

GA 01.414/2.02

DRYVAC P

Operating Instructions

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Note:

References to illustrations consist of (figure number/item number). For example, (1/2) refers to Figure 1, Item 2.

DRYVAC is a registered trademark of Leybold.

Safety Information

Hazard analyses per European standard EN 1012 were conducted for the DR YVAC® 25, 50 and 100 P pumps. Every person involved with connecting, operating or maintaining these pumps shall have read and understood this DR YVAC operating instruction manual in order to avoid hazards and operating malfunctions.

DRYVAC P pumps are designed to pump down vacuum chambers to pressure values in the rough and fine vacuum ranges, and are intended for industrial use.

Precautionary notes in these instructions:

Warning – This indicates procedures and operations which must be strictly observed to prevent hazards to persons.

Caution – This indicates procedures and operations which must be strictly observed to prevent damage or destruction of the pump.

Media compatibility

DRYVAC P pumps are authorized for use only in those applications and processes which are listed in Table 1 of this manual. Contact Leybold before using a DR YVAC for applications and processes which are not listed.

Warning



Standard DRYVAC P pumps are not suited for pumping media which could ignite or explode. If these pumps are nonetheless used in such applications, the owner / operator must take the precautionary measures required for explosion protection in compliance with legal requirements.

Electrical Safety

Warning



Disconnect the pump from the main power supply before beginning any assembly or disassembly work. Take measures to ensure that the pump cannot be started. The electrical connections shall be made only by a qualified and licensed electrician, in accordance with local codes.

Mechanical Safety

Warning



Do not expose any parts of the body to the vacuum. In particular do not operate the pump with flanges open, or loosen any flange, oil filling or drain screws when a vacuum is present, even if the pump is switched off.

Remove the cover panels only when the pump is switched off.

Do not remove the pump or perform any maintenance work before it has been vented and has come to a complete stop.

Protection Against Hazardous Gases

The inlet and exhaust line connections must be tight. Hazardous gases could escape at leaks or the gases being pumped could react with humid air.

The pump's overall leak rate is $<1 \cdot 10^{-5}$ mbar-l-s⁻¹. Install a housing evacuation unit when pumping hazardous gases.

Whenever the pump is opened to:

- refit the purge-control plate
- check the direction of rotation
- remove the intake or exhaust line
- remove the pump from the system

the following safety instructions must be observed:

Warning



If the DRYVAC has pumped hazardous gases, you must determine the nature of the hazard and take the appropriate safety precautions. Comply with all safety regulations. Take adequate safety precautions before opening the intake or exhaust.



If necessary, use gloves, a respirator and/or protective clothing and work under an exhaust hood.



DRYVACs that are used in semiconductor processes, for example, can be contaminated with process gases. These gases may be toxic and hazardous to health. In addition, deposits with similarly dangerous properties can form inside the pump. Many of these gases and deposits can seriously corrode the pump, especially when they are mixed with humid air.

To avoid health hazards and corrosion damage when the pump is detached from the system, lay a container of desiccant on the inlet splinter guard and then seal the pump immediately at all flange connections. Store the pump with a desiccant, in a polyethylene bag.

Handling PFPE

Since PFPE is used when pumping corrosive media, it can be contaminated with these media during use. Thus it is necessary to take appropriate precautionary measures depending on the medium that has been pumped (see "Protection against hazardous gases").

Warning



Hazardous decomposition products may be formed at temperatures exceeding 350°C (660°F). Thus smoking is prohibited in rooms where PFPE is being used or handled; do not expose cigarettes or other tobacco products to PFPE.

All safety regulations applicable to handling the medium being pumped shall also be observed when working with PFPE and the pump.

PFPE must be reclaimed or disposed of as a toxic waste.

Returning Equipment

Complete the form at the back of this manual before returning equipment to Leybold for service. This form notifies us of any toxic or other harmful products (as defined by the applicable regulations such as the Common Market Guideline L360, 1976/1979 or VBG 16) that may exist in or near the equipment. Attach the form to the pump or enclose it with the pump. This statement detailing the contamination is required to satisfy legal requirements and to protect our employees.

1 Description

1.1 Design and Function

The DRYVAC 25P, 50P and 100 P are dry-compression vacuum pumps designed especially for semiconductor etching and CVD processes. Refer to Section 1.2 for technical data.

Pump operating principle

DRYVACs are four-stage hook-and-claw vacuum pumps. Figure 1 illustrates the DRYVAC's operating principle.

The two rotors (1/1) turn in opposite directions inside the pumping chamber. As they rotate, they open and close the intake (1/5) and outlet (1/4) slots with each cycle.

The pumping chamber is divided by the rotors. Gas is drawn in on the one side of the rotors and compressed on the other side.

The top sketch shows the beginning of the suction and compression cycle. As the rotors rotate, the sealed space above the rotors (1/2) is reduced in size and the gas is compressed. At the same time, the right rotor begins opening the inlet slot and gas is drawn into the pumping chamber below the rotors.

In the center sketch, the left rotor is starting to open the outlet slot, and compressed gas is being discharged from the pumping chamber.

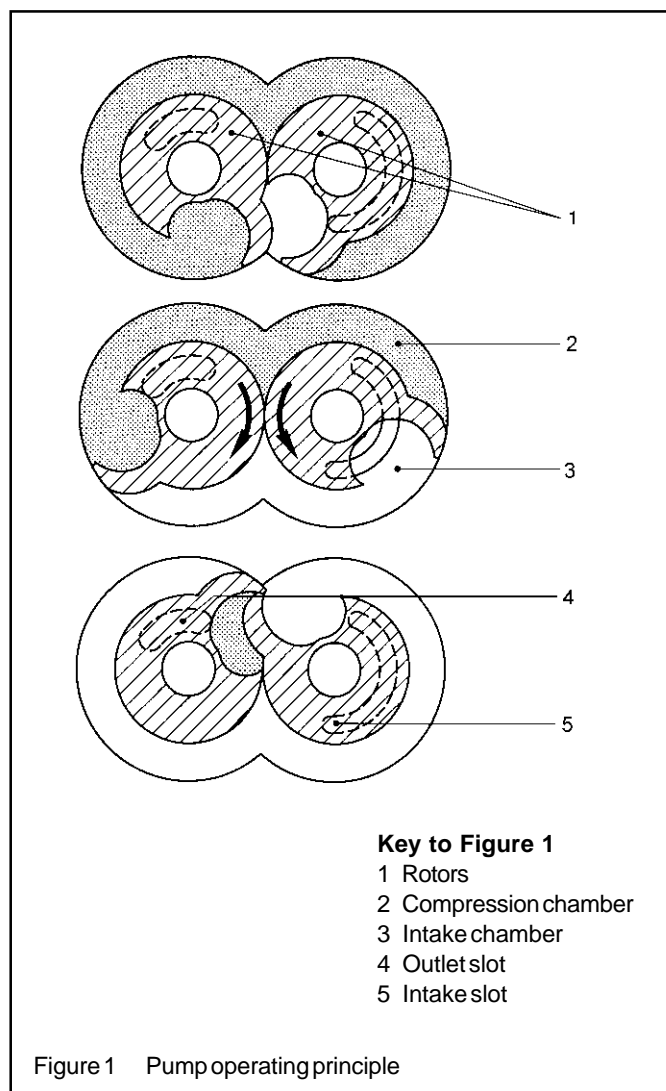
In the bottom sketch, the cycle has been completed and the inlet and outlet slots are closed. Once the rotors have passed through the neutral position, the cycle starts again.

Design

There are four pumping stages (2/2) located one above the other. The stages are pinned together.

The gas enters the pump through the intake port, is pumped through four pump stages, flows through an exhaust silencer (2/4), and through a non-return valve into the exhaust.

The rotors are driven by two vertical shafts connected to the motor (2/1) and synchronized by gears.

