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VARIAN

VHS-250 Diffusion Pumps

Instruction Manual

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WARRANTY

Products manufactured by Seller are warranted against defects in materials and workmanship for twelve (12) months from date of shipment thereof to Customer, and Seller's liability under valid warranty claims is limited, at the option of Seller, to repair, replacement, or refund of an equitable portion of the purchase price of the Product. Items expendable in normal use are not covered by this warranty. All warranty replacement or repair of parts shall be limited to equipment malfunctions which, in the sole opinion of Seller, are due or traceable to defects in original materials or workmanship. All obligations of Seller under this warranty shall cease in the event of abuse, accident, alteration, misuse, or neglect of the equipment. In-warranty repaired or replacement parts are warranted only for the remaining unexpired portion of the original warranty period applicable to the repaired or replaced parts. After expiration of the applicable warranty period, Customer shall be charged at the then current prices for parts, labor, and transportation.

Reasonable care must be used to avoid hazards. Seller expressly disclaims responsibility for loss or damage caused by use of its Products other than in accordance with proper operating procedures.

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Except as stated herein, Seller makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and, except as stated herein, Seller shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise. Statements made by any person, including representatives of Seller, which are inconsistent or in conflict with the terms of this warranty shall not be binding upon Seller unless reduced to writing and approved by an officer of Seller.

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All claims under warranty must be made promptly after occurrence of circumstances giving rise thereto, and must be received within the applicable warranty period by Seller or its authorized representative. Such claims should include the Product serial number, the date of shipment, and a full description of the circumstances giving rise to the claim. Before any Products are returned for repair and/or adjustment, written authorization from Seller or its authorized representative for the return and instructions as to how and where these Products should be returned must be obtained. Any Product returned to Seller for examination shall be prepaid via the means of transportation indicated as acceptable by Seller. Seller reserves the right to reject any warranty claim not promptly reported and any warranty claim on any item that has been altered or has been returned by non-acceptable means of transportation. When any Product is returned for examination and inspection, or for any other reason, Customer shall be responsible for all damage resulting from improper packing or handling, and for loss in transit, notwithstanding any defect or non-conformity in the Product, in all cases, Seller has the sole responsibility for determining the cause and nature of failure, and Seller's determination with regard thereto shall be final.

If it is found that Seller's Product has been returned without cause and is still serviceable, Customer will be notified and the Product returned at its expense; in addition, a charge for testing and examination may be made on Products so returned.

12/1/93

Declaration of Conformity
Konformitätserklärung
Déclaration de Conformité
Declaración de Conformidad
Verklaring de Overeenstemming
Dichiarazione di Conformità

VARIAN

We/Wir/Nous/Nosotros/Wij/Noi: Varian, Inc.
Varian Vacuum Technologies
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declare under our sole responsibility that the product,
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déclarons sous notre seule responsabilité que le produit,
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VMF-11	VHS-4	HS-16
AX-65	M-6	HS-20
AX-150	VHS-6	HS-32
HS-2	VHS-250	NHS-35
M-2	VHS-10	
M-4	VHS-400	

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auf das sich diese Erklärung bezieht, mit der/den folgenden Norm(en) oder Richtlinie(n) übereinstimmt.
auquel se réfère cette déclaration est conforme à la (auz) norme(s) ou au(x) document(s) normatif(s).
al que se refiere esta declaración es conforme a la(s) norma(s) u otro(s) documento(s) normativo(s).
waamaar deze verklaring verwijst, aan de volende norm(en) of richtlijn(en) beantwoordt.
a cui se riferisce questa dichiarazione è conforme alla/e sequente/I norma/o documento/I normativo/i.

73/023/EEC	Low Voltage Directive
EN 61010-1	"Safety requirements for electrical equipment for measurement, control and laboratory use", incorporating amendments, numbers 1 and 2.

Fred C. Campbell

Frederick C. Campbell

Operations Manager
Varian Vacuum Technologies
Lexington, Massachusetts, USA

February 2000

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SAFETY CONSIDERATIONS

READ THE FOLLOWING INSTRUCTIONS;
TAKE ALL NECESSARY PRECAUTIONS

OPERATION AND MAINTENANCE OF THIS EQUIPMENT INVOLVES SERIOUS RISK. IT IS THE RESPONSIBILITY OF THE USER TO MAINTAIN SAFE OPERATING CONDITIONS AT ALL TIMES. VARIAN ASSUMES NO LIABILITY FOR PERSONAL INJURY OR DAMAGE RESULTING FROM OPERATION OR SERVICE OF THE EQUIPMENT.

Carelessly or improperly operated equipment can cause serious injury or death and/or damage to the equipment. The emergency and safety procedures in this manual are provided to help users and qualified persons to operate and service the unit safely. Recommendations are believed to reflect accepted industry practices in effect on the date of publication of this manual. Special applications must be reviewed and approved by an industrial hygienist or chemical safety engineer.

Varian has no control over the use of this equipment and is not responsible for personal injury or damage resulting from its use. The safe use and disposal of hazardous or potentially hazardous materials of any kind is the sole responsibility of the user. Observe all WARNINGS and CAUTIONS to minimize the serious hazards involved.

It is the sole responsibility of users of Varian equipment to comply with all local, state, and federal safety requirements (laws and regulations) applicable to their system. Employ the services of an industrial hygienist and/or a qualified chemical safety engineer in order to ensure safe installation and use.

This instruction manual contains information which will assist qualified operators in the operation, and qualified service engineers to carry out field-servicing the Varian equipment.

SAFETY CONSIDERATIONS

READ THE FOLLOWING INSTRUCTIONS;
TAKE ALL NECESSARY PRECAUTIONS

SAFE INCORPORATION OF VARIAN DIFFUSION PUMPS INTO VACUUM SYSTEMS IS THE RESPONSIBILITY OF THE SYSTEMS DESIGNER. TAKE APPROPRIATE ACTION THROUGH REDUNDANCY, AND/OR OTHER SAFEGUARDS TO PROTECT PERSONNEL AND PROPERTY FROM THE HAZARDS DESCRIBED BELOW AND IN THE INSTALLATION, OPERATION, AND MAINTENANCE INSTRUCTION MANUAL. SAFE OPERATION IS THE RESPONSIBILITY OF THE USING ORGANIZATION AND ITS PERSONNEL. READ THE INSTRUCTION MANUAL AND UNDERSTAND HOW TO AVOID HAZARDS PRIOR TO OPERATING THE DIFFUSION PUMP. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO DIFFUSION PUMPS OR EQUIPMENT WHICH UTILIZES SUCH PUMPS OR DIFFUSION PUMP FLUID MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY OR DEATH. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

THESE SHEETS AND THE INSTALLATION, OPERATION, AND MAINTENANCE INSTRUCTIONS CAN HELP YOU TO OPERATE THIS PUMP SAFELY AND EFFICIENTLY. READ THEM. SPECIAL OPERATING CONSIDERATIONS AND PRECAUTIONS WILL BE FOUND IN THE OPERATION INSTRUCTIONS. UNINFORMED OR CARELESS OPERATION OF THIS PUMP CAN RESULT IN POOR PERFORMANCE, DAMAGE TO THE PUMP OR OTHER PROPERTY, SERIOUS BODILY INJURY, AND POSSIBLE DEATH.

USERS OF THIS EQUIPMENT SHOULD BE ALERT TO TWO LEVELS OF HAZARDS IDENTIFIED BY THE FOLLOWING SYMBOLS:

⚠ WARNING

Warnings are used when failure to observe instructions or precautions could result in injury or death to humans.

CAUTION

Cautions are used when failure to observe instructions could result in significant damage to equipment and/or facilities.

Designers of systems which utilize diffusion pumps must design out hazards wherever possible; provide guards, safety features, and interlocks for hazards which cannot be designed out; warn with respect to hazards which cannot be designed out and which remain after utilizing guards, safety features, and interlocks; and lastly, provide procedures and instructions on proper use, servicing, etc., so as to minimize risk.

SAFETY CONSIDERATIONS

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THE INSTALLATION, OPERATION, AND/OR SERVICING OR DIFFUSION PUMPS INVOLVES ONE OR MORE OF THE FOLLOWING HAZARDS, ANY ONE OF WHICH, IN THE ABSENCE OF SAFE OPERATING PRACTICES AND PRECAUTIONS, COULD POTENTIALLY RESULT IN DEATH OR SERIOUS HARM TO PERSONNEL.

