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Agilent Technologies

AX-65 Diffusion Pump

INSTRUCTION MANUAL

Part No. 699901062
Revision E
June 2005

AX-65 Diffusion Pump

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 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 replaced 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.

When products are used with toxic chemicals, or in an atmosphere that is dangerous to the health of humans, or is environmentally unsafe, it will be the responsibility of the Customer to have the product cleaned by an independent agency skilled and approved in handling and cleaning contaminated materials before the product will be accepted by Vacuum Technologies for repair and/or replacement.

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.

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.

Disclaimer

Operation and maintenance of this equipment involves serious risk. It is the responsibility of the user to maintain safe operating conditions at all times. Vacuum Technologies assumes no liability for personal injury or damage resulting from operation or service of the equipment.

Vacuum Technologies 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 the users of Vacuum Technologies 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.

Warranty Replacement and Adjustment

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 Customer's expense; in addition, a charge for testing and examination may be made on Products so returned.

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Contents

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Figures

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Tables

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

VARIAN

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Vacuum Technologies
121 Hartwell Avenue
Lexington, MA, 02421-3133 USA

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AX-65 Diffusion Pump

to which this declaration relates is in conformity with the following standard(s) or other normative documents.
auf das sich diese Erklärung bezieht, mit der/den flogenden 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) beantwoodt.
a cui se rifersce questa dichiarazione è conforme alla/e sequente/I norma/o documento/I normativo/i.

VMF-11	**M-2**	**VHS-6**	**HS-16**
AX-65	**M-4**	**VHS-250**	**HS-20**
AX-150	**VHS-4**	**VHS-10**	**HS-32**
HS-2	**M-6**	**VHS-400**	**NHS-35**

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

Frederick C. Campbell

Frederick C. Campbell
Operations Manager
Vacuum Technologies
Varian, Inc.
Lexington, Massachusetts, USA

February 2000

Preface

Documentation Conventions

This manual uses the following documentation conventions:

WARNING *Warnings indicate a particular procedure or practice, which if not followed correctly, could lead to serious injury.*

CAUTION *Cautions indicate a particular procedure or practice, which if not followed, could cause damage to the equipment.*

NOTE *Notes contain important information.*

Before operating or servicing equipment, read and thoroughly understand all operation/ maintenance manuals provided by Vacuum Technologies. Be aware of the hazards associated with this equipment, know how to recognize potentially hazardous conditions, and how to avoid them. Read carefully and strictly observe all cautions and warnings. The consequences of unskilled, improper, or careless operation of the equipment can be serious.

In addition, consult local, state, and national agencies regarding specific requirements and regulations. Address any safety, operation, and/or maintenance questions to your nearest Vacuum Technologies office.

Diffusion Pump Hazards

Designers of systems utilizing diffusion pumps must design out hazards wherever possible. For hazards that cannot be designed out, warnings, procedures, and instructions on proper use and servicing are provided. Please use guards, safety features, and interlocks as recommended.

Refer to Table 1 for a list of general hazards and recommended actions, Table 2 on page xv for a list of prohibited actions that can result in explosions, and Table 3 on page xvi for a list of pressurization hazards that can result in damage to equipment.

The installation, operation, and servicing of diffusion pumps involves one or more of the hazards in Table 1, any one of which in the absence of safe operating practices and precautions, could potentially result in death or serious harm to personnel.

Table 1 General Hazards

Hazard	Suggested Corrective Action
Loss of utility: water and/or electricity	Provide sufficient backup water and power supply as necessary 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 the pressure in foreline is above 0.5 Torr (0.67 mbar)
Overtemperature	Fit temperature sensors and pump fluid level sensors with a feedback to an interlock on the heater power supply
Loss of electrical 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 and Corrosivity	Vent toxic and/or corrosive gases to a safe location; ensure adequate dilution or scrubbing to safe levels; take all actions required to meet air quality standards
Explosion	Integrate pressure relief valves
	Do not use hydrocarbon-based pumping fluids

Explosion

- Operation of the diffusion pump without continuous evacuation below 0.5 Torr (0.67 mbar), or without coolant and introducing a strong oxidizer (such as air) or explosive vapors or powders or materials which may react with pumping fluids in a hot pump (above 300 °F or 150 °C) 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 shock waves.
- *Three elements are required for explosion:* fuel, oxidizer, and an ignition. A combination of temperature and pressure can be a source of ignition. Most diffusion pump fluids are fuels. Hydrocarbon fluids are more prone to oxidize and explode than synthetic silicone-based fluid. The oxidizer can be air, which can be introduced by a leak, deliberately brought in via a process, or inadvertently admitted by operator error.
  Oxygen and other strong oxidizers are even more dangerous than air. 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 injury. Never operate large diffusion pumps utilizing hydrocarbon oils without a complete safety analysis for the entire system and for the application.
- *Explosion and Fire from Acetone and Alcohol:* Diffusion pumps are typically cleaned with acetone and alcohol. When combined with air, oxygen, and other oxides, 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.

Never operate a large diffusion pump under the conditions listed in Table 2. Any of these situations increases the probability of an explosion.

Table 2 Explosive Conditions

Prohibited Action	Explosion-Causing Condition
Do not run pump without cooling water	Overtemperature
Do not run pump with low level of pump fluid	Overtemperature
Do not run pump without proper backing or holding pump	Overpressure
Do not run pump when not evacuated below 0.5 Torr (0.66 mbar)	Overpressure
Do not admit air to, or rough through, a pump with hot boiler	Overpressure plus strong oxidizer
Do not open drain or fill plug while pump is under vacuum, especially when it is hot	Overpressure plus strong oxidizer
Do not contaminate pump with explosive vapors	Lower explosive threshold of gas mixtures
Do not remove, defeat, or override safety counter-measures such as pressure and thermal switches and valve sequencer interlocks	Overtemperature, overpressure, more combustible mixtures
Do not machine or weld any part of the pump without removing all fluid or solvent residue in pump	Source of ignition
Do not use unsuitable pumping fluid	Lower explosive threshold of gas mixture

Pressurization Hazards

Large vacuum pumps and their components are designed for vacuum service. They 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 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 hazards in Table 3 to develop.

