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Contents ***Page***

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.

LIMS is a Leybold trademark for the Leybold Integrated Monitoring System software.

Safety Information

Hazard analyses per European standard EN 1012 were conducted for the DR YVAC SET 251S and 501S pumps. Every person involved with connecting, operating or maintaining these pumps shall have read and understood this DR YVAC SET operating instruction manual in order to avoid hazards and operating malfunctions.

DRYVAC SET 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 SET pumps are authorized for use only in those applications and processes which are listed in Table 2 of this instruction manual. Contact Leybold before using a DR YVAC pump for applications and processes which are not listed.

Warning

Standard DRYVAC SET 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 of f.

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 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

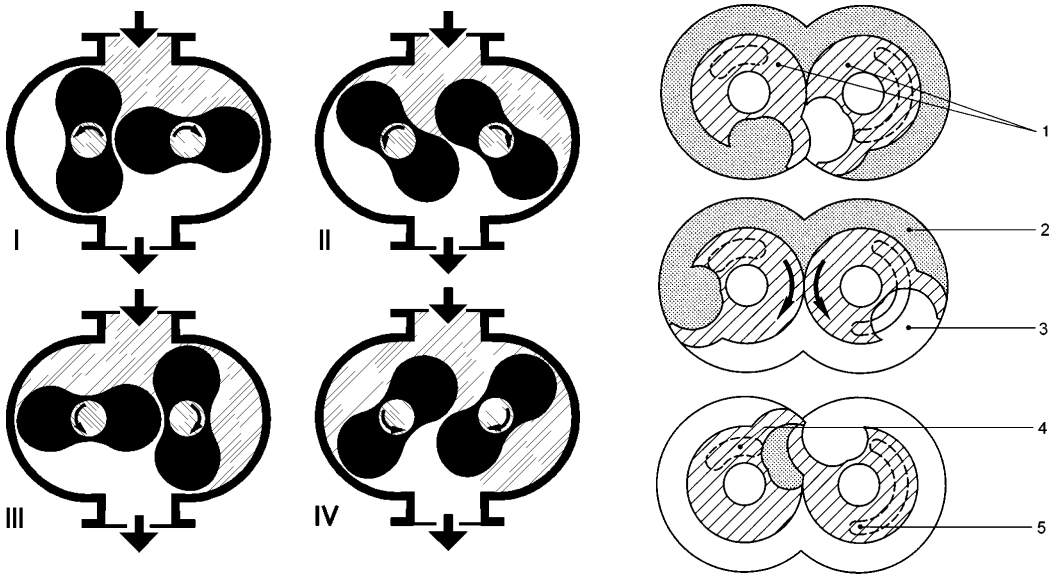
Hazardous decomposition products may be formed at temperatures exceeding 350°C (660°F). Thus smoking is prohibited in rooms where PFPE is being used or handled; do not expose cigarettes or other tobacco products to PFPE.

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 requirement and to protect our employees.



Key to Figure 1
1 Rotors
2 Compression chamber
3 Intake chamber
4 Outlet slot
5 Inlet slot

Roots Pump

DRYVAC Hook-and-Claw Pump

Figure 1 Schematic of the DRYVAC SET operating principles

1 Description

1.1 Design and Function

The DRYVAC SET is a dry-compression vacuum pump designed especially for semiconductor processes.

DRYVAC SET pump models 251S and 501S combine a four-stage DR YVAC hook-and-claw pump with a flanged-on Roots pump.

The model 251S pump contains a DR YVAC 50S and a RUVAC WS-PFPE 251 Roots pump.

The model 501S pump contains a DR YVAC 100S and a RUVAC WS-PFPE 501 Roots pump.

DRYVAC SET operating principles

Figure 1 illustrates the DR YVAC SET's operating principles.

Roots Pump

Also known as Roots blowers, this pump contains two symmetrical impellers rotating in opposite directions. The impellers have roughly the cross section of a figure "8" and are synchronized by gears so that they move past each other and the casing without contact.

In impeller positions I and II, the volume in the intake port is increased. When the impellers rotate further to position III, part of the volume is sealed of f from the intake side.

In position IV , this volume is opened to the discharge side, and gas at backing pressure (higher than the intake pressure) flows in. The inflowing gas compresses the gas volume pumped from the intake side. As the impellers rotate further , the compressed gas is exhausted out the discharge port.

The above procedure occurs twice per complete revolution of each impeller .

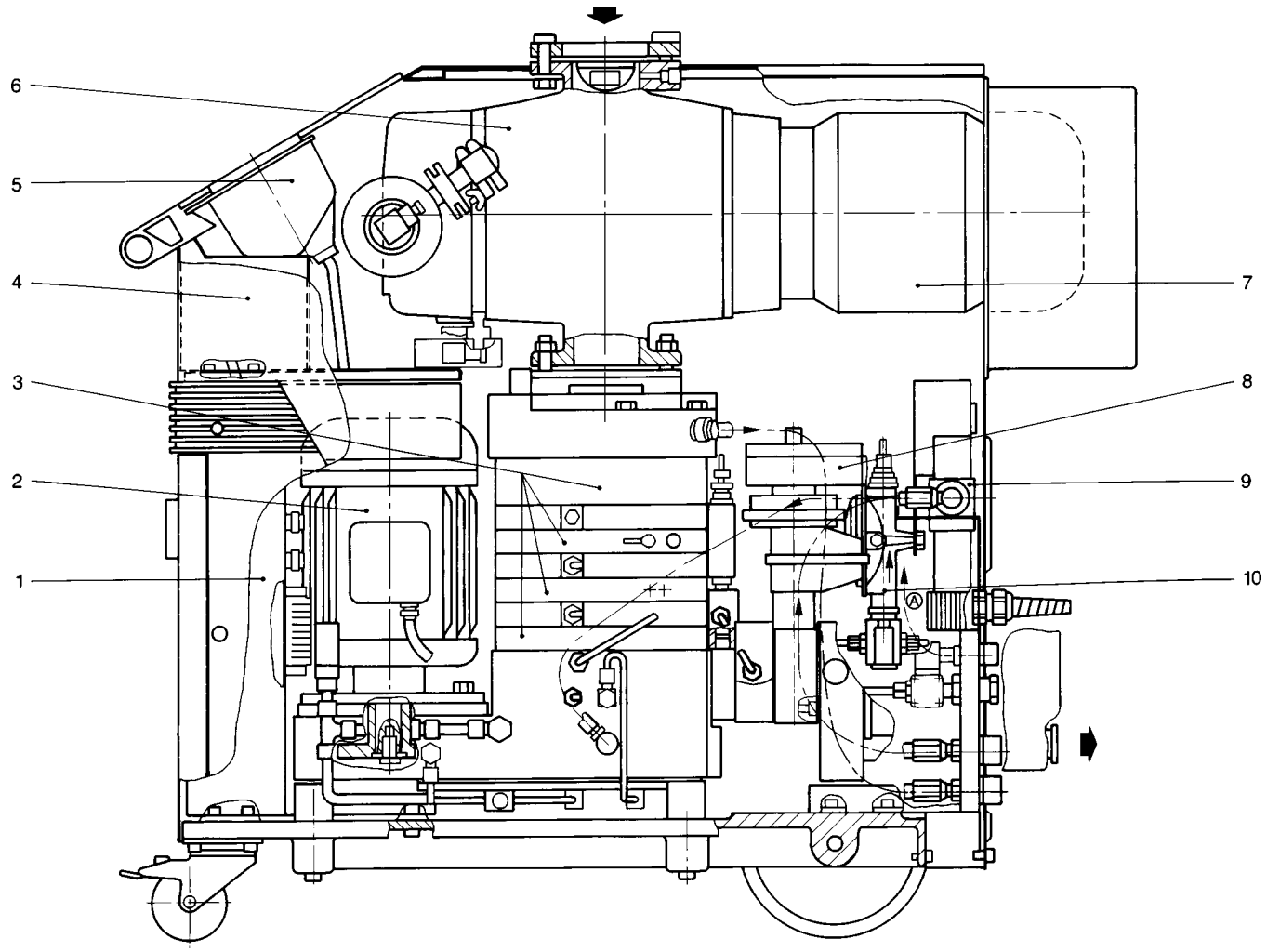
DRYVAC Pump

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 .



Key to Figure 2

1 DRYVAC power supply
2 DRYVAC motor
3 DRYVAC pump stages
4 Roots pump power supply
5 Control unit
6 Roots pump
7 Roots pump motor
8 Exhaust shutoff valve
9 Thermostat valve
10 Inert gas pressure regulator

Figure 2 Sectional drawing of a DRYVAC SET

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.

Roots Pump Design

Although the pumping chamber of the Roots pump is free of sealing agents and lubricants, the gears and bearings are lubricated with PFPE (perfluoropolyether) oil.

The gears and bearings are located in two side chambers of the housing. These two side chambers are separated from the pumping chamber by the impeller seals. During pump operation, the side chambers are evacuated via the impeller seals.

The side chambers are linked to each other by two tube passages. One tube links the two PFPE reservoirs, while the other tube links the evacuated spaces above the PFPE supply .

Both side chambers contain integrated oil pumps to ensure that the gears and bearings receive suf ficient PFPE oil.

The Roots pump is driven by a “canned” motor (2/7). On such a motor , the rotor and stator windings are separated by a vacuum-tight “can” of nonmagnetic material. The rotor runs in the vacuum on the pump’ s drive shaft; thus a shaft feedthrough to the atmosphere is not needed.

The Roots pump can run on a mains frequency either 50 or 60 Hz with the standard motor .

The Roots pump is air-cooled. The air flow for cooling both the motor and pump is produced by a fan, located under the motor 's fan cover .

DRYVAC Pump Design

There are four pumping stages (2/3) located one above the other . The stages are pinned together .

The gas enters the DR YVAC through the intake port, is pumped through four pump stages, and flows through an exhaust silencer into the exhaust.

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

The DRYVAC SET 251S can run on a mains frequency of either 50 or 60 Hz with the standard motor .

The DRYVAC SET 501S is fitted with one of several gear size combinations, depending on the local mains frequency . Thus the DR YVAC pump will always operate at 3000 r.p.m.

The pumping chamber is free of sealants and lubricants; however , PFPE oil 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 valve (2/9). The pump stages are air cooled.

Enclosure

The DRYVAC SET is fully enclosed; the enclosure panels can be removed in just a few steps. The outlet for the ventilation air is on the top of the enclosure.

The enclosure has lockable casters and a handle, which allows the DR YVAC SET to be easily moved.

Exhaust shutoff valve

The exhaust shutof f valve (2/8) closes the exhaust when the DRYVAC SET is not running. It operates on compressed air and is controlled by a solenoid valve. The valve' s position indicators signal whether the valve is open or closed.

Inert Gas Barrier and Purge Gas Device

The DRYVAC pump has a mechanism for barrier gas and for purge gas. Inert gas for these devices is connected at the back of the DR YVAC SET cabinet. It flows into the pump through the main inert gas valve and two pressure regulators (2/10).

The barrier gas 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 flows through the purge gas block, the purge control plate, connecting pipes and nozzles, and into the three lower pump stages.

Electrical Equipment

The standard DR YVAC SET model is monitored by several limit switches and a PT100 temperature sensor (refer to Table 1).

The temperature sensor measures the outlet temperature of the cooling water . The control unit monitors the process' setting with this sensor and with the purge-gas flow indicator .

All monitoring equipment signals are brought together and processed in the power supplies of the DR YVAC (2/1) and Roots pump (2/4). The DRYVAC SET is operated from the control unit (2/5).

The control unit includes pushbutton controls and a three-line display that shows the DR YVAC SET's operating status in clear text; you have the option of English or German.

The control unit is mounted on the top of the DR YVAC SET enclosure . It can also be attached up to 2.5 meters (8 feet) away using the optional extension cable (P/N 200-80-855). Its front panel fits into one half of a standard 19" rack (3 height modules).

During the initial start-up, you must set the DR YVAC to the desired process. Thereafter , it can be switched on and of f with the ST ART and STOP buttons. Run-up, operation, and run-down are then automatically controlled as appropriate for the relevant process.

When unacceptable conditions arise, the DR YVAC SET automatically switches of f. The error messages are stored to simplify troubleshooting.

The parallel interface allows you to connect the DR YVAC SET to a central system control (see Figure 9).

The DRYVAC SET's transformer and rectifier generate the DC voltages required for control and operation. Each control voltage has a separate fuse.

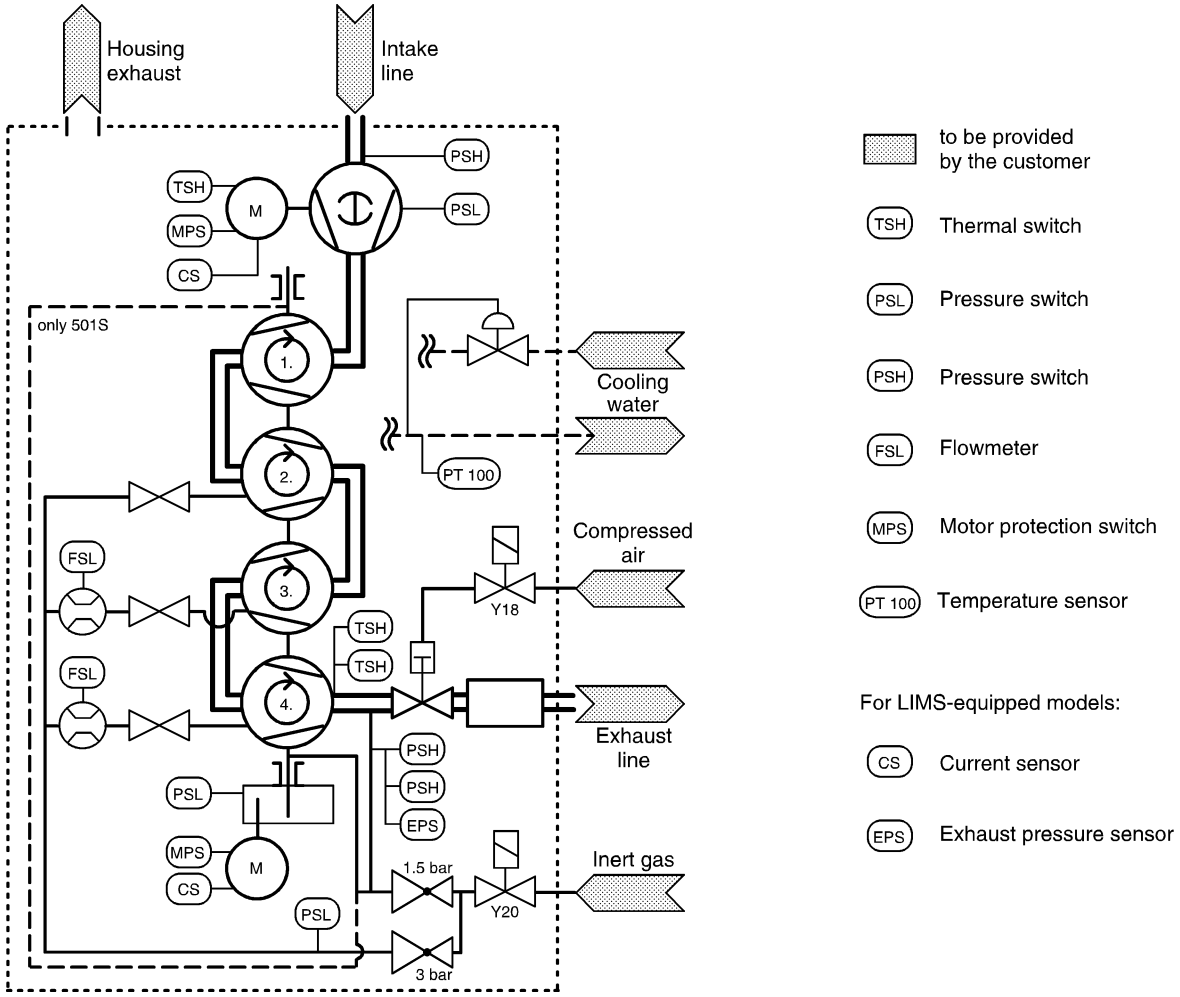


Figure 3 Simplified schematic of the DRYVAC SET

1.2 Standard Equipment

The DRYVAC SET is delivered with both the DR YVAC pump and the Roots pump filled with PFPE oil.