Hazard	Suggested Corrective Action
Loss of utility: water and/or electricity	Provide sufficient water and backup power to effect a safe shutdown under worst case conditions.
Overpressure in foreline	Provide an interlock to ensure that the power supply to the pump heater cannot be activated if the foreline pump is not running AND/OR pressure in foreline is above 0.5 Torr (66.5 Pa).
Overtemperature	Fit temperature sensors and pump fluid level sensors with feedback to an interlock on the heater power supply.
Insufficient water flow through the main cooling coils	Use water flow sensor and feedback to interlock on the heater power supply.
Water trapped between inlet and outlet of quick-cool coil, or liquid nitrogen trapped between inlet and outlet of liquid nitrogen trap	Provide vent or pressure relief valves for both quick-cool coil and liquid nitrogen trap.
Loss of ground integrity	Incorporate ground fault interrupt circuit into heater power supply.
Positive pressure in pumping system	Integrate pressure relief valve in vacuum system.
High voltage	Prevent personnel contact with high voltages; design and attach warnings.
Toxicity/Corrosivity	Toxic and/or corrosive gases must be vented to a safe location, ensuring adequate dilution or scrubbing to safe levels, taking all action required to meet air quality standards.

SAFETY CONSIDERATIONS

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Hazard	Suggested Corrective Action
Explosion	Integrate pressure relief valves in all systems using pumps 10 inches or larger in diameter. Do not use or recommend the use of hydrocarbon-based pumping oils.

a. **Explosion** – Operation of the diffusion pump without prior and continuous evacuation (below 0.5 Torr (66.5 Pa)) or coolant and introducing a strong oxidizer (such as air) or explosive vapors or powders or materials which may react with pumping fluids into a hot (above 300°F or 150°C) pump can cause an explosion. Such an explosion can violently expel valves and other hardware, slam open doors that are not designed for appropriate pressure relief, or burst other components of the vacuum system. Serious injury or death may result from expelled parts, doors, shrapnel, and/or shock waves.

b. All diffusion pumps are typically cleaned with acetone or alcohol. When combined with air, oxygen, and other oxidizers, alcohol and most other solvents are very flammable and explosive. Never permit any trace of these cleaners to remain in or on the pump. Always remove all traces of alcohol and acetone and other cleaners with clean, dry, oil-free compressed air.

Three elements are required: fuel, oxidizer, and source of ignition. A combination of temperature and pressure can be a source of ignition. Most diffusion pump fluids except mercury are fuels. Hydrocarbon oils are more prone to oxidize and explode than synthetic silicone-based oil. Oxidizers can be air (a strong oxidizer) from a leak or can be deliberately introduced in a process or can be inadvertently admitted to the system by operator or process controller error. Oxygen and other strong oxidizers are even more dangerous. Certain conditions of temperature and pressure can cause a combustible mixture to explode. The larger the diffusion pump, the greater the risk of explosion and the greater the risk of damage and/or injury. Never operate diffusion pumps larger than 10 inches in diameter with hydrocarbon oils without a full safety analysis for the complete system and application. Never operate any diffusion pump in the following ways because they increase the probability of an explosion.

Prohibited Action	Explosion-Causing Condition
Run pump with no cooling water	Overtemperature
Run pump with low level of pump fluid	Overtemperature
Run pump without proper backing or holding pump	Overpressure
Run pump when not evacuated below 0.5 Torr (66.5 Pa)	Overpressure
Admit air to, or rough through, a pump with hot boiler	Overpressure plus strong oxidizer

SAFETY CONSIDERATIONS

READ THE FOLLOWING INSTRUCTIONS;
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Prohibited Action	Explosion-Causing Condition
Open drain or fill plug while pump is under vacuum, especially when it is hot	Overpressure plus strong oxidizer
Contaminate pump with explosive vapors, powders, or reactive materials	Lower explosive threshold of gas mixtures
Remove, defeat, or override safety countermeasures such as pressure and thermal switches and valve sequencer interlocks	Overtemperature, overpressure, more combustible mixtures
Machine or weld without removing all oil or solvent residue in pump	Source of ignition
Use unsuitable pumping fluid especially in large pumps	Lower explosive threshold of gas mixture

Systems larger than 10 inches must be designed with pressure relief devices to provide safe pressure relief from internal explosions. Always recognize that safety devices can fail or malfunction. Provide redundant protection by installing devices having different failure modes, failure mechanisms, and failure causes. Be certain that exhaust duct materials are capable of withstanding the corrosivity, temperature, and pressure of exhausted products.

c. **Pressure** – Pumps and their components are designed for vacuum service; they are not designed to be pressurized which could cause them to burst possibly expelling shrapnel at lethal velocities. Serious accidents have been caused by intentional pressurization of vacuum systems and their components. **Never pressurize any part of a vacuum system for test or any other purpose.** Always provide pressure relief when designing diffusion pumps into systems and ensure that pressure relief motion is limited to safe envelopes. Never permit the following:

Prohibited Action	Result
Block inlet and vent of liquid nitrogen trap and lines	LN_2 trap and/or lines burst
Close isolation valves at inlet and discharge of main watercooling coils and pump is reheated	Water turns to steam and bursts coils
Pressurize pump body	Body of pump bursts
Hole through vacuum wall	Loss of structural integrity of wall

d. **Poisonous and/or Corrosive Compounds** – When pumping poisonous, reactive, and/or corrosive gas, vapors, or chemicals, even proper operation and regeneration will not always ensure that all hazardous materials have been totally removed. If hazardous gas, vapors, chemicals, or combustible mixtures are pumped, sufficient quantities may exist during operation or remain after regeneration to cause severe injury or death. Overheating the pump oil, exposing it to air or reactive materials, or overpressurizing it above the normal operating range (approximately 1mTorr (.133 Pa)) will decompose the oil and possibly make it toxic. This is especially true of backstreamed mechanical pump oils which are more volatile (unstable). Overheating of accidentally introduced or backstreamed mechanical pump oils cannot be protected against by thermal switches which are set for diffusion pump oil.

   Refer to specific instruction manuals for detailed instructions and precautions. Always vent the pump and relief valve to a safe location thus ensuring adequate dilution to safe levels, and take all other action required to meet quality air standards. Always handle pump fluids and hardware with an awareness of the possible deadly hazards involved and the necessity for great care and attention to safety precautions.

   Diffusion pumps are typically cleaned with acetone or alcohol. Acetone, alcohol, and most other solvents are irritants, narcotics, and depressants, and/or carcinogenic. Their inhalation and ingestion may produce serious effects. Even absorption through the skin can result in moderate toxicity. Always ensure that cleaning operations are performed in large, well-ventilated rooms. Use of self-contained breathing apparatus may be necessary depending upon the solvent type and vapor concentration in surrounding air.

e. **High Voltage** – Diffusion pumps operate at voltages (up to 480 V) high enough to kill through electrical shock. Design equipment utilizing these pumps to prevent personnel contact with high voltages. Securely attach prominent hazard warnings. Personnel should always break the primary circuit to the power supply when direct access to the heater or wiring is required.

f. **Hot Surfaces** – Boiler temperatures reach 530°F (275°C) which can cause serious burns when touched. Always ensure that surfaces have cooled near room temperature before touching them.

g. **Hot Coolant and/or Steam** – The water used to cool the pump can reach scalding temperatures. Touching or rupture of the cooling surface can cause serious burns. Water left inside quick cool coils from previous use will turn to steam when the pump is reheated. This steam must be allowed to escape without contacting personnel. Whenever possible, design the water system with interlock valves so that power cannot be applied to the pump unless water is flowing in the main cooling coils (not quick-cooling coils).

h. **Cold Surfaces** – Liquid nitrogen traps cooled by liquid nitrogen are commonly used in diffusion pumps. Metal surfaces at liquid nitrogen temperature can cause severe frostbite if contacted by unprotected skin. These surfaces remain cold for some time (at least a half hour) after the liquid nitrogen has evaporated.