Table 3 Pressurization Hazards

Prohibited Action	Result
Do not pressurize the pump body (above 1 atm.)	Body of pump bursts
Do not make a hole through the vacuum wall	Loss of structural integrity of wall

- ❑ *Pressure Relief Devices:* Systems 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 corrosiveness, temperature, and pressure of exhausted products.

Dangerous Substances

- ❑ *Chemical Dangers of Acetone and Alcohol:* 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.
- ❑ *Poisonous and Corrosive Compounds:* When pumping poisonous, reactive, and/or corrosive gas, vapors, or chemicals, proper operation and regeneration do 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.

- *Pump Fluids:* Overheating the pump fluid, exposing it to air or reactive materials, or over-pressurizing it above the normal operating range, approximately $1x10^{-3}$ Torr ($1.3x10^{-3}$ mbar) decomposes the fluid and possibly makes it toxic. This is especially true of backstreamed mechanical pump fluids which are more volatile (unstable). Overheating of accidentally introduced or backstreamed mechanical pump fluids cannot be protected against by thermal switches which are set for diffusion pump fluid.
- *Process Gasses:* Process gasses are frequently toxic, flammable, corrosive, explosive, or otherwise reactive. Vacuum Technologies has no control over the types of gasses passing through the user's diffusion pump as these are entirely under the control of the process user and/or the hardware systems integrator. Since these gasses 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 and similar components to ensure that the exhaust meets all air and water pollution control regulations.

High Temperatures

- *Hot Surfaces:* Boiler temperatures reach 530 °F (275 °C) which can cause serious burns. Always ensure that surfaces have cooled to near room temperature before touching them.
- *Hot Cooling Water and Steam:* The water used to cool the pump can reach scalding temperatures. Touching or rupture of the cooling surface can cause serious burns. 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.

High Voltages

Diffusion pump heaters operate at voltages (up to 480 V) high enough to kill. Design systems 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.

Asphyxiation

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.

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Installation

Before unpacking and installing the AX-65 Diffusion Pump, thoroughly familiarize yourself with this instruction manual and the diffusion pump specifications. Further, examine all other technical material supplied in order to gain a better understanding of the operating principles, limitations, correct application, and the hazards involved with the use of this equipment.

This chapter consists of:

Operating Characteristics

The operating characteristics and physical specifications of the AX-65 diffusion pump are given in Table 1-1, the electrical configurations available are given in Table 1-2, respectively. The graph in Figure 1-1 on page 1-4 shows air speed and throughput as a function of inlet pressure.

NOTE

All tests were done using polyphenyl ether fluid (Santovac 5).

Table 1-1 Operating Specifications

Specification	Units	AX-65 with cold cap	AX-65 with baffle
Operating Range	Torr mbar	$3x10^{-3}$ to $<5x10^{-8}$ $3.9x10^{-3}$ to $<6.5x10^{-8}$	$8.0x10^{-3}$ to $<5x10^{-8}$ $10.4x10^{-3}$ to $<6.5x10^{-3}$
Pumping Speed, Maximum	l/s, Air l/s, Helium	65 90	30 65
Throughput (Air), Max.			
Optimum Range	Torr-l/s mbar-l/s	0.19 0.25	
Overload Range (@ $1x10^{-2}$ Torr)	Torr-l/s mbar-l/s	0.30 0.40	
Forepressure, Max.			
No Load	Torr mbar	0.75 1.00	
Full Load	Torr mbar	0.60 0.78	
Compression Ratio	Air He	$4x10^7$ $2x10^6$	
Backstreaming Rate at Pump Inlet	$mg/cm^2/min$	$<2x10^{-4}$	$<2x10^{-5}$
Electrical Power VAC, 50/60 Hz, 1 phase	Watts	200/250	
Warmup Time	minutes	7	
Cooldown Time	minutes	10	
Fluid Charge	cc	30	
Recommended backing pump capacity	cfm (m^3/hr)	≥ 1.5 (2.5)	
Cooling Fan	cfm	30	
Inlet Flange	N/A	NW50 or ISO-63-K	
Body	N/A	Stainless steel	
Jet Assembly	N/A	Three-stage, self-aligning, aluminum, w/aluminum cold cap	
Net Weight	lbs (kg)	8 (3.63)	

Table 1-2 AX-65 Electrical Specifications

Model	Voltage	Part Number	
		Inlet Flange Type	
		KF50	ISO63
AX-65 with standard cold cap	115V, 250W	L9670301	L9707301
AX-65 with internal baffle	115V, 250W	L9670311	L9707311
AX-65 with standard cold cap	220V, 250W	L9670302	L9707302
AX-65 with internal baffle	220V, 250W	L9670312	L9707312
AX-65 with standard cold cap	115V, 200W	L9670303	L9707303
AX-65 with internal baffle	115V, 200W	L9670313	L9707313
AX-65 with standard cold cap	220V, 200W	L9670304	L9707304
AX-65 with internal baffle	220V, 200W	L9670314	L9707314
AX-65 with standard cold cap	90V, 250W	L9670305	L9707305
AX-65 with internal baffle	90V, 250W	L9670315	L9707315
AX-65 with standard cold cap	165V, 250W	L9670306	L9707306
AX-65 with internal baffle	165V, 250W	L9670316	L9707316