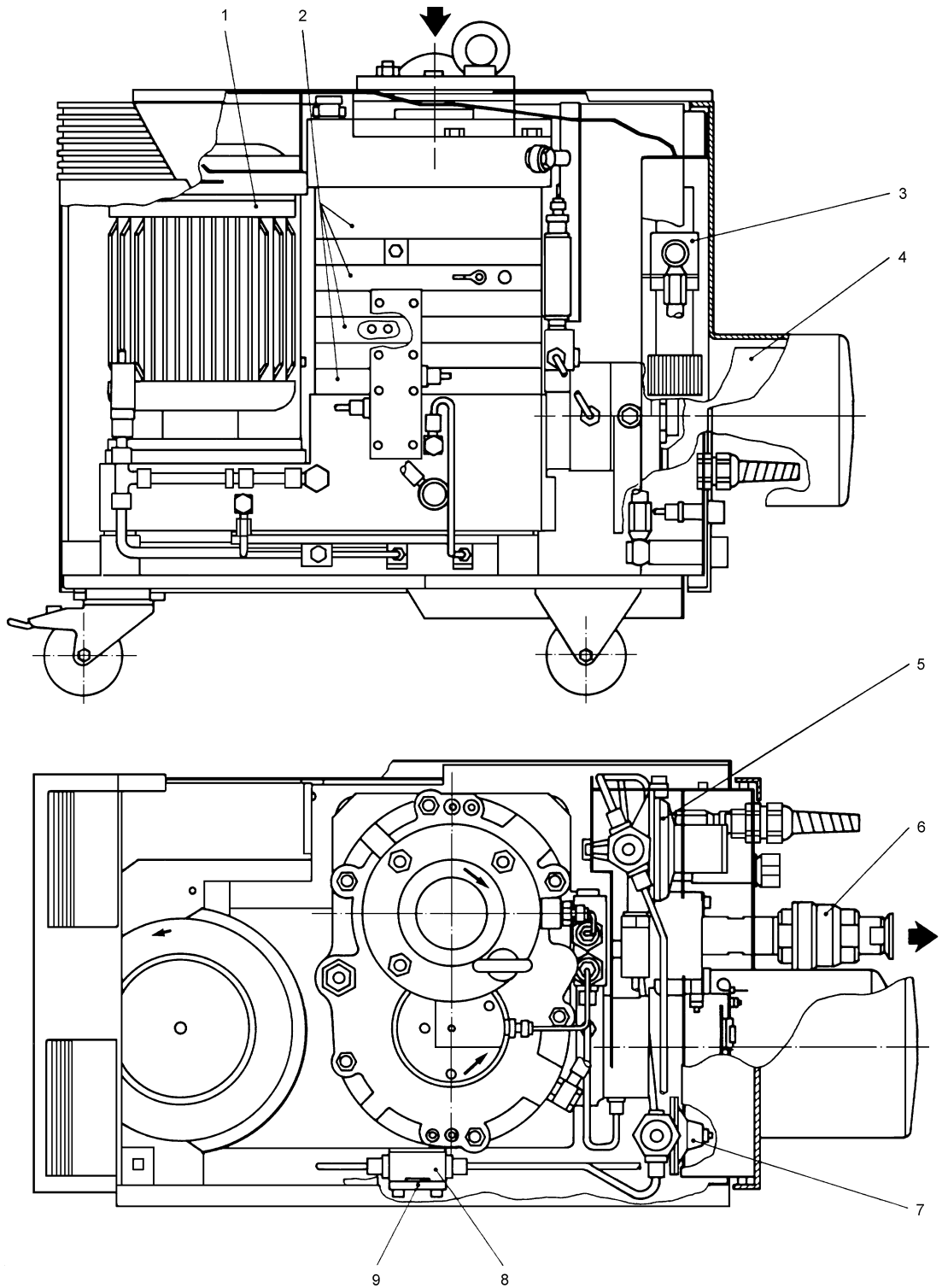


The pumping chamber is free of sealants and lubricants; however, PFPE (perfluoropolyether) is used to lubricate the gearing and the lower bearings. The upper bearings are PFPE-grease lubricated.

Piston rings are used to seal each shaft where it passes through the stages. The gear box is isolated from the pumping chamber by piston rings and radial shaft seals. The upper bearings are isolated by shaft seals.

The bearings and seals are mounted in the water-cooled upper and lower end plates. The supply of cooling water is regulated by a thermostat (2/3). The pump stages are air cooled.

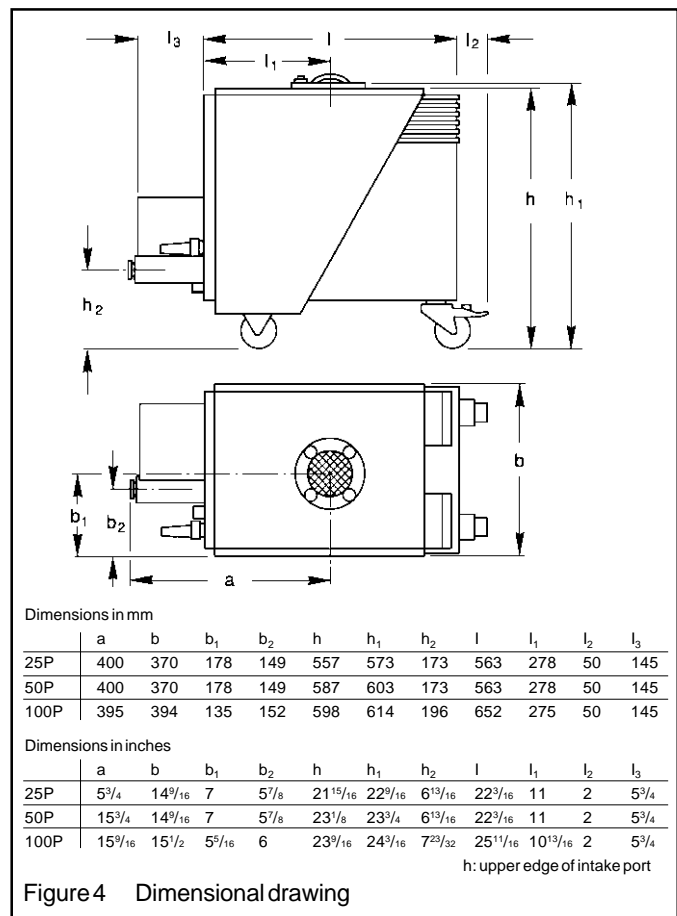
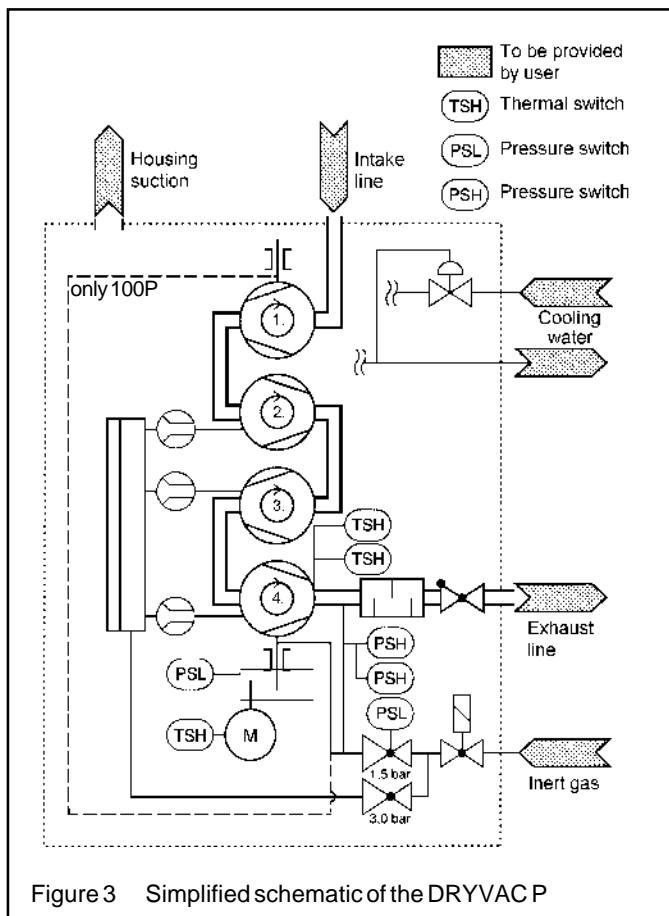
The pump is fully enclosed by panels, which can easily be removed for maintenance purposes. An air outlet for cabinet ventilation is on the top of the DRYVAC.



Key to Figure 2

- | | |
|------------------------------|------------------------------------|
| 1 Motor | 6 Check valve |
| 2 Pump stages | 7 Pressure regulator 3.0 bar |
| 3 Thermostat valve | 8 Interstage purge block |
| 4 Exhaust silencer | 9 Purge-control plate (reversible) |
| 5 Pressure regulator 1.5 bar | |

Figure 2 Sectional drawing of a DRYVAC 100P



Inert Gas Barrier and Purge Gas Device

The DRYVAC P has a mechanism for barrier gas and for purge gas.

Inert gas for these devices is connected at the back of the pump. It flows into the pump through a solenoid valve and two pressure reducers (1.5 bar and 3.0 bar).

The barrier gas, which flows through the 1.5 bar regulator, protects the lower radial shaft seals and bearings against aggressive media and particles. In addition, the barrier gas is pumped to the exhaust pressure switches and protects them against contamination.

The purge gas, which flows through the 3.0 bar regulator, the interstage purge block, the purge-control plate, connecting pipes and nozzles, and into the three lower pump stages, protects the pump stages against deposits.

Electrical Equipment

The electrical equipment of the DRYVAC P includes four pressure switches, three thermal switches, and one solenoid valve. These devices are normally connected to the plant's control equipment for the purpose of controlling the pump.

The exhaust pressure is monitored by two pressure switches. The first switch warns of an abnormally high exhaust pressure, while the second switch signals that the exhaust pressure is too high for continued pump operation.

The gearbox oil pressure is monitored by an oil-pressure switch. The contacts of this switch can be used to indicate whether the pump is running or shutdown.

The fourth pressure switch monitors the barrier-gas pressure.

The DRYVAC P is equipped with two thermal switches that monitor pump temperature. The first switch warns of an abnormally high temperature, while the second switch signals that the temperature is too high for continued pump operation.

The third thermal switch monitors the motor temperature.

The pump's supply of inert gas is controlled by its inert-gas-solenoid valve.

The connections for the switches and the inert-gas-solenoid valve are brought together in two sub-D plugs on the back of the DRYVAC.

