum Lifter. The rotation speed of the Yoke Rotator is controlled by the flow coming from the carrier vehicle. This flow can be reduced by the flow control valves fitted to the yoke.

1. Two flow control valves (1), one for each direction of rotation, are used to control the Yoke Rotator speed.
2. Adjust both valves equally together.
3. Turn the valves clockwise in to reduce the flow/speed. Turn the valves counterclockwise out to increase the flow/speed.
4. Start with both valves turned all the way in for minimum rotation speed until enough experience with the equipment operation is achieved before increasing the flow/speed.
5. Environmental conditions, carrier vehicle hydraulic performance, the size and weight of the load, and jobsite layout conditions all have an impact of the rotation speed requirements. It is advisable to start at a low rotational speed, and gradually increase the speed setting only as experience and familiarity with all of these conditions is gained.

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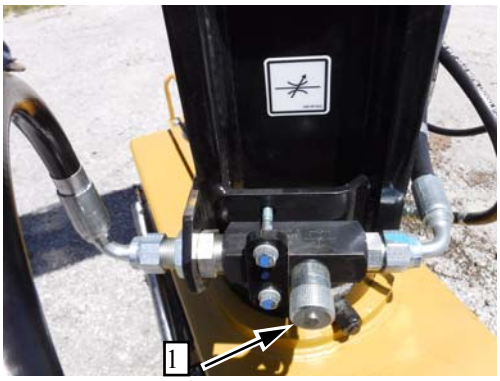

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Vacuum Indicators (Audible and Visual)

After starting the engine, if the vacuum level in the Vacuum Tank as indicated by the vacuum tank gauge is less than -15 inHg (-50.8 kPa), the audible alarm will sound and the Amber Vacuum Status Beacon will flash. Do not operate with inadequate vacuum. Do not lift a load when the vacuum is outside the operating range. Once the vacuum level increases above -18 inHg (-61 kPa), the audible alarm will stop and the Amber Vacuum Status Beacon will stop flashing and the Green Vacuum Status Beacon will flash. The vacuum level will continue to rise until it reaches the maximum obtainable level.

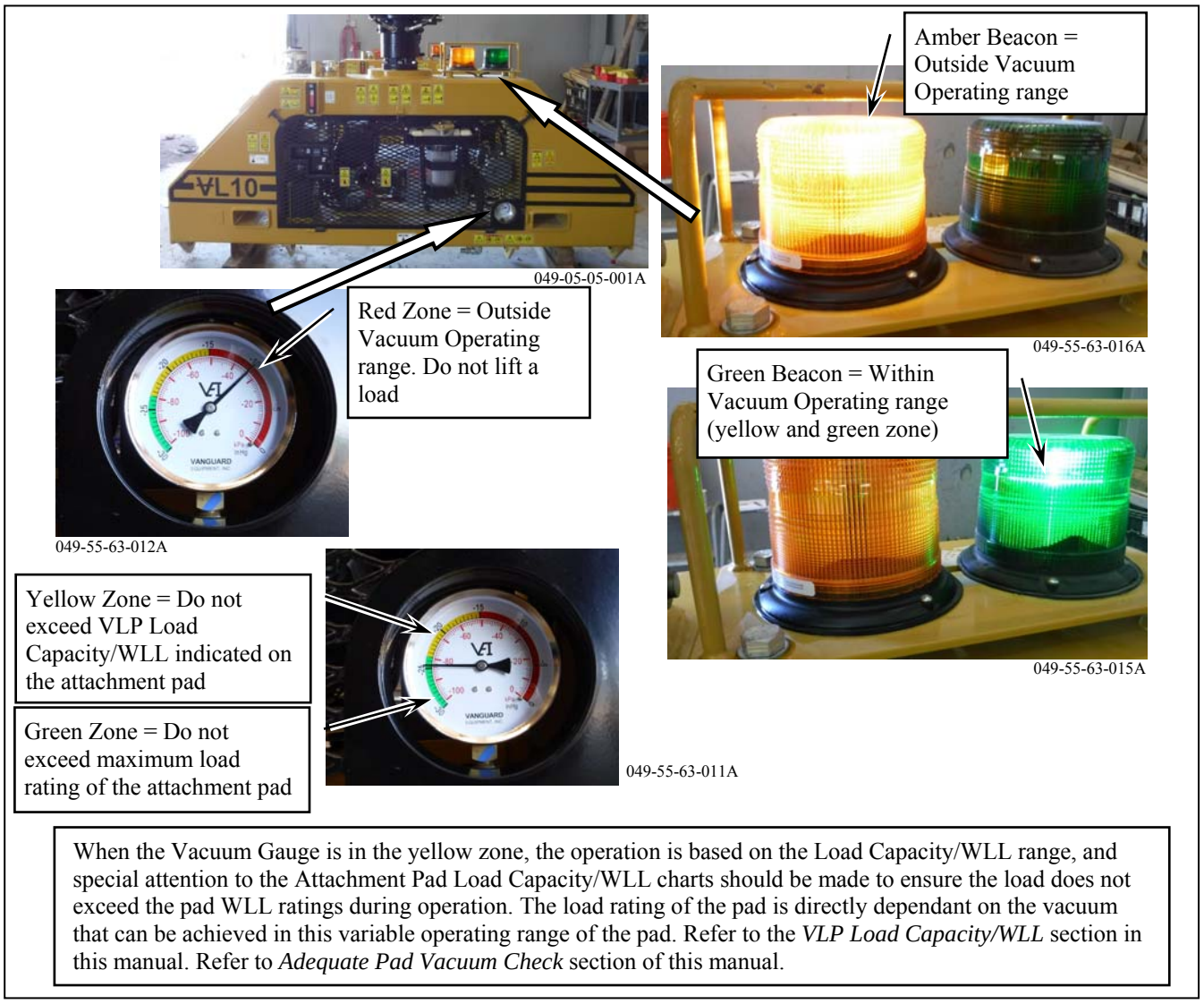

Figure 29: Vacuum Indicators (Visual)

Equipment attachment

Excavator attachment

Notice

Do not make any modifications to the Vacuum Lifter (VL), the Rotator Yoke, or any of the associated pins, adapters, spacers, or hardware, etc. This includes interchanging rotator assemblies. Contact your dealer or Vanguard Equipment for the correct, authorized, replacement parts.

1. Ensure that the excavator is capable of supporting the total weight of the load, including: the Vacuum Lifter (VL), the attachment pad, and the load to be lifted.
2. Ensure that the combined weight of the load—Vacuum Lifter Pipe (VLP) attachment AND the weight of the supported pipe-load to be lifted—does not exceed the VL Yoke-Pin Load Capacity/WLL.
3. Ensure that the Rotator Yoke is wide enough to accommodate the excavator stick width.
4. Ensure that the correct yoke connection pin (1), pin adapters (2), spacers (3), and retaining hardware (4) are available for proper fit up without excessive spacer free play; contact your dealer or Vanguard equipment for the correct components and quantities.
5. Ensure that the excavator hydraulic circuit used (either the bucket function, or the auxiliary function) is adjusted so that the pressure does not exceed 5000 psi (348 bar) maximum pressure setting, and the flow does not exceed 10 GPM (40 l/min). Refer to the excavator hydraulic adjustment instructions. **Note:** Significant damage can occur if the Rotator Yoke hydraulic system is connected to a hydraulic system that is above the maximum pressure setting.
6. Inspect the yoke connection pin (1) the yoke adapters (2), spacers (3), and retaining hardware (4) to ensure there is no damage or excessive wear.
7. Use the Vacuum Lifter (VL) Transport Tubes to move the lifter into place below the excavator; use forklift or slings of adequate capacity, refer to the Load handling and Shipping weight info. Use the Tank Stand Legs to support the lifter on a firm, stable surface.
8. With the excavator sick-arm (5) centered on the yoke, line up with pin-bores.
9. Attach the Rotator Yoke to the excavator, using the correct number of spacers to fill in the gap to leave at least a 3/8-inch (10 mm) gap, and no more than a 5/8-inch (16 mm) gap. Try to use the same number of spacers on each side of excavator stick, so it is centered in the yoke.
10. Use retaining hardware (4) to secure pin (1) in the yoke. Push pin through yoke bores, pin adapter bores (2) if present, and pin (1) bore. Each yoke requires retaining hardware on one end only. Tighten to 370 ±50 Nm (275 ±37 Lb-ft).
11. Grease the pin, refer to the maintenance section for details.

Notice

Take special precautions to avoid contaminating the hydraulic system. Ensure that all connection fittings and hose ends are clean and free of dirt, debris, and contamination before disconnecting or connecting the hydraulic hoses and fittings. Hydraulic contamination could severely damage the Rotator Yoke and/or the excavator system. DO NOT allow the hydraulic system to be contaminated. Refer to the carrier vehicle' operator and maintenance manual.

12. Connect the Rotator Yoke extension hoses (6) to the excavator hydraulic system (7) using either the bucket circuit or the auxiliary circuit. Hydraulic fitting adapters (7) may be required depending on the excavator.

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Use Transport Tubes for moving Vacuum Lifter into place

Use Tank Legs to support Vacuum Lifter on a stable surface

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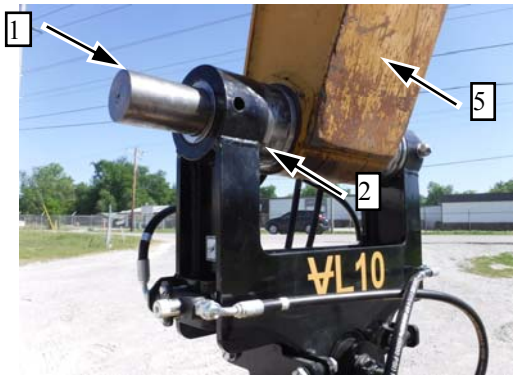

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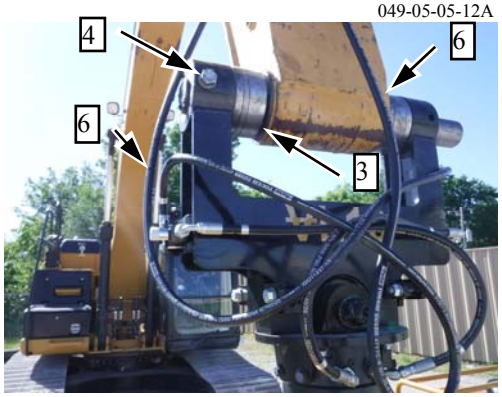

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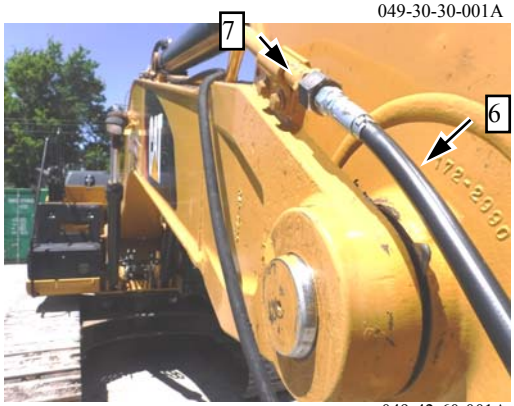

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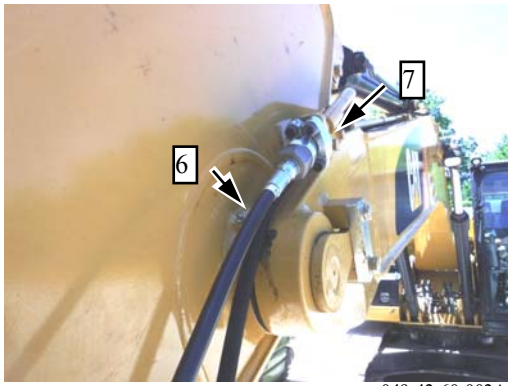

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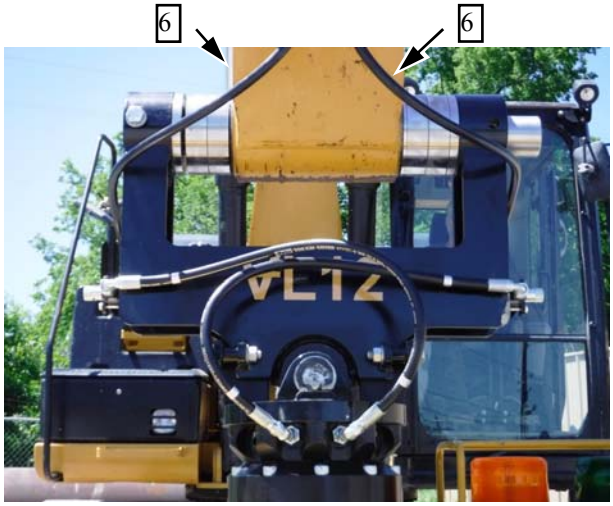
13. Coil the excess extension hoses (6) up on the excavator stick-arm and secure them so that they do not interfere with the rotation of the yoke or the movement of the excavator arms. The extension hoses (6) do not rotate with the yoke, so they do not need to be too long.



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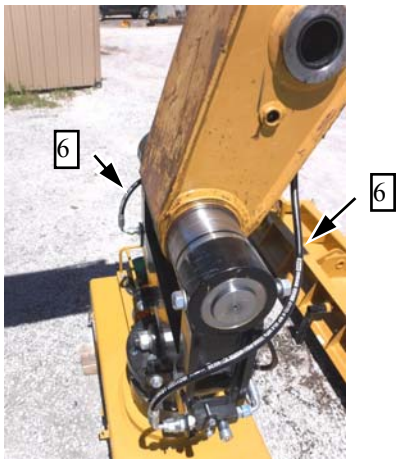

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14. Ensure the area is clear of personnel and obstacles. Slowly rotate the Vacuum Lifter (VL) completely around in one direction, then the opposite direction to ensure correct rotation direction with the carrier's controls. If the rotation is not correct, swap the connections of the extension hoses (6) at the yoke to reverse the control direction.
15. Slowly rotate the Vacuum Lifter (VL) completely around in one direction for several rotations, then reverse the direction and slowly rotate it in the other direction for several rotations. Repeat this as necessary to bleed any air out of the system until smooth operation is achieved.
16. Adjust the rotation speed of the Rotator Yoke, see the *Yoke Rotator Speed Control Valves* section.

Vacuum Lifter Pipe (VLP) - Connection to Vacuum Lifter (VL)

Always ensure the correct Vacuum Lifter Pipe (VLP) attachment size is used for the pipe being lifted. The Vacuum Lifter Pipe (VLP) attachment size designation identifies nominal pipe diameter that can be lifted.
See the "Vacuum Lifter Pipe (VLP) attachment size designation" in the *Equipment Information Section*, and the "VLP Load Capacity/WLL" in the *Load Capacity/WLL* section of this manual.

Vacuum Lifter Pipe (VLP) attachment size designation. Identifies nominal pipe diameter that can be lifted.

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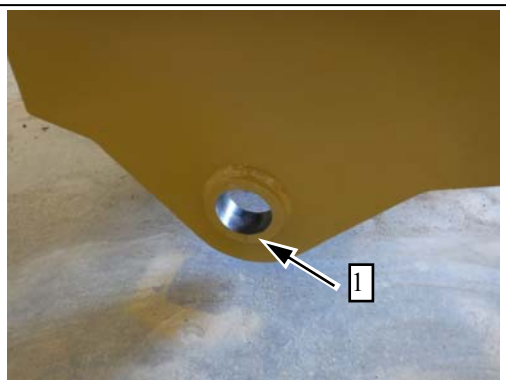

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Inspect the Vacuum Pad Attachment Lugs (1) on the Vacuum Lifter (VL) to ensure they are not overly worn or out of round.

Use pad Transport Tubes to move attachment pads into place below the Vacuum Lifter (VL); use forklift or slings of adequate capacity, refer to the Load handling and Shipping weight info. Use the Pad Stand Legs to support the attachment pad on a firm, stable surface.

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Using the carrier vehicle's controls, lower the Vacuum Lifter (VL) towards the attachment pad, leaving enough room to be able to access the vacuum-hose connection-fittings. Ensure the Vacuum Lifter (VL) and the Vacuum Lifter Pipe (VLP)

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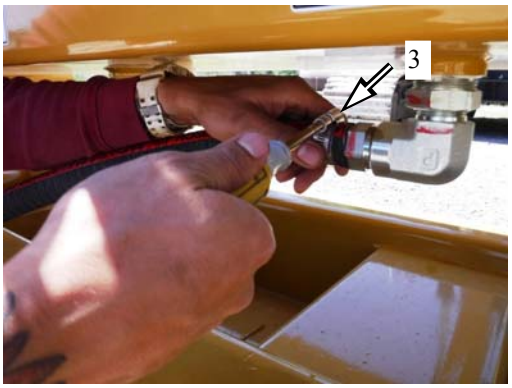

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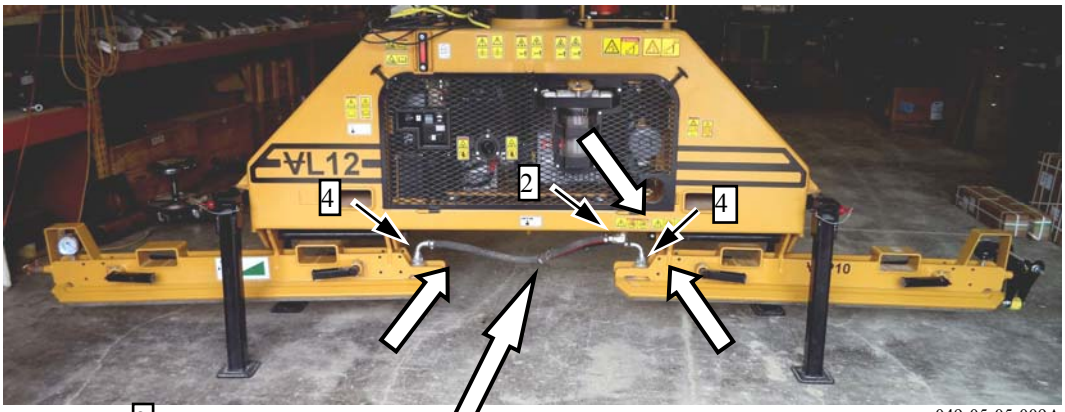
attachment pads are adequately supported and braced so that they will not move or shift position while being worked on.

Connect the vacuum hose assembly to the Vacuum Lifter (VL) vacuum-fitting (2), the hose should already be connected to the Vacuum Lifter Pipe (VLP) attachment pad vacuum-fitting (4), use a small amount of spray-lube to assist sliding the hose over the barbed connection if necessary. Ensure both hose ends fully engage the complete length of the hose-barb fitting. Ensure both ends are secured, tighten each end of the hose-connections securely with the worm-clamps (3).

Note: The pair pads have one hose-connection connection at the Vacuum Lifter (VL) (2) and two hose-connections at the pads (4). The pair pad hose assembly has a Tee-connection with three worm clamps (3), ensure that these are also tight.

Pair Pad vacuum hose connections



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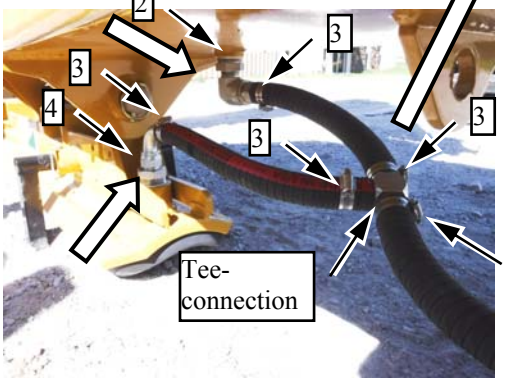

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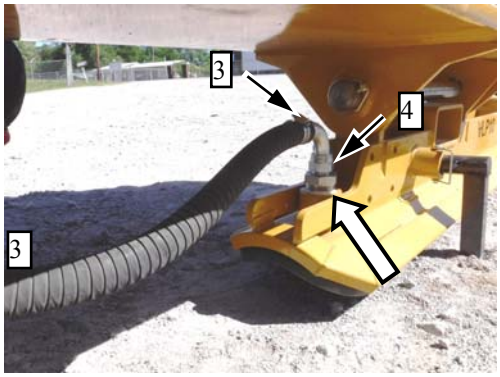

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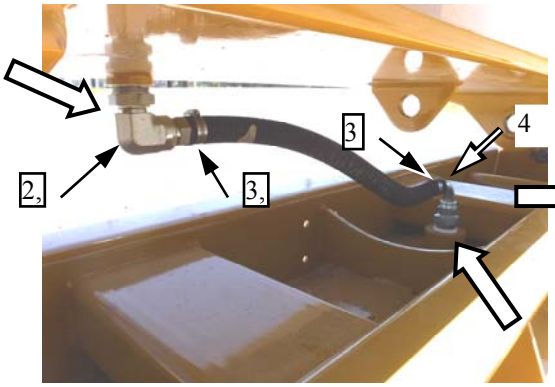
Single Pad vacuum hose connections



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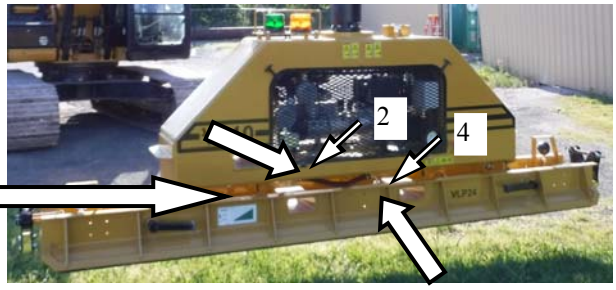

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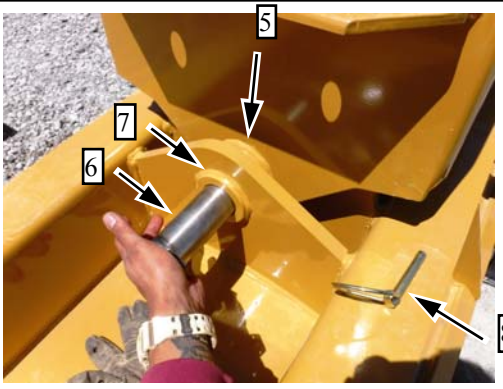
Note: The single pads have one hose-connection at the Vacuum Lifter (VL) (2), and one connection at the pad (4).

Line up the Vacuum Lifter (VL) pin bores (5) with the bores in the Attachment Lugs. Insert the Vacuum Pad Attachment Pin (6) through each of the attachment lugs (7). Secure the Vacuum Pad Attachment Pins with the linch pin (8)**.**



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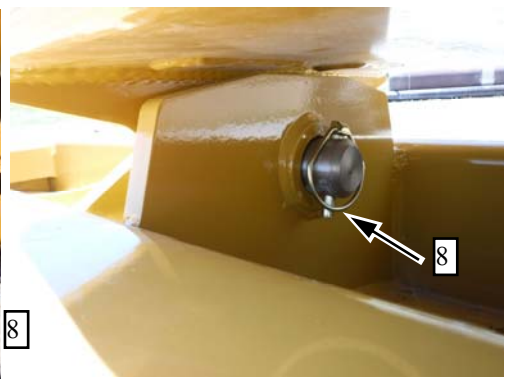

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Note: There are a minimum of two attachment lugs (3) per each attachment pad, always use all available attachment lugs (3) to secure the pad to the Vacuum Lifter.

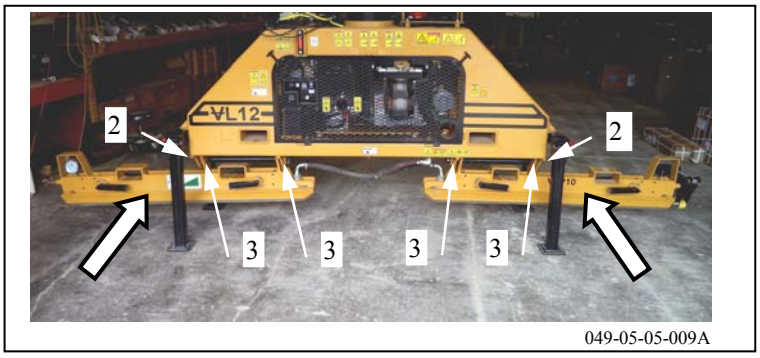


Figure 30: Pair Pads VLP Attached to Vacuum Lifter VL (Always use two)

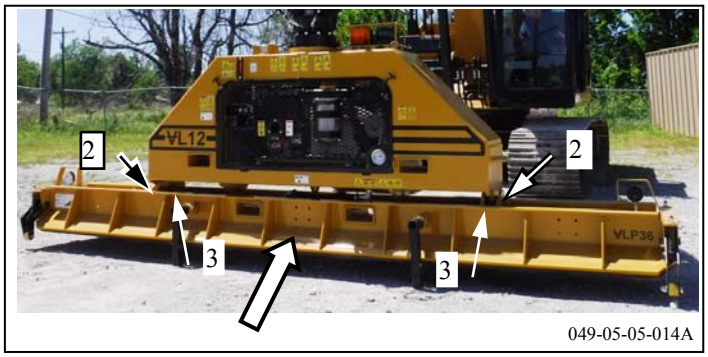


Figure 31: Single Pad VLP Attached to Vacuum Lifter VL (use just one on each end)

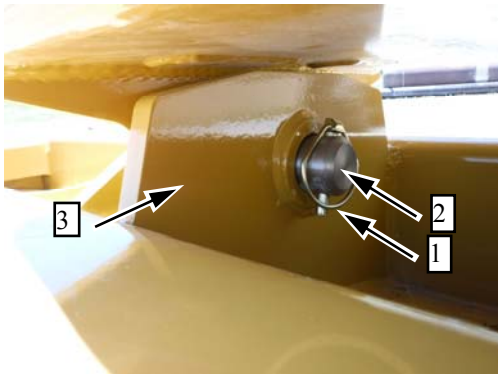
Note: Always use Pair Pads in groups of two with the Vacuum Lifter centered between the two Pair Pads; never use just one Pair Pad to lift a load.

Vacuum Lifter Pipe (VLP) - Removal from Vacuum Lifter (VL)

Use the Pad Stand Legs to support the Vacuum Lifter Pipe (VLP) attachment pad on a firm, stable surface. Ensure the Vacuum Lifter Pipe (VLP) attachment pads are adequately supported and braced so that they will not move or shift position while being worked on.

Lower the Vacuum Lifter (VL) so that the VLP pad is supported by the stable surface and the attachment pins do not carry any of the weight and are free to rotate. Ensure the Vacuum Lifter (VL) is adequately supported and braced so that they will not move or shift position while the attachment pad is being removed.

Remove the linch pin (1) from the Vacuum Pad Attachment Pin (2). Remove the Vacuum Pad Attachment Pin (2) from the attachment lugs (3). Remove the remaining Vacuum Pad Attachment Pins (2). Once all of the Vacuum Pad Attachment Pins have been removed, slowly raise the Vacuum Lifter (VL) slightly to gain access to the vacuum hose connections (3) if required. Remember, the vacuum hoses are still connected so do not raise the unit too much or damage to the hoses could result.



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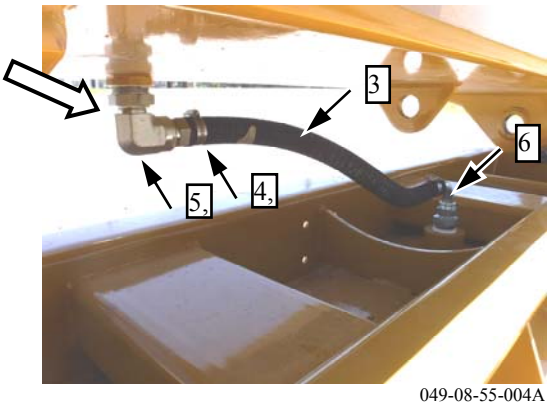
Loosen the vacuum hose assembly worm-clamp (4) at the Vacuum Lifter (VL) fitting (5). Only remove the vacuum hose (3) from the Vacuum Lifter (VL) (5), keep the hose secured to the Vacuum Lifter Pipe (VLP) attachment pad(s) (6). Once the hose assembly is removed from the Vacuum Lifter (VL) (5), retighten the worm-clamp (4) to secure it back to the hose assembly (3) so it does not get lost.

Single Pad vacuum hose connections



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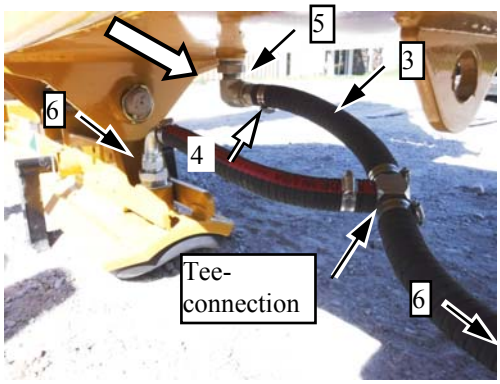
Pair Pad vacuum hose connections



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Note: Single pads have on one hose connection to the Vacuum Lifter (VL) and one connection to the attachment pad, it is recommended to keep the hoses connected to the pad. **Note:** Pair pads have one connection to the Vacuum Lifter (VL), and the two pads are connected to each other, it is recommended to keep the pair pads connected to each other at the job site.

Cover the exposed hose connections to prevent foreign objects, debris, or wildlife, etc., from getting into the vacuum hoses.

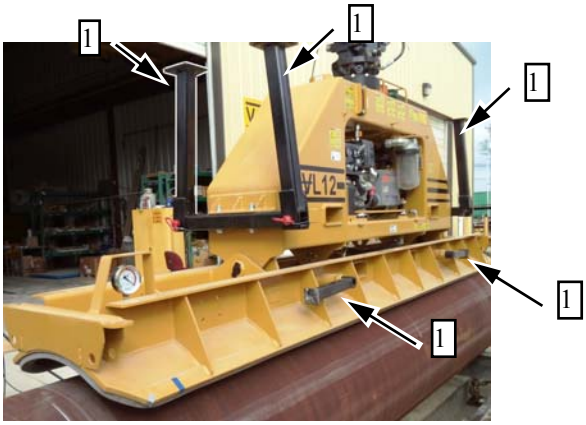
Move the Vacuum lifter out of the way, and insert the Vacuum Pad Attachment Pins (2) back into the Vacuum Lifter Pipe (VLP) attachment pad(s); keep the pins with the pads. Insert the linch pin (1) into each of the Vacuum Pad Attachment Pins (2) to secure the Vacuum Pad Attachment Pins back to the pads. The Vacuum Lifter (VL) can now be attached to another pad. If the VL unit is not going to be connected to another attachment pad, cover the exposed fitting to prevent foreign objects, debris, or wildlife, etc., from getting into the vacuum tank.

Vacuum Lifter Operation

Ensure you are familiar with the operation of the carrier vehicle and its controls.

Start the Vacuum Lifter (VL) engine, and ensure that the vacuum system is functioning, it may be necessary to prime the Vacuum Valve, see the section below. Refer to Vacuum Pump Routine Maintenance and Troubleshooting in appendix if the vacuum is not being created.

Raise the Vacuum Lifter (VL), and ensure that all of the Tank Legs on the VL and the pad stand legs are raised to the stowed position (1). Each VL has four legs, and each pad has four legs.



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Operate the Rotator Yoke, if fitted, to ensure the correct rotation direction with the carrier vehicle's controls. Correct if necessary. Refer to the *Excavator attachment* above to reverse the direction if it is not correct.

Prime Vacuum Valve

It may be necessary to prime the vacuum valve after starting the engine. Place the pad-attachment onto the load, see the *Working with a Load* section of this manual. DO NOT lift the load. If a load is not available, use a piece of cardboard or a clean rag to block the suction hole in the pad. Ensure that the cardboard or rag is large enough so that it will not be sucked up into the hosing, always hold onto the cardboard or rag. Switch on the vacuum valve to prime the vacuum valve. Once the vacuum level increase above approximately -10 inHg (-34 kPa), switch off the vacuum valve by turning the controller to "release load" to remove the vacuum from the pad. If used, remove the rag or cardboard from the pad. Once the vacuum level in the tank reaches -18 inHg (-61 kPa), the audible alarm will stop and the Amber Vacuum Status Beacon will stop flashing while the Green Vacuum Status Beacon will flash. The vacuum level will continue to rise until it reaches to the maximum obtainable level.

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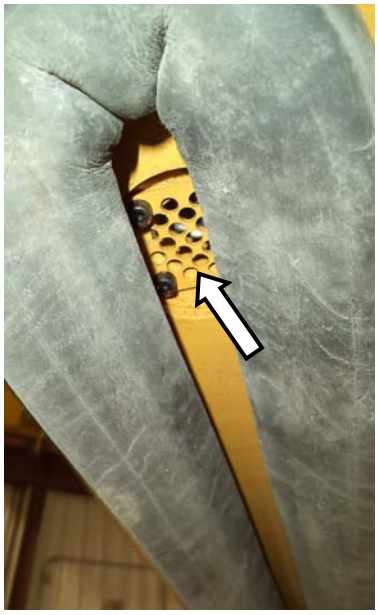

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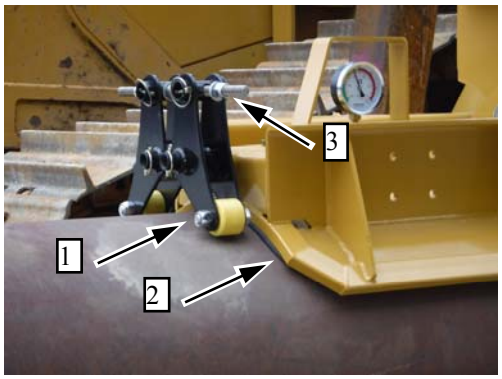
Guide Wheel Adjustment Check

Ensure correct operation of the guide wheels (1). Slowly position the VLP pad over the pipe and slowly lower down onto the pipe. Ensure that the guide wheels (1) contact the pipe before the pad seal (2), and that they begin to open and align the VLP pad with the pipe. If they do not properly align the pad, adjust the guide wheels opening width accordingly with the



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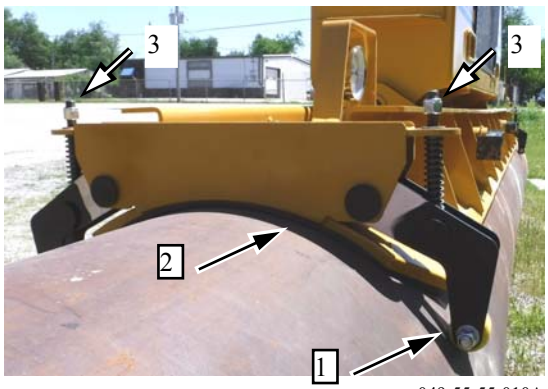

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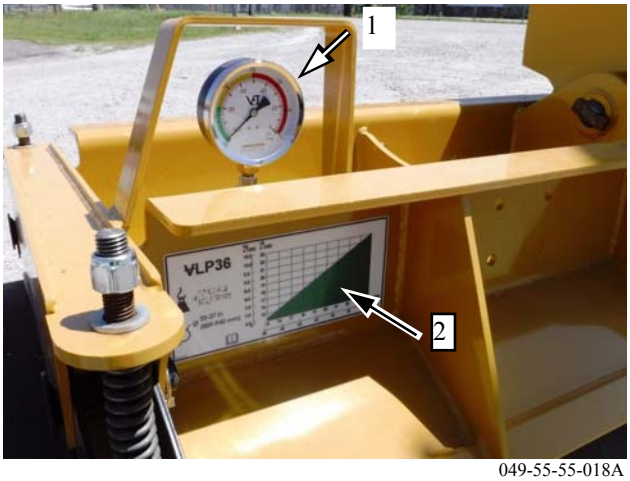
adjustment screw (3).

Adequate Level Vacuum Check

DO NOT lift a load. Conduct a test on a pipe to ensure and confirm that the adequate vacuum level can be achieved prior to beginning work. With the pad lowered onto the pipe, engage the vacuum. Observe the vacuum gauge on the pad (1) to determine the maximum vacuum that can be developed at the pad. This is the vacuum value that must be used to determine the maximum working load limit (WLL) (2) that can be safely lifted and supported by the pad. See the *Load Capacity/WLL* section in this manual. The vacuum level at the pad should equalize to be the same as the vacuum level in the Vacuum Lifter (VL) (3). If vacuum levels are not equal, this could be due to leaks. Check for leaks, including the pad seal. Never attempt to lift a load that requires a higher vacuum level than can be achieved at the pad. When the Vacuum Gauge (1) indicates a vacuum level in the yellow zone, do not exceed the loading shown by the graph-line load, refer to the VLP Load Capacity/WLL section in this manual.



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Working with a Load

Always keep the area clear of people. Never lift a load when someone is in the work area. Never lift a load over people.

Slowly lower the pad onto the load, this will allow the guide wheels to work properly to help align the pad with the pipe. Always place the Vacuum Lifter and the pad or pads on the pipe so it is balanced and centered on the load, mark the center of the pipe to help.

The vacuum level may drop when connecting the pad to the load, it may be necessary to wait a few moments for the vacuum level to rise back to the adequate level to pick up the load. Always ensure that the adequate vacuum is achieved at the pad to lift the load before picking the load up from the supporting surface. Refer to the *Vacuum Indicators (Audible and Visual)* section of this manual.

Always lift, rotate and move the load slowly. Slower operation will reduce the chance of the seal coming out of the pad, and decrease the possibility of leaks, and increase productivity.

It is better to operate Vacuum Lifter with Engine Operator Controls facing the operator, this ensures that all information such as fuel level, etc., is clearly visible at all times.

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049-05-05-031A

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Always keep the load as low as possible, never lift it higher than required to carry out the job. Always keep the load low when traveling with a load.

Be aware of overhead power lines, always keep a lookout for overhead power lines. Be aware of obstacles, keep a lookout for obstacles, especially when rotating the load or travelling with a load.

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049-05-05-030A

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Always lower the load all the way down to the supporting surface or truck, etc. Never release the vacuum before the load is all the way down. Do not drop the load from a height.

Always allow enough time for the vacuum to switch off at the pad to fully release the load, use the pad-gauge to determine when the vacuum is gone at the pad. Several seconds may be required to remove the vacuum depending on the size of the attachment pad.