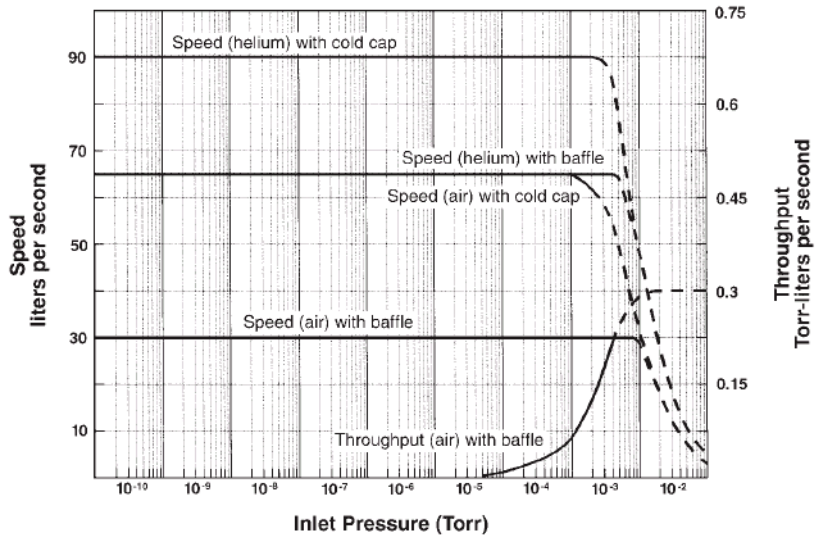

Figure 1-1 AX-65 Speed/Throughput Curves

Installation

Installation consists of:

- ❑ "Unpacking"
- ❑ "Pump Oil Choice and Installation" on page 1-5
- ❑ "Vacuum System Connections" on page 1-5
- ❑ "Electrical Connections" on page 1-6
- ❑ "Thermal Switch" on page 1-7

Unpacking

To unpack:

1. Inspect the pump to ensure that no damage has occurred during shipping. Do not discard any evidence of rough handling; report any damage to the carrier and to Vacuum Technologies without delay.

NOTE

Diffusion pumps are factory-packed to permit prolonged storage in suitably protected areas without special precautions.

2. Remove the flange cover. Do not scratch the O-ring seal surface on the inlet flange.
3. Inspect the internal jet assembly. It should be concentric and firmly seated on the bottom of the diffusion pump. Using a flashlight, ensure that the ejector nozzle is directly in line with the foreline.

The pump requires no initial cleaning prior to charging it with the appropriate diffusion pump oil.

Pump Oil Choice and Installation

When a diffusion pump is integrated into a system that has internal electronics, use a polyphenyl ether diffusion pump fluid such as Santovac 5. These fluids have higher boiling temperatures and should, therefore, be used in pumps with 250 Watt heaters. Fluids with lower boiling points, such as DC-704, should be used in pumps with 200 Watt heaters.

The recommended oil charge for the AX-65 diffusion pump is 30 cc. When a cold pump is filled with a 30 cc charge of oil, the oil level should be visible within the cold range on the sight glass.

To fill the oil:

- ❑ Remove the fill plug and pour the oil into the pump inlet by pouring it into the fill and drain assembly.

Vacuum System Connections

Refer to Figure 1-2 during this procedure.

WARNING

Utility failure can cause damage to the equipment, overheating, and explosions. Designers of the 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.

To establish vacuum system connections:

1. Install the diffusion pump must be installed with the body vertical and plumb. Ensure that the pump inlet mating flange on the system is horizontal within ± 1°. The boiler plate must be horizontal to prevent uneven fluid level. Failure to meet this requirement could result in overheating of the diffusion pump boiler plate.
2. Prepare the inlet O-ring by wiping it with a clean, lint-free cloth. Use a small amount of diffusion pump oil to clean the inlet O-ring.
3. Install the centering ring assembly on the inlet flange using an NW50 clamp. Do not damage or scratch the sealing surface.
4. Connect the pump NW16 foreline to the backing pump (customer-supplied).
5. Ensure the integrity of the vacuum connections by using a helium mass spectrometer leak detector to check for leaks.

Electrical Connections

WARNING

Diffusion pump heaters operate at voltages 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 circuit of the power supply when direct access to the heater or wiring is required. Read the safety section in the front of this manual.

NOTE

Make all electrical connections in accordance with all applicable laws and industrial codes.

The diffusion pump has been designed to operate at a specific voltage. The voltage is specified on the label that is mounted on the side of the pump.

Electrical connections consists of:

1. Connect the green insulation wire to ground (Figure 1-2).
2. Connect the remaining two wires to line voltage.

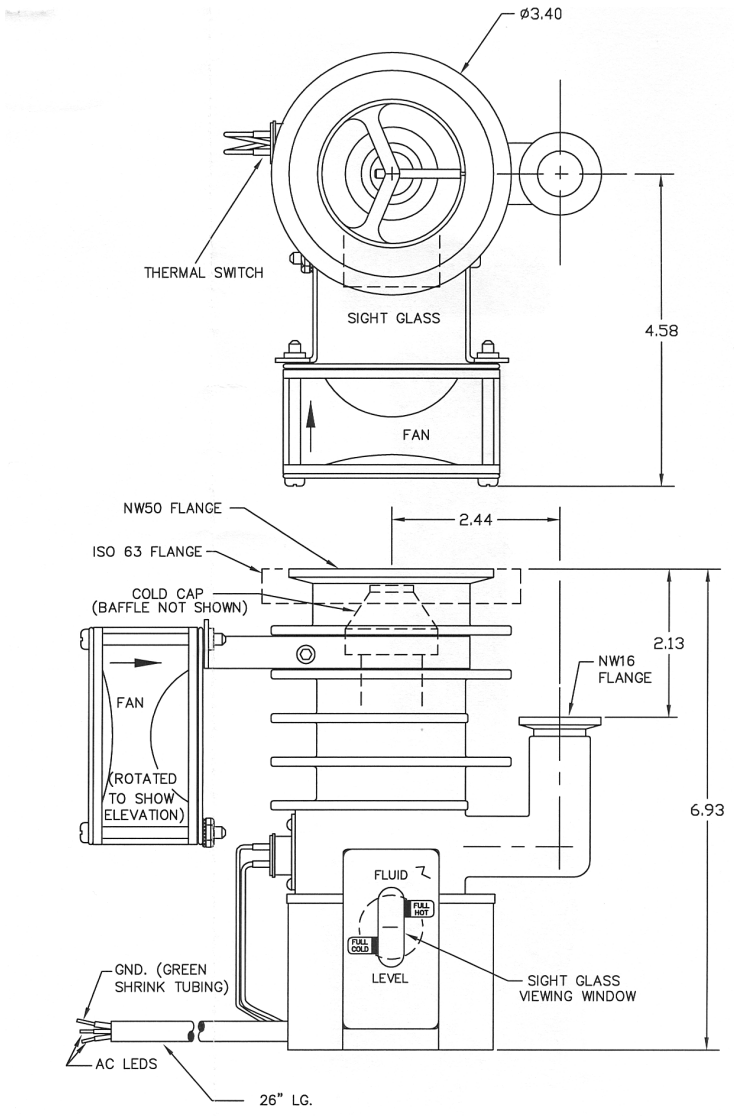

Figure 1-2 AX-65 Diffusion Pump Installation Diagram

Thermal Switch

A normally-closed, overtemperature thermal switch has been attached to pump body on the side of the pump. Loss of cooling, high pressure, or low fluid level causes the contacts of the thermal switch to open. When the problem has been corrected, the thermal switch automatically resets.

A *Pump Ready* thermal switch is available as an option. It is normally open and closes when the pump reaches operating temperature.

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Operations

Operation consists of:

- ❑ “Startup Procedure”
- ❑ “Shutdown Procedure” on page 2-2

WARNING

The following conditions increase the risk of explosion:

- ❑ *Air leaks into the system*
- ❑ *Roughing through a hot diffusion pump, which can cause hot hydrocarbon fluids to ignite or explode when exposed to air*
- ❑ *Air release or the admission of air to a pump with a hot boiler (permitting a strong oxidizer to contact the hot pump fluid)*
- ❑ *Pressure above 1 milliTorr ($1.3X10^{-3}$ mbar). High-pressure operation may cause excessive backstreaming.*
- ❑ *Insufficient (or low level of) pump fluid*
- ❑ *Foreign matter in the pumping fluid, which changes its viscosity and obstructs flow passages*

CAUTION

- ❑ *Do not turn on the heater without fluid in the pump. This may ruin the heaters and damage the pump.*
- ❑ *Do not air-release the pump while the boiler is hot. Most diffusion pump fluids break down under these conditions.*
- ❑ *Do not operate the pump heater unless the cooling fan is running as it causes the pump and fluid to overheat.*
- ❑ *Do not operate without the internal splash baffle or a foreline baffle. This can cause a greater than normal fluid loss.*

Startup Procedure

To start the pump:

NOTE

During initial operation of the diffusion pump, the fresh charge of diffusion pump oil may go through a degassing process. This may result in inlet and foreline pressure fluctuations. These pressure fluctuations are normal.

1. Evacuate (rough pump) the diffusion pump with the appropriate mechanical pump (customer supplied). The backing pump should remain connected to the foreline of the diffusion pump. The gas load must be reduced to the maximum throughput specification (0.30 Torr-liters/sec) or less.
2. Turn on the cooling fan to the pump body.
3. Turn on the power to the diffusion pump heater.
4. Monitor inlet and foreline pressures.

CAUTION

Do not operate the pump with forepressure (outlet pressure) above approximately 0.5 Torr (see Table 1-1 on page 1-2 for tolerable forepressure). The pump will not function properly and excessive backstreaming results.

During operation of the diffusion pump, the gas load at the inlet should not exceed the maximum throughput capability of the pump. The discharge pressure should not exceed the specified tolerable forepressure.

Shutdown Procedure

WARNING ***Hot Surfaces***

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

Explosion Possibility

Air-releasing (or admitting air) to a pump when the boiler is hot permits a strong oxidizer to contact the hot pump oil.

Read the safety section in the front of this manual.

To shutdown the pump:

1. Turn off the power to the diffusion pump.
2. Make sure the cooling fan remains blowing across the pump. It takes approximately ten minutes for the pump to cool down enough so that the pump can be vented to atmosphere.

   The temperature of the pump body just above the boilerplate should be a maximum of 130 °F before the pump is vented. This can be confirmed by measuring the pump body temperature approximately 1" above the pump base with a temperature measurement device supplied by the customer.

Troubleshooting

Troubleshooting consists of:

- ❑ “Leakage”
- ❑ “Outgassing”
- ❑ “Poor Pump or System Performance” on page 3-2

Leakage

If leakage is the suspected cause of poor system performance, first check the following items:

- ❑ Inlet and foreline connections
- ❑ Drain and fill plugs
- ❑ Other compression fittings, such as high-vacuum gauges in the system
- ❑ Threaded connections, such as a foreline gauge

Before proceeding with a program of step-by-step troubleshooting, check the performance and accuracy of the vacuum gauges used on the system.

Outgassing

High-vacuum systems, even without external leakage, can have high gas loads 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 the 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 from the following relationship:

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

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

Poor Pump or System Performance

Table 3-1 lists the faults, the probable causes and corrective actions to take if you have a problem with a large diffusion pump.