SAFETY CONSIDERATIONS

READ THE FOLLOWING INSTRUCTIONS;
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i. **Cold Coolant** – Liquid nitrogen, a cryogenic liquid, is used in traps. If it is splashed on body tissues or eyes, it can cause severe frostbite or blindness. The extremely low temperature of liquefied nitrogen can cause skin damage similar to high temperature burns. Contact with the cold gas evolving from the liquid may produce the same effect. Delicate tissues, such as the eye tissues, are most easily damaged by exposure to cold gas or liquid. To minimize the risk of hazardous contact of cold gaseous nitrogen with any part of the body, wear personal safety equipment recommended for use with cryogenic materials including face shield, full-sleeved lab coat, and clean, dry gloves which fit loosely so they can be thrown off quickly if frozen by contact with the gas.

j. **Asphyxiation** – If a large amount of liquid nitrogen is spilled in a small, poorly ventilated room or equipment, death from suffocation can result. All diffusion pumps are typically cleaned with acetone or alcohol. Acetone, alcohol, and most other solvents are very volatile (unstable). During cleaning, the volatility of these cleaners may permit their gases to displace air and its life-supporting oxygen which could cause death or serious injury by asphyxiation. Always ensure that cleaning operations are performed in large, well-ventilated areas.

   While still hot, the diffusion pump may also contain decomposed and/or overheated pump oils which can also be an asphyxiant.

k. **Large, Heavy Weights** – Diffusion pumps larger than 10 inches in diameter require power-assisted equipment and the use of trained moving/installation personnel in order to avoid dropping, slipping, and/or overturning the pump thus severely injuring personnel. Check weight of equipment before lifting and do not stand under equipment being moved.

SAFETY CONSIDERATIONS

READ THE FOLLOWING INSTRUCTIONS;
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⚠ WARNING

High voltages can kill. Always break the primary circuit to the power supply before starting to work on the heater and/or its wiring.

⚠ WARNING

Diffusion pumps are typically cleaned with acetone, alcohol, or other solvents.

When heated, sprayed or exposed to high temperature equipment, these solvents become flammable and explosive, causing serious injury or death. **Do not use near a high-temperature source.** Ventilate working area with a blower and use in large, well-ventilated room. When heated or sprayed, solvents also become 4 to 5 times heavier than air and will flow down, settling in tanks, pits, and low areas, thus displacing air which can kill by asphyxiation. Use in a large, well-ventilated room. Use of a self-contained breathing apparatus may be necessary.

Acetone, alcohol, and other solvents are irritants, narcotics, depressants, and/or carcinogenics. Their inhalation and/or ingestion may produce serious effects. Prolonged or continued contact with the skin will result in absorption through the skin and moderate toxicity. Always ensure that cleaning operations are carried out in large, well-ventilated rooms, and wear eyeshields, gloves, and protective clothing.

⚠ WARNING

Varian has no control over the types of gases passing through this pump. These are entirely under the control of the process user and/or the hardware systems integrator. Frequently, process gases are toxic, flammable, corrosive, explosive, or otherwise reactive. Since these gases can cause serious injury or death, it is very important to plumb the exhaust of the pump to the facility's hazardous gas exhaust system which incorporates appropriate filters, scrubbers, etc., to insure that the exhaust meets all air and water pollution control regulations.

SAFETY CONSIDERATIONS

READ THE FOLLOWING INSTRUCTIONS;
TAKE ALL NECESSARY PRECAUTIONS

⚠ WARNING

Certain gases can become corrosive and toxic when trapped in oil. Always wear protective gloves when handling dirty pump oil, drain it into a closable container, and do not breathe the fumes of the oil. Always use fully self-contained breathing apparatus.

⚠ WARNING

Hot oils can cause serious burns. Wear protective gloves and long sleeved, loose fitting, heat resistant garments when draining pump oil.

⚠ WARNING

When lifting some Varian diffusion pumps, use power-assisted equipment and trained moving/installation personnel to avoid dropping, slipping, and/or overturning the pump and severely injuring personnel. Check weight of equipment before lifting and do not stand under equipment being moved.

CAUTION

Acetone, alcohol, and other solvents degrade O-ring materials reducing their ability to hold a vacuum. Do not use acetone or any solvents on O-rings. If necessary to clean O-rings, wipe with lint-free, clean cloth, wash in detergent and water, or use a small amount of pump oil.

NOTE

Always dispose of used or dirty oil properly and in compliance with all local, state, and federal environmental laws and regulations.

INSTALLATION, OPERATION, AND MAINTENANCE

VHS-250 Series Diffusion Pumps

Model No: K0543301 (120 volts)
K0543302 (240 volts)
K0543306 (208 volts)

Before unpacking and installing the pump, the user should thoroughly familiarize himself with this instruction manual and the data sheets applicable to the particular pump model furnished. He should also examine all other technical material enclosed in order to gain a better understanding of the operation principles, limitations, correct application of the diffusion pump, the hazards involved, what to do and what not to do in order to avoid these hazards and performance problems.

INSTALLATION

Unpacking

Pumps are factory packaged to permit prolonged storage in suitably protected areas without special precautions.

a. Remove flange covers, blank plugs, protective plugs, from water connections, etc. Be careful not to scratch or otherwise damage or mar the sealing surface-usually an O-ring groove on top of the large inlet flange.

b. Discard any internal packing which may have been used during shipment to protect the internal components. Make sure the pump was not damaged in shipping. Inspect for the possibility of water in the pump resulting from rigors of shipping (rain or excessive condensation).

c. For noncritical work, after making sure that there are no foreign materials inside the pump, it may be charged with fluid and used without disassembly. Otherwise, it should be disassembled and cleaned. In general, cleaning may be required if the expected vacuum level is to be below 10^{-6} (.000133Pa)

d. Check the internal jet assembly. It should be concentric and firmly seated on the bottom of the pump. Using a flashlight, check to make sure that the ejector nozzle is opposite the foreline (the pump outlet connection). In pumps with ejector nozzles, the jet assembly should not rotate because of an indexing pin at the bottom.

e. The cold cap placed on top of the jet assembly should be in good thermal contact with the cooled wall of the pump. It should be concentric with the upper nozzle, i.e., there should be no contact at the periphery of the cold cap and the nozzle under it.

Cleaning a New Pump

a. Read cold cap maintenance and installation data which will be found in a separate section of these instructions. Remove the cold cap in accordance with these instructions.

b. Disassemble the internal jet system from the body of the pump. (See figure for a typical jet assembly.)

c. Withdraw the splash baffle (if supplied) located at the bottom of the pump.

d. Remove fill and drain plugs and gaskets if supplied.

e. Thoroughly clean all components of the jet assembly and pump casing interior (but not O-ring gaskets) with acetone or alcohol.

⚠ WARNING

Explosion, Toxicity, Asphyxiation

Diffusion pumps are typically cleaned with acetone, alcohol, or other solvent. These solvents, when combined with air, oxygen or other strong oxidizer can cause death or serious injury because they are very flammable and explosive. The inhalation or ingestion of these solvents can be fatal and even absorption through the skin can be moderately toxic. The volatility of these solvents permits them to displace air which could kill by asphyxiation. **Read the warning sheet at the front of the manual and very carefully observe all the required actions.**

f. Remove all traces of the cleaning fluid by carefully drying with hot air gun or oil-free compressed air.

g. For reassembly, reverse the above procedure.

h. Clean the flanges and O-ring grooves thoroughly with acetone or alcohol, using clean, lint-free rags.

⚠ CAUTION

Acetone and other solvents degrade O-ring materials reducing their ability to hold vacuum. Do not use Acetone or other solvent on O-rings. If necessary to clean O-rings, wipe with lint-free, clean cloth or use a small amount of diffusion pump oil.

i. Remove all traces of acetone or alcohol by carefully drying with a hot air gun or oil-free compressed air. Install O-ring gasket.

Utility and System Connections

a. Safety Considerations and Interlocks

⚠ CAUTION

Utility Failure

Can cause damage to the equipment, overheating and explosions. Designers of equipment using diffusion pumps must take appropriate system design action to protect personnel and property from possible hazards. **Read the safety section at the beginning of this manual.**

a. Some pumps are equipped with a manual reset thermostat mounted on a bar joining the lowest body cooling coil and the edge of the boiler. These thermostats have been designed so that a cooling water failure or low oil level in the boiler will result in an increase in the temperature of the bar, causing the normally closed contacts of the thermostat to open. When the trouble has been corrected, the thermostat may be reset by depressing the pushbutton.