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

The intake and exhaust ports and the inert gas fitting are sealed for shipping.

The DRYVAC SET is shipped with the following:

- A 2-meter (6.5-foot) main power cable without plug and
- An Allen key for removing or installing the exhaust silencer .

Table 1 — Switches and Valves

Component	Component label	Name in Figure 3	Display[1]	Switching point[2]	Plug label
Temper ature sensor PT100	B10	PT 100	"Process temp. <tmin >tmax"	Refer to Sec. 3.4.1	2X3
Thermal switch, pump Alarm	S17 (N.C.)	TSH	"A Temperature"	T ≥ 95/125°C[3]	2X8
Thermal switch, pump W arning	S16 (N.C.)	TSH	"W Temperature"	T ≥ 85/115°C[3]	2X7
Exhaust pressure switch, Alarm	S14 (N.C.)	PSH	"A Exhaust pressure"	p ≥ 1.5 bar	2X5
Exhaust pressure switch, W arning	S12 (N.C.)	PSH	"W Exhaust pressure"	p ≥ 1.3 bar	2X4
Pressure switch, lubrication DR YVAC	S10 (N.O.)	PSL	"W Lubrication/A Lubrication"	p ≤ 1.5 bar	2X11
Pressure switch, lubrication Roots pump	S31 (N.O.)	PSL	"W Oilpressure HV"	p ≤ 350 mbar	4X2
Pressure switch Roots pump ON/OFF	S32 (N.C.)	PSH	"W Input pressure HV"	p ≥ 20-35 mbar	4X1
Thermal switch motor Roots pump	S30 (N.C.)	TSH	"W Motor temp. HV"		4X3
Pressure switch, inert gas pressure	S13 (N.O.)	PSL	"W N2 pressure"	p ≤ 2.5 bar	2X10
Flow indicator , inert gas, 3rd stage	S20 (N.O.)	FSL	"W Flow 3rd stage"	≤300 Nl/hr	2X9
Flow indicator , inert gas, 4th stage	S18 (N.O.)	FSL	"W Flow 4th stage"	≤1500 Nl/hr	2X13
Position indicator , exhaust shutof f valve	S15 (N.O.)	—	"A Shutof f valve"		2X6
Standby set detection		—	"Standby installed" [4]		2X15
Flush valve detection		—	"Flush valve installed" [4]		2X14
LTO set detection		—	"L TO installed" [4]		2X9
Motor contactor , DRYVAC pump	1K1	—	Closed in case of operation		
Auxiliary contact, motor contactor	1K1	—	"A Motor contactor"		—
Motor protection switch, DR YVAC pump	1Q1	MPS	"A Circuit breaker"	Nominal motor current	—
Motor protection switch Roots pump	3Q1	MPS	"W Circuit breaker HV"	Nominal motor current	—
Motor protection switch, transformer	1Q2				
Compressed air valve		Y18	opens in case of RUN-UP 1		2X18
Main inert gas valve		Y20	opens in case of RUN-UP 1		2X20
Purge gas valve, 2nd stage (option)	Y17	—	closed in case of ST ANDBY		2X17
Purge gas valve, 3rd stage (option)	Y16	—	closed in case of ST ANDBY		2X16
Purge gas valve, 4th stage (option)	Y15	—	closed in case of ST ANDBY		2X15
Flush valve (option)	Y14	—	opens in case of FLUSH		2X14
For LIMS-equipped models:					
Exhaust pressure sensor	—	EPS	—	Section 1.3	2X12
Current sensor , DRYVAC	—	CS	—	Section 1.3	5XP6
Current sensor , Roots pump	—	CS	—	Section 1.3	5XP5

[1] When the first letter in the display is "W" (W arning), the pump is approaching a critical value; when the first letter is "A" (Alarm), the pump shuts down because it exceeded a critical value.
[2] All pressures listed are in absolute values.
[3] The higher temperature switch limit is for the DR YVAC SET model 501S.
[4] Displayed only in REPOR T.

N.O. = Normally Open
N.C. = Normally Closed

1.3 LIMS-Equipped Models

DRYVAC S or SET models that have a -P or -10 after their catalog numbers are equipped for use with Leybold's Integrated Monitoring System (LIMS). LIMS monitors exhaust pressure, operating current, and cooling water temperature to alert you to potential problems. LIMS does not shutdown the DRYVAC when an alarm setpoint is exceeded. A separate operating instruction is available on LIMS.

The following describes the sensors and RS-232 interface that are added to these LIMS-equipped DRYVAC models.

Exhaust Pressure Transducers

The exhaust pressure transducer gives an analog output of the exhaust pressure. When connected to the LIMS system, it shows trends to alert you when the exhaust pressure is increasing. This allows you to schedule exhaust maintenance before damaging deposits form in the DRYVAC. Exhaust maintenance usually involves changing the exhaust silencer and cleaning the silencer flange and exhaust lines.

If you have LIMS, set the exhaust warning and alarm at the same pressures as the digital switch settings (1.3 bar for warning and 1.5 bar for alarm). You can lower the LIMS exhaust-pressure settings if desired based on experience with your process.

Transducer Range: 0 to 3.45 bar (0 to 50 psia)

DRYVAC Current Monitoring

The DRYVAC current sensor gives an analog output of the DRYVACs motor current. When connected to the LIMS system, it shows trends to alert you of increased loading on the DRYVAC.

If you have LIMS, set the alarm for DRYVAC current at the full load amperage of its motor. The warning can be set anywhere below full load amperage.

Current Sensor Range: 0 to 40 amps

Current Monitoring for RUVAC Roots Pump

The RUVAC current sensor gives an analog output of the roots pump motor current. When connected to the LIMS system, it shows trends to alert you of increased loading on the roots pump. Increased loading often indicates that process deposits are building up in the roots pump.

If you have LIMS, set the alarm for RUVAC current at the full load amperage of its motor. The warning can be set anywhere below full load amperage.

Current Sensor Range: 0 to 40 amps

DRYVAC Process Temperature Monitoring

An analog Pt100 temperature sensor and two digital thermal pills are included with the standard DRYVAC S and SET models. The Pt100 alerts you when the temperature is outside of the recommended range for your process. The thermal pills protect the pump from mechanical damage from excessive temperatures.

The thermal pills measure the module temperature directly on the second stage housing. When the warning thermal pill trips, it alerts you that the temperature is approaching a critical temperature. When the alarm thermal pill trips, it shuts down the DRYVAC.

The Pt100 sensor monitors the cooling water temperature at the pumping module. This temperature is controlled by the thermostat valve. If you have the LIMS software, it monitors the analog signal from the Pt100. Use the LIMS software to set the warning 2 °C above the maximum process setting and the alarm 5 °C above the maximum process setting. The usual process temperature ranges are 47–63 °C for process groups A & B, and 27–43 °C for process groups C & D as listed in Table 2. Thus, if your process is in Group B, set the warning at 65 °C and the alarm at 68 °C. You can adjust the temperature settings in the LIMS software if desired based on experience with your process.

RS 232 Interface

The RS232 output connector is located on the rear of the DRYVAC and can be connected through a conversion box to a computer loaded with the LIMS software.

1.4 Technical Data

DRYVAC SET Model 251S

Pumping Speed:
- 60 Hz operation ..... 250 $m^3 \cdot h^{-1}$ (147 cfm)
- 50 Hz operation ..... 210 $m^3 \cdot h^{-1}$ (124 cfm)

Ultimate pressure with purge-control plate set for "ETCH":
- 60 Hz operation .....$\leq 2 \cdot 10^{-3}$ mbar (1.5×10^{-3} Torr)
- 50 Hz operation .....$\leq 3 \cdot 10^{-3}$ mbar (2×10^{-3} Torr)

Maximum intake pressure in continuous operation* ..... 5 mbar (4 Torr)

Motor power ..... 3.9 kW (5.3 hp)
Power rating at an intake pressure of 10^{-1} mbar ..... 2.5 kW (3.4 hp)

Rotational speed:
- 60 Hz operation ..... 3600 rpm
- 50 Hz operation ..... 3000 rpm

Noise level with the exhaust line connected .... 65 dB(A)

Cooling water requirements, approx:
- At water temp. of 15 °C (59°F) ..... 70 $l \cdot hr^{-1}$ (18 gal/hr)
- Maximum cooling water temp. ..... 25°C (77°F)
- Cooling water pressure* ..... 2–10 bar (14–130 psig)
- Cooling water connection, female threads NPT 1/2"

Inert gas pressure* ..... 4–10 bar (43–130 psig)
Inert gas connection, female thread ..... NPT 3/8"
Inert gas flow ..... Refer to Table 2

Barrier gas pressure* ..... 1.5 bar (7 psig)
Purge gas pressure* ..... 3.0 bar (29 psig)

Air pressure for activating exhaust shutoff valve ..... 6–7 bar (72–87 psig)
Compressed air connection, female thread . NPT 1/4"

Lubricant quantity in roots-pump gear box .. 1.3 l (1.4 qt)
Maximum ambient temp. ..... 40°C (104°F)
Weight ..... 290 kg (640 lb)

Intake port ..... DN 63 ISO-K
Exhaust port ..... DN 25 KF

DRYVAC SET Model 501S

Pumping Speed:
- 60 Hz operation ..... 480 $m^3 \cdot h^{-1}$ (283 cfm)
- 50 Hz operation ..... 400 $m^3 \cdot h^{-1}$ (236 cfm)

Ultimate pressure with purge-control plate set for "ETCH":
- 60 Hz operation .....$\leq 2 \cdot 10^{-3}$ mbar (1.5×10^{-3} Torr)
- 50 Hz operation .....$\leq 3 \cdot 10^{-3}$ mbar (2×10^{-3} Torr)

Maximum intake pressure in continuous operation* ..... 5 mbar (4 Torr)

Motor power ..... 6.2 kW (8.4 hp)
Power rating at an intake pressure of 10^{-1} mbar ..... 3.4 kW (4.6 hp)

Rotational speed:
- 60 Hz operation ..... 3000 rpm
- 50 Hz operation ..... 3000 rpm

Noise level with the exhaust line connected .... 70 dB(A)

Cooling water requirements, approx:
- At water temp. of 15 °C (59°F) ... 100 $l \cdot hr^{-1}$ (25 gal/hr)
- Maximum cooling water temp. ..... 25°C (77°F)
- Cooling water pressure* ..... 2–10 bar (14–130 psig)
- Cooling water connection, female threads NPT 1/2"

Inert gas pressure* ..... 4–10 bar (43–130 psig)
Inert gas connection, female thread ..... NPT 3/8"
Inert gas flow ..... Refer to Table 2

Barrier gas pressure* ..... 1.5 bar (7 psig)
Purge gas pressure* ..... 3.0 bar (29 psig)

Air pressure for activating exhaust shutoff valve ..... 6–7 bar (72–87 psig)
Compressed air connection, female thread . NPT 1/4"

Lubricant quantity roots-pump in gear box .. 1.8 l (1.9 qt)
Maximum ambient temp. ..... 40°C (104°F)
Weight ..... 360 kg (795 lb)

Intake port ..... DN 63 ISO-K
Exhaust port ..... DN 40 KF

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

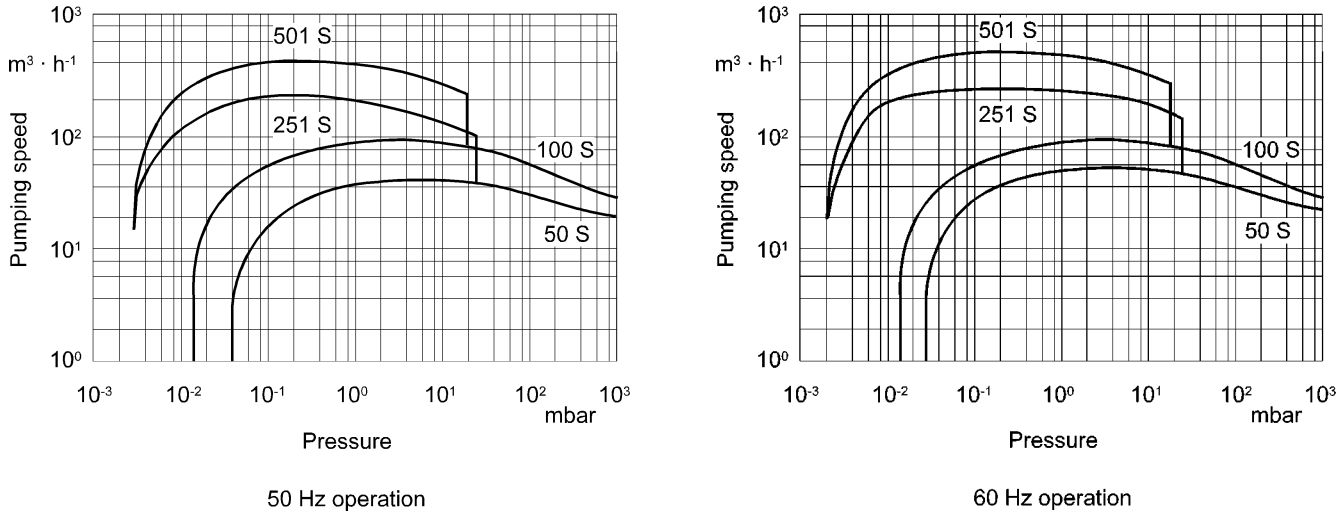
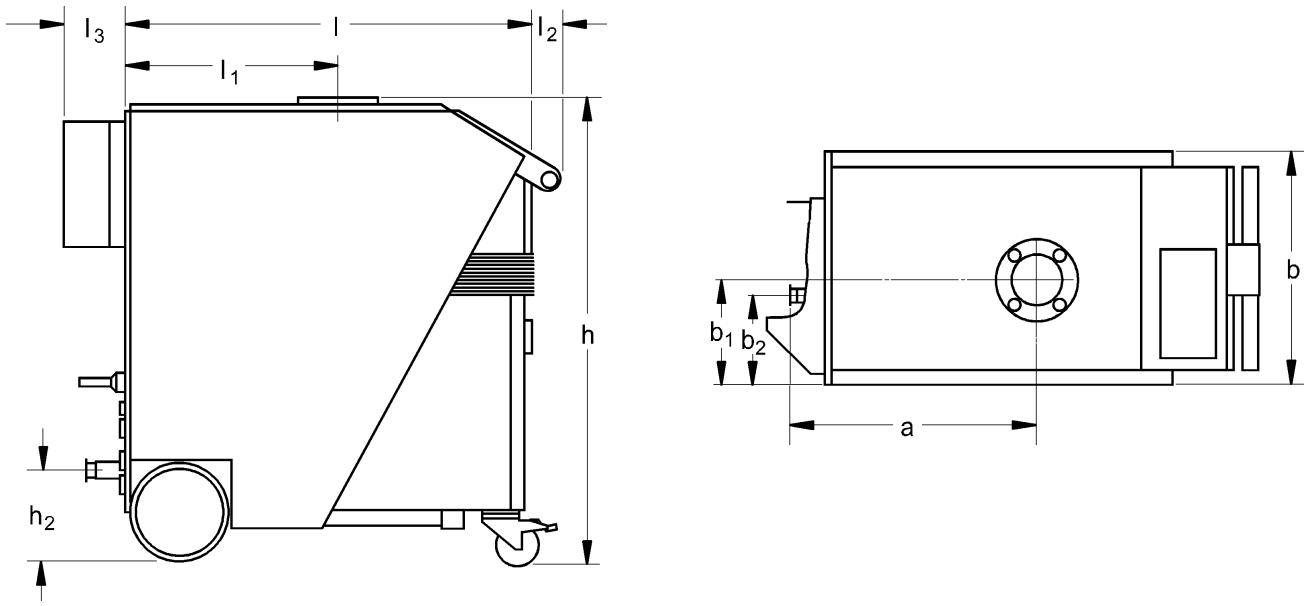