Table 3-1 Troubleshooting Guide

Fault	Probable Cause	Corrective Action
Poor system pressure	Leaks in system, virtual or real	Locate and repair
Poor ultimate pressure	Contaminated pump fluid	Examine and clean pump; replace fluid
	Low heat input	Check voltage. Check for continuity, burned-out element, poor thermal contact
	Excessive or too cold cooling	Check temperature and correct.
	High forepressure	Check for leak in foreline, poor mechanical pump performance, breakdown of mechanical pump fluid
Low speed (Prolonged cycle after checking gas load conditions)	Low heat input	Check heaters
	Low oil level	Add oil
	Improperly located jets	Check and repair or replace
Inlet pressure surges	Incorrect heater voltage	Check and correct voltage
	Fluid outgassing	Condition fluid by operating the pump for a 24 hours
	Leak in system ahead of pump inlet	Check and correct
High chamber contamination of the pump fluid	Forepressure too high	Check for leak in foreline, poor mechanical pump performance, breakdown of pump fluid, and incorrect valve operation
	Prolonged operation in overload range: 10^{-3} Torr	Adhere to operating procedures
	Improper system operation and air release procedures	Adhere to operating procedures
Pump will not start	Safety circuits open	Inspect for electrical short or overtemperature condition
	Main power off	Check main power source

Appendix A. Maintenance and Service

Pump maintenance consists of:

- ❑ “Periodic Inspection”
- ❑ “Cleaning” on page A-1
- ❑ “Changing the Heater Element” on page A-3
- ❑ “Changing the Heater Element” on page A-3

Perform these periodic checks to assure trouble-free operation. This maintenance prevents costly down-time and cleaning procedures. Maintain a day-to-day log of pump and system performance to identify marked variations that require corrective action.

Periodic Inspection

Fluid Level

When the pump is running, the fluid level should remain within the zone indicated as *FULL HOT*. If the fluid level falls below this zone, cool down the pump. Once the pump cools down, add fluid so that the fluid level is within the zone indicated as *FULL COLD*. A 30 cm^3 charge of oil brings the fluid level of an empty pump up to the *FULL COLD* level.

Cooling

Ensure that cooling fan flow is unobstructed and at specified flow rates and temperatures.

Cleaning

WARNING

- ❑ *Cleaning a diffusion pump involves the use of acetone and alcohol, both of which are toxic and explosive. Take careful note of the following warnings before starting a cleaning process.*
- ❑ *When heated, sprayed or exposed to high temperature equipment, these solvents become flammable and explosive, causing serious injury or death.*
- ❑ *When heated or sprayed, acetone or alcohol also becomes 4 to 5 times heavier than air and flows down, settling in tanks, pits, and low areas, thus displacing air which can kill by asphyxiation.*

- ❑ *Acetone, alcohol, and other solvents are irritants, narcotics, depressants, and carcinogenic. Their inhalation and ingestion may produce serious effects. Prolonged or continued contact with the skin will result in absorption through the skin and moderate toxicity.*
- ❑ *Do not use near a high temperature source. Ventilate the working area with a blower and use in a large, well-ventilated room. The use of a self-contained breathing apparatus may also be necessary.*
- ❑ *Always ensure that cleaning operations are carried out in large, well-ventilated rooms. Wear eyeshields, gloves, and protective clothing.*

CAUTION

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

To clean the pump:

1. Turn off the power and disconnect the power supply plug.
2. Allow the pump to cool for approximately ten minutes, then turn off the cooling fan.
3. Disconnect the inlet flange and foreline connections. Be careful not to scratch or damage the O-ring sealing surface.
4. Remove the cold cap and jet assembly.
5. Drain the diffusion pump fluid.
6. Remove all O-rings and gaskets.
7. Thoroughly clean the diffusion pump body interior and the jet assembly with acetone followed by an isopropyl alcohol rinse. The inside of the pump can be dried using dry nitrogen.
8. Install the jet assembly when the inside of the pump body and the jet assembly have dried. Make sure the ejector stage lines up with the foreline. A pin in the pump body engages in a slot in the jet assembly.
9. Place the jet cap (3) on the jet assembly (Figure A-1).
10. Put the spring (1) in the counterbore of the jet cap.
11. Place the centering plate (2) on the spring.
12. Reinstall the cold cap (4).
13. Add 30 cc of diffusion pump fluid, as described in “Pump Oil Choice and Installation” on page 1-5.
14. Reinstall the diffusion pump in the system as described in “Installation” on page 1-4.

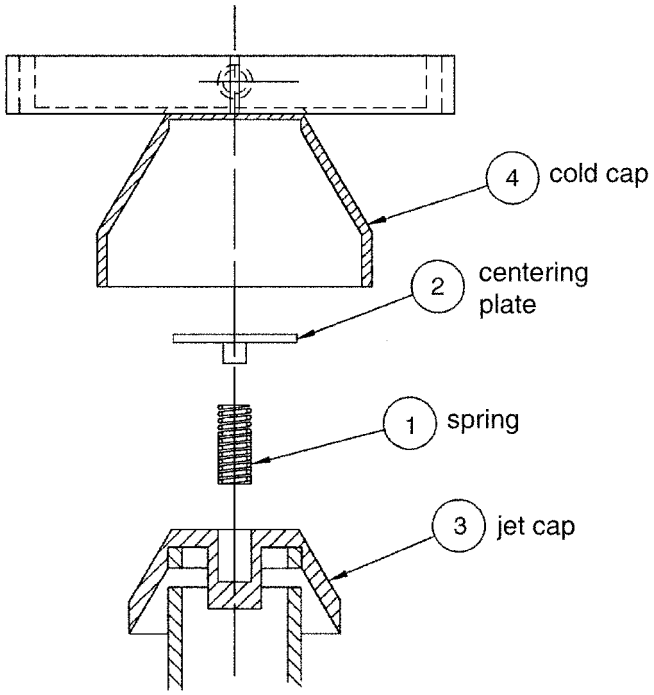

Figure A-1 Jet Cap Assembly Diagram

Changing the Heater Element

WARNING

Diffusion pump heaters operate at voltages 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 circuit of the power supply when direct access to the heater or wiring is required. Read the safety section in the front of this manual.