Smaller pumps are shipped with the thermostat wired in series with the diffusion pump heater. It may be rewired and series connected in the coil circuit of the contactor which controls power to the diffusion pump heater.

A small lamp of the same voltage as the diffusion pump heater may be connected across the terminals of the thermostat. The lamp will normally be shunted by the contacts. However, when the contacts open, the lamp will receive full line voltage and give visual trouble indication.

b. Vacuum Connections

1. The pump must be installed with the body vertical and plumb. Check that the mating flange on the system (to the pump inlet) is horizontal within ±1°. If this condition is not met, correct system before installing the pump. The boiler of the pump (especially for large pumps) must be horizontal to prevent uneven fluid level and avoid local overheating where the fluid level would be too shallow.
2. Prepare inlet O-ring seals by wiping them with a clean cloth. Do not use solvents. Use a small amount of diffusion pump oil to wet the cleaning cloth. Install the O-ring in the groove being careful not to damage the sealing surface with cuts, bruises or scratches.
3. Using appropriate lifting apparatus for larger pumps, align the bolt holes of the flanges and assemble the bolts. Tighten the bolts to compress the O-ring seal until light contact is achieved between metal flanges.
4. Connect the foreline (outlet) flange in the same manner. Some pumps do not have a foreline flange. The forelines of these smaller sized pumps are usually connected to the foreline manifold by means of a piece of elastomeric or plastic hose which is suitable for vacuum service. Ideally, the inside diameter of the hose should be slightly smaller than the outside diameter of the foreline and manifold. Lightly lubricate the foreline and manifold tubulations with diffusion pump oil for easy Installation. Securely attach the base to the manifold and foreline with hose clamps.
5. Check fill and drain plugs for tightness. Apply light to medium torque, enough to compress gaskets. Minute leaks through the gaskets may develop with use in this location. They may not be detectable with very sensitive mass spectrometer leak detectors but will not affect the pump performance.

c. Cooling Water Connections

The following method of external connections is recommended:

1. Water connections are designed for standard pipe fittings. The cooling water supply (gallons/minutes) specified on data sheets Is designed to be adequate if the temperature of the water supplied does not exceed 80°F. For higher temperatures it will be necessary to increase the water flow if maximum pump throughput is to be realized.

NOTE

Discharge should be made to an open drain to provide adequate flow. It must be designed and installed in accordance with all Federal, State, and local laws and regulations. Special provision must be made in designing a recirculating cooling system to obtain adequate cooling and heat exchange to insure inlet temperature below 80°F. The use of quick-cool coils around the heater section in Varian pumps is optional. It will permit more rapid cooling to temperature when the pump is to be opened for service (or otherwise exposed to atmosphere).

2. The quick-cool coil (if supplied) at the boiler plate MUST be connected to an open drain and the feed line controlled by a separate water 3-way valve (open, closed, and vent to atmosphere). The drain must be below the boiler level so that it is drained completely when the quick-cool water supply is shut off and the pump is operating.

d. Electrical Connections

⚠ WARNING

High Voltage

Diffusion pump heaters operate at high voltages (up to 240 volts) which are high enough to kill through electrical shock. During installation check the drawings and be sure to attach all hazard warnings and cautions. Always break the primary circuits of the power supply when direct access to the heater or wiring is required. **Read the safety section in the front of this manual.**

1. The pump heater has been designed to operate at a certain voltage. Check the heater for correct supply voltage and, in the case of multiphase connections, for load balance by measuring the resistance of each branch.
2. Make connections to the terminals in the junction box (at the foreline). The use of flexible conduit is recommended to facilitate removal of the pump for service.

   The pump should not be operated at more than 5% over the rated voltage.

   Make connections per wiring diagram provided with each pump.

e. Thermostats

For protection of the diffusion pump in the event of utility failures and/or incorrect system operation, the inclusion of simple safety devices and interlocks in the system design should be considered. There should be an electrical interlock to prevent energizing the pump heaters unless the forepump is running. The thermostat, on pumps so equipped, will cut the power when the pump overheats in such a case. However, this should be reserved for emergencies as repeated heating at atmospheric pressure may damage the pump fluid.

Most Varian pumps are equipped with manual reset thermostats mounted on a bar joining the lowest body cooling coil and the edge of the boiler. Cooling water failure or low fluid level in the boiler will result in an increase of the temperature of the bar, causing the normally **closed** contacts of the thermostat to open. When the trouble has been corrected, the thermostat may be reset by depressing the reset push button.

Varian pumps are shipped with the thermostat wired in series with the diffusion pump heater. The thermostat may be rewired and series connected in the holding coil circuit of the contactor which controls power to the diffusion pump heater.

Initial Vacuum Test

The purpose of this test is to establish the leak tightness of the system, specifically the vacuum connections to the diffusion pump. (To eliminate misleading indications and the masking of leaks by the fluid, the tests should be carried out preferably with the diffusion pump "dry" i.e.,before it is charged with the pumping fluid).

⚠ WARNING

Pressure

Pumps and their components are designed for vacuum service and are not designed for pressurization, which could cause them to burst, possibly expelling shrapnel at lethal velocities. Serious accidents have been caused by intentional pressurization of vacuum systems and their components. **Never pressurize any part of a vacuum system for test or any other purposes. Read the safety section in the front of this manual.**

a. Confirm the vacuum ultimate pressure characteristics of the mechanical pump. This should closely approximate the value quoted in the manufacturer's data, if the mechanical pump is correctly installed, adjusted and filled with clean oil. Pressure measurements should be made with a continuously indicating total pressure gauge, such as a thermocouple gauge. This test can be performed to evaluate either valved or unvalved systems. Connect the outlet of the diffusion pump to the inlet of the mechanical backing pump, using appropriate vacuum tight connections.

b. In the case of a valved system, close the roughing valve and main isolation valve ahead of the diffusion pump. In the case of unvalved systems, the entire work chamber volume must be included in the test. Evacuate the entire system with the mechanical pump only. Let the mechanical pump reach an ultimate pressure in the system. This reading should approximate the value obtained in step (a) above (usually 10 to 50 microns (1.33 to 6.65 Pa)). If it does not, examine for leakage. If leakage is suspected, follow standard procedures for leak testing. These will depend on the type of vacuum gauges and/or leak detection equipment available. The most effective are helium leak detectors such as Varian 936 series instruments.

Pump Fluid Installation

☞ NOTE

Prior to installation in the diffusion pump, fluids must be stored in clean, tightly closed containers and should be clearly identified in accordance with their type. Do not mix pumping fluids of different type and origin. Generally, it is also not a good idea to mix used and new fluid portions for a pump charge.

⚠ WARNING

Toxicity/Corrosive Compounds, Hot Surfaces

Running the pump with very low oil level causes hot surfaces and the oil to be decomposed and possibly toxic. Such decomposed oil and any residue from toxic/corrosive materials pumped will be present on the dipstick when the fluid level is measured. **Read the safety section at the front of the manual.**

a. The recommended fluid charge for the pump is stated in the data sheet. The fluid charge will gradually be depleted through use, but the pump will continue to operate normally. When the charge is reduced to about 60% of the initial amount, the boiler temperature may begin to rise and under this condition the thermostat is designed to open the heater circuit.

b. Some diffusion pumps are furnished with fill and drain fittings with special elastomer sealed plugs. The fill plug is furnished with a graduated dipstick so that the oil level in the cold pump can be checked.

c. Remove the plug from the filling port of the pump and Install the specified quantity of fluid. The correct quantity is indicated on the pump nameplate. Check the level by means of the dipstick. The fluid can also be poured in from the pump inlet or foreline.

d. Replace the filler plug, using a new gasket. The special elastomer gaskets should not be reused if the pump has been operated for more than a few days. Tighten-the filler plug using moderate torque (75 inch pounds maximum). Lubricate the O-ring with pump fluid before installation.

OPERATION

During initial operation, the newly installed pump fluid may be subjected to a degassing process. This may result in foreline pressure fluctuations and "bursts". Such fluctuations are to be considered normal.

Start-Up Procedure

CAUTION

Damage to Pump

- Do not turn on the heater without fluid in the pump. This may ruin the heaters and damage the pump.