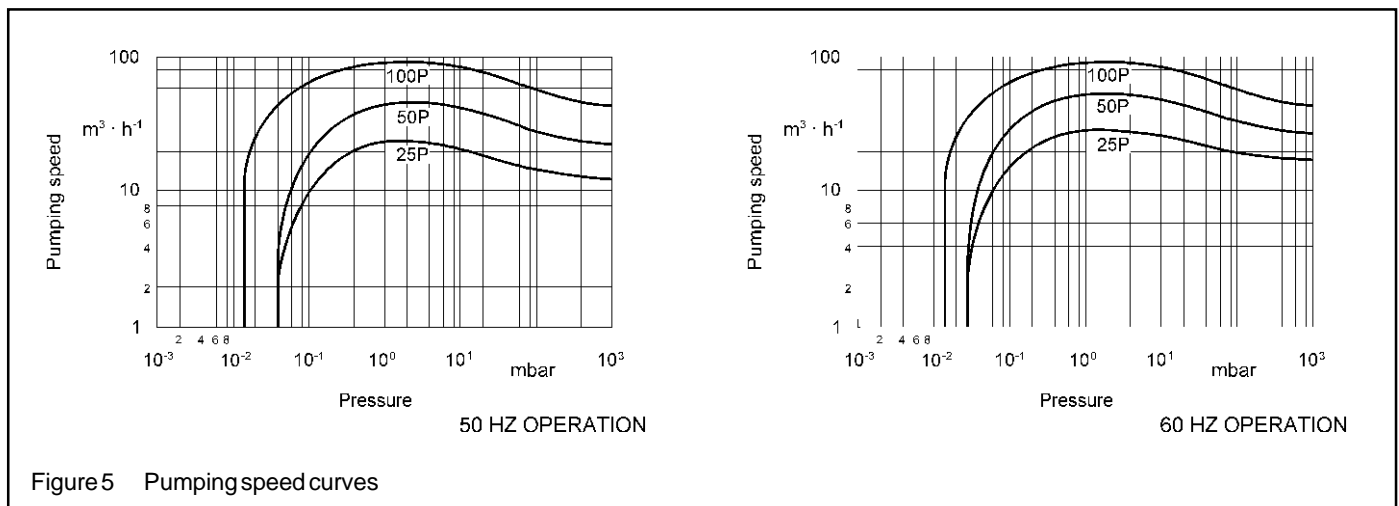


Figure 5 Pumping speed curves

1.2 Technical Data

DRYVAC 25P	50P	100P
Pumping Speed		
50 Hz operation 25 m ³ · h ⁻¹ (14.7 cfm)	45 m ³ · h ⁻¹ (26.5 cfm)	100 m ³ · h ⁻¹ (59 cfm)
60 Hz operation 30 m ³ · h ⁻¹ (17.7 cfm)	55 m ³ · h ⁻¹ (32.4 cfm)	100 m ³ · h ⁻¹ (59 cfm)
Ultimate pressure* with purge-control plate set to "ETCH"		
50 Hz operation 4 · 10 ⁻² mbar (3 × 10 ⁻² Torr)	4 · 10 ⁻² mbar (3 × 10 ⁻² Torr)	1.5 · 10 ⁻² mbar (1.1 × 10 ⁻² Torr)
60 Hz operation 2.5 · 10 ⁻² mbar (1.9 × 10 ⁻² Torr)	2.5 · 10 ⁻² mbar (1.9 × 10 ⁻² Torr)	1.5 · 10 ⁻² mbar (1.1 × 10 ⁻² Torr)
Maximum intake pressure		
in continuous operation 1000 mbar (750 Torr)	300 mbar (225 Torr)	150 mbar (112 Torr)
Motor power 2.8 kW (3.8 hp)	2.8 kW (3.8 hp)	4.0 kW (5.4 hp)
Rotational speed of pump		
50 Hz operation 3000 rpm	3000 rpm	3000 rpm
60 Hz operation 3600 rpm	3600 rpm	3000 rpm
Noise level with the exhaust		
line connected 62 dB(A)	62 dB(A)	68 dB(A)
Cooling water requirements (approx.) at		
a water temp. of 15°C (59°F) 70 l · hr ⁻¹ (18.5 gal/hr)	70 l · hr ⁻¹ (18.5 gal/hr)	100 l · hr ⁻¹ (26.4 gal/hr)
Maximum cooling water temp. 25°C (77°F)	25°C (77°F)	25°C (77°F)
Cooling water pressure* 2 – 10 bar (14 – 130 psig)	2 – 10 bar (14 – 130 psig)	2 – 10 bar (14 – 130 psig)
Cooling water connection, female threads NPT 1/2"	NPT 1/2"	NPT 1/2"
Inert gas pressure* 4 – 10 bar (43 – 130 psig)	4 – 10 bar (43 – 130 psig)	4 – 10 bar (43 – 130 psig)
Inert gas connection, female threads NPT 3/8"	NPT 3/8"	NPT 3/8"
Inert gas flow Refer to Table 1	Refer to Table 1	Refer to Table 1
Barrier gas pressure* 1.5 bar (7 psig)	1.5 bar (7 psig)	1.5 bar (7 psig)
Purge gas pressure* 3.0 bar (29 psig)	3.0 bar (29 psig)	3.0 bar (29 psig)
Lubricant quantity in gear box 0.75 l (0.8 qt)	0.75 l (0.8 qt)	0.8 l (0.85 qt)
Maximum ambient temperature 40°C (104°F)	40°C (104°F)	40°C (104°F)
Weight 170 kg (375 lbs)	180 kg (397 lbs)	210 kg (463 lbs)
Intake port DN 63 ISO-K	DN 63 ISO-K	DN 63 ISO-K
Exhaust port DN 25 KF	DN 25 KF	DN 40 KF

*All pressures given in bar or mbar are absolute values.

TABLE 1 – Process Settings*

Process Group	Processes	Thermostat Valve	Purge Control Plate	Inert Gas Consumption NI/hr
A	Al-Etching, Si-Etching Poly-Si-Etching, SiO ₂ -Etching, Tungsten-Etching	4	ETCH side faces out	1000 – 1500
B	PECVD-WSi ₂ , PECVD-SiO ₂ , PECVD-Si ₃ N ₄ , PECVD-Poly-Silicon, PECVD-TEOS, PECVD-W, PECVD-PSG, PECVD-BPSG, Ion implanter	MOCVD, LPCVD-SiO ₂ , LPCVD-Si ₃ N ₄ , LPCVD-Poly-Silicon, LPCVD-TEOS, LPCVD-W	4 CVD side faces out	4000 – 5000
C†	LTO LPCVD-PSG, LPCVD-BPSG	2	CVD side faces out	6000 – 7000
D†	LPCVD-WSi ₂	2	CVD side faces out	4000 – 5000

* Consult your Leybold sales representative to confirm the correct process setting for you application.

† Additional DR YVAC modifications may be necessary for these applications. Consult your Leybold sales representative for additional information.

1.3 Standard Equipment

The DRYVAC P is delivered ready for operation with its gear box filled with PFPE (perfluoropolyether) lubricant.

A sealing disk with dirt trap and a union flange are attached to the intake port.

The intake and exhaust ports, the water inlet and outlet fittings, and the inert gas fitting are sealed for shipping.

The pump is shipped with the following:

- A 2-meter (6.5-foot) main power cable without plug.
- An Allen key for removing or installing the exhaust silencer (refer to Section 4.2).
- The mating connectors for the DR YVAC's X18 and X19 sub-D connectors (refer to Section 2.3.1).
- A purge nozzle for L TO processes (refer to Section 2.1.3).

1.4 Ordering Data

	Catalog No.
DRYVAC 25P	138 13
DRYVAC 50P	138 33
DRYVAC 100P with 3-phase motor	
200-208-240/400-480 V*, 60 Hz, 3 phase	138 74
200/400 V*, 50 Hz, 3 phase	138 73
Repair kit:	
DRYVAC 25/50 P	899552
DRYVAC 100 P	899555
Exhaust silencer SD 25-501	137 50
Dry canister for shipping and storage	200 78 563

*All voltage ±10% from value listed.

2 Installation

2.1 Adapting the Pump to the Process

Warning



If the DRYVAC has pumped hazardous gases, you must determine the nature of the hazard and take the appropriate safety precautions. Comply with all safety regulations. Take adequate safety precautions before opening the intake or exhaust.

The DRYVAC is delivered set up for the processes of group B in Table 1 – unless specified otherwise by the sales order. This setup opens the purge-gas supply to the individual pump stages.

If your process is in group A of Table 1, you must remove the cover panels of the pump, and reverse the purge-control plate as described in Section 2.1.1.

2.1.1 Converting to ETCH Processes

For the ETCH processes listed in group A of Table 1, reverse the purge-control plate. Turning the plate so that its "ETCH" side faces out shuts off the purge-gas supply to the pump stages.

If LTO processes were being run with the CVD setting, follow the procedure in Section 2.1.3; however, replace the installed nozzle of the 3rd pump stage with a \varnothing 0.6 nozzle.

Reverse the purge-control plate as follows (see Figure 6):

1. Open the 1/4-turn retaining clips on top of the pump, and take off the two top covers.
2. Open the four 1/4-turn retaining clips on the rear panel, and take off the panel.
3. Unscrew the socket-head capscrews holding on the side panels, and remove panels.
4. Unscrew the eight socket-head capscrews of the purge-control plate.
5. Turn over the purge-control plate, and reinstall it so that the side marked "ETCH" is visible from the outside; ensure that its rubber gasket is aligned correctly.
6. Reassemble the pump cabinet.

2.1.2 Converting from ETCH to CVD Processes

When converting from ETCH to CVD processes (the processes of groups B, C and D in Table 1), follow the procedure in Section 2.1.1; however, the purge control panel must be turned so that the word CVD is facing out.