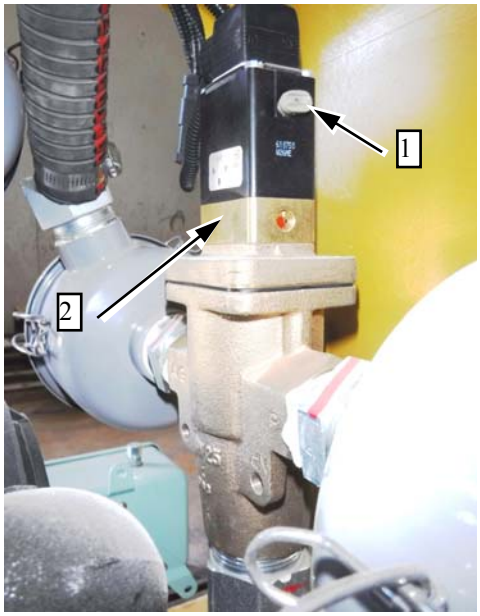
Draining the Vacuum Lifter (VL) tank

At the end of each workday, ensure the vacuum from the tank is removed (drained).

1. With the attachment pad not supporting, and clear of any load, ensure that the Vacuum Lifter (VL) Engine Stop/Run/Start Switch is at RUN. **Note:** it is not necessary for the engine to be running at this stage.
2. Operate the controller to "Pick up/Support load".
3. The sound of the tank draining will be heard at the beginning, but will become more quiet as the vacuum drains out of the tank.
4. Turn of the Stop/Run/Start Switch to STOP, and turn the Battery Disconnect to off. The tank will continue to drain until the entire vacuum is gone.
5. Once the vacuum is completely drained, the tank gauges should both be showing 0 inHg (0 kPa). Replace any gauge that is not showing 0 inHg (0 kPa).

Manual Load Release

If the Wireless Remote Transmitter/Receiver or the Wired Controller becomes unusable, the load can be released with Manual Valve Actuator (1). The Manual Valve Actuator is not intended to be used for regular operation - it should be used when the other controllers do not respond, and only when the load is safely supported on the ground. Nver use the Manual Valve Actuator to release a suspended load.



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⚠ WARNING

Operationg the Manual Valve Actuator will release the load immediately. Always use extreme caution when operting, make sure that load is fully supported on the ground, is braced and supported against rolling.

Manual Valve Actuator (1) is located on the Vacuum Valve Pilot (2), on operator side of the Vacuum Lifter (VL).

To operate Manual Valve Actuator (1) press Actuator knob (1) and turn 90 degrees clockwise. Actuator knob will lock in vertical position.

When Manual Valve Actuator knob is locked in vertical position, the valve can no longer be actuacted electronically. Push and turn Manual vavle Actuator knob 90 degrees counterclockwise to unlock it. Actuator Vavle knob will lock in horizontal position, and electrical operation is restored. Determine the cause of the Wireless Remote Transmitter/Receiver or the Wired Controller inoperation before using the Vacuum Lifter.

Machine Parking

Always place the pad firmly on a pipe (1), or the tank legs (2) to support the Vacuum Lifter (VL) and excavator sick-boom. DO NOT use the pad legs (3). Ensure the unit is resting on a hard, stable surface capable of supporting the weight. When storing the unit on a pipe (1), tilt the unit slightly away from the excavator to stop the unit from falling if the hydraulics bleed off due to internal leaks in the excavator system.

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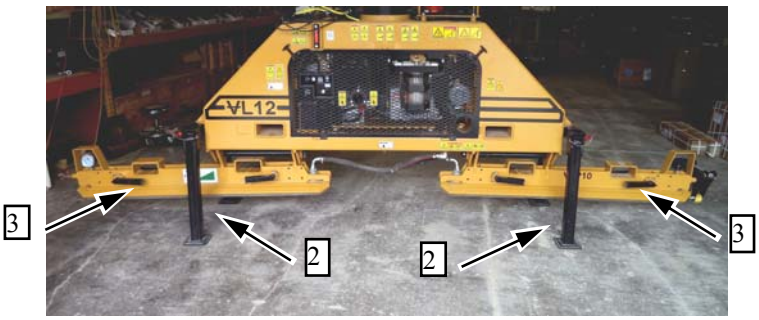

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Drain the vacuum as per the steps in *Draining the Vacuum Lifter (VL) tank*.

Turn the Vacuum Lifter (VL) wireless remote off (if in use), STOP the Vacuum Lifter (VL) engine and turn the Battery Disconnect to OFF. Refer to the *Operator Controls* section of this manual.

Make sure all guards are in place, and locked if required.

Refer to the host-carrier vehicle's Operation and Maintenance Manual for specific machine parking instructions. Follow the host-carrier vehicle's parking instructions.

Transportation Information

1. Transport the Vacuum Lifter (VL) without any attachment-pads—Vacuum Lifter Pipe (VLP), etc.—connected.
2. Secure the attachment pins to the attachment-pads, not to the Vacuum Lifter (VL).
3. Ensure all open fittings and hose-ends are covered and blocked off.

Obey all jurisdictional transportation laws that apply. Refer to the *Vacuum Lifter (VL) Weight* and to the *Pad Weight - Load handling and Shipping Weight* section of this manual for weight and dimension considerations.

Maintenance and Lubrication Section

Unless otherwise instructed, all maintenance work must be performed with the Vacuum Lifter (VL) engine switched off and with the Battery Disconnect turned to the OFF position. Refer to the *Operator Controls* section of this manual. Make sure the Vacuum Lifter is properly parked, see section *Machine Parking* in this manual. If using host-carrier vehicle, it must be turned off and parked properly, refer to the hoisting/host-carrier-vehicle's Operation and Maintenance Manual.

Lubricant Viscosities

General

- Follow Host-carrier-vehicle manufacture's maintenance and lubrication instructions for vehicle service as required.
- To prevent corrosion damage to the slewing drive interior, if not used regularly, rotate the slewing canopy between its limits of travel several times at least once a month.

Selecting the Viscosity

The proper lubricant viscosity grade is determined by the minimum outside temperature. This is the temperature when the machine is started and when the machine is operated. In order to determine the proper lubricant viscosity grade, refer to the "Min" column in the table. This information reflects the coldest ambient temperature condition for starting a cold machine and for operating a cold machine. Refer to the "Max" column in the table in order to select the oil viscosity grade for operating the machine at the highest temperature that is anticipated.

Lubricant Viscosities for Ambient Temperatures

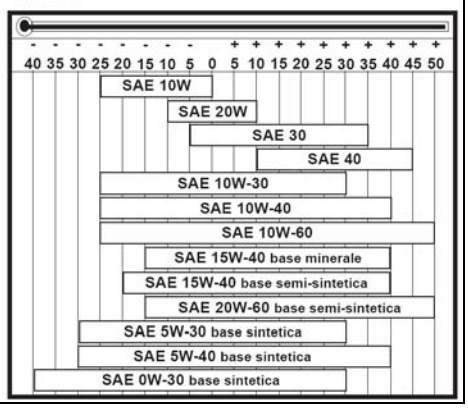
Lubricant Viscosities for Ambient Temperatures						
Compartment or System	**Oil Type and Classification**	**Oil Viscosities**	**°C**		**°F**	
			Min	**Max**	**Min**	**Max**
Grease Spec	**Mobil Mobilux EP 2**		-40	50	-40	122
	Caterpillar Ultra 5Molly NGLI #0		-40	35	-40	95
	Caterpillar Ultra 5Molly NGLI #1		-35	40	-31	104
	Caterpillar Ultra 5Molly NGLI #2		-30	50	-22	122
	Caterpillar Arctic Platinum NGLI #0		-40	20	-40	68
Vacuum Pump System	**SEE BELOW: VACUUM PUMP OIL FOR LOW TEMPERATURE**					
Hydraulic System	**Follow Host-carrier-vehicle's Requirements**					
Gearbox	**Mobil SHC634 Synthetic**		-34	107	-30	225
Engine System	**API CF-4/SG ACEA E2,B2 MIL-L46152 D/E**		GRADE 			
	API SJ/CF					
	MIL-L-46152 D/E					

Table 2: Lubricant viscosities for ambient temperature

Capacities (Refill)

Compartment or System		
Fuel Tank	4.75 gal	18 l
Engine oil	1.3 quarts	1.2 l
Vacuum pump oil	1.06 quarts	1.0 l
Gearbox oil	0.344 quart	0.325 l

Table 3: Fluid refill capacities

VACUUM PUMP OIL FOR LOW TEMPERATURE:
R580, temperatures +5°C to +12°C (41°F to 54°F)
R530 +12°C to +32°C (90°F to 104°F)
R570 +32°C to + 40°C (90°F to 104°F)
R590 +32°C to +40°C (90°F to 104°F)
30w non-detergent -7C 38C (20F TO 100F)

Maintenance Interval Schedule (MIS)

Ensure that all safety information, warnings, and instructions are read and understood before any operation or any maintenance procedures are performed. The user is responsible for the performance of maintenance, including all adjustments, the use of proper lubricants, fluids, filters, and the replacement of components due to normal wear and aging. Failure to adhere to proper maintenance intervals and procedures may result in diminished performance of the product and/or accelerated wear of components. Use service hours, or calendar time, WHICHEVER OCCURS FIRST, in order to determine the maintenance intervals. Products that operate in severe operating conditions may require more frequent maintenance.

Service Intervals

Note: Before each consecutive interval is performed, all maintenance from the previous interval must be performed. Perform the following servicing at EVERY interval they occur; for example, the 10 hour and 50 hour service are also performed at the 200 hour interval, etc.

Every 10 Service Hours or Daily

- Diesel Fuel Filter - Check
- Vacuum Engine Fuel Level - Check
- Vacuum Engine Oil - Check
- Vacuum Engine Air Cleaner - Check
- Vacuum Pump Oil - Check
- Vacuum Filters - Check
- Yoke Pin - Lubricate
- Guide Wheels - Check
- Operation Controls and Alarm System - Check
- Host-carrier-vehicle Hydraulic System Oil Level – Check
- Hydraulic Hoses and fittings for leaks – Check
- Vacuum Hoses and fittings for leaks – Check
- Electrical cables for signs of damage to insulation - Check, replace if damaged
- Lift Test - Perform
- Yoke Bumpers - Check

Every 25 Service Hours or Bi-Weekly

- Rotator Hydraulic Drive (VL10): check for external cracks, wear, corrosion and functional safety. Screw connections: check, tighten if necessary. Pinned joints and safety parts: check, tighten or replace if necessary.

Initial 50 Service Hours

- Vacuum Engine Oil - Change
- Vacuum Engine Oil Filter - Replace (new added)

Every 50 Service Hours or 1 Week

- Vacuum Pump for oil leaks - Check
- Rotator Hydraulic Drive (VL12, VL16) screw connections - Check, tighten if necessary.

Every 150 Service Hours or 1 Month

- Vacuum Engine Oil - Change
- Vacuum Engine Oil Filter - Replace
- Vacuum Pump Exhaust Filter - Check

Every 6 Months

- Vacuum Pump - Clean housing, fans, ventilation grills and cooling fins. Refer to Vacuum Pump Routine Maintenance and Troubleshooting in the appendix
- Pinned Joints - Check, replace or repair if necessary

Every 500 Service Hours

- Diesel Fuel Filter - Replace
- Vacuum Engine Fuel Filter - Replace
- Vacuum Engine Cooling Fins - Clean
- Vacuum Pump Oil and Oil Filter - Change
- Vacuum Pump Float Valve - Check
- Rotator Hydraulic Drive (VL10) - Inspect according to regional safety and health regulations.

Every 1000 Service Hours or 1 Year

- Vacuum Pump Exhaust Filter - Replace. Refer to Vacuum Pump Routine Maintenance and Troubleshooting in the appendix
- Vacuum Pump Inlet Screen - Check, clean if necessary. Refer to Vacuum Pump Routine Maintenance and Troubleshooting in the appendix
- Rotator Hydraulic Drive (VL10) Seals - Replace.
- Rotator Hydraulic Drive (VL12, VL16) check for: cracks, wear, corrosion and functional safety BGR 500 / part 1, chapter 2.8, section 3.15.2.
- Rotator Hydraulic Drive mounting screw connections - Check, tighten if necessary

Initial 1500 Service Hours

- Gearbox Oil - Change

Every 5000 Service Hours

- Gearbox Oil - Change

Diesel Fuel Filter - Check

Before working with Diesel Fuel Filter STOP the Vacuum Lifter (VL) engine and turn the Battery Disconnect to OFF. Refer to the *Operator Controls* section of this manual.

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1. Locate Fuel Filter (1) inside Vacuum Lifter (VL) on non-operator side between Diesel Engine and Vacuum Pump.

2. Check Fuel Filter (1) for water inside. Water is heavier than diesel fuel and will settle to the bottom of the Bowl (2) and appear different in color. The Fuel Filter Bowl (2) must be drained before contaminants reach the bottom of the white Filter Element (3).

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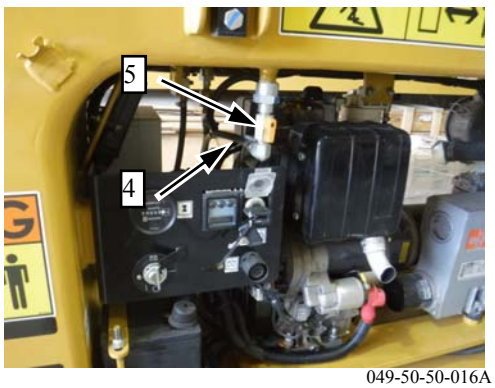
3. If contaminants are below the bottom of the Filter Element (3), Fuel Filter does not have to be drained, otherwise continue to next steps.
4. Shut off fuel Supply Line (4) with hand operated Valve (5). Yellow lever must be positioned horizontally.



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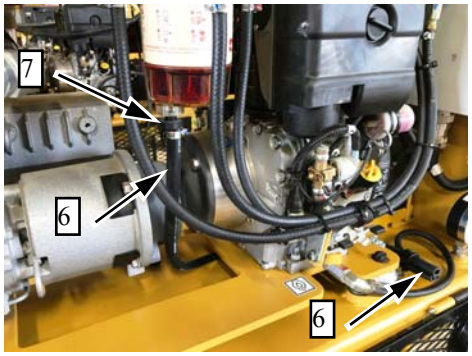
5. Prepare container for diesel fuel and separate Fuel Filter Drain Hose (6) from other hoses on non-operator side of Vacuum Lifter. Make sure Fuel Filter Drain Hose (6) can freely rotate and the end of hose is in container for diesel fuel. Prepare clean rug, small amount of fuel may leak during draining Fuel Filter. Note: drain screw is self venting so fuel will start flowing immediately.



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6. Quickly fully unscrew black Drain Screw (7) in the bottom of the Bowl (2), do not stop half way! Be prepared for small amount of fuel that may leak during opening Drain Screw (7).
7. Drain Fuel Filter (1) until all water is gone from the Bowl (2). Fully close black Drain Screw (7).
8. Loosen Vent Plug (8) on top of the Fuel Filter and slowly open hand operated Valve (5) on the Fuel Supply Line (4). Diesel fuel will start flowing inside the Fuel Filter. Completely fill Fuel Filter with diesel, some fuel may spill through Vent Plug (8).

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9. Close hand operated Valve (5) on fuel Supply Line (4) and close Vent Plug (8). Ensure Fuel Filter is topped with diesel.
10. Fully open hand operated Valve (5) on the Supply Line (4), Turn the Battery Disconnect to ON, start the engine and check for leaks. Correct as necessary with the Engine and Battery Disconnect OFF.

Diesel Fuel Filter - Replace

Before working with Diesel Fuel Filter STOP the Vacuum Lifter (VL) engine and turn the Battery Disconnect to OFF. Refer to the *Operator Controls* section of this manual.

049-05-05-014A

1. Locate Fuel Filter (1) inside Vacuum Lifter (VL) on non-operator side between Diesel Engine and Vacuum Pump.

2. Check Fuel Filter (1) for water inside. Water is heavier than diesel fuel and will settle to the bottom of the Bowl (2) and appear different in color. The Fuel Filter Bowl (2) must be drained before contaminants reach the bottom of the

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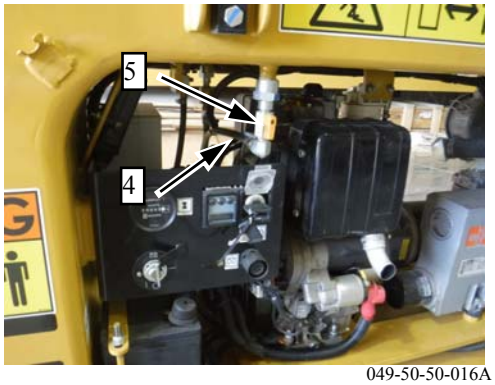
white Filter Element (3).

3. If contaminants are below the bottom of the Filter Element (3), Fuel Filter does not have to be drained, otherwise continue to next steps.
4. Shut off fuel Supply Line (4) with hand operated Valve (5). Yellow lever must be positioned horizontally.



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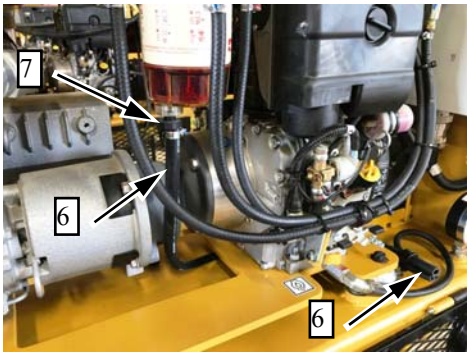
5. Prepare container for diesel fuel and separate Fuel Filter Drain Hose (6) from other hoses on non-operator side of Vacuum Lifter. Make sure Fuel Filter Drain Hose (6) can freely rotate and the end of hose is in container for diesel fuel. Prepare clean rug, small amount of fuel may leak during draining Fuel Filter. Note: drain screw is self venting so fuel will start flowing immediately.



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6. Quickly fully unscrew black Drain Screw (7) in the bottom of the Bowl (2), do not stop half way! Be prepared for small amount of fuel that may leak during opening Drain Screw (7).
7. Drain Fuel Filter (1) until all water and diesel are gone from the Bowl (2). Fully close black Drain Screw (7).
8. Unscrew the Element (3) and Bowl (2) off together from Fuel Filter housing.
9. Remove the Bowl (2) from Element (3) and clean the O-ring gland.
10. Retain Bowl (2) and replace Element (3) with a new one.
11. Ensure all seals are not damaged, replace if necessary. Apply a coating of clean fuel or motor oil to the Bowl O-ring and new O-ring of Element.
12. Spin the Bowl onto new Element snugly by hand only and then spin them both onto the filter head snugly by hand only. Do not use tools.
13. Loosen Vent Plug (8) on top of the Fuel Filter and slowly open hand operated Valve (5) on the Fuel Supply Line (4). Diesel fuel will start flowing inside the Fuel Filter. Completely fill Fuel Filter with diesel, some fuel may spill

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through Vent Plug (8).

14. Close hand operated Valve (5) on fuel Supply Line (4) and close Vent Plug (8). Ensure Fuel Filter is topped with diesel.
15. Fully open hand operated Valve (5) on the Supply Line (4), Turn the Battery Disconnect to ON, start the engine and check for leaks. Correct as necessary with the Engine and Battery Disconnect OFF.

Gearbox Oil - Change

Before working with Vacuum Pump STOP the Vacuum Lifter (VL) engine and turn the Battery Disconnect to OFF. Refer to the *Operator Controls* section of this manual. Gearbox (1) is located between the Vacuum Lifter Engine and Vacuum Pump and is accessible from non-operator side of the Vacuum Lifter (VL). Gearbox oil change should be preferably performed while warm.

1. Put a drain tray under the Drain Plug (2) (bottom plug).
2. Unscrew Vented Filler Plug (3) (top plug) and then unscrew the Drain Plug (2) to drain the old oil.
3. When the oil stream dwindles, close the Drain Plug (2) and unscrew Level Plug (4) (side plug).
4. Add new oil through opening after removed Vented Filler Plug (3) until oil level reaches bottom of Level Plug (4).

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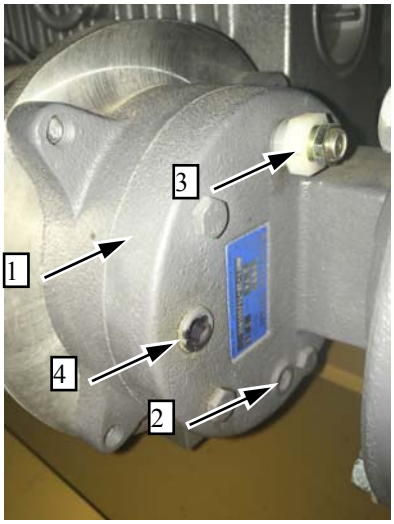

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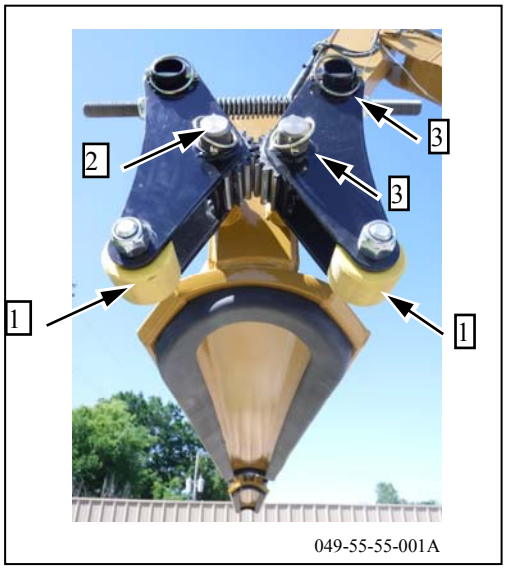
5. Securely close all three plugs. Make sure that Vented Plug is screwed in on the upper most position.

Guide Wheels - Check

Check Vacuum Lifter Pipe (VLP) attachment Guide Wheels for any damage. Ensure free rotation of Wheels (1) and that the Guide Wheels pivot freely on Guide Wheels Holders (2). Check that all four lynch pins (3) are present and securely attached. Never use Guide Wheels if any damage is present: they can prevent the VLP attachment from proper vacuum creation, and/or damage to the pipe surface can occur.



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Lift Test - Perform

A pad attachment and a proper size load are needed for following test. This procedure could result in the sudden and unexpected dropping of the load. Ensure area is clear of all personnel, and the surface below load is adequate for sudden and unexpected load drop.

1. Check if all vacuum gauges on attachment pad are showing 0 inHg (0 kPa). Replace any pad-gauge that is not showing 0 inHg (0 kPa).
2. Position Vacuum Lifter with attachment pad on the load. Start the engine, if not already running, and apply vacuum to the load. Do not lift the load.
3. Once the maximum obtainable vacuum level has been reached, shut the engine off by turning the Vacuum Lifter (VL) engine Stop/Run/Start Switch to STOP. All vacuum gauges on Vacuum Lifter and attachment pads should read approximately the same vacuum level.
4. Ensure there are no leaks in vacuum tank, vacuum connection equipment, or attachment pad(s).
5. Return to the host carrier's cab. Keep well away from the load. Slowly and carefully lift the load not more than 6-inch (15 cm) above the ground. Make sure load is not touching the ground.
6. Support the load for at least 4 minutes. Watch Vacuum Lifter attachment gauge. Vacuum level drop must not exceed 10% during the 4-minute test time. Use table below to check maximum allowable vacuum drop for different vacuum levels.

Maximum Obtainable Vacuum level	**-inHg (-kPa)**	29 (98)	28 (95)	27 (91)	26 (88)	25 (85)	24 (81)	23 (78)	22 (75)	21 (71)	20 (68)	19 (64)	18 (61)	17 (58)	16 (54)	15 (51)
Allowable drop	**-inHg (-kPa)**	2.9 (9.8)	2.8 (9.5)	2.7 (9.1)	2.6 (8.8)	2.5 (8.5)	2.4 (8.1)	2.3 (7.8)	2.2 (7.5)	2.1 (7.1)	2.0 (6.8)	1.9 (6.4)	1.8 (6.1)	1.7 (5.8)	1.6 (5.4)	1.5 (5.1)

7. Test Rotator Hydraulic Drive for proper operation and functional safety, make sure there are no strange rotational behaviors such as lack of braking capability.
8. Slowly lower the load on the ground after test.
9. If vacuum drop exceeded 10% during test time or if load was dropped inspect vacuum lifter equipment and attachment pad(s). Lower the load, and check the unit for leaks, etc. Repair as required, retest the unit. Repeat as required until the problem is resolved. Do not work with equipment that does not pass this test.

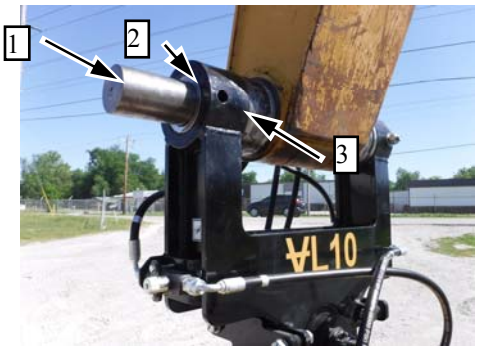
Operation Controls and Alarm System - Check

1. With the tank drained, and the pads not on any load, ensure all gauges are showing 0 inHg (0 kPa). If there is any vacuum in the tank, refer to the *Draining the Vacuum Lifter (VL) tank* section in this manual to release the vacuum. Replace any gauge that is not showing 0 inHg (0 kPa) after vacuum is released.
2. Start the Vacuum Lifter engine to build vacuum in the tank, see section *Engine Stop/Run/Start Switch*. See *Prime Vacuum Valve* section of this manual if the vacuum level does not begin to build.
3. Audible alarm will sound and Amber Vacuum Status Beacon will be flashing until vacuum level reaches approximately -18 inHg (-61 kPa). When the vacuum level increases above -18 inHg (-61 kPa), the audible alarm will stop and the Amber Vacuum Status Beacon will stop flashing, while the Green Vacuum Status Beacon will flash.
4. Make sure attachment pad is not on load and vacuum inlet is not blocked. Switch the controller to "Pick up/Support load" position to allow the vacuum level to fall.
5. Once vacuum level falls below -15 inHg (-51 kPa), the Green Vacuum Status Beacon will stop flashing, the Amber Vacuum Status Beacon will be flashing and Audible alarm will begin to sound.
6. Switch the controller to "Release load" position before reaching -10 inHg (-30 kPa) to allow the vacuum will to build up in the vacuum tank for Lift Test (if applicable).
7. Never start working with Vacuum Lifter if any of safety devices are not working or the Wireless Remote Transmitter or the Wired Controller are not working properly. Contact Vanguard for troubleshooting assistance.

Pinned Joints - Check, replace or repair if necessary

Before attempting to check pinned joint parts make sure that all components are adequately and fully supported and machine is properly parked and supported.

1. Remove top Yoke Pin (1) and check for wear, cracks, deformation and other damage. Replace if necessary.
2. Remove top Yoke Bushings (2) (if present) from Yoke Attachment Lugs (3) and check for wear, cracks, deformation and other damage. Replace if necessary.
3. Inspect the Yoke Attachment Lugs (3) on the Rotator Yoke to ensure they are not overly worn or out of round. Repair or contact Vanguard or your dealer if wear exceeds 1/8 in (3 mm) over nominal bore diameter of 3.95 in (100.3 mm).
4. Reassemble top Yoke Pin (1) and top Yoke Bushings (2) (if required) back in the unit. Refer to *Excavator attachment* section in this manual.
5. Remove Yoke Pin (4) by unscrewing Nut (5) on the side of yoke with hydraulic hoses. Check pin for wear, cracks, deformation and other damage. Replace pin if necessary. Check rotator bore diameters:
    a. For VL10 unit: with yoke pin removed check wear in rotator head bores to ensure they are not overly worn or out of round. Replace rotator head if bore diameter exceeds 1.7946 in (45.5 mm).
    b. For VL12 and VL16 units: with yoke pin removed check bores in Rotator Yoke Base (6) to ensure they are not overly worn or out of round. Replace Rotator Yoke Base (6) if bore diameter exceeds 1.90 in (48.0 mm). See section Rotator Hydraulic Drive Mounting Screw Connections in this manual for bolts torque.
6. Reassemble Yoke Pin (4). Pay special attention to direction of Yoke Pin. The Yoke Pin Nut (5) shall be on side of yoke with hydraulic hoses and flat surface on pin collar should seat properly on step under bore on the other side. Tighten Yoke Pin Nut (5) to 550 Nm (405 Lb-ft).
7. Remove Vacuum Lifter Pipe (VLP) attachment pins (7) and check for wear, cracks, deformation and other damage. Refer to *Vacuum Lifter Pipe (VLP) - Removal from Vacuum Lifter (VL)* section in this manual. Replace if necessary.
8. Inspect the Vacuum Pad Attachment Lugs (8) on the Vacuum Lifter (VL) to ensure they are not overly worn or out of round. Repair or contact Vanguard or your dealer if wear exceeds 1/8 in (3 mm) over nominal bore diameter of 2.125 in (54 mm).
9. Inspect the Pad Attachment Lugs (9) on the Vacuum Lifter Pipe (VLP) attachment to ensure they are not overly worn or out of round. Repair or contact Vanguard or your dealer if wear exceeds 1/8 in (3 mm) over nominal bore diameter of 2.125 in (54 mm) for pair pad or 2.0 in (50.8 mm) for single pad.
10. Reassemble Vacuum Lifter Pipe (VLP) attachment pins (7) refer to Vacuum Lifter Pipe (VLP) - *Connection to Vacuum Lifter (VL)* section in this manual.



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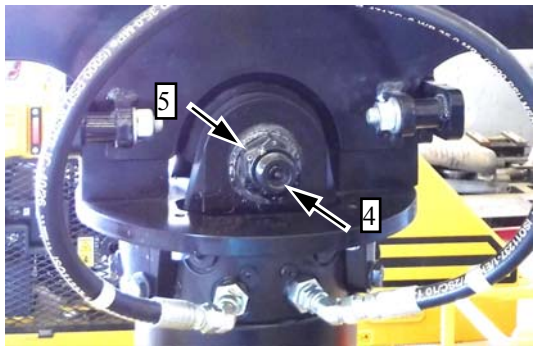

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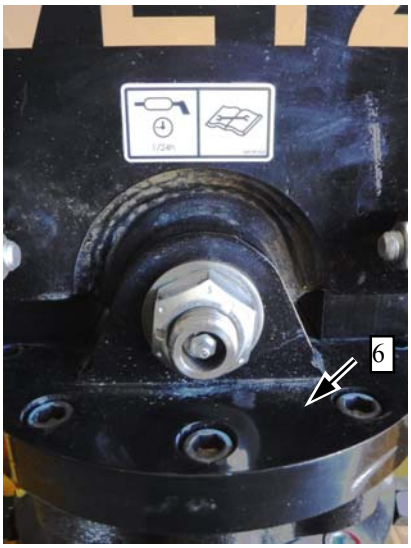

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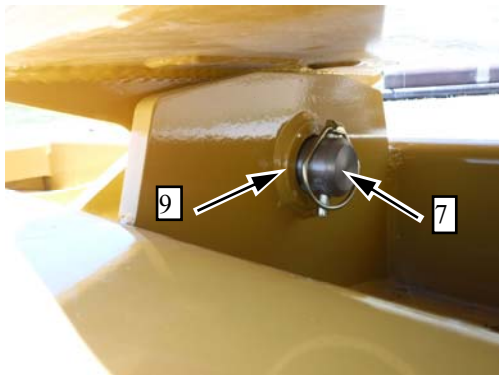

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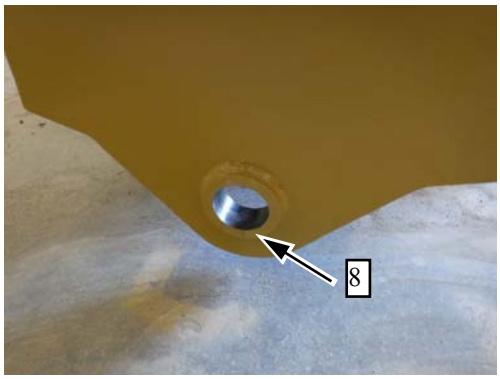

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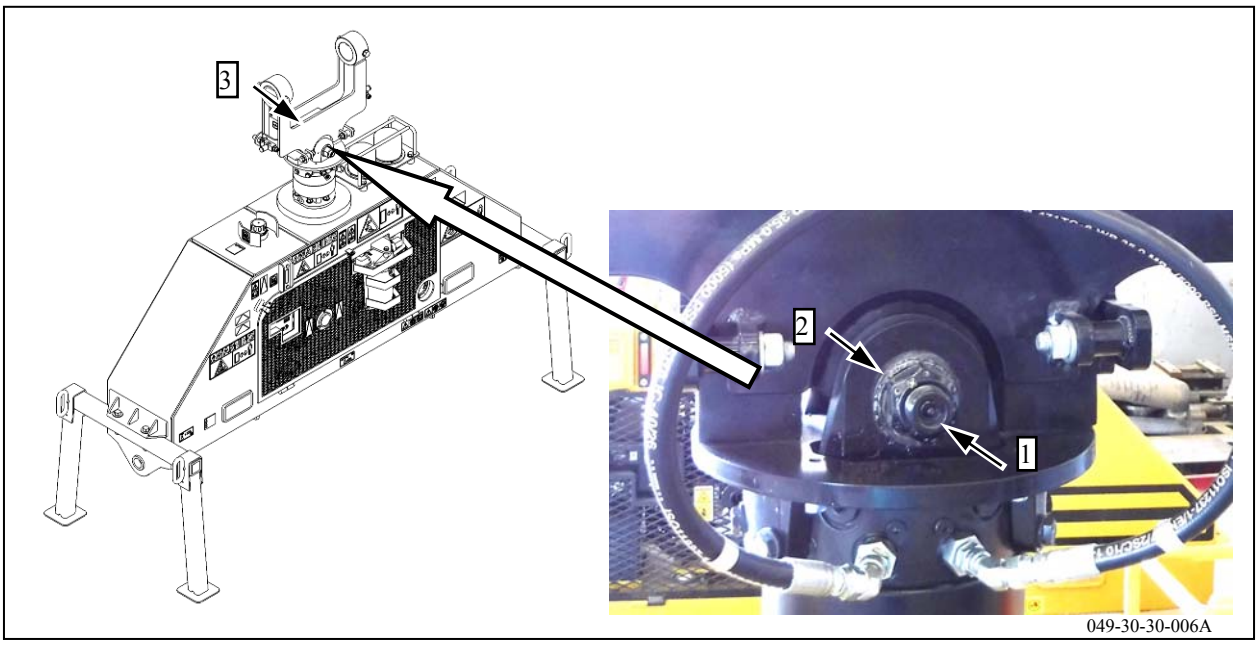
Rotator Hydraulic Drive (VL10): check for external cracks, wear, corrosion and functional safety. Screw connections: check, tighten if necessary. Pinned joints and safety parts: check, tighten or replace if necessary.

Before attempting to check Rotator Hydraulic Drive make sure that Vacuum Lifter (VL) yoke is adequately and fully supported, and machine is properly parked and supported.

Check pinned connection for abnormal play. If there is play, remove pin and check wear as described below:

1. Remove yoke pin (1) by unscrewing nut (2) on the side of yoke with hydraulic hoses. Check yoke pin (1) for wear, cracks, deformation and other damage. Replace if necessary.
2. With yoke pin removed check wear in rotator head bores as per instructions in *Pinned Joints - Check, replace or repair if necessary* section in this manual.
3. Check two bushings inside yoke base (3) for wear, cracks, deformation and other damage. Replace if wear exceeds 1/8 in (3 mm) over nominal bushing diameter of 1.776 in (45.1 mm).
4. Reassemble yoke pin (1). Pay special attention to direction of yoke pin. The Yoke Pin Nut (2) shall be on side of yoke with hydraulic hoses and flat surface on pin collar should seat properly on step under bore on the other side. Tighten yoke pin nut (2) to 550 Nm (405 Lb-ft).



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Rotator Hydraulic Drive Mounting Screw Connections - Check, tighten if necessary

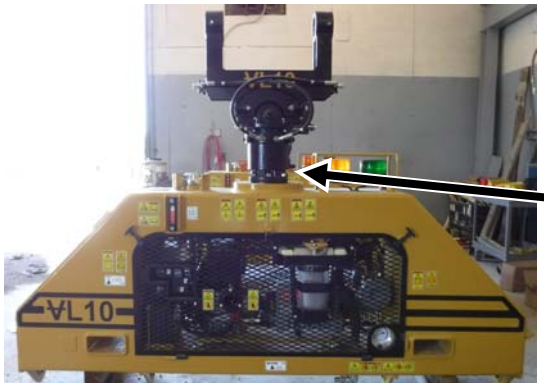
To compensate for possible settling, it is necessary to retighten the bolts to the prescribed torque. This shall be done without an external load applied to the bolt connection, so make sure that machine is properly parked.

Inspection: The following procedure is to be used only as an indication that minimum assembly requirements have been achieved or maintained.

1. Start at one bolt at Lower Bolts (1) and work around the bolt circle to check all bolts. For VL12 and VL16 only: check also Upper Bolts (2).
2. Apply the static inspection torque in the tightening direction.
3. The fastener shall not move when the static inspection torque is applied.
4. In case of loose bolts, replace <u>all</u> bolts and washers (if necessary) with new ones.

Installation: The following procedure is to be used only for reinstallation of the Rotator Hydraulic Drive mounting bolts.

1. When replacing or reassembling bolts, apply removable strength Thread Lock, Loctite Blue 242, or equivalent to the bolt threads.
2. Preload the bolts crosswise. See the general pattern in sketch below of how bolts get torque in crosswise sequence.
3. Do the crosswise torqueing of all bolts to 30% of installation torque. Then repeat crosswise torque to 80% of installation torque. Finally, crosswise torque to 100% of the installation torque as noted. Repeat for all bolts.
4. Once the bolt is tightened, permanently mark the position of the bolt head to that of the stationary structure. This will be used later during inspection to be sure the bolt head has not unwound.