Damage to Pump Fluid

- Do not air release the pump while the boiler is hot. Most diffusion pump fluids are heat sensitive and will breakdown under these conditions.
- Do not operate the pump without the internal splash ballle or foreline baffle. If the splash baffle is omitted, there may be instability and low speed. If the foreline baffle is omitted, there may be more than usual fluid loss.
- Do not operate the pup for extended periods at inlet pressure above 1 micron (.133 Pa). High pressure operation may cause excessive backstreaming.
- Do not operate the pump heater unless the cooling water is circulating. It will cause the pulp and fluid to overheat.

Evacuate the diffusion pump by means of the mechanical roughing pump to a pressure level below .05 Torr (66.5 Pa). The diffusion pump will not function unless the discharge pressure is less than the tolerable forepressure (approximately .05 Torr (66.5 Pa). Experience with a particular system may indicate that a larger value is temporarily permissible, before proceeding with steps (a) and (b) below.

a. Turn on the cooling water supply to the pump body and check that adequate flow is provided by examining the amount of water discharged at the visual drain points.

b. Switch on the power to the diffusion pump heater.

c. Check inlet and forepressure performance by means of the system instrumentation.

d. During operation, the gas load at the inlet of the diffusion pump should not exceed the maximum throughput capability of the pump. This means that the pressure at the inlet flange should not exceed (except in transient conditions) approximately 2 x 10^{-3} Torr to 8 x 10^{-4} Torr (.266 to .1064 Pa) depending on the size of the pump (the higher figure for the smallest pump). During operation, the discharge pressure must be below the specified tolerable forepressure.

CAUTION

Do not operate the pump with forepressure (outlet pressure) above approximately 0.5 Torr (66.5 Pa). (See specifications on tolerable forepressure.) The pump will not function and excessive backstreaming will result.

Shut Down Procedure

WARNING

Hot Surfaces

Boiler temperatures reach 275°C (530°F) which can cause serious burns when touched. Always ensure surfaces have cooled near room temperature before touching them.

Explosion Possibility

Air release or admitting air to a pump with a hot boiler permits a strong oxidizer to contact the hot pump oil.

Read the safety section in the front of this manual.

CAUTION

Do not operate the quick-cool coil when the pump is cold or out of service, to prevent harmful collection of condensation on the boiler plate, heater and heater terminals.

a. Switch off the power to the diffusion pump heaters.

b. Admit cooling water to the quick-cool and continue to circulate it until the pump body just above the boiler heat shield can be touched (approximately 130°F). In valved systems which have tight inlet and foreline connections, It is possible to close valves to isolate the diffusion pump at inlet and discharge, to air release the remainder of the system, shut off the heat to the diffusion pump and stop the mechanical pump.

With this method, the quick-cool coil does not have to be used. However, the water flow through the pump should be maintained until the boiler cools down below about 300°F (150°C).

MAINTENANCE AND SERVICE

General

Diffusion pumps generally require little attention when correctly operated. However, it is advisable to perform some periodic checks to insure continued trouble-free operation. By simple preventive maintenance, costly down-time and cleaning procedures can be avoided. A day-to-day log of pump and system performance will indicate the condition of the pump and marked variations will show the need for corrective action.

Periodic Inspection

The frequency of inspection will depend on the type of system, its operation and utilization. The maximum interval between inspections is established on the basis of experience. It is recommended that the following items be regularly examined.

⚠ WARNING

Make sure the pump is at room temperature before attempting service.

Read the safety section in the front of this manual.

a. With the pump cold, check the condition and level of fluid. These can be inspected by withdrawing a sample through the drain and by the dipstick of the filler plug, respectively. (Use new O-ring gaskets when replacing fill and drain plugs). Slight discoloration of the fluid does not affect the performance.

b. Loss of fluid can be caused by the following:

1. Incorrect air admittance procedures and/or admittance of excessive air or other gas to a hot pump.
2. Inadequate water cooling.
3. Continuous operation at inlet pressures above 10^{-3} Torr (.133 Pa)
4. Failure to reinsert foreline baffle in pump assembly.

c. With the pump cold, check that the heaters are bolted snugly to the boiler plate and that all terminals are tight and in good condition.

d. Check the total heater input and balance of load if a multi-phase heater is used.

e. Check to insure that cooling water flow is unobstructed and not below specified quantities.

Cleaning

Complete cleaning of the pump may be periodically required because of the gradual deterioration of some pump fluids. Removal of the pump from the system is then necessary. Check specific pump instruction section for any special cleaning instructions.

⚠ WARNING

Poisonous and or Corrosive Compounds

If hazardous gas, vapors, chemicals or combustible mixtures are pumped, sufficient quantities may exist during operation. Proper operation will not always ensure that all hazardous materials have been removed. They may remain after regeneration and can cause death or severe injury.

Explosion, Toxicity, Asphyxiation

Diffusion pumps are cleaned with acetone, alcohol or other solvents. These solvents, when combined with air, oxygen, or other strong oxidizer can cause death or serious injury because they are very flammable and explosive. The inhalation or ingestion of these solvents can be fatal and even absorption through the skin can be moderately toxic. The volatility of these solvents permits them to displace air which could kill by asphyxiation.

Read the safety section in the front of the manual and very carefully observe all the required actions.

CAUTION

Acetone and other solvents degrade O-ring materials reducing their ability to hold vacuum. Do not use Freon TF or other solvent on O-rings. If necessary to clean O-rings, wipe with lint-free, clean cloth or use a small amount of diffusion pump oil.

a. Disconnect all water cooling lines and pull out the plug supplying power to the pump heater.

b. Unbolt the inlet; and foreline connections and remove the pump from the system.

c. Drain the pump of all fluid.

d. Remove the jet assembly following the procedures outlined.

e. Thoroughly clean the pump body Interior by using acetone, followed by alcohol. Dry with a hot air gun or oil-free compressed air.

f. Thoroughly clean the jet assembly per specific pump instructions (see section below). Use a rinse of acetone followed by wiping all surfaces with alcohol, and finally dry them with a hot air gun or oil-free compressed air.

g. Install the jet in the pump body, using the reverse procedure of step (d).

h. Reinstall the pump in the system as previously described.

Disassembling and Reassembling the Jet Assembly

Be sure to refer to the specific pump Instructions before removing the Jet assembly from the pump body. Reassemble the Jet assembly in the reverse order of disassembly

Cold Cap Assembly

Refer to the specific pump Instructions before removing the cold cap assembly from the pump body. Reassemble the cold cap assembly In the reverse order of disassembly.

Changing the Heater Element

See specific pump Instructions provided with each pump.

⚠ WARNING

High Voltage

Diffusion pump heaters operate at high voltages (up to 450 volts) which are high enough to kill through electrical shock. During installation check the drawings and be sure to attach all hazard warnings and cautions. Always break the primary circuits of the power supply when direct access to the heater or wiring is required.

Read the safety section in the front of this manual.

CAUTION

Poor clamping with inadequate thermal contact may result in reduced heater life. Clamping bolts should be tight enough to avoid air gaps between heaters and the boiler plate.

TROUBLESHOOTING

Leakage

Analysis of general operational experience with diffusion pumps indicates that certain locations are more prone to the incidence of leaks. The following locations should be checked first, if leakage Is the suspected cause for poor system performance:

a. Inlet and foreline connections.

b. Drain and fill plugs.

c. Other compression fittings, such as high vacuum gauges In the system.

d. Threaded connections, such as a foreline gauge.

Outgassing

High vacuum systems even without external leakage can have high gas load due to outgassing from internal surfaces or processes. The pressure in the system Is a result of gas load divided by pumping speed (p = Q/S). If the gas load (Q) exceeds the maximum throughput capability of tine diffusion pump, the diffusion pump, will not function and the pumping action will essentially be due to the mechanical backing pump. To estimate the gas load isolate the system from all pumps after evacuation and measure the rate of pressure increase. The gas load can be estimated as follows:

$$Q = \frac{V \times \Delta P}{\Delta t}$$

where V is the isolated volume, ΔP the pressure rise, and Δt time period of measurement.

Poor Pump or System Performance

Before proceeding with a program of step-by-step troubleshooting, check the performance and accuracy of the vacuum gauges used on the system. The following table shows common symptoms, and lists the most frequent causes for poor performance.