Figure 4 Pumping speed curves



Dimensions in mm

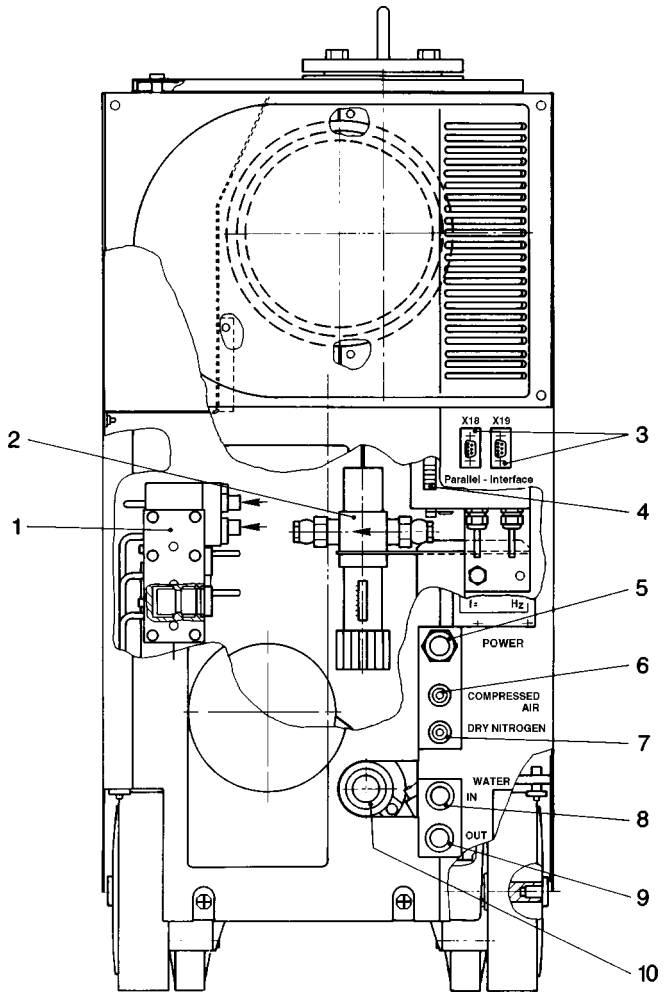
	a	b	b_1	b_2	h	h_2	l	l_1	l_2	l_3
251S	502	450	205	175	877	179	807	426	60	116
501S	476	450	170	187	929	203	866	410	60	158

Dimensions in inches

	a	b	b_1	b_2	h	h_2	l	l_1	l_2	l_3
251S	19 25/32	17 23/32	8 3/32	6 29/32	34 1/2	7 1/16	31 25/32	16 25/32	2 3/8	4 9/16
501S	18 3/4	17 23/32	6 23/32	7 3/8	36 19/32	8	34 3/32	16 5/32	2 3/8	6 7/32

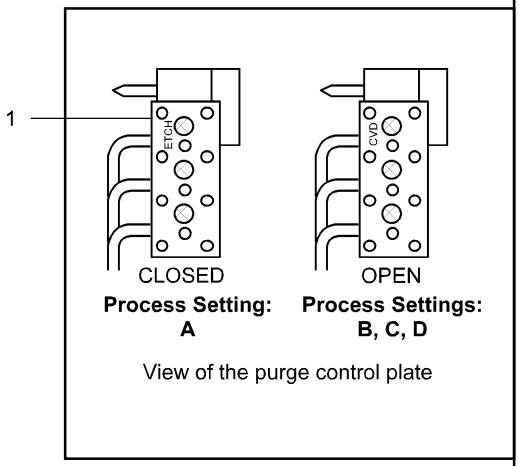
h: upper edge of intake port

Figure 5 Dimensional drawing



Key to Figure 6

1 Purge control plate
2 Thermostat valve
3 Interface/Sub-D connectors
4 DIP switches
5 Main power connection
6 Compressed air connection
7 Inert gas connection
8 Cooling water inlet
9 Cooling water outlet
10 Exhaust port



View of the purge control plate

Figure 6 Connectors and operating controls at back

1.5 Ordering Data

DRYVAC SET with motor:	251S Catalog Number	501S Catalog Number
200 V*, 50 Hz/200-208-240 V*,60 Hz 3 phase	138 50	
400 V*, 50 Hz/400-480 V*, 60 Hz 3 phase	138 51	
200 V*, 50 Hz, 3 phase		138 80
400 V*, 50 Hz, 3 phase		138 81
200-208-240 V*, 60 Hz, 3 phase		138 82
400-480 V*, 60 Hz, 3 phase		138 83
Repair Kit†	899557†	899558†
Exhaust silencer SD	137 50	137 50
RUVAC oil-drain extension kit	200 77 105	200 77 105
Flush valve FS	13760	137 65
Standby set SBV	137 70	137 70
LTO-Set	137 75	137 75
Dry canister for shipping and storage	200 78 563	200 78 563

*All voltage ±10% from value listed.

†The repair kit includes all seals, bearings, & normal wear parts of both the DRYVAC & roots pump.

*Table 2 — Process Settings**

Process Group Setting	DIP Switch Setting	Processes	Thermo-stat Valve Setting	Purge Control Plate	Option Required	Inert Gas Consump-tion	Pump Operating Temp.
A	5 ON 6, 7, & 8 OFF	Al-Etching, Si-Etching, Poly-Si-Etching, SiO_2-Etching Tungsten-Etching	4	Closed (ETCH)	No	1000-1500 Nl/hr	47-63°C 117-145°F
B	6 ON 5, 7, & 8 OFF	MOCVD, PECVD-SiO_2 PECVD-Si_3N_4, PECVD-TEOS, PECVD-Poly-Silicon, PECVD-PSG, PECVD-BPSG PECVD-W, PECVD-WSi_2, LPCVD-SiO_2, LPCVD-Si_3N_4, LPCVD-Poly/Silicon, LPCVD-TEOS, LPCVD-W, Ion implanter	4	Open (CVD)	No	4000-5000 Nl/Hr	47-63°C 117-145°F
C†	7 ON 5, 6, & 8 OFF	LTO, LPCVD-PSG, LPCVD-BPSG	2	Open (CVD)	LTO-Set	6000-7000 Nl/hr	27-43°C 81-109°F
D†	8 ON 5, 6, & 7 OFF	LPCVD-WSi_2	2	Open (CVD)	No	4000-5000 Nl/hr	27-43°C 81-109°F

* Consult your Leybold sales representative to confirm the correct process setting for your application.
† Additional DRYVAC modifications may be necessary for these applications. Consult your Leybold sales representative for additional information.

2 Installation

2.1 Adapting the DRYVAC to the Process

Warning

If the DRYVAC SET 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 2 – unless specified otherwise by the sales order . This setup opens the purge-gas supply to the individual pump stages.

If your process is in the "C" group in Table 2, install the LTO set as described in Section 2.10.3.

If your process is in the "A" group in Table 2, seal off the supply of purge gas into the DR YVAC pump stages as follows (see Figure 6):

1. Open the four ˘-turn retaining clips and take of f the rear housing panel.
2. Remove the eight screws securing the plate (6/1) to the interstage purge block; remove the plate.
3. Turn over the plate and reinstall it with the outside in; when installed correctly for process A, the side of the plate marked "ETCH" faces out and the side marked "CVD" faces in.
4. Reinstall the rear housing panel.

Key to Figure 7

1 Lockable casters
2 Main switch
3 Handle
4 Control unit
5 PFPE fill plug for Roots pump
6 Intake port
7 Lifting flange
8 Ventilation grids (Connection for housing exhaust)
9 Middle section of cover
10 Sight glass

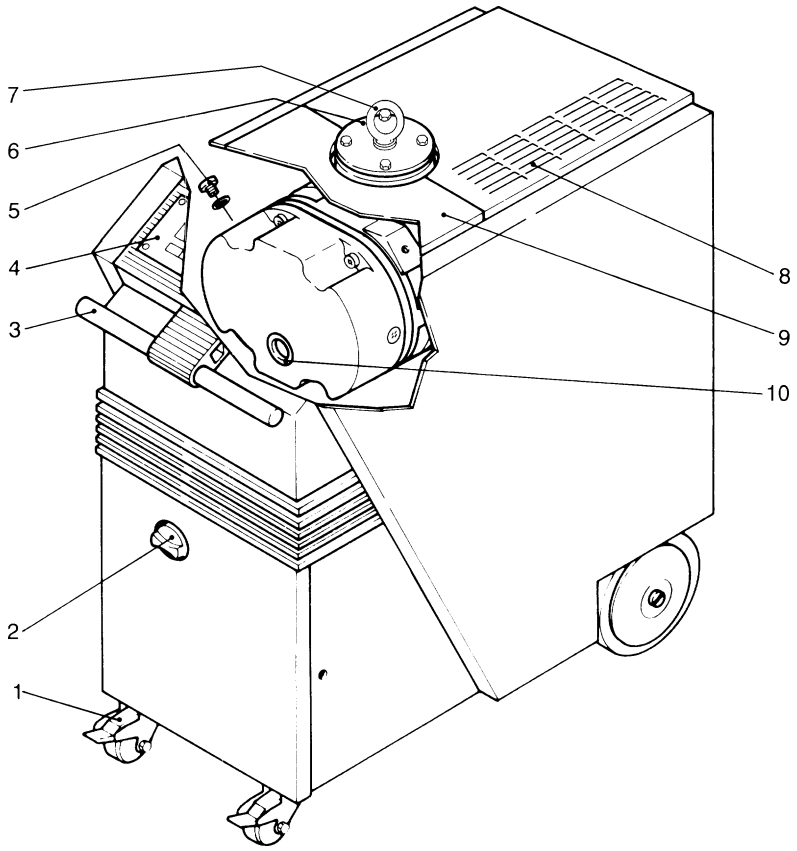


Figure 7 Connectors and operating controls at front

2.2 Setting Up the DRYVAC SET

If the DR YVAC SET needs to be lifted into position, use the lifting flange (7/7) to pick up the pump.

Position the DR YVAC SET on a flat even surface in a dry location. Then, lock the casters.

Note: If the DR YVAC SET is not level, PFPE oil from the side chambers of the Roots pump may enter the pumping chamber .

The ambient temperature should be above 12 °C (54°F) or the DR YVAC SET may not start.

The ambient temperature must not exceed 40 °C (104°F). Don't obstruct the ventilation grids. If installing the DR YVAC SET in an enclosed cabinet or system, ensure that suf ficient ventilation is available.

2.3 Roots Pump Oil

PFPE oil has already been added to the roots pump before shipping. Thus, you do not need to add PFPE oil to the roots pump before starting the DR YVAC SET.

Unlatch the 1/4-turn retaining clips and lift the control unit/cover (8/2) to view the Roots pump sight glass (7/10). The correct PFPE level is in the center of the sight glass (7/10) when the Roots pump is not operating.

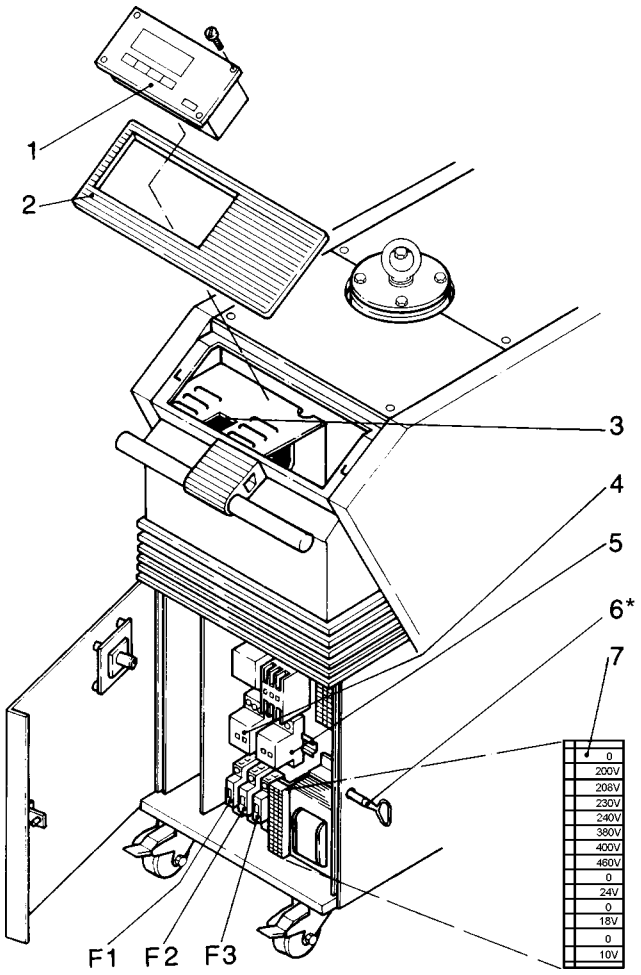
Warning

Use only PFPE oil in the Roots pump. Hydrocarbon oil or other fluids could have a dangerous reaction with the process gas.

Note: If the PFPE level is too low , the bearings and gears will not be lubricated adequately; if it is too high, PFPE may enter the pumping chamber .

Note: The fill port must be sealed airtight. The inflow of air may lead to PFPE-ladened air entering the pumping chamber via the impeller seals.

Note: An optional oil-drain extension kit (P/N 200 77 105) is available for the Roots pump.



Key to Figure 8

1 Control unit
2 Control unit cover
3 Motor protection switch for Roots pump
4 Motor protection swtich for DRYVAC pump
5 Motor protection switch for transformer
6 Power supply cabinet key*
7 Terminal block
F1 Circuit breaker
F2 Circuit breaker
F3 Circuit breaker

* Your model of the DRYVAC SET may not have a cabinet key. The key has been eliminated and replaced with a screwdriver slot.

Figure 8 Opening the front door

2.4 Electrical Connections

Warning

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

The following are the standard DR YVAC SET voltages and frequencies:

Catalog Number		Voltage, Frequency
251 S	138 50	200V, 50Hz / 200-208-240V*, 60Hz
	138 51	400 V, 50 Hz / 400-480 V*, 60 Hz
501 S	138 80	200 V*, 50 Hz
	138 81	400 V*, 50 Hz
	138 82	200-208-240 V*, 60 Hz
	138 83	400-480 V*, 60 Hz

*All voltage ±10% from value listed.

Catalog numbers 13850, 13880, and 13882 are preset at 208 V, while 13851 and 13881 are preset at 380 V . If your local AC power source varies from these settings, refer to Section 2.4.1 to change the transformer settings so that the control voltage is as exact as possible.

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
251 S	3 ph, 200 V*, 50 Hz	17.5 A
	3 ph, 200-208-240 V*, 60 Hz	17.5 A
	3 ph, 400 V*, 50 Hz	10.5 A
	3 ph, 400-480 V*, 60 Hz	10.5 A
501 S	3 ph, 200 V*, 50 Hz	24.4 A
	3 ph, 200-208-240 V*, 60 Hz	24.4 A
	3 ph, 400 V*, 50 Hz	14.5 A
	3 ph, 400-480 V*, 60 Hz	14.5 A

Protective earth conductors (grounds) shall always be installed in accordance with applicable codes and shall be continuous and uninterrupted.