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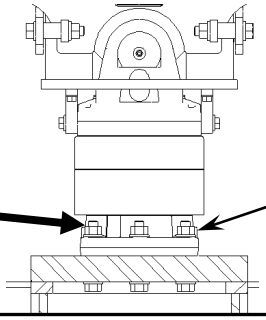

Lower bolts (1)

<u>VL10 BOLT TORQUES</u>
Static inspection torque: Lower bolts (1) = 320 Nm (235 Lb-ft)
Installation torque: Lower bolts (1) = 380 Nm (280 Lb-ft)

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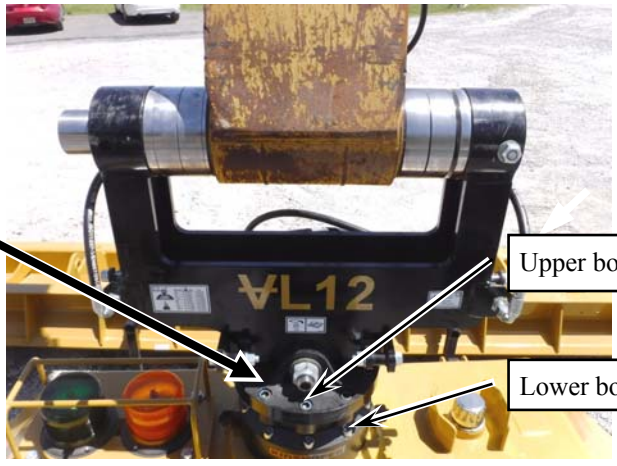

Upper bolts (2)

Lower bolts (1)

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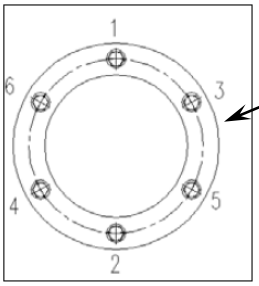

To reinstall bolts (1) and (2), tighten in a crosswise pattern (typical, for reference only)

<u>VL12, VL16 BOLT TORQUES</u>
Static inspection torque: Lower bolts (1) = 320 Nm (235 Lb-ft), Upper bolts (2) = 367 Nm (270 Lb-ft)
Installation torque: Lower bolts (1) = 380 Nm (280 Lb-ft), Upper bolts (2) = 412 Nm (304 Lb-ft)

Vacuum Engine Air Cleaner - Check

Before working with Vacuum Engine STOP the Vacuum Lifter (VL) engine and turn the Battery Disconnect to OFF. Refer to the *Operator Controls* section of this manual. Make sure Engine is level and cool.

1. Open air cleaner cover by removing Knob (1).

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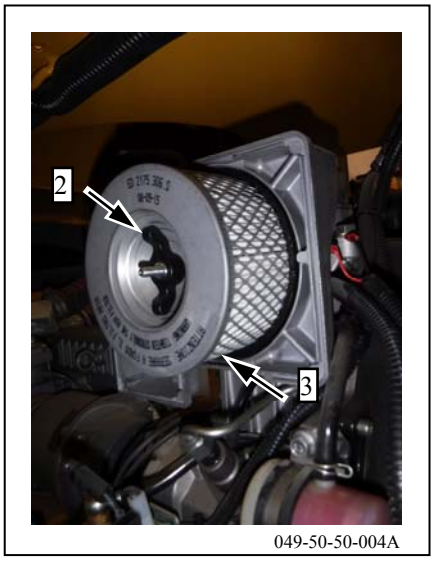
2. Unscrew Wing Nut (2) and remove Air Filter (3).



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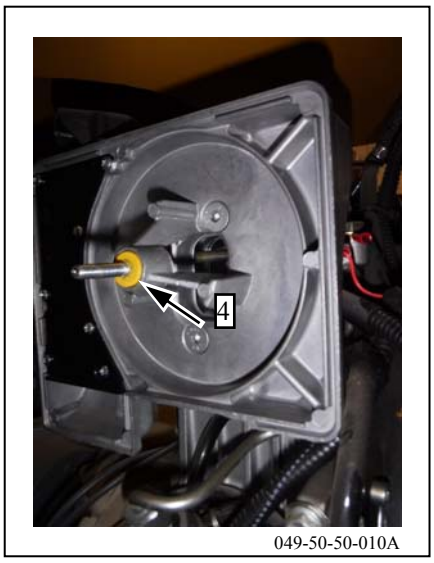
3. Check if Rubber Seal (4) behind Air Filter is in good condition.



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4. Clean or replace Air Filter if necessary. Clean Air Filter with air blast. Air must be blown from inside to outside the cartridge at a distance of at least 15 cm from the paper. Do not reuse the Air Filter if any damage or deterioration has occurred. Replace with a new filter. When replacing the Air Filter, also replace the Rubber Seal (4), a new seal is included in new Air Filter package.
5. If the Housing (5) appears clogged, remove, clean, and reassemble.

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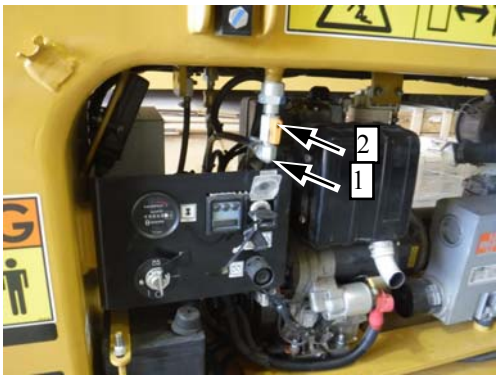
6. Reinstall the Rubber Seal (4), and the Air Filter (3). Tighten the Wing Nut (2), do not over tighten.
7. Securely mount the Air Filter and the Cover, tighten Knob (1) to prevent dust or other impurities from bypassing filtration system and damaging the Diesel Engine.

Vacuum Engine Cooling Fins - Clean

Note: Engine in the Vacuum Lifter (VL) is not equipped with tank on engine therefore there is no need to remove engine tank and fuel lines before attempting to clean cooling fins. Refer to Engine Manual in the appendix for detailed procedure on Cooling Fins cleaning.

Vacuum Engine Fuel Filter - Replace

Shut off fuel Supply Line (1) with hand operated Valve (2) before replacing Engine Fuel Filter (3). Yellow lever must be closed (positioned horizontally). This will keep amount of fuel drain to minimum. Engine Fuel Filter (3) is located on non-operator side of the Vacuum Lifter (VL). Refer to Engine Manual in the appendix for detailed procedure on Fuel Filter change. Open fuel Supply Line (1) with hand operated Valve (2) after changing Engine Fuel Filter.



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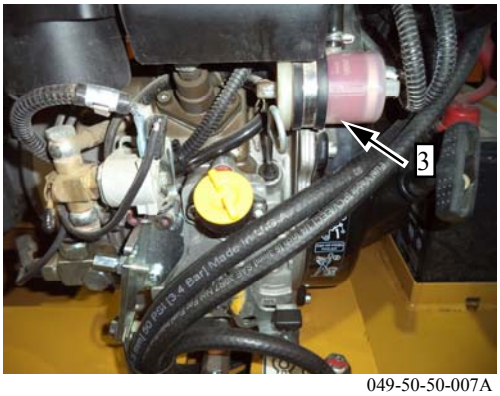

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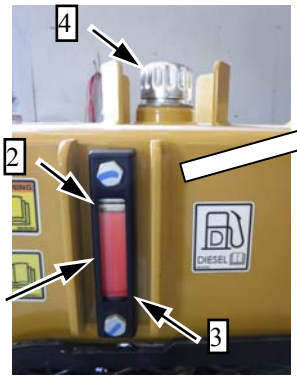
Vacuum Engine Fuel Level - Check

Check diesel fuel level in Fuel Level Gauge (1) on operator side of Vacuum Lifter, when unit is level. Always keep fuel level between the BLACK FULL (2) line and the RED EMPTY (3) line on Fuel Level Gauge (1). Do not overfill. Add diesel fuel as needed through Diesel Fuel Fill (4) on top of Vacuum Lifter. Fuel tank capacity is approximately 18 liters (4.75 gal). Avoid spilling fuel onto the pad seal as this may cause premature failure of the seal. Clean up all spills immediately; follow local environmental spill response requirements.



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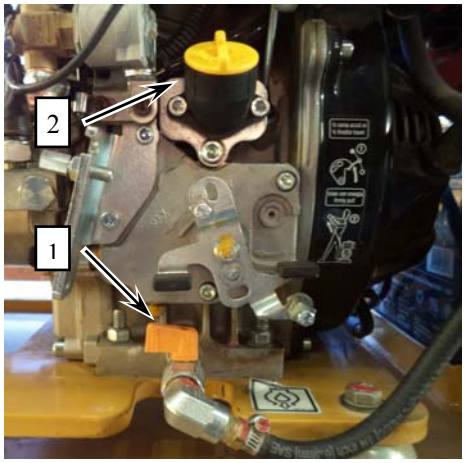
Vacuum Engine Oil - Change

Vacuum Engine is equipped with hand operated hand operated Valve (1) on non-operator side of the Vacuum Lifter (VL) for draining the oil. Use Side Oil Fill (2) above hand operated Valve (1) to refill new oil. Refer to Engine Manual in the appendix for detailed procedure on Engine Oil change.



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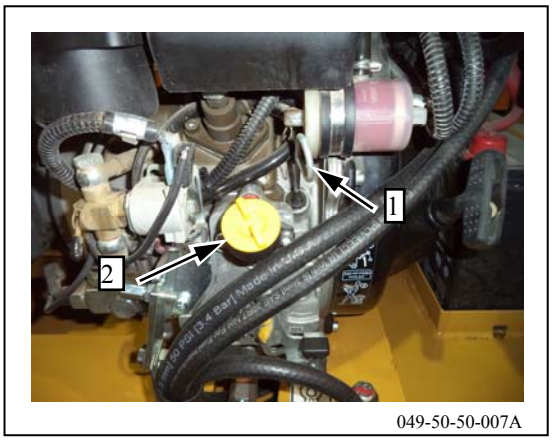
Vacuum Engine Oil - Check

Before working with Vacuum Engine STOP the Vacuum Lifter (VL) engine and turn the Battery Disconnect to OFF. Refer to the *Operator Controls* section of this manual. Make sure Engine is level and cool so oil has time to drain into sump.

1. Locate Diesel Engine on non-operator side of (VL) Vacuum Lifter

049-50-50-010A

2. Remove Dipstick (1) and read oil level.



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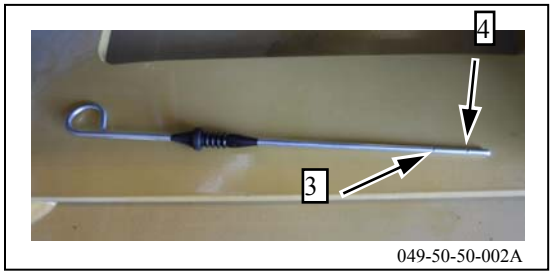
3. Oil level trace on Dipstick must be between MAX (3) and MIN (4) mark.
4. Add oil if necessary through Oil Fill. Do not overfill. See *Lubricant Viscosities* for Ambient Temperatures for oil information.
5. After adding oil clean and reinstall Dipstick, remove it and read oil level again.
6. If oil level trace on Dipstick is between MAX and MIN, reinstall dipstick correctly.



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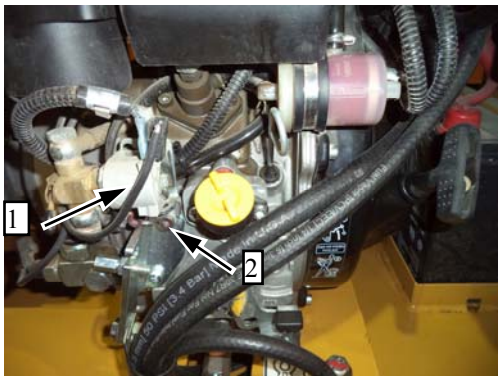
Vacuum Engine Oil Filter - Replace

Engine Oil Filter is located on non-operator side of the Vacuum Lifter (VL). Engine is equipped with Fuel Solenoid (1). Remove and retain Fuel Solenoid (1) by unscrewing two hex socket head bolts (2) under fuel solenoid. Refer to Engine Manual in the appendix for detailed procedure on Internal Engine Oil Filter change.



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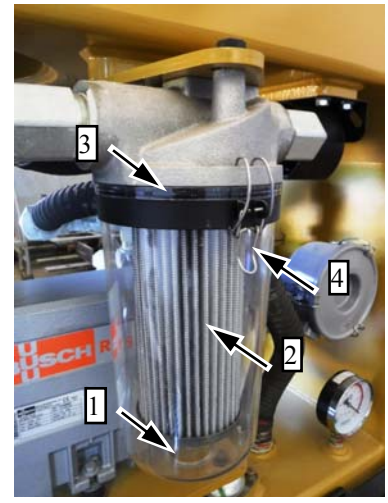
Vacuum Filters - Check

Before removing any Vacuum Filter cover, make sure there is no vacuum in tank. All Vacuum Gauges must read 0 inHg. See *Draining the Vacuum Lifter (VL) tank* section in this manual. STOP the Vacuum Lifter (VL) engine and turn the Battery Disconnect to OFF. Refer to the *Operator Controls* section of this manual. Keeping all filters clean will significantly extend life of other vacuum elements and reduce brake-down time.

Vacuum Pre-Filter check

1. Locate Vacuum Pre-Filter on the operator side of the Vacuum Lifter (VL). See *Equipment Information Section* for detailed placement of Pre-Filter.
2. Check bottom of Transparent Bowl (1) for any dust or debris. Inspect Filter Element (2) for excessive dust and dirt, damage, or deterioration. Do not reuse the Filter Element (2) if any damage or deterioration has occurred. Replace with a new element. Visually check Seal (3) for any damage.



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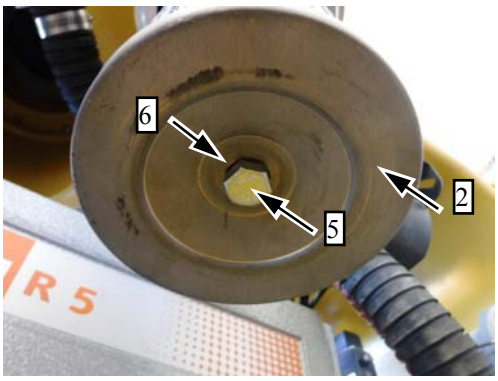
3. If Transparent Bowl (1) is empty, and the Filter Element (2) is clean and does not have any damage, and the Seal (3) is undamaged, Vacuum Pre-Filter can be used without disassembly. Otherwise disassemble as below.
4. To remove Transparent Bowl (1) unclick two Retainers (4) and carefully slide Transparent Bowl down. Clean Transparent Bowl of any dust, debris, etc.

5. Remove Bolt (5) under Filter Element (2) and slide Filter Element down. Make sure Seal (6) on bolt is not damaged. Replace if necessary.



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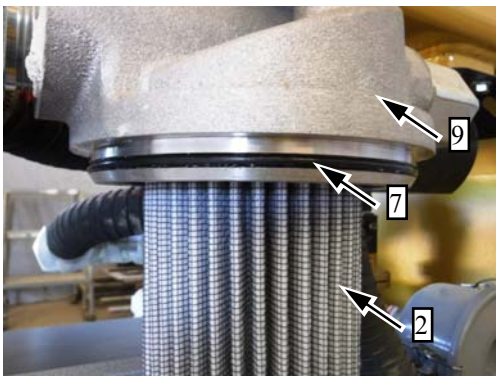
6. Inspect Seals (7) and (8) on Casting (9) against any damage. Replace any damaged seal.



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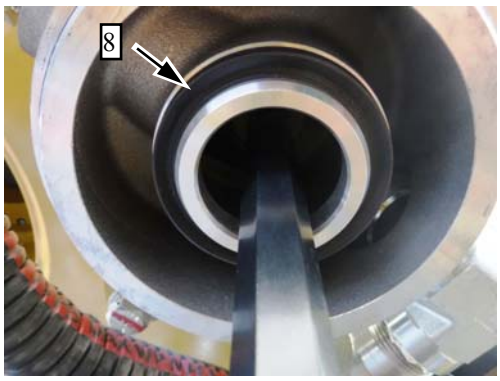

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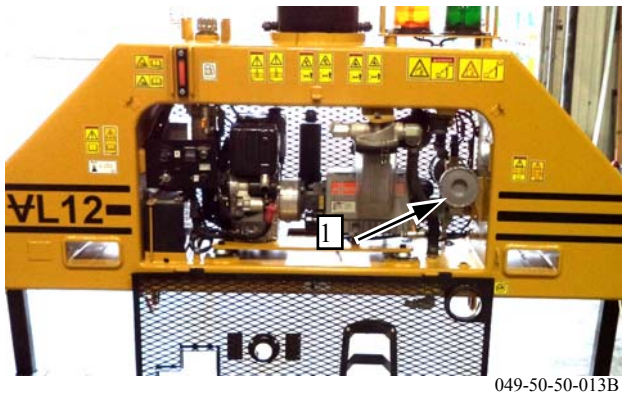
7. The Filter Element (2) may be washed in warm soapy water, vacuumed or gently blown out. The element should be dry before reinstallation. Do not clean the element more than three times. Replace the element after a maximum of three cleanings. Inspect the element for damage, replace with new a new element if damaged, torn, or clogged.
8. Slide the cleaned or new Filter Element onto Casting (9) and secure with Bolt (5). Make sure all Seals are properly seated in place. Tighten to snug-fit, do not over tighten.
9. Slide Transparent Bowl (1) and reattach two Retainers (4) onto Casting (9). Make sure Seal (7) is properly seated against Transparent Bowl and Bowl is securely attached to casting head.

Vacuum Filters check

1. Locate the three Vacuum Filters (1). One filter is on operator side, two are on non-operator side.



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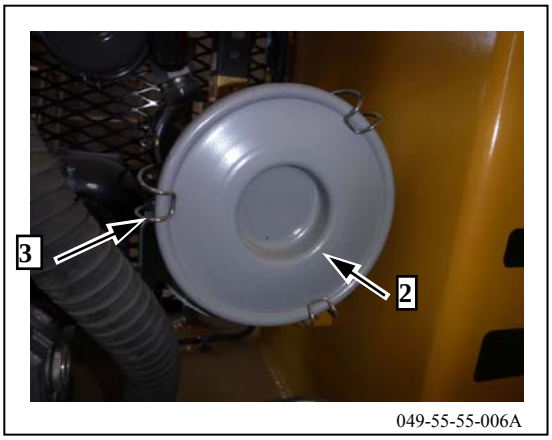
2. Remove and retain Front Cover (2) by opening three Retainers (3). Be careful, as the Filter Element inside is not retained and may fall out.



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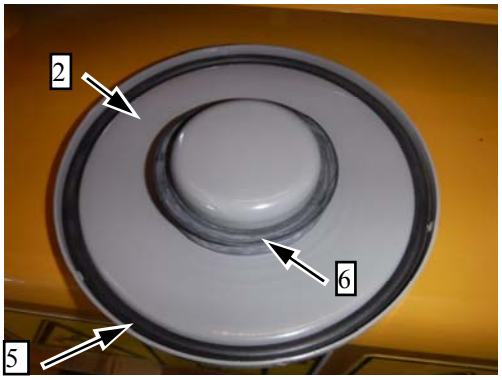
3. Carefully remove the Filter Element (4). Inspect Filter Element for excessive dust and dirt, damage or deterioration. Do not reuse the Filter Element if clogged or any damage or deterioration has occurred. Do not wash, replace with a new element.
4. Inspect two outer-Seals (5) and (6) on Front Cover (2) and one inner-Seal (7) on Filter Housing (8) for any damage. If any seal is damaged, replace.



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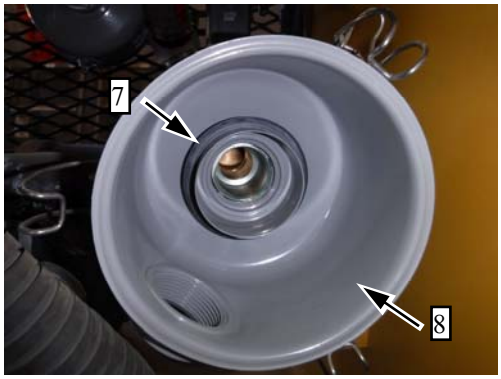

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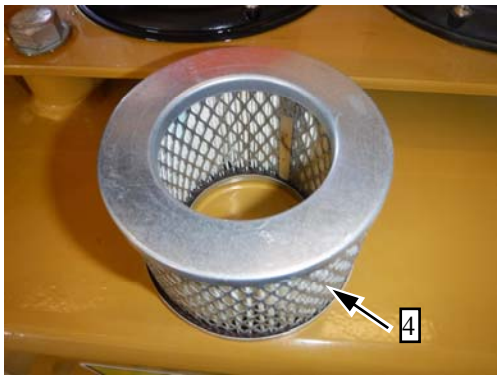
5. Replace Filter Element (4) inside Filter Housing (8). Make sure Filter Element (4) is properly seated on Seal (7). Close Front Cover (2) and reattach three Retainers (3) in place.



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Vacuum Pump Exhaust Filter - Check

Vacuum Pump Pressure Gauge (1) is located on the back of the Vacuum Pump on operator side of the Vacuum Lifter (VL). Start the Vacuum Lifter Engine, see section *Engine Stop/Run/Start Switch* in this manual. Make sure suction hole in the Vacuum Lifter Pipe (VLP) Attachment pad is not covered, so vacuum is NOT building up in the tank. If vacuum is building up in the tank, switch vacuum valve into "Pick up/Support load" position, see section *Wireless Remote Transmitter* in this manual. Check that the reading on the Pressure Gauge (1) is in the green field. If reading on the Pressure Gauge (1) is on the red field, refer to Vacuum Pump Routine Maintenance and Troubleshooting in the appendix.

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Vacuum Pump Float Valve - Check

Before attempting to check Vacuum Pump Float Valve, refer to Vacuum Pump Routine Maintenance and Troubleshooting in the appendix for pump schematic showing the parts location as referenced below.

1. Remove 90 degrees elbow in pump gas discharge (d) exhaust.
2. Remove the gas discharge (d) exhaust cover above the float valve (j, 200).
3. Remove oil from the floater chamber with the aid of a suction hose or a wash bottle.
4. Undo the screws and remove the axial flow fan cover (f).

Note: while undoing the banjo fitting, of the oil return line (j), a small amount of oil will leak out, keep a cleaning rag ready. Be careful not to lose the sealing rings of the banjo fitting.

5. Undo the banjo fitting of the oil return line (j) from the oil separator (n) and bend the oil return line a little bit aside.
6. It may be necessary to remove vacuum pump pressure gauge from oil fill plug (k) to undo the two screws of the flange of the float valve (j, 200) and pull the float valve out of separator (n), Check the cleanliness and function of the float valve (j, 200), blow out with compressed air, if necessary.
7. Make sure that o-ring on the flange of the float valve (j, 200) is in place and undamaged, replace with a new o-ring, if necessary.
8. Insert the float valve (j, 200) in the proper orientation in the oil separator (n) and fasten it with two screws and lock washers.
9. Connect the banjo fitting of the oil return line (j) to the oil separator (n) with the hollow-core screw and two seal rings.
10. Fasten the fan cover (f) to the vacuum pump with the screws.

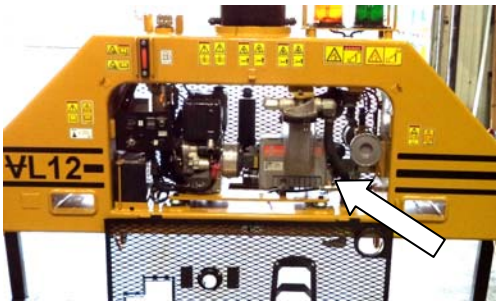
If the exhaust filters (o, 120) are replaced with new, refer to Vacuum Pump Routine Maintenance and Troubleshooting in the appendix. Only if the exhaust filters (o, 120) are not meant to be changed, too:

1. Make sure that the seal (141) under the gas discharge (d) exhaust cover is clean and undamaged, if necessary replace with a new seal (141)
2. Mount the exhaust cover (d) together with seal (141), hex head screws and lock washers on the oil separator (n).
3. Mount back 90 degrees elbow in pump gas discharge (d) exhaust.

Vacuum Pump Oil - Check

Before working with Vacuum Pump STOP the Vacuum Lifter (VL) engine and turn the Battery Disconnect to OFF. Refer to the *Operator Controls* section of this manual. Vacuum pump must be level and cool so oil has time to drain into sump. The oil might appear to be foamy, which is a normal phenomenon with aerated oil. Under normal circumstances, it should not be necessary to add or drain oil from the pump between recommended oil changes.

1. Locate Vacuum Pump on operator side of (VL) Vacuum Lifter and approach side further away from operator's panel.
2. Check for oil level and color in Sight Gauge (1). Oil level must be between MAX (2) and MIN (3) marks.
3. It is normal for the oil to be foamy and light in color in an operating pump. However, if the oil is milky colored, it is an indication that water is present in the oil.
4. If the oil is black and tar like or contaminated in any way, if pump was noisy or was overheating, then depending on the severity of the contamination, a thorough flushing may be needed. Refer to Vacuum Pump Routine Maintenance and Troubleshooting in appendix.
5. If oil level is below MIN (3) mark, add oil. Remove Oil Fill Plug (4) together with a Pressure Gauge (5) and add oil until level is between MAX (2) and MIN (3) marks. Close Oil Fill Plug (4) together with a Pressure Gauge (5) after adding oil.



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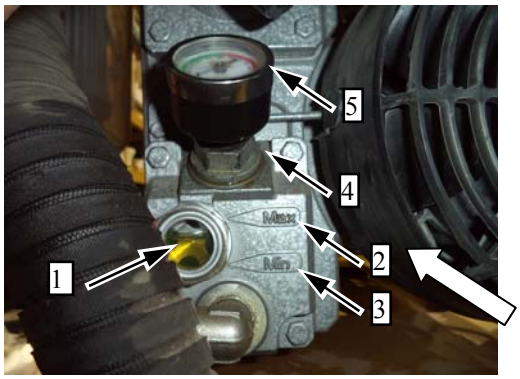

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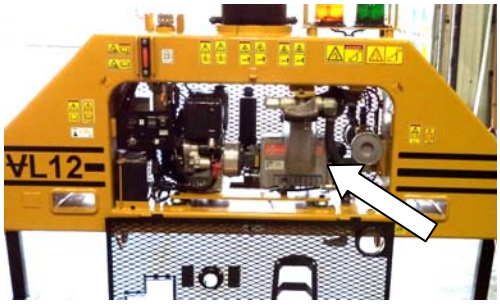
Vacuum Pump Oil and Oil Filter - Change

Before working with Vacuum Pump STOP the Vacuum Lifter (VL) engine and turn the Battery Disconnect to OFF. Refer to the *Operator Controls* section of this manual. After switching off the Vacuum Pump at normal operating temperature wait no more than 20 minutes before the oil is drained. Note, that the oil shall still be warm when being drained! Vacuum pump must be level. Locate Vacuum Pump on the operator side of (VL) Vacuum Lifter and approach side further away from operator's panel.

1. Make sure that the Vacuum Pump is vented atmospheric pressure. Check if all Vacuum Gauges are showing 0 inHg (0 kPa). See *Draining the Vacuum Lifter (VL) tank* section in this manual.
2. Put a drain tray under the Oil Drain Hose (1)
3. Open hand operated Valve (2) on the oil drain line.
4. When the oil stream dwindles, close the hand operated Valve (2) on the oil drain line.
5. Switch the Vacuum Pump on for a few seconds by starting Vacuum Lifter Engine, see section *Engine Stop/Run/Start Switch* in this manual. Stop the Vacuum Lifter Engine and turn the Battery Disconnect to OFF. Refer to the *Operator Controls* section of this manual.
6. Open hand operated Valve (2) on the oil drain line and drain remaining oil from the Vacuum Pump.
7. When the oil stream dwindles, close the hand operated Valve (2) on the oil drain line.
8. Closely examine drained oil if is dark colored, contaminated or carbonized. Depending on the severity of the contamination, a thorough flushing may be needed. Refer to Vacuum Pump Routine Maintenance and Troubleshooting in appendix.
9. To replace the Oil Filter (3) make sure all oil is drained.
10. Oil Filter (3) is located on the Vacuum Pump, close to the Vacuum Lifter Engine. Remove the Oil Filter (3) from the Vacuum Pump.
11. Apply a drop of fresh oil on the seal ring of the new Oil Filter.
12. Mount the new Oil Filter on the Vacuum Pump and tighten by hand. Make sure to tighten new oil filter securely against the aluminum sealing surface so that leaks will not occur.
13. Dispose of the used Oil Filter in compliance with applicable regulations.

14. To add new oil, make sure hand operated Valve (2) on the oil drain line is closed and the new Oil Filter (3) is properly mounted. Remove Oil Fill Plug (4) together with a Pressure Gauge (5) and add oil until level is between MAX (6) and MIN (7) marks in Sight Gauge (8). Close Oil Fill Plug (4) together with a Pressure Gauge (5) after adding oil.



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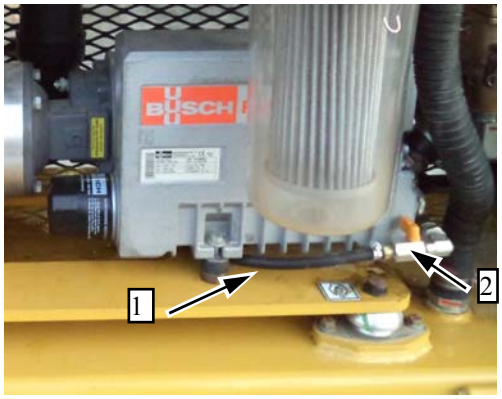

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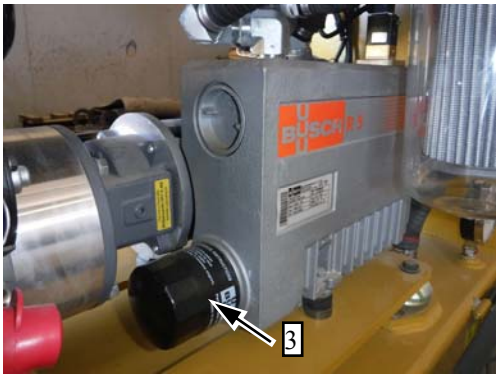

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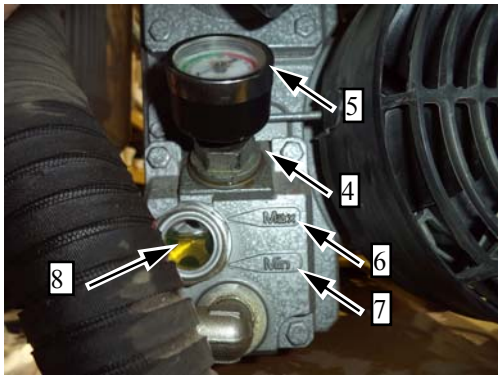

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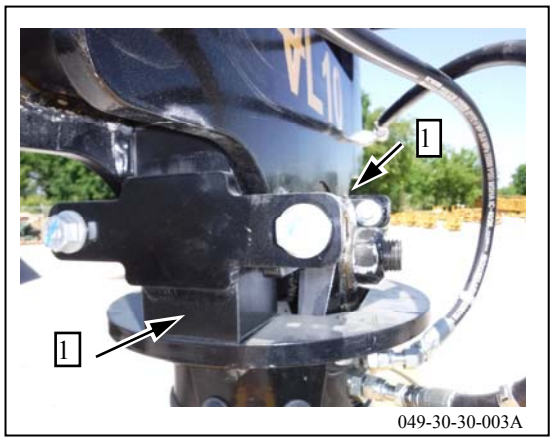
Yoke Bumpers - Check

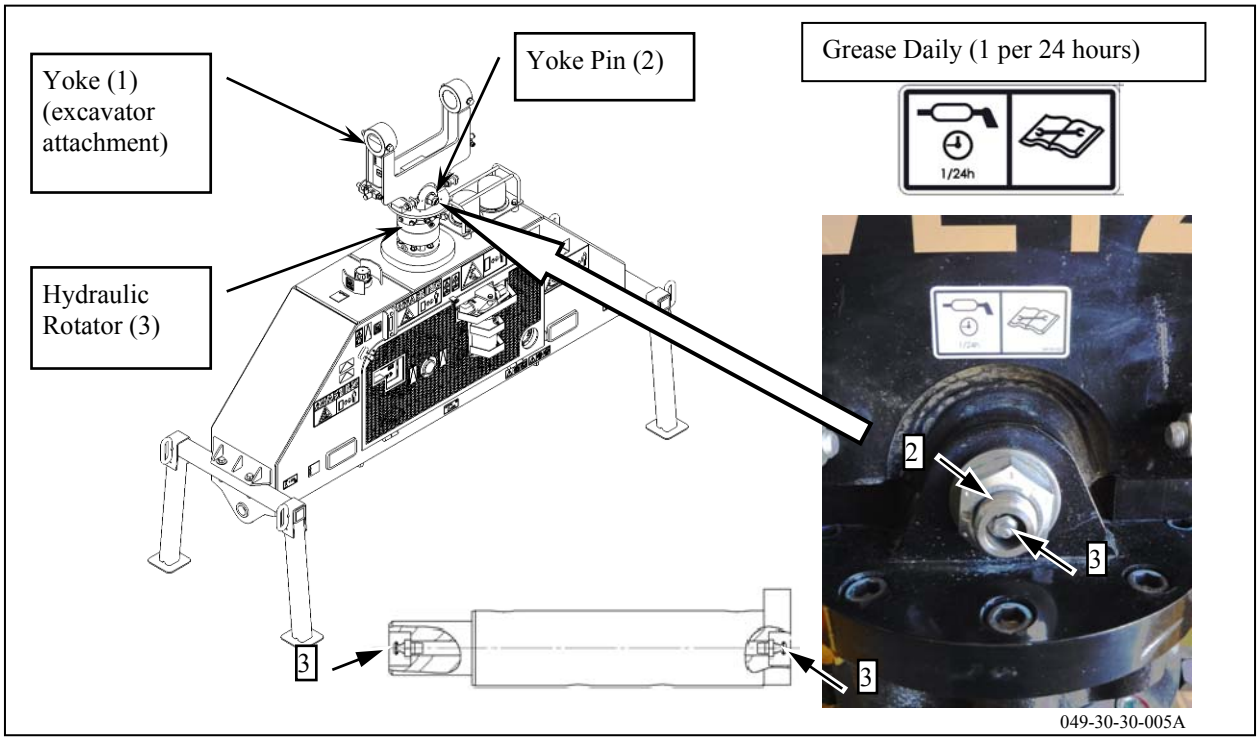
Check Yoke Bumpers (1), one on each side of yoke, for any cracks, deformation, wear, etc. Replace if necessary.



Yoke Pin - Lubricate

Following procedure applies only to Vacuum Lifters (VL) equipped with Rotator Yoke. Yoke Pin must be greased every day before work begins. Use Grease Nipples on both ends of Yoke Pin. Apply grease until fresh grease is visible being forced out.

1. Locate Yoke (1) on top of Vacuum Lifter. Yoke Pin (2) is above Hydraulic Rotator (3).
2. Grease Nipples (4) are on both ends of Yoke Pin (2).



Pad Seal replacement - complete seal

⚠ WARNING

For seal replacement use only genuine seal provided by Vanguard. Using other types of pad seal could reduce load capability, and could result in serious injury or death.

Use the Seal Tool for seal installation located on non-operator side doors, inside the Vacuum Lifter (VL) next to Manual

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Canister. Seal Tool is accessible after opening non-operator side doors.

Figure 32: Seal Tool placement

1. To replace the entire seal (1) in the Vacuum Lifter Pipe (VLP) Attachment pad remove the attachment pad from the Vacuum Lifter (VL), see the *Vacuum Lifter Pipe (VLP) - Removal from Vacuum Lifter (VL)* section in this manual. If only a short length of seal is damaged see *Pad Seal Repair - short section* in this manual.
2. Position Vacuum Lifter Pipe (VLP) Attachment pad upside down to access the seal (1), adequately supported on a stable surface, at a comfortable working height (3 ft, or 0.9 m) or as local health and safety regulations require. Seal replacement can also be done when the VLP attachment is supported by Pad Stand Legs (rotated upside down) on flat, stable surface. The working height should always be done at the correct ergonomic height, as local health and safety regulations require.
3. Remove the seal (1) from the pad; gently roll the seal out of the Seal-Profile channel (2). Clean the Seal-Profile channel (2) thoroughly. Remove any debris, dirt or old glue, etc. Never use any glue or adhesive inside channel to retain seal, gluing the seal into the profile will make it very difficult to remove later.

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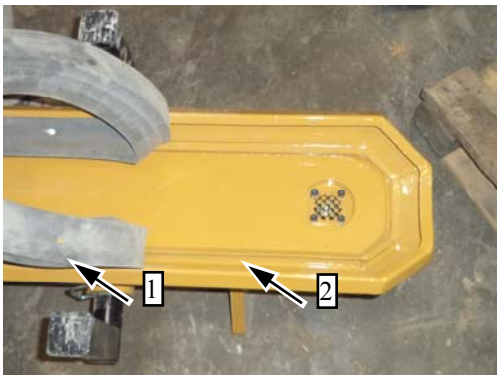

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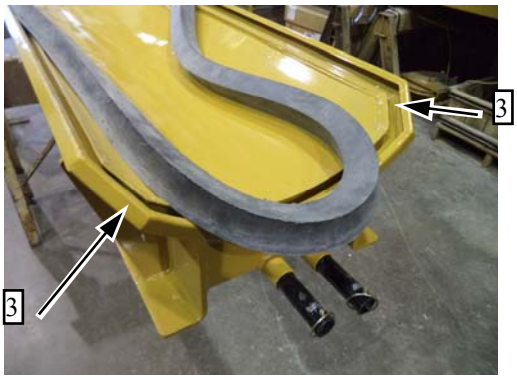
4. Measure the complete length of Seal-Profile channel (2) all the way around the pad to determine the amount of seal needed. The Seal around the VLP attachment can be composed of several short pieces, but the minimum seal length must not be less than 18-inch (46 cm). Ensure that the minimum distance for a seal connection from a corner is at least 12-inch (30 cm). **Note:** The ends of each seal-joint have to overlap approximately 0.375-inch (1 cm) to 0.5 in (1.3 cm) at each connection, the seal has to be longer than the space it is filling.