Table 1 Troubleshooting

Fault	*Probable Cause*	*Action*
Poor system pressure	a. Leaks in system, virtual or real	Locate and repair.
	b. High process gas load.	Measure gas load, eliminate cause.
	c. System dirty.	Clean system to reduce outgassing.
Poor ultimate pressure	a. Contaminated pump fluid.	Examine and replace.
	b. Low heat input.	Check voltage. Check for continuity, burned-out element, poor thermal contact.
	c. Inadequate cooling water flow.	Check water pressure. Check tubing for obstructions and backpressure.
	d. Excessive or too cold cooling water.	Check temperature. Adjust flow.
	e. High forepressure.	Check for leak in foreline, poor mechanical pump performance, breakdown of mechanical pump fluid.
	f. Water in quick-cool coil	Check and remove cause.
Low speed (Prolonged Cycle after checking gas load conditions).	a. Low heat input.	Check heaters.
	b. Low fluid level.	Add fluid.
	c. Malfunctioning pump assembly. Improperly located jets. Damaged jet system.	Check and repair or replace.
Inlet pressure surges	a. Incorrect heater input.	Check and correct.
	b. Fluid outgassing.	Condition fluid by operating the pump for a few hours.
	c. Leak in system ahead of pump inlet.	Check and correct.
High chamber contamination	a. Too high forepressure.	Check for leak in foreline, poor mechanical pump performance, breakdown of pump fluid and incorrect valve operation.
	b. Prolonged operation at high throughput at pressure above 10^{-3} Torr (.133 Pa)Pump will not start.	Review procedures
	c. Improper system operation and air release procedures.	Review procedures
Pump will not start	a. Safety circuits and/or protective devices prevent contactor from staying closed. Check and correct.	Check utilities, flow switches, interlocks. Check thermostat operation.

Installation, Operation and Maintenance
VHS Series Diffusion Pumps

Before unpacking the installing any of these pumps, the user should read the Safety precautions and general installation, operation and maintenance instructions in the front section of this manual. He should also read the following specific instructions and specifications which pertain to VHS series diffusion pumps.

Safety Considerations and Interlocks

For protection of the diffusion pump in the event of utility failures and/or incorrect system operation, the inclusion of simple safety devices and interlocks in the system design should be considered. There should be an electrical interlock to prevent energizing the pump heaters unless the forepump is running. The thermostat, on pumps so equipped, will cut the power when the pump overheats in such a case. However, this should be reserved for emergencies as repeated heating at atmospheric pressure may damage the pump fluid.

Varian VHS series pumps are equipped with manual reset thermostats mounted on a bar joining the lowest body cooling coil and the edge of the boiler. Cooling water failure or low fluid level in the boiler will result in an increase of the temperature of the bar, causing the normally **closed** contacts of the thermostat to open. When the trouble has been corrected, the thermostat may be reset by depressing the reset push button.

Varian VHS series pumps are shipped with the thermostat wired in series with the diffusion pump heater. The thermostat may be rewired and series connected in the holding coil circuit of the contactor which controls power to the diffusion pump heater.

A small lamp of the same voltage as the diffusion pump heater may be connected across the thermostat terminals. The lamp normally shunted by the contacts, will receive full line voltage and give visual trouble indication when the contacts are open.

Vacuum Connections

The pump **must** be installed with the body vertical and plumb.

a. Place the gaskets in the appropriate grooves provided in the sealing flange at the pump inlet and foreline.

b. Connect the inlet and foreline flanges to the flat faced mating flanges provided on the system. If the inlet-flange is to be bolted to a trap or a valve with tapped holes in the flange (usually ¾-10), use bolts 1¼" long.* Bolts longer than 1¼" could not be used, since the cooling coils would interfere with the bolt heads. As an alternative, 2" studs may be screwed into the tapped holes of the mating component flange.

c. Check fill and drain plugs for tightness. Minute leaks through the gaskets may develop with use in this location and may be detectable with very sensitive mass spectrometer leak detectors, but will not affect pump performance.

*VHS-6 and VHS-250mm pumps only.

The Jet Assembly

To disassemble the jet from the pump body:

a. Loosen the nut on the cold cap clamp. Lift out the cold cap assembly.

b. Unscrew the top cap.

c. The different sections of the jet assembly may now be lifted out, one section at a time.

To reassemble the jet assembly:

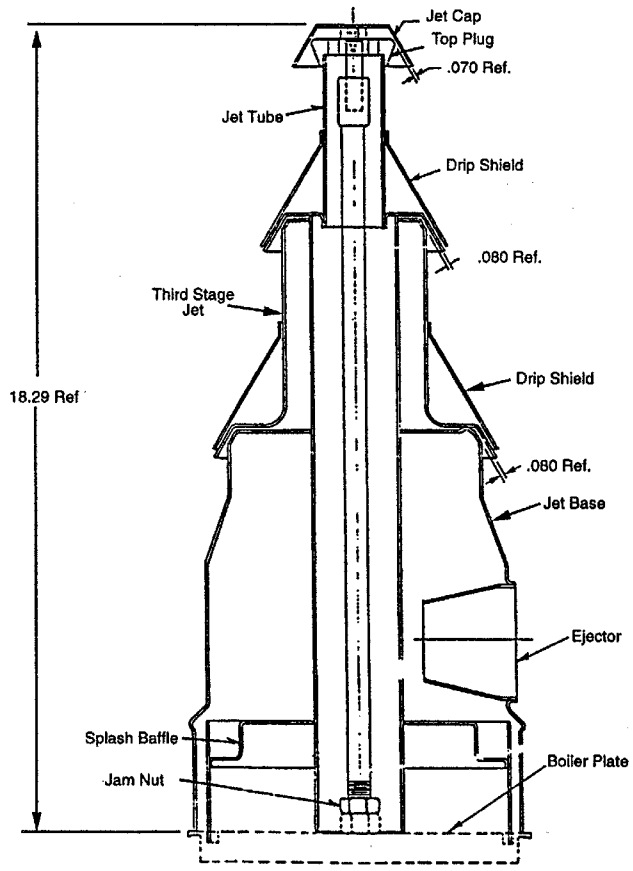
a. Insert splash baffle.

d. Insert the base in the pump body. Be sure that the slot in the base engages the block on the boiler plate, to align the ejector stage with the foreline.

c. Install the third stage and second stage spinnings in sequence, being certain that they are firmly seated.

d. Insert the top cap stud through the orifice plate, allowing it to engage the threads in the spring coupling. Screw the cap down. Avoid excessive tightening.

e. Check to see that the ceramic bushing on the top cap is screwed down finger tight. Lower the cold cap in place, using the ceramic bushing on the jet cap to center it. The cold cap fork fits over the copper fin attached to the pump body. Set up tightly on the clamp nut.



VHS-6 & VHS-250 Diffusion Pump – Jet Assembly

Replacement of Heater

The VHS heater is a tubular heater of triangular cross section, would into a flat spiral. It is held firmly against the boiler plate by a unique clamp which requires only a single bolt.

To replace the heater, proceed as follows:

1. Pull the female plug which supplies power to the heater.
2. Remove the cover to the thermostat and disconnect the thermostat leads.
3. Remove the male plug assembly. It is held in place by two wing nuts.
4. Unscrew the wing nuts holding the heater cover in place. Drop the cover and slide it out of the way.
5. Remove the heater clamp nut. The clamp and heater may now be removed as one unit.
6. When connecting the leads to the terminal of the new heater, use milk of magnesia on the threads of the terminal screws.
7. Be sure that the boiler surface is clean and smooth before clamping the new heater in place. Coat the clamping stud with milk of magnesia before installing the clamp nut.
8. Reassemble all parts, using the reverse procedure. Before turning power on the heater, check at the prongs of the male plug for continuity and for resistance to ground.

DIFFUSION PUMPS – VHS SERIES

Model VHS-250 Type No. 0718

GENERAL

This specification sheet contains all information relating to the physical and operating characteristics of the Model VHS-250 diffusion pump, Type No. 0178. Before unpacking and installing the pump, the user should familiarize himself with the information in the specification sheet and the basic instruction manual for the VHS series pumps.