2.1.3 Converting to LTO Processes

For LTO processes, the nozzle of the 3rd pump stage (6/4 or 6/7) must be replaced by the nozzle enclosed separately with the pump. Replacing this nozzle increases the purge gas flow in the 3rd pump stage.

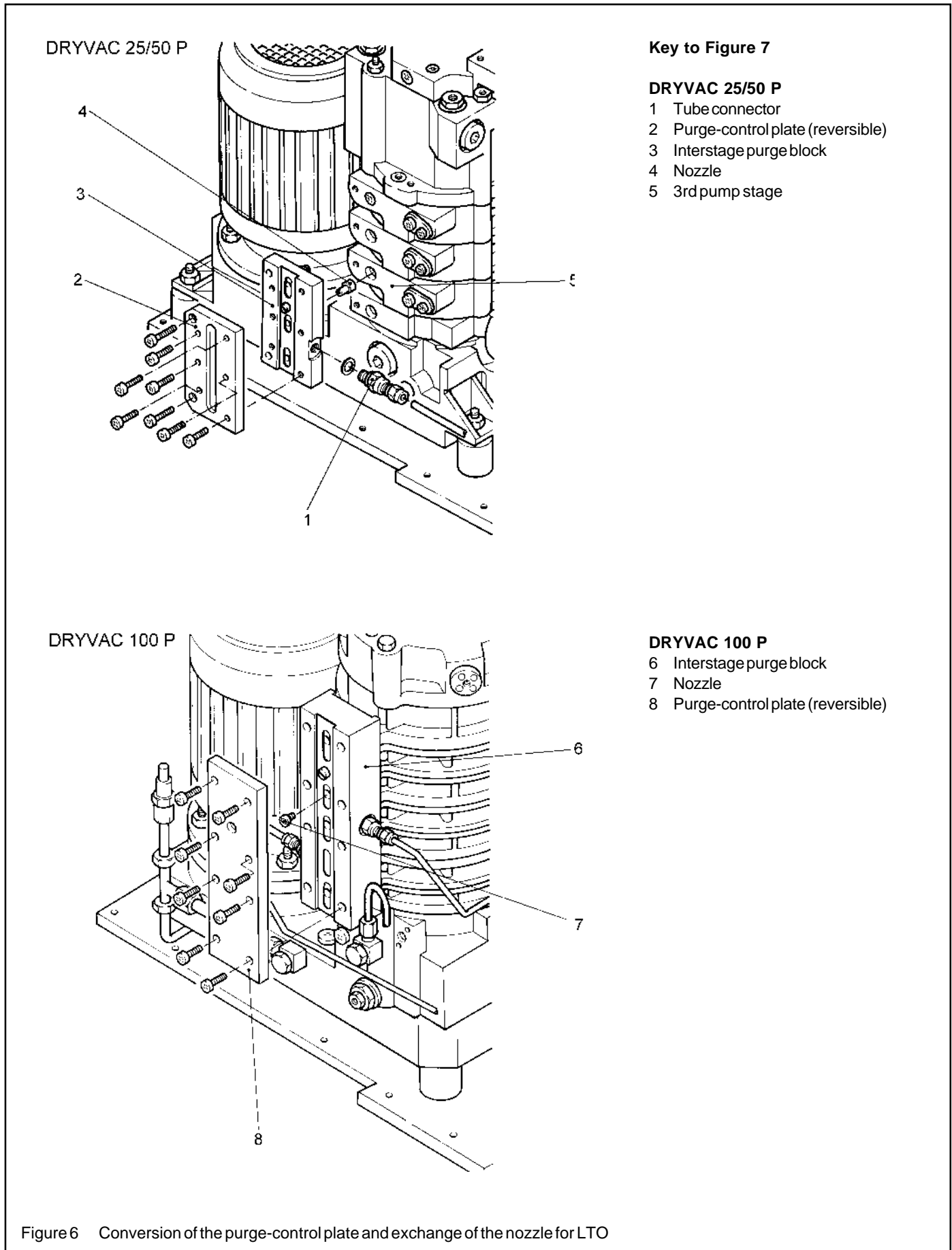
Replace the nozzle as follows (see Figure 6):

1. Open the 1/4-turn retaining clips on top of the pump, and take off the two shells.
2. Open the four 1/4-turn retaining clips on the rear panel, and take off the panel.
3. Unscrew the socket-head capscrews holding on the side panels, and remove panels.
4. For DRYVAC 25/50 pumps only, remove the tube connector (6/1) from the connection block (6/3).
5. Unscrew the eight socket-head capscrews of the purge-control plate (6/2 or 6/8), and remove plate.
6. For DRYVAC 25/50 pumps only, pull off the connection block (6/3) from the pump.
7. Unscrew the \varnothing 0.6 nozzle (6/4 or 6/7); then screw in the \varnothing 0.8 nozzle.
8. For DRYVAC 25/50 pumps only, reinstall the connection block and tube connector. Be careful not to damage the O-rings on the connection block.
9. Install the purge-control plate so that the side marked "CVD" is visible from the outside. Observe the correct alignment of the sealing strap.
10. Reassemble the pump cabinet.

2.1.4 Main Inert Gas Valve

Standard DRYVAC P models have a 24 V **AC/DC** main inert gas valve. However, this valve is locked in the open bypass position (manual override). In this position, the purge will flow continuously.

Refer to Section 2.3.1 for instructions if you want to use 24 V to open and close this valve.



2.2 Setting up the Pump

Eyebolts are provided for lifting and moving the pump. Do not tip or turn the pump during movement. Do not stand beneath the suspended pump during movement.

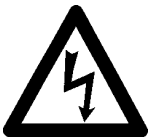
Set the pump on a flat even surface in a dry location. Lock the casters after the pump is in place.

The pump is of safety class IP 20. Protect the pump against dripping and splashed water.

The ambient temperature must not exceed 40°C (104°F). Do not obstruct the ventilation grids. If installing the pump in an enclosed cabinet or system, ensure that sufficient ventilation is available.

2.3 Electrical Connections

Warning



Electrical connections should be made only by a qualified and licensed electrician, in accordance with local codes. Disconnect the pump from all voltages before beginning any assembly or disassembly work. Take measures to ensure that the pump cannot be started.

2.3.1 Connection to the Plant Control Equipment

Seven switches and one solenoid valve are installed in the DRYVAC. The connection of the switches and of the main inert gas valve are brought together in two sub-D connectors (X18 and X19) at the back of the housing. The switch contacts open in response to abnormal operating conditions (Figure 7).

The voltage source for the control circuits must be provided from the secondary windings of an isolation transformer or from some other isolated source. In addition, ensure that the control voltage applied to X18 does not exceed 24 V (AC or DC), and that the contact load of each switch does not exceed 24 V AC/DC, 250 mA.

The DRYVAC's input and output signals must be positively isolated from potentially hazardous voltages in down-line processing. This isolation shall be effective even if there is a defect in the electrical system.

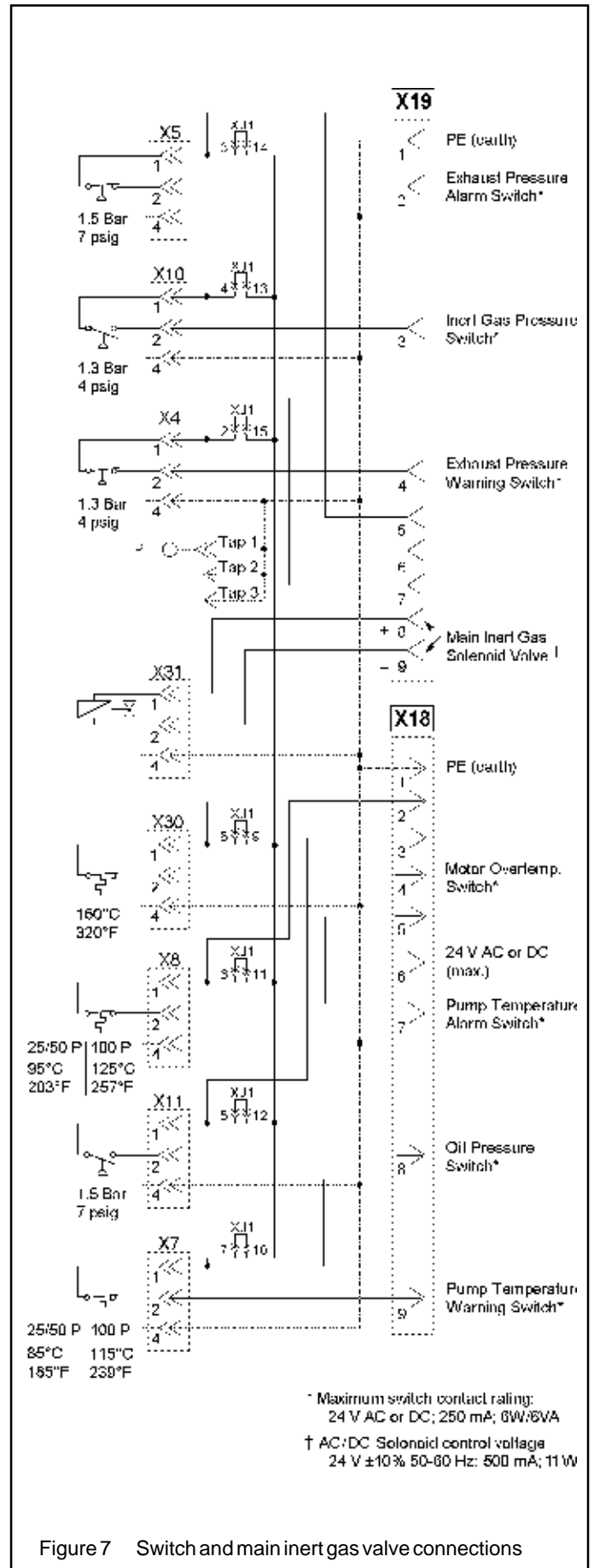


Figure 7 Switch and main inert gas valve connections

Caution Do not connect equipment to terminals other than the ones listed in the following instructions.