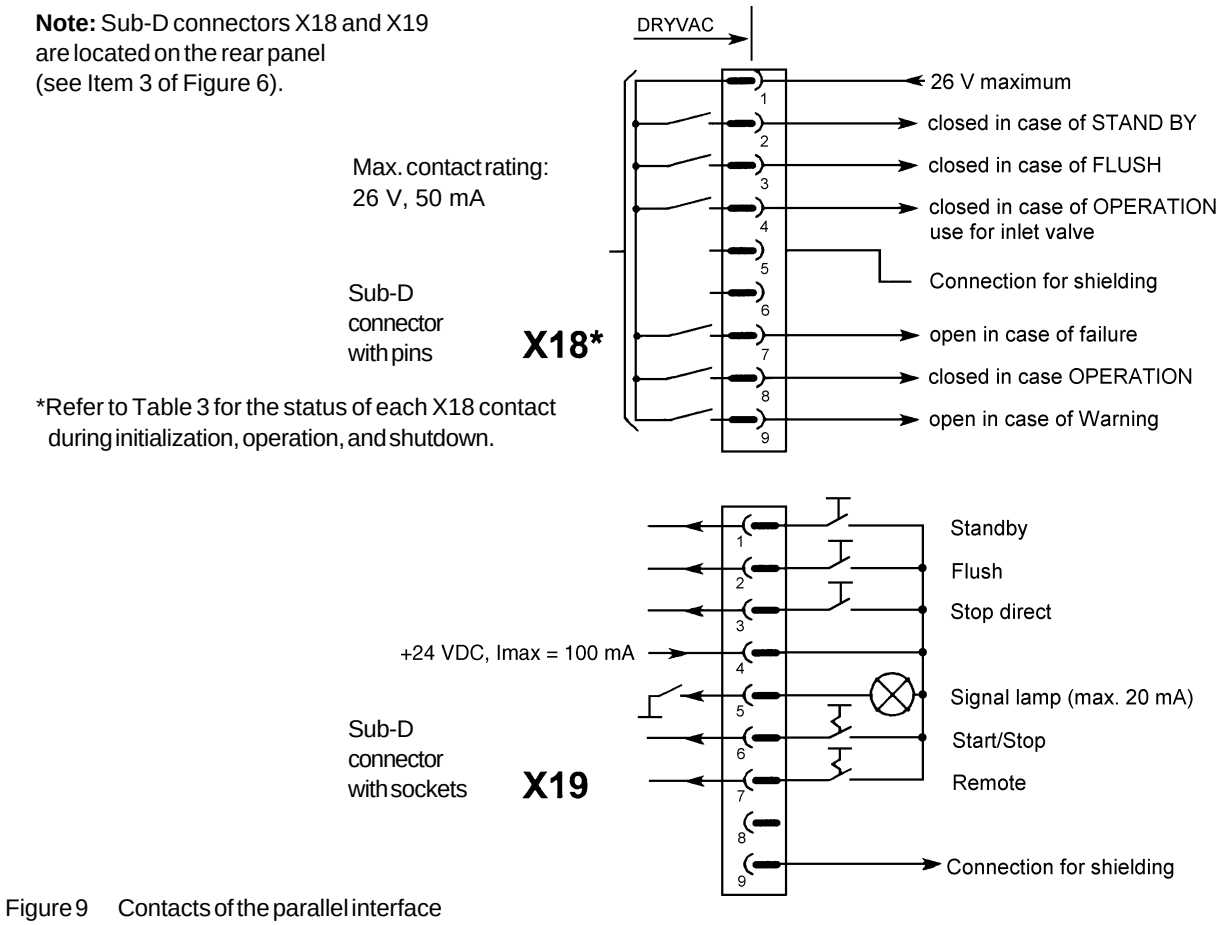


Figure 9 Contacts of the parallel interface

2.4.1 Setting the DRYVAC SET to the Operating Voltage

The DRYVAC SET's transformer generates the voltages required for control and regulation.

Catalog number 13850, 13880, and 13882 are preset at 208 V; if your local AC power source is 200V , change the transformer settings as follows.

Catalog numbers 138 51 and 138 81 are preset at 380 V ; if your local AC power source is something other than 380 V, change the transformer setting as follows.

Warning **Disconnect the DRYVAC SET from your AC power source before making any electrical connections. Electrical connections should be changed only by a qualified electrician.**

1. Turn of f the main switch and open the front door with the power supply cabinet key (8/6). Note that the key has been replaced with a screwdriver slot on recent pump models.
2. Change the connection of a black lead at the terminal block (8/7) to match the voltage of your local AC power source.
3. Ensure that the motor protection switches (8/3, 8/4, and 8/5) and circuit breakers F1, F2, and F3 are turned ON. Then, close the front door .

The DRYVAC SET can be modified for use with other supply voltages or frequencies. Contact Leybold for details.

2.4.2 Connecting an External Remote Control

The parallel interface allows the DR YVAC SET to be connected to an external remote control. The connection is made via two 9-pin sub-D connectors (6/3).

Connector X18 allows you to check the DR YVAC SET's operational status.

Connector X19 allows for remote control of the DR YVAC SET by way of floating (dry) contacts.

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 Terminal 4 of X19 does not exceed 24 V (AC or DC), and that the contact load of each switch connected to X18 does not exceed 26 V AC/DC @ 50 mA.

Table 3 — Interface (X18) Contact Status

			Run		
X18 Contacts	Power Off	Initialization/Ready to Start	Wait	Operation	Rundown
1 & 7 (Fail)	Open	Close*	Close	Close	Close
1 & 8 (Operation)	Open	Open	Open	Close	Open
1 & 9 (Warning)	Open	Close	Open	Close	Close

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

Caution **Do not connect equipment to terminals other 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.

Figure 9 shows the pin-out of the individual contacts of the sub-D connectors. See Table 3 for the status of each X18 contact during initialization, operation, and shutdown

The customer-supplied lines for plugs X18 and X19 must be shielded control lines. Connect the shielding according to Figure 9.

Standby Contact

(applies only if you have the stand-by set option)

Momentarily closing the contact changes the status of the purge valves. It closes the purge-gas valves to the DRYVAC pump stages if they were open; if they were closed, it opens them.

Flush Contact

(applies only if you have the flush-valve option)

Momentarily closing the contact changes the status of the flush valve. It closes the flush valve if it was open; it opens the flush valve if it was closed.

Direct Stop Contact

When the direct stop contact closes, the DR YVAC SET is shut down immediately; **there is no run-down phase**. Use this contact only in emergencies.

Signal lamp

A signal lamp, which lights when the DR YVAC SET is operating, can be connected via contact 5 of connector X19.

Start/Stop Contact

The DRYVAC SET can be started via the Start/Stop contact if the control unit hasn't received an alarm message.

If you shutdown the DR YVAC SET at the control unit, it won't restart automatically even if the contact is closed. To restart, open the contact and close it again.

If the DR YVAC SET doesn't start (the signal lamp doesn't light), review the error report at the control unit (refer to Section 3.7).

Remote Contact

When the remote contact is open, commands can be given simultaneously from the parallel interface and the control unit. **When the remote contact is closed, all of the buttons on the control unit are disabled except REPORT. The DRYVAC SET can only be operated through the remote control interface.**

Disconnecting the Control Unit

The control unit can be removed from the DR YVAC SET and installed up to 2.5 meters (8 feet) away as follows:

1. Remove four screws on the front of the control unit to remove it from the DR YVAC SET enclosure.
2. Disconnect the cable plug from the back of the control unit.
3. Use the adapter cable supplied with the DR YVAC SET to connect the control unit to the cable.
4. Install the control unit at its new location. Its front panel dimensions allow it to be mounted in half of a standard 19" rack (3 height modules). Don't attempt to extend the cable any farther than its maximum permissible extension of 2.5 meters (8 feet).

2.5 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^{--})	≤ 70 mg/l = 0.7 mmol/l
Calcium ions	> 1.0 mmol/l = 100 ppm
	≤ 2.7 mmol/l = 268 ppm
Hydrogencarbonate hardness	125 to 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 (6/8) and your drain line is connected to the DRYVAC water outlet (6/9).

If you will be using a water flowmeter, install it in the water supply line rather than in the drain line.

Caution **Operation without cooling water results in the DRYVAC exceeding its temperature limits and shutting down (refer to Section 3.4.3).**

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

The DRYVAC 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 enclosure 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 2). Contact your Leybold sales or service representative if you have questions about the correct thermostat-valve setting.

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

2.6 Connecting the Inert Gas and Compressed Air Supply

Remove the shipping seal from the DRY NITROGEN fitting (6/7) 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.

Caution: **If you are adding a purge to the foreline, install a solenoid valve that automatically shuts off this purge when power to the DRYVAC is disconnected. Otherwise, the DRYVAC could be damaged from excessive pressure after power is disconnected.**

Remove the shipping seal from the COMPRESSED AIR fitting (6/6) and connect your compressed air supply. The air pressure should be 6 to 7 bar absolute (72 to 87 psig). **Ensure that the compressed air pressure remains above 5 bar (58 psig) during operation; even a brief drop below 5 bar (58 psig) causes the DRYVAC SET to automatically shut down.**

2.7 Setting the DRYVAC to Match the Process

All DIP switches are set to the OFF position at the factory.

Turn off the main switch (7/2) before resetting any DIP switch.

Refer to Table 4 and Figure 10 to reset each of the eight DIP switches (6/4) on the rear of the DRYVAC.

Note: The setting for DIP switches 5 through 8 depends on your process as listed in Table 2. Only one process DIP switch (5 through 8) can be ON; the rest must be off.

After resetting the eight DIP switches, turn ON the main switch:

```
Self Test or Initialization
```

is displayed while the control unit checks the settings. It won't respond to any commands until it finishes this internal check.

Once its internal check is finished, the process setting; for example:

```
PROC SETTING
PROCESS A
Confirm!
```

is displayed.

- **If the process displayed is wrong,** turn off the main switch and reset DIP switches 5 through 8 according to Table 2.
- **If the process displayed is correct,** confirm by *simultaneously* pressing the REPOR T and STOP buttons.

Once you have confirmed the process, the following is displayed:

PROCESS A
Ready to start

Check the direction of rotation of the DRYVAC and Roots pump as described in Section 2.8 before placing the DRYVAC SET into operation for the first time.

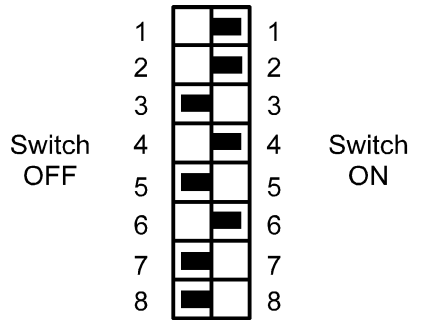


Figure 10 DIP switches - typical settings for Process B

Table 4 — DIP Switch Settings

DIP Switch	OFF	ON	Recommended Setting
1	DRYVAC remains of f after a power failure. You must manually restart the pump by pressing the REPOR T and then the ST ART button or by applying the remote start signal.	DRYVAC returns to its previous operational status after a power failure. "AUT O START" appears on the DR YVAC's LCD display when the power returns. **Exception:** If a power failure occurs during run-down, the DR YVAC remains of f.	ON
2	**Graphics and text mode.** The DRYVAC requires a 2-minute initialization and self-test period after you switch its power on. **Note:** Graphics mode means that the titles on the LCD display are shown in larger size.	**Text mode only.** The DRYVAC requires only an 8-second self-test period during start-up and after a power failure.	ON
3	This switch is used only after a repair to reset the 4-hour shutdown timer for low oil pressure and explained in Section 3.4.4.		OFF
4	Text in DR YVAC's LCD display is in German.	Text in DR YVAC's LCD display is in English.	ON if operator knows English: OFF if operator knows German.
5	DRYVAC will be used on a process listed in Group B, C, or D of Table 2.	DRYVAC will be used on a process listed in Group **A** of Table 2.	The setting for DIP switches 5, 6, 7 & 8 depends on the process group listed in Table 2. Only one of these switches can be ON; the rest must be OFF. For example, if your process is in Group B, set switch 6 to ON and switches 5, 7 & 8 to OFF.
6	DRYVAC will be used on a process listed in Group A, C, or D of Table 2.	DRYVAC will be used on a process listed in Group **B** of Table 2.	
7	DRYVAC will be used on a process listed in Group A, B, or D of Table 2.	DRYVAC will be used on a process listed in Group **C** of Table 2.	
8	DRYVAC will be used on a process listed in Group A, B, or C of Table 2.	DRYVAC will be used on a process listed in Group **D** of Table 2.	

Key to Figure 11
1 Lifting flange assembly
2 Gasket
3 Sealing disk
4 Dry canister
5 Screen dirt trap

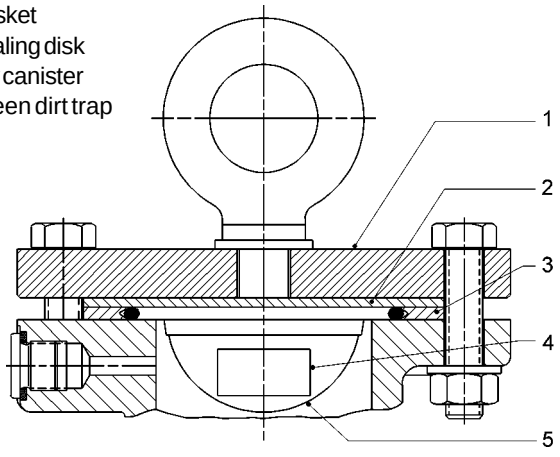


Figure 11 Shipping seals

2.8 Checking the Direction of Rotation

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 and the dry canister from the intake port (see Figure 1 1), and ensure that the DRYVAC SET's intake and exhaust ports are open. Save the shipping seals for future use.
2. Press the ST ART button and check for air being sucked into the intake port. Then, immediately set the main switch to OFF .

   The DRYVAC will automatically shutdown if you allow it to run in the wrong direction for more than 3 seconds (refer to Section 3.4.4).
3. If air wasn't being sucked into the intake port, first ensure that the incoming power is OFF , and then interchange two of the DR YVAC SET's input power leads **at the power source**.

2.9 Connecting the Intake and Exhaust Lines

Caution: Air/moisture leaks in the system's inlet or exhaust line can cause deposits and premature failure. Use kit (P/N 200-77-106) when leak testing the DR YVAC to avoid damaging its regulator .

2.9.1 Connecting the Intake Line

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

We recommend installing a valve between the DR YVAC SET and the vacuum chamber . Wire the valve so that it opens only when the pump is in the OPERA TION mode. A contact (Sub-D connector X18, contact 8) is available for controlling this inlet valve (see Figure 9).

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

If dirt might enter the DR YVAC SET from the vacuum chamber or from the piping, ensure that the screened dirt trap is installed in the pump' s intake flange.

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 require special configurations. Consult your Leybold sales representative.

2.9.2 Connecting the Exhaust Line

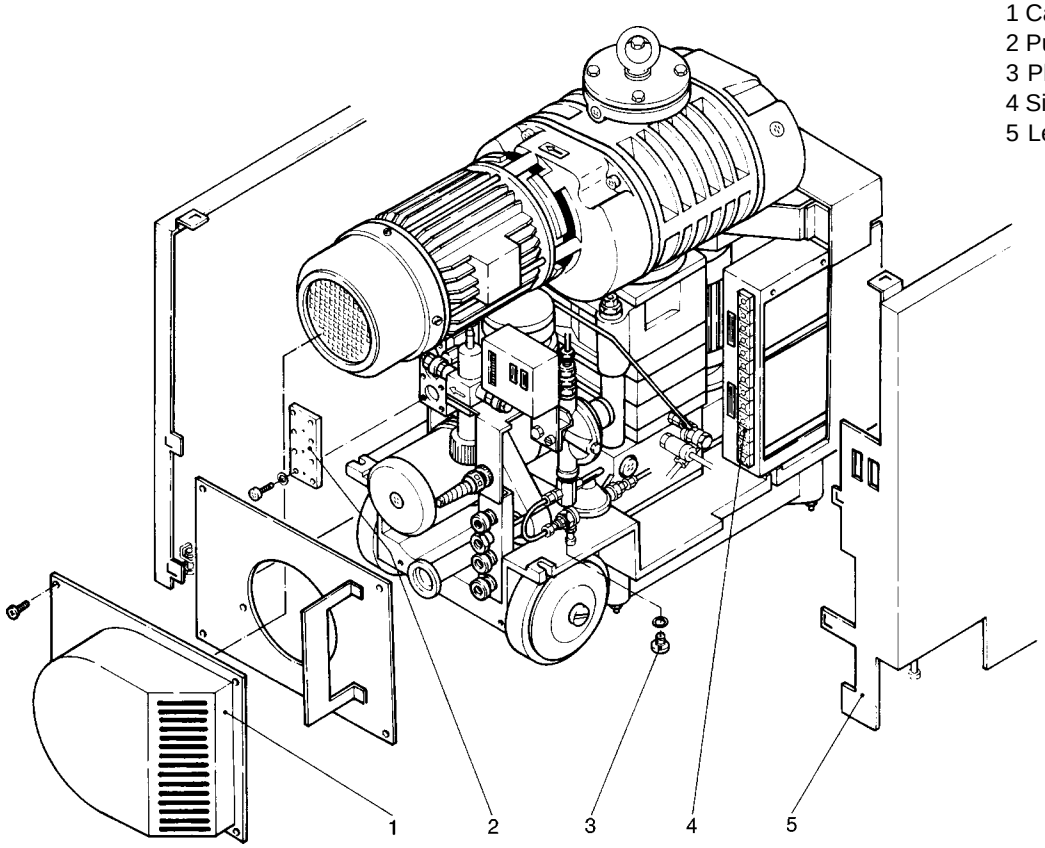
Connect the exhaust line; use bellows to eliminate tension in the line.