The cartridge heater has been factory-coated with an anti-seize lubricant to facilitate removal simply by pulling on the cartridge heater electrical leads. However, in some cases, after extended operation, the heater can be more difficult to remove. In this event, proceed as follows:

1. Turn off the power to the diffusion pump and disconnect the power supply connector.
2. Let the pump cool until it is lukewarm to touch. It is easier to drain out the oil when it is still lukewarm.
3. Drain the fluid from the pump and turn the pump upside down.
4. Allow the pump to cool down completely.
5. Remove the heater cover and insulation.
6. Apply penetrating oil around the cartridge heater and let it stand for 10 minutes.

7. Drive a 1/4" wide flat blade screwdriver approximately 1/8" deep into the center of the heater between the electrical leads.
8. Gently turn the screwdriver to break the heater free.
9. Pull the heater up by the leads, twisting it if necessary.

NOTE

If the heater does not pull out freely, a second application of penetrating oil may be necessary.

10. Apply an anti-seize compound to the new heater and install it.

Appendix B. Parts and Replacement

Table B-1 lists the parts available from Vacuum Technologies. Please call the 800 number listed inside this manual. Refer to Figure B-1.

Table B-1 AX-65 Diffusion Pump Replacement Parts List

Item	Part Number	Description
1	L9674301	Jet Assembly
2	L9675301	Cold Cap
3	L9706001	Inlet Baffle
4	L9995301	Jet Alignment Kit
5	L9994301 L9994303 L9994302 L9994304 L9994307 L9994308	Heater Harness, 90V, 250W Heater Harness, 115V, 250W Heater Harness, 165V, 250W Heater Harness, 220V, 250W Heater Harness, 115V, 200W Heater Harness, 220V, 200W
6	L9964001	Normally Closed Overtemperature Thermal Switch (set to open at 365 °F)
7	L9964002	Optional Normally Open Pump Ready Switch (set to close at 170 °F)
8	661300138	Fan, Universal Voltage
9	L9676301	Foreline Baffle
10	L9680301	Centering Ring Assembly, NW50, with Viton O-ring
11	KC16AV	Centering Ring Assembly, NW16, with Viton O-ring
12	L9701002	Bottom Insulation (1 required with heater harness)
	695405001	Diffusion Pump Fluid, Santovac 5, 40 cc

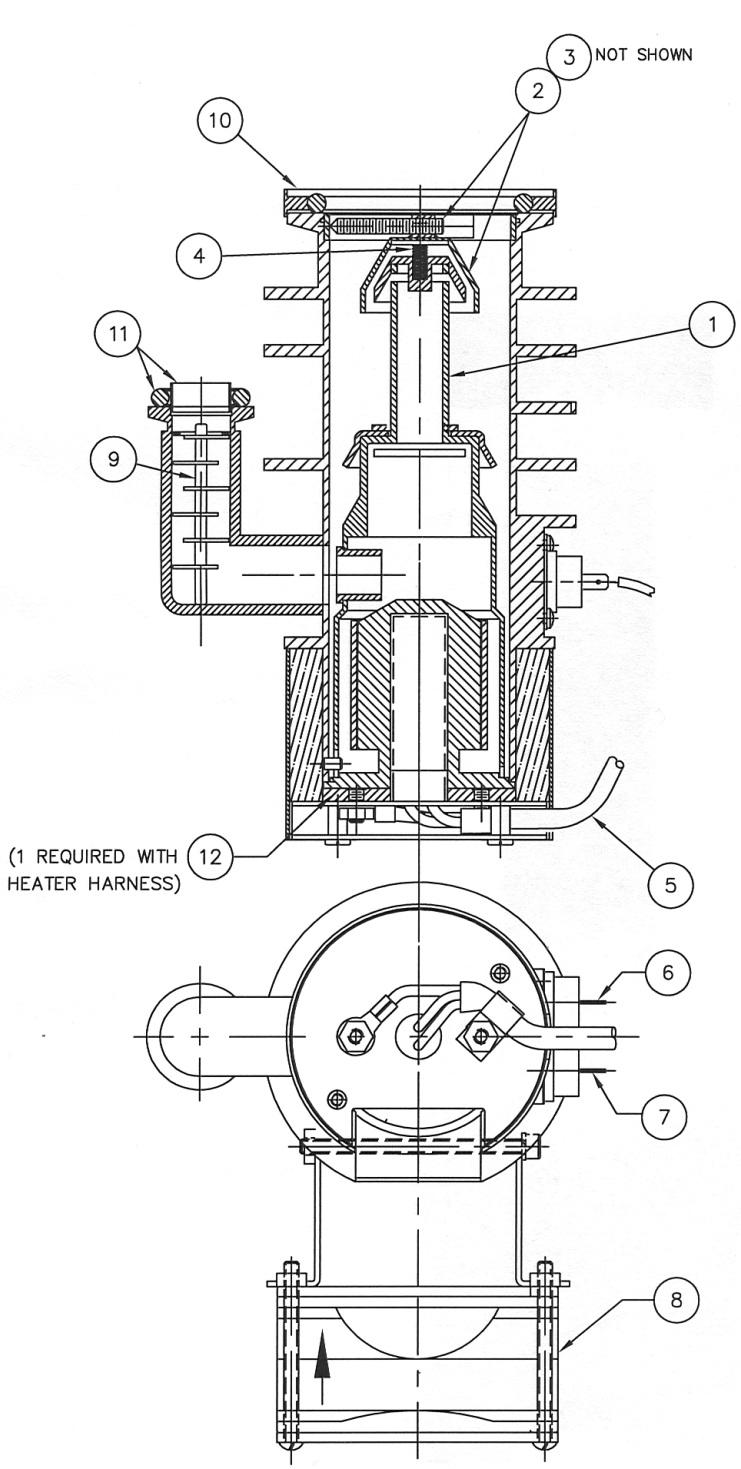

Figure B-1 Parts Diagram

Table B-2 compares diffusion pump fluid characteristics.

