ULVAC

SUPER TRAP
CRYO-T SERIES
Instruction Manual

Inline/Appendage/In-Situ

Export Control Policy

Vacuum pumps that pump nitrogen gas at pumping speed of 15000L/s or more fall under row 2(35) of appended table 1 of Japan's Export Trade Control Order, which is based on international export control regimes. Also, when applying a refrigerator system to a cryocooler for optical sensors, the cryocooler falls under row 10(2) of appended table 1 of Japan's Export Trade Control Order as well.

Customers must follow all related rules and regulations such as Foreign Exchange and Foreign Trade Act and take appropriate procedures when exporting or re-exporting those products.

D/N.MB00TFNE, 2017AT13 **ULVAC CRYOGENICS INCORPORATED**

Introduction

Thank you for choosing our products. This instruction manual gives information and precautions on handling, installation, operation, and maintenance of the product.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. To ensure proper use of this product, read this instruction manual carefully and keep this manual close at hand so that you can use for reference during operation.

If you purchased our other products and/or optional devices with this product, read relevant instruction manuals carefully.

1. About the personnel who are involved in handling our products

All personnel involved in handling our products should take a general safety education and training that is officially accepted in the country where our product is used. The personnel are also required to have specialized knowledge/skills and qualification on the electricity, the machinery, the cargo handling, and the vacuum. Especially, the personnel should be familiar with handling a cryopump in order to use it safely. Since we offer a training session (which is subject to fees) as needed for people who use cryopumps for the first time, please do not hesitate to contact our Service Engineering Division to join the training session.

2. Warranty

2.1 Gratis warranty period and Warranty coverage

【Gratis warranty period】

Note that an installation period of less than one year after installation in your company or your customer's premises or a period of less than 18 months (counted from the date of production) after shipment from our company, which is shorter, is selected.

【Coverage】

(1) Failure diagnosis

As a general rule, diagnosis of failure should be done on site by customer. However, ULVAC CRYOGENICS or our service network can perform this service for an agreed fee upon the customer's request. There will be no charge if the cause

of the breakdown is found to be a fault of ULVAC CRYOGENICS.

(2) Damage during transportation

When damage by delivery/transportation is admitted, the product will be repaired free of charge within the range of the guarantee expressed in the sales contract.

(3) Breakdown repairs

There will be a charge for breakdown repairs, replacements and on-site visits for the following seven conditions. In those cases the cost shall be your own expense even though the product is within the warranty period.

① Breakdowns due to improper storage or handling, careless accident, software or hardware design by the customer.
② Breakdowns due to modifications of the product without consent of the manufacturer.
③ Breakdowns due to maintenance of the product without authentic parts or breakdowns resulting from using the product outside the specified specifications of the product.
④ Breakdowns due to contamination or corrosion caused by user's use conditions.
⑤ Breakdowns due to natural disasters (such as fire, earthquake, flood, lightning, salt damage, and so on) , environmental pollution, irregular voltage, and /or usage of undesignated power source.
⑥ Breakdowns that are outside the terms of warranty.
⑦ Consumables and/or replacement service.

Since the above services are limited to within Japan, diagnosis of failures, etc are not performed abroad. If you desire the after service abroad, please contact ULVAC CRYOGENICS and consult us for details in advance.

2.2 Exclusion of opportunity loss from warranty liability

Regardless of the gratis warranty term, compensation to opportunity losses incurred to your company or your customers by failures of ULVAC CRYOGENICS products and compensation for damages to products other than ULVAC CRYOGENICS products and other services are not covered under warranty.

2.3 Repair period after production is discontinued

ULVAC CRYOGENICS shall accept product repairs for seven years after production of the product is discontinued.

3. Service Form

After the products are delivered, please fill out the following information in the blanks. If you have any questions or technical problems, please feel free to contact the nearest Customer Support Center or headquarters. Please refer to "Service Network".

Cryopump／Super trap Model	: _____
Cryopump／Super trap Serial No.	: _____
Refrigerator Model	: _____
Refrigerator Serial No.	: _____
Compressor Model	: _____
Compressor Serial No.	: _____
Temperature controller／Thermal display Model	: _____
Temperature controller／Thermal display Serial No.	: _____
Option Part Model	: _____
Optional Part Serial No.	: _____

4. Notes for repair and maintenance requests

We may decline your request for the repair or the maintenance of our products if you refuse to give us information about the presence of the hazardous substance and/or contaminant.

Also, please be aware that we do not accept liability for damages by the contaminant, which might be caused during transportation to our office or the nearest customer support center. To avoid such accident, please pay careful attention to packing of the product

5. In case of breakdown and accident

When breakdown or accident occurs, we may ask for keeping the product on site as it is or retrieving the product to investigate its cause. Also we may ask for reporting the detailed process and/or the operating condition. When unidentified malfunction was generated, please contact our Service Engineering Division or

the nearest customer support center with reference to the chapter of Service Network. We ask for cooperation about the above.

6. General Precautions

(1) It is strictly prohibited to duplicate, open, and transfer this instruction manual or any of its parts to a third person without written permission from ULVAC CRYOGENICS.

(2) Information in this document might be revised without a previous notice for the specification change and the improvement of the product.

(3) If you have any questions or comments on this document, please do not hesitate to contact us. The phone numbers of local customer support centers are listed at the end of this manual.

Safety Considerations

Our products have been designed to provide extremely safe and dependable operation when properly used. Following safety precautions must be observed during normal operation and when servicing them.

WARNING **A warning describes safety hazards or unsafe practices which could result in severe injury or loss of life.**

CAUTION **A caution describes safety hazards or unsafe practices which could result in personal injury or equipment damage.**

Toxic gas or chemicals used.
There is a risk of severe injury upon contact.

Corrosive chemicals used.
There is a risk of severe injury upon contact.

Flammable gas used.
There is a danger of fire or burn injury.

Explosive gas used.
There is a risk of fire or explosion.

Hazardous voltage .
Electric shock may cause severe injury or loss of life.

Hot heating part present.
There is a risk of burn injury.

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Safety Instructions

The following precautions must be observed before installing, operating, or servicing CRYO-T series Super Trap.

1. Rupture of cylinder by corrosion

The cylinder of refrigerator is mainly made of stainless steel and copper.

Special precautions must be taken when pumping corrosive gas which may be produced by plasma reaction, sputtering, etc. in chamber, and corrodes cylinder materials.

For maximum performance of the refrigerator, the stainless steel cylinder thickness is very thin. During normal operation, the pressure of helium gas in the refrigerator is approximately 2 - 2.5 MPa(gage) and if the corrosion develops, the cylinder may rupture at weak portion.

☆If the Super Trap is used to pump corrosive gases, periodic pressure proof test is recommended.

☆ULVAC CRYOGENICS INC. tests the pressure proof of cylinder by increasing the gas pressure 1.5 times as high as the operating pressure.

2. Assembly and disassembly of refrigerator

The refrigerator contains high-pressure and high-pure helium gas.

When disassembling your refrigerator, please contact our customer support section, your local ULVAC TECHNO, Ltd., CS center, or ULVAC KYUSHU Corp. for technical assistance.

Take the following special precautions for maintenance or disassembly of the refrigerator.

1. Discharge the helium gas completely using discharging adapter from self-sealing coupling of both helium return and supply flexible hose.
2. Make sure that the helium gas pressure is indicated 0 MPa (gage) and then loosen the bolt.

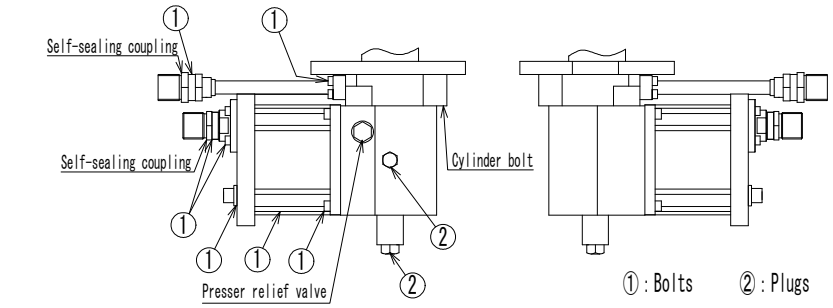
NOTE: Do not loosen the bolts and plugs pointed by arrows in Figure 4 before discharging the helium gas. Ignoring this note may cause severe injury or equipment damage.

Take the following precautions when assembling the refrigerator by yourself.

1. Tighten the bolts of each part in the diagonal carefully.
2. For the heaviest load by the high-pressure helium gas, cylinder bolts (M5x6) need 6.9N・m (70kgf・cm) of torque. For RS80/RS80T refrigerator (M6x6), 11.6N・m （118kgf・cm） of torque is required.
3. Fill the refrigerator with the helium gas slowly confirming that there is no defect.
4. When adding the helium gas, please follow the all instructions described in section 8 in this manual.

Ensure that the bolts are securely tightened. Loosened bolts or bolts under the regulation torque could cause severe injury or equipment damage.