The exhaust line should have the same or larger diameter than the DR YVAC SET's 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 SET together with oil-sealed pumps to one central exhaust system. Using a common exhaust line could result in condensate back-streaming 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 DRYVAC SET; if necessary , you can place an exhaust hood over the ventilation grids for certain clean-room applications.



Key to Figure 12
1 Cabinet ventilation panel
2 Purge control plate
3 Plug screw
4 Signal receptacles
5 Left side panel

Figure 12 Installing the standby set

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

2.10 Options (Standby, Flush, & LTO)

2.10.1 Standby Option

When the standby set is installed, the flow of purge gas into the DR YVAC stages can be stopped by pressing the STANDBY button on the control unit.

When the ST ANDBY button is pressed,

STANDBY

is displayed.

The flow of purge gas to the 2nd, 3rd, and 4th pump stages is shut of f. The standby contact at the parallel interface closes and the OPERA TION contact opens.

Pressing the ST ANDBY button again restarts the purge gas supply . However , if your DR YVAC is set to “PROCESS A”, the purge gas supply to the DR YVAC stages remains of f.

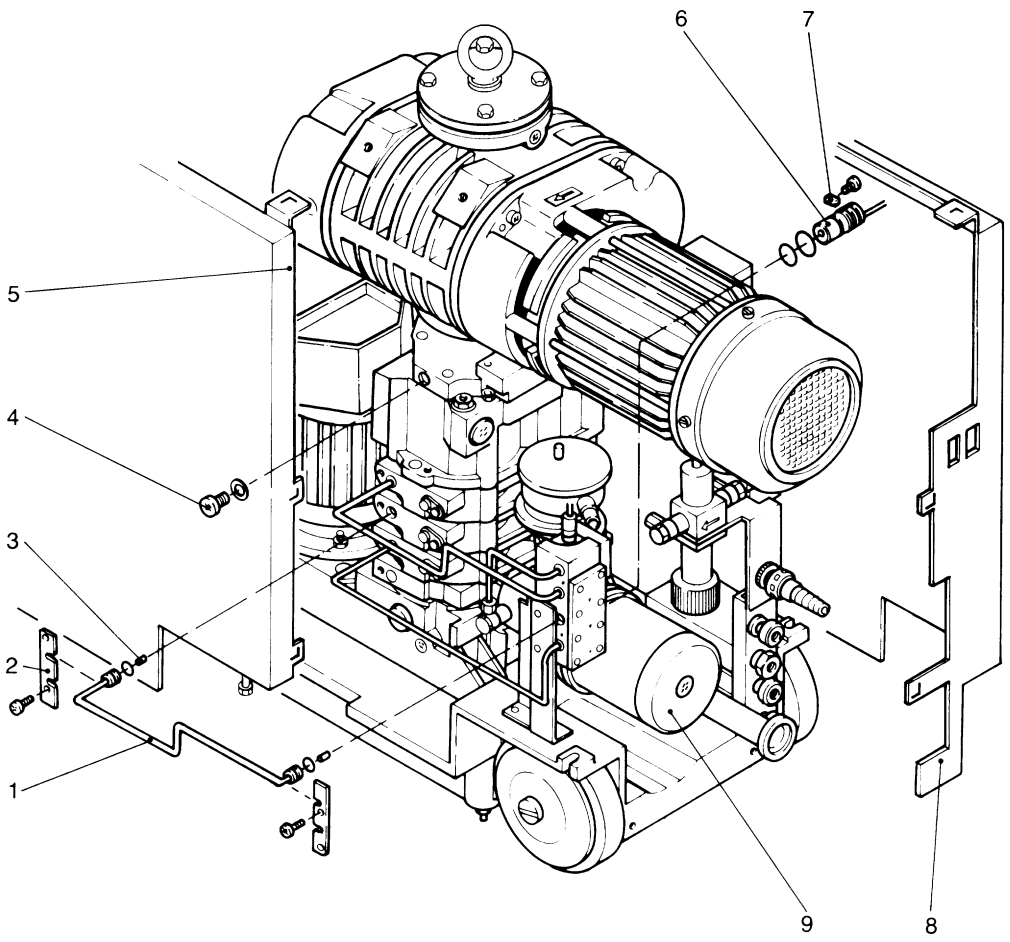
The standby set consists of a purge gas valve plate with three electromagnetic valves. The control unit can switch these three valves simultaneously .

You can determine if the standby option is installed by pressing the REPOR T button as described in Section 3.7; “Installed Options” is the last item in the report sequence.

Warning

If the DRYVAC SET has pumped hazardous gases, determine the nature of the hazard and take the appropriate safety precautions. Comply with all safety regulations. Take adequate safety precautions before opening the purge control plate.

Disconnect the DRYVAC SET from your AC power source before starting work.



Key to Figure 13
1 Purge gas tube, 3rd stage
2 Retainer plate
3 Nozzle
4 Plug screw (as shown for 251S; for 501S, plug screw is located on side of intake port facing toward rear of cabinet)
5 Right side panel
6 Flow indicator
7 Retaining plate
8 Left side panel
9 Exhaust silencer

Figure 13 Installing the flush valve and LTO set

Install the standby set as follows:

1. Open the four 1/4-turn retaining clips; then remove the control unit and its cover (see Figure 8).
2. Open all necessary 1/4-turn retaining clips and take of f both top covers and the rear panel.
3. Remove four screws on the cabinet ventilation panel (12/1) and remove the panel.
4. Loosen the two wingnuts below the left side panel (12/5) and remove the panel.
5. Unscrew eight capscrews and remove the purge control plate (12/2). In its place, install the electromagnetic valves. Insert the surge suppressor over each valve before connecting the cables. Ensure that the rubber seals fit properly .
6. Connect each valve plug to its signal receptacle (12/4) as listed below:

Purge gas valve	**R e c e p t a c l e**
2nd stage, Y17	2X 17
3rd stage, Y16	2X 16
4th stage, Y15	2X 15

7. Secure the electrical cables so they can't contact the DR YVAC casing or the exhaust.
8. Reinstall the side panel, the top covers, the rear panel, the ventilation panel, and the control unit. **Don't forget to reinstall the ground cables.**

2.10.2 Flush Valve Option

When the flush option is installed, the DR YVAC can be flushed with purge gas by pressing the FLUSH button.

When the FLUSH button is pressed,

FLUSH

is displayed. The flush valve is opened and purge gas flows below the intake port into the DR YVAC. If the standby set is installed, the purge gas valves also open.

The flush valve closes automatically after 5 minutes. You can close it sooner by pressing the FLUSH button a second time.

You can determine if the Flush option is installed by pressing the REPOR T button as described in Section 3.7; “Installed Options” is the last item in the report sequence.

Warning

If the DRYVAC SET has pumped hazardous gases, determine the nature of the hazard and take the appropriate safety precautions. Comply with all safety regulations. Take adequate safety precautions before opening the purge-gas tubing.

Disconnect the DRYVAC SET from your AC power source before starting work.

Proceed as follows to install the flush valve:

1. Remove the DR YVAC SET panels as follows:
   a. Open the four 1/4-turn retaining clips; then remove the control unit and its cover (see Figure 8).
   b. Open all necessary 1/4-turn retaining clips and take of f both top covers and the rear panel.
   c. Remove four screws on the cabinet ventilation panel (12/1) and remove the panel.
   d. Loosen the two wingnuts below the left side panel (13/8) and remove the panel.
   e. Loosen the two wingnuts below the right side panel (13/5) and remove the panel.
2. Remove plug screw (13/4). In its place, screw the tube complete with solenoid valve into the threaded hole on the intake port.
3. Remove plug screw (12/3). In its place, connect the tube from the flush kit. Connect the other end of this tube to the solenoid valve/tube assembly installed in step 2.
4. Connect the valve plug to its signal receptacle (12/4) (receptacle 2X 14).
5. Secure the electrical cables so they can’t contact the DRYVAC’s casing or the exhaust.
6. Reinstall the side panels, the top covers, the rear panel, the ventilation panel, and the control unit. **Don’t forget to reinstall the ground cables.**

2.10.3 LTO Option

The LTO set must be installed for processes included in the “PROCESS C” group (refer to Table 2). It results in a large flow of purge gas into the 3rd pump stage. The flow indicator for the 3rd stage is also modified. Contact your Leybold sales or service representative for recommendations for these applications.

You can determine if the L TO option is installed by pressing the REPOR T button as described in Section 3.7; “Installed Options” is the last item in the report sequence.

Warning

If the DRYVAC SET has pumped hazardous gases, determine the nature of the hazard and take the appropriate safety precautions. Comply with all safety regulations. Take adequate safety precautions before opening the purge-gas tubing.

Disconnect the DRYVAC SET from your AC power source before starting work.

Proceed as follows to install the L TO set:

1. Remove the DR YVAC SET panels as follows:
   a. Open the four 1/4-turn retaining clips; then remove the control unit and its cover (see Figure 8).
   b. Open all necessary 1/4-turn retaining clips and take of f both top covers and the rear panel.
   c. Remove four screws on the cabinet ventilation panel (12/1) and remove the panel.
   d. Loosen the two wingnuts below the left side panel (13/8) and remove the panel.
   e. Loosen the two wingnuts below the right side panel (13/5) and remove the panel.
   f. Remove the two retaining plates (13/2).
2. Install the new nozzle as follows:
   a. Pull out the center purge-gas tube (13/1).
   b. Unscrew the nozzle (13/3) and replace it with the LTO-set nozzle.
   c. Reinstall the tube (13/1).
3. Install the new 3rd-stage flow indicator as follows:
   a. Disconnect the plug of the 3rd-stage flow indicator from its receptacle 2X 9 (12/4).
   b. Remove the retaining plate (13/7).

c. Pull out the flow indicator (13/6) for the 3rd stage and replace it with the L TO flow indicator .

d. Insert the plug of the L TO flow indicator into signal receptacle 2X 9 (12/4).

e. Secure the electrical cables so they can't contact the DR YVAC's casing or the exhaust.

4. Reinstall the retaining plates (13/2 and 13/7).

5. Reinstall the side panels, the top covers, the rear panel, the ventilation panel, and the control unit. **Don't forget to reinstall the ground cables.**

2.10.4 Battery Backup Option

The battery backup option (P/N 721-42-091) is useful if you have frequent short-term power interruptions.

If the power failure lasts less than 1 second, the battery buf fers the control voltage so that the DR YVAC immediately restarts when power returns without going through initialization or self test. All output signals remain unchanged.

The battery backup interface is the same as the standard DRYVAC except that X18 contacts 1 & 7 (Fail) are open when the pump is OFF and its main power switch is ON (Initialization/Ready to Start).

The battery backup option should be installed by a Leybold service technician.

The battery is fully charged when you receive the pump, and it recharges as the pump runs. Thus, it is not normally necessary to recharge the battery . The battery should last for about 5 years.

To check the battery , turn of f the main power switch. If the battery is OK, the background light on the display will dim but the text will remain visible for about 5 seconds. If the battery is discharged, the display and text will fade immediately when you switch of f power .

If you do need to recharge the battery , turn the pump's power switch ON and allow it to recharge for 24 hours before starting the pump.

Note: The FLUSH or ST AND BY button operates only if the optional flush or stand-by kit is installed.

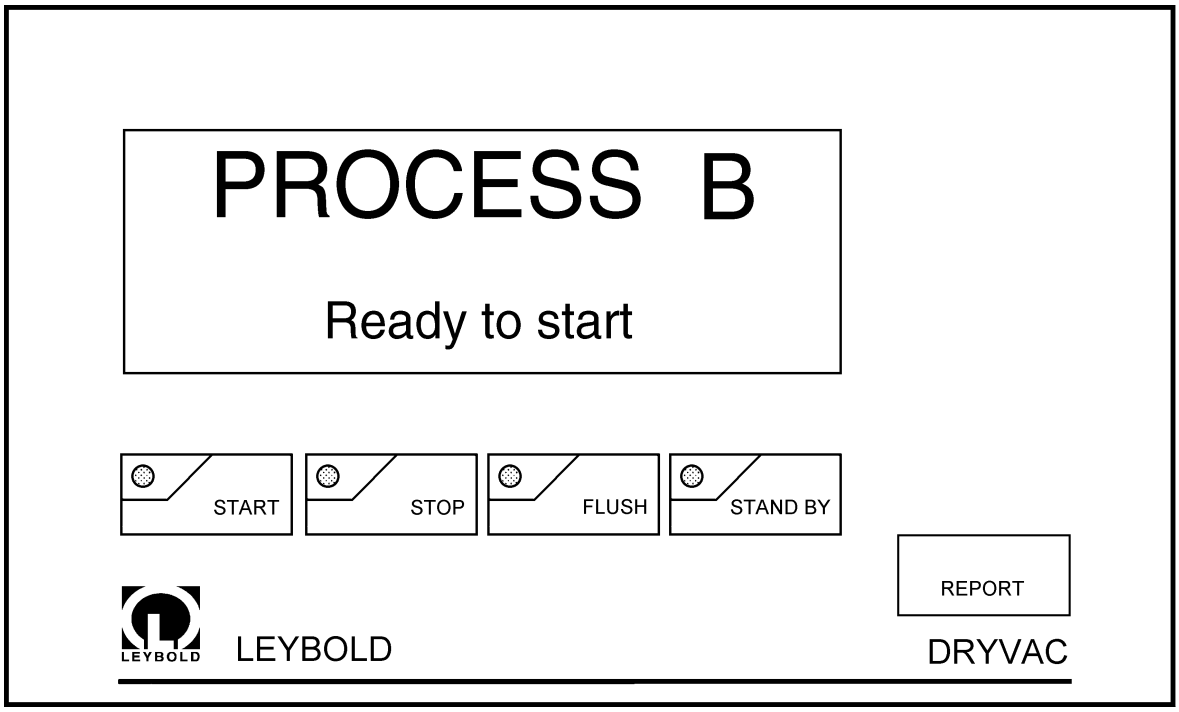


Figure 14 Control Unit Display

3 Operation

Before starting the DR YVAC SET, use the start-up checklist on page 38 to ensure that the pump is set up properly .

3.1 Start-up

Caution **Do not open the DRYVAC SET to process gas until the display indicates "OPERATION". If you open the pump to process while the display indicates "WAIT", vapors may condense in the cool pump.**

1. Switch ON the DR YVAC SET.

   Self Test

   is displayed for less than 8 seconds.

   Note: If DIP switch 2 is set to OFF , the LCD display will show

   Initialization

   for about 2 minutes. You can not operate the DR YVAC until this internal check is finished.

2. Open the inert gas supply; ensure that the inert gas pressure is at least 4 bar (43 psig).

3. Open the compressed air supply; ensure that the air pressure is 6 to 7 bar (72 to 87 psig).

4. Open the cooling water supply .

   The control unit displays the following:

   PROCESS A, B, C, or D
   Ready to start

   The STOP LED lights up.

5. Press the ST ART button.

   The STOP LED goes out and the ST ART LED flashes.

   RUN-UP

   is displayed.

   After the DR YVAC SET has run up, it must reach the temperature required for the process that you selected. During warm-up ,

   WAIT
   Process temp. <tmin

   is displayed. This W AIT status lasts about 20 to 40 minutes.

When the DR YVAC SET has reached its process temperature,

OPERATION

is displayed. The DRYVAC SET is now ready to evacuate process gases.

The display "OPERA TION" indicates that the DR YVAC pump is operating, and does not indicate the status of the Roots pump.

The Roots pump is running during W AIT and OPERATION if the intake pressure is below the threshold of its pressure switch.

The pressure-switch thresholds of the Roots pump are as follows:

DRYVAC SET 501S ..... 20 mbar (15 Torr)
DRYVAC SET 251S ..... 25 mbar (19 Torr)

During continuous operation, the DR YVAC SET's intake pressure must remain below the switching threshold of the intake pressure switch.

Section 3.7 describes how to use the REPOR T button. The FLUSH and ST ANDBY buttons operate only if the optional flush or stand-by kit is installed on your DR YVAC SET (refer to Section 2.10).