Table B-2 Comparison of Diffusion Pump Fluid Characteristics

	NEOVAC SY	DC-702	DC-704	DC-705	SANTOVAC 5
Fluid Type	**Synthetic Hydrocarbon**	**Silicone**	**Single-Component Silicone**	**High-Purity Silicone**	**Mixed 5-Ring Polyphenyl Ether**
Ultimate Pressure (Torr) Untrapped	Low 10^{-8} Range	10^{-6}	10^{-7} to 10^{-8}	10^{-9} to 10^{-10}	10^{-10}
Ultimate Pressure (Torr) Trapped	1 x 10^{-11} Range	-	to 10^{-11}	to 10^{-11}	-
Viscosity c.s.t.	40 °C = 25 50 °C = 17	25 °C = 45	25 °C = 39	25 °C = 175	25 °C = 2400
Ultimate Pressure	Very Good	Fair	Very Good	Excellent	Excellent
Thermal Stability	Good	Excellent	Excellent	Excellent	Very Good
Oxidation Resistant	Good	Excellent	Excellent	Excellent	Very Good
System Cleanliness	Very Good	Good	Very Good	Very Good	Excellent

NOTE

For leak detectors, Vacuum Technologies recommends the use of Santovac 5 only.

Table B-3 gives diffusion pump fluid part numbers.

Table B-3 Ordering Information

Description	Contents	Vacuum Technologies Part No.
NEOVAC SY	1 liter/1,000 cc 1 gallon/3.8 liters 5 gallons/18.9 liters	K6948301 K6948305 K6948315
DC-702 Silicone	500 cc 1 gallon/3.8 liters 5 gallons/18.9 liters	695472005 695472008 695472015
DC-704 Silicone	500 cc 1 gallon/3.8 liters 5 gallons/18.9 liters	695474005 695474008 695474015
DC-705 Silicone	500 cc 1 gallon/3.8 liters	695475005 695475008
Santovac 5	40 cc 65 cc 500 cc	695405001 695405002 695405005

VARIAN

Request for Return
Health and Safety Certification

ISO 9001 REGISTERED

1. Return authorization numbers (RA#) **will not** be issued for any product until this Certificate is completed and returned to a Varian, Inc. Customer Service Representative.
2. Pack goods appropriately and drain all oil from rotary vane and diffusion pumps (for exchanges please use the packing material from the replacement unit), making sure shipment documentation and package label clearly shows assigned Return Authorization Number (RA#) VVT cannot accept any return without such reference.
3. Return product(s) to the nearest location:

North and South America	**Europe and Middle East**	**Asia and ROW**
Varian, Inc. Vacuum Technologies 121 Hartwell Ave. Lexington, MA 02421 Fax: (781) 860-9252	Varian S.p.A. Via F.lli Varian, 54 10040 Leini (TO) – ITALY Fax: (39) 011 997 9350	Varian Vacuum Technologies Local Office

For a complete list of phone/fax numbers see www.varianinc.com/vacuum

4. If a product is received at Varian, Inc. in a contaminated condition, **the customer is held responsible** for all costs incurred to ensure the safe handling of the product, and **is liable** for any harm or injury to Varian, Inc. employees occurring as a result of exposure to toxic or hazardous materials present in the product.

CUSTOMER INFORMATION

Company name: .....

Contact person: Name: ..... Tel: .....

Fax: ..... E-mail: .....

Ship method: Shipping Collect #: ..... P.O.#: .....

Europe only: VAT Reg Number: ..... *USA only:* ❒Taxable ❒Non-taxable

Customer ship to: ..... Customer bill to: .....

....

....

PRODUCT IDENTIFICATION

Product Description	Varian, Inc. Part Number	Varian, Inc. Serial Number

TYPE OF RETURN (check appropriate box)

❒ Paid Exchange	❒ Paid Repair	❒ Warranty Exchange	❒ Warranty Repair	❒ Loaner Return
❒ Credit	❒ Shipping Error	❒ Evaluation Return	❒ Calibration	❒ Other

HEALTH and SAFETY CERTIFICATION

VACUUM TECHNOLOGIES CANNOT ACCEPT ANY BIOLOGICAL HAZARDS, RADIOACTIVE MATERIAL, ORGANIC METALS, OR MERCURY AT ITS FACILITY. CHECK ONE OF THE FOLLOWING:

❒ I confirm that the above product(s) has (have) **NOT** pumped or been exposed to any toxic or dangerous materials in a quantity harmful for human contact.

❒ I declare that the above product(s) has (have) pumped or been exposed to the following toxic or dangerous materials in a quantity harmful for human contact (Must be filled in):

Print Name..... Signature ..... Date .....

PLEASE FILL IN *THE FAILURE REPORT SECTION* ON THE NEXT PAGE

Do not write below this line

Notification (RA) #: ..... Customer ID #: ..... Equipment #: .....