OPERATING SPECIFICATIONS

Optimum Operating Range	1 x 10^{-3} to < x 10^{-9} Torr (.133 to < .000000133 Pa)
Maximum Pumping Speed	3700 liters per second for air 4600 liters per second for helium
Maximum Forepressure	No load – 6.5 x 10^{-1} Torr (86.45 Pa) At 2.5 Torr liters per second – 5.5 x 10^{-1} Torr At 332.5 Pa liters per second (73.15 Pa)
Throughput	3.5 Torr liters per second (at 10^{-2} torr) 465.6 Pa liters per second (at 1.33 Pa)
Backstreaming Rate at pump inlet	.000 5 mg/cm^2/min
Power Required (Approximately)	1850-2200 watts
Heat-Up Time	10 minutes

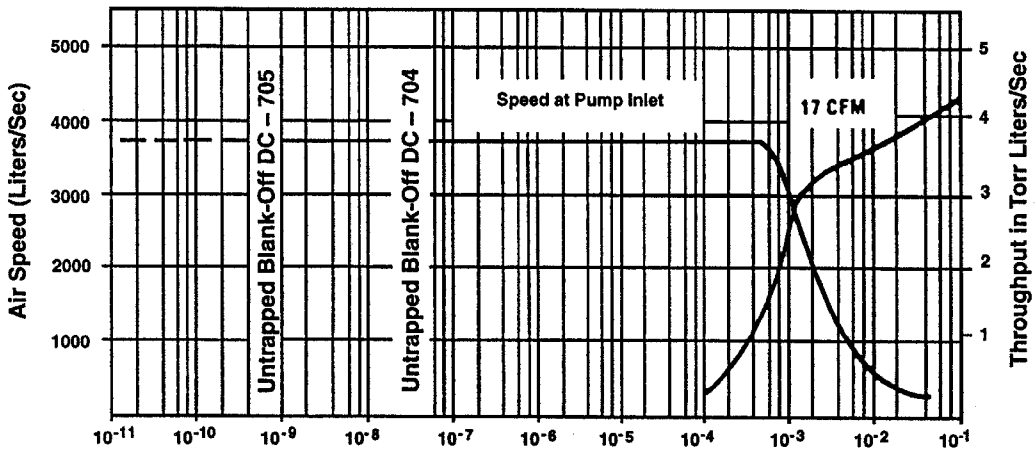
Cool-Down Time	10 minutes
Fluid Charge	500 cc
Cooling Water Requirements	0.25gpm at 60°F to 80°F inlet temperature
Backing Pump Size Recommended	17-cfm or larqer for optimum throughput

PHYSICAL SPECIFICATIONS

Flanged Connection

	Inlet	Foreline	
OD	13.19 inches	5 inches	
ID	10.75	1 61/64	
Thickness	.63	5/8	
Bolt Circle	12.205	3 7/8 inches	
No. of Holes	12	4	
Size of Holes	7/16	5/8 Diameter	
Orientation	Straddle Centerline		Straddle Centerline
Gasket Groove		10.951 I.D.	2 7/32
		.25 wide	19/54 W

Height	22½ inches (allow additional 2 inch for heater removal)
Jet Assembly	4-stage Self-Aligning
Foreline Baffle	Stacked Half Moons
Cold Cap	Conduction Cooled
Water Connection	1/8 FPT

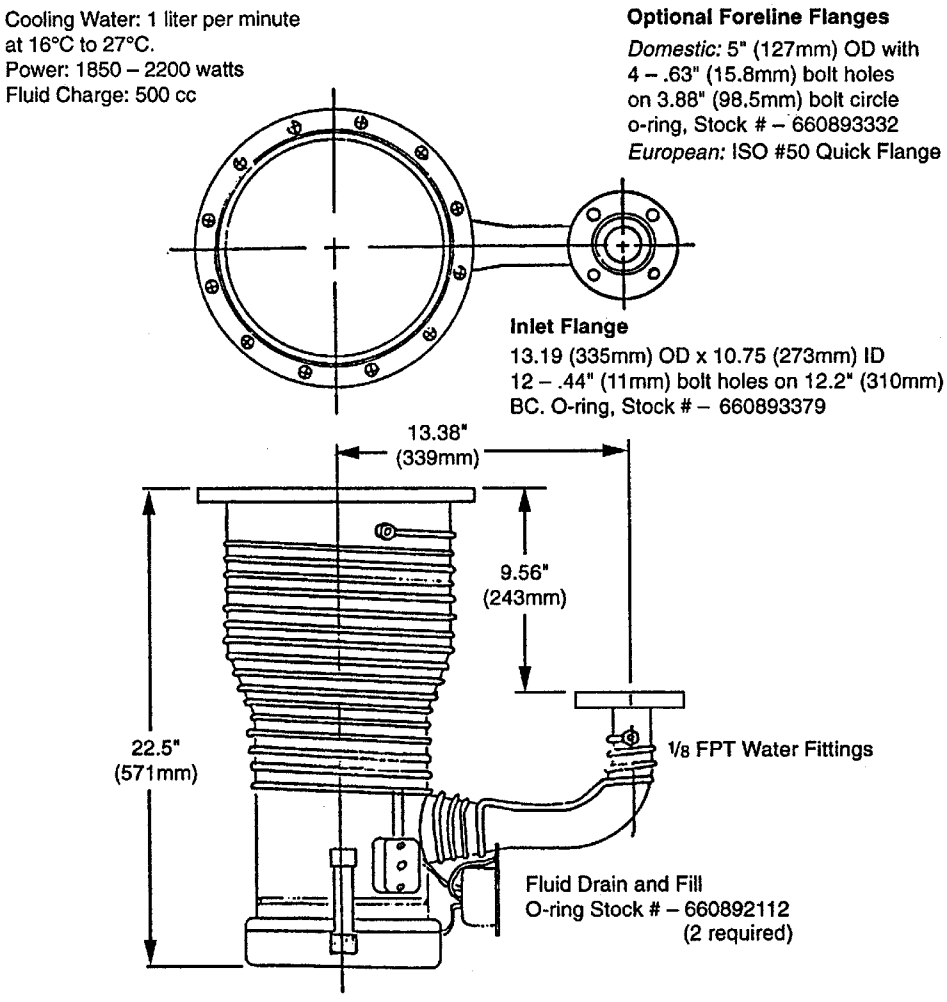


1 Torr = 133 Pa

VHS-250 mm Speed Curve

MATERIALS OF CONSTRUCTION

Body	Stainless Steel
Flanges	Stainless Steel
Jet Assembly	Stainless Steel
Foreline Baffle	Stainless Steel
Cooling Coils	Copper
Heater Reflector	Aluminum
Cold Cap	Copper
External Finish	Varian Medium Green
Actual Weight	55 Pounds
Shipping Weight	65 Pounds (approximately)