5. Cut required length of seal. Be careful to leave smooth, square ends. If an end has an angle or is not flat, a vacuum leak may occur.
6. Make sure seal is free from any damage, otherwise premature seal wear or a vacuum leak may occur.
7. Never start the seal close to the corner of the pad (3). The end of the seal must be at least 12-inch (30 cm) from a corner of the pad.



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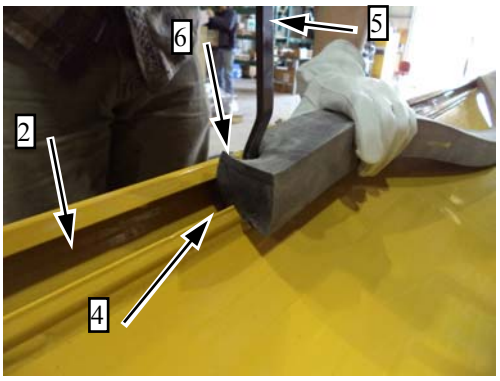
8. Place inside corner (4) of seal into the Seal-Profile channel (2), and while holding seal down with one hand, use the supplied Seal Tool (5) to push the outside edge (6), into the Seal Profile (2). Do not stretch the seal while pushing inside profile.



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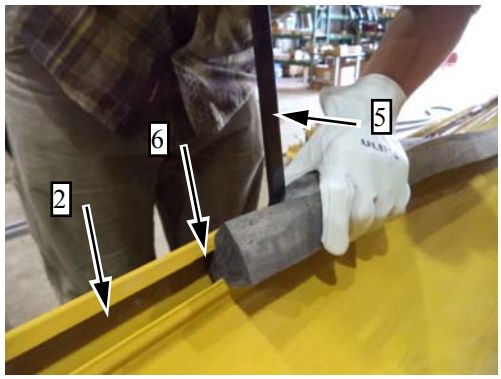

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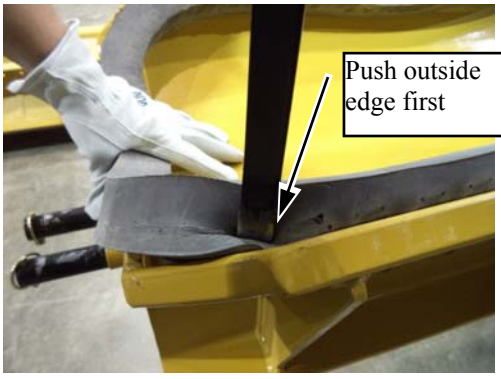
9. Work your way around the pad while pushing the outside edge of seal into the profile. Pay special attention when pushing seal in corners not to damage or stretch the seal. Repeat pushes every so often until seal is inside channel.



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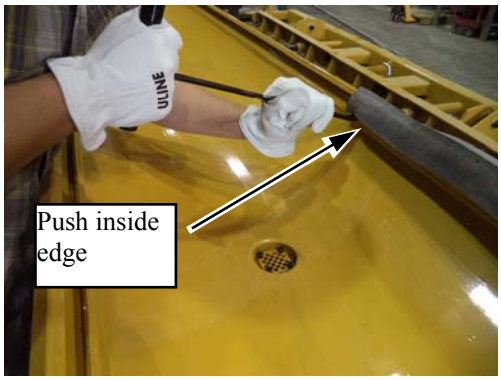
10. After installing the outside the edge, also go around and push the inside edge of seal around the pad, until the seal is sitting fully in the profile-channel, filling it completely.
11. Stop pushing seal approximately 6 in (15 cm) from the end. Remove approximately 6 in (15 cm) of seal from the other end, so both connecting ends are out of the profile-channel. Make sure seal overlaps 0.375-inch (1 cm) to 0.5-



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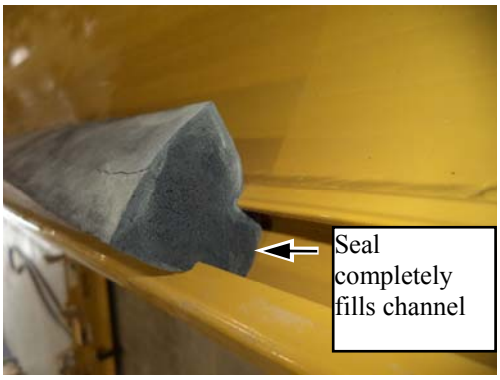

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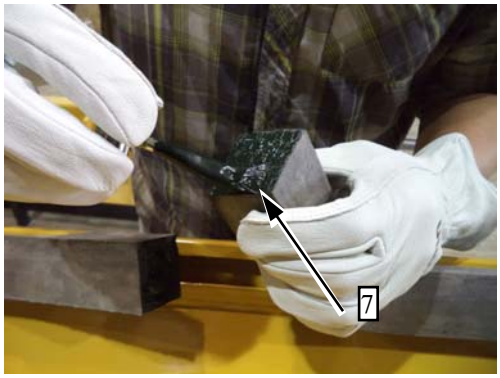
inch (1.3 cm).

12. Apply Seal Glue (7) to both joint-ends so they are fully covered. Do not use excessive amount of Seal Glue, otherwise it will get to channel and seal removal may not be possible without damaging the seal. A thin layer of Seal Glue is enough; make sure Seal Glue covers whole cross section of seal. Use brush under the lid of Seal Glue can.
13. Allow the glue to dry, approximately 1-2 minutes.
14. After the glue is dry, apply a second coat of glue to both ends (8) to reactivate the dried glue. This step will make a stronger, better boned-joint.



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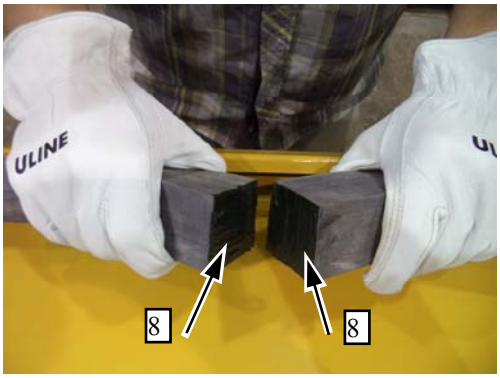
15. Bond the joint immediately Press the two ends firmly together to bond them (9). Remove any excess glue from outside the joint. Do not allow excess Seal Glue to get into the Seal-Profile channel. Install the joint into the profile-channel. Make sure the joined ends are aligned in the profile-channel, and that both ends are fully seated, without any step along the joint. Ensure that the whole surface is bonded together. A vacuum leak may occur if connection



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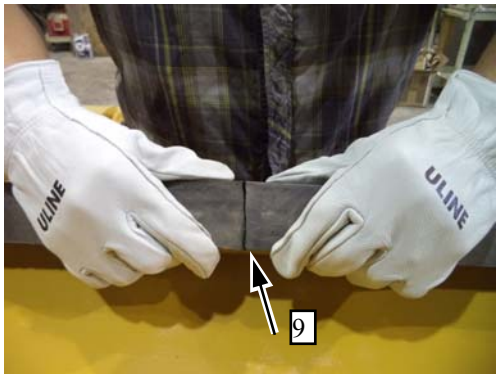

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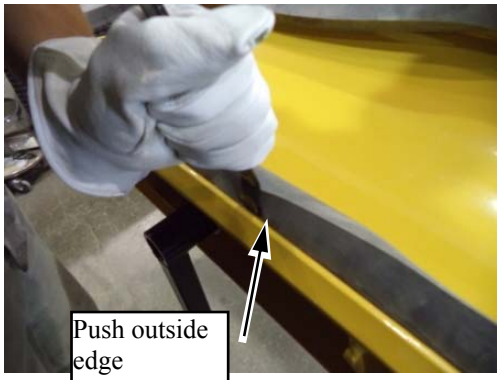
is not done correctly.

16. Recheck whole length of seal to ensure it is fully seated and retained in the profile-channel, correct where necessary.



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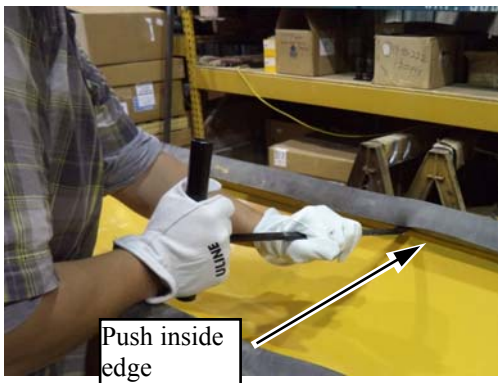

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Pad Seal Repair - short section

⚠ WARNING

For seal replacement use only genuine seal provided by Vanguard. Using other types of pad seal could reduce load capability can result in serious injury or death.

Use provided Seal Tool for seal installation which is located on non-operator side doors, inside the Vacuum Lifter (VL) next

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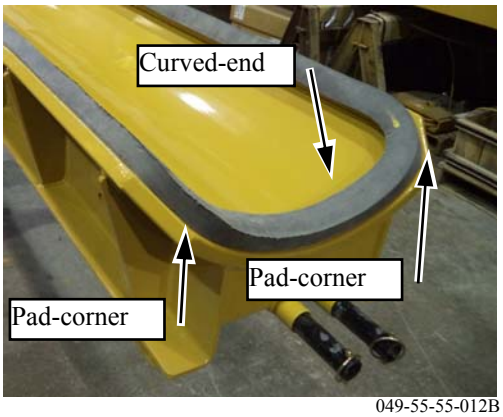
to Manual Canister. Seal Tool is accessible after opening non-operator side doors.

Figure 33: Seal Tool placement



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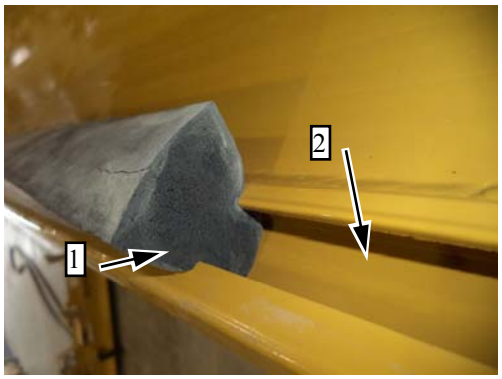
When a short portion of the seal is damaged or worn, remove only the short section. Usually damage occurs at the pad-corners, or at the curved-end of the profile-channel. The replacement section must be at least 18 in (46 cm). A replacement joint must be at least 12 in (30 cm) from a pad-corner, so the minimum length for seal replacement in some cases, near a corner for example, may be longer than 18 in (46 cm). It may be necessary to replace the section at through the entire curved-end, plus the two pad-corners, plus the length to be the minimum distance from the pad-corners, this could add up to give a much longer "minimum length".

Note: It is possible to replace a short section of the seal with the Vacuum Lifter Pipe (VLP) attachment pad still connected to, and supported by the Vacuum Lifter (VL). Before approaching unit or walking under it make sure it is properly secured and safely supported, and the host-carrier-vehicle is properly parked with the controls locked out; refer to the instructions in the host-carrier-vehicle operator manual. To repair or replace the seal, it is strongly recommended to remove the attachment pad from the Vacuum Lifter (VL), see the *Vacuum Lifter Pipe (VLP) - Removal from Vacuum Lifter (VL)* section in this manual.



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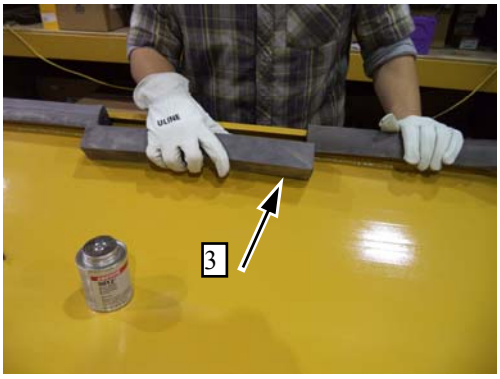
1. With the pad stabilized and adequately supported at a comfortable working height (3 ft, or 0.9 m) or as local health and safety regulations require, cut out the damaged portion of seal from the attachment pad. Ensure to cut out the length needed to meet the minimum length requirements as detailed above. Be careful to leave smooth, square ends (1). If an end has an angle or is not flat, a vacuum leak may occur.
2. Clean Seal-Profile channel (2) thoroughly. Remove any debris, dirt or old glue. Never use any glue or adhesive inside

channel to retain seal, gluing the seal into the profile will make it very difficult to remove later.

3. If there is no significant damage to previously used section, it may be flipped upside down (worn surface towards the pad) for reuse. Never rotate the seal only 90 degrees (worn surface towards inside or outside).
4. Make sure seal is free from any damage, otherwise premature seal wear or a vacuum leak may occur.

5. Measure and cut length of seal needed for replacement (3). **Note**: The ends of each seal-joint have to overlap approximately 0.375-inch (1 cm) to 0.5 in (1.3 cm) at each connection, the seal has to be longer than the space it is filling.
6. Cut required length of seal. Be careful to leave smooth, square ends. If an end has an angle or is not flat, a vacuum leak may occur.



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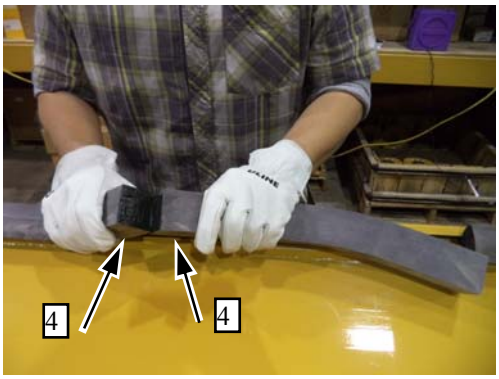
7. Remove approximately 6-inch (15 cm) of the seal still in the pad from the connecting end, so both seal ends (4) are out of the Seal-Profile channel.



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8. Apply Seal Glue (5) to both joint-ends so they are fully covered. Do not use excessive amount of Seal Glue, otherwise it will get to channel and seal removal may not be possible without damaging the seal. A thin layer of Seal Glue is enough; make sure Seal Glue covers whole cross section of seal. Use brush under the lid of Seal Glue can.

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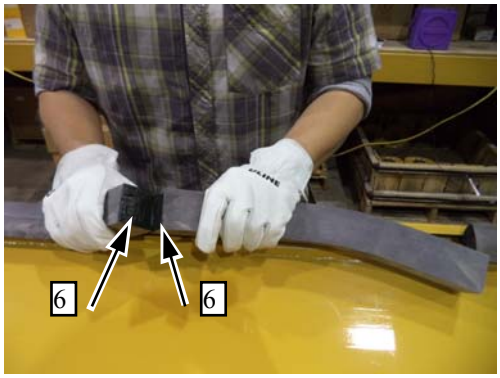
9. Allow the glue to dry, approximately 1-2 minutes.

10. After the glue is dry, apply a second coat of glue to both joint-ends (6) to reactivate the dried glue. This step will make a stronger, better boned-joint.
11. Bond the joint immediately Press the two ends firmly together to bond them (7). Remove any excess glue from outside the joint. Do not allow excess Seal Glue to get into the Seal-Profile channel. Install the joint into the profile-channel. Make sure the joined ends are aligned in the profile-channel, and that both ends are fully seated, without any step along the joint. Ensure that the whole surface is bonded together. A vacuum leak may occur if connection is not done correctly.



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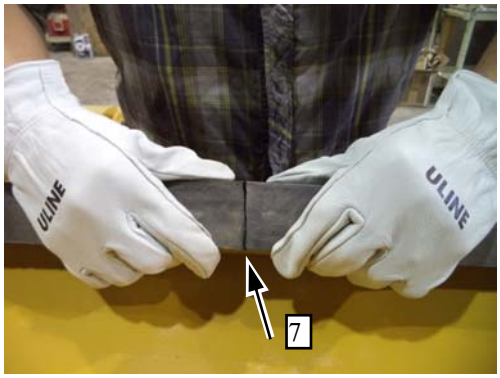

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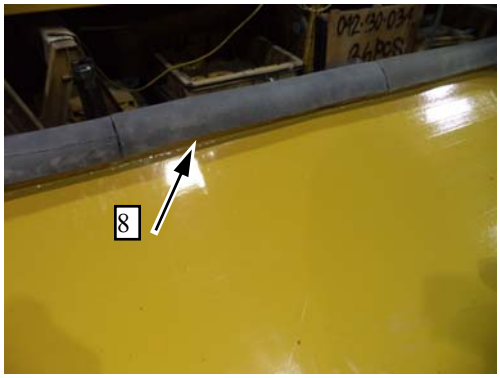
12. Place one corner of seal inside profile and while holding seal down with hand use provided Seal Tool to push other, outside edge inside the Seal Profile. Never start pushing seal closer than 12 in (30 cm) from any corner. Repeat pushing every so often until seal is inside channel. Do not stretch the seal while pushing inside profile.
13. After finishing with outside edge, push also inside edge of seal in replacing section until seal is sitting fully in channel.
14. Stop pushing seal approximately 6 in (15 cm) from the end. Remove approximately 6 in (15 cm) of seal from the other end, so both connecting ends are not in channel. Make sure seal overlaps from 0.375 in (1 cm) to 0.5 in (1.3 cm).

15. Bond the seal-joint together, following the same gluing steps outlined above.
16. Properly replaced section of seal (8) will not have any negative impact on attachment pad performance.



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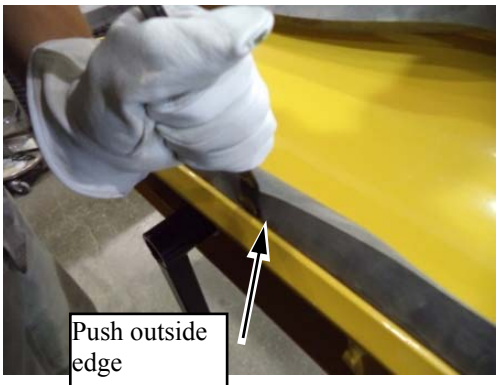
17. Check whole length of seal to ensure it is installed correctly all the way around the pad, correct where necessary on outside or inside of seal.



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Notice

This equipment is to be operated and serviced by qualified personnel only. Refer to the *Safety* section of this manual.

Do not attempt to bypass any of the safety equipment or instrumentation on this equipment.

Do not attempt to operate this equipment with any of the safety equipment or instrumentation bypassed.

General information

The following faults are some of the typical problems that can be anticipated during normal operation of the Vacuum Lifter (VL). The solutions listed are some of the acceptable corrections to those problems.

Unless otherwise instructed, all maintenance work must be performed with the Vacuum Lifter (VL) engine switched off and with the Battery Disconnect turned to OFF position. Refer to the *Operator Controls* section of this manual. Make sure the Vacuum Lifter is properly parked, see section *Machine Parking* in this manual. If using host-carrier vehicle, it must be turned off and parked properly, refer to the hoisting/host-carrier-vehicle's Operation and Maintenance Manual. Make sure the Vacuum Lifter and host-carrier-vehicles are secured against inadvertent start-up.

Vacuum Faults

1. Vacuum Won't Build Up or Reach Maximum Level
2. Vacuum Lifter Will not Pick Up or Release the Load, or Vacuum Cannot Be Discharged from the Tank
3. Vacuum Is Leaking

Vacuum Won't Build Up or Reach Maximum Level

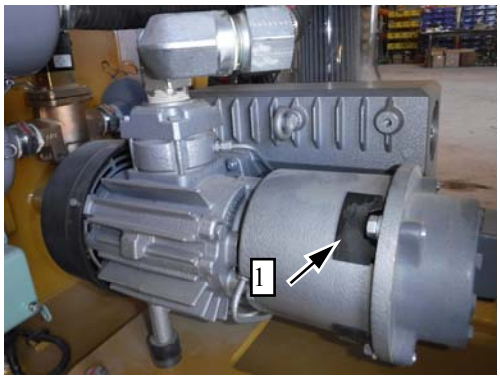
	Possible Cause	Solution
1	Vacuum Pump, Gearbox or Engine fault.	See following pages for troubleshooting for Vacuum Lifter (VL) components.
2	Vacuum Engine idling.	See *Engine Faults* section in this manual.
3	Vacuum Valve is in Pick up/Support load position.	Make sure vacuum inlet ports are covered or pad attachments are on pipe. Vacuum Valve needs at least approximately -10 inHg (-34 kPa) of vacuum to operate. Refer to *Prime Vacuum Valve* section in this manual.
4	Leaks in vacuum lines.	Make sure all vacuum hoses are securely attached and there are no leaks or open connections.
5	Obstructed vacuum lines/ports.	Verify if there are no obstructions in vacuum lines and if all ports and connections are clean and clear.
6	Atmospheric conditions.	Maximum obtainable vacuum in Vacuum Lifter (VL) is strictly dependant on current atmospheric pressure. Atmospheric pressure is decreasing for high altitudes, therefore maximum vacuum obtainable at high altitude will not be as high as at sea level. See maximum theoretical obtainable vacuum for reference: • at sea level, max vacuum is -29 inHg (-101 kPa), • in Denver, CO, USA (5,280 ft, 1600 m), max vacuum is -24 inHg (-82 kPa), • in Mexico City, Mexico (7,380 ft, 2250 m), max vacuum is -22 inHg (-80 kPa), • in La Paz, Bolivia (11,942 ft, 3640 m), max vacuum is -18 inHg (-61 kPa). **IMPORTANT:** Never attempt to work if vacuum in the tank does not reach at least -15 inHg (-50.8 kPa). Refer to *Working with a Load* section in this manual for more information.

Vacuum Lifter Will not Pick Up or Release the Load, or Vacuum Cannot Be Discharged from the Tank

	Possible Cause	Solution
1	Vacuum Valve fault.	Check *Vacuum Valve Faults* section for more troubleshooting options.
2	Wireless Remote Transmitter/Receiver fault.	Check *Load Pickup/Release Circuit with Wireless Remote Transmitter/Receiver* Faults section for more troubleshooting options.
3	Wired Controller fault.	Check *Load Pickup/Release Circuit with Wired Controller* Faults section for more troubleshooting options.
4	Obstructed vacuum lines/ports.	Verify there are no obstructions in vacuum lines and that all ports and connections are clean and clear.

Vacuum Is Leaking

	Possible Cause	Solution
1	Leaks in vacuum lines.	Make sure all vacuum hoses are securely attached and there are no leaks or open connections.
2	Leaks in Vacuum Lifter pad attachment seal.	Verify if leak is between Vacuum Lifter pad attachment and load. Check if load has smooth, clean, non-porous surface. See *Vacuum Seal Faults* section in this manual for more troubleshooting options.



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Vacuum Pump Faults

Figure 34:Vacuum Pump Won't Build Up Vacuum - Troubleshooting - numbered callouts reference numbered problem list below

Vacuum Pump Won't Build Up Vacuum

	Possible Cause	Solution
1	Vacuum Pump is not being driven.	**IMPORTANT NOTE: Never touch or come in contact with rotating elements.** Shut Engine off and turn Battery Disconnect Switch to OFF (O) position. See *Battery Disconnect Switch* section in this manual If coupling is not visible, remove black plastic cover on pump coupling cover to see coupling. Verify if coupling inside Vacuum Pump coupling cover (between Gearbox and Vacuum Pump) and/or Vacuum Pump shaft are rotating by using the Recoil Starting rope (See *Engine Recoil Starting* section in this manual). REPLACE COUPLING IF DAMAGED
2	Vacuum Engine idling.	Ensure Engine throttle lever is set to MAX position. Refer to *Engine Stop/Run/Start Switch* and *Post Start-Up (Maximum throttle/Manual throttle Minimum idle/Stop)* sections in this manual.
3	Vacuum Pump fault.	Refer to *Appendix C - Vacuum Pump Routine Maintenance and Troubleshooting* for more troubleshooting options.

Vacuum Seal Faults

Vacuum Seal Won't Stay in Channel

	Possible Cause	Solution
1	Vacuum Seal is stretched.	Make sure vacuum seal is not stretched when installing in the channel. Pay special attention while installing seal in corners. Make sure vacuum seal is sitting deep inside the channel. See *Pad Seal replacement - complete seal* or *Pad Seal Repair - short section* in this manual.
2	Working too fast.	Working too fast will contribute to the seal rolling out from the channel. Following these steps will help prevent this problem: • Try to align the Vacuum Lifter pad attachment as close to the centre of the load as possible • Use the guide wheels to assist positioning. Set the guide wheels up before starting work. See *Guide Wheel Adjustment Check* section in this manual • Do not apply vacuum until Pad Attachment is fully and correctly seated on the load • Wait until Pad Attachment Vacuum Gauges are showing 0 inHg vacuum after releasing the load. This may take a couple seconds depending on the attachment size, but will help keep the seal in the pad. **Working slower and accurately will greatly improve your efficiency.**

Vacuum Seal Is Leaking

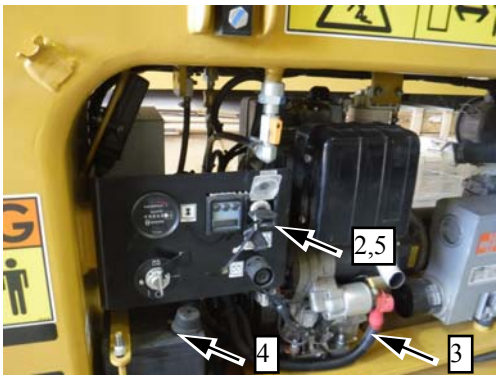
	Possible Cause	Solution
1	Vacuum Seal is installed incorrectly.	Pay special attention while installing the seal into the channel. Make sure seal is sitting deep inside the channel. See *Pad Seal replacement - complete seal* or *Pad Seal Repair - short section* in this manual.
2	Poor Vacuum Seal connection joints.	Make sure all Vacuum Seal connections in the Pad Attachment are complete, smooth, and do not have gaps. See *Pad Seal replacement - complete seal* or *Pad Seal Repair - short section* in this manual.
3	Vacuum Seal is damaged.	Vacuum Seal may get damaged and worn over time. See following steps to help increase seal life: • Work slowly and accurately, see *Vacuum Seal Won't Stay in Channel* section above • Try to avoid direct sunlight and ozone exposure to the seal, never store seals/pads in direct sunlight for any extended period of time. • Ensure lifting load is clean and its surface is free from defects Replace the seal, or section of seal, when necessary. See *Pad Seal replacement - complete seal* or *Pad Seal Repair - short section* in this manual for more information.

Vacuum Seal Seems To Be Dry And Cracked

	Possible Cause	Solution
1	Sun and ozone exposure.	Avoid direct sunlight and ozone exposure of the seal whenever possible, it can contribute to cracking and reduce seal life.

Engine Faults

1. Engine Won't Crank
2. Engine Won't Start
3. Engine Won't Go to Full Speed (Run)
4. Battery Fails to Charge or 12VDC Alternator Overcharging (High DC voltage)
5. Engine Won't Stop



Engine Won't Crank

Figure 35:Engine Won't Crank - Troubleshooting - numbered callouts reference numbered problem list below

	Possible Cause	Solution
1	Battery Disconnect Switch in OFF (O) position.	Verify if Battery Disconnect Switch is in ON (I) position. See *Battery Disconnect Switch* section in this manual.
2	Automotive style fuse blown.	Fuse is located on the back side of Engine Stop/Run/Start Switch, in the middle, inside a rubber cover. Check and replace with fuse of the same type and rating. Spare fuses are located on the bottom of electric enclosure behind the engine.
3	Loose or missing wires.	Check wires connecting Engine and Battery.
4	Low or dead battery.	Verify 12VDC battery charge capacity. Replace if battery fails to hold a charge. Attempt to jumpstart, refer to *Engine Starting with Jump Start Cables* section in this manual.
5	Faulty Stop/Run/Start switch.	Replace defective switch.
6	Bad starter motor or starter solenoid.	Replace engine's starter motor.
7	Engine fault.	Refer to *Appendix B - Engine Manual* for more troubleshooting options.

Engine Won't Start

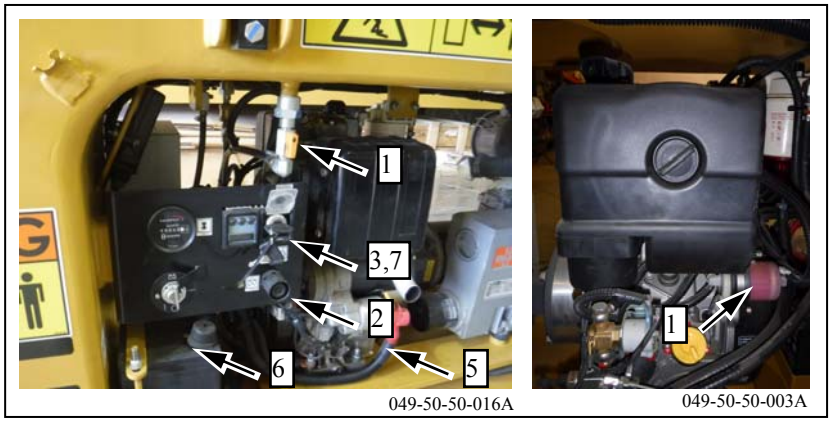


Figure 36:Engine Won't Start - Troubleshooting - numbered callouts reference numbered problem list below

	Possible Cause	Solution
1	No fuel.	Check fuel level in Fuel Tank by checking Fuel Level Gauge. Check if fuel supply line Shut-Off Valve is open. Check if Fuel Filter is not clogged. Check if Engine Fuel Filter is primed (housing is transparent). Check fuel lines for restrictions.
2	Glow Plugs (Cold Start Aid) not working/not used.	Use Glow Plugs while starting Engine in low temperatures. Refer to *Engine Stop/Run/Start Switch* and *Post Start-Up (Maximum throttle/Manual throttle Minimum idle/Stop)* sections in this manual. See *Glow* Plug Circuit Faults in this manual for Glow Plugs troubleshooting.
3	Automotive style fuse blown.	Fuse is located in the middle on the back side of Engine Stop/Run/Start Switch, inside a rubber cover. Check and replace with spare fuse of the same type and rating. Spare fuses are located on the bottom of electric enclosure behind the engine.
4	Engine throttle lever set to STOP	See *Post Start-Up (Maximum throttle/Manual throttle Minimum idle/Stop)* section in this manual for more information.
5	Loose or missing wires.	Check wires connecting Engine and Battery.
6	Low or dead battery	Verify 12VDC battery charge capacity. Replace battery if it fails to hold a charge.
7	Faulty Stop/Run/Start switch.	Replace defective switch.
8	Engine fault.	Refer to *Appendix B - Engine Manual* for more troubleshooting options.

Engine Won't Go to Full Speed (Run)

	Possible Cause	Solution
1	Vacuum Engine idling.	Ensure Throttle Lever is set to MAX position, refer to *Post Start-Up (Maximum throttle/Manual throttle Minimum idle/Stop)* section in this manual.
2	Engine fault.	Refer to *Appendix B - Engine Manual* for more troubleshooting options.

Battery Fails to Charge or 12VDC Alternator Overcharging (High DC voltage)

	Possible Cause	Solution
1	Loose or missing wires.	Check wires connecting Engine and Battery.
2	Faulty battery.	Replace battery. Maintenance-free battery is originally supplied and does not require maintenance or inspection. Refer to documentation accompanying other battery types for maintenance instructions.
3	Faulty 12VDC alternator.	Refer to *Appendix B - Engine Manual* for more troubleshooting options.

Engine Won't Stop

Figure 37:Engine Won't Stop - Troubleshooting - numbered callouts reference numbered problem list below

	Possible Cause	Solution
1	Manual reset lever in wrong position	Manual Reset Lever is on non-operator side of the engine, next to oil fill. Make sure Manual Reset Lever is in DOWN position for normal operation. Engine cannot be stopped by the Engine Stop/Run/Start Switch if Manual Reset Lever is in UP position. Turn Manual Reset Lever to stop the engine if Engine Stop/Run/Start Switch is not working.
2	Engine fault.	Refer to *Appendix B - Engine Manual* for more troubleshooting options.

Vacuum Valve Faults

Vacuum Valve Won't Switch

	Possible Cause	Solution
1	Battery Disconnect Switch in OFF (O) position.	Verify if Battery Disconnect Switch is in ON (I) position. See *Battery Disconnect Switch* section in this manual.
2	Engine Stop/Run/Start Switch in STOP position.	Verify if Engine Stop/Run/Start Switch is in START position. Refer to *Engine Stop/Run/Start Switch* section in this manual
3	Not enough vacuum in tank, or Vacuum valve not primed.	Vacuum Valve needs at least approximately -10 inHg (-34 kPa) of vacuum to operate. Refer to *Prime Vacuum Valve* section in this manual.
4	Automotive style fuse blown.	Check and replace with spare fuse of same type and rating. Spare fuses are located on the bottom of electric enclosure behind the engine. See *Electrical Circuit Faults* section for fuse location.
5	Faulty electrical connection.	See *Electrical Circuit Faults* section for more troubleshooting options.

Vacuum Valve Leaks

	Possible Cause	Solution
1	Not enough vacuum in tank to fully operate valve.	Vacuum Valve needs at least approximately -10 inHg (-34 kPa) of vacuum to operate. Refer to *Prime Vacuum Valve* section in this manual.
2	Foreign debris inside Vacuum Valve.	Vacuum Valve may need maintenance.

Gearbox Faults

Gearbox Is Leaking Oil

Note: there is a hole on the bottom of coupling cover between Engine and Gearbox for indication if there is an oil leak. Verify if the source of the leak is Gearbox or Engine.

	Possible Cause	Solution
1	Gearbox overfilled with oil.	Verify if Gearbox is not overfilled with oil. Refer to *Gearbox Oil - Change* section in this manual for oil change procedure. Oil level should be just below Oil Level Plug.
2	Wrong position of Vent Plug.	Verify position of Vent Plug. Vent Plug should be placed on upper most location. Refer to *Gearbox Oil - Change* section in this manual for more information.
3	Blown seals.	Verify if Gearbox is leaking through seals. Replace Gearbox if seals are leaking.

Gearbox Is Overheating

	Possible Cause	Solution
1	Wrong amount of oil.	Verify proper amount of oil in Gearbox. Refer to *Gearbox Oil - Change* section in this manual for oil change procedure. Oil level should be just below Oil Level Plug.
2	Old, contaminated oil.	Make sure oil is changed at specified intervals. See *Service Intervals* section in this manual for more information.
3	Break-in period.	During the initial period of operation, higher than normal temperatures may be seen, up to 160°F (71°C).

Vacuum Switch Faults

Note: Vacuum Switch unit is located on non-operator side of Vacuum Lifter (VL) on the lower, left side behind safety doors.

Vacuum Alarm is Not Functioning correctly

	Possible Cause	Solution
1	Battery Disconnect Switch in OFF (O) position.	Verify that Battery Disconnect Switch is in ON (I) position. See *Battery Disconnect Switch* section in this manual.
2	Engine Stop/Run/Start Switch in STOP position.	Verify t Engine Stop/Run/Start Switch is in RUN position. Refer to *Engine Stop/Run/Start Switch* section in this manual
3	Vacuum Switch set up improperly.	See *Vacuum Switch Setup* Guide below for more information.
4	Faulty electrical connection.	See *Electrical Circuit Faults* section for more troubleshooting options.
5	Vacuum port blocked	Check that vacuum port is not blocked or clogged with thread sealant.

Vacuum Switch Setup Guide

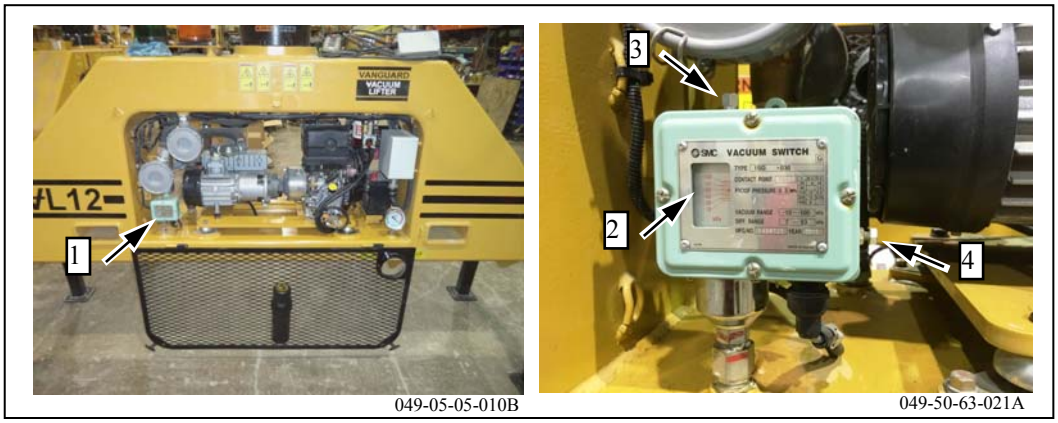


Figure 38:
Vacuum Switch Setup Guide - numbered callouts reference numbers listed below in brackets ( )

Before attempting to change Vacuum Switch (1) setup, make sure that Vacuum Gauges are working properly. Pay special attention during changes, as safety features of Vacuum Lifter (VL) rely on proper setup of this Vacuum Switch. Before starting, read through and understand all following steps.