3.2 Pumping Non-Aggressive Gases

The DRYVAC SET is designed to pump aggressive gases during semiconductor production.

It can also be used to pump clean gases by setting the DRYVAC SET to "PROCESS A" and starting it. When "OPERA TION" is displayed, shut of f the inert gas supply . You can ignore the "W N2 pressure" warning when pumping clean gases.

Caution **When the inert gas supply is shut off, the DRYVAC shaft seals are not protected against either dust or aggressive gases and vapors.**

3.3 Shutdown

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

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

To shutdown, press the ST OP button.

RUN-DOWN

is displayed. The DRYVAC SET continues to run for 10 minutes with the inert gas valve open. The STOP LED flashes.

Then, at the end of 10 minutes the motor is switched of f and the main inert gas valve and the shutof f valve are closed. The STOP LED lights.

You can abort the shutdown and restart the pump during the 10-minute rundown by pressing ST ART.

In an emergency , you can use the main switch to shutdown without purging the DR YVAC. If you shutdown in this manner , correct any malfunctions, restart the DR YVAC SET, and then shut it down with inert-gas purging to remove toxic or hazardous gases from the pump.

Warnings

During operation, the DRYVAC SET'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 have a foreline purge, shut off this purge flow when power is disconnected from the DRYVAC. Purging the foreline after power is disconnected could result in damage to the DRYVAC from excessive pressure. The DRYVAC's exhaust valve cannot open to release the pressure when power is not available to the pump.

If the DR YVAC SET will be shutdown for an extended period, seal its intake and exhaust ports, and purge the DRYVAC with inert gas at a pressure of 1,000 mbar (760 Torr); refer to Section 3.5.

Refer Section 3.6 if the DR YVAC SET will be disconnected from the system.

3.4 Response to Malfunctions

Refer to Section 5 (troubleshooting) for the recommended corrective actions for each error displayed on the control unit.

3.4.1 Process Temperature Fault

Note: The warning and alarm temperatures referred to in Sections 3.4.2 and 3.4.3 are independent of the process; these temperature limits are set to prevent excessive temperature from damaging the DR YVAC.

The operating temperatures listed below are automatically set depending on which process group you selected in Section 2.7.

Process Group Setting	A, B	C, D
Thermostat valve setting	4	2
Minimum operating temp.	47ºC (117ºF)	27ºC (81ºF)
Maximum operating temp.	63ºC (145ºF)	43ºC (109ºF)

If the DR YVAC is below the minimum operating temperature for the selected process,

Process temp < tmin

is displayed and the DR YVAC shifts to the W AIT status. It switches back to the OPERA TION status only after the temperature rises 3 Kelvin above the minimum operating temperature.

If the DR YVAC is above the maximum operating temperature for the selected process,

Process temp > tmax

is displayed and the DR YVAC shifts to the W AIT status. It switches back to the OPERA TION status only after the temperature drops 3 Kelvin below the maximum operating temperature.

Thus, there is a delay in returning to the OPERA TION status after a cold start or after a short overheating. The wait status lasts about 20 to 40 minutes during a normal cold start (refer to Section 3.1).

3.4.2 DRYVAC Warnings

When the first letter in the display is a “W” (W arning), the DR YVAC is approaching a critical operating limit; when the first letter is an “A” (Alarm), the DR YVAC SET shuts down because the DR YVAC exceeded a critical limit. Refer to Section 3.4.3 for information on Alarms.

If the flow indicator reading does not correspond to the process group setting,

W flow 3rd/4th stage

is displayed and the DR YVAC SET switches to the W AIT status. This is the only W arning that changes the pump’ s status. Other warnings, such as “W temperature”, just alert you that the DR YVAC is approaching a critical operating limit, but they don’t change the DR YVAC’s operational mode. When a warning is displayed, determine the source of the problem and correct any malfunctions.

3.4.3 DRYVAC Alarms

When one of the following “A” (alarm) messages is displayed, the DR YVAC SET **shuts down immediately** and automatically closes the main inert gas valve and the exhaust shutof f valve:

- A Motor protection switch
- A Motor contactor
- A Temperature
- A Exhaust pressure
- A Shutof f valve

After eliminating any malfunctions, restart the DR YVAC SET and then shut it down with an inert gas purging cycle. Shutdown with inert gas purging removes toxic or hazardous gases from the pump.

3.4.4 DRYVAC Oil Pressure Warning and Alarm

The warning

W Lubrication

is displayed if the oil pressure in the DR YVAC gear box remains under 1.5 bar (7 psig) for longer than 3 seconds while the pump is running .

A timer starts when this warning is displayed and begins decreasing from 240 minutes (4 hours). The current counter reading can be displayed by pressing the REPORT button. The DRYVAC SET automatically shuts down and displays

A Lubrication

when the counter reaches zero. This delayed shutdown allows you to complete your process. Following shutdown, the DR YVAC must be repaired. After repair , reset the timer to 240 minutes as follows:

1. Turn DIP switch 3 ON while the DR YVAC SET is shutdown (see Figures 6 and 10).

2. Turn ON the DR YVAC SET at the main switch.

   The message

   PROC. SETTING
   Set oil t = 4h
   Confirm!

   is displayed.

3. Simultaneously press the REPOR T and ST OP buttons.

   The message

   Reset switch

   is displayed.

4. Turn DIP switch 3 OFF .

Another timer in the control unit records every period that the DR YVAC ran with insuf ficient oil pressure for more than 3 seconds. This counter can't be reset.

If the oil pressure is below 1.5 bar (7 psig) for more than 3 seconds **during run-up,** the DR YVAC SET switches of f.

3.4.5 Roots (HV) Pump Warnings

If the motor temperature of the Roots pump becomes too high,

W Motortemp. HV

is displayed. The Roots pump is switched of f, but the DRYVAC pump continues to operate. Once the Roots pump motor has cooled down, it is switched on again. The DR YVAC SET can not be started when the motor temperature of the Roots pump is too high.

If the motor protection switch of the Roots pump is switched of f,

W Circuit breaker HV

is displayed. The DR YVAC continues to operate. The DRYVAC SET can not be started when the motor protection switch of the Roots pump is of f.

If the intake pressure is too high for the Roots pump to operate,

W Input pressure HV

is displayed. The Roots pump is switched of f if the intake pressure stays too high for more than 3 seconds. The DRYVAC continues to operate.

If the oil pressure of the Roots pump is too low ,

W Oilpressure HV

is displayed. Both the DR YVAC and Roots pump continue to operate. A timer in the control unit records every period that the Roots pump ran with insuf ficient oil pressure. Pump models with "-P" after their catalog numbers do not have a Roots pump oil-pressure switch and thus do not display this warning.

3.5 Shutdown for an Extended Period

Press the ST OP button. The DR YVAC SET continues to run for 10 minutes with the inert gas valve open. Then, the motor switches of f and the main inert-gas valve and the exhaust valve close.

Warnings

During operation, the DRYVAC SET's temperature can exceed 100ºC (212ºF). 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.

Isolate the intake port from the system either by a valve or a blank flange, or vent the system and the pump with inert gas to a pressure of 1000 mbar (750 T orr).

When the DR YVAC is at a standstill and the main switch is turned ON, the exhaust valve automatically opens when the DR YVAC's exhaust pressure exceeds 1.5 bar (7 psig). It closes again when the pressure drops. This process is repeated as long as incoming inert gas causes the pressure limit to be exceeded. This protects the DR YVAC from a detrimental overpressure at standstill. However , **you should not operate the DRYVAC in this way for an extended period.**

Warning

Hazardous gas may be released from the DRYVAC SET or the process chamber when the exhaust valve opens. Therefore, when working near the exhaust, prevent the exhaust valve from opening by disconnecting the pump from the AC mains. You must also shut off the inert-gas flow to the DRYVAC when the exhaust valve can't open to prevent the pressure in the DRYVAC from rising to dangerous levels.

The control unit won't accept any operator commands while the exhaust valve is open in response to an overpressure during a standstill.

3.6 Storing and Shipping

Shutdown the DRYVAC SET as described in Section 3.3.

Warnings

During operation, the DRYVAC SET's temperature can exceed 100ºC (212ºF). 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.

Place dry canisters onto the DRYVAC SET's inlet to protect the pump's interior from moisture. Then, seal the intake and exhaust ports. You can reuse the shipping seals that were originally on these ports (see Figure 11); but you must use new dry canisters (P/N 200 78 563).

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

Drain the cooling water before storing or shipping the DRYVAC SET by performing one of the following procedures:

Draining Water From the DRYVAC SET Model 501S

1. Turn off the water supply.
2. Open the four ¼-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 SET Model 251S

1. Turn off the water supply.
2. Open all necessary ¼-turn retaining clips and take off the rear panel, the top covers, and the rear ventilation panel.
3. Unscrew the two wing nuts at the bottom of the left-side panel and slide the panel to the rear to remove it.
4. Completely open the thermostat valve (setting less than 1). Then disconnect the cooling water hoses; remove the M12x1.5 plugscrew from the left side of the gear housing; and let the water drain out. Blow compressed air through the water discharge to remove any remaining water.
5. Reinstall the plugscrew, side panel, top covers, rear panel, and ventilation panel.. **Don't forget to reinstall the ground cables.**

Avoid tipping the DRYVAC SET during shipping and storage. If the pump is tipped, PFPE oil from the roots pump could enter the pumping chamber.

The DRYVAC SET must be shipped either in a gas-tight container or sealed in plastic.

If the DRYVAC SET will be returned to Leybold, it must be accompanied by a listing of all hazardous substances that might be present in or around it. Complete the form at the back of this manual before sending any equipment to Leybold.

3.7 Report (REPORT button)

Press the REPORT button to display information about the DRYVAC SET's operational status. Refer to Section 5, the troubleshooting chart, for the recommended corrective actions for each error report.

When the REPORT button is pressed,

DRYVAC V (Software-version)
REPORT

is displayed. Each report is displayed for 3 seconds before automatically moving on to the next report.

Information is displayed in the following sequence:

Stored alarms (A's), such as:

- A Temperature
- A Exhaust pressure
- A Shutoff valve
- A Motor protection switch
- A Motor contactor
- A Lubrication

These stored alarms indicate why the DRYVAC SET was shutdown.

Current alarms (A's) — These are the same as the stored alarms except that the DR YVAC SET isn't ready to restart. **Correct the malfunction before restarting the pump.**

Warnings (W's), such as:

- Process temp < tmin
- Process temp > tmax
- W Temperature
- W Exhaust pressure
- W Lubrication
- W N2 pressure
- W Flow

The above W arnings mean that the DR YVAC is nearing a critical limit, but is still fully operational. **Determine the reason for the warning and correct any malfunction as soon as possible.**

For the "W N2 pressure" or "W flow" W arnings, you must shut of f the process gas if the malfunction can't be eliminated immediately . Operating without purge will eventually cause serious damage to the DR YVAC. Refer to Section 3.2 if you are pumping clean gases.

The following W arnings pertain only to the Roots pump, which is switched of f if a "W Input pressure HV", "W Motortemp. HV", or "W Circuit breaker HV" Warning occurs. The DRYVAC SET will not start if a "W Motortemp. HV" or "W Circuit breaker HV" W arning is displayed.

- W Oilpressure HV
- W Input pressure HV
- W Motortemp. HV
- W Circuit breaker HV

Operating hours — Displays the total hours the DR YVAC SET has operated.

Process Temperature — Displays the cooling water temperature in ºC.

Lubr. Lack — If the oil pressure has always been normal, the display shows:

"Lubr lack DV(4h) 240"

and then:

"Lubr lack DV 000.0 h"

If the DR YVAC's oil pressure was inadequate, the first display shows less than 4 hours (240 minutes). The time shown is the time that remains until the DR YVAC SET shuts down due to insuf ficient oil pressure (refer to Section 3.4.4).

The second "Lubr lack" display shows the total cumulative time the DR YVAC and/or Roots pump ran with inadequate oil pressure. This timer can not be reset. If neither pump has operated with inadequate oil pressure, the second display will indicate 000.0 hours.

Process Setting — Displays the process you selected such as A, B, C, or D (refer to Table 2 and Section 2.7).

Installed Options — Displays any installed options such as:

- Standby set
- Flush valve
- LTO set

If no options are installed, it skips this item.

The report can be interrupted by pressing the REPOR T button again. It can be restarted at any time.

Stored alarms can be ignored when the DR YVAC SET is being put into operation for the first time. If an error report is displayed when the DR YVAC SET is switched on, you must press the REPOR T button before starting the pump.

Once all malfunctions have been eliminated, you can restart the DR YVAC SET by pressing the ST ART button. This erases all stored error reports.

4 Maintenance

4.1 Routine Maintenance

The DRYVAC SET 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 Sec. 4.2).

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

Warnings

Disconnect the DRYVAC SET from your AC power source before maintaining or repairing the pump. Take appropriate precautions to ensure that the pump can't start.

During operation, the DRYVAC SET's temperature can exceed 100ºC (212ºF). Always allow the pump to cool before removing it from the system or before opening its housing.

If the DRYVAC SET has pumped hazardous gases, determine the nature of the hazard and take the appropriate safety precautions. Comply with all safety regulations.

Before doing any maintenance or repair , shutdown the DRYVAC SET as described in Section 3.3 and disconnect it from the system. Refer to Section 3.6 to prepare the pump for shipping.

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

If the DR YVAC SET will be returned to Leybold, it must be accompanied by a listing of all hazardous substances that might be present in or around it. Complete the form at the back of this manual before sending any equipment to Leybold.

4.2 Replacing the Exhaust Silencer

As deposits build up in the exhaust silencer , the DRY-VAC exhaust pressure increases until,

W Exhaust pressure

is displayed. The DRYVAC can continue to operate; however , the exhaust silencer must be changed as soon as possible. Otherwise, the exhaust pressure will continue to increase until the DR YVAC switches of f and

A Exhaust pressure

is displayed.

Refer to Item 8 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

Disconnect the DRYVAC SET from your AC power source before removing the exhaust silencer. Take appropriate precautions to ensure that the pump can't start.

During operation, the DRYVAC SET's temperature can exceed 100ºC (212ºF). Always allow the pump to cool before removing it from the system or before opening its housing.

If the DRYVAC SET has pumped hazardous gases, determine the nature of the hazard and take the appropriate safety precautions. Comply with all safety regulations.

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

1. Open the four ˘-turn retaining clips and take of f the rear panel.
2. Use the Allen key supplied with the pump, and a 17-mm wrench to unscrew the exhaust silencer (13/9).
3. Unscrew shipping cover from new exhaust silencer .
4. Apply PFPE grease on gasket of new exhaust silencer .
5. Install the exhaust silencer and tighten it to 20 Nm (27 ft-lb).