VARIAN

Request for Return Health and Safety Certification

ISO 9001 REGISTERED

FAILURE REPORT
(Please describe in detail the nature of the malfunction to assist us in performing failure analysis):

TURBO PUMPS AND TURBOCONTROLLERS

Claimed Defect		**Position**	**Parameters**	
❒ Does not start	❒ Noise	❒ Vertical	Power:	Rotational Speed:
❒ Does not spin freely	❒ Vibrations	❒ Horizontal	Current:	Inlet Pressure:
❒ Does not reach full speed	❒ Leak	❒ Upside-down	Temp 1:	Foreline Pressure:
❒ Mechanical Contact	❒ Overtemperature	❒ Other	Temp 2:	Purge flow:
❒ Cooling defective	❒ Clogging	.....	Operation Time:	
Describe Failure:				
Turbocontroller Error Message:				

ION PUMPS/CONTROLLERS

❒ Bad feedthrough	❒ Poor vacuum
❒ Vacuum leak	❒ High voltage problem
❒ Error code on display	❒ Other .....
Describe failure:	
Customer application:	

VALVES/COMPONENTS

❒ Main seal leak	❒ Bellows leak
❒ Solenoid failure	❒ Damaged flange
❒ Damaged sealing area	❒ Other .....
Describe failure:	
Customer application:	

LEAK DETECTORS

❒ Cannot calibrate	❒ No zero/high background
❒ Vacuum system unstable	❒ Cannot reach test mode
❒ Failed to start	❒ Other .....
Describe failure:	
Customer application:	

INSTRUMENTS

❒ Gauge tube not working	❒ Display problem
❒ Communication failure	❒ Degas not working
❒ Error code on display	❒ Other .....
Describe failure:	
Customer application:	

ALL OTHER VARIAN, INC.

❒ Pump doesn't start	❒ Noisy pump (describe)
❒ Doesn't reach vacuum	❒ Overtemperature
❒ Pump seized	❒ Other .....
Describe failure:	
Customer application:	

DIFFUSION PUMPS

❒ Heater failure	❒ Electrical problem
❒ Doesn't reach vacuum	❒ Cooling coil damage
❒ Vacuum leak	❒ Other .....
Describe failure:	
Customer application:	

Sales and Service Offices

Canada
Central coordination through:
Varian, Inc.
121 Hartwell Avenue
Lexington, MA 02421
USA
Tel: (781) 861 7200
Fax:(781) 860 5437
Toll Free: (800) 882 7426

China
Varian Technologies - Beijing
Room 1201, Jinyu Mansion
No. 129A, Xuanwumen Xidajie
Xicheng District
Beijing 1000031
P.R. China
Tel: (86) 10 6608 1031
Fax:(86) 10 6608 1541

France and Benelux
Varian s.a.
7 avenue des Tropiques
Z.A. de Courtaboeuf – B.P. 12
Les Ulis cedex (Orsay) 91941
France
Tel: (33) 1 69 86 38 13
Fax:(33) 1 69 28 23 08

Germany and Austria
Varian Deutschland GmbH
Alsfelder Strasse 6
Postfach 11 14 35
64289 Darmstadt
Germany
Tel: (49) 6151 703 353
Fax:(49) 6151 703 302

India
Varian India PVT LTD
101-108, 1st Floor
1010 Competent House
7, Nangal Raya Business Centre
New Delhi 110 046
India
Tel: (91) 11 5548444
Fax:(91) 11 5548445

Italy
Varian, Inc.
Via F.lli Varian, 54
10040 Leini, (Torino)
Italy
Tel (39) 011 997 9 111
Fax (39) 011 997 9 350

Japan
Varian, Inc.
Sumitomo Shibaura Building, 8th Floor
4-16-36 Shibaura
Minato-ku, Tokyo 108
Japan
Tel: (81) 3 5232 1253
Fax:(81) 3 5232 1263

Korea
Varian Technologies Korea, Ltd.
Shinsa 2nd Building 2F
966-5 Daechi-dong
Kangnam-gu, Seoul
Korea 135-280
Tel: (82) 2 3452 2452
Fax:(82) 2 3452 2451

Mexico
Varian S.A.
Concepcion Beistegui No 109
Col Del Valle
C.P. 03100
Mexico, D.F.
Tel: (52) 5 523 9465
Fax:(52) 5 523 9472

Russia
Central coordination through:
Varian, Inc.
via F.lli Varian 54
10040 Leini, (Torino)
Italy
Tel: (39) 011 997 9 252
Fax: (39) 011 997 9 316

Taiwan
Varian Technologies Asia Ltd.
18F-13 No.79, Hsin Tai Wu Road
Sec. 1, Hsi Chih, Taipei Hsien
Taiwan, R.O.C.
Tel: (886) 2 2698 9555
Fax:(886) 2 2698 9678

UK and Ireland
Varian Ltd.
28 Manor Road
Walton-On-Thames
Surrey KT 12 2QF
England
Tel: (44) 1932 89 8000
Fax:(44) 1932 22 8769

United States
Varian, Inc.
121 Hartwell Avenue
Lexington, MA 02421
USA
Tel: (781) 861 7200
Fax:(781) 860 5437

Other Countries
Varian, Inc.

Via F.lli Varian 54
10040 Leini, (Torino)
Italy
Tel: (39) 011 997 9 111
Fax:(39) 011 997 9 350

Customer Support and Service:

North America
Tel: 1 (800) 882-7426 (toll-free)
vtl.technical.support@varianinc.com

Europe
Tel: 00 (800) 234 234 00 (toll-free)
vtl.technical.support@varianinc.com

Japan
Tel: (81) 3 5232 1253 (dedicated line)
vtj.technical.support@varianinc.com

Korea
Tel (82) 2 3452 2452 (dedicated line)
vtk.technical.support@varianinc.com

Taiwan
Tel: 0 (800) 051 342 (toll-free)
vtw.technical.support@varianinc.com

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