1. Set the base pressure with Indicator (2) at -61 kPa by turning Adjusting Bolt (3) above scale. This is only for reference. Exact value has to be verified later with vacuum gauge.
2. Make sure there is no vacuum in the tank. Start the unit and build vacuum up. See *Prime Vacuum Valve* section in this manual for additional information.
3. Verify with vacuum gauge that Audible Alarm stops, that Amber Vacuum Status Beacon stops flashing, and that Green Vacuum Status Beacon starts flashing at -18 inHg (61 kPa). If not, make adjustments to increase or decrease setting as per Step 1.
4. Stop the Vacuum Engine with Engine Stop/Run/Start Switch, then turn key on "RUN" position.
5. Slowly drain the vacuum tank. See *Draining the Vacuum Lifter (VL) tank* section for more information.
6. Stop draining the vacuum tank at -15 inHg (50.7 kPa) either by closing the vacuum inlet or by operating Wireless Remote Transmitter or Wired Controller to Pick up/Support Load position.
7. Audible Alarm and Amber Vacuum Status Beacon should start at exactly -15 inHg (50.7 kPa). If they start at a different pressure, use Hysteresis Adjustment Screw (4) on the side of the Vacuum Switch to correct it. **Be careful**: loosening this bolt too much may cause it to fall out with hysteresis adjusting spring from inside the vacuum switch. Hysteresis must be within the specified range, operation may be unstable when activated out of the specified range. Adjust the Hysteresis Adjustment Screw (4) with a flat head screwdriver until alarm goes on at -15 inHg (-50.7 kPa). Turn to the right to increase and to the left to decrease. **DO NOT LOOSEN EXCESSIVELY**.
8. After above steps are finished, test the setup several times and verify that:
    a. when the vacuum level is increasing from 0 inHg to maximum: Audible Alarm and Amber Vacuum Status Beacon stop and Green Vacuum Status Beacon starts flashing at -18 inHg (61 kPa) on vacuum gauge.

b. when releasing vacuum from maximum value to 0 inHg: Green Vacuum Status Beacon stops flashing and Audible Alarm and Amber Vacuum Status Beacon start at -15 inHg (50.7 kPa) on vacuum gauge.
c. If these values are not met, adjust Vacuum Switch settings as per Points 1 - 8.

Vacuum Filters Faults

Vacuum Filters Leaking Air

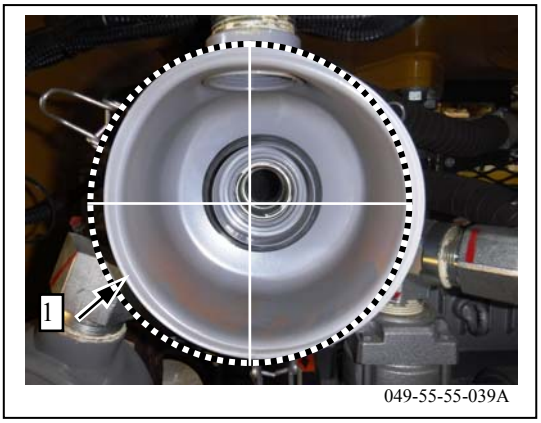


Figure 39:
Vacuum Switch Setup Guide - numbered callouts reference numbered problem list below. Guidelines shown to indicate perfect shape.

	Possible Cause	Solution
1	Housing is bent.	Check if housing is not bent, even small deformation can cause air leaks. Clean or replace filtration element and filter housing. See *Vacuum Filters - Check* section under *Maintenance and Lubrication* section in this manual.
2	Seal is dirty or damaged.	Clean seals. If leak still occurs, replace with new seals. See *Vacuum Filters - Check* section under *Maintenance and Lubrication* section in this manual.

Hydraulic Rotator Faults

Hydraulic Rotator Won't Operate

	Possible Cause	Solution
1	Hydraulic connection fault	Check hydraulic line connections. Refer to *Excavator Attachment* section in this manual.
2	Not enough hydraulic pressure	Ensure excavator hydraulic circuit is functional and it creates flow and pressure to operate Hydraulic Rotator. Refer to *Excavator Attachment* section in this manual.
3	Closed Control Valves	Open the Speed Control valves located on the yoke. See the *Yoke Rotator Speed Control Valves* section in this manual for information on how to adjust the Control Valves.
4	Left or right rotation blocked	Test opposite rotation by swapping (connecting) hoses other way around.

Hydraulic Rotator Operates Too Slow/Too Fast

	Possible Cause	Solution
1	Control Valves need adjustment	See the*Yoke Rotator Speed Control Valves* section in this manual for information on how to adjust the Control Valves.

Hydraulic Rotator Does Not Stop, attachment continues to turn

	Possible Cause	Solution
1	Oil leak on control valve of crane or excavator	Check by closing off both rotator connections. Try to rotate by hand. If rotator still turns, there is internal leak. If it does not turn, the problem is with directional control valve. Seal valve if necessary.

Vacuum Gauges Faults

Tank and Pad(s) Vacuum Gauges Do Not Show Same Value

	Possible Cause	Solution
1	Vacuum Gauge Accuracy	Gauge accuracy is ±1 inHg (3.3 kPa), which means that maximum allowable difference in vacuum indication should not exceed 2 inHg (6.6 kPa) between two different gauges. Replace defective Vacuum Gauge(s).
2	Shock loading	Vacuum Gauges are delicate instruments and repetitive shock loading can damage them. Replace defective Vacuum Gauge(s).
3	Blocked Gauge Port	Inspect Gauge connection and port to ensure no debris is blocking the port

Vacuum Gauge Dose Not Show a Vacuum Level When a Vacuum is Present

	Possible Cause	Solution
1	Defective Gauge	Replace defective Vacuum Gauge(s).
2	Blocked Gauge Port	Inspect Gauge connection and port to ensure no debris is blocking the port

Electrical Circuit Faults

When making any new connection or any alteration to an electrical circuit, always shut the Engine off and turn the Battery Disconnect Switch to OFF (O) position. See *Battery Disconnect Switch* section in this manual.

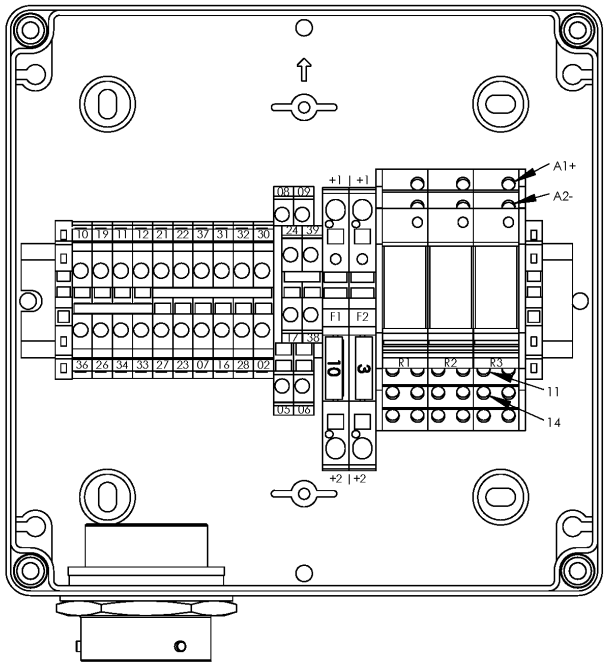
IMPORTANT: electrical schematic is shown at the end of the *Troubleshooting* section.

Always check that electric enclosure is powered up first as all electrical circuits are powered from there. If Audible Alarm and/or Vacuum Status Beacons are working, this is a clear indication that there is power in Electrical Enclosure. See *Electrical Enclosure Power Circuit* Faults section below.

1. Electrical Enclosure Power Circuit Faults,
2. Electrical Enclosure Main Harness Check,
3. Load Pickup/Release Circuit with Wireless Remote Transmitter/Receiver Faults,
4. Load Pickup/Release Circuit with Wired Controller Faults,
5. Audible Alarm and Amber Vacuum Status Beacon Circuit Faults,
6. Green Vacuum Status Beacon Circuit Faults,
7. Vacuum Switch Circuit Faults,
8. Glow Plug Circuit Faults.

Electrical Enclosure Power Circuit Faults

049-50-50-010B



049-50-63-021A - INSIDE LAYOUT OF ELECTRICAL ENCLOSURE

Figure 40:Electrical Enclosure Power Circuit Faults - Troubleshooting

Electrical enclosure is located on non-operator side of Vacuum Lifter (VL) on the right side behind safety doors. To open, unscrew the four plastic bolts at each corner.

	Possible Cause	Solution
1	Battery Disconnect Switch in OFF (O) position.	Verify if Battery Disconnect Switch is in ON (I) position. See *Battery Disconnect Switch* section in this manual.
2	Engine Stop/Run/Start Switch in STOP position.	Verify if Engine Stop/Run/Start Switch is in START position. Refer to *Engine Stop/Run/Start Switch* section in this manual
3	Low or dead battery.	Verify 12VDC battery charge capacity. Replace battery if it fails to hold a charge.
4	Automotive style fuse blown.	Verify if fuses F1 (10 AMP) and F2 (3 AMP) inside enclosure are not blown. If blown, replace with correct spare fuse. Spare fuses are located on the bottom of electric enclosure behind the engine. Always use fuse with same correct rating.
5	Relay not working	Verify if amber diode on relay R3 is ON. If diode is OFF there may be a problem with relay R3. To test function, relay R3 may be temporarily bypassed by connecting external jumper wire between terminals #11 and #14 on relay R3. Remove jumper wire after completion of the test.
6	Loose wires.	In electrical enclosure, check: • Continuity of wire #1 connected to Battery Disconnect Switch and to terminal +1 in fuse F1 in electric enclosure • Continuity of wire #2 connected to Main Ground and to terminal #2 in electric enclosure • Continuity of wire #4 connected to Fuel Solenoid on non-operator side of the Engine and to terminal +1 in fuse F2 in electric enclosure • Continuity of wire #37 between terminal +2 in fuse F1 and terminal #11 in relay R3 • Continuity of wire #35 between terminal +2 in fuse F2 and terminal A1+ in relay R3 • Continuity of wire #30 between terminal A2- in relay R3 and terminal #30, • Continuity between terminals #30 and #2 in terminals strip • Continuity of wire #36 between terminal #14 in relay R3 and terminal #36

Electrical Enclosure Main Harness Check

If there is no continuity between Electric Enclosure and any other connection, there may be a problem with the Main Harness. Disconnect the main harness from the enclosure and check each wire for continuity between female and corresponding male side as per the functions listed below.

1. Female side of main harness and wires outside of electric enclosure

Main Harness pin number	Wire number	Wire end location
1	1	Battery Disconnect Switch
2	2	Main Ground
4	4	Engine Fuel Solenoid
5	5	Vacuum Valve (4-pin harness)
6	6	Vacuum Valve (4-pin harness)
7	7	Vacuum Valve (4-pin harness)
8	8	Wireless Remote Receiver
9	9	Wireless Remote Receiver
10	10	Heater (optional)
11	11	Vacuum Switch
12	12	Vacuum Switch
13	13	Vacuum Switch
14	14	Vacuum Switch
15	15	Green Vacuum Status Beacon
16	16	Amber Vacuum Status Beacon
17	17	Amber Vacuum Status Beacon
19	19	Wireless Remote Receiver
21	21	Wireless Remote Receiver
22	22	Heater (optional)
23	23	Audible Alarm
24	24	Audible Alarm
26	26	Hour Meter
27	27	Hour Meter
28	28	Green Vacuum Status Beacon

2. Male side of main harness and wires inside electric enclosure

Main Harness pin number	Wire number	Wire end location	Terminal number
1	1	Fuse F1	+1
2	2	Terminal blocks	2
4	4	Fuse F2	+1
5	5	Terminal blocks	5
6	6	Terminal blocks	6
7	7	Terminal blocks	7
8	8	Terminal blocks	8
9	9	Terminal blocks	9
10	10	Terminal blocks	10
11	11	Terminal blocks	11
12	12	Terminal blocks	12
13	13	Relay R2	A1+
14	14	Relay R1	A1+
15	15	Relay R1	14
16	16	Terminal blocks	16
17	17	Terminal blocks	17
19	19	Terminal blocks	19
21	21	Terminal blocks	21
22	22	Terminal blocks	22
23	23	Terminal blocks	23
24	24	Terminal blocks	24
26	26	Terminal blocks	26
27	27	Terminal blocks	27
28	28	Terminal blocks	28

Load Pickup/Release Circuit with Wireless Remote Transmitter/Receiver Faults

Make sure that Electrical Enclosure is powered. If not, refer to *Electrical Enclosure Power Circuit* Faults above.

049-50-63-017A

049-55-63-017A

Figure 41: Load Pickup/Release Circuit with Wireless Remote Transmitter/Receiver Faults - Troubleshooting

1. Wireless Remoter Receiver not powered (all diodes OFF)

	Possible Cause	Solution
1	Automotive style wire-harness fuse blown.	Open Electrical Enclosure and verify that 3 AMP wire-harness fuse #19 (on wire #19) is not blown. If blown, replace with spare fuse. Spare fuses are located on the bottom of electric enclosure behind the engine.
2	Loose wires.	Open Electrical Enclosure, remove left harness from Wireless Remote Receiver and check: • continuity between terminals #36 and #19, • continuity of wire #19 connected to terminal #19 in electrical enclosure and to pin #6 in harness, • continuity of wire #21 connected to terminal #21 and pin #3 in harness, • continuity between terminal #21 and #2 in electric enclosure, • continuity of wire #2 connected to Main Ground and to terminal #2 in electric enclosure.
3	Wireless Remote Receiver Fault	Refer to *Appendix A - Wireless Remote Transmitter/Receiver Operation and Troubleshooting* for more troubleshooting options.

2. Wireless Remoter Receiver is powered and linked with Transmitter

Before checking the following points, test the Vacuum Valve by switching it with Wireless Remote Transmitter. Switching it will cause the Vacuum Valve to produce an audible "click" this means the Vacuum Valve is receiving power and the problem is not electrical related.

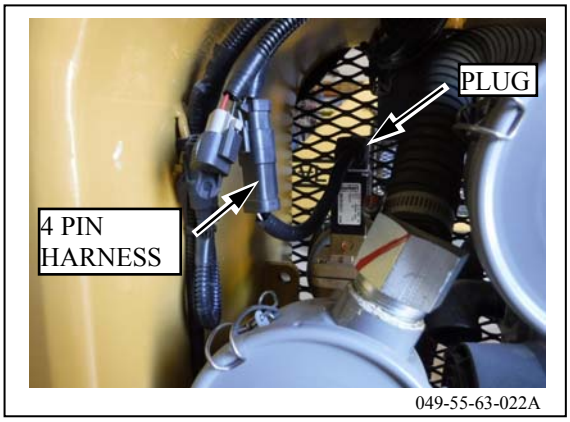


Figure 42: Load Pickup/Release Circuit with Wireless Remote Transmitter/Receiver Faults - Troubleshooting

	Possible Cause	**Solution**
1	Harness not connected	Make sure 4-pin harness connecting Vacuum Valve is connected to harness going from Electric Enclosure (not from Wired Controller), and is properly connected. See *Wired Controller Removal (Wireless Remote Transmitter connected)* section in this manual.
2	Loose wires.	Open Electrical Enclosure, remove left harness from Wireless Remote Receiver and check: • continuity of wire #8 connected to terminal #8 in electrical enclosure and to pin #7 in harness, • continuity of wire #9 connected to terminal #9 and pin #8 in harness, • continuity between terminal #5 and #8 in electric enclosure, • continuity between terminal #6 and #9 in electric enclosure.
3	Loose wires.	Remove 4-pin harness connecting Vacuum Valve and Electric Enclosure and check: • continuity of wire #5 connected to terminal #5 in electrical enclosure and to pin #1 in harness, • continuity of wire #6 connected to terminal #6 and pin #2 in harness, • continuity of wire #7 connected to terminal #7 and pin #3 in harness, • continuity between terminal #7 and #2 in electric enclosure, • continuity of wire #2 connected to Main Ground and to terminal #2 in electric enclosure.
4	Loose wires.	With 4-pin harness removed, unscrew plug from top of Vacuum Valve and check: • continuity between pin #1 in harness and contact #1 valve plug, • continuity between pin #2 in harness and contact #2 valve plug, • continuity between pin #3 in harness and contact #3 valve plug, • continuity between contact #3 and ground (⏚) contact in valve plug.
5	Wireless Remote Receiver Fault	Refer to *Appendix A - Wireless Remote Transmitter/Receiver Operation and Troubleshooting* for more troubleshooting options.

Load Pickup/Release Circuit with Wired Controller Faults

Before checking the following points, test the Vacuum Valve by switching it with Wireless Remote Transmitter. Switching it will cause the Vacuum Valve to produce an audible "click" this means the Vacuum Valve is receiving power and the problem is not electrical related.

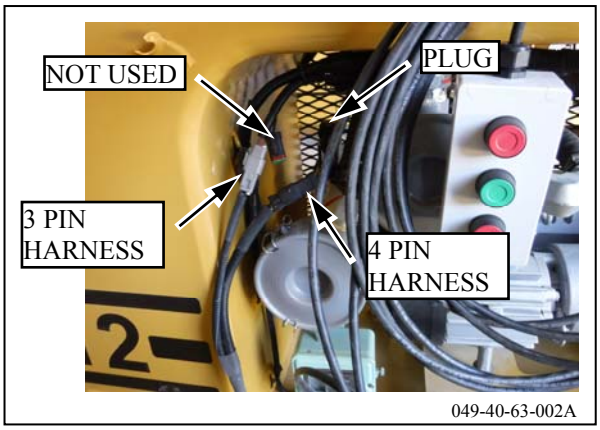


Figure 43: Load Pickup/Release Circuit with Wired Controller Faults - Troubleshooting

	Possible Cause	Solution
1	Harness not connected	Make sure 4-pin harness connecting Vacuum Valve and 3-pin harness going from Battery Disconnect Switch are connected to harnesses going from Wired Controller. See *Wired Controller Installation (Wireless Remote Transmitter disconnected)* section in this manual.
2	Automotive style fuse blown.	Verify that the 3 AMP wire-harness fuse #44 (on wire #44) connected to Battery Disconnect Switch, behind Operator Controls, is not blown. If blown, replace with spare fuse of the same rating. Spare fuses are located on the bottom of electric enclosure behind the engine.
3	Loose wires.	Disconnect 3-pin harness on cable going from Battery Disconnect Switch and check: • continuity of wire #44 connected to Battery Disconnect Switch and terminal A in harness, • continuity of wire #45 connected to Main Ground and terminal B in harness,
4	Loose wires.	Disconnect 4-pin harness between Vacuum Valve and Wired Controller and check following on Wired Controller: • continuity of wire #3 between pin #3 on 4-pin harness and pin B on 3-pin harness, • continuity of wires #25 and #18 between pin A on 3-pin harness and pin #2 on 4-pin harness with both red buttons depressed, • continuity of wires #25 and #29 between pin A on 3-pin harness and pin #1 on 4-pin harness with green button depressed.
5	Loose wires.	With 4-pin harness removed, unscrew plug from top of Vacuum Valve and check: • continuity between pin #1 in harness and contact #1 valve plug, • continuity between pin #2 in harness and contact #2 valve plug, • continuity between pin #3 in harness and contact #3 valve plug, • continuity between contact #3 and ground contact in valve plug.
6	Loose wires.	Open Wired Controller by unscrewing four bolts on each corner and verify if there are no loose or damaged wires.

Audible Alarm and Amber Vacuum Status Beacon Circuit Faults

The Audible Alarm and the Amber Vacuum Status Beacon should always flash and sound at the same time, and only when the Green Vacuum Status Beacon is not flashing. Make sure Vacuum Switch is set up properly, see section *Vacuum Switch Faults*. Make sure the vacuum level is below -15 inHg (50.7 kPa), see *Vacuum Switch Setup Guide* in this section. There should be preferably no vacuum in tank to make sure that alarms should actually work.

	Possible Cause	**Solution**
1	Harness not connected.	Make sure 2-pin harness connecting Audible Alarm is connected to harness going from Electric Enclosure and 2-pin harness going from Amber Vacuum Status Beacon is connected to harness going from Electric Enclosure. Amber Vacuum Status Beacon harness is marked with an orange zip tie.
2	Automotive style fuse blown.	Open Electric Enclosure and verify the 3 AMP wire-harness fuse #33 (on wire #33) is not blown. If blown, replace with spare fuse of the same rating. Spare fuses are located on the bottom of electric enclosure behind the engine.
3	Relay not working	Verify if amber diode on relay R2 is ON. If diode is OFF there may be a problem with relay R2. To test function, relay R2 may be temporarily bypassed by connecting external jumper wire between terminals #11 and #14 on relay R2. Remove jumper wire after completion of the test.
4	Loose wires.	In electrical enclosure, check: • continuity between terminals #36 and #33, • continuity of wire #33 between terminals #33 and #11 in relay R2, • continuity of wire #31 between terminal A2- in relay R2 and terminal #31, • continuity between terminals #31 and #2, • continuity of wire #38 between terminals #14 in relay R2 and terminal #38.
5	Loose wires.	Disconnect 2-pin harness on cable going to Audible Alarm and check: • continuity between terminal #38 and #17 in electric enclosure. • continuity of wire #17 connected to terminal #17 and terminal #1 in harness, • continuity of wire #16 connected to terminal #16 and terminal #2 in harness, • continuity between terminal #16 and #2 in electric enclosure, • continuity of wire #2 connected to Main Ground and to terminal #2 in electric enclosure.
6	Loose wires.	Disconnect 2-pin harness on cable going to Amber Vacuum Status Beacon and check: • continuity between terminal #38 and #24 in electric enclosure. • continuity of wire #24 connected to terminal #24 and terminal #1 in harness, • continuity of wire #23 connected to terminal #23 and terminal #2 in harness, • continuity between terminal #23 and #2 in electric enclosure, • continuity of wire #2 connected to Main Ground and to terminal #2 in electric enclosure.
7	Vacuum Switch.	See *Vacuum Switch Circuit* Faults section below.

Green Vacuum Status Beacon Circuit Faults

Green Vacuum Status Beacon should always flash when both the Audible Alarm and Amber Vacuum Status Beacon are off. Make sure Vacuum Switch is set up properly, see *Vacuum Switch Faults* section and make sure vacuum level is above set up value, there should be preferably maximum obtainable vacuum in tank, but at least -18 inHg (-61 kPa) to make sure that alarm should actually work.

	Possible Cause	**Solution**
1	Harness not connected.	Make sure 2-pin harness connecting Green Vacuum Status Beacon is connected to harness going from Electric Enclosure. Green Vacuum Status Beacon harness is marked with green zip tie.
2	Automotive style fuse blown.	Open Electric Enclosure and verify the 3 AMP wire-harness fuse #34 (on wire #34) is not blown. If blown, replace with spare fuse of the same rating. Spare fuses are located on the bottom of electric enclosure behind the engine.
3	Relay not working	Verify if amber diode on relay R1 is ON. If diode is OFF there may be a problem with relay R1. To test function, relay R1 may be temporarily bypassed by connecting external jumper wire between terminals #11 and #14 on relay R1. Remove jumper wire after completion of the test.
4	Loose wires.	In electrical enclosure, check: • continuity between terminals #36 and #34, • continuity of wire #34 between terminals #34 and #11 in relay R1, • continuity of wire #32 between terminal A2- in relay R1 and terminal #32, • continuity between terminals #32 and #2, • continuity of wire #2 connected to Main Ground and to terminal #2 in electric enclosure.
5	Loose wires.	Disconnect 2-pin harness on cable going to Green Vacuum Status Beacon and check: • continuity of wire #15 between terminal #14 on relay R1 and #1 in harness, • continuity of wire #28 connected to terminal #28 and terminal #2 in harness, • continuity between terminal #28 and #2 in electric enclosure, • continuity of wire #2 connected to Main Ground and to terminal #2 in electric enclosure.
6	Vacuum Switch	See *Vacuum Switch Circuit* Faults section below.

Vacuum Switch Circuit Faults

There are two Vacuum Switch working alternately - when the first one is open, the second one is closed and vice versa. Switches are operated by vacuum-level in the tank. Before checking the following steps, make sure Vacuum Switch is set up properly, see *Vacuum Switch Setup Guide* in this section.
Also make sure the vacuum gauges are working properly, see *Vacuum Gauges Faults* section.

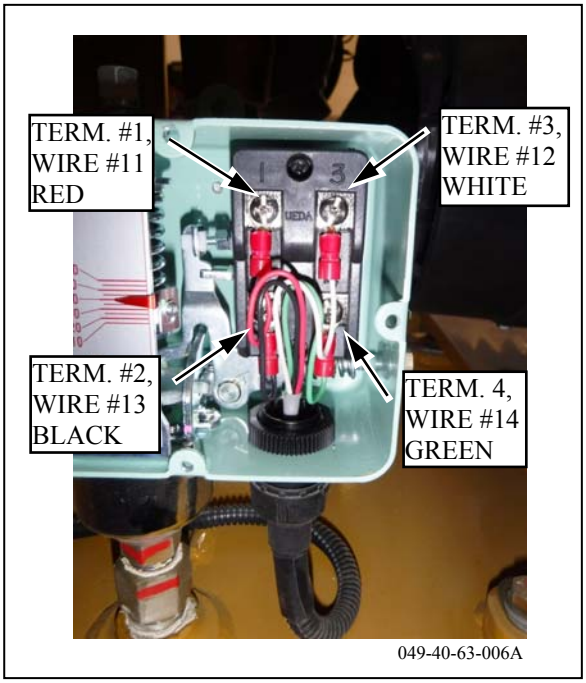


Figure 44:Vacuum Switch Circuit Faults troubleshooting

	Possible Cause	Solution
1	Automotive style fuse blown.	Open Electric Enclosure and verify the 3 AMP wire-harness fuse #11 (on wire #11) and the 3 AMP wire-harness fuse #12 (on wire #12) are not blown. If blown, replace with spare fuse from of the same rating. Spare fuses are located on the bottom of electric enclosure behind the engine.
2	Harness not connected.	Make sure ring terminals inside Vacuum Switch are connected properly. Open front cover of Vacuum Switch by unscrewing four bolts on each corner and check if: • red wire #11 is connected to terminal #1, • black wire #13 is connected to terminal #2, • white wire #12 is connected to terminal #3, • green wire #14 is connected to terminal #4.
3	Faulty switches.	Verify continuity between switches. Note, that always one switch will be open and another closed. Check switches with no vacuum in tank and with full vacuum to make sure both are working. Check: • continuity between terminals #1 and #2, • continuity between terminals #3 and #4.
4	Loose wires.	Check: • continuity of wire #11 between terminal #11 in electric enclosure and terminal #1 in vacuum switch, • continuity of wire #12 between terminal #12 in electric enclosure and terminal #3 in vacuum switch, • continuity of wire #13 between terminal #2 in vacuum switch, and terminal A1+ in relay R2, • continuity of wire #14 between terminal #4 in vacuum switch, and terminal A1+ in relay R1.

Glow Plug Circuit Faults

You can verify if Glow Plugs are working by looking at Glow Plugs Indicator Light next to Glow Plug Push Button. See *Glow Plug* section in this manual for more information.

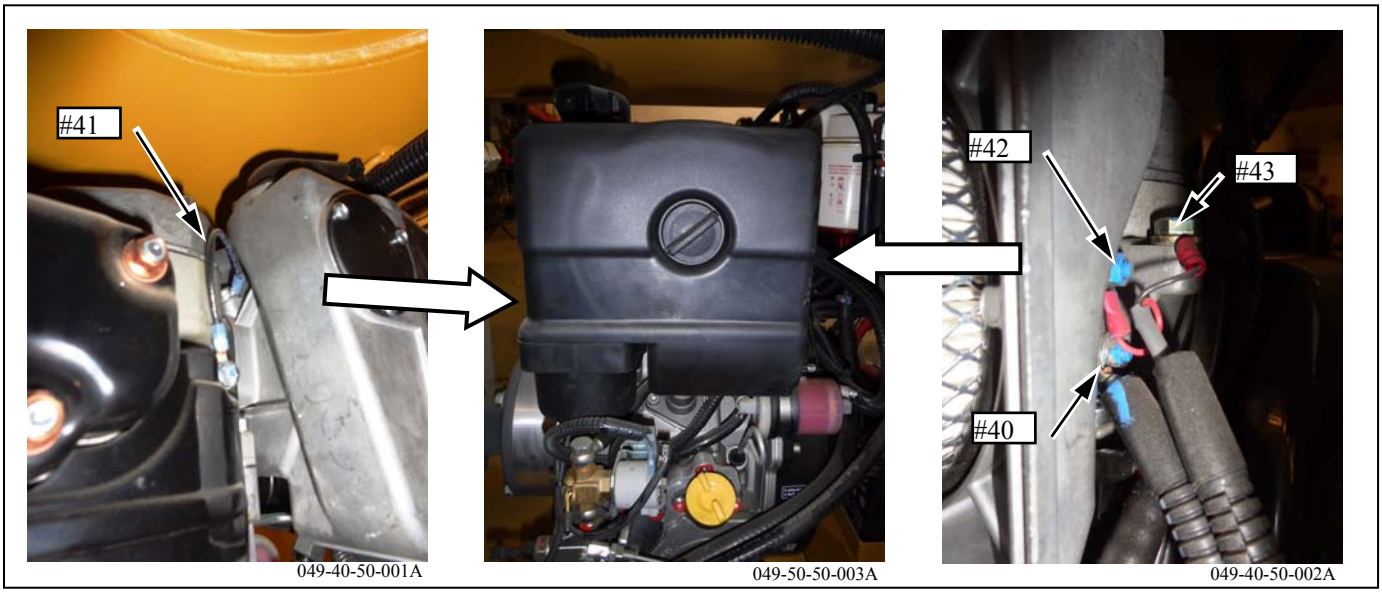


Figure 45:
Glow Plug Circuit Faults troubleshooting

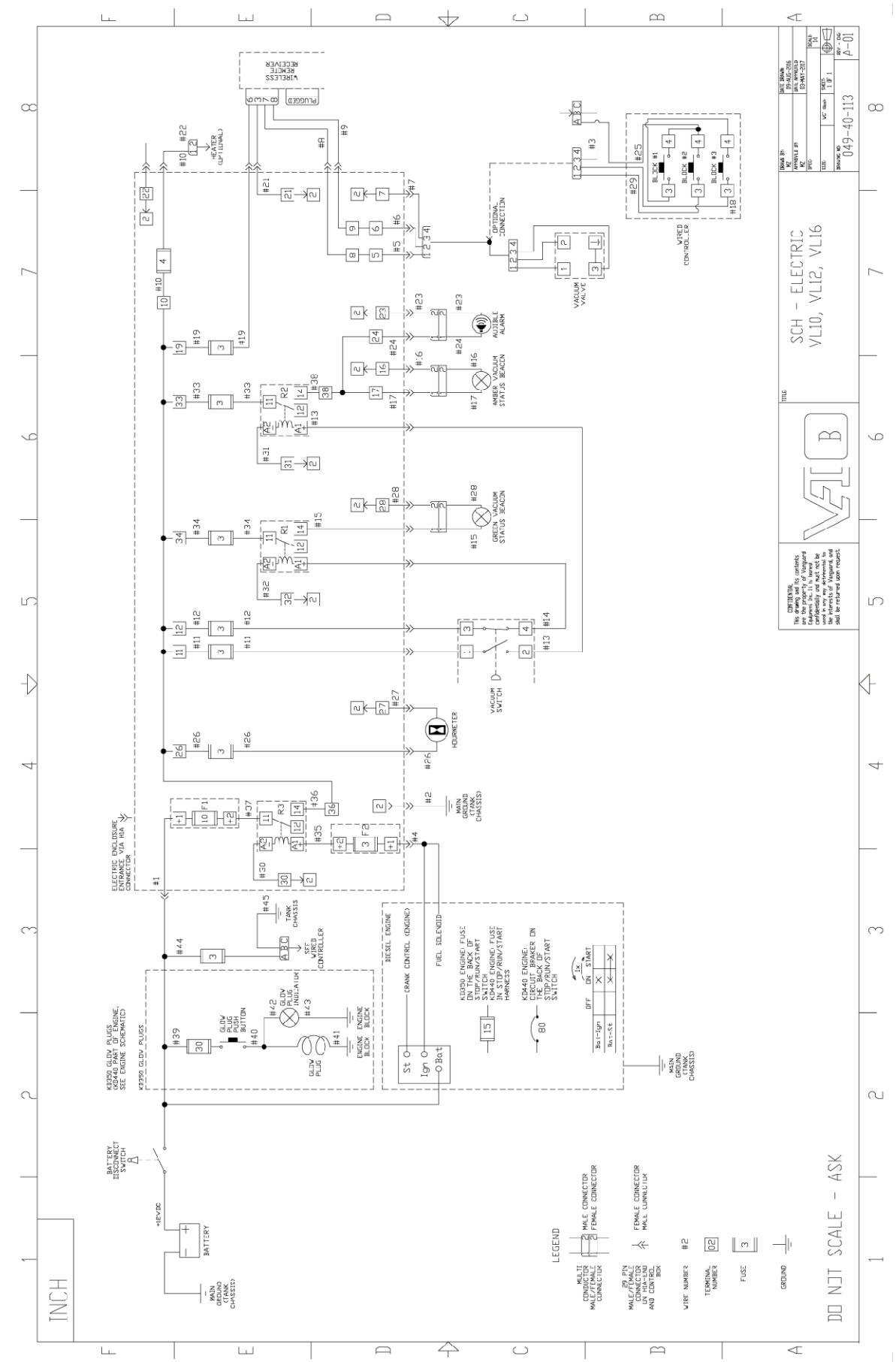
1. **If Indicator Light is turning ON when pressing Glow Plug Push Button, it means that Glow Plugs are receiving power. To verify completion of circuit check following:**

	Possible Cause	Solution
1	Loose ground wire	Check continuity of wire #41 from Engine Air Cleaner to Engine Block. Wire is accessed from the front of Engine (shaft side) on the right side. It is a black wire with two ring terminals.

2. **If Indicator Light is not turning ON when pressing Glow Plug Push Button, check following:**

	Possible Cause	Solution
1	Battery Disconnect Switch in OFF (O) position.	Verify if Battery Disconnect Switch is in ON (I) position. See *Battery Disconnect Switch* section in this manual.
2	Automotive style fuse blown.	Verify if fuse on wire #39 behind Operator Controls is not blown. If blown, replace with spare fuse of the same rating. Spare fuses are located on the bottom of electric enclosure behind the engine.
3	Loose wires.	Check: • continuity of wire #39 from Battery Disconnect Switch to Glow Plug Push Button top terminal on Operator Controls, • continuity between Glow Plug Push Button top and bottom terminals when Button is depressed, • continuity of wire #40 between Glow Plug Push Button bottom terminal and Glow Plug bottom terminal on the Engine, • continuity between Glow Plug top and bottom terminals on the Engine, • continuity of wire #42 between Glow Plug top terminal and Indicator Light top terminal, • continuity between Indicator Light top and bottom terminals, • continuity of wire #43 between Indicator Light bottom terminal and Engine block, on the right of Glow Plug terminals, • continuity of wire #41 from Engine Air Cleaner to Engine Block. Wire is accessed from the front of Engine (shaft side) on the right side. It is a black wire with two ring terminals.

Electrical Schematic



Appendices: Equipment Modules' Operation and Maintenance Manuals

A) Wireless Remote Transmitter/Receiver Operation and Troubleshooting

B) Engine Manual and Troubleshooting

C) Vacuum Pump Routine Maintenance and Troubleshooting

Appendix A - Wireless Remote Transmitter/Receiver Operation and Troubleshooting

The following pages are taken from information published by the original equipment manufacturer (OEM), and are subject to change without notice.

Power the Transmitter

1. Install Batteries

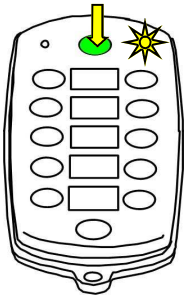
Remove the battery cover on the back of the transmitter using a slotted screwdriver and insert 4 "AA" alkaline batteries. Orientation of the batteries is embossed inside the battery housing.

T110 Battery Housing

2. Turn on the Transmitter

Refer to the **Light Legend** below for diagram details.

1. Press Power [ON]



WARNING: do not install batteries backwards, charge, put in fire, or mix with other battery types. May explode or leak causing injury. **Replace all batteries at the same time as a complete set and do not mix and match battery types.**

NOTE: *For operation at temperatures below –10°C lithium batteries are recommended. Low temperatures reduce battery performance for both alkaline and lithium types. Refer to the battery manufacturer's specifications for detailed information on low temperature performance.*

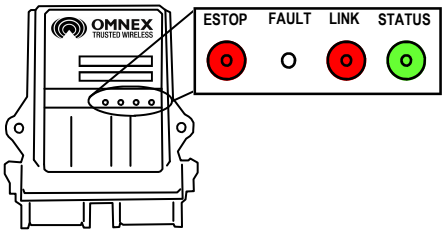
If the transmitter's (Active) light does not flash, check the battery orientation.

To turn off the transmitter, press the Power [OFF] button.

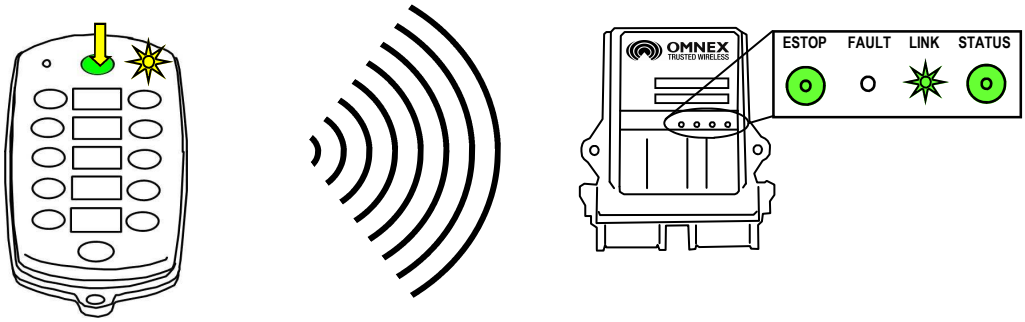
Test the Transmitter / Receiver Link

Follow these steps to ensure that there is a radio link between the transmitter and receiver.
Refer to the **Light Legend** below for diagram details

1. Power R160



2. Power T110



NOTE: *The transmitter will shut itself off (and the receiver will then shut off all outputs) after 10 minutes of inactivity as a battery saving feature. Momentarily operating any button on the transmitter, including the [Power] button will restart the 10 minute timer.*

The ORIGA System is now ready for use.

If the receiver's (Link) light does not become GREEN follow the steps under **Download ID Code**.