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

Malfunction/ Display at the Control Unit	***Probable Cause***	***Recommended Corrective Action***	***References †***
1.1 Pump does not start/ **No display**	Motor circuit switch 1Q2 is turned off.	Open the door at the front; turn switch on.	2.4.1
	Errors in the main power connection.	Check and rectify the wiring. Verify that the main supply voltage is correct.	2.4
1.2 Pump does not start/ "**STOP**" LED lights up.	One of the malfunctions listed below at 7, 8, 9, 13, 14, or 15 has been detected.	Refer to the descriptions of malfunctions under 7, 8, 9, 13, 14, or 15. Press the REPORT button to review the error report.	
	The position indicator at the exhaust shutoff valve is malfunctioning.	Repair the exhaust shutoff valve.	Service
	The pump has seized causing the motor protection switch to trip during start-up	Repair or replace the pump.	Service
1.3 Pump run up briefly, then "**W Lubrication**" is displayed.	Motor is malfunctioning.	Repair or replace the motor.	Service
	Pump is rotating in the wrong direction.	Shut off power to the pump. Interchange two of the phase leads.	2.8
	Insufficient oil in the DRYVAC gearbox.	Measure the oil level through the fill plug. The range is 6 to 9 mm ($^1/_4$ to $^3/_8$ inch) for the DRYVAC 100S model and 12 to 15 mm ($^1/_2$ to $^5/_8$ inch) for the DRYVAC 50S model.	Service
2. Pump does not reach ultimate pressure	Unsuitable measurement procedure or gauge.	Measure pressure at pump's intake port using suitable gauge.	---
	Purge gas supply is open	If you have the STANDBY option and if the process permits, use the STANDBY button to close the purge-gas valve.	2.10.1
	The pump has an external leak.	Find the leak; repair the pump.	Service
	Optional flush valve is leaking or will not close.	Replace the valve.	2.10.2
	Evaporating liquids in the pump.	Measure the partial pressure of the non-condensable gases. To do so, insert a low-temperature trap between the gauge and the intake port. If the ultimate pressure is achieved while this trap is operating, liquids are evaporating in the pump. One possible remedy: Open the purge gas valve and let the pump run $^1/_2$ hour without process load.	---
	Vacuum chamber is leaking or dirty	Seal or clean the vacuum chamber.	---
	Intake line is leaking or dirty.	Seal or clean the intake line.	---
	Roots pump does not run; malfunction 14, 15, or 16 has been detected.	See malfunctions 14, 15, and 16.	
3. Evacuation period is too long. (Pumping speed is too low.)	Intake line is too long or too narrow.	Install intake lines that have an adequate diameter; keep lines as short as possible.	2.9.1
	Dirt trap at intake port is clogged.	Clean dirt trap.	---
	Intake line is leaking or dirty.	Clean the pump.	Service
	Pump rotation speed is too slow.	Check whether the frequency of your AC power source complies with the specifications for this pump.	Name-plate 2.4
4. The pressure in the system rises too quickly after the pump shuts down.	System or intake line is leaking.	Check the system and the intake line.	---
	The pump has an external leak.	Repair the pump.	Service

* When the first letter in the display is "W" (W arning), the pump is approaching a critical value; when the first letter is "A" (Alarm), the pump shuts down because it exceeded a critical value.

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

Malfunction/ Display at the Control Unit	***Probable Cause***	***Recommended Corrective Action***	***References †***
5. The pump is extremely loud.	Motor bearing failure or gear problem.	Replace the motor or gears.	Service
	Pump bearings are malfunctioning.	Rebuild the pump.	Service
	Liquid "knocking" in the pump (too much liquid in the pump).	Install the exhaust line so that it slopes downward from the pump or install a condensate trap. Increase the purge gas supply.	2.9.2
	Mechanical strain in the roots pump caused by rigid connection to its inlet.	Use bellows to connect the roots pump inlet.	2.9.1
	Roots pump is very contaminated.	Clean the pump.	Service
	Oil slinger in the roots pump is rubbing against the cover or the oil-tube.	Repair the pump.	Service
6. Oil is found in the pumping chamber.	Oil level in the roots pump is too high.	Drain PFPE from the roots pump to reach the correct level.	3.6
	Oil is leaking from the system.	Check the system.	2.2
	Pump is not level.	Level the pump.	2.2
	Roots pump has an external leak.	Check that the oil-fill plug is sealed properly; install a new gasket if necessary.	2.2
	Pump has an internal leak.	Service the pump.	Service
7. "**A Shutoff valve**" is displayed.	Insufficient air pressure at the exhaust shutoff valve.	Ensure that the compressed air supply is at least 6 bar (72 psig).	2.6
	Supply of compressed air was interrupted briefly.	Ensure that the compressed air supply is at least 6 bar (72 psig).	2.6
	Switch, plug, or cable malfunction.	Replace the malfunctioning part. Switch circuit breakers ON.	Service
8. Exhaust pressure is too high. "**W Exhaust pressure**" is displayed first. If it continues to rise "**A Exhaust pressure**" is displayed and the pump switches off.	Exhaust line is clogged.	Clean the exhaust line.	---
	Exhaust line is too narrow or too long.	Install an exhaust line which is large enough, and is as short as possible.	2.9.2
	Exhaust shutoff valve is malfunctioning.	Replace the valve.	Service
	Exhaust silencer is clogged.	Replace the exhaust silencer.	4.2
	Switch, plug, or cord malfunction.	Replace the malfunctioning part. Switch the circuit breakers ON.	Service
9. Temperature "**W Temperature**" is displayed first. If it continues to rise, "**A Temperature**" is displayed and the pump switches off.	Process gas is too hot.	Change the process.	---
	Ambient temperature is too high.	Change pump site or supply cooler air.	---
	Cooling air flow is restricted.	Clean the ventilation grids and the cooling air ducts; increase the distance between the grids and the walls.	---
	Friction in the pump is too high.	Repair the pump.	Service
	The switch, plug, or cable is malfunctioning.	Replace the malfunctioning part. Switch the circuit breakers ON.	Service

* When the first letter in the display is "W" (W arning), the pump is approaching a critical value; when the first letter is "A" (Alarm), the pump shuts down because it exceeded a critical value.

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

Malfunction/ Display at the Control Unit	***Probable Cause***	***Recommended Corrective Action***	***References*** †
10. "**Process Temperature <tmin** or **>tmax**" is displayed.	Pump is in the warm-up phase.	Wait until the pump has reached its process temperature.	3.1
	Cooling water supply is not opened.	Turn ON the cooling water supply.	---
	Cooling water pressure is too low. Cooling water flow is too low. Cooling inlet temperature is too high.	Ensure that there is an adequate supply of cooling water: pressure 2–10 bar (14–130 psig), consumption about 100 l/hr (100 qt/ hr) at water temperature of 15 °C (59°F). The max. cooling water inlet temperature is 25°C (77°F).	2.5
	Lime deposits in the cooling water lines to 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 are connected incorrectly.	Connect the cooling water lines correctly.	2.5
	The thermostat valve is set incorrectly.	Set the thermostat valve correctly.	2.5
	The pump was not filled with cooling water during installation.	Fill the pump with cooling water.	2.5
	Switch, plug, or cable is malfunctioning.	Replace the malfunctioning part; switch the circuit breakers ON.	Service
11. Oil pressure First "**WLubrication**" is displayed. After 4 hours, "**ALubrication**" is displayed and the pump is switched off; see Section 3.4.4.	The pump is rotating in the wrong direction; see malfunction 1.3.	Shut off power to the pump. Interchange two of the phase leads.	2.8
	Insufficient oil in the DRYVAC gear box.	Measure the oil level through the fill plug. The range is 6 to 9 mm (1/4 to 3/8 inch) for the DRYVAC 100S model and 12 to 15 mm ($^1/_2$ to $^5/_8$ inch) for the DRYVAC 50S model.	Service
	The DRYVAC oil pump is malfunctioning.	Repair the pump.	Service
	Switch, plug, or cable malfunction.	Replace the malfunctioning part. Switch circuit breakers ON.	Service
12. Either "**WN2-pressure**" or "**W Flow**" is displayed.	The inert gas valve is not open.	Open the inert gas supply.	---
	Insufficient inert gas pressure.	Set the correct inert gas pressure (4–10 bar, 43–130 psig).	2.6
	The purge-gas valves are restricted.	Replace the valves.	Service
	The main inert gas valve is restricted.	Replace the valve. The valve is closed when deenergized. If it does not open, check the power supply, connections, and fuses.	Figure 7 Service
	The purge-gas nozzles are dirty.	Clean the nozzles.	Service
	The purge-gas valve plate or purge-gas line was mounted incorrectly during pump conversion.	Correctly install the purge-gas valve plate or purge gas line.	2.10.2/ 2.10.3
	Switch, plug, or cable is malfunctioning.	Replace the malfunctioning part. Switch circuit breakers ON.	Service

* When the first letter in the display is "W" (W arning), the pump is approaching a critical value; when the first letter is "A" (Alarm), the pump shuts down because it exceeded a critical value.

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

Malfunction/ Display at the Control Unit	***Probable Cause***	***Recommended Corrective Action***	***References †***
13. "**A Circuit breaker**" is displayed (the motor protection switch has tripped).	The intake pressure is too high.	Modify the system.	---
	The pump has seized.	Repair the pump. If the pump doesn't start, check whether it turns freely. Remove the middle segment of the top cover and use a 5-mm Allen key (200 mm long) to turn the motor shaft from the outside.	Service
	Main supply voltage is too low.	Connect the pump to the correct voltage.	2.4
	Ambient temperature is too high.	Change the site or ensure a cooler air supply.	---
	Switch, plug, or cable malfunction.	Replace the malfunctioning part. Switch the circuit breakers ON.	Service
	---	Switch the motor protection switch ON.	Figure 8
14. "**W Circuit breaker HV**" is displayed (motor protection switch of the roots pump has tripped).	The intake pressure is too high.	Modify the system.	---
	The roots pump has seized.	Repair the pump.	Service
	Main supply voltage is too low.	Connect the pump to the correct voltage.	2.4
	Ambient temperature is too high.	Change the site or ensure a cooler air supply.	---
	Switch, plug, or cable malfunction.	Replace the malfunctioning part. Switch the circuit breakers ON.	Service
	---	Switch the motor protection switch ON. Remove the control unit to access the roots-pump circuit breaker.	Figure 8
15. "**W Motor temp. HV**" is displayed The roots pump is switched off.	The process gas is too hot.	Modify the process.	---
	The ambient temperature is too high.	Change site or ensure a cooler air supply.	---
	The flow of cooling air is restricted.	Clean the ventilation grids and cooling air channels; provide more space between the ventilation grids and the walls.	---
	There is too much friction in the roots pump.	Repair the roots pump.	Service
	Switch, plug, or cable malfunction.	Replace the malfunctioning part. Switch the circuit breakers ON.	Service
16. "**W Input pressure HV**" is displayed The roots pump is switched off after 3 seconds.	The intake pressure of the roots pump is too high.	---	
	Switch, plug, or cable malfunction.	Replace the malfunctioning part.	Service
17. "**W Oil pressure HV**" is displayed	Insufficient oil in the roots pump.	Add PFPE to the correct level.	2.3
	Oil pump in the roots pump is malfunctioning.	Repair the pump	Service
	Switch, plug, or cable malfunction.	Replace the malfunctioning part. Switch the circuit breakers ON.	Service
18. "**Key not allowed**" is displayed	The user pressed the FLUSH or STAND BY buttons which function only if the FLUSH or STAND BY options have been installed.	Press permissible buttons.	

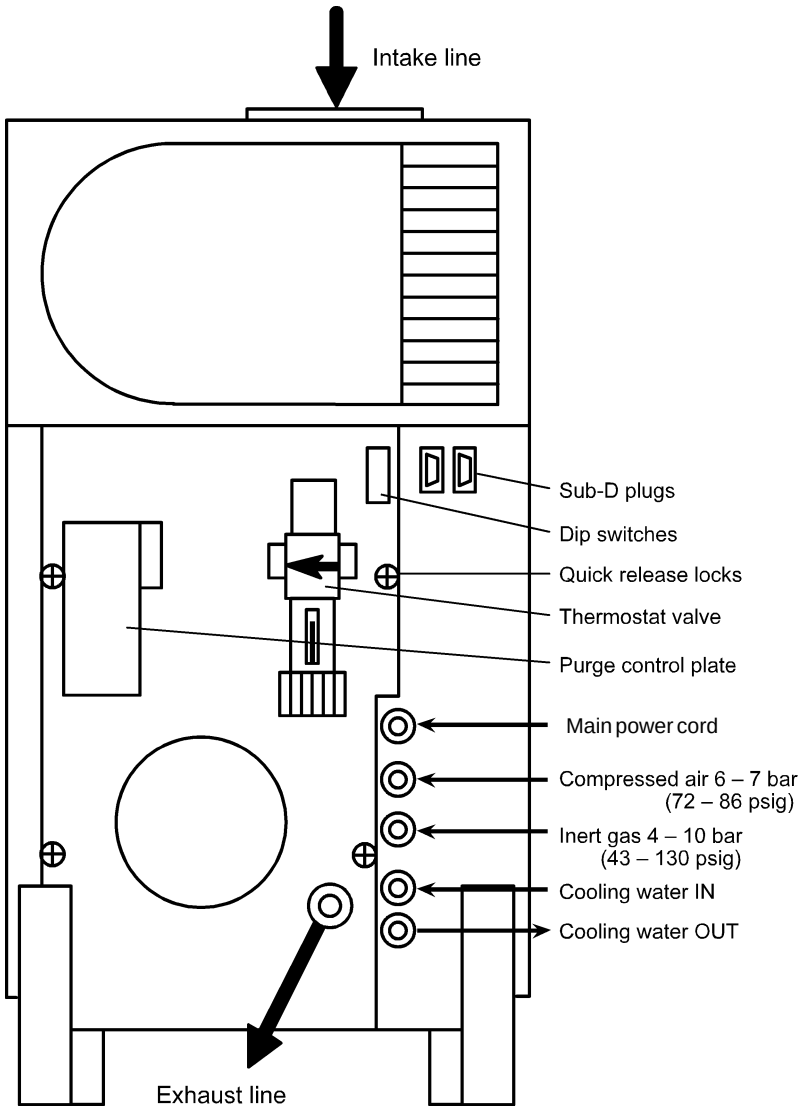
* When the first letter in the display is "W" (W arning), the pump is approaching a critical value; when the first letter is "A" (Alarm), the pump shuts down because it exceeded a critical value.

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

Malfunction/ Display at the Control Unit	***Probable Cause***	***Recommended Corrective Action***	***References*** †
19. "**Call error report**" is displayed	When this is displayed, review the error report.	Press the REPORT button.	3.7
20. "**Remote operation**" is displayed	The pump is set to remote operation at the interface.	Open the REMOTE contact at the parallel interface.	2.4.2
21. "**Process not allowed**" is displayed	Process setting isn't allowed since an important option is absent.	Install option or select another process.	2.7/ 2.10.3
22. "**Wrong proc. setting**" is displayed	More than one process has been set at the DIP switches.	Set only a single process.	2.7
23. "**Confirm**" is displayed	---	Press the STOP and REPORT keys simultaneously.	2.7

* When the first letter in the display is "W" (W arning), the pump is approaching a critical value; when the first letter is "A" (Alarm), the pump shuts down because it exceeded a critical value.

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



Process Settings

Process group	DIP switches	Thermo-stat valve	Purge control plate	Option Required
A	5 ON	4	closed (ETCH)	—
B	6 ON	4	open (CVD)	—
C	7 ON	2	open (CVD)	LTO
D	8 ON	2	open (CVD)	—

Start-up Checklist

Have you read the installation & start-up instructions in this manual? ..... ❒

Is purge system configured correctly (refer to Section 2.1)? ..... ❒

Is the main AC voltage correct (refer to Section 2.4)? ..... ❒

Is the DR YVACs transformer wired for the applied voltage ..... ❒

Are cooling water inlet and outlet connected correctly? ..... ❒

Is DRYVAC filled with cooling water? ..... ❒

Is thermostat valve set to correct process? ..... ❒

Is inert gas connected (4-10 bar , 43-130 psig)? ..... ❒

Is compressed air connected (6-7 bar , 72-86 psig)? ..... ❒

Are DIP switches set to correct process? ❒

Is the main switch turned ON? ..... ❒

Is the process confirmed (REPORT + STOP)? ..... ❒

Are the shipping seals removed? ..... ❒

Is the direction of rotation correct? ..... ❒

Are the enclosure panels reinstalled? ..... ❒

Is the intake line equipped for the process (refer to Section 2.9.1)? ..... ❒

Is the intake line clean and oil free? ..... ❒

Is the intake line connected with bellows? .. ❒

Is the exhaust line connected to a proper exhaust system? ..... ❒

Are the inlet and exhaust lines free of leaks? ..... ❒

Is the inert gas supply open? ..... ❒

Is the compressed air supply open? ..... ❒

Is the cooling water supply open? ..... ❒

Is the exhaust line open and free of deposits? ..... ❒

Are the preset process group and "Ready to Start" displayed? ..... ❒

Press the start button and wait for the pump to reach its process temperature.