Failure to connect the switches as described may result in major damage to the pump, and lead to a loss of warranty.

Connect the switches and solenoid valve to the plant control equipment as described below.

Connect a **control voltage** of 24 V (max.) AC or DC to connector X18, pin 6. This control voltage is applied to the contacts of all switches for the purpose of indicating whether a switch is opened or closed.

The main inert gas valve is shipped locked in the open bypass position (manual override). In this position, you do not need to supply power to the valve -- the valve is locked open and the purge will flow continuously.

If you want to use 24 V to open and close the main inert gas valve, first rotate the locking screw on the metal base of the valve so that its screw slot is parallel to the arrow on the valve. When the locking screw is set in this manner, the valve is "normally closed". To open the valve, connect 24 V (10%) AC or DC to pins 8 and 9 of the pump's X19 Sub-D connector. The valve's rating is 500 mA, 11W, 50/60 Hz.

A label on the back panel of the pump illustrates how to rotate the locking screw. The valve is plumbed to the back of the DRYVAC's "DR Y N2" port. The screw is located on the metal base of the valve.

DRYVAC 25/50/100 P models before S/N L961320915 did not have the AC/DC/manual override valve. Most of these older models were shipped without a main inert gas valve. However, some were shipped with a 24 V AC or 24 V DC valve.

Connect the **oil-pressure switch** so that the pump switches off when its contact opens (connector X18, pin 8). The switch opens when the oil pressure is <1.5 bar (7 psig), indicating that the pump isn't operating or that the oil level is very low. Note that it is also open for 3 seconds during start-up, until the oil pressure increases. Bridge this switch for 3 seconds to allow the oil pressure to build during start-up.

Caution Don't bridge the oil-pressure switch for more than 3 seconds. If this switch is bridged for >3 seconds and the rotation direction is wrong during start-up, the pump will be damaged from insufficient lubrication.

Connect the **"Warning" thermal switch** so that it activates a warning annunciator (such as a light, horn, bell, or buzzer) when its contact opens (connector X18, pin 9). The switch opens to alert you that the pump is approaching a critical state. You can, however, continue to operate the pump after the "warning" thermal switch opens.

Connect the **"Alarm" thermal switch** so that the pump shuts down when its contact opens (connector X18, pin 7). Failure to shutdown the pump when this switch opens results in major damage to the pump.

Connect the **"Warning" exhaust pressure switch** so that it activates a warning annunciator (such as a light, horn, bell, or buzzer) when its contact opens (connector X19, pin 4). The switch opens when the pressure is >1.3 bar (4 psig) to alert you that the exhaust pressure is higher than normal. You can, however, continue to operate the pump after the "warning" exhaust pressure switch opens.

Connect the **"Alarm" exhaust pressure switch** so that the pump shuts down when its contact opens (connector X19, pin 2). The switch opens when the exhaust pressure is >1.5 bar (7 psig). Failure to shutdown the pump when this switch opens results in major damage to the pump.

Connect the **motor overtemperature switch** so that the pump shuts down when its contact opens (connector X18, pin 4). Failure to shutdown the pump when this switch opens results in major damage to the motor.

Connect the **inert gas pressure switch** so that either a warning is sounded, or the pump is shut down when its contact opens (connector X19, pin 3). This switch opens when the inert gas pressure is <1.3 bar (4 psig). Your choice of action depends on the process. Operation without a barrier gas may damage the pump when running certain processes.

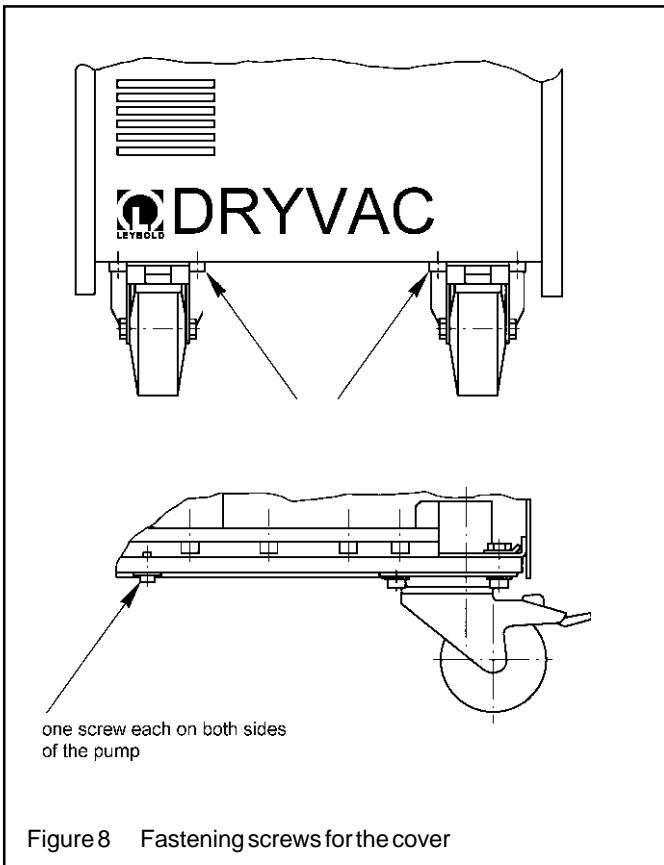


Figure 8 Fastening screws for the cover

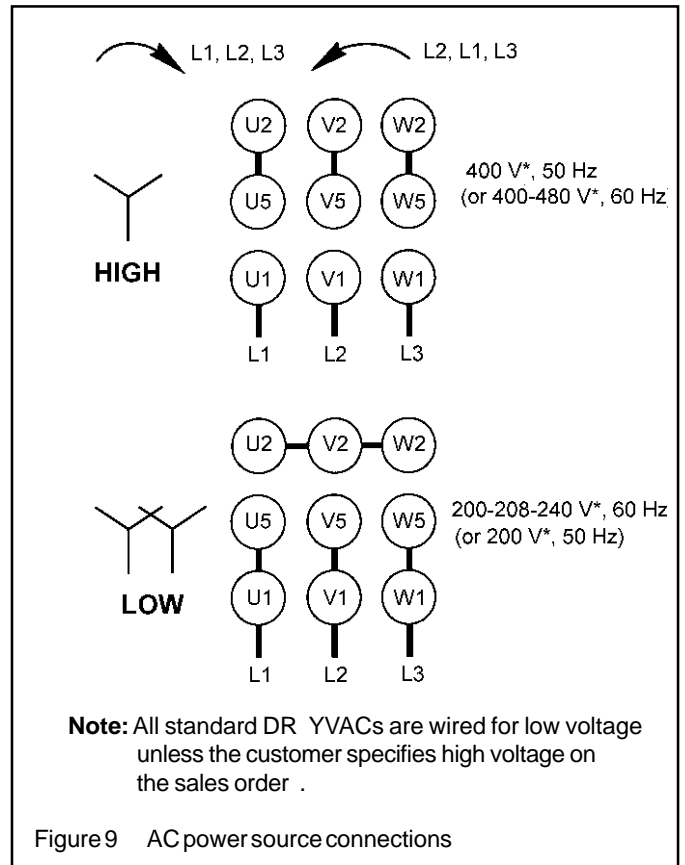


Figure 9 AC power source connections

2.3.2 AC Power Source

The DRYVAC is supplied with a 2-meter (6.5 ft) power cable (3-phase + ground).

The following are the standard pump voltages and frequencies. All standard DR YVACs are wired for low voltage unless the customer specifies high voltage on the sales order .