Light Legend	Solid	Slow Flash	Fast Flash	Red Light	Green Light	Yellow Light	Alternating Red & Green Light

Download ID Code (Use in case of Link Test failure)

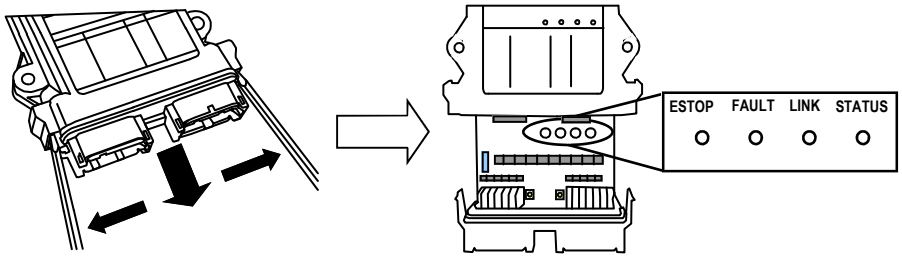
Follow these steps to download the transmitter's unique ID Code into the receiver. This will allow the receiver to establish a radio link with a specific transmitter. Refer to **Troubleshooting Chart #4** for Tips and Considerations

NOTE: *It is necessary to download the ID Code when replacing either the transmitter or the receiver.*

1. Opening the R160 Case

The cap is held on by two plastic tabs at opposing sides, which can be unlatched as shown using a screwdriver. Once the cap is free, the R160 can slide open.

Use a small slotted screwdriver to press the Side Tabs inward.



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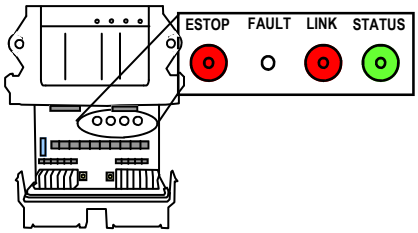
2. Power R160

A. Supply power to the receiver. The (E-Stop) light and the (Link) light will come on RED and the (Status) light will come on GREEN

A.



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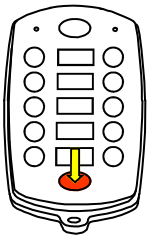
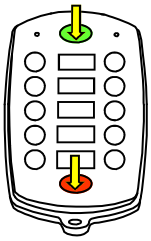
3. Power T110 into Configuration Mode

A. Press and Hold Power [OFF]
B. Press and Hold Power [ON]
C. Release Power [OFF] button
D. Release Power [ON] button

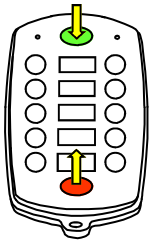
A.



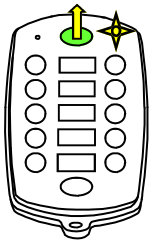
B.



C.



D.



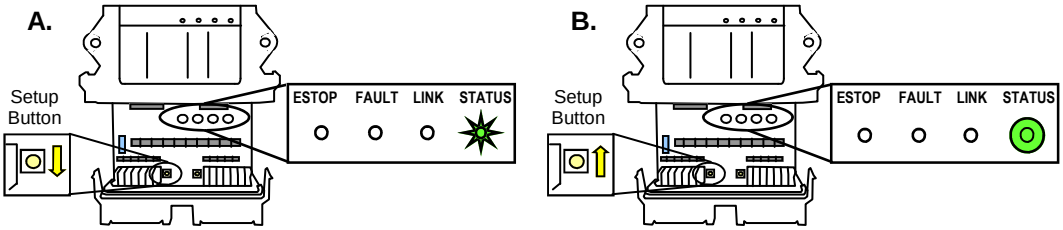
Light Legend	Solid	Slow Flash	Fast Flash	Red Light	Green Light	Yellow Light	Alternating Red & Green Light

Download ID Code (Use in case of Link Test failure)

4. Put R160 into Setup Mode

A. Press & hold [Setup] button until (Status) light goes from slow flash to fast flash

B. Release [Setup] button. (Status) light goes to solid GREEN, (Link) light turns off



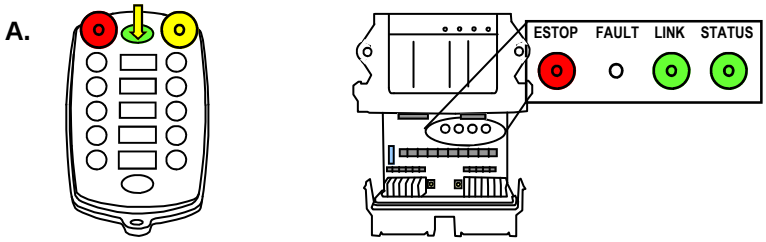
NOTE: *If left idle in Setup Mode for over 30 seconds, the receiver will time out. The (Link) light and (Status) light will flash RED rapidly. To return to Setup Mode, repeat step 4.*

---

5. Send Code

NOTE: *When downloading a new ID to a receiver, a safety feature requires that the transmitter be in close proximity to the receiver. This will prevent a transmitter from accidentally reprogramming a different receiver in the area.*

A. Press Power [ON] button to send code

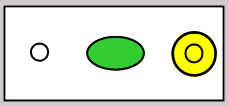
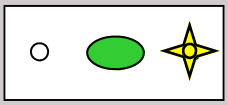
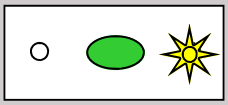
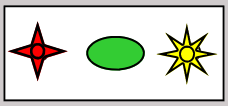
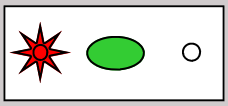
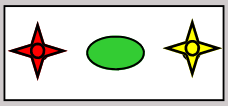
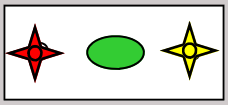
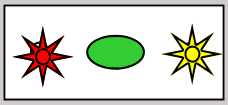
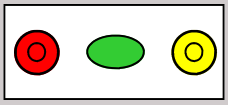


Once the ID Code has been downloaded, the RED (Battery) light and the YELLOW (Active) light on the transmitter will go out. The (Link) light on the receiver will change from GREEN to RED.

NOTE: *When replacing the receiver cover, ensure the cover snaps completely into place to create a weather proof seal around the base of the receiver.*

Light Legend	Solid	Slow Flash	Fast Flash	Red Light	Green Light	Yellow Light	Alternating Red & Green Light

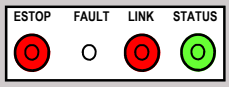
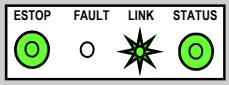
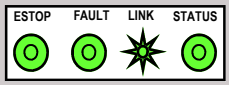
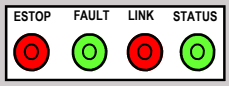
Diagnostics—T110 Transmitter

Indicator Lights	Description	Solution
	Occurs when ever a function is pressed. Will also remain on momentarily on Power Up.	N/A
	Transmitter is in Download mode.	To take it out of Download mode turn transmitter off and turn it back on again.
	Transmitter is in Operating mode.	N/A
	Low Battery.	Change Batteries ***Note:*** *Low batteries will last approximately 8 hours once the Low Battery light begins to flash. Replace batteries during next break.*
	Fast Flash for approx. 10 seconds indicates T110 failure.	Send the unit in for service.
	Stuck button detected.	Toggle the buttons a few times. Call for service. Send the unit in for service.
	**On Power Down** Unit is still powered, likely due to an on function or stuck button.	Toggle the buttons a few times. Call for service. Send the unit in for service.
	Transmitter is in Configuration mode.	To take it out of Configuration mode turn transmitter off and turn it back on again.
	Transmitter is downloading ID Code.	Wait for approximately 5 seconds. Once the download is complete the transmitter will automatically shut off.

Light Legend	Solid	Slow Flash	Fast Flash	Red Light	Green Light	Yellow Light	Alternating Red & Green Light

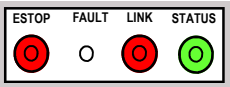
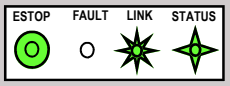
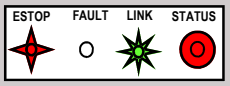
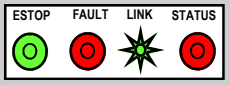
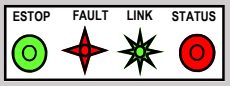
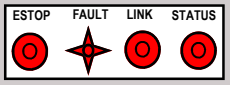
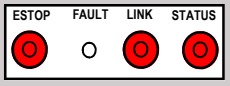
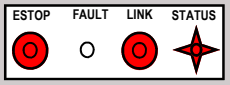
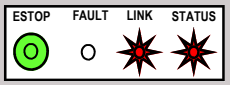
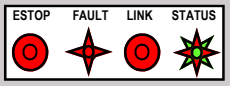
Diagnostics - R160 Receiver

Normal Operation

	Transmitter is OFF If the transmitter is off, the receiver is operating properly.
	Transmitter is ON When the transmitter is turned on, the Link light (fast flashing) and E-Stop (GREEN) indicates the receiver is operating properly
	Transmitter is in Operation When a function is activated on the transmitter, the Fault light will turn on GREEN. This indicates the receiver is operating properly
	Transmitter is OFF When a latched function is activated then the transmitter is turned off, the Fault light will stay on GREEN. If the system was intentionally designed this way, the receiver is operating properly, if not call for service.

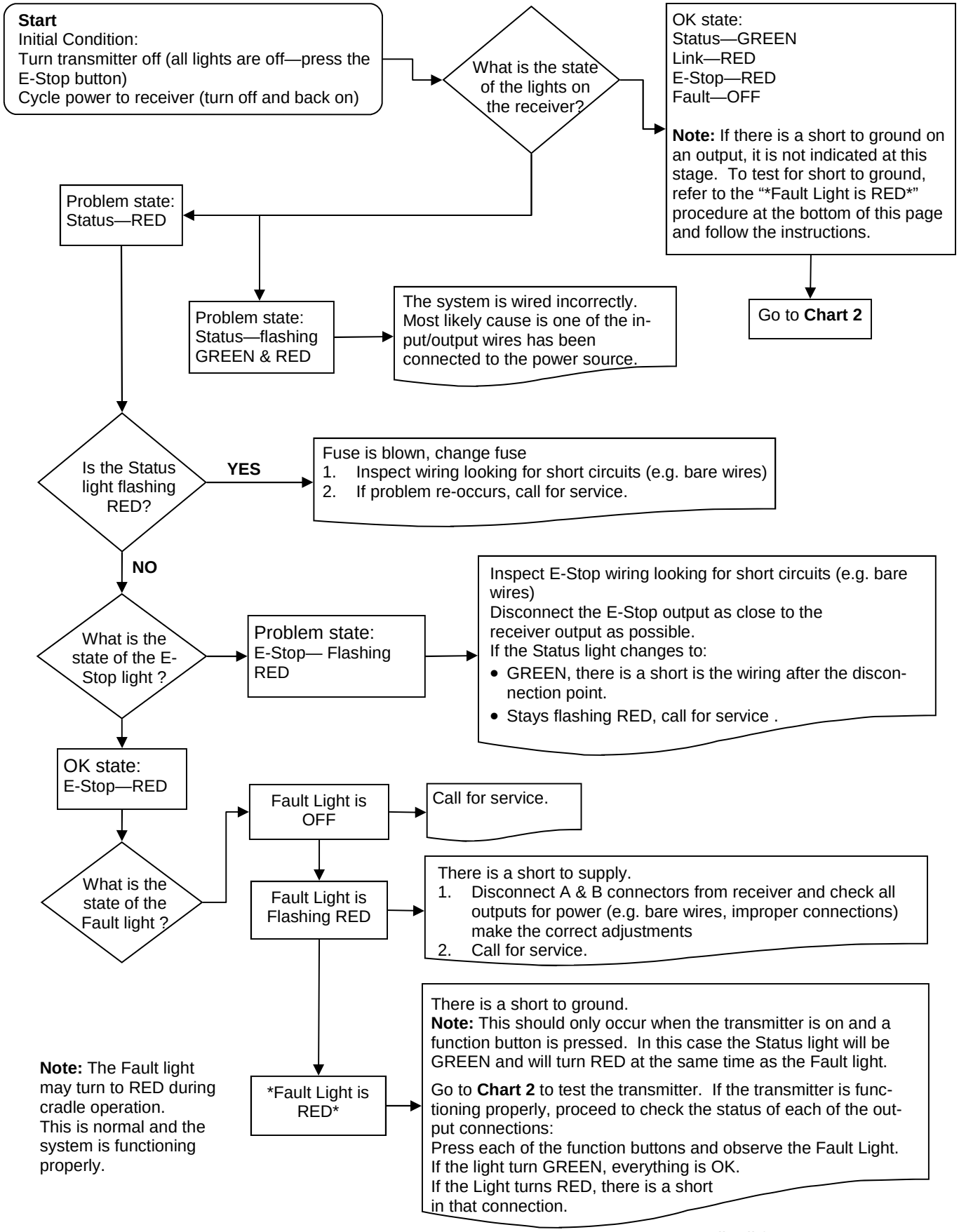
Trouble Indicators

Note: *In some cases, the indicator lights will be different depending on whether the transmitter is on or off. Please note the transmitter status in the "Description" column for each case.*

Indicator Lights	Description	Solution
	Transmitter is ON The reason is the transmitter is not communicating with the receiver.	Refer to **Troubleshooting Chart #3** for solutions
	Transmitter is ON A low battery condition has been detected.	To detect intermittent conditions caused by poor or corroded ground or power circuits, the GREEN light will continue to flash for 30 seconds after the condition has been removed.
	Transmitter is ON An internal fault with the E-Stop has been detected.	Inspect E-Stop wiring for short circuit. Disconnect E-Stop wire as close to the receiver output as possible. If the Status light changes to: • GREEN, a short occurs after disconnection point. • Stays flashing RED, send it in for service .
	Transmitter is ON A short to ground or excessive current draw on an output. It is most likely caused by a wiring fault.	Ensure transmitter is functioning properly, check status of each output connection: Press each function button and observe Fault Light. • If GREEN, everything is OK. • If RED, there is a short in that connection.
	Transmitter is ON The E-Stop output has been connected with one of the other outputs	Follow the wire and check for connections with other wires, disconnect to see if condition clears. If not, call for service.
	Transmitter is OFF A wiring short to the battery has been detected.	Refer to **Troubleshooting Chart #1** for solutions
	Transmitter is OFF The receiver has detected an internal fault.	Refer to **Troubleshooting Chart #1** for solutions
	Transmitter is OFF Blown fuse detected.	Refer to **Page 6** for instructions on how to open the receiver case to access fuse. Check wiring for shorts or bare spots. If fuses continue to blow, call for service.
	Transmitter is ON A setup failure has occurred.	Either hold the Setup button for 5 seconds to return to Setup mode or cycle power to return to the normal operating mode.
	Transmitter is OFF The receiver is powered incorrectly.	Most likely cause of this condition is that an output wire or the E-Stop wire has been connected to the power supply while the power wire is disconnected from the power supply.

Light Legend	Solid	Slow Flash	Fast Flash	Red Light	Green Light	Yellow Light	Alternating Red & Green Light

Test the Receiver—R160



Test the Transmitter—T110

Turn off the receiver
Ensure there are good batteries in the transmitter
Turn on the transmitter

What is the state of the lights?

OK state:
Active light—steady for about 3 seconds then goes to fast flash.
Battery light—OFF

Press one of the buttons

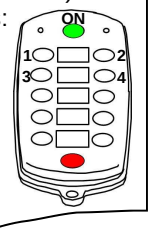
Does the Active light go to solid YELLOW?

NO

YES

Go to **Chart 3**

The transmitter may be in secure mode (this will only be the case if the transmitter has been programmed for the secure mode feature)
To check for this follow these steps:
1. Turn off transmitter
2. Turn on transmitter
3. Press these buttons in order:
   - 3, 1, 4, 2, ON (Green)
4. Press anyone of the buttons



Does the Active light go to solid YELLOW?

YES

NO

Reconfigure the transmitter to ensure it is out of secure mode
Refer to the Installation / Configuration manual for directions.

Neither light comes on at any time

Complete the following steps in order:
1. Check battery orientation
2. Clean battery contacts
3. Check or Replace batteries
4. Send in for service

Both the Active light and the Battery light flash at the same time

Stuck button:
1. Toggle the buttons a few times
2. If condition persists, send the unit in for service

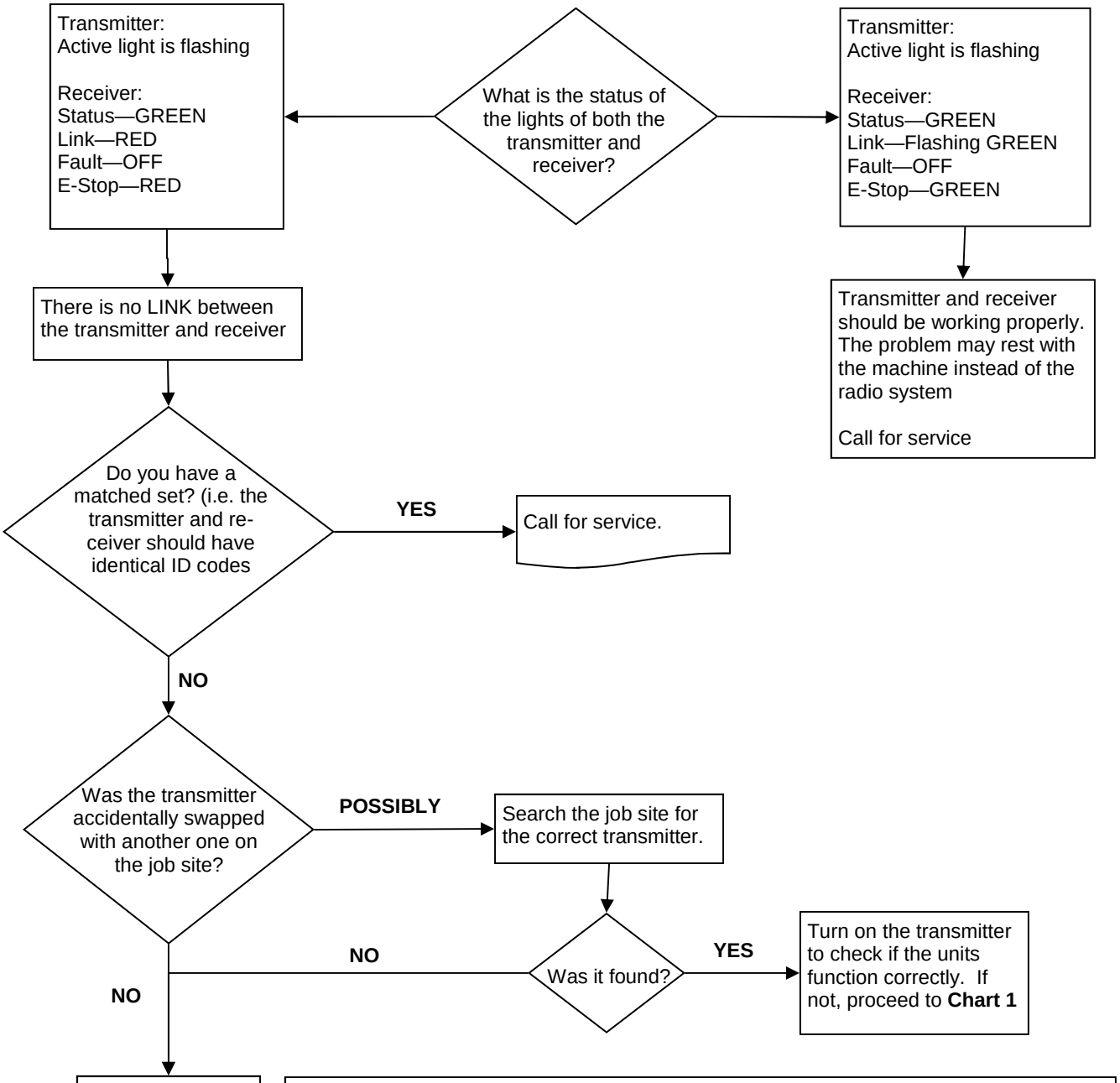
Active light and Battery light flashing alternately

Low Battery—Change Batteries
Note: *Low batteries will last approximately 8 hours once the Low Battery light begins to flash. Replace batteries during next break.*

Battery light flashes for 10 seconds then both lights are OFF

Transmitter failure—send unit in for service

Testing the Transmitter / Receiver Communication



!!Caution!!

Note: Before you proceed with the Download ID procedure located on **Page 7,** great care and caution must be adhered to. Also, refer to **Chart #4** for Tips and Considerations.

If by accident, the transmitters have been switched with another unit, by downloading the ID code to a new receiver, it is possible for the transmitter to operate 2 units at the same time (if the original receiver unit is still on the job site). Therefore it must be certain that the transmitter / receiver pair are the correct set.

Secondly, once the download procedure is completed, ensure all other units on the job site are stopped. Test the operation of the newly configured set to ensure no other machines on the site work with the same transmitter.

Once you are certain that the transmitter / receiver pair are a unique set, continue normal operations.

Considerations when Downloading the ID

Potential downloading issues

If testing of the receiver and transmitter both show the system as working (Chart 1 & 2), then the transmitter and receiver will both go into Download/Configuration mode.

Possible issues could arise during Step 4, the download phase of reprogramming. In this case there are 2 symptoms to look for:

1. The Link light on the receiver will not turn GREEN when the power switch is toggled on the transmitter to download
2. The receiver will "time out" indicating that it didn't receive a signal from the transmitter within the 30 seconds from the time the receiver was put into Setup Mode.

If all indications appear normal during the download phase, test the link by turning on the transmitter (note: the transmitter shuts off after transmitting the ID code in Step 4)

1. If the Link light on the receiver doesn't turn GREEN, the receiver didn't receive all of the information that was sent from the transmitter.

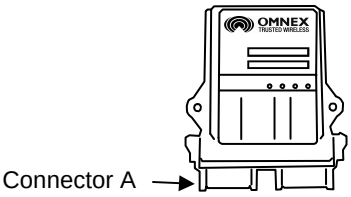
Possible Solutions

1. Try the Downloading steps again
2. If this doesn't correct the problem, send both the transmitter and receiver in for service.

Note: *you could try to determine whether the fault lies with the transmitter or receiver by completing the Reprogramming procedure with a different transmitter. If this step works, then the fault lies with the original transmitter. If not, the fault may lie with the receiver.*

!!Caution!!

Note: Before attempting reprogramming with another transmitter, understand that reprogramming the receiver with another transmitter, could result in two receivers on the job site responding to the one transmitter. If the original transmitter was sent in for repair, disconnect the receiver (disconnect connector A) to continue using the machine without remote capability and without fear of inadvertently operating the machine with the other transmitter.



Reprogramming Tips:

1. Be patient and deliberate when pressing the Power and E-Stop buttons in the correct order during power up in Configuration mode
2. Use a pointy instrument to depress the Setup button on the receiver (i.e. a pen) as the button is relatively small
3. Follow each step as laid out in the procedure
4. Never lay the receiver circuit board down on anything metallic (there are contact points on the back which could contact the metal and damage the receiver)

Appendix B - Engine Manual and Troubleshooting

The following pages are taken from information published by the original equipment manufacturer (OEM), and are subject to change without notice.

MAINTENANCE
MANUTENZIONE
ENTRETIEN
WARTUNG
MANUTENCION
MANUNTENAÇÃO

- **Perform all maintenance procedures after engine has cooled.**
- **Le operazioni di manutenzione vanno effettuate a motore freddo.**
- **Les opérations d'entretien doivent être effectuées à moteur froid.**
- **Die Instandhaltungsarbeiten bei kaltem Motor ausführen.**
- **Los trabajos de mantenimiento se hacen con motor frio.**
- **As operações de manuntenção fazem-se com o motor frio.**

KOHLER®

Use only genuine Kohler repair parts. Failure to use the correct replacement parts could cause severe engine wear or damage, and may void the warranty. Follow all procedures and recommendations in this document.

Utilizzare esclusivamente ricambi Kohler. L'uso di ricambi scorretti può causare gravi danni al motore o accelerarne l'usura e può invalidare la garanzia.
Il mancato rispetto delle operazioni descritte nelle pagine seguenti possono comportare il rischio di danni tecnici alla macchina e/o all'impianto. L'inosservanza provoca la decadenza della garanzia.

Utiliser uniquement des pièces de rechange Kohler d'origine. Ne pas utiliser les pièces de rechange correctes pourrait entraîner l'usure ou des dégâts graves du moteur et pourrait annuler la garantie.
La non-observance des opérations décrites dans les pages suivantes peut comporter le risque de dommages techniques à la machine et / ou à l'installation. La garantie n'est plus valable en cas d'inobservation.

Nur Original-Ersatzteile von Kohler verwenden. Bei Verwendung anderer Teile besteht die Gefahr von schweren Motorbeschädigungen oder hohem Motorverschleiß und Sie können Ihren Garantieanspruch verlieren.
Die Nichtbeachtung der Vorgänge, die auf den folgenden Seiten beschrieben sind, können zu technischen Schäden an der Maschine und/oder der Anlage führen.
Bei Behandlungs- oder Wartungsfehler erlischt die Garantie verlangen.

Use únicamente piezas de repuesto originales Kohler. No utilizar las piezas de repuesto correctas puede ocasionar graves daños o desgaste del motor, y puede anular la garantía.
El incumplimiento de las operaciones descriptas en las páginas siguientes puede acarrear daños técnicos a la máquina y/o a la instalación. El incumplimiento provoca la anulacion de la garantia.

Utilize apenas peças de substituição originais da Kohler. A utilização das peças de reposição incorrectas pode causar danos graves ou desgaste ao motor e com isto anular a garantia.
A falta de cumprimento das operações descritas nas páginas seguintes podem comportar o perigo de danos técnicos para a máquina e/ou para a instalação. A inobservância provoca a decadência da garancia.

AFTER FIRST 50 HOURS OF OPERATION
SOLO DOPO LE PRIME 50 ORE
APRES LES 50 PREMIERES HEURES
NACH DEN ERSETEN 50 BETRIEBSSTUNDEN
DESPUÉS DE LAS PRIMERAS 50 HORAS
APÓS AS PRIMEIRAS 50 HORAS

Change Oil
Sostituzione Olio Motore
Remplacement Huile Moteur
Öldaten-Wechsel.
Sostitución Aceite del Motor
Substituição óleo do motor

p. 68-69

Replace Oil Filter
Sostituzione Filtro Olio
Remplacement Filtre à Huile
Ölfilter-Wechsel
Sostitución filtro Aceite
Substituição Filtro Óleo

p. 70-72

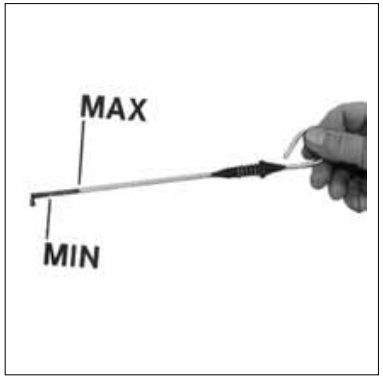
Every 10 Hours
Ogni 10 Ore
Toutes les 10 Heures
Alle 10 Stunden
Cada 10 Horas
Cada 10 Horas

10 Hours
H 10

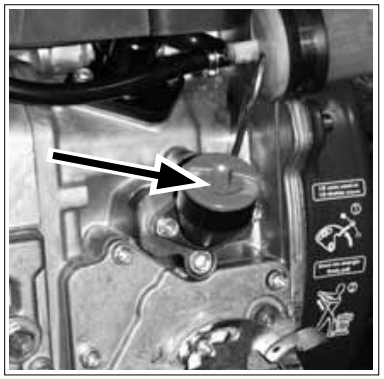
Check Oil Level
Controllo Livello Olio Motore
Contrôle Niveau Huile Moteur
Motorölstand-Kontrolle
Control Nivel Aceite del Motor
Contrôle Nivel Óleo do Motor

- Make sure engine is stopped, level, and cool so oil has time to drain into sump.
- Il rifornimento e il controllo livello olio deve essere effettuato con il motore in posizione orizzontale.
- Le ravitaillement et le contrôle du niveau d'huile doit être fait avec le moteur sur une surface plane.
- Um das Öl nachzufüllen und den Stand zu prüfen, muß der motor immer eben stehen.
- El abastecimiento y el control nivel aceite debe efectuarse con el motor sobre terreno plano.
- O abastecimento e o controle do nível do óleo deve ser feito com o motor em posição perfeitamente horizontal.

- Remove dipstick and read oil level; reinstall dipstick correctly.
- Controllare che il livello sia quasi al massimo. Reinserire in modo corretto l'asta livello olio.
- Verifier que le niveau soit presque au maximum. Remettre correctement en place la jauge d'huile
- Kontrollieren dass der Ölstand fast Maximum zeigt. Den Ölmeßstab auf korrekte Weise einstecken.
- Controlar que el nivel se encuentre casi al màximo. Reintroducir en modo correcto la varilla nivel aceite.
- Controlar que o nivel seja quase ao maximo. Introduzir correctamente a haste do nível do óleo.



- In some applications, the oil filling inlet cannot be accessed through the opening located on the rocker-arm cover. Use the fill tube on the drain side or on the air filter side, as shown below.
- In alcuni casi non sarà possibile effettuare il rabbocco dell'olio dal tappo presente sul cappello bilancieri per cui si dovrà eseguire l'operazione usando il foro presente o sul lato scarico o sul lato filtro aria come da figure.
- Dans certains cas, il n'est pas possible d'effectuer aucune remise à niveau d'huile à travers le bouchon situé sur la chape des culbuteurs. Il faudra alors se servir du trou sur le côté déchargement ou sur le côté filtre à air, comme montré par les figures.
- In einigen Fällen kann das Nachfüllen des Öls nicht über den Stopfen auf der Kipphebelabdeckung erfolgen. Für diesen Arbeitsvorgang wird die Öffnung verwendet, die sich auf der Ablassseite oder auf der Luftfilterseite befindet, wie aus den Abbildungen hervorgeht.
- En algunos casos no será posible efectuar la recarga de aceite a través del tapón situado sobre la tapa de los balancines, por lo tanto la operación deberá ejecutarse utilizando el orificio situado en el lado del vaciado o en el del filtro del aire, como muestran las figuras.
- Em alguns casos não será possível efectuar o enchimento do óleo através da tampa presente no topo dos balanceiros, portanto a operação deverá ser efectuada utilizando o furo presente ou no lado da descarga ou no lado do filtro do ar, conforme indicado nas figuras.



NOTES - NOTE - BEMERKUNG - NOTAS

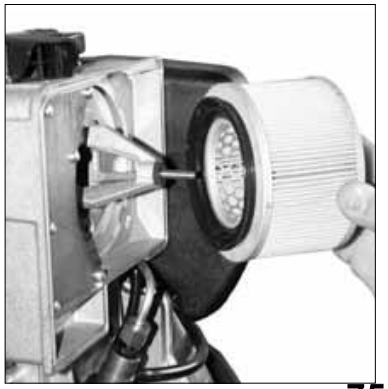
For 315-350-400-420-440 engines with dry type air cleaner
Per motori 315-350-400-420-440 con filtro aria a secco
Pour moteurs 315-350-400-420-440 avec filtre à air sec
Für Motoren 315-350-400-420-440 mit Trockenluftfilter
Para motor 315-350-400-420-440 con filtro aire a seco
Para motores 315-350-400-420-440 com filtro ar à seco

KD315-350 Engines
Per Motori KD315-350
Pour Moteurs KD315-350
Für Motoren KD315-350
Para Motor KD315-350
Para Motores KD315-350

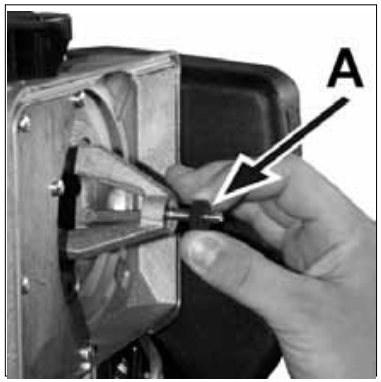
Air Cleaner Check and Maintenance
Controllo e Pulizia Filtro Aria
Contrôle et Nettoyage Filtre à Air
Luftfilter-Kontrolle und Reinigung
Comprobar y Limpiar Filtre de Aire
Contrôle e Limpeza Filtro Ar

- Open air cleaner cover.
- Aprire il filtro.
- Ouvrir le filtre.
- Öffnen Sie den Luftfilter.
- Abrir il filtro.
- Abrir o filtro.

- Unscrew wing nut (1) and remove air filter.
- Svitare il dado alettato (1) e togliere la massa filtrante.
- Dévisser l'écrou à ailettes (1) et enlever la masse filtrante.
- Die Flügelmutter (1) abschrauben und die Filtermasse herausnehmen.
- Destornille la tuerca de mariposa (1) y quite la masa filtrante
- Desparafusar a porca com abas (1) e extrair a massa filtrante.



- Check that rubber seal is in good condition (A).
- Verificare l'integrità della guarnizione in gomma (A).
- Vérifier le bon état du joint en caoutchouc (A).
- Überprüfen, ob die ummidichtung (A) Schäden aufweist.
- Controle que le junta en caucho (A) esté íntegra.
- Verificar a integridade da guarnição de borracha (A).



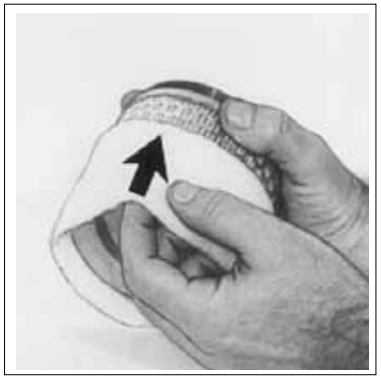
- Clean or replace air filter if necessary.
- Pulire il filtro se è intasato.
- Nettoyer le filtre si obstrué.
- Wenn der filter verstopft ist, reinigen.
- Limpiar el filtro si esta obstruido.
- Limpar o filtro se estiver sujo.

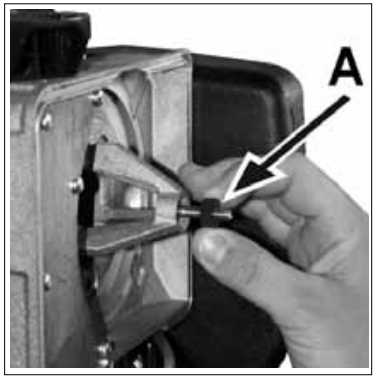
- Remove precleaner and wash with water and soap.
- Togliere e lavare il prefiltro con acqua e sapone.
- Enlever et laver le prefiltre avec de l'eau et du savon.
- Vorfilter abnehmen und mit Seifenwasser waschen.
- Quitar y lavar el prefiltro con agua y jabón.
- Tirar e lavar o prefiltro com água e detergente.

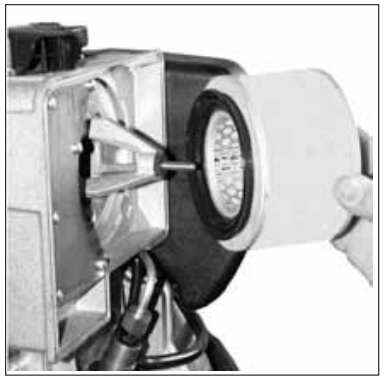
- Dry precleaner carefully.
- Asciugare il prefiltro.
- Essuyer le prefilter.
- Vorfilter trocknen.
- Secar el prefiltro.
- Secar o prefiltro.

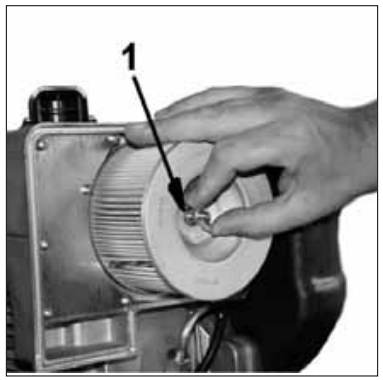
- If the housing appears clogged, remove, clean, and reassemble.
- Smontare e pulire il prefiltro se intasato.
- Si le préfiltre est encrassé, le désassembler et le nettoyer.
- Der Vorfilter sollte im Falle der Verstopfung ausgebaut und gereinigt werden.
- Desmonte y limpie el prefiltro si éste estuviera obturado.
- Se a carcaça parece obstruída, remova, limpe, e remonte.

- Reinstall precleaner (optional), rubber seal (A), and air filter. Tighten the wing nut (1).
- Rimontare il filtro aria ponendo attenzione che la guarnizione (A) sia inserita in modo corretto, quindi serrare il dado alettato(1).
- Réassembler le filtre à air, en vérifiant que le joint (A) est inséré de façon correcte, ensuite serrer l'écrou à ailettes (1).
- Bei der erneuten Montage des Luftfilters ist darauf zu achten, dass die Dichtung (A) korrekt eingesetzt wird. Dann ist die Flügelmutter anzuziehen.
- Vuelva a montar el filtro cuidando que la junta (A) esté insertada correctamente, luego apriete la tuerca de mariposa (1).
- Remontar o filtro do ar prestando atenção para inserir a guarnição (A) em modo correcto, e em seguida fecha a porca (1) com aletas.









- When replacing air filter, also replace the rubber seal(A), (a new seal is included in new air filter package).
- La guarnizione in gomma (A) và sempre sostituita quando si sostituisce la massa filtrante e per questo motivo è inserita nella scatola a ricambio.
- Le joint en caoutchouc (A) doit être toujours remplacé lorsqu'on remplace la masse filtrante, pour cette raison il est inséré dans la boîte de rechange.
- Die Gummidichtung (A) wird bei jedem Austausch des Filterelements ausgewechselt, aus diesem Grund befindet sie sich in der Schachtel mit dem Ersatzteil.
- La guarnición de goma (A) se debe sustituir cada vez que se sustituya la masa filtrante, por eso se introduce en la caja de recambio.
- A guarnição de borracha (A) deve sempre ser substituída quando substituir a massa filtrante e por este motivo é inserida na caixa em dotação.

- Do not reuse air filter or precleaner if any damage or deterioration has occurred. Replace with new.

- Se la massa filtrante è stata pulita altre volte, o se è irrimediabilmente intasata gettarla e sostituirla.

- Si la masse filtrante a déjà été nettoyée plusieurs fois, ou bien si elle est irrémédiablement encrassée, la remplacer.

- Wenn das Element bereits mehrere Male gereinigt worden oder unwiederbringlich verstopft ist, wegwerfen und erneuern.

- Si la masa filtrante ya ha sido limpiada otras veces, o si está irremediablemente obstruida, tirarla o sustituirla.