RM type Refrigerator



R type Refrigerator

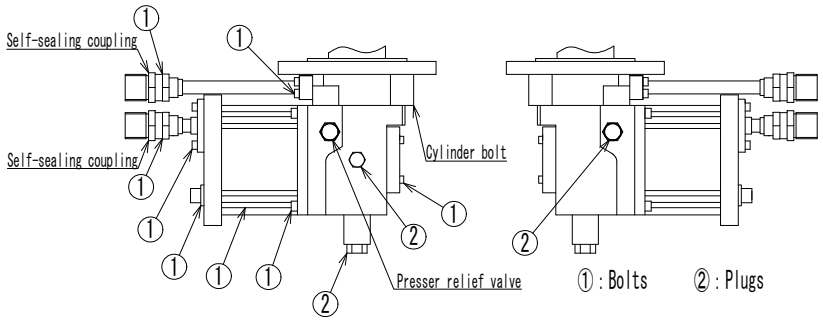


Figure 1　Bolt Location

3. Do not charge the system with excessive helium gas

For regeneration, our Super Traps use high-pressure helium gas circulated in the refrigerator system. Charging helium gas more than the specified value does not increase the refrigerator performance. Conversely, the pressure relief valve could blow out if helium gas pressure exceeds the specified value. Excessive charging of helium gas could result in leakage and defect of the Super Trap system.

Do not charge the system with helium gas more than necessary.

4. Power source of Super Trap system

Refer to the Table 1-1 in the instruction manual of compressor unit for required power source.

- Install ground-fault interrupter.
- Do not connect other equipments to the same power source.
- Make sure to connect the earth wire to a ground terminal.

5. Condensation of water vapor

Water vapor may condense on the Super Trap mount or 80K cryopanel under following conditions:

1. Lowered degree of vacuum during cool-down or normal operation.
2. When warming up the Super Trap for the regeneration.

DO NOT place electrical devices under the Super Trap to avoid short-circuit. It is recommended to attach a water tray to catch water drops.

6. Temperature notice

The allowable maximum temperature of the Super Trap is 70°C (343K).
Excessive temperature may cause a damage to the product.
Accordingly, always monitor the temperature of the sensor inside the Super Trap not to exceed 70°C (343K).

The temperature sensor inside the Super Trap may be damaged by exposing to the heat source from the customer's equipment. If there is a possibility of damage to the product, run the Super Trap and keep the temperature sensor at room temperature (approx. 20°C (293K)).
Also, make sure to power-on the Super Trap system whenever there is a heat source from customer's equipment.

Thermo-electromotive force of K Thermocouple (mV)

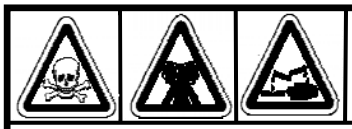
The reference junction : 20°C

Temp.(°C)	0	2	4	6	8
10	-0.401	-0.321	-0.241	-0.161	-0.080
20	0.000	0.081	0.162	0.243	0.324
30	0.405	0.487	0.568	0.650	0.732
40	0.814	0.896	0.978	1.060	1.143
50	1.225	1.308	1.390	1.473	1.556
60	1.638	1.721	1.804	1.887	1.970
70	2.053				

Reference : JIS C 1602-1995

Disposal Consideration

Regulations and the ordinance concerning industrial waste treatment are provided in the country and region to discard. When disposing our products, please process abandonment according to relevant regulations and ordinance, etc.



WARNING

When it seems that the cryopump or refrigerator has been used to evacuate a toxic or dangerous material, you must contact a safety supervisor before discarding, and discard it after removing the poisonous material according to directions of the safety supervisor.

We will offer you Material Safety Data Sheet (called MSDS) of our products upon your request. If you have any questions, please contact our Service Engineering Division or the nearest customer support center.

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1. SUPER TRAP DESCRIPTION

1.1. General

CRYO-T Super Trap system employs closed-cycle helium refrigeration system that enables to obtain high or ultra high vacuum with simple operation.

As shown in Figure 1-1, Super Trap system consists of a Super Trap assembly (including cold head), a compressor unit, connecting piping (flexible hoses), and some cables as shown in Figure 1-1.

■CRYO-T Model Codes

CRYO-T □ □ □ □

Inlet Flange Bore

Type

F: Inline C: Appendage N: In-Situ

Refrigerator Unit

A: RMS10 series
B: RMS50 series
C: RMS80T series
D: RMS150T series

Inner Heater

H: Mounted Blank: Not mounted

※Model codes shown above have been given to Super Traps launched later than September, 2006.

1.2. Standard Inline / Appendage Configuration

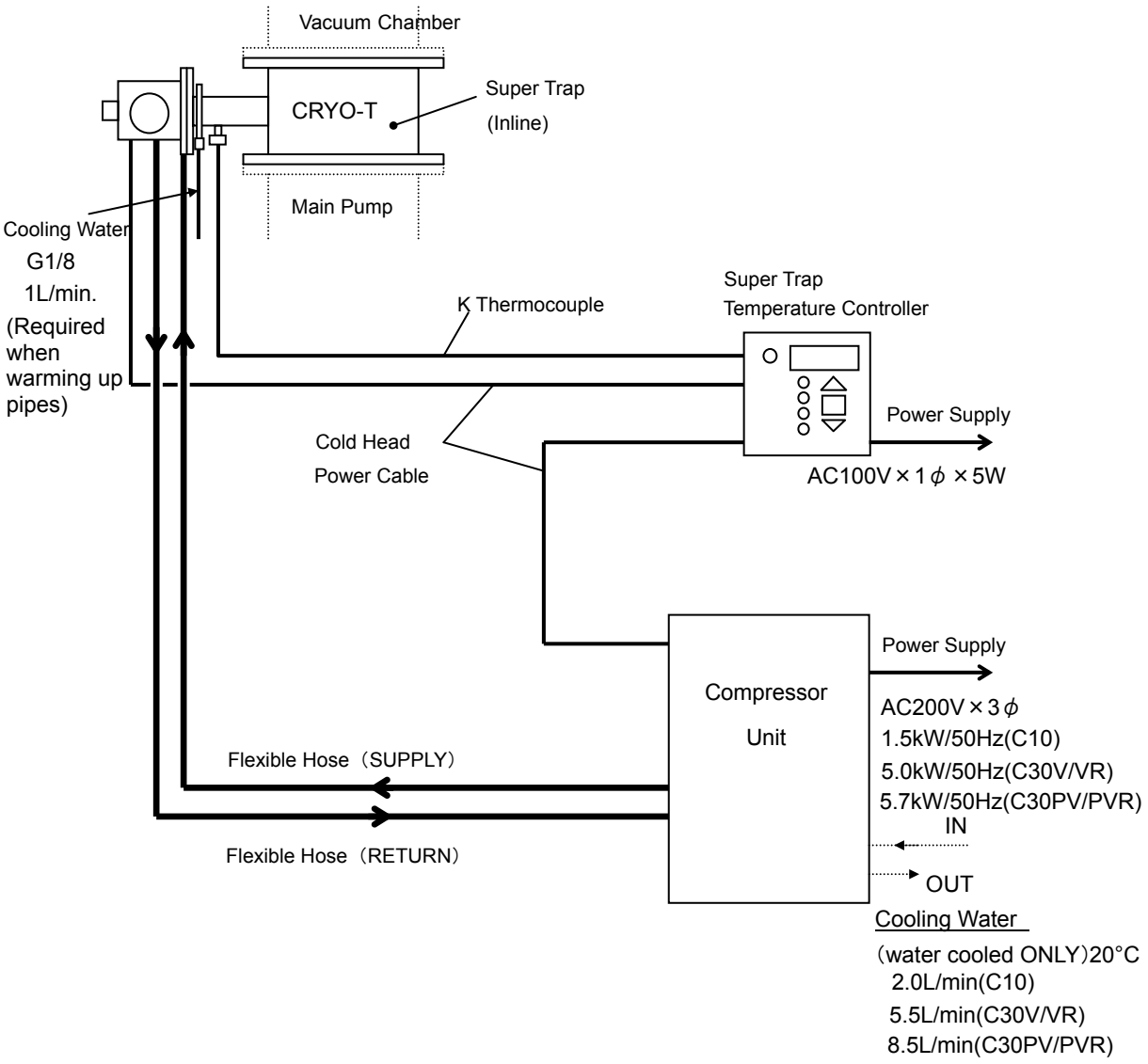
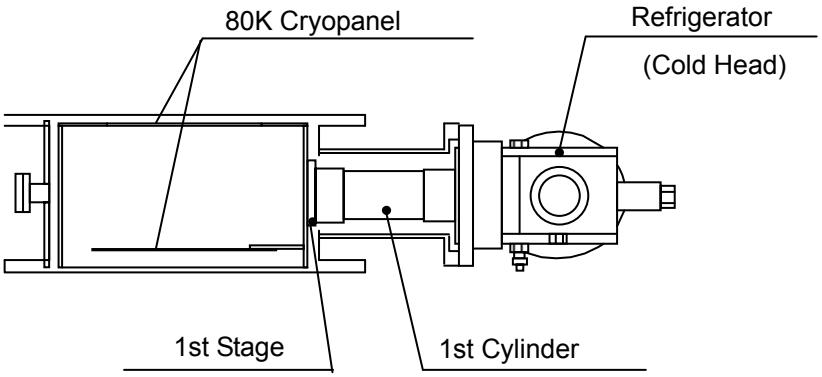
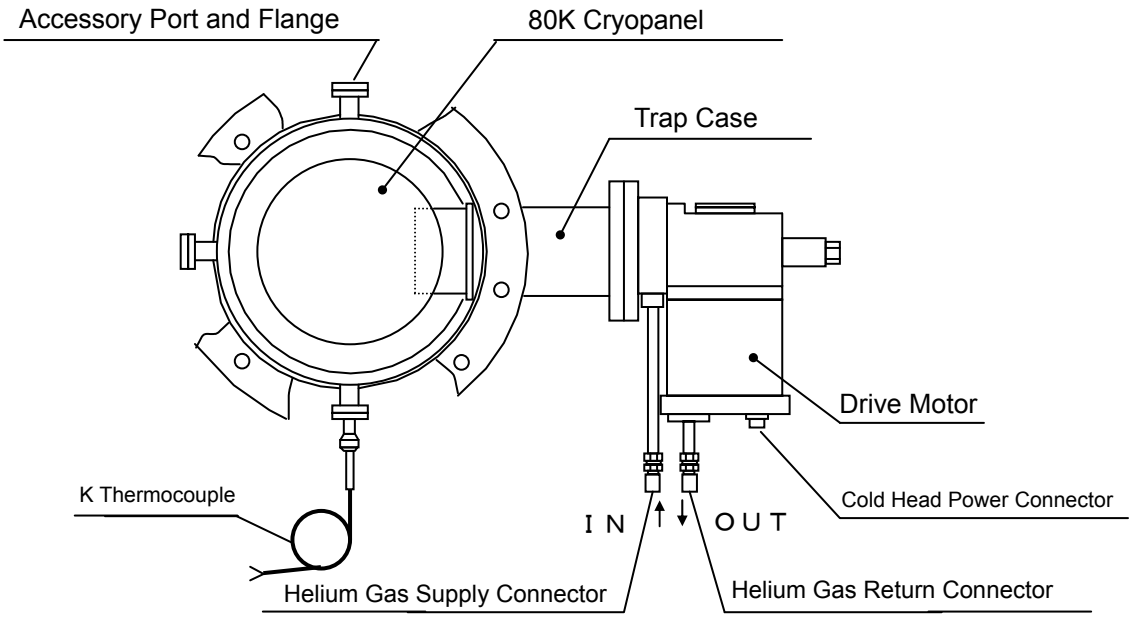


Figure 1-1 Standard Inline Configuration





For the external drawings, refer to “Specifications” delivered along with the product.

Figure 1-2 Major Components of Inline Super Trap

1.3. Standard In-Situ Configuration

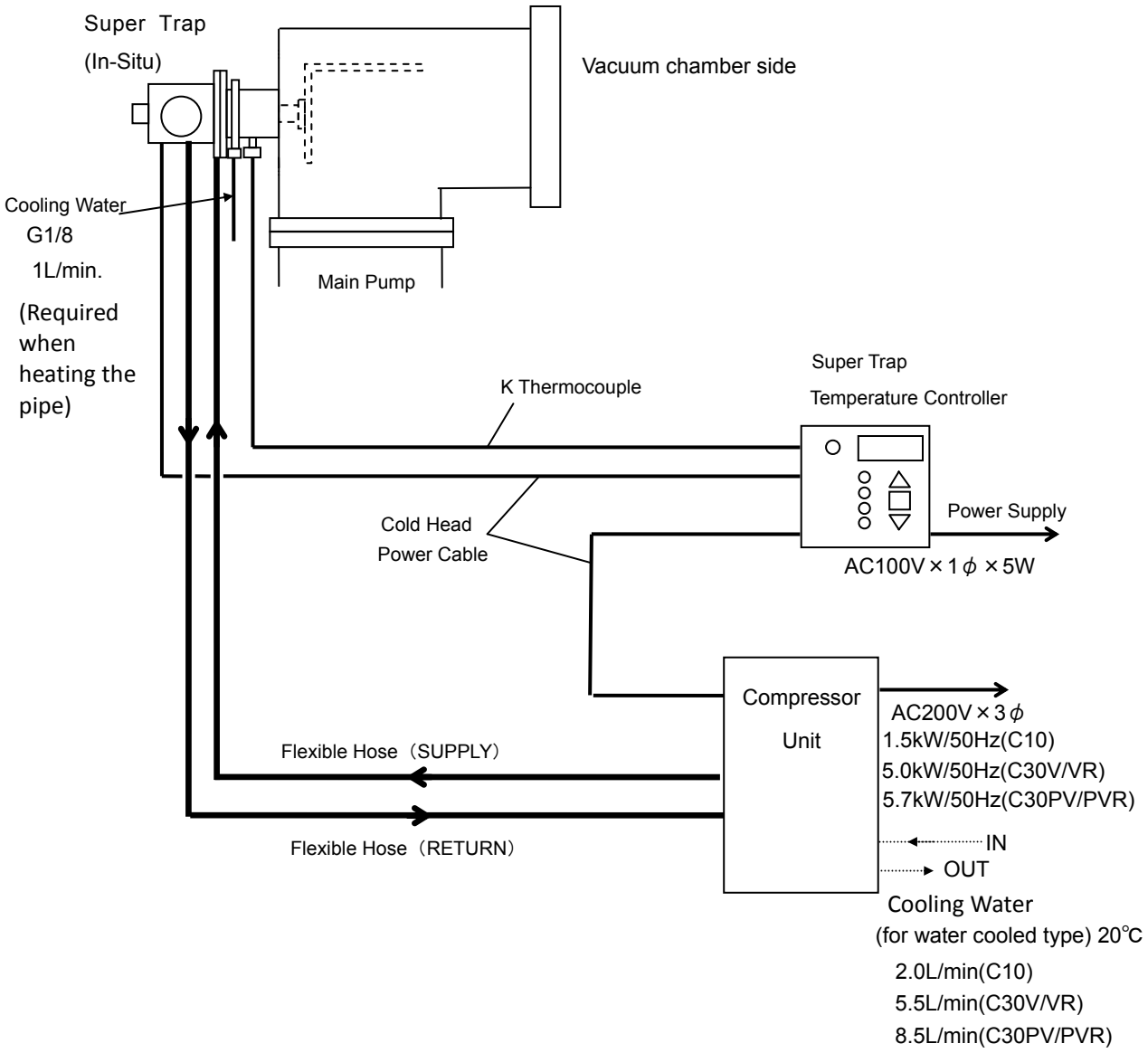
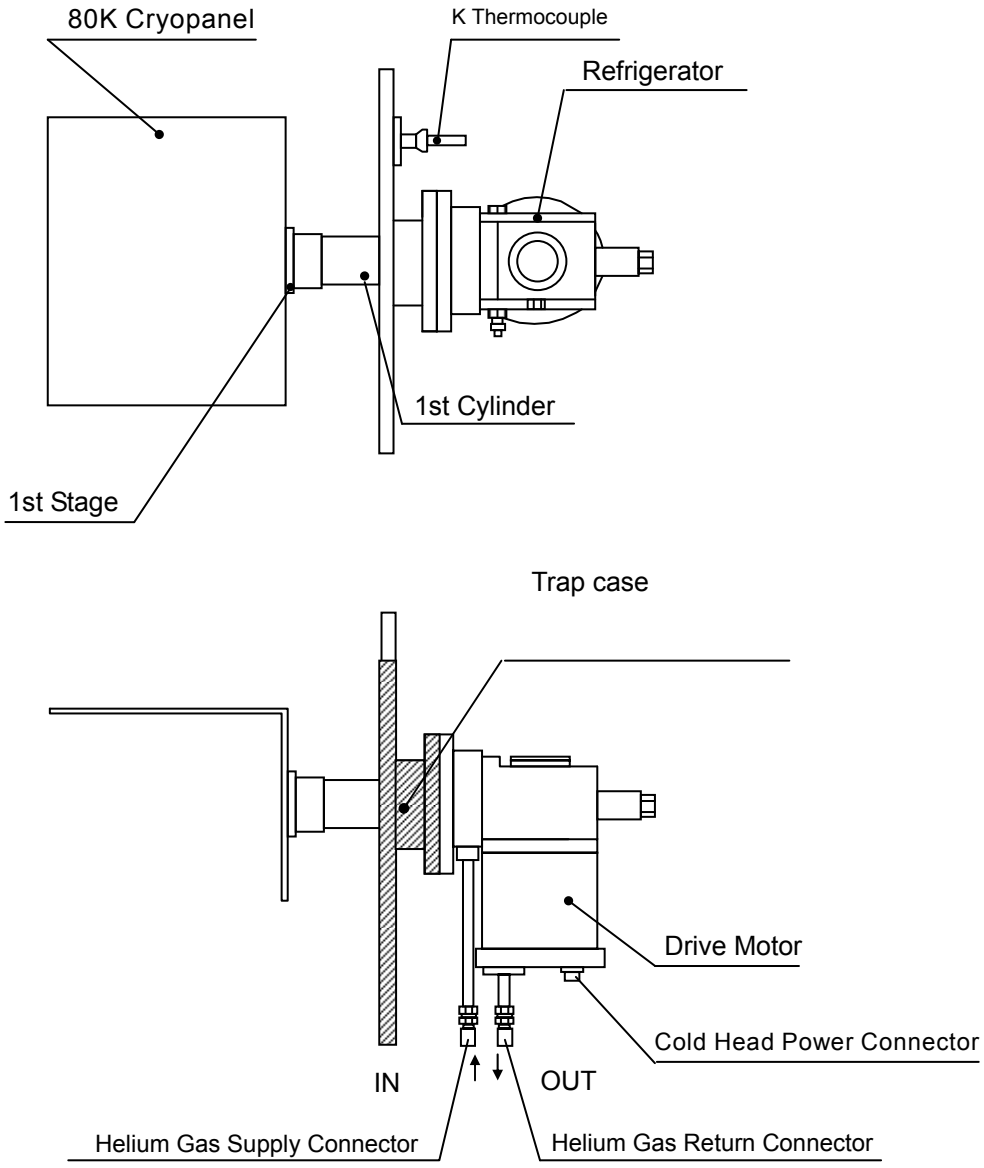


Figure 1-3 Standard In-Situ Configuration



For the external drawings, refer to “Specifications” delivered along with the product.

Figure 1-4 Major Components of In-Situ Super Trap

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2. INSPECTION

2.1 Shipping List

Our product has been fully inspected before shipment. However, please make sure that there is no visible damage, and items in the following tables have been delivered properly.

◇One CRYO-T Super Trap system (Three cartons)

Description	Quantity	Carton
CRYO-T Super Trap	1	1
Compressor Unit	1	1
Accessories	(*1)	1
Super Trap Temperature Control Box	1	

(＊1) Contents of accessories depend on the model of your compressor unit. Check the compressor unit instruction manual for details.

◇Super Trap assembly alone (One carton)

Description	Quantity	Carton
CRYO-T Super Trap	1	1
Super Trap instruction manual	1	
Specification sheet	1	

2.2 Super Trap

Remove the Super Trap from the shipping carton and check the following.

a. Any damages or dents to Super Trap exterior or accessories.
b. Any damages to the mounting flange or 80K cryopanel.
   Put the protective cover after the check.
c. Any damages to the K thermocouple.

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3. INSTALLATION

3.1 Auxiliary Equipments

For CRYO-T Super Trap system, following equipments are required.
Especially, the main pump such as cryopump, turbo molecular pump, diffusion pump, and roughing pump and valve are indispensable.

◆Main pump : Used to pump gases such as N_2 and Ar which cannot be pumped by the Super Trap. (e.g. Cryopump, Turbo Molecular Pump, Diffusion Pump)
The ultimate pressure of main pump shall be less than 0.1 Pa.

◆Roughing pump : Used to rough pump the Super Trap and discharge the released gases from Super Trap during regeneration. The ultimate pressure of roughing pump shall be less than 1Pa.

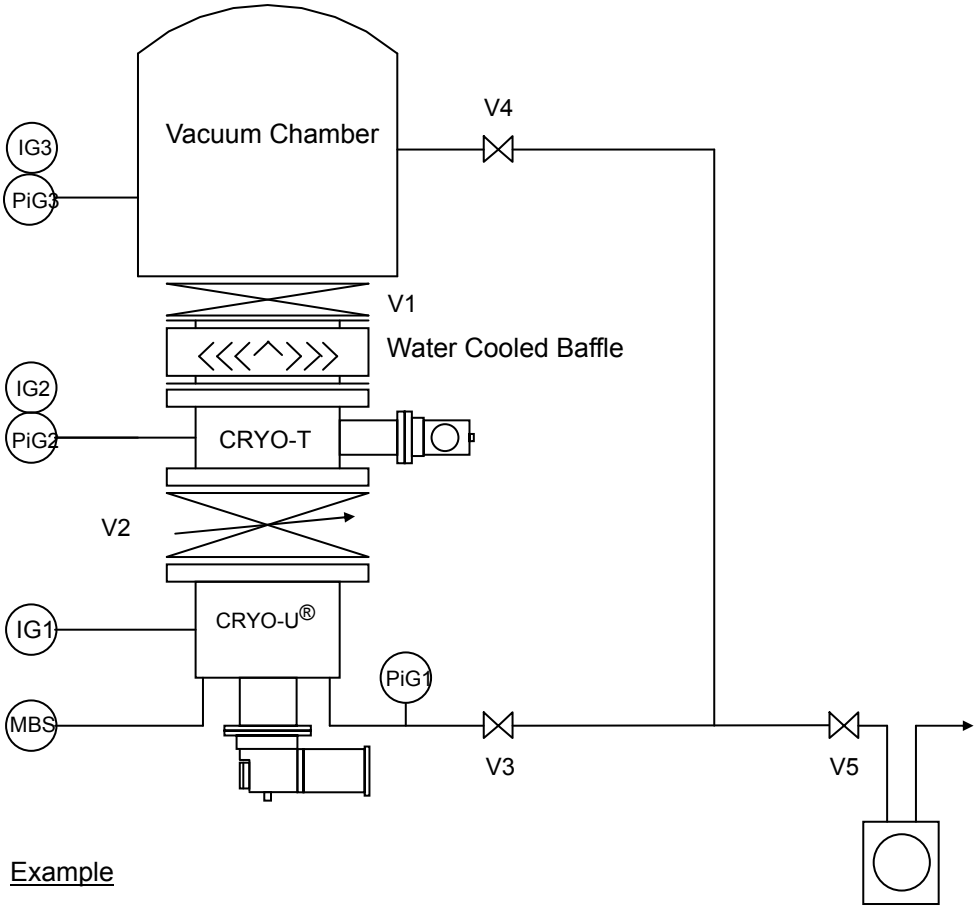
◆Roughing valve : Used to isolate the Super Trap from the roughing pump during Super Trap operation.

◇Vacuum gauge for rough pumping
: Used to measure the pressure during rough pumping and regeneration. Measurable range : Atmospheric pressure to 1Pa.

◇Vacuum gauge for high-vacuum pumping
: Used to measure the pressure during Super Trap operation.
Ionization gauge is recommended.
Measure range : 10^{-1} to 10^{-6}Pa

◇Main valve : Used to isolate vacuum chamber from Super Trap to prevent contamination caused by discharged gases from Super Trap. Gate valve, clapper valve, or L-type valve is used.

3.1.1 Installing Inline and Appendage Super Trap

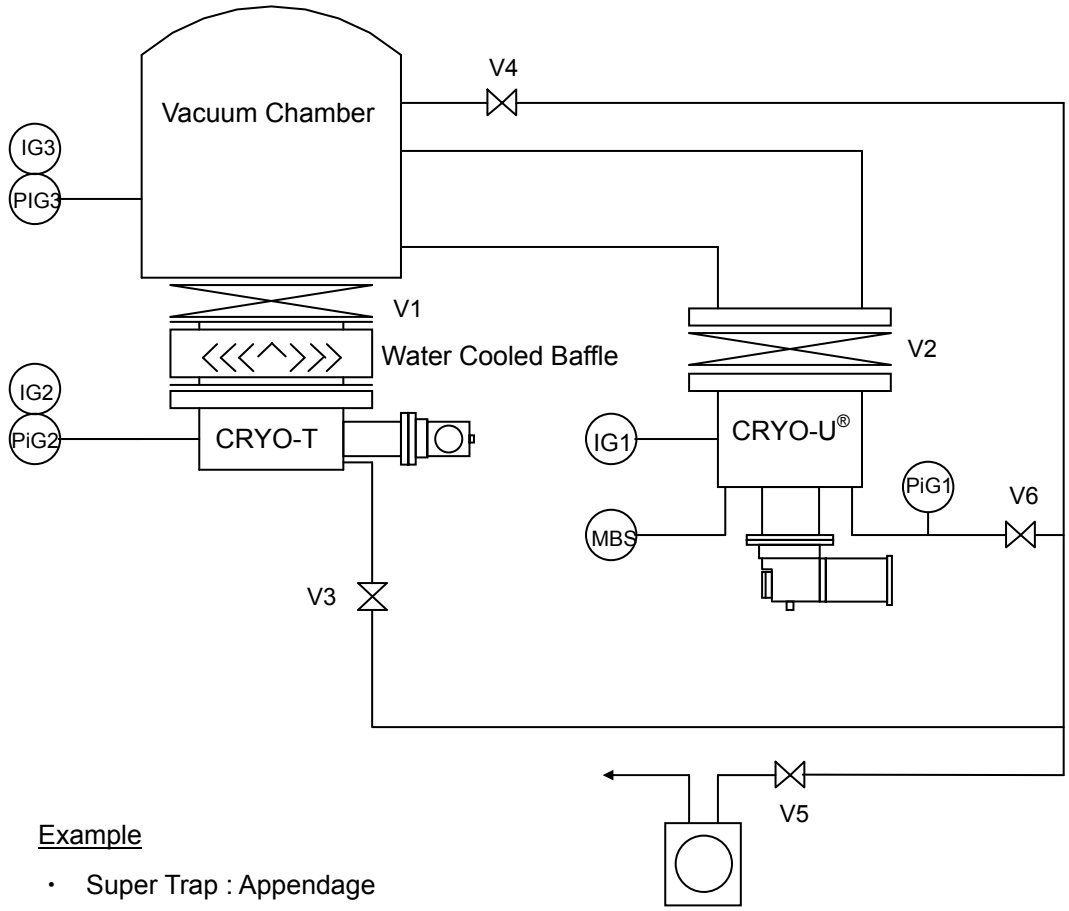


Example

- Super Trap : Inline
- Main Pump : Cryopump

MBS : CRYO METER MBS
PiG1 : CRYOPUMP PIRANI GAUGE
PiG2 : SUPER TRAP PIRANI GAUGE
PiG3 : VACUUM CHAMBER PIRANI GAUGE
IG1 : CRYOPUMP IONIZATION GAUGE
IG2 : SUPER TRAP IONIZATION GAUGE
IG3 : VACUUM CHAMBER IONIZATION GAUGE
V1 : MAIN VALVE
V2 : CONDUCTANCE VALVE
V3 : CRYOPUMP AND SUPER TRAP ROUGHING V ALVE
V4 : VACUUM CHAMBER ROUGHING VALVE
V5 : ROUGHING VALVE

Figure 3-1 Pumping System for Inline Super Trap



Example

- Super Trap : Appendage
- Main Pump : Cryopump

MBS : CRYO METER MBS
PiG1 : CRYOPUMP PIRANI GAUGE
PiG2 : SUPER TRAP PIRANI GAUGE
PiG3 : VACUUM CHAMBER PIRANI GAUGE
IG1 : CRYOPUMP IONIZATION GAUGE
IG2 : SUPER TRAP IONIZATION GAUGE
IG3 : VACUUM CHAMBER IONIZATION GAUGE
V1 : MAIN VALVE
V2 : MAIN VALVE
V3 : SUPER TRAP ROUGHING V ALVE
V4 : VACUUM CHAMBER ROUGHING VALVE
V5 : ROUGHING VALVE
V6 : CRYOPUMP ROUGHING VALVE

Figure 3-2 Pumping System for Appendage Super Trap

■Installing Super Trap to Vacuum System

◇The Super Trap may be installed in any orientation. However, if the orientation is changed during operation, the coldhead performance may be deteriorated. Contact us when you wish to change the orientation.

◇If the chamber has any heat source, install the Super Trap in a way that the intake of a Super Trap does not to face directly to the heat source. Refer to Figure 3-3 for recommended mounting locations.

◇Refer to Figure 3-4 for recommended maintenance space for Super Trap.

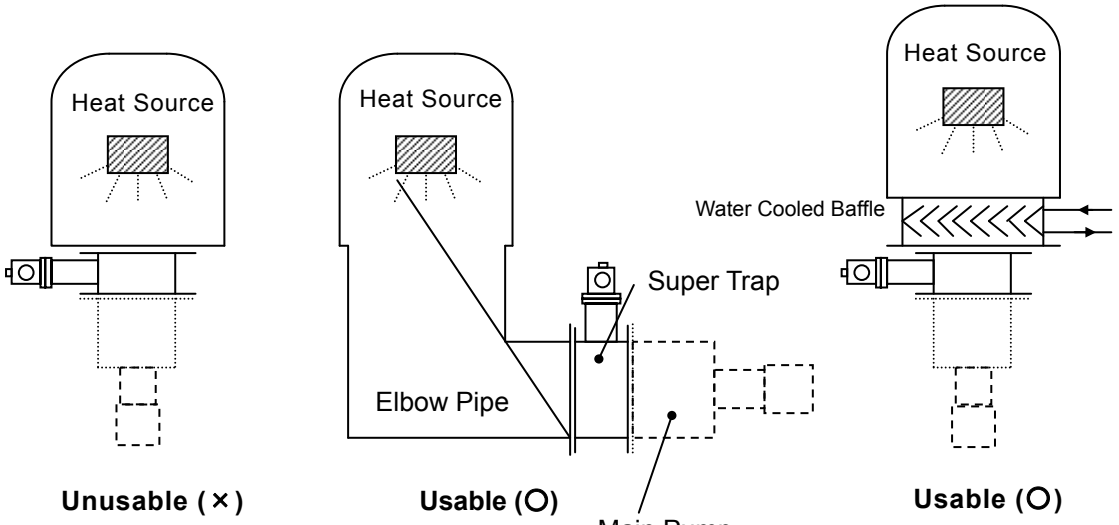
◇Install main valve between the Super Trap and vacuum chamber.

Install the CRYO-T Super Trap as follows:

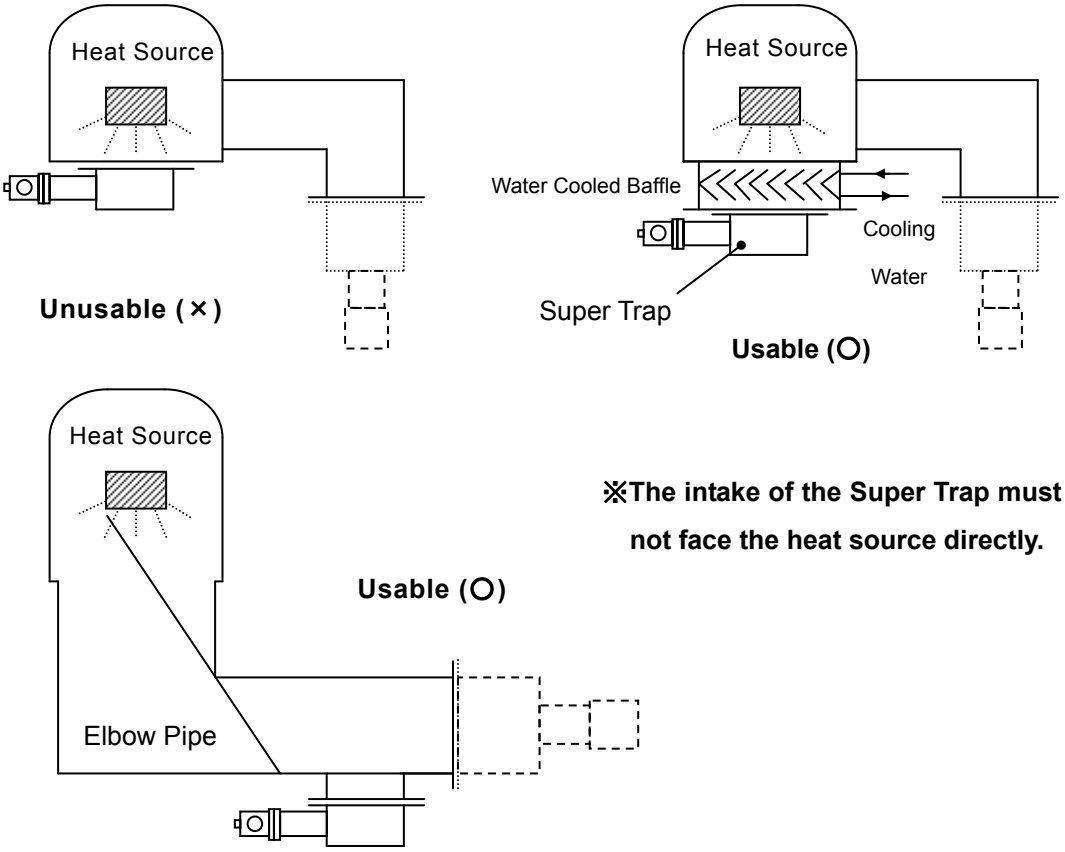
1. Remove the protective cover from Super Trap.
2. Clean the surface of the flange and insert the O-ring into the O-ring groove uniformly.
3. Install Super Trap to main valve or vacuum chamber.

Make sure that all bolts are firm enough.

【Inline】

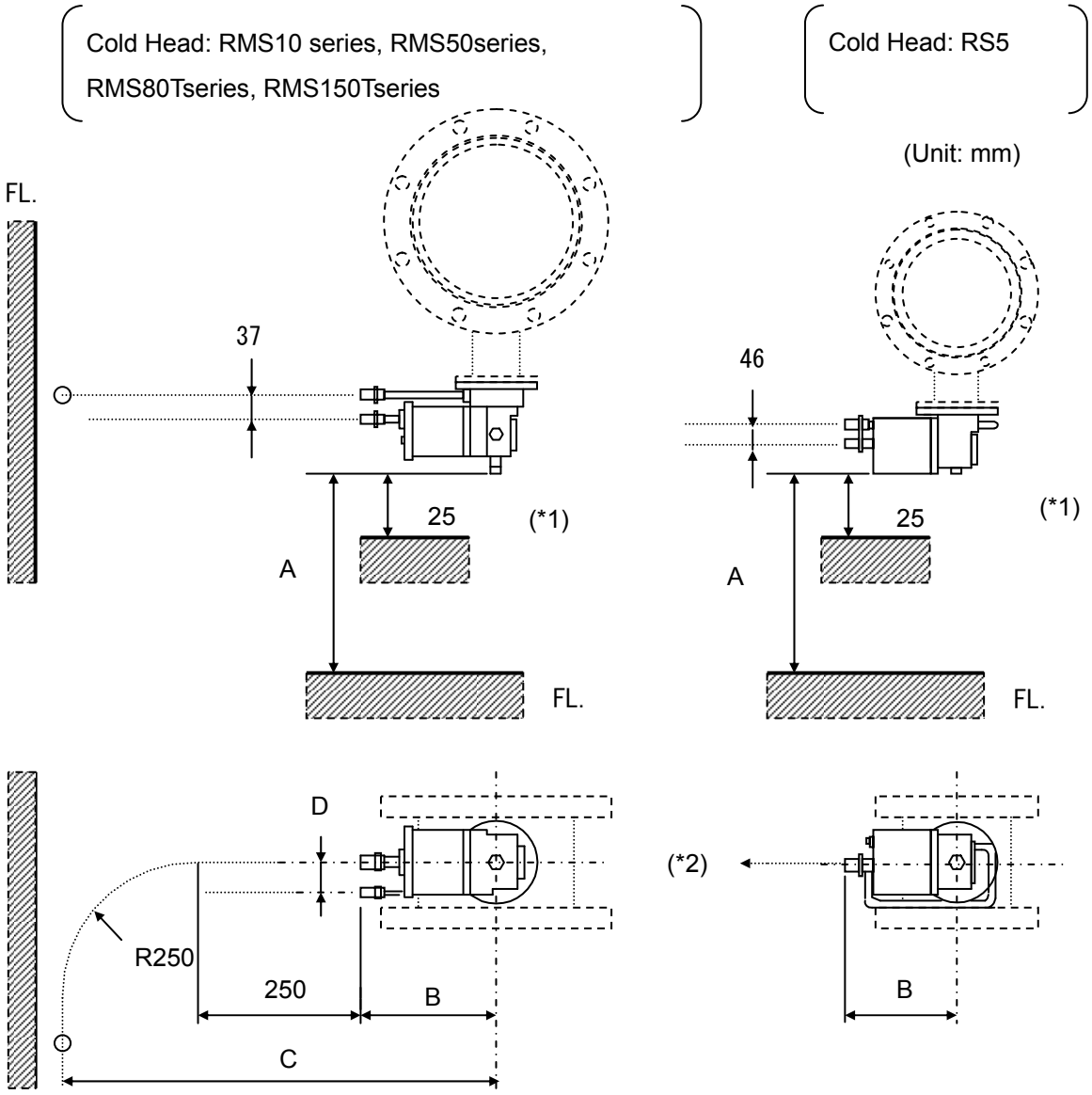


【Appendage】



※The intake of the Super Trap must not face the heat source directly.

Figure 3-3 Installation to the Vacuum System with Heat Source
(Inline and Appendage)



NOTE

(*1) Install the cold head unit considering the space for maintenance activities. “A” is the recommended distance.

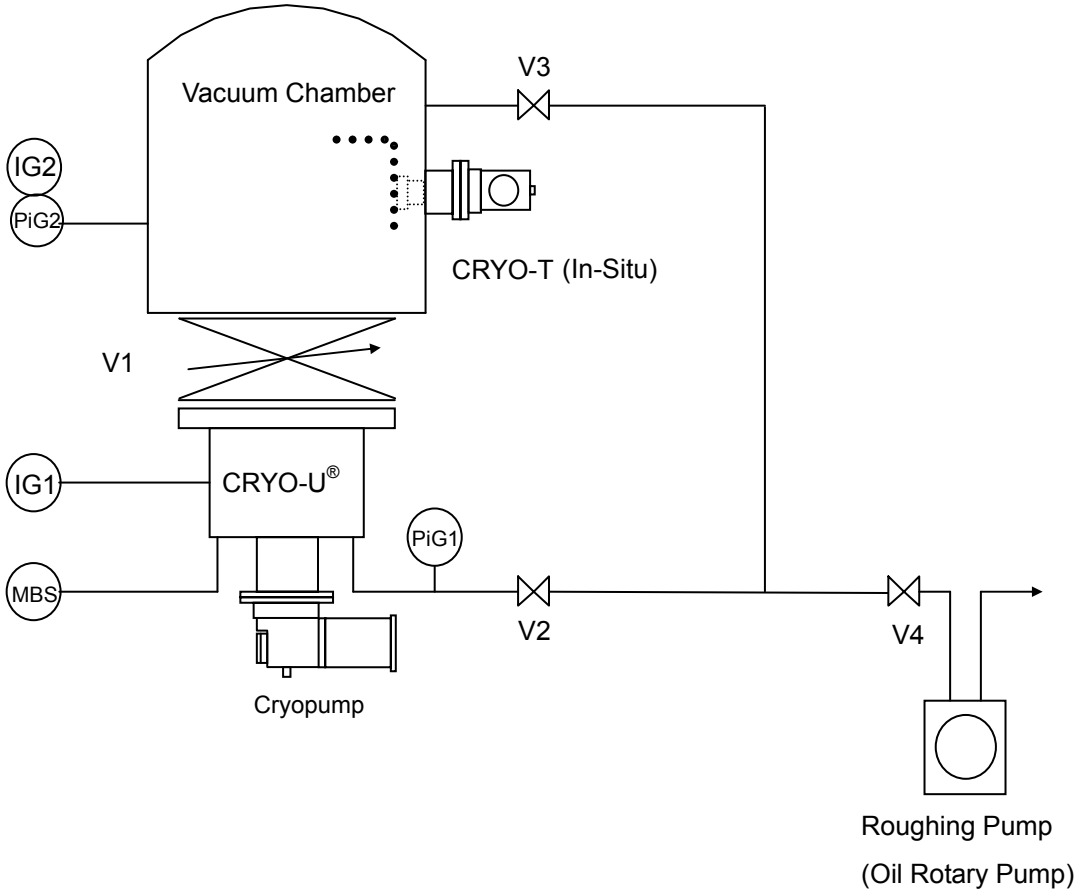
(*2) The distance of the flexible hose to the floor is the same as the figure on the left.

(Unit:mm)

	RMS10 RMS10T	RMS50 RMS50T	RMS80T	RMS150T	RS5
A	210	210	210	250	115
B	248	295	295	317	197
C	748	795	795	817	697
D	68	68	72	72	-

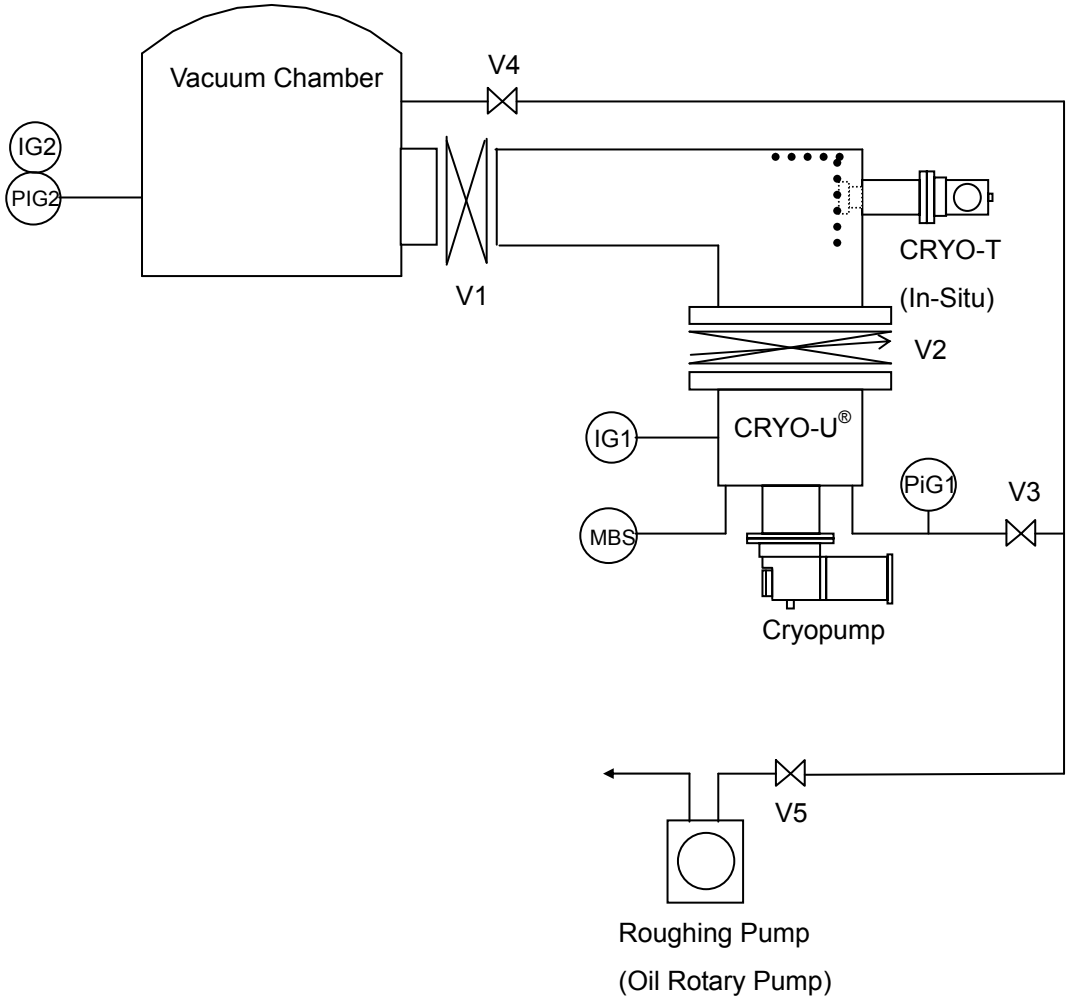
Figure 3-4 Installation & Maintenance Space (Inline and Appendage-type)

3.1.2 Installing In-Situ Super Trap



MBS : CRYO METER MBS
PiG1 : CRYOPUMP PIRANI GAUGE
PiG2 : VACUUM CHAMBER PIRANI GAUGE
IG1 : CRYOPUMP IONIZATION GAUGE
IG2 : VACUUM CHAMBER IONIZATION GAUGE
V1 : CONDUCTANCE VALVE
V2 : CRYOPUMP ROUGHING VALVE
V3 : VACUUM CHAMBER ROUGHING VALVE
V4 : ROUGHING VALVE

Figure 3-5 Vacuum System Schematic Diagram for In-Situ type (1)



MBS : CRYO METER MBS
PiG1 : CRYOPUMP PIRANI GAUGE
PiG2 : VACUUM CHAMBER PIRANI GAUGE
IG1 : CRYOPUMP IONIZATION GAUGE
IG2 : VACUUM CHAMBER IONIZATION GAUGE
V1 : MAIN VALVE
V2 : CONDUCTANCE VALVE
V3 : CRYOPUMP ROUGHING VALVE
V4 : VACUUM CHAMBER ROUGHING VALVE
V5 : ROUGHING VALVE

Figure 3-6 Vacuum System Schematic Diagram for In-Situ type

■Installing Super Trap to Vacuum System

◇There is no limitation on the CRYO-T Super Trap mounting angle. However, when the mounting location is needed to be changed, please contact us.

◇If the chamber has any heat source, install the Super Trap not to face directly to the heat source. Refer to Figure 3-7 for recommended mounting locations.

◇Refer to Figure 3-9 for recommended maintenance space for Super Trap.

◇Install the CRYO-T Super Trap as follows:

●When a cold head and 80K cryopanel are delivered as assembly.

1. Remove the Super Trap from the shipping carton. Do not touch 80K cryopanel with bare hands.
2. Clean the surface of the mounting flange of the Super Trap and install the gasket (O-ring or metal gasket). Then install the Super Trap and fix it with bolts.
   When the customer install K thermocouple, be sure to put indium sheet on to the crimping terminal of K thermocouple and install it in the proper position.
   Refer to Figure 3-8 and Specifications for the installing method.
3. Make sure that no bolt loosened and then perform leak test.

●When a cold head and 80K cryopanel are delivered separately.

1. Remove the Super Trap from the shipping carton. Do not touch 80K cryopanel with bare hands.
2. Clean the surface of the mounting flange of the Super Trap and install the gasket (O-ring or metal gasket). Then install the Super Trap and fix it with bolts. Make sure that all bolts are tightened firmly.
3. In order to keep good thermal conduction, put indium sheet on to the heat station of cold head, and then install the 80K cryopanel.
4. Put indium sheet on to the crimping terminal of K thermocouple and install it in the proper position referring to Figure 3-8 and Specifications.
5. Make sure that there are no bolts loosening and then perform leak test.

CAUTION

- If K thermocouple is installed loosely or without indium sheet, it does not measure temperature correctly and may result in damage to the 80K cryopanel or cold head. Especially, the Super Trap with inner heater needs to be handled with special care.
- Always use new indium sheet and never reuse them.

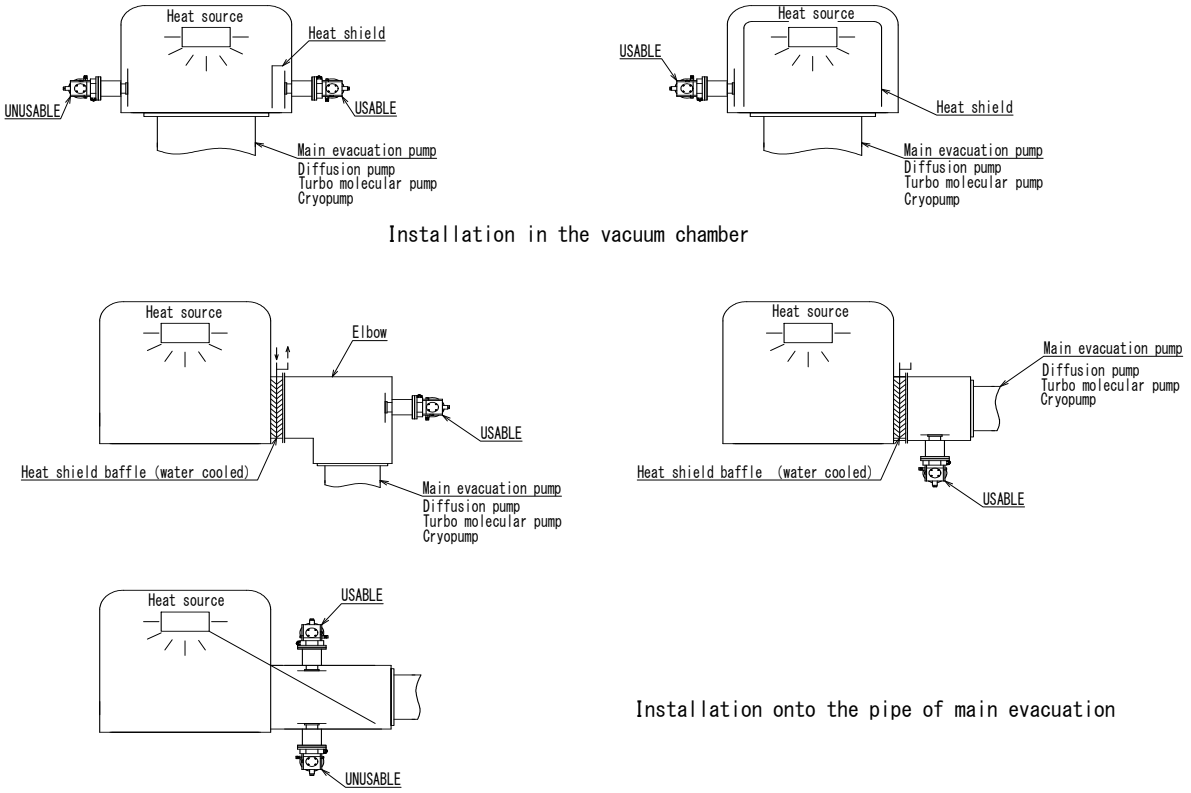


Figure 3-7 Installation to the Vacuum System with Heat Source (In-Situ)

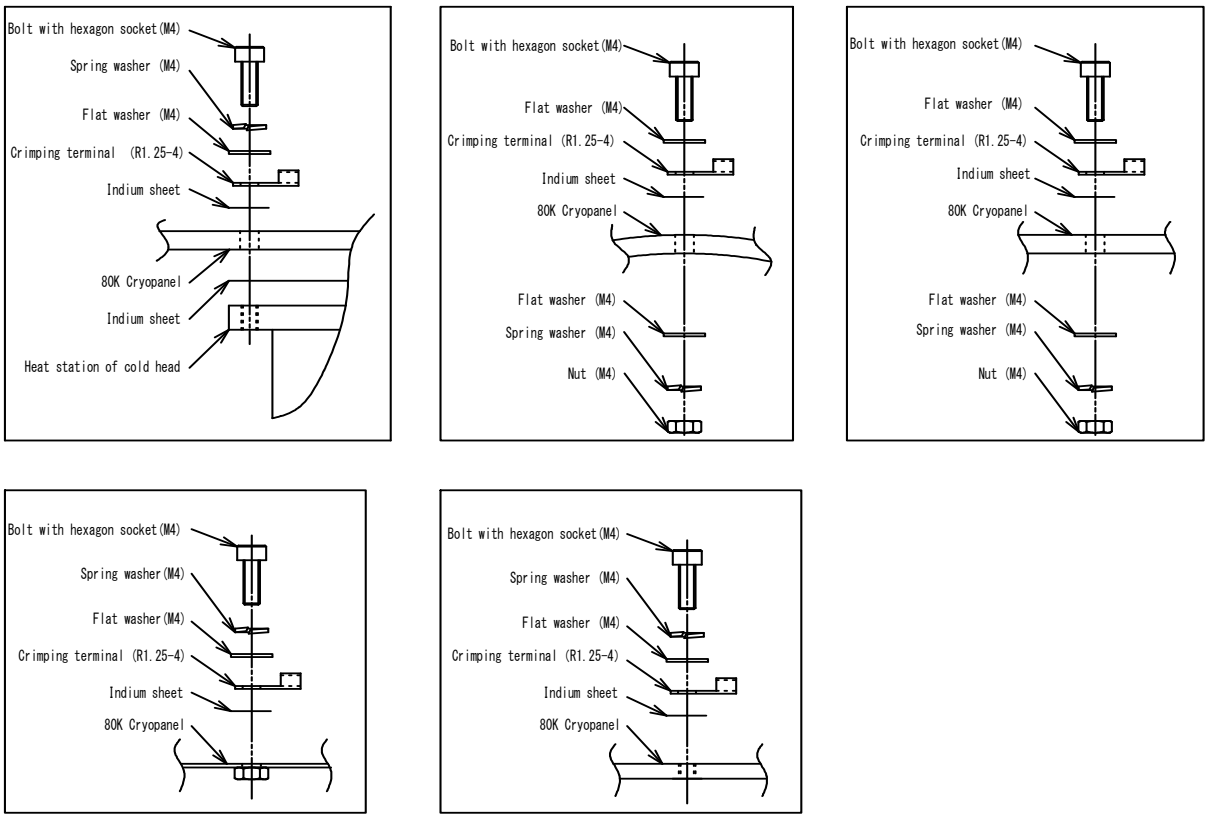
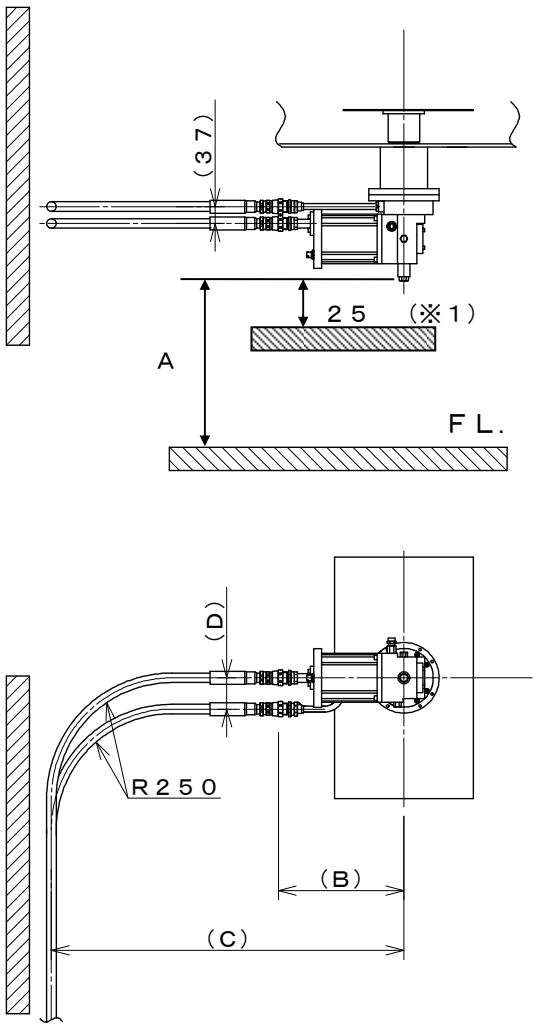


Figure 3-8 K thermocouple Installation (In-Situ type)

(Unit: mm)



NOTE

(*1) Install the cold head unit considering the space for maintenance activities. “A” is the recommended distance.

(Unit: mm)

	RMS10 RMS10T	RMS50 RMS50T	RMS80T	RMS150T
A	210	210	210	250
B	248	295	295	317
C	748	795	795	817
D	68	68	72	72

Figure 3-9 Installation & Maintenance Space (In-Situ)

3.2 Connecting Super Trap to Compressor Unit (Connecting Flexible Hose)

CAUTION

- Read the handling notes in appendix B about the connection of the flexible hoses.
- When connecting flexible hoses, always use two single head spanners of width across flat 26mm and 30mm.
- Do not forcibly bend flexible hoses. They may be damaged and cause helium leakage.
- Do not connect or disconnect self-sealing coupling frequently. It may cause gas leakage.
- If there is a leakage, you may have to replace it with a new one according to the situation of the occurrence of leakage.

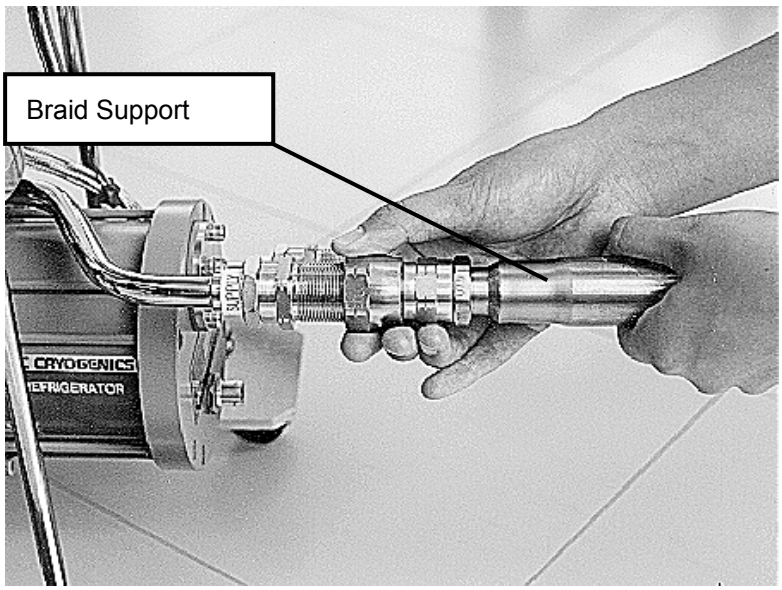
1. Remove all dust plugs and caps from supply and return flexible hoses, compressor unit and cryopump. Clean flat rubber gaskets on the self-sealing couplings to be free from dust or metallic powder.
2. Connect the flexible hoses between the compressor unit and the cryopump as follows (see Figure 3-10):
   a. Connect one end of the “SUPPLY” labeled flexible hose to the helium-gas SUPPLY connector on the compressor unit, and connect the other end of the hose to the SUPPLY connector of the Super Trap.
   b. Connect one end of the “RETURN” labeled flexible hose to the helium-gas RETURN connector on the compressor unit, and connect the other end of the hose to the RETURN connector of the Super Trap.
3. Check the helium gas pressure on the compressor unit. If the pressure is higher than the specified value, pull out the helium gas by opening the gas charge valve **slowly**. If the pressure is lower than the specified value, charge helium gas as described in Section 6.3 in this manual.

3.3 Connecting Electrical Cables

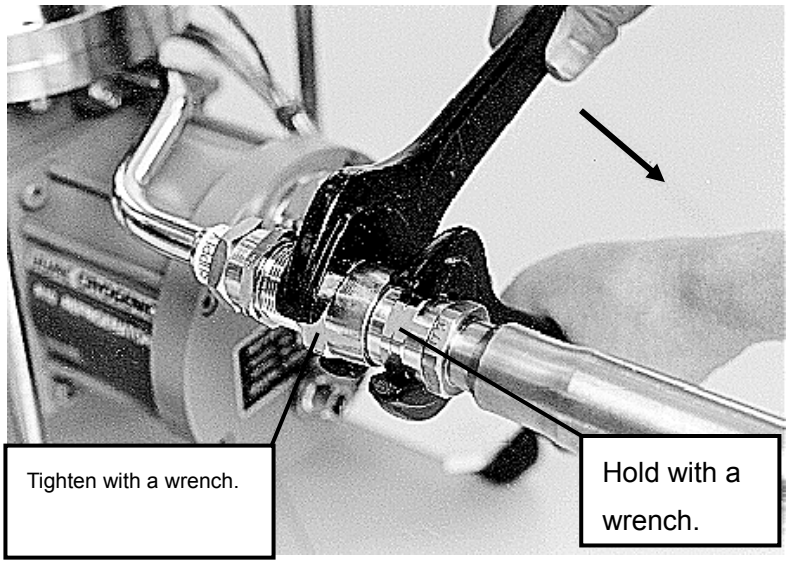
WARNING

- Do not connect the compressor unit power cable until all other connections have been made between the components and the cryopump system.

1. Connect the refrigerator power cable from the compressor unit to the cryopump.
2. Connect the ground.
3. Connect the input power cable from the compressor unit to its power source.
4. The procedure to startup the compressor unit differs depending on the models.
   Refer to the compressor unit instruction manual for more information.



①Hold the braid support straight and tighten the self-sealing coupling by hand.



②Tighten the self-sealing coupling using two wrenches **until the fittings are firmly sealed.** When using torque wrench, the recommended torque value is 20N･m.

Figure 3-10 Connecting Flexible Hoses

3.4 Disconnecting Flexible Hose

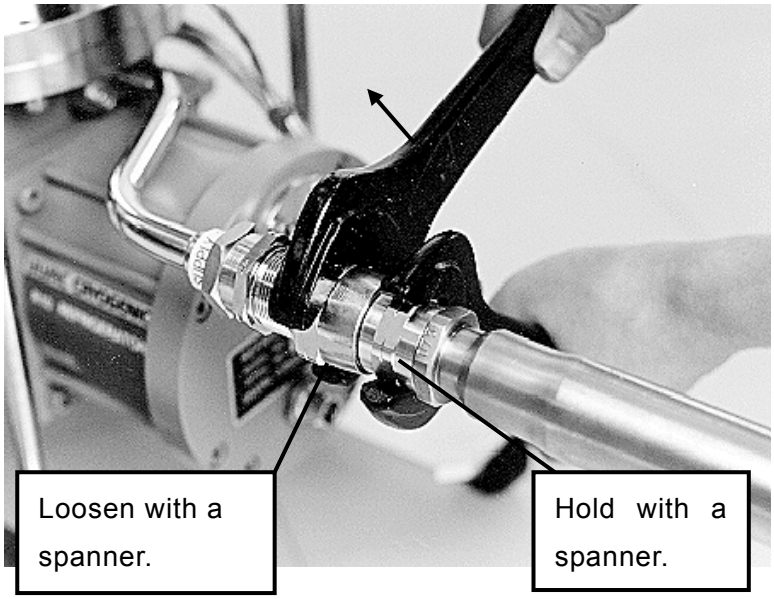
CAUTION

When disconnecting flexible hoses, be sure to use two single open end spanners with width across flat 26mm and 30mm.

1. Shut down the compressor unit.
2. After the Super Trap has been warmed up to room temperature, disconnect the flexible hoses.

CAUTION

- If removing the flexible hoses before the refrigerator reaches room temperature, helium gas shut up into the refrigerator increases pressure with the rise of temperature, and may blow off from a pressure relief valve finally. It might cause a helium leakage also.
- However, only when carrying out helium circuit decontamination procedures for the refrigerator unit, disconnect the flexible hoses from helium gas supply and return connectors at the compressor unit side right after shutdown. Refer to Section 6.4 for more details.



Loosen the self-sealing coupling using two spanners.

Figure 3-11 Disconnecting Flexible Hose

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4. OPERATION

*The procedures described in this section is referring to an exhaust system showed in Figure 3-1.

4.1. Before Startup

Before starting operation, check the following:

1. The flexible hoses and cables are properly connected.
2. The gauges are mounted on appropriate ports.
3. The main valve is closed.
4. The roughing valves are closed.
5. The helium gas pressure gauge on the compressor unit reads the specified value.

It is recommended to keep an operating log to find the first sign of trouble as fast as possible. This will help you get prompt technical assistance from us. The operating log is in Appendix A.

4.2. Rough Pumping

4.2.1. Roughing Inline / Appendage Super Trap

Super Trap Single Operation

Rough pump the Super Trap to the pressure which can keep the adiabatic vacuum (10^{-1} - 10^{-2}Pa).

Operation in Conjunction with Main Pump (Cryopump, Oil Diffusion Pump, Turbo Molecular Pump)

Rough pump the vacuum chamber to the roughing pressure of the main pump, then start up the Super Trap at the same time as starting the main pump operation. Refer to the main pump instruction manual for the appropriate roughing pressure.

1. Startup the roughing pump.
2. Open the roughing valves and then rough pump the Super Trap.

4.2.2. Roughing In-Situ Super Trap

1. Turn ON the roughing pump.
2. Open the roughing valves and then rough pump the Super Trap.

Super Trap Single Operation

Rough the Super Trap to the pressure which can keep the adiabatic vacuum (10^{-1} - 10^{-2}Pa).

Super Trap Operation in Conjunction with Main Pump (Cryopump, Oil Diffusion Pump, Turbo Molecular Pump)

Rough pump the vacuum chamber to the roughing pressure of