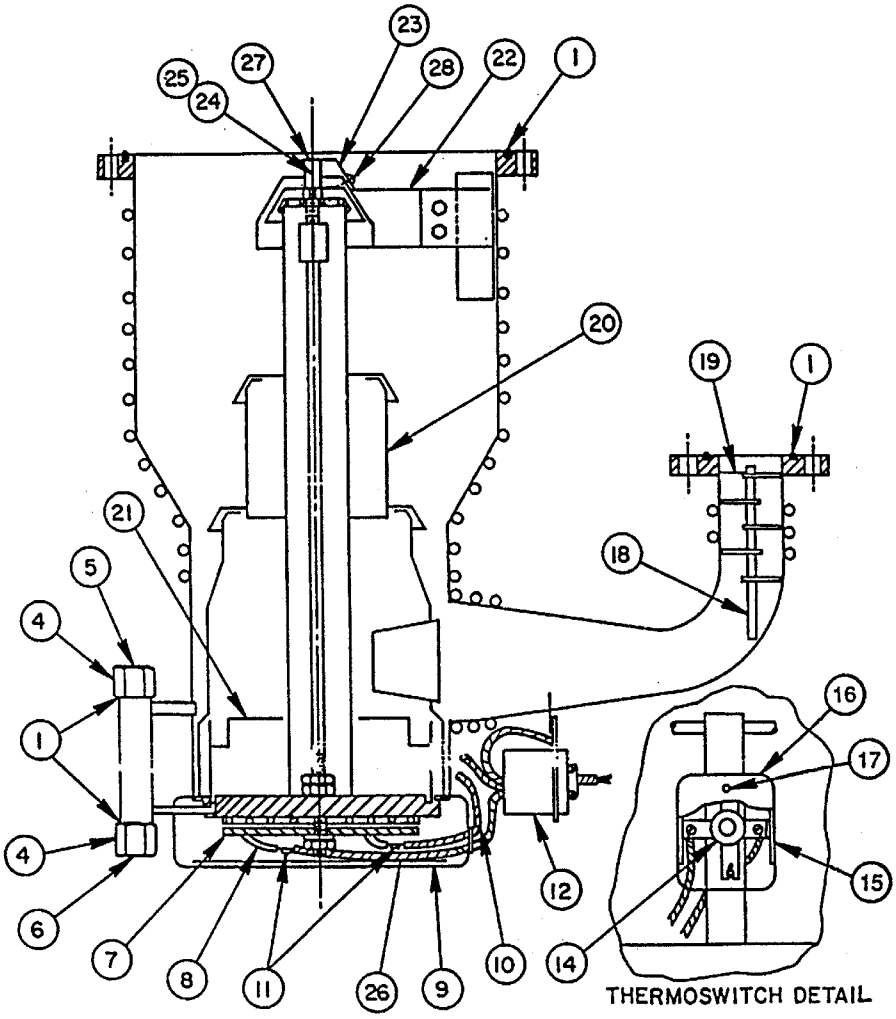


Varian NRC VHS-250 mm Diffusion Pump
Cat. # – 0178DK0543 MOK 1375

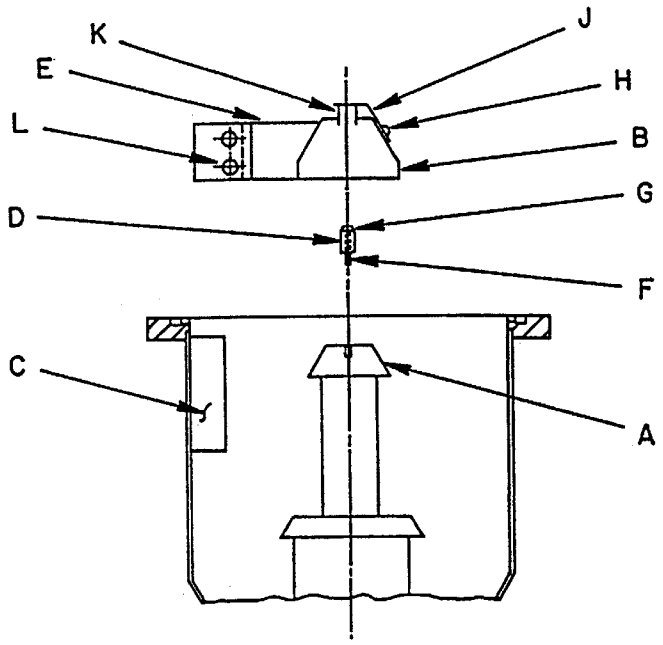
VHS-250 DIFFUSION PUMP REPLACEMENT PARTS LIST

Refer to Diagram MPK 1384

Item	Part Number	Description		No. Required
1	K0377178	O-Ring Kit		2
4	86680001	Drain and Fill Nuts	Items 4, 5, and 6 are obsolete	2
5	86121001	Fill Plug	L9173001 – Fill and Drain Plug	1
6	87181001	Drain Plug	2 required	1
7	86643301	Heater Clamp Assembly		1
8	647306125	Heater 2200w 120v		
8	647306175	Heater 2200w 208v		
	647306225	Heater 2200w 240v		
9	85736001	Reflector		1
10	656180100	Heater Wire		4 ft.
11	648056280	Nickel Lugs		2
12	K3434301	Electrical Connector Assy (120v 1 phase)		1
12	K3435301	Electrical Connector Assy (208/220/240v 1 Ph)		1 5
14	642906025	Klixon Thermoswitch		1
15	89867001	Thermostat Insulator		1
16	85838001	Thermostat Enclosure		1
17	619120001	Thermostat Mounting Studs		2
18	85840301	Foreline Baffle		1
19	699992168	Retaining Ring (Tru Arc N5000-163) standard		1
20	F9548301	Jet Assembly		1
21	F3373301	Splash Baffle		1
22	F9584301	Cold Cap Assembly		1
23	86715001	Cold Cap Spring		1
24	699006025	Ceramic Spacer		1
25	619120012	S/S 8-32 stud ½ lg		1
26	86087001	Insulator (Heater)		
27	612220118	No. 8-32 x ¼ lg Hex Socket Hd machine screw, S/S		1
28	614120230	No. 6-32 x 3/16 lg Round Head machine screw, S/S		1



VHS-250 mm Replacement Parts Diagram – MPK-1384



VHS-250 – Cold Cap Installation

Cold Cap Installation

The #8-32 stud (F) must be threaded into the ceramic bushing (D) until it bottoms (finger tight). Thread #8-32 hex socket head screw (G) into top of ceramic bushing (D) until it bottoms.

Install ceramic bushing assembly onto top jet cap (A) by threading stud (F) into tapped hole in top jet cap. Install only finger tight.

Attach spring clip (J) to cold cap (B) with #6-32 screw (H) so that the clip rests on top of sleeve (K).

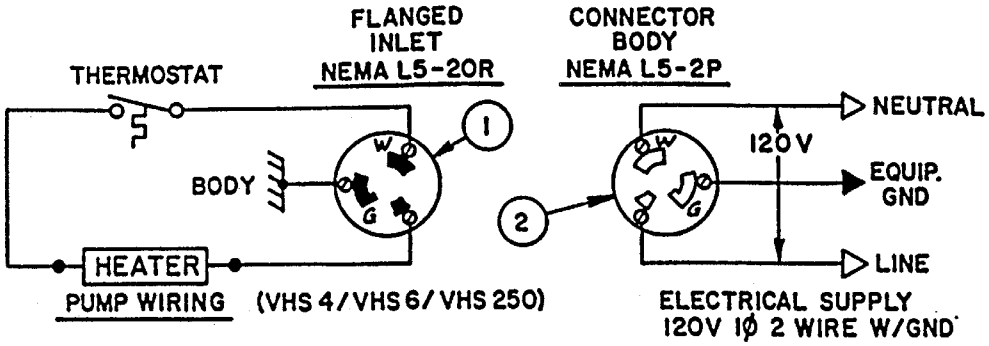
Lower cold cap assembly carefully onto top jet cap assembly (A). The ceramic bushing fits in sleeve (K) and the clamp bars (E) straddle the body bar (C).

Lower cold cap until the horizontal portion of the spring clip (J) touches the head of screw (G). Make sure that the clearance between the cold cap and the top jet cap is even all around the periphery.

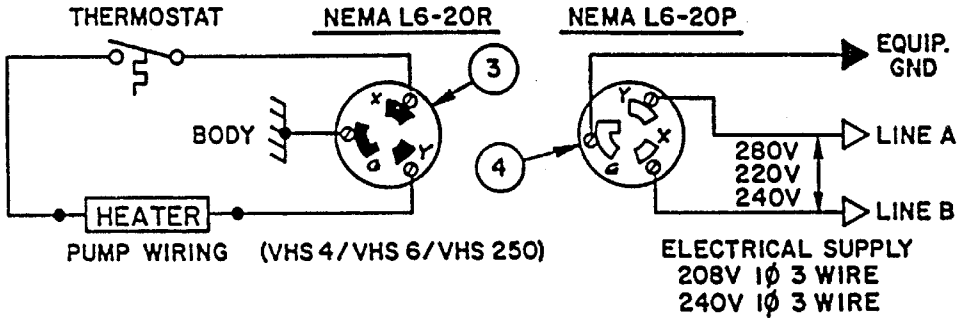
Carefully tighten the captive bolts (L) making sure that there is no strain on the ceramic bushing and no shift in the position of the cold cap.

N.B. The cold cap must be thermally isolated from the top jet cap and concentric with it.

Issue 2 June/1983



Device Rating – 20A 125 VAC 3 Wire Grounding



Device Rating – 20A 250 VAC 3 Wire Grounding

Flanged Inlet (Male)	Connector Body (Female)
20A 125V Hubbell No. 2315 (L5-20R) ①	Hubbell No. 2313 (L5-20P) ②
20A 250V Hubbell No. 2325 (L5-20R) ③	Hubbell No. 2323 (L6-20P) ④

NOTE

Thermostat contacts open on temperature rise (manual reset).

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