- Se a massa filtrante já foi limpada outras vezes , ou se for irremediavelmente entupida, jogá-la substitui-la.

- Use only genuine Kohler repair parts.
- Utilizzare esclusivamente ricambi Kohler.
- Utiliser uniquement des pièces de rechange Kohler d'origine.
- Nur Original-Ersatzteile von Kohler verwenden.
- Motorbeschädigungen oder hohem
- Use únicamente piezas de repuesto originales Kohler.
- Utilize apenas peças de substituição originais da Kohler. .

- Securely mount air filter and cover to prevent dust or other impurities from bypassing filtration system and damaging engine.
- Accertarsi che il filtro sia montato in modo corretto altrimenti polvere ed altro possono entrare nei condotti aspirazione.
- Vérifier que le filtre est monté correctement pour empêcher à la poussière ou autres saletés de pénétrer dans les conduits admission.
- Sicherstellen, daß der Filter korrekt montiert ist. Andernfalls können Staub und Fremdkörper in den saug leitungen.
- Cerciorarse que el filtro esté montado en modo correcto de lo contrario el polvo u otros elementos pueden entrar en los conductos aspiración.
- Verificar que o filtro esteja montado correctamente para evitar que a poeira possa entrar nos condutos de aspiração.

KD400-420-440 Engines
Per Motori KD400-420-440
Pour Moteurs KD400-420-440
Für Motoren KD400-420-440
Para Motor KD400-420-440
Para Motores KD400-420-440

Air Cleaner Check and Maintenance
Controllo e Pulizia Filtro Aria
Contrôle et Nettoyage Filtre àAir
Luftfilter-Kontrolle und Reinigung
Comprobar y Limpiar Filtre de Aire
Contrôle e Limpeza Filtro Ar

- Open air cleaner.
- Aprire il filtro.
- Ouvrir le filtre.
- Öffnen Sie den Luftfilter.
- Abrir il filtro.
- Abrir o filtro.

- Unscrew wing nut (1) and remove air filter.
- Svitare il dado alettato (1) e togliere la massa filtrante.
- Dévisser l'écrou à ailettes (1) et enlever la masse filtrante.
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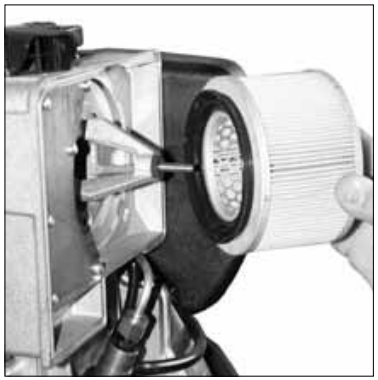

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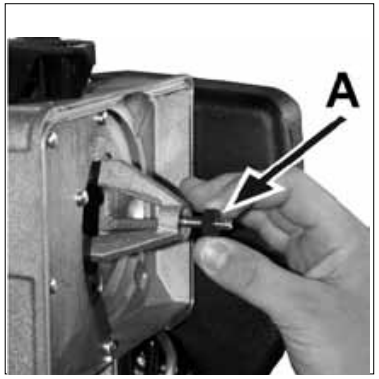

- If the housing appears clogged, remove, clean, and reassemble.
- Smontare e pulire il prefiltro se intasato.
- Si le préfiltre est encrassé, le désassembler et le nettoyer.
- Der Vorfilter sollte im Falle der Verstopfung ausgebaut und gereinigt werden.
- Desmonte y limpie el prefiltro si éste estuviera obturado.
- Se a carcaça parece obstruída, remova, limpe, e remonte.

- Reinstall rubber seal (A), and air filter, then tighten wing nut (1).
- Rimontare il filtro aria ponendo attenzione che la guarnizione (A) sia inserita in modo corretto, quindi serrare il dado alettato(1).
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- Bei der erneuten Montage des Luftfilters ist darauf zu achten, dass die Dichtung (A) korrekt eingesetzt wird. Dann ist die Flügelmutter anzuziehen.
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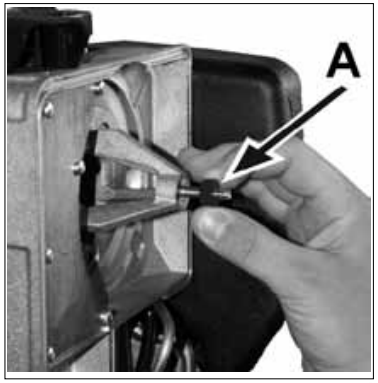

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- Si la masse filtrante a déjà été nettoyée plusieurs fois, ou bien si elle est irrémédiablement encrassée, la remplacer.

- Wenn das Element bereits mehrere Male gereinigt worden oder unwiederbringlich verstopft ist, wegwerfen und erneuern.

- Si la masa filtrante ya ha sido limpiada otras veces, o si está irremediablemente obstruida, tirarla o sustituirla.

- Se a massa filtrante já foi limpada outras vezes , ou se for irremediavelmente entupida, jogá-la substitui-la.

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- **Utiliser uniquement des pièces de rechange Kohler d'origine.**

- **Nur Original-Ersatzteile von Kohler verwenden.**

- **Use únicamente piezas de repuesto originales Kohler.**

- **Utilize apenas peças de substituição originais da Kohler.**

- Securely mount air filter and cover to prevent dust or other impurities from bypassing filtration system and damaging engine.
- Accertarsi che il filtro sia montato in modo corretto altrimenti polvere ed altro possono entrare nei condotti aspirazione.
- Vérifier que le filtre est monté correctement pour empêcher à la poussière ou autres saletés de pénétrer dans les conduits admission.
- Sicherstellen, daß der Filter korrekt montiert ist. Andernfalls können Staub und Fremdkörper in den saug leitungen.
- Cerciorarse que el filtro esté montado en modo correcto de lo contrario el polvo u otros elementos pueden entrar en los conductos aspiración.
- Verificar que o filtro esteja montado correctamente para evitar que a poeira possa entrar nos condutos de aspiração.

NOTES - NOTE - BEMERKUNG - NOTAS

Every 250 Hours
Ogni 250 Ore
Toutes les 250 Heures
Alle 250 Stunden
Cada 250 Horas
Cada 250 Horas

250 Hours
h 250

Change Oil (Models with Standard Oil Sump)

Sostituzione Olio Carter per Motori con Coppa olio Standard

Remplacement Huile Carter Pour les Moteurs Avec Carter D'Huile Standard

Öl Wechsel Bei Motoren Mit Standardölwanne

Sostitución Aceite Cárter Para Motores con Cárter de Aceite Estándar

Substituição Óleo Carter Para Motores de Cárter Padrão Para o Óleo

- **In case of low use: every 6 months.**
- **In caso di scarso utilizzo: ogni 6 mesi.**
- **En cas d'emploi limitè: tous les 6 mois.**
- **Benutzung: alle 6 Monate.**
- **En caso de escasa utilización: cada 6 meses.**
- **Em situações de reduzida utilização, todos os 6 meses.**

PRESCRIBED LUBRICANT - OLIO PRESCRITTO - HUILE INDIQUÉE
VORGESCHRIEBENE SCHMIERÖLE - ACEITE RECOMENDADO - ÓLEO RECOMENDADO

KD 225 **KD 315** **KD 350**	**AGIP SUPERDIESEL MULTIGRADE 15W-40**	specifications specifiche spécification Spezifikation especificado especificação	**API CF 4** **ACEA E2-B2** **MIL-L-46152 D/E**
KD 400 **KD 420** **KD 440**	**AGIP MULTIGRADE 5W-40**		**API CF** **ACEA B2-B4** **MIL-L-2104 C / MIL-L46152 D**

- For oil capacity see Page 45.
- Per la capacità olio vedi Pag. 45.
- Pour contenance huile voir Page 45.
- Fassungsvermögen siehe Seite 45.
- Para capacidad ver Pág. 45.
- Para capacidade óleo veja Pág. 45.

- **In dusty or dirty conditions, change oil and oil filter every 150 hours.**
- **In ambienti sporchi o polverosi, l'olio e il filtro vanno cambiati ogni 150 ore.**
- **Dans des conditions poussiéreuses ou sales, changer l'huile et le filtre à huile toutes les 150 heures.**
- **Öl und Ölfilter in schmutzigen bzw. staubigen Umfeldern alle 150 Betriebsstunden wechseln.**
- **En condiciones de polvo o suciedad, cambie el aceite y el filtro de aceite cada 150 horas.**
- **Em condições de poeira ou sujidade, mude o óleo e o filtro do óleo a cada 150 horas.**

- **Change the oil while the engine is still warm, the oil will flow more freely.**
- **Onde ottenere il rapido e completo scarico dell'olio motore, si consiglia di eseguire tale operazione a motore caldo.**
- **Pour vidanger rapidement et totalement l'huile du moteur il est recommandé de faire cette opération quand le moteur est chaud.**
- **Damit das Motoröl schnell und vollständig ausläuft, sollte man den Vorgang bei warmem Motor vornehmen.**
- **Para lograr una descarga rápida y completa del aceite motor, se aconseja de efectuar dicha operación con motor caliente.**
- **Para fazer sair em modo rápido e completo o óleo do motor aconselhamos efectuar esta operação com o motor quente.**

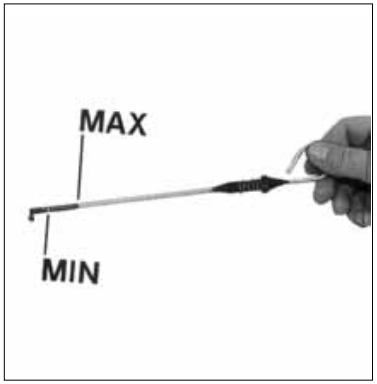
- **Avoid prolonged or repeated skin contact with used engine oil, or wear protective gloves. If contact cannot be avoided, thoroughly wash exposed areas with soap and water. Respect the environment; dispose of used oil in accordance with local ordinances.**
- **L'olio motore esausto può essere causa di cancro alla pelle se lasciato ripetutamente a contatto e per periodi prolungati. Se il contatto con l'olio fosse inevitabile, si consiglia di lavarsi accuratamente le mani con acqua e sapone non appena possibile. Non disperdere l'olio esausto in ambiente in quanto altamente inquinante.**
- **L'huile moteur épuisée peut être la cause de cancer de la peau si laissée fréquemment à contact pour des périodes prolongées. Si le contact avec l'huile est inévitable, se laver les mains à l'eau et savon avec soin dès que possible. Ne pas vidanger l'huile épuisée dans le milieu, car elle a un haut niveau de pollution.**
- **Schmieröl kann Hautkrebs erzeugen, wenn es häufig in Hautkontakt kommt. Kann ein Kontakt nicht vermieden werden, sollte man sich so schnell wie möglich die Hände gründlich waschen. Wegen dem hohen Grad der Umweltverschmutzung, ist Sorge zu tragen, daß kein Öl ins Erdreich.**
- **El aceite del motoe sucio (usaoo) puede ser causa de cancer de piel, si es repetidamente ó prolongado su contacto. Si el contacto con el aceite fuese inevitable, se aconseja lavarse adecuadamente las manos con jabon lo antes posible. Non dispersar o tirar el aceite usado: por ser de un alto nivel de contaminante.**
- **O óleo velho do motor pode provocar cancro na pele se entrar frequentemente em contacto e por períodos prolongados com a mesma. No caso em que o contacto com o óleo seja inevitável, aconselha-se lavar bem as mãos com água e sabão assim que for possível. Não dispersar o óleo velho no ambiente porque é muito poluidor.**

- Remove drain plug and drain oil into an approved container.
- Togliere il tappo e scaricare l'olio in un contenitore adatto.
- Enlevez le bouchon et vidangez l'huile dans un récipient approprié.
- Den Stopfen abschrauben und das Öl in einen geeigneten Behälter auslaufen lassen.
- Quitar el tapón y descargar el aceite en un contenedor idóneo.
- Retirar o tampão e recolher o óleo num recipiente apropriado.

- Reinstall drain plug.
- Rimettere il tappo scarico olio.
- Revisser le bouchon de vidange.
- Abiaßschraube wieder einsetzen.
- Montar el tapon vaciado aceite.
- Repor o tampa descarregamento óleo.

- Remove oil fill cap.
- Togliere il tappo rifornimento olio.
- Dévisser le bouchon de remplissage d'huile.
- Entfernen Sie die Öleinfüllschraube.
- Quitar el tapón llenado aceite.
- Tirar o tampa reabastecimento óleo.

- Fill to correct level with oil. Reinstall fill cap.
- Versare l'olio e rimettere il tappo.
- Verser l'huile et remettre le bouchon.
- Füllen Sie das Öl ein und schließen Sie den Öleinfüllstutzen wieder.
- Poner aceite y montar el tapón.
- Verter o óleo e repor o tampa.



- With engine on a level surface check that oil level is between the “min” and “max” marks on dipstick.
- Controllare che il livello sia al massimo, con il motore in piano.
- Verifier que le niveau soit au maximum avec le moteur en plan.
- Mit Motor auf ebene Flâche Kontrollieren dass Ölstand Maximum zeigt.
- Controlar que el nivel se encuentre al máximo, con el motor en plano.
- Verificar que o nível esteja no máximo, com o motor em posição horizontal.

- Before restarting, verify dipstick, drain, and fill cap have been correctly installed.
- Prima del riavvio accertarsi che, l‘asta livello, il tappo scarico olio e il tappo rifornimento olio siano montati in modo corretto onde evitare fuoriuscite di lubrificante
- Avant de redémarrer contrôlez que la jauge niveau, le bouchon de vidange d’huile et le bouchon de remplissage huile sont montés correctement afin d’éviter les fuites de lubrifiant.
- Vor dem Neustart sicherstellen, daß der meßstab, der Ölablaßstopfen und der Öleinfüllstopfen korrekt montiert sind, damit kein Schmierstoff auslaufen kann.
- Antes de volver a poner en marcha cerciorarse que la varilla nivel, el tapón de descarga aceite y el tapón de abastecimiento aceiteestén montados en modo correcto para evitar pérdidas de lubricante.
- Antes de proceder novamente ao arranque, verificar que a haste de nível, o tampão de descarregamento do óleo e o tampão de introdução do óleo estejam devidamente nos seus alojamentos para evitar a saída de lubrificante.

NOTES - NOTE - BEMERKUNG - NOTAS

Every 500 Hours
Ogni 500 Ore
Toutes les 500 Heures
Alle 500 Stunden
Cada 500 Horas
Cada 500 Horas

500 Hours
h 500

In case of low use: every 12 months

In caso di scarso utilizzo: ogni 12 mesi

En cas d'emploi limitè: tous les 12 mois

Im Falls einer niedrigen Benutzung: alle 12 Monate

En caso de escasa utilización: cada 12 meses

Em situações de reduzida utilização, todos os 12 meses

Replace Internal Oil Filter
Sostituzione Filtro Olio
Remplacement Filtre à Huile
ÖI Filter Wechsel
Sostitución Filtro Aceite
Substituição Filtro Óleo

- Remove and replace oil filter.
- Togliere e gettare il filtro olio.
- Enlever et jeter le filtre à huile.
- Entfernen und ersetzen Sie den Ölfilter.
- Sacar y botar el filtro de aceite.
- Tirar e botar o filtro óleo

- **Use only genuine Kohler repair parts.**
- **Utilizzare esclusivamente ricambi Kohler.**
- **Utiliser uniquement des pièces de rechange Kohler d'origine.**
- **Nur Original-Ersatzteile von Kohler verwenden.**
- **Use únicamente piezas de repuesto originales Kohler.**
- **Utilize apenas peças de substituição originais da Kohler.**

- **Respect the environment; dispose of used oil filter in accordance with local ordinances.**
- **Quando si sostituisce il filtro olio, tenerlo separato da altri rifiuti.**
- **Lors du remplacement du filtre à huile, le tenir séparé des autres déchets.**
- **Wenn man den Ölfilter ersetzt, ist er getrennt von dem anderen Abfall aufzubewahren.**
- **Cuando se cambia el filtro aceite, mantenerlo separado de otros desechos.**
- **Quando se substitui o filtro do óleo o mesmo deve ser separado dos outros refugos.**

Change Oil (Models With a Large Capacity Oil Sump)
Sostituzione Olio Carter per Motori con Coppa Olio Maggiorata
Vidange Huile Carter Pour Moteurs Avec Carter Huile Agrandi
Ölwechsel des Gehäuses für Motoren mit Vergrößerter Ölwanne
Sustitución del Aceite del Cárter Para Motores con Cárter de Aceite Aumentado
Substituição do Óleo do Cárter Para Motores Com Cárter Óleo Aumentado

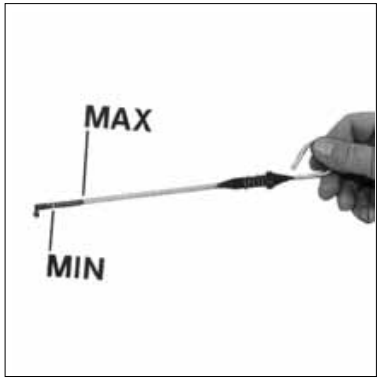
- **Change oil while engine is still warm, the oil will flow more freely.**
- **Onde ottenere il rapido e completo scarico dell'olio motore, si consiglia di eseguire tale operazione a motore caldo.**
- **Pour vidanger rapidement et totalement l'huile du moteur il est recommandé de faire cette opération quand le moteur est chaud.**
- **Damit das Motoröl schnell und vollständig ausläuft, sollte man den Vorgang bei warmem Motor vornehmen.**
- **Para lograr una descarga rápida y completa del aceite motor, se aconseja de efectuar dicha operación con motor caliente.**
- **Para fazer sair em modo rápido e completo o óleo do motor aconselhamos efectuar esta operação com o motor quente.**

- Remove drain plug (A) and drain oil into an approved container.
- Togliere il tappo A e scaricare l'olio in un contenitore adatto.
- Enlevez le bouchon A et vidangez l'huile dans un récipient approprié.
- Den Stopfen abschrauben A und das Öl in einen geeigneten Behälter auslaufen lassen.
- Quitar el tapón A y descargar el aceite en un contenedor idóneo.
- Retirar o tampão A e recolher o óleo num recipiente apropriado.

- Reinstall oil drain plug.
- Rimettere il tappo scarico olio.
- Revisser le bouchon de vidange.
- Abiaßschraube wieder einsetzen.
- Montar el tapon vaciado aceite.
- Repor o tampa descarregamento óleo.

- Remove oil fill cap.
- Togliere il tappo rifornimento olio.
- Dévisser le bouchon de remplissage d'huile.
- Entfernen Sie die Öleinfüllschraube.
- Quitar el tapón llenado aceite.
- Tirar o tampa reabastecimento óleo.

- Add oil to to correct level. Reinstall the fill cap.
- Versare l'olio e rimettere il tappo.
- Verser l'huile et remettre le bouchon.
- Füllen Sie das Öl ein und schließen Sie den Öleinfüllstutzen wieder.
- Poner aceite y montar el tapón.
- Verter o óleo e repor o tampa.



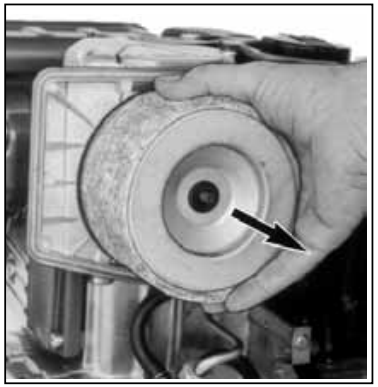
- On a level surface check that oil level is between “min” and “max” marks on the dipstick.
- Controllare che il livello sia al massimo, con il motore in piano.
- Verifier que le niveau soit au maximum avec le moteur en plan.
- Mit Motor auf ebene Flâche Kontrollieren dass Ölstand Maximum zeigt.
- Controlar que el nivel se encuentre al máximo, con el motor en plano.
- Verificar que o nível esteja no máximo, com o motor em posição horizontal.

- **Before restarting, verify dipstick, drain, and fill cap have been correctly installed.**
- **Prima del riavvio accertarsi che, l‘asta livello, il tappo scarico olio e il tappo rifornimento olio siano montati in modo corretto onde evitare fuoriuscite di lubrificante**
- **Avant de redémarrer contrôlez que la jauge niveau, le bouchon de vidange d’huile et le bouchon de remplissage huile sont montés correctement afin d’éviter les fuites de lubrifiant.**
- **Vor dem Neustart sicherstellen, daß der meßstab, der Ölablaßstopfen und der Öleinfüllstopfen korrekt montiert sind, damit kein Schmierstoff auslaufen kann.**
- **Antes de volver a poner en marcha cerciorarse que la varilla nivel, el tapón de descarga aceite y el tapón de abastecimiento aceiteestén montados en modo correcto para evitar pérdidas de lubricante.**
- **Antes de proceder novamente ao arranque, verificar que a haste de nível, o tampão de descarregamento do óleo e o tampão de introdução do óleo estejam devidamente nos seus alojamentos para evitar a saída de lubrificante.**

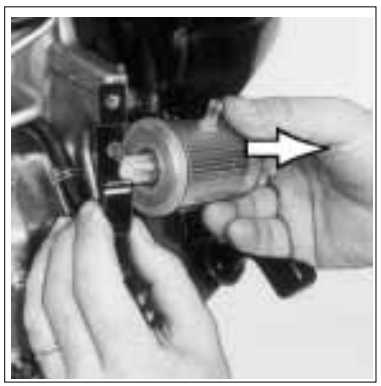
Fuel Filter Replacement
Sostituzione Filtro Combustibile
Remplacement Filtre à Combustible.
Wechsel-Brennstoffilter
Sostitución Filtro Combustible
Substituição Filtro Combustíve

- **Ensure fuel tank is completely empty of fuel. Disable engine by disconnecting negative (-) battery lead.**
- **Accerti che serbatoio di combustibile sia completamente vuoto di combustibile. Renda invalido il motore staccando (-) il cavo di batteria negativo**
- **Assurez que réservoir de carburant est complètement vide du carburant. Désactivez le moteur en déconnectant (-) le câble de batterie négatif.**
- **Stellen Sie sicher, dass Kraftstoffbehälter vom Kraftstoff vollständig leer ist. Sperren Sie Maschine, indem Sie negative (-) Batterieleitung trennen.**
- **Asegúrese que depósito de combustible sea totalmente vacío del combustible. Inhabilite el motor desconectando (-) el cable de batería negativo.**
- **Assegure-se de que tanque de combustível esteja completamente vazio do combustível. Incapacite o motor desconectando (-) o cabo de bateria negativo.**

- Remove air cleaner cover and air filter.
- Aprire il filtro e togliere la massa filtrante.
- Ouvrir le filtre à air et sortir la cartouche filtrante.
- Öffnen Sie den Luftfilter und entfernen Sie das Element.
- Abrir il filtro y sacar la masa filtrante.
- Abrir o filtro e tirar a massa filtrante.



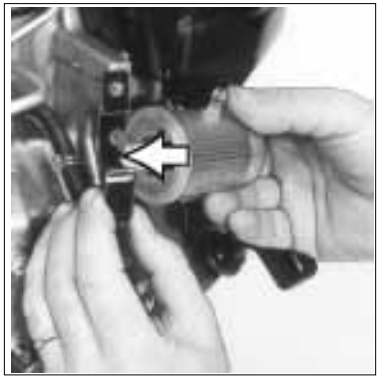
- Change fuel filter.
- Togliere e gettare il filtro combustibile.
- Démonter et jeter le filtre à gas-oil.
- Entfernen und ersetzen Sie den Kraftstoffilter.
- Quitar y botar el filtro combustible.
- Tirar e deitar fora o filtro combustível.



- **Respect the environment; dispose of used filter in accordance with local ordinances.**
- **Quando si sostituisce il filtro combustibile, tenerlo separato da altri rifiuti.**
- **Lors du remplacement du filtre à combustible, le tenir séparé des autres déchets**
- **Wenn man den Kraftstoffilter ersetzt, ist er getrennt von dem anderen Abfall aufzubewahren.**
- **Cuando se cambia el filtro combustible, mantenerlo separado de otros desechos.**
- **Quando se substitui o filtro do combustível o mesmo deve ser separado dos outros refugos.**

- **Use only genuine Kohler repair parts.**
- **Utilizzare esclusivamente ricambi Kohler.**
- **Utiliser uniquement des pièces de rechange Kohler d'origine.**
- **Nur Original-Ersatzteile von Kohler verwenden.**
- **Use únicamente piezas de repuesto originales Kohler.**
- **Utilize apenas peças de substituição originais da Kohler.**

- Install new fuel filter.
- Rimontare il filtro combustibile.
- Remonter le filtre à gas-oil.
- Setzen Sie den Kraftstiffilter.
- Montar el filtro combustible.
- Remontar o filtro combustivel.

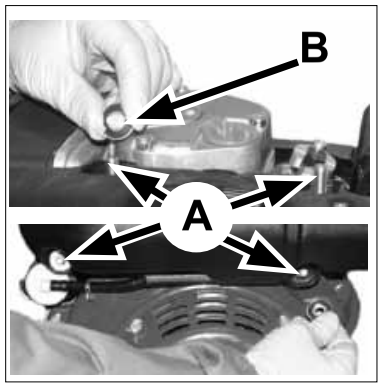


- Reinstall air filter and air cleaner cover.
- Rimontare il filtro aria.
- Remonter le filtre à air.
- Setzen Sie den Luftfilter wieder zusammen.
- Montar el filtro aire.
- Remontar o filtro ar.

Cleaning Fuel Tank
Pulizia Serbatoio
Nettoyage du Réservoir
Reinigung des Tanks
Limpieza del Depósito
Limpeza do Depósito

- **If diesel fuel flows slowly into fuel filter, it may be necessary to clean tank.**
- **Se il gasolio esce lentamente è necessario pulire il serbatoio come indicato di seguito.**
- **Si le gasoil sort lentement il est nécessaire de nettoyer le réservoir comme indiqué ci-après.**
- **Wenn der Diesel langsam austritt, muss der Tank laut folgender Anleitung gereinigt werden.**
- **Si el gasóleo sale demasiado lentamente, es necesario limpiar el depósito tal y como indicado abajo.**
- **Se o gasóleo sair lentamente será necessário limpar o depósito como abaixo indicado.**

- Loosen and remove four nuts (A). Note direction of seal (B) and spacers.
- Allentare e togliere i quattro dadi (A) ponendo attenzione al corretto senso di rimontaggio della guarnizione (B).
- Desserrer et enlever les quatre écrous (A) en faisant attention à la direction correcte de remontage du joint (B).
- Die vier Muttern (A) lockern und entfernen und darauf achten, wie die Dichtung (B) beim späteren Wiedereinbau liegen muss.
- Aflojar y remover las cuatro tuercas (A) prestando atención para respetar la dirección correcta cuando se vuelve a montar la guarnición (B).
- Afrouxe e tire as quatro porcas (A) prestando atenção no correcto sentido de remontagem da guarnição (B).



- Disconnect fuel tank vent tube and remove it from seat.
- Scalzare i tubi rifiuto carburante posti sul retro del serbatoio ed estrarlo dalla propria sede.
- Déconnecter les tuyaux d'évacuation du carburant situés derrière le réservoir et l'extraire de son logement.
- Die Schläuche für den Leckölrücklauf, die sich auf der Rückseite des Tanks befinden, abziehen und den Tank herausnehmen.
- Remover los tubos de retorno de carburante situados en la parte trasera del depósito y removerlo de su asiento.
- Descalce os tubos de resíduos do carburante posicionados na traseira do depósito e extraia-o da própria sede.

- **Wear protective gloves to avoid skin contact with fuel.**
- **Usare guanti protettivi onde evitare il contatto diretto del gasolio con la pelle.**
- **Utiliser des gants de protection afin d'éviter le contact direct du gasoil avec la peau.**
- **Schutzhandschuhe verwenden, um den direkten Kontakt des Dieselöls mit der Haut zu vermeiden.**
- **Utilizar guantes de protección para evitar el contacto directo con el gasóleo.**
- **Utilize luvas protectoras para evitar o contacto directo do gasóleo com a pele.**

- Plug outlet (A) and pour in 1 quart (1 liter) of diesel fuel into tank.
- Tenendo chiuso il foro di uscita (A) versare circa 1 litro di gasolio nel serbatoio.
- En maintenant le trou de sortie (A) fermé verser 1 litre environ de gasoil dans le réservoir.
- Die Austrittsöffnung (A) geschlossen halten und ca. 1 Liter Diesel in den Tank füllen.
- Manteniendo el orificio de salida (A) cerrado, verter aproximadamente 1 litro de gasóleo en el depósito.
- Mantendo fechado o furo de saída (A) deite cerca de 1 litro de gasóleo no depósito.

- Install fuel tank cap. Verify outlet hole (A) and vent hole (B) are plugged and shake tank to loosen deposits.
- Rimettere il tappo e tenendo chiuso il foro (A) e i fori (B) agitarlo in modo da permettere il distacco delle incrostazioni.
- Remettre le bouchon et en maintenant fermé le trou (A) et les trous (B) l'agiter afin de permettre le détachement des incrustations
- Den Deckel wieder aufsetzen, die Öffnung (A) und die Öffnungen (B) geschlossen halten und den Tank schütteln, um die Verkrustungen zu lösen.
- Volver a colocar el tapón y mantener cerrado el orificio (A) y los orificios (B). Luego, agitar para remover las incrustaciones
- Recoloque a tampa e mantendo fechado o furo (A) e os furos (B) agite-o a fim de permitir a remoção das incrustações

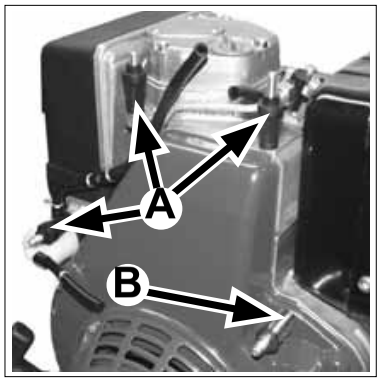
- **Respect the environment; dispose of used fuel in accordance with local ordinances.**
- **Non disperdere in ambiente il combustibile in quanto altamente inquinante**
- **Ne jetez le combustible dans la nature car il est hautement polluant.**
- **Den Kraftstoff vorschriftsmäßig entsorgen, weil er ein stark verschmutzender Stoff ist.**
- **No provocar pérdidas de combustible en el ambiente ya que el mismo posee un elevado poder contaminante.**
- **Não dispersar no ambiente o combustível para evitar a poluição do mesmo.**

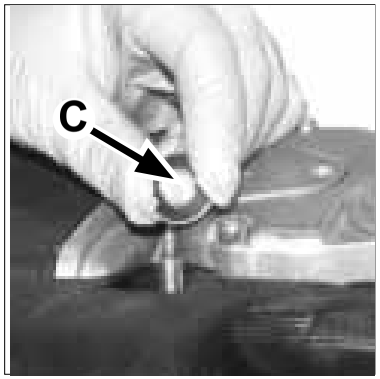
- Remove fuel tank cap and drain tank.
- Togliere il tappo e svuotare il serbatoio
- Enlever le bouchon et vider le réservoir
- Den Deckel entfernen und den Tank leeren.
- Quitar el tapón y vaciar el depósito
- Tire a tampa e esvazie o depósito

- **When using compressed air, always wear protective goggles.**
- **Quando viene usata aria compressa è importante utilizzare occhiali protettivi.**
- **Lors de l'utilisation de l'air comprimé, il est important de mettre des lunettes de protection.**
- **Wenn Druckluft verwendet wird, unbedingt eine Schutzbrille tragen.**
- **Si se usa aire comprimido es importante utilizar gafas de protección.**
- **No caso em que se use ar comprimido é importante usar óculos de protecção.**

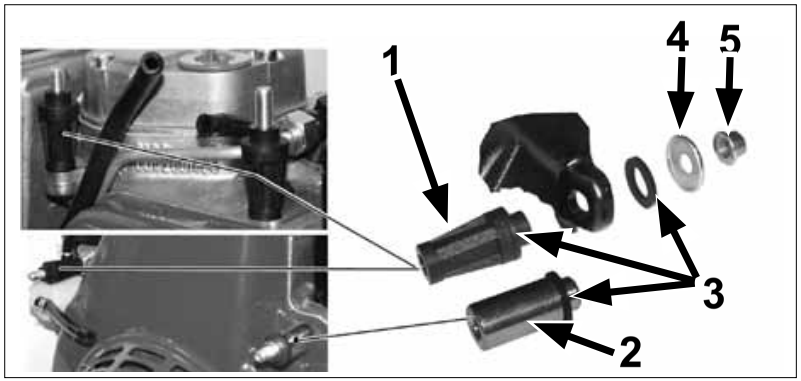
- Blow compressed air into fuel outlet hole.
- Soffiare con aria compressa nel foro di uscita carburante.
- Souffler de l'air comprimé dans le trou de sortie du carburant.
- Druckluft in die Kraftstoffaustrittsöffnung blasen.
- Soplar en el orificio de salida de carburante con aire comprimido.
- Sopre com ar comprimido no furo de saída do carburante.

- Reinstall tank noting location of plastic spacers (A), metal spacer (B) and vibration-dampening rubber rings (C).
- Rimontare il serbatoio ponendo attenzione a riposizionare correttamente i distanziali in plastica (A) il distanziale in metallo (B) e gli anelli antivibranti in gomma (C).
- Remonter le réservoir en faisant attention à repositionner correctement les entretoises en plastique (A) l'entretoise en métal (B) et les bagues antivibratoires en caoutchouc (C).
- Den Tank wieder einbauen und dabei darauf achten, dass die Distanzstücke aus Kunststoff (A), das Distanzstück aus Metall (B) sowie die schwingungsdämpfenden Gummiringe (C) korrekt eingesetzt werden.
- Volver a instalar el depósito prestando atención para colocar correctamente los distanciadores de plástico (A), el distanciador de metal (B) y los anillos antivibratorios de goma (C).
- Volte a montar o depósito prestando atenção em recolocar correctamente os distanciadores de plástico (A) o distanciador de metal (B) e os anéis anti-vibração de borracha (C).

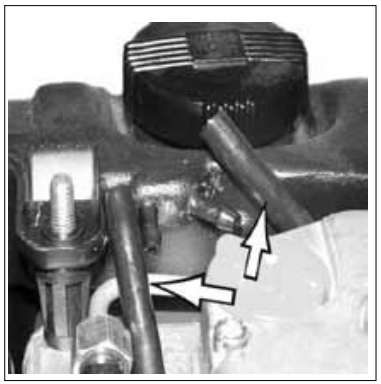




1. Plastic spacer 2. Metal spacer 3. Vibration-dampening rubber ring 4. Washer 5. Nut
1. Distanziale in plastica 2. Distanziale in metallo 3. Anello antivibrante in gomma 4. Rondella 5. Dado
1. Entretoise en plastique 2. Entretoise en métal 3. Bague antivibratoire en caoutchouc 4. Rondelle 5. Ècrou
1. Distanzstück aus Kunststoff 2. Distanzstück aus Metall 3. Schwingungsdämpfender Gummiring 4. Unterlegscheibe - 5. Mutter
1. Distanciador de plástico 2. Distanciador de metal 3. Anillo antivibratorio de goma 4. Arandela 5. Dado
1. Distanciador de plástico 2. Distanciador de metal 3. Anel anti-vibração de borracha 4. Aro 5. Dado

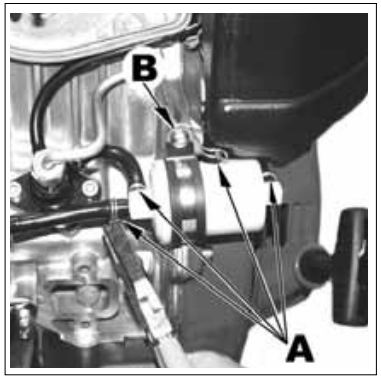


- Insert the diesel fuel vent tube and the tank pipe back into the correct position to avoid leakage.
- Reinserire i tubi rifiuto gasolio e il tubo da serbatoio a filtro in modo corretto onde evitare fuoriuscite di gasolio.
- Réinsérer les tuyaux d'évacuation du gasoil et le tuyau du réservoir au filtre de façon correcte, afin d'éviter de possibles sorties du gasoil.
- Die Schläuche für den Leckölrücklauf und die Leitung vom Schlauch zum Filter wieder richtig einsetzen, damit kein Diesel auslaufen kann.
- Volver a colocar los tubos de retorno de gasóleo y el tubo desde depósito a filtro prestando atención para evitar las pérdidas de gasóleo.
- Reintroduza os tubos de resíduos do gasóleo e o tubo que vai do depósito para o filtro de uma maneira correcta a fim de evitar saída de gasóleo.



Fuel Filter Replacement (Engine Models Equipped With Oil Pressure Alert System)
Sostituzione Filtro Combustibile per Motori Dotati di Sistema Oil Alert
Remplacement du Filtre du Combustible Pour Moteurs Équipés de Système Oil Alert
Auswechseln des Kraftstofffilters bei Motoren, die mit dem Oil-Alert-System Ausgestattet Sind
Sustitución del Filtro de Combustible Para Motores Dotados de Sistema Oil Alert
Substituição do Filtro do Combustível Para Motores Equipados com Sistema Oil Alert

- Release four clamps (A) and disconnect fuel lines, noting location. Remove screw (B) and remove fuel filter.
- Sganciare le quattro fascette (A), svitare la vite (B), scalzare i tubi e sostituire il filtro.
- Décrocher les quatre colliers (A), dévisser la vis (B), déconnecter les tuyaux et remplacer le filtre.
- Die vier Schellen (A) lösen, die Schraube (B) aufschrauben, die Leitungen abziehen und den Filter auswechseln.
- Desenganchar las cuatro abrazaderas (A), destornillar el tornillo (B), reemplazar los tubos y sustituir el filtro.
- Desenganche as quatro faixas (A), desparafuse o parafuso (B), tire os tubos e substitua o filtro.



- Install new fuel filter in same position; secure with screw (B). Reconnect fuel hoses in same position as locations from removal step. Secure with four clamps (A).
- Sostituire il filtro combustibile (che ha un solo senso di montaggio) ponendo attenzione ad inserire correttamente i tubi nella propria sede onde evitare fuoriuscite di gasolio.
- Remplacer le filtre combustible (qui peut être monté dans une seule direction) en faisant attention à insérer correctement les tuyaux dans leur logement, afin d'éviter de possibles sorties de gasoil.
- Den Kraftstofffilter auswechseln (er kann nur in einer Richtung eingesetzt werden) und dabei darauf achten, dass die Leitungen korrekt an ihren Platz gesetzt werden, damit kein Diesel austreten kann.
- Sustituir el filtro de combustible (que tiene un sólo sentido de montaje) prestando atención para introducir correctamente los tubos en su asiento y evitar así las pérdidas de gasóleo.
- Substitua o filtro do combustível (que há apenas um sentido de montagem) prestando atenção em introduzir correctamente os tubos na própria sede a fim de evitar saídas de gasóleo.

- **Respect the environment; dispose of used fuel filter in accordance with local ordinances.**
- **Quando si sostituisce il filtro combustibile, tenerlo separato da altri rifiuti.**
- **Lors du remplacement du filtre à combustible, le tenir séparé des autres déchets**
- **Wenn man den Kraftstoffilter ersetzt, ist er getrennt von dem anderen Abfall aufzubewahren.**
- **Cuando se cambia el filtro combustible, mantenerlo separado de otros desechos.**
- **Quando se substitui o filtro do combustível o mesmo deve ser separado dos outros refugos.**

- **Use only genuine Kohler repair parts.**
- **Utilizzare esclusivamente ricambi Kohler.**
- **Utiliser uniquement des pièces de rechange Kohler d'origine.**
- **Nur Original-Ersatzteile von Kohler verwenden.**
- **Use únicamente piezas de repuesto originales Kohler.**
- **Utilize apenas peças de substituição originais da Kohler.**

Cleaning Cooling Fins
Pulizia Alette Raffreddamento.
Nettoyage Ailettes Refroidissement
Kuehlrippen Reinigung
Limpieza Aletas Refrigeración
Limpeza das Aletas de Arrefecimento

- Disconnect fuel line and empty fuel tank. Remove fuel tank mounting hardware and remove fuel tank.

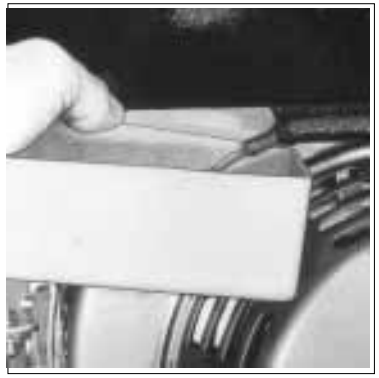
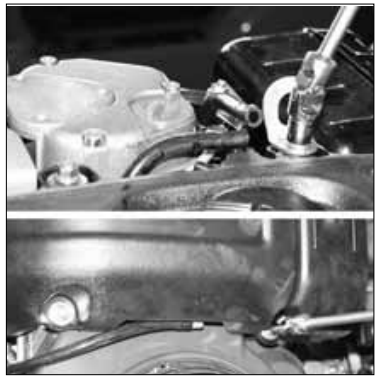
- Svuotare il serbatoio, e dopo aver svitato i dadi di fissaggio e scalzato i tubi gasolio rimuoverlo.

- Vider le réservoir et, après avoir dévissé les écrous de fixation et enlevé les tuyaux du gasoil, l'ôter.

- Den Tank entleeren und nach Abschrauben der Befestigungsmuttern und dem Freilegen der Dieselleitungen den Tank abnehmen.

- Vacíe el depósito y, después de destornillar las tuercas de fijación y desconectar el tubo del gasóleo, extráigalo.

- Esvaziar o tanque e, após ter desparafusado as porcas de fixação e removido os tubos de gasóleo, removê-lo.

- Remove air shroud mounting hardware and remove air shroud.

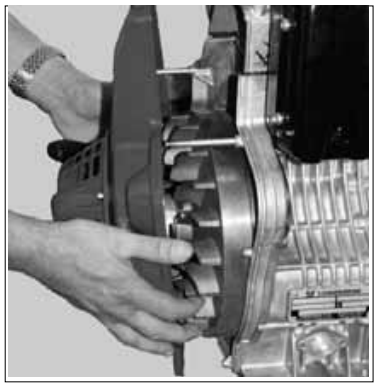
- Svitare i dadi di fissaggio convogliatore, ed estrarlo.

- Dévisser les écrous de fixation du convoyeur et l'enlever.

- Die Befestigungsmuttern der Kühlerhaube abschrauben, und diese herausnehmen.

- Destornille las tuercas de fijación del canalizador y extráigalo.

- Desparafusar as porcas de fixação do transportador, extrai-lo.



- When using compressed air, always wear protective goggles.

- Quando viene usata aria compressa è importante utilizzare occhiali protettivi.

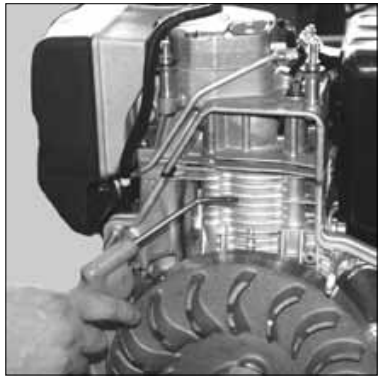
- Lors de l'utilisation de l'air comprimé, il est important de mettre des lunettes de protection.

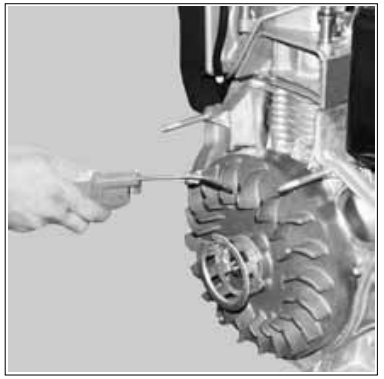
- Wenn Druckluft verwendet wird, unbedingt eine Schutzbrille tragen.

- Si se usa aire comprimido es importante utilizar gafas de protección.

- No caso em que se use ar comprimido é importante usar óculos de protecção.

- Use compressed air on cylinder cooling fins and flywheel.
- Soffiare con aria compressa le alette cilindro e volano.
- Souffler de l'air comprimé sur les ailettes du cylindre et du volant.
- Die Rippen von Zylinder und Schwungrad mit Druckluft durchblasen.
- Insufle aire comprimido en las aletas del cilindro y en el volante.
- Soprar com ar comprimido as abas do cilindro e do volante.





- In case cooling fins are very dirty, clean with a brush soaked in detergent and blow clean with compressed air.

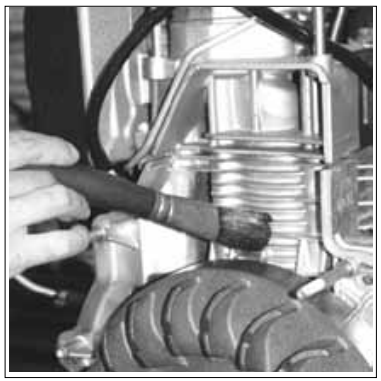
- Nel caso in cui le alette risultassero molto sporche pulire con un pennello imbibito con aqua e detersivo soffiare con aria compressa.

- Au cas où les ailettes étaient très sales, les nettoyer au moyen d'un pinceau imbibé de détersif, ensuite souffler avec de l'air comprimé.

- Sollten die Rippen stark verschmutzt sein, sind diese mit einem seifenwassergetränkten Pinsel zu reinigen und mit Druckluft zu durchblasen.

- Si las aletas están muy sucias límpielas con un pincel empapado de detergente e insufle aire comprimido.

- Caso as abas estejam muito sujas, limpar com um pincel embebido de detergente e soprar com ar comprimido.



POSSIBLE CAUSES AND TROUBLE SHOOTING

THE ENGINE MUST BE STOPPED IMMEDIATELY WHEN:

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

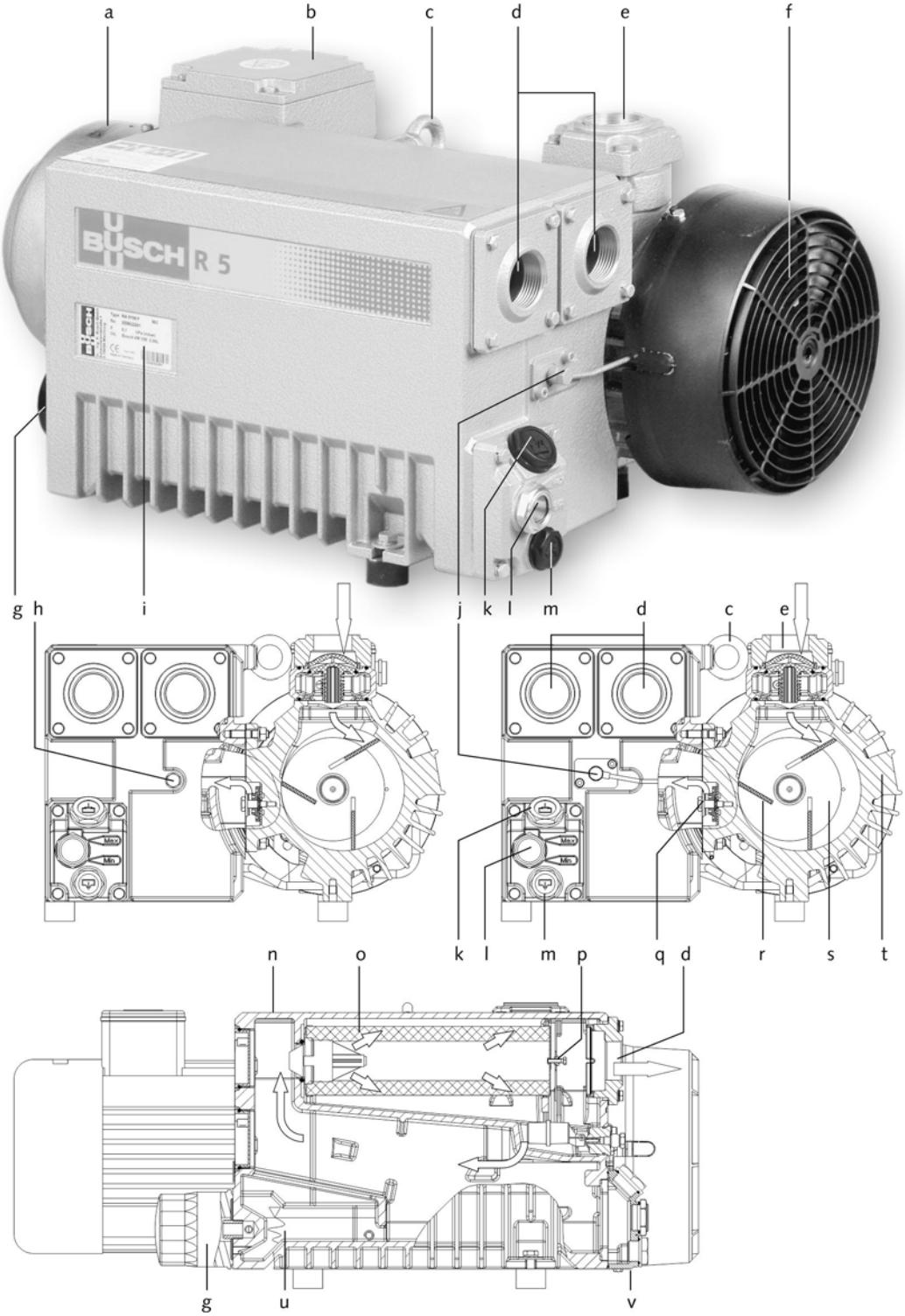
TABLE OF LIKELY ANOMALIES AND THEIR SYMPTOMS

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	Too low oil pressure	Increase oil level	Excessive oil consumption	oil and fuel dripping from exhaust
FUEL CIRCUIT	Clogged pipes	■		■							
	Clogged fuel filter	■	■	■			■				
	Air inside fuel circuit	■	■	■	■		■				
	Clogged tank breather hole	■	■	■							
	Faulty fuel pump	■	■								
	Injector jammed	■									
	Jammed injection pump delivery valve	■									
	Wrong injector setting					■					■
	Excessive plunger blow-by	■				■			■		
	Jammed injection pump delivery control	■		■	■						
	Wrong injection pump setting		■	■	■	■					
LUBRICATION	Oil level too high				■		■			■	
	Jammed pressure relief valve							■			
	Worn oil pump							■			
	Air inside oil suction pipe							■			
	Faulty pressure gauge or switch							■			
	Clogged oil suction pipe							■			
ELECTRIC SYSTEM	Battery discharged	■									
	Wrong or inefficient cable connection	■									
	Defective ignition switch	■									
	Defective starter motor	■									
MAINTE-NANCE	Clogged air filter	■		■		■				■	
	Excessive idle operation						■			■	■
	Incomplete running-in						■			■	■
	Engine overloaded	■	■	■		■					
SETTINGS/REPAIRS	Advanced injection	■									
	Delayed injection	■				■	■				
	Incorrect governor linkage adjustment	■			■						
	Broken or loose governor spring		■	■							
	Idle speed too low		■		■						
	Worn or jammed piston rings						■			■	■
	Worn or scored cylinders						■			■	■
	Worn valve guides						■			■	■
	Jammed valves	■									
	Worn bearings							■			
	Governor linkage not free to slide	■	■		■						
	Drive shaft not free to slide					■					
	Damaged cylinder head gasket	■									

Appendix C - Vacuum Pump Routine Maintenance and Troubleshooting

The following pages are taken from information published by the original equipment manufacturer (OEM), and are subject to change without notice.



a Directional arrow
b Terminal box
c Eye bolt
d Gas Discharge
e Suction connection
f Axial flow fan
g Oil filter
h Oil return valve
i Nameplate
j Float valve with oil return line
k Oil fill plug
l Oil sight glass
m Oil drain plug
n Oil separator
o Exhaust filter
p Filter spring
q Exhaust valve
r Vane
s Rotor
t Cylinder
u Oil sump
v Service cover

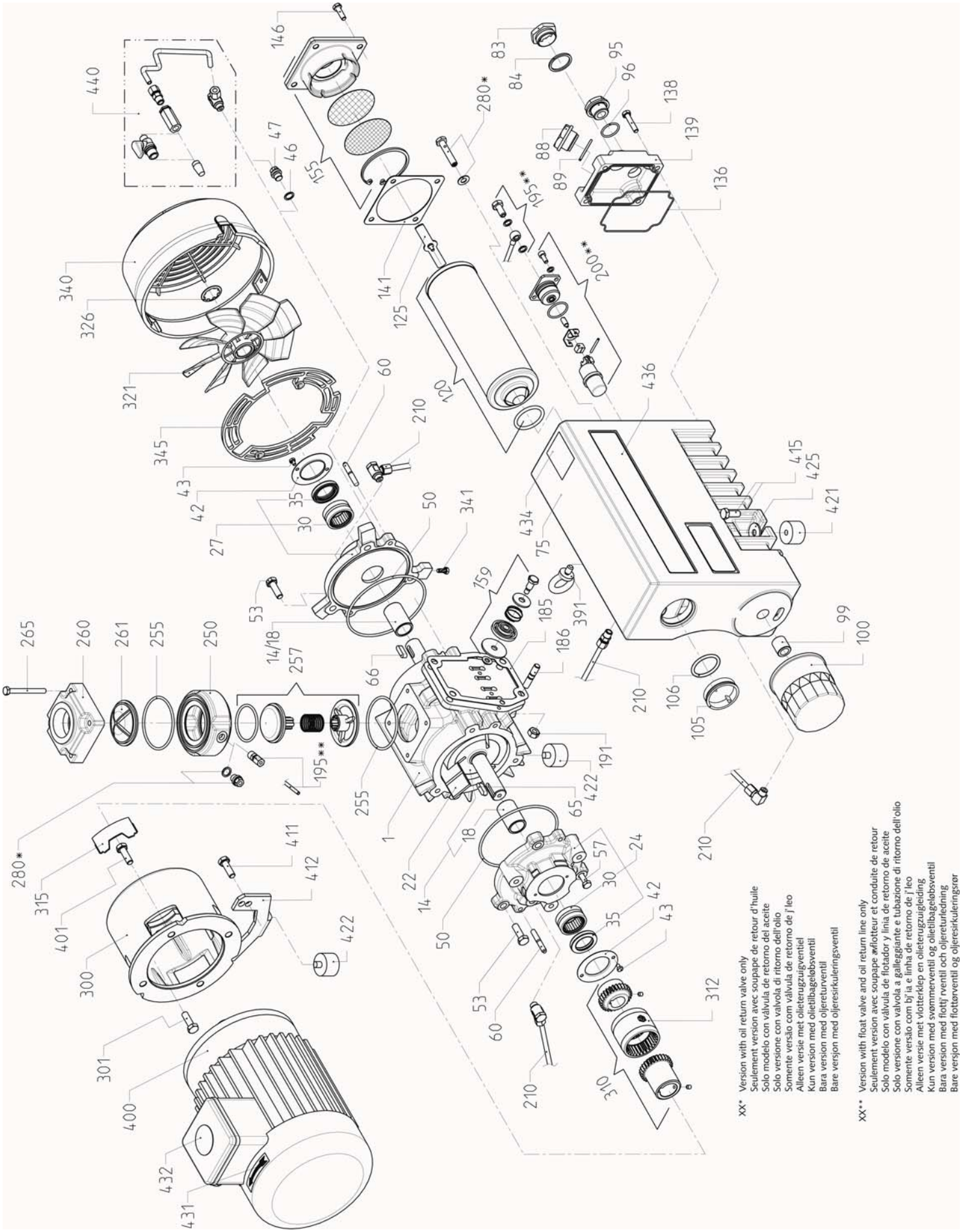
Figure 1 - Major Features of a Typical R 5 Vacuum Pump

Parts List for R 5 0025-0100 F

Ref	Description
001	Cylinder
015	Rotor
018	Bearing Sleeve
022	Vane
024	Assembly, endplate, motor side
025	Endplate, motor side
026	Endplate, fan side
027	Assembly, endplate, fan side
030	Bearing
035	Shaft seal
042	Shaft seal retaining plate
043	Screw
046	O-ring
047	Plug, gas ballast
050	O-ring
053	Screw
057	Screw
060	Taper pin
065	Shaft key
066	Shaft key
075	Exhaust box
083	Oil sight glass
084	Sight glass gasket
088	Oil fill plug
089	Oil fill plug gasket
090	Fill plug gauge assembly
090.1	Pressure gauge green/red fld
095	Oil drain plug
096	O-ring
099	Nipple
100	Oil filter
105	Drum plug
106	O-ring
120	Exhaust filter
125	Exhaust filter spring
136	Service block gasket
138	Screw
139	Service block
141	Exhaust cover gasket
144	Retaining ring
145	Exhaust cover plate
146	Screw
151	Exhaust screen, coarse
152	Exhaust screen, fine
155	Assembly, exhaust cover
159	Exhaust valve assembly
185	Gasket, cylinder/exhaust box
186	Stud
191	Nut
195	Oil return line
200	Oil return float valve assembly
210	Oil feed lines
219	Hydraulic fitting, straight
220	Hydraulic fitting, straight
221	Hydraulic fitting, banjo
222	Hydraulic fitting, straight
223	Hydraulic fitting, elbow
227	Hollow screw
228	Hollow screw
230	Oil tubing, coil
231	Oil tubing, fan side
232	Oil tubing, motor side
233	Hydraulic fitting, banjo
240	Cooling coil with fittings
250	Lower inlet flange
251	Valve disk
252	Valve guide
253	O-ring
254	Valve spring
255	O-ring
257	Assembly, anti-suckback valve
260	Upper inlet flange
261	Conical inlet screen
265	Screw
291	Hydraulic fitting, straight
295	Oil return line kit
300	Motor mounting bracket
301	Screw
310	Coupling, complete
311	Coupling half, pump side
312	Coupling insert
313	Coupling half, motor side
319	Spacer
321	Fan
326	Retaining ring
340	Fan guard
341	Screw, self tapping
345	Fan cover screen
391	Eyebolt
400	Motor
401	Screw
411	Screw
412	Motor foot bracket
415	Screw
416	Stud
421	Foot, rubber
422	Foot, rubber w/ stud
423	Lock washer
424	Nut
425	Flat washer
431	Label, directional arrow
436	Label, Busch
440	Gas ballast assembly

Note: This parts list includes parts for all the pumps covered by this manual. Your specific model might not necessarily have all tha parts indicated in this list. Refer to the illustration for your specific model pump when comparing part numbers or consult the factory.

Illustration of RA 0025-0040



3.0 ROUTINE MAINTENANCE

R 5 Series pumps require very little maintenance; however, to insure optimum pump performance, the following steps are recommended.

3.1 Pump Oil

3.1.1 Oil Level

WARNING

Do not add oil while the pump is running since hot oil vapor may escape through the oil fill port. Risk of burns.

WARNING

Insufficient oil quantity in the pump has the potential, under certain conditions, to lead to self-ignition of the remaining oil, causing damage to the pump, injury, or death.

With the pump installed relatively level, make sure that there is sufficient clean oil in the pump. The oil level should be observed on a daily basis and/or after 8 hours of operation and should be replenished if it drops below the 1/4 mark on the oil sight glass (83).

Oil level readings should be done only when the pump is turned off. Oil can be added to the oil fill port if the pump is shut off and the circulating oil has sufficient time to return to the oil sump. The oil might appear to be foamy, which is a normal phenomenon with aerated oil.

Under normal circumstances, it should not be necessary to add or drain oil from the pump between recommended oil changes.

A significant drop in oil level means there is an oil leak or that an exhaust filter is broken. The pump may be smoking excessively. It is normal for the oil to be foamy and light in color in an operating pump. However, if the oil is milky colored, it is an indication that water is present in the oil. If the pump is equipped with a gas ballast, it may be possible to purge water from the oil by operating the pump for an extended period with the inlet connection blanked off and the gas ballast open. If the oil is dark colored, it is contaminated or carbonized and must be changed or evaluated. Depending on the severity of the contamination, a thorough flushing may be needed. Contact the factory for flushing oil (Busch R568) and refer to Section 3.1.4.

3.1.2 Oil Type and Quantity

See Section 1.5 for details on oil type

Pump sizes 0025 and 0040 have an approximate oil capacity of 1 quart. Sizes 0063 and 0100 use approximately 2 quarts.

3.1.3 Oil and Filter Change

Oil life is dependent upon the conditions to which it is exposed. A clean, dry air stream and an oil operating temperature under 210°F are ideal conditions. When using R530 (hydrocarbon oil), it is recommended that oil changes are made every three (3) to four (4) months or 500 to 750 hours of operation, or as necessary if high heat is contaminating the oil. The use of Busch R570 or R590 synthetic oils could extend the operating hours between oil changes under ideal conditions. Oil samples should be taken regularly when exceeding the 500-750 hour recommendation.

Excessive Heat

WARNING

When changing the oil and filters, it may be necessary to flush the pump to remove any build-up of degraded oil from the sumps, oil lines, coolers, etc., to ensure proper oil flow through the pump. Reduced oil flow, especially through cooling coils, can cause mechanical damage or extreme overheating, which could cause the oil vapors to ignite, damaging the pump and causing injury or death.

When the pump is subjected to operating conditions that will cause the oil to be heated above 235°F, the oil will carbonize and become contaminated after a relatively low number of operating hours. The higher the temperature, the quicker the oil becomes contaminated. If the oil temperature is too severe, Busch R570 or R590 synthetic oil should be used to withstand the elevated temperatures. If synthetic oil is used in place of mineral oil, the pump should be flushed with Busch R568 oil before changing oil types.

Auxiliary oil cooling is the most practical approach to a severe heating problem.

Contaminated Air Stream

When the air stream contains a solid and/or liquid that can contaminate the oil, it must be changed more often. If the air stream contains a small percentage of contaminates and/or they are slightly aggressive (mild acids, etc.), synthetic oil, such as Busch R570, will resist breakdown better than the standard Busch R530. The solution is to install a filter or knock-out pot to keep the contaminates out of the pump.

Oil change intervals can only be established by experience with the pump operating in the actual conditions (see previous paragraph for some of the conditions). Develop the oil change interval by periodically checking an oil sample removed from the pump. When the oil sample has become dark in color (from solids and carbonized particles) or is milky looking (from water), it is time to discard it. As mentioned before, a thorough flushing may be required.

3.1.4 Oil Flushing Procedure

Flushing is needed under certain conditions. Some pumps will be beyond flushing and will need to be overhauled.

To help determine if flushing is needed, observe the condition of the oil as it is drained from the pump. Is it black and tar like or contaminated in any way? Was the pump noisy, overheating, or was the motor overload shutting the pump off? How old is the pump and when was the last time the oil was changed?

If the above conditions exist or you don't know when the last oil change was performed further investigation is needed. Also, when changing from one oil type such as R530 to another type such as R590 or R570 it will be beneficial to flush. Although the oils are compatible, mixing a lesser grade oil such as R530 with a synthetic oil like R570 will reduce the effectiveness of the synthetic oil.

All of the oil will be removed and replaced with the flushing oil (Busch R-568), and eventually that will be replaced by whatever Busch oil is needed for your particular application. Have enough oil and oil filters on hand for a couple of flushes. The following describes the steps in the flushing procedure:

Shut the pump off, drain all the oil from the pump by removing drain plug (95) and remove the gas discharge cover plate(s) (155) from the exhaust box. Remove the exhaust filter spring (125) and the exhaust filter (120) and look at the internal walls of the oil sump. If the walls are discolored but have no build up of any kind one can proceed with the flushing.

If gelled or burnt oil is clinging to the walls, this material must be scraped and removed prior to flushing. Proceed by scraping and cleaning as much of the exhaust box as possible. The more debris that is removed, the more effective the flushing will be. Reinstall exhaust filter, filter spring, and discharge cover plate, and proceed with the flushing. At this point one must remember that the oil lines and oil cooler (if equipped) might also be plugged to a point where no amount of flushing will make a difference and a complete overhaul will be the only option. Depending on the severity of the oil contamination flushing may be a last ditch effort.

Drain all of the oil from the pump. The more contaminated oil you remove now the more effective the oil flushing will be.

Remove the oil filter (100) and install a new one. It is recommended that you do not change the exhaust filter or filters until after the flushing to prevent contamination of any new filters.

Fill the exhaust box with the proper amount of flushing oil (Busch R-568).

If possible run the pump with the inlet closed and off of the process. Run the pump for approximately six hours, shut the pump off and drain a small sample of oil into a clear container.

Examine it. If it is clear to amber run the pump for another six hours and examine it again. If after the first six hours it is black drain it and fill again using another new oil filter.

If after the second flushing the oil still remains black the pump may have too much contaminated oil in it to flush out properly. There may be residue remaining in the lines and cooler that will not flush out. An overhaul will be necessary.

If after the second six hour period the oil still remains clear to amber in color drain it, change the oil filter and fill with the regular oil. At this point also change the exhaust filters.

Run the pump with a fresh charge of the oil to be used in your application (not R-568), and monitor the operating conditions closely. Check for noise, overheating and oil condition until a regular oil change schedule can be established.

Do not let the oil turn black. Change it before it fails. If the oil is kept in good condition the pump will last for years. If the oil starts to turn black do not hesitate to flush again. Keeping on top of the oil changes will prevent costly overhauls.

If you are just switching from one type of oil to another a single six hour flush is all that is necessary (follow the above instructions). Remember to change to a new exhaust filter or filters (120) after the flushing and not before.

3.2 Automotive-Type Oil Filter

These R5 F Series pumps are equipped with an automotive-type oil filter (100). When replacing the automotive-type oil filter, use only a genuine Busch filter.

Note: Make sure to tighten the Busch oil filter securely against the aluminum sealing surface so that leaks will not occur.

3.3 Exhaust Filter

WARNING

If the gas entering this pump is a health hazard, use rubber gloves and all necessary personal protection equipment when performing the exhaust filter replacement operation.

Every nine (9) to twelve (12) months, or as necessary, replace the exhaust filter elements. The service life of the exhaust filters varies widely with pump application. It is only necessary to change the filters when the elements become clogged with foreign material or burned oil. Indications of clogged filters are smoke and oil mist coming from the pump exhaust, higher than normal motor current, or oil leaking from the gas ballast (if equipped).

A pressure gauge is supplied with your R 5 vacuum pump as part of the oil fill plug (88). This gauge has a green field and a red field. Pressure within the green field would indicate normal pressure. Pressure in the red field (for a continuous period of time) requires an immediate change of the exhaust filter(s) (120).

In order to replace the filter, remove the screws (146) retaining the exhaust port cover plate. Pull the cover plate assembly (155) off the exhaust box; set it aside. Use a slotted head screw driver to loosen the exhaust filter retaining spring (125), then rotate and remove the spring. Pull the filter cartridge (120) out of the exhaust box.

WARNING

Wear safety glasses when installing or removing the spring retainers. The retainers can, if not secured correctly, slip off and fly out of the exhaust box, causing eye injury.

To field test an exhaust filter element, remove it from the pump, allow it to cool, clean the sealing end (or O-ring end), and use compressed air to blow through the element. Apply approximately 3 to 6 psi (maximum allowable operating pressure across the filter).

WARNING

Do not inhale through the filter or allow your mouth to come in direct contact with the filter.

Use a clean shop rag to seal off the connection between the air hose and the filter. If you can blow through it, the element is not plugged. If plugged, discard it and install a new one. The filter cannot be cleaned successfully. Visually inspect the filter element for cracks.

Use a clean shop rag to seal off the connection between the air hose and the filter. If you can blow through it, the element is not plugged. If plugged, discard it and install a new one. The filter cannot be cleaned successfully. Visually inspect the filter element for cracks.

Reinstall the filter elements. Make sure the open end of the element is properly seated down in its recess in the exhaust box with the O-ring correctly positioned. Retain the filter with the spring clip (125), tighten the tension screw until the filter is secure. Place the exhaust port gasket (141) and cover (155) in position on the exhaust box and retain with the cap screws (146).

3.4 Vacuum Inlet Filter

If the pump is equipped with a special vacuum inlet filter in applications where powder, dust or grit is present, the filter cartridge should be cleaned on a weekly basis, or as required, depending on the amount of foreign particles to which the pump is exposed.

3.5 Routine Maintenance Schedule

See the motor manufacturer's manual for the periodic motor maintenance.

Daily:

- Visually check oil level and color (see 3.1.1).

Weekly:

- Check the vacuum pump for oil leaks.

Monthly:

- Test exhaust filter(s) for proper function.

- Remove the suction line from the pump inlet so that the pump is pulling on atmospheric air. Check that the reading on the filter pressure gauge is in the green field. Reconnect the suction line.

- Check inlet filter (if installed). Clean or replace as necessary.

Every 6 months:

- Make sure that the housing is free from dust and dirt, clean if necessary.

- With the pump shut off and secured against inadvertent start-up, clean the fans, ventilation grills, and cooling fins.

Every year:

- Replace exhaust filters (120)

- Replace inlet air filter (if installed)

- Check the inlet screen (261), clean if necessary

- Clean gas ballast filter (440) (if installed)

Every 500 - 2000 Operating Hours

- Change the oil and the oil filter (100) (see 3.1.3)

- Check the float valve (200)

As necessary: Check and/or clean the standard inlet screen. If the optional inlet filter is used, replace the filter material as practice determines.

The oil cooling coils (only on model 0100) and any motor or pump grill covers on all models should be inspected regularly for debris. Clean as necessary. Soiling prevents cool air intake or movement and may lead to overheating of the pump.

Drain drip legs on exhaust piping.

3.6 Overhaul Kit/Filter

An overhaul kit containing a set of gaskets and O-rings, vanes, bearings and bearing sleeves, shaft seals and taper pins, is available from the factory.

Also, a filter kit containing oil drain plug, gaskets, automotive-type oil filter, exhaust filter, and synthetic baffle strainer (where applicable), is available from the factory.

When ordering, please be ready to provide all of the information from the nameplate.

4.0 TROUBLESHOOTING

Problem	Possible Cause	Remedy
Pump does not reach “blank-off” pressure, or the pump takes too long to evacuate the system	Oil is contaminated	Shut off pump, drain oil and replace automotive-type oil filter (where applicable) when pump is cool. Flush and fill pump with new oil and take new blank off measurement after operating temperature is reached.
	Leakage in suction line	Check the piping for leaks.
	Wire mesh inlet screen (261) plugged	Clean wire mesh inlet screen. Install inlet filter if problem repeats frequently.
	No oil or not enough oil in oil reservoir	Shut off pump and add necessary oil.
	Automotive-type oil filter (100) is dirty or clogged	Replace automotive-type oil filter, exchange oil, if necessary, and refill with fresh oil.
	Inlet valve plate (257) stuck in closed or partially open position due to contamination	Disassemble inlet valve and screen. Clean as required.
	Oil tubing plugged and/or leaking	Replace, clean and/or retighten the oil fittings. Replace only with same size tubing.
	Shaft seal (35) leaking	Replace the shaft seal.
	Exhaust valve (159) is not properly seated or it is partially stuck open	Properly seat or loosen exhaust valve.
	Vanes (22) are blocked in the rotor (14) or they are damaged	Free vanes or replace with new ones.
	Radial clearance between the rotor (22) and cylinder (1) is no longer adequate.	Re-set the radial clearance.
	Internal parts worn or damaged	Replace worn or damaged parts.
	Oil float valve (200) broken or stuck open	Check the cleanliness and function of the oil float valve. Blow out with compressed air if necessary.
	Gas ballast (440) open	Close gas ballast.

Problem	Possible Cause	Remedy
Pump will not start		
	The motor starter overload settings are too low or trip level is too low	Check overload settings in motor starter for size and setting according to motor nameplate data.
	A fuse is blown	Check the fuses, replace if necessary
	Connection wiring is too small or runs are too long causing too great a voltage drop	Use proper wiring size.
	Pump or motor is blocked	Remove fan cover (340) and try to turn pump and motor by hand. If frozen, remove motor from pump and check motor and pump separately. If pump is frozen, contact Busch LLC Service Department in Virginia Beach, Virginia for suggestions.
Pump starts, but requires high power	Oil too heavy (viscosity too high) or ambient temperature below 5 degrees C (41°F)	Change to R580 vacuum oil if very cold, or warm up oil before starting the pump.
	Pump runs in the wrong direction	Check for correct rotation which is counterclockwise when looking at the motor from the motor's fan side.
	Pump is overfilled with oil or wrong kind of oil is used	Correct the oil level and quality per Section 1.5 and use recommended oil
	Exhaust filters (120) in exhaust chamber are clogged and appear burned black with pump oil	Replace exhaust filters, maintain proper oil condition, oil level, and use only Busch recommended vacuum oil
	The exhaust filter (120) is clogged due to process material	Contact the factory in Virginia Beach, Virginia for recommendations.
	Foreign particle in pump; vanes (22) broken; bearing (30) seizing	Remove foreign parts, and replace vanes and bearings.

Problem	Possible Cause	Remedy
Pump discharges smoke at the exhaust port or expels oil droplets from the exhaust Note: An oil filling plug with pressure gauge (88) is provided on all R5 F Series pumps, so that the pressure in front of the exhaust filters can be monitored. The green field indicates that the filters are still effective. Back pressure that causes a continuous reading in the red field requires immediate change of exhaust filters.	Exhaust filter (120) is not properly seated with O-ring or filter material is cracked	Check condition and check for proper seating of exhaust filters. Replace if necessary. Also, check filter spring clips for tightness.
	Exhaust filter (120) is clogged with foreign particles	Replace exhaust filter.
	The oil return valve is stuck closed. Proper function allows valve to open when oil level begins to build and closes when oil is drained. **WARNING** Do not apply pressure or vacuum by mouth	Free or replace the oil return check valve.
	Oil return line (195) is clogged	Free clogged line or replace. Check that oil is being drawn out of the exhaust filter area while the vacuum pump is operating.
Pump runs very noisily	Coupling insert (312) worn	Replace coupling insert in motor/pump coupling.
	Bearing (30) noise	Replace bearings.
	Vanes (22) stuck	Replace vanes, Use recommended Busch oil. Change oil more frequently.
The pump runs very hot. See Technical Data for typical oil sump temperature. Note: The oil temperature with a closed inlet should be approximately 185-225°F depending on pump type. At 24 in. Hg, the oil in the pump can go above 225°F. These values are taken at an ambient temperature of 68°F. The maximum recommended ambient operating temperature for an R 5 is 104°F on a continuous basis. When it is necessary to operate a pump in ambient temperatures above this limit, careful oil monitoring and/or optional water cooling is necessary. Contact the factory for details.	Not enough air ventilation to the pump	Clean motor and pump air grills. Do not install the pump in an enclosed cabinet unless a sufficient amount of cool air is supplied to the pump. On pumps with oil cooling coils, clean outside fin assembly. Bring ambient air temperature down.
	Automotive-type oil filter (100) clogged and pump does not receive enough oil	Change automotive oil filter.
	Not enough oil in oil reservoir, or badly burned oil is used for pump lubrication	Drain and refill only with Busch recommended oil. Increase oil change intervals.

Problem	Possible Cause	Remedy
Pump is seized	Pump operated without oil and vanes (22) are broken	Disassemble and exchange vanes; contact Busch LLC Service Department in Virginia Beach, Virginia for suggestions.
	Pump was operated for an extended period of time in the wrong rotation	Inspect vanes and replace; contact Busch LLC Service Department in Virginia Beach, Virginia for suggestions .
	Liquid carryover into the pump cylinder broke vanes while pump was running, or oil broke vanes on start-up	(a) Install condensate trap on the inlet of the pump (b) Pump was overfilled with oil in oil reservoir. Follow oil filling procedure (see Section 1.5) and do not overfill (c) Built-in, anti-suck-back valve leaking while pump was shut down and vacuum was left in manifold. Clean valve seat and check that anti-suck-back valve holds vacuum on inlet when pump is shut down d) Two pumps or a receiver is on the same main line. Install a manual or automatic operated valve in front of each pump
Automotive-type oil filter (100) does not get warm within two to five minutes when cold pump is started	Automotive-type oil filter is clogged	Replace automotive-type filter per Section 3.2 and exchange oil per Section 1.5.
	Wrong automotive-type filter is used and/or oil lines and oil coolers leading to pump are clogged	Use only automotive filter as listed in Section 3.2 and blow lines free. Flush oil cooler.

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