Catalog No.	Voltage, Frequency
25 P: 138 13200-208-240 /400-480 V*, 60 Hz 200/400 V*, 50 Hz
50 P: 138 33200-208-240/400-480 V*, 60 Hz 200/400 V*, 50 Hz
100 P: 138 74200-208-240/400-480 V*, 60 Hz
138 73 200/400 V*, 50 Hz

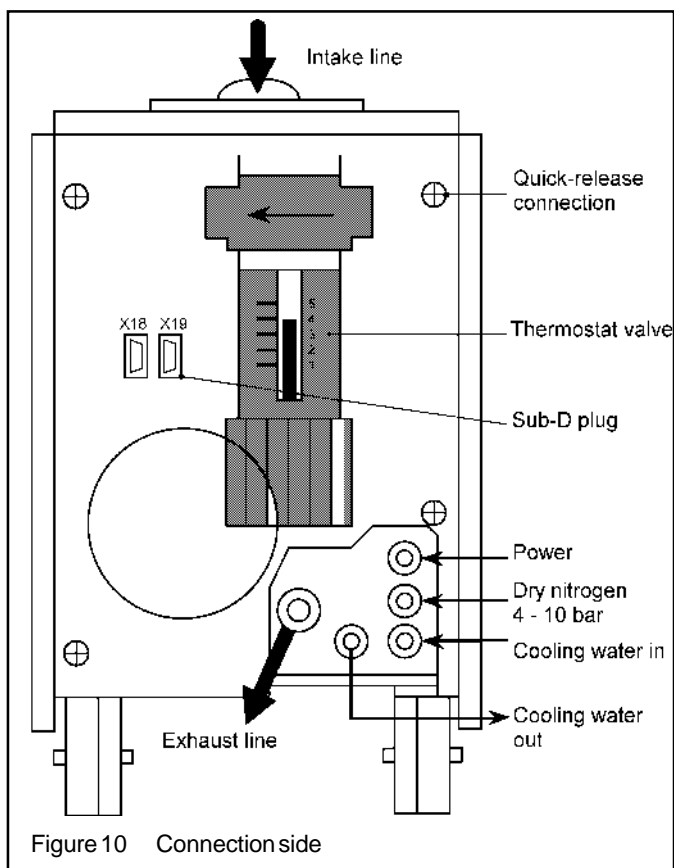
If necessary , change the pump's connections to match the applied AC line voltage as follows:

1. Access the motor junction box by removing the four bolts (Figure 8) on the base of the pump, and remove the front panel.
2. Change the connections on the motor terminal block (Figure 9) to match the applied AC line voltage and frequency .
3. Replace the front panel.

Connect the pump's AC line cord to its rated AC voltage and frequency through a suitable circuit breaker (see the DRYVAC nameplate). Don't turn ON the breaker until all electrical and vacuum connections have been made.

DRYVAC	Main power	Full load current
25 P	3 Ph AC 200 V*, 50 Hz	11 A
	3 Ph AC 200-208-240 V*, 60 Hz	11 A
	3 Ph AC 400 V*, 50 Hz	5.5 A
	3 Ph AC 400-480 V*, 60 Hz	5.5 A
50 P	3 Ph AC 200 V*, 50 Hz	11 A
	3 Ph AC 200-208-240 V*, 60 Hz	11 A
	3 Ph AC 400 V*, 50 Hz	5.5 A
	3 Ph AC 400-480 V*, 60 Hz	5.5 A
100 P	3 Ph AC 200 V*, 50 Hz	15 A
	3 Ph AC 200-208-240 V*, 60 Hz	15 A
	3 Ph AC 400 V*, 50 Hz	7.5 A
	3 Ph AC 400-480 V*, 60 Hz	7.5 A

*All voltages are ±10% from value listed.



The pump is shipped without cooling water. Fill the cooling channels as follows:

1. Open the four 1/4-turn retaining clips on the rear of the pump and remove the rear panel.
2. Completely open the thermostat valve (setting less than 1).
3. Open the cooling water supply and wait until the water flows out of the cooling water outlet.
4. Set the thermostat to the recommended setting for your process (refer to Table 1). Contact your Leybold sales or service representative if you have questions about the correct thermostat-valve setting.
5. Replace the rear panel.

Caution Operating the DRYVAC with an incorrect thermostat valve setting may cause premature failure of the pump and void the warranty.

2.5 Checking the Direction of Rotation

2.4 Connecting the Cooling Water

The cooling water should have the following properties:

pH	7.0 to 8.5
Chloride (Cl ⁻)	≤ 75 mg/l = 2.1 mmol/l
Sulfate (SO ₄ ⁻²)	≤ 70 mg/l = 0.7 mmol/l
Calcium ions	> 1.0 mmol/l = 100 ppm
	≤ 2.7 mmol/l = 268 ppm
Hydrogencarbonate hardness	125 – 179 ppm

Significant deviations from the recommended values may result in premature corrosion or deposits.

Connect the cooling water lines. Ensure that your water supply line is connected to the DRYVAC water inlet and your drain line is connected to the DRYVAC water outlet (see Figure 10).

Caution Operation without cooling water will damage the pump if the alarm thermal switch is not wired as described in Section 2.3.1.

Note: Special modifications may be required when using deionized (DI) water. Consult your Leybold sales or service representative for information.

Warning



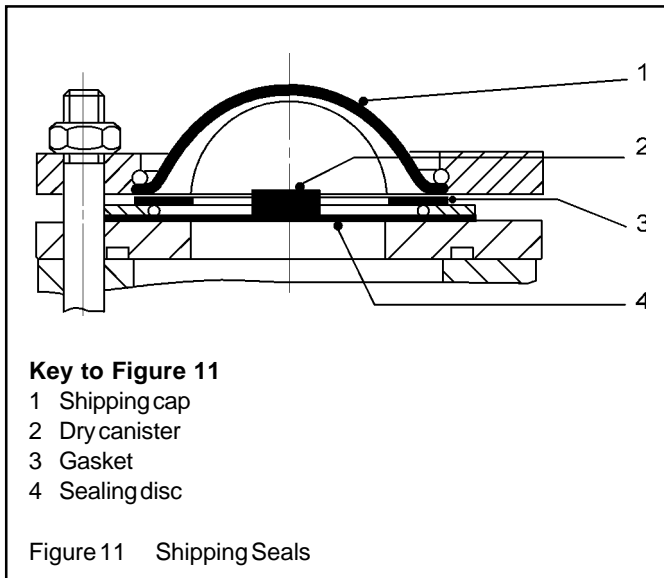
If the pump previously pumped hazardous gases, take appropriate precautions.

Caution

Don't remove the shipping seals until you are ready to install the pump. The pump's interior must be protected against humidity as long as possible.

Check the direction of rotation as follows:

1. Remove the shipping seals from the intake port (see Figure 11) and ensure that the pump's intake and exhaust ports are open. Save the shipping seals for future use.
2. Loosen the four 1/4-turn retaining clips, and remove the front top half of the housing.
3. Briefly switch ON the pump and check whether the motor fan turns counterclockwise; then immediately turn OFF the pump.



If the pump rotated in the wrong direction (clockwise), first ensure that the incoming power to the pump is OFF, and then interchange two of the input leads at the motor junction box.

4. Reinstall the cover .

Warning



All housing panels and covers must be reinstalled to protect the operators against contact with the hot pump.

If the oil-pressure switch is connected correctly as described in Section 2.3.1, the pump will switch off after 3 seconds if its rotation direction is wrong. The pump will be damaged if it rotates in the wrong direction for longer than 3 seconds.

2.6 Connecting the Inert Gas Supply

Remove the shipping seal from the DR Y NITROGEN fitting and connect your inert gas supply . The supply pressure should be 4 to 10 bar absolute (43 to 130 psig). Dry nitrogen is normally used as the inert gas.

2.7 Connecting the Intake Line

Note: Air/moisture leaks in the system's inlet or exhaust line can cause deposits and premature failure.

The intake line should have the same or larger diameter than the DR YVAC intake flange. The line must be clean and oil-free.

We recommend installing a valve between the pump and the vacuum chamber .

A RUVAC WS 151 or WS 251 roots pump can be connected directly to the intake port of a DR YVAC 25P. A RUVAC WS 251 or WS 501 can be connected directly to the intake port of a DR YVAC 50P or 100P.

Connect the intake line to the intake port; use bellows to eliminate tension in the line.

Always install the supplied dirt trap in the intake flange to prevent dirt from entering the pump from the vacuum chamber or from the piping.

When etching aluminum, we recommend that the intake line be at least 100 mm (4 inches) in diameter or be heated to at least 80°C (176°F).

LPCVD nitride and TEOS applications may require special configurations to ensure satisfactory DR YVAC operation. Consult your Leybold sales or service representative.

2.8 Connecting the Exhaust Line

Connect the exhaust line; use bellows to eliminate tension in the line. Be sure the exhaust line connections are tight to prevent hazardous gases from escaping.

The exhaust line should have the same or larger diameter than the DR YVAC exhaust flange. The exhaust line must be able to withstand 1.5 bar absolute (7 psig) since the DR YVAC doesn't automatically shutdown until the exhaust pressure increases to 1.5 bar (7 psig).

Avoid connecting the DR YVAC together with oil-sealed pumps to one central exhaust system. Using a common exhaust line could result in condensate backstreaming into the DR YVAC or in dust adhering in the exhaust line.

Special modifications may be necessary to eliminate noise and vibration when connecting several exhaust lines to a single plenum. Consult your Leybold sales or service representative.

The outlet for the ventilation air is on the top of the DR YVAC; if necessary, you can place an exhaust hood over the pump for certain clean-room applications.

Keep the exhaust line free of deposits. If the exhaust flow becomes restricted, deposits often collect in the DRYVAC.

3 Operation

3.1 Start-up and Operation

Open the inert gas supply by energizing the solenoid of the main inert gas supply valve; ensure that the inert gas pressure is at least 4 bar (43 psig).

Open the cooling water supply .

Switch ON the pump.

If the motor 's circuit breaker trips when evacuating a large vacuum chamber , pre-evacuate the chamber with a small-diameter line (soft pump line).

3.2 Shutdown

Note: Refer to Appendix A for the shutdown procedure for processes that generate particles.

We recommend that you operate the DR YVAC continuously . Allow it to continue operating overnight with its inlet closed to avoid corrosion during idle periods.

To shutdown, close the valve to the vacuum chamber and purge the pump with inert gas by allowing it to run for an additional 15 minutes. Then switch OFF the pump and close the water supply .

Warnings



During operation, the pump's temperature can exceed 100°C (212°F). Always allow the pump to cool down before removing it from the system or before opening its housing.