Start-up: Date: _____ Name: _____ Dept.: _____

Remarks:

Notes:

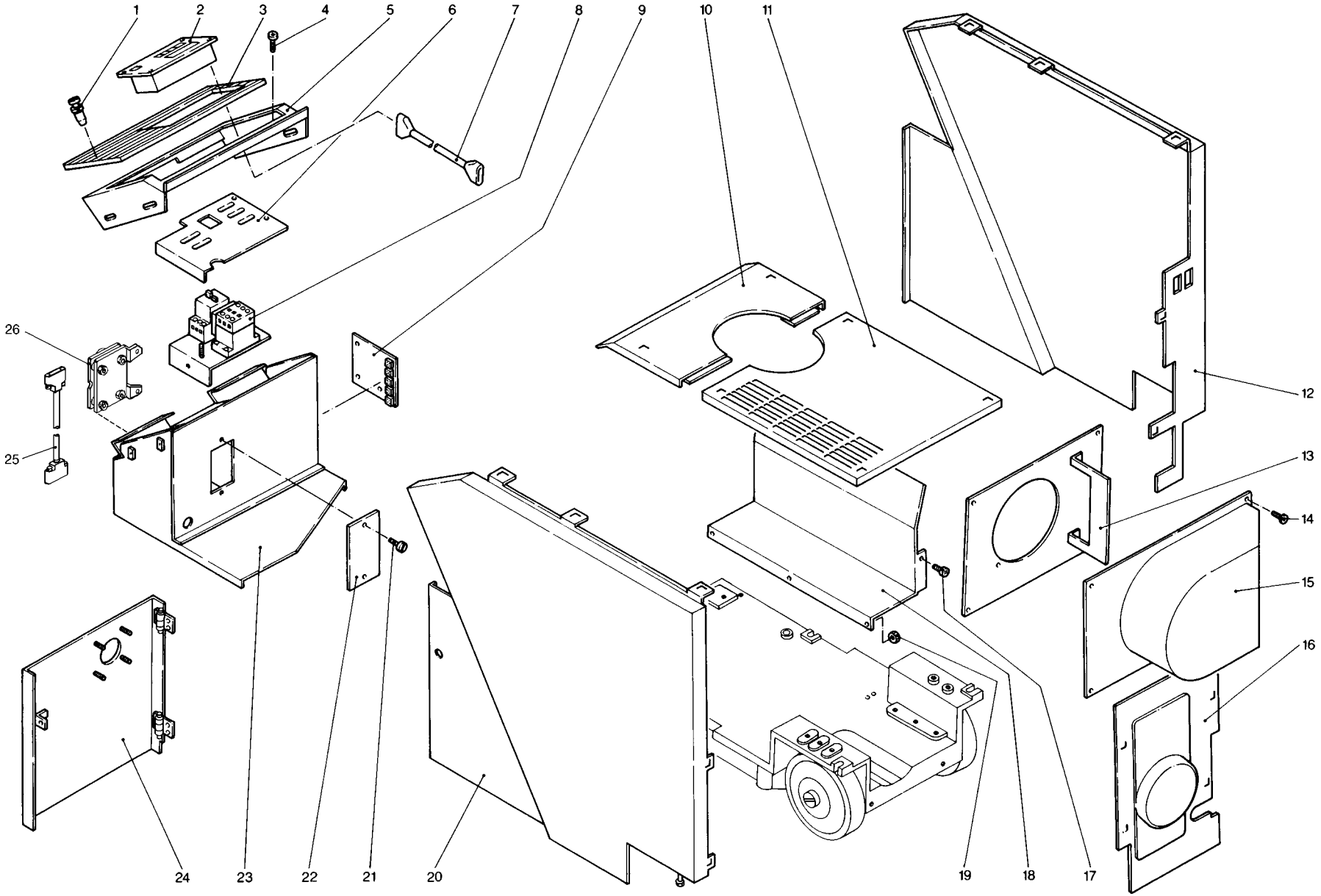


Fig./Abb. 1

01-E06-353-2.2

Pos.	Quanity Stückzahl Nombre de pièces 251S	501S	see Fig. 1/zu Abb. 1/appartient fig. 1 Description	Benennung	Désignation	Dimensions (mm) Abmessungen (mm), W erkstof f Material/Matériel		Part Number Bestell-Nr . Nº de réf.	Remarks Bemerkungen Remarques
1	12	14	Metal ˇ-turn Fasteners:	Schnellverschluß	Fermeture rapide				
			Stud			6.4 x 14	St	***200 77 069***	
			Snap ring			5.8 x 0.7	Stainless St	***200 77 067***	
			Receptacle			SQC4-20 (size 4)	St	***200 77 068***	
			Grommet			11.1 x 4.4	St	***200 77 070****	***Requires special installation tools.
			Washer			14.3 x 9.5 x 0.8	St	***200 77 071***	
2	1	1	Control unit	Anzeige / Bedienteil	Panneau de commande			200 80 729	
3	1		Cover	Blende	Diaphragme	390 x 172.6		200 78 681	
3		1	Cover	Blende	Diaphragme	390 x 272.6		200 78 682	
4	4	4	Socket head capscrew	Zylinderschraube	Vis à tête cylindrique	M 6 x 10	DIN 912	201 03 253	
5	1		Support	Blendenträger	Support	384 x 145		200 78 679	
5		1	Support	Blendenträger	Support	384 x 225		200 78 680	
6	1	1	Cover	Abdeckung	Couverture	210 x 146		200 78 683	
7	1	1	Connecting cable	Verbindungsleitung	Câble de connexion			200 80 736	
8	1	1	Motor starter board	Geräteplatte, bestückt	Plague d'unté, équipeé	4 – 6 A		200 80 948	
8	1		Motor starter board	Geräteplatte, bestückt	Plague d'unté, équipeé	2.4 – 4 A		200 80 947	
8		1	Motor starter board	Geräteplatte, bestückt	Plague d'unté, équipeé	6 – 10 A		200 80 949	
9	1	1	Printed circuit board	Leiterplatte, bestückt	Carte à circuits imprimés			200 80 927	
10	1		Cover , front	Deckel, vorne	Couvercle avant	390 x 213.7	St	200 78 316	
10		1	Cover , front	Deckel, vorne	Couvercle avant	390 x 199.5	St	200 78 459	
11	1		Cover , back	Deckel, hinten	Couvercle, arrière	416 x 390	St	200 78 317	
11		1	Cover , back	Deckel, hinten	Couvercle, arrière	400 x 390	St	200 78 460	
12	1		Left side panel	Seitenverkleidung, links	Paroi gauche	795.3 x 784.5	St	200 78 707	
12		1	Left side panel	Seitenverkleidung, links	Paroi gauche	854.3 x 806	St	200 78 634	
13	1		Cover plate	Abdeckblech	Couvercle en tôle			200 78 678	
13		1	Cover plate	Abdeckblech	Couvercle en tôle			200 78 677	
14	4	4	Machine screw	Linsenschraube	Vis à tête bombée	M 4 x 16	DIN 966	200 77 032	
15	1		Cabinet ventilation panel	Ansaugkulisse	Habillage	446 x 264		200 78 213	
15		1	Cabinet ventilation panel	Ansaugkulisse	Habillage			200 78 313	
16	1		Rear panel	Rückwand	Panneau arrière	519 x 307		200 78 185	
16		1	Rear panel	Rückwand	Panneau arrière	519 x 307		200 78 184	
17	1	1	Socket head capscrew	Zylinderschraube	Vis à tête cylindrique	M 5 x 8	DIN 912	201 03 214	
18	1		Air deflection panel	Abluftkulisse	Tôle chicane	426.5 x 113.5	St	200 78 300	
18		1	Air deflection panel	Abluftkulisse	Tôle chicane	461.5 x 113.5	St	200 78 462	
19	3	3	Hex nut	Sechskantmutter	Ecrou hexagonal	M 5	DIN 934	211 01 108	
20	1		Right side panel	Seitenverkleidung, rechts	Paroi droite	795.3 x 784.5	St	200 78 706	
20		1	Right side panel	Seitenverkleidung, rechts	Paroi droite	854.3x 806	St	200 78 635	
21	2	2	Socket head capscrew	Zylinderschraube	Vis à tête cylindrique	M 3 x 10	DIN 84	201 04 161	
22	1	1	Window	Fenster	Fenêtre	120 x 80	Acrylgl.	200 78 685	
23	1	1	Control unit enclosure	Elecktrokasten	Boîtier			200 78 684	
24	1		Front door	Fronttür	Porte frontale	412 x 390	St	200 78 703	
24		1	Front door	Fronttür	Porte frontale	412 x 390	St	200 78 639	
25	1	1	Cable					***200 77 926****	* For LIMS-equipped models
26	1	1	Current sensor board					***200 77 930****	

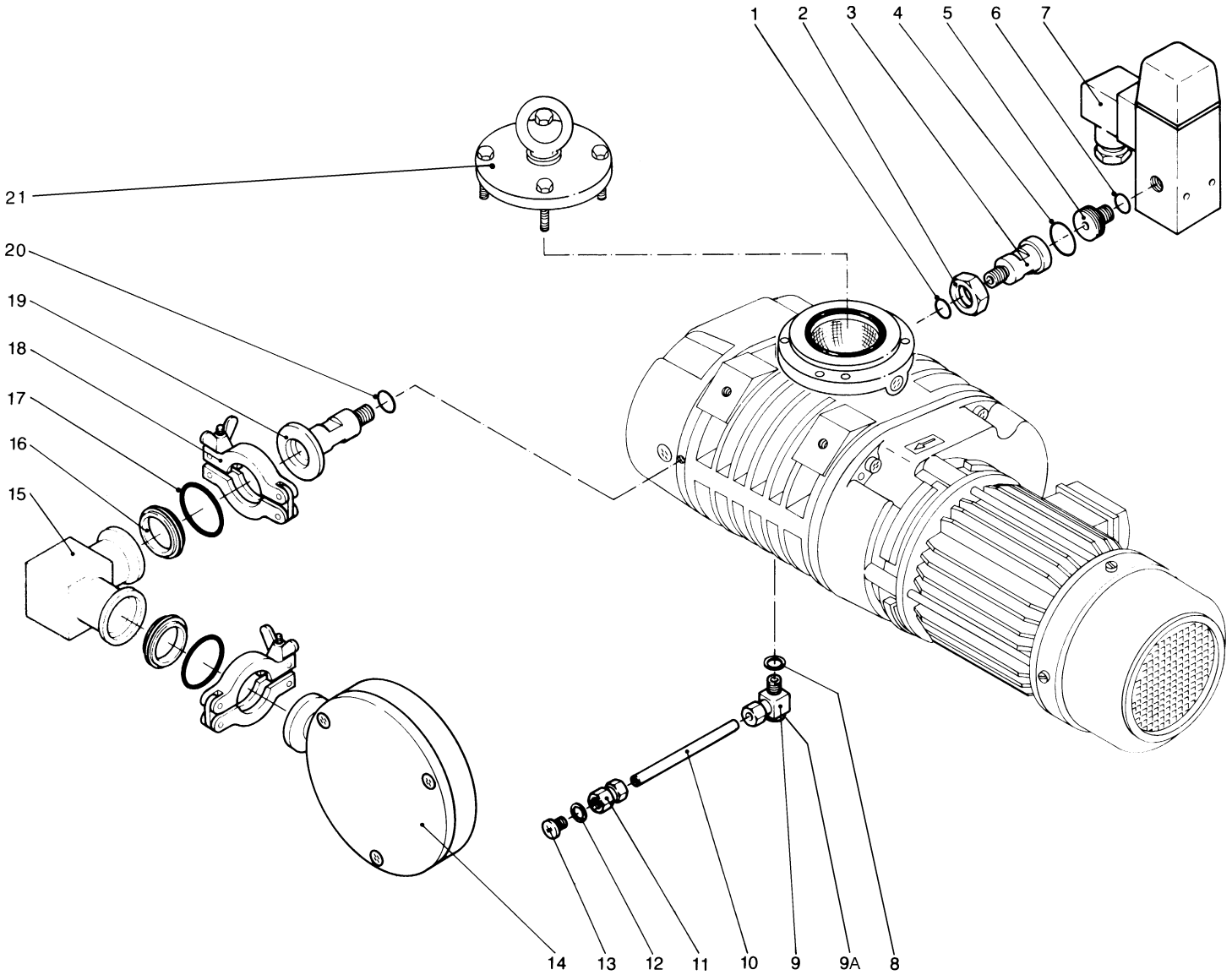


Fig./Abb. 2

01-E06-351-2.2

Pos.	Quanity Stückzahl Nombre de pièces 251S	501S	see Fig. 2/zu Abb. 2/appartient fig. 2 Description	Benennung	Désignation	Dimensions (mm) Abmessungen (mm), W erkstof f Material/Matériel	Part Number Bestell-Nr . Nº de réf.	Remarks Bemerkungen Remarques
1	1	1	O-ring	O-Ring	Joint torique	8 x 2 FPM	239 70 149	
2	1	1	Collar nut	Überwurfmutter	Ecrou à ergot	M 20 x 1	200 13 807	
3	1		Adapter	Einschraubstück	Raccords fileté	M 8	200 78 502	
3		1	Adapter	Einschraubstück	Raccords fileté	M 8	200 13 806	
4	1	1	USIT ring	USIT Ring	Joint USIT	U12.7 x 18 x 1.5	230 02 108	
5	1	1	Threaded adapter	Einschraubstück	Raccords fileté	M 20 x 1; G 1/8"	200 13 808	
6	1	1	USIT ring	USIT Ring	Joint USIT	U10.7 x 16 x 1.5	230 02 106	
7	1	1	Oil - pressure switch S31	Öldruckschalter S31	Interrupteur à pression d'huile	0.1 – 1 bar; 24V / 6A	200 78 619	
8	1	1	Copper gasket	Flachdichtung	Joint plat	16 x 20 x 3 Cu / DIN 7603	224 01 214	Optional
9	1	1	Rotable angle fitting	Winkelverschraubung	Raccord d'angle fileté		200 78 670	Optional
9A	1	1	Copper gasket	Flachdichtung	Joint plat	22 x 27 x 1.5 Cu / DIN 7603	224 01 219	Optional
10	1	1	Extension tube	Distanzrohr	Douille d'écartement	12 x 1 x 177	200 78 501	Optional
11	1	1	Coupling adapter	Gerade Verschraubung	Raccord à vis droit	GAI 12-PLM	200 78 500	Optional
12	1	1	Copper gasket	Flachdichtung	Joint plat	16 x 20 x 1.5 Cu DIN 7603	224 01 214	Optional
13	1	1	Plug screw	Verschlußschraube	Vis de fermeture	M 16 x 1.5 D DIN 908	201 27 105	Optional
14	1	1	Pressure switch	Druckschalter	Interrupteur manométrique	PS 114	to order/	
15	1	1	KF elbow	Winkelstück	Eqerre de soutien	DN 16 KF	884 61 B2	
16	2	2	Centering ring	Zentrierring	Anneau de centrage	DN 16 KF	231 94 405	
17	2	2	O-ring	O-Ring	Joint torique	18 x 5 FPM	239 70 176	
18	2	2	Clamping ring	Spannring	Collier de serrage	DN 10/16 KF	230 60 101	
19	1	1	Adapter	Einschraubstück	Raccords fileté	M 8 / KF 16	200 78 503	
20	1	1	O-ring	O-Ring	Joint torique	8 x 2 FPM	239 70 149	
21	1	1	Lifting flange assembly				200 77 064	
			Please indicate the model and serial number when ordering spare parts.	Bitte geben Sie bei der Bestellung von Ersatzteilen außer de Typenbezeichnung auch die Fabrikations-Nummer an.	Veuillez indiquer dans vos commandes de pièces de rechange le modèle et le numéro de fabrication de la pompe.			

For the other spare parts of the DR YVAC SET, refer to the following spare parts lists:
Die übrigen Ersatzteile für die unten aufgeführten DR YVAC-Typen fiden Sie unter folgenden ET Nummern:
Pour les autres pièces de rechange des types mentionnés ci-dessous veuillez vous reporter aux numéros des listes de pièces de rechange suivants:

DRYVAC SET 251S = ET 03.108 Ruvac 251 + ET 01.404 DRYVAC 50S

DRYVAC SET 501S = ET 03.108 Ruvac 501 + ET 01.408 DRYVAC 100S

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 dif ficult 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 of f 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 of f all process gas but do not shut the customer's inert-gas purge to the OEM tool. The water discharge temperature should be about 55ºC (130ºF).
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 1 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 110ºF (45ºC).
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 80ºF (27ºC). Then switch of f the DR YVAC motor .
5. After the DR YVAC's motor shuts of f, 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 setscrew 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.