If the DRYVAC previously pumped hazardous gas, take appropriate precautions before opening the intake or exhaust.



If you continue to purge the pump with inert gas after shutdown, avoid exceeding a pressure of 1.5 bar (7 psig).

If the DR YVAC will be shutdown for an extended period, seal its intake and exhaust ports, and purge it with inert gas at a pressure of 1,000 mbar (760 Torr).

Refer Section 3.3 if the DR YVAC will be disconnected from the system.

3.3 Storing and Shipping

Shutdown the pump as described in Section 3.2.

Warnings



During operation, the pump's temperature can exceed 100°C (212°F). Always allow the pump to cool down before removing it from the system or before opening its housing.



If the DRYVAC previously pumped hazardous gas, take appropriate precautions before opening the intake or exhaust.

To avoid health hazards and corrosion damage when the DRYVAC is detached from the system, place dry canisters onto the pump' s inlet to protect the pump' s interior from moisture. Then, seal the DR YVAC' s intake and exhaust ports. You can reuse the shipping seals that were originally on the pump (see Figure 1 1); but you must use new dry canisters (P/N 200-78-563).

Caution

Always drain the cooling water before storing or shipping the pump. Failure to drain the water can result in the water freezing and bursting the pump housing.

Draining Water From the DRYVAC 100P

1. Turn off the water supply .
2. Open the four 1/4-turn retaining clips on the rear panel, and take off the panel.
3. Completely open the thermostat valve (setting less than 1). Disconnect the cooling water hoses and drain the water . Blow compressed air through the water discharge to remove any remaining water .
4. Reinstall the rear panel.

Draining Water From the DRYVAC 25P and 50P

1. Turn off the water supply .
2. Open all necessary 1/4-turn retaining clips and take off the rear panel and the top covers.
3. Unscrew the hex socket screws at the bottom of the left-side panel and remove the panel.

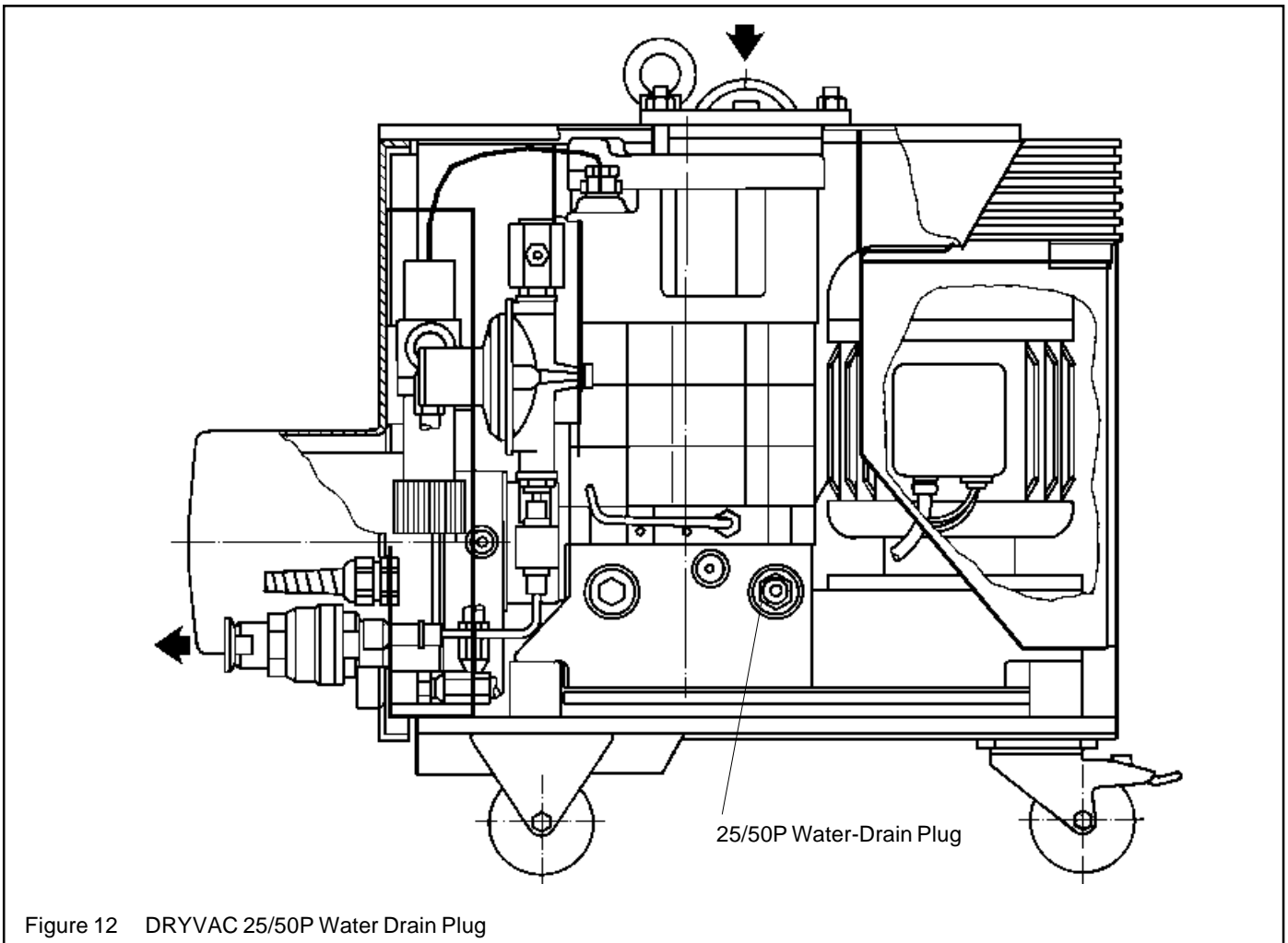


Figure 12 DRYVAC 25/50P Water Drain Plug

4. Completely open the thermostat valve (setting less than 1). Then disconnect the cooling water hoses; remove the M12x1.5 plugscrew (12/1); and let the water drain out. Blow compressed air through the water discharge to remove any remaining water .
5. Reinstall the plug screw , the side panel, the top covers, and the rear panel.

Service by Leybold

If you ship a pump to Leybold, be sure to indicate whether the pump is free of substances that could be hazardous to health or if it is contaminated. If it is contaminated, indicate the nature of the hazard.

You must complete the form at the back of this manual before sending any equipment to Leybold. Attach the form to the pump or enclose it with the

pump. This statement detailing the contamination is required to satisfy legal requirement and to protect our employees.

Leybold will return to the sender any pumps that are not accompanied by a contamination statement.

Pack the pump so that it cannot be damaged during shipping. The pump must also be shipped either in a gas tight container or sealed in plastic so that no contaminants can escape from the packaging.

4 Maintenance

4.1 Routine Maintenance

The DRYVAC may require rebuilding periodically depending on your application and your production cycle. In some installations, the rebuild interval may vary from 12 to 24 months. If you seldom need to clean the inlet and exhaust lines, then the rebuild interval could be longer. **Contact your Leybold service center for recommendations on rebuild intervals for your particular installation.** Also ask about the service options available in your region.

Typically, the only other routine maintenance is replacing the exhaust silencer if it becomes clogged (see Section 4.2).

All work must be done by suitably trained personnel. Maintenance or repair done by inexperienced personnel may affect the life and performance of the pump and may void the warranty.

Before doing any maintenance or repair, shutdown the pump as described in Section 3.2 and disconnect it from the system.

Caution Always drain the cooling water before storing or shipping the pump. Failure to drain the water can result in the water freezing and bursting the pump housing.

If the pump will be returned to Leybold, it must be accompanied by a listing of all hazardous substances which might be present in or around it. Complete the form at the back of this manual before sending any equipment to Leybold. Refer to Section 3.3 to prepare the pump for shipping.

4.2 Replacing the Exhaust Silencer

If the exhaust silencer starts to become clogged, the “Warning” exhaust pressure switch will open. The pump can continue to operate under this warning condition, but steps should be taken to service the exhaust silencer as soon as possible.

If the exhaust silencer becomes clogged to the point where the “Alarm” exhaust pressure switch opens, then the pump must be shut down, and the exhaust silencer serviced immediately.

Refer to Item 3 of the troubleshooting chart for other possible causes of excessive exhaust pressure.

For particulate/vapor generating processes, we recommend checking the exhaust silencer and silencer flange monthly. Install a new silencer (P/N 13750) and clean the silencer flange if you find significant accumulation of contaminants.

Warnings



During operation, the pump’s temperature can exceed 100°C (212°F). Always allow the pump to cool down before removing it from the system or before opening its housing.



If the DRYVAC previously pumped hazardous gas, take appropriate precautions before opening the intake or exhaust.



If necessary, use gloves, a respirator and/or protective clothing and work under an exhaust hood.

Change the exhaust silencer (P/N 137 50) as follows:

1. Open the four 1/4-turn retaining clips and take off the rear panel.
2. Use the Allen key supplied with the silencer and a 17-mm wrench to unscrew the exhaust silencer (2/4).
3. Unscrew the shipping cover from the new exhaust silencer.
4. Apply PFPE grease on the gasket of the new exhaust silencer.
5. Install the exhaust silencer and tighten it to 25 Nm (18 lb-ft).

The shipping cover can be used to seal the old exhaust silencer.

Caution Comply with local environmental regulations when disposing of the old exhaust silencer.

5 Troubleshooting

Symptom	Possible cause	Recommended corrective action	Refer-ences*
1.1 Pump does not start.	Motor circuit breaker is off.	Check setting of motor breaker. Turn ON the breaker.	2.3.2
	Error in power connection.	Check wiring and repair. Check the voltage at your AC power source.	2.3.2
	See Symptom 2, 3, 4 or 5 below.	See notes on malfunction 2, 3, 4 or 5.	---
	Pump has seized causing the motor circuit breaker to open at start-up.	Repair the pump.	Service
	Motor malfunction.	Repair or replace the motor.	Service
1.2 Pump runs up briefly and then shuts down.	Direction of rotation is wrong. If the oil pressure switch is connected as described in Section 2.3.1, the pump will shutdown after running in the wrong direction for 3 seconds.	Disconnect the pump from your AC power source. Interchange two of three input leads.	2.5
2. Pump temperature is too high. The "Warning" thermal switch opens to alert the operator that the pump temperature is above normal. When the "Alarm" thermal switch opens, the pump must be shut down.	Intake pressure is too high in continuous operation.	Modify the system.	1.2
	Process gas is too hot.	Modify the process.	---
	Ambient temperature is too high.	Change site or supply cooler air.	---
	Cooling air is restricted.	Clean the ventilation grids and cooling air channels. Increase the distance between the vent grids and the walls.	---
	Too much friction inside the pump.	Repair the pump.	Service
	Cooling water inlet is not open.	Open the cooling water supply.	3.1
	Cooling water pressure is too low.	Ensure sufficient supply of cooling water.	1.2
	Lime deposits in cooling water channels inside the pump. [During normal operation, the cooling water temperature will be below 70°C (158°F). At these temperatures, deposits form very slowly. Early clogging is an indication of some operational difficulty.]	Repair the pump.	Service
	Dirt deposits in the pump's cooling water channels.	Dismantle the pump and clean the cooling water channels.	Service
	Cooling water lines connected incorrectly.	Connect the cooling water lines correctly.	2.4
Switch, plug, or cord malfunction.	Replace malfunctioning part.	Service	

* This column refers to the section in the Operating instructions that contains the applicable repair information.

Symptom	Possible cause	Recommended corrective action	References*
3. Exhaust pressure is too high. The "Warning" pressure switch opens to alert the operator that the exhaust pressure is above normal. When the "Alarm" pressure switch opens, the pump must be shut down.	Exhaust line is clogged.	Clean the exhaust line.	---
	Exhaust silencer is clogged.	Replace the exhaust silencer.	4.3
	Exhaust line is too long or too narrow.	Install a shorter or wider diameter exhaust line.	2.8
	Switch, plug, or cord malfunction.	Replace malfunctioning part.	Service
4. Oil pressure is too low. Switch has opened.	Pump rotation direction is incorrect; see malfunction 1.2.	Disconnect the pump from the power supply. Interchange two phases at your AC power source.	2.5
	Too little lubricant in the gearbox.	Measure the lubricant level via the fill plug. The target value is 6 to 9 mm ($\frac{1}{4}$ to $\frac{3}{8}$ inch) for the 100P and 12 to 15 mm ($\frac{1}{2}$ to $\frac{5}{8}$ inch) for the 25/50P.	Service
	Oil pump malfunction.	Repair the oil pump.	Service
	Switch, plug, or cord malfunction.	Replace malfunctioning part.	Service
5. Motor temperature is too high. Switch has opened.	Intake pressure is too high in continuous operation.	Modify the system.	1.2
	Exhaust pressure is too high.	Clean or modify the exhaust line.	2.8
	Ambient temperature is too high.	Change site or supply cooler air.	---
	Cooling air is restricted.	Clean the ventilation grids and cooling air channels. Increase the distance between the vent grids and the walls.	---
	Incorrect AC power connection.	Wire the pump's transformer to match the AC power source.	2.3.2
	Pump contaminated by deposits.	Clean pump.	Service
	Switch, plug, or cord malfunction.	Replace malfunctioning part.	Service
6. Evacuation period is too long. (Pumping speed is to low.)	Intake line is too long or too narrow.	Install a shorter or wider diameter intake line.	2.7
	Dirt trap at intake port is clogged.	Clean dirt trap.	---
	Intake line is leaking or dirty.	Seal or clean the intake line.	---

* This column refers to the section in the Operating instructions that contains the applicable repair information.

Symptom	Possible cause	Recommended corrective action	References*
7. Pump does not reach ultimate pressure.	Unsuitable measurement procedure or measuring instrument.	Use correct measurement procedure with proper measuring instrument. Check pressure directly at pump intake port.	---
	Pump has external leak.	Find leak and repair pump.	Service
	Evaporating liquids in pump.	Measure the partial pressure of non-condensable gases. To do so, insert a cryo trap between the gauge and the intake port. If the ultimate pressure is reached using this measurement, there are liquids evaporating in the pump. A possible remedy is to allow the pump to run for half an hour without process load.	---
	Vacuum vessel is leaking or dirty.	Seal or clean vacuum vessel.	---
	Intake line is leaking or dirty.	Seal or clean the intake line.	---
8. Pump is extremely loud.	Motor bearing failure.	Repair or replaced the motor.	Service
	Bearing malfunction.	Repair the pump.	2.8
	Liquid "knocking" in pump. (Too much liquid in pump.)	Install the exhaust line with a downward slope away from the pump, or install a condensate trap.	

* This column refers to the section in the Operating instructions that contains the applicable repair information.

Appendix A

Shutdown for Particulate-Generating Processes

A.1 The Problem

In many processes, a DR YVAC may accumulate particles as it cools during shutdown. Often the DR YVAC is then difficult or impossible to restart.

For this reason, we recommend avoiding shutdowns and operating the pump continuously where possible. For example, we recommend that the customer install a gate valve between the chamber and the vacuum system; this valve can be closed allowing the DR YVAC to operate while the OEM tool is being cleaned.

However, if the customer must shutdown the DR YVAC for longer than 10 minutes, use the procedure in Section A.1 or A.2. The procedures in Section A.1 and A.2 are not required for clean processes.

A.2 Shutdown Procedure for Particulate-Generating Processes

The following is the standard shutdown procedure for processes that generate particles. If you must shutdown the DR YVAC quickly, refer to Section A.3.

Notify the equipment user before starting the shutdown procedure.

1. Shut off all process gas but do not shut the customer's inert-gas purge to the OEM tool.
2. Run the DR YVAC with inert-gas purging until all reactive process gas is flushed from the pump.
3. Close the isolation valve on the process tool and on the foreline if applicable; then allow the DR YVAC to operate with inert-gas purging until you are sure that all residual process gas has been removed. The time needed depends on the process but in general, the longer the better.
4. Perform steps 2 through 8 of Section A.3 to complete the shutdown.

A.3 Accelerated Shutdown Procedure

The following procedure accelerates the DR YVAC cool-down so that process gases condense and are cleared from the pump while it is operating. However, the accelerated cool-down results in particles condensing in the DRYVAC which could cause wear.

Notify the equipment user before starting the shutdown procedure.

1. Shut off all process gas but do not shut the customer's inert-gas purge to the OEM tool. The water discharge temperature should be about 130°F (55°C).
2. Open the thermostat valve a couple turns; then listen for unusual motor noise. If the motor sounds like it is straining, stop the cooling-water flow momentarily to increase the temperature and reduce the particulate load in the pump. Then, slowly reopen the thermostat valve. Gradually open the thermostat valve a couple turns at a time until it is open all the way past the 0 mark.
3. Allow the DR YVAC to continue operating without process gas, and with full water flow and inert-gas purge until the discharge water temperature reaches about 110°F (45°C).
4. Close the isolation valve on the process tool and on the foreline if applicable; and allow the DR YVAC to operate until the cooling water discharge stabilizes at about 80°F (27°C). Then switch off the DR YVAC motor.
5. After the DR YVAC's motor shuts off, proceed as follows:
 - a. Allow the DR YVAC to cool for 5 minutes while the cooling water continues to flow through the DRYVAC.
 - b. Then, switch ON the DR YVAC motor for 5 seconds to clear away reacted process build-up and switch off the power again.

- c. Repeat Steps 5a and 5b a second time.
 - d. Manually rotate the motor fan to check if it turns freely . If you feel any binding as you rotate the fan, repeat Steps 5a and 5b until the motor fans rotates easily . Normally you can rotate the fan using a small screwdriver or a 5-mm allen wrench on the allen set screw in the center of the fan.
 - e. Compare the temperature of the water inlet and the water discharge. They should be about the same temperature. If the discharge water is warmer than the inlet water , repeat Steps 5a, 5b, and 5d until the discharge water cools.
6. After the pump has been shutdown for about 1/2 hour , manually rotate the motor fan again to check if it turns freely . If you feel any binding as you rotate the fan, switch on the motor for 5 seconds and repeat Step 5 until the motor fans rotates easily .
 7. Allow full cooling-water flow through the DR YVAC until you are ready to restart it. Reset the thermostat valve to the recommended setting for your process when restarting the DR YVAC.
 8. If you will be disconnecting the inlet or exhaust line for maintenance, purge the DR YVAC with inert gas and then seal its inlet and exhaust ports. This prevents moisture or air from corroding the pump's interior or from reacting with process deposits. If you will be storing or shipping the pump, place a dry canister (P/N 200 78 563) onto the inlet screen before sealing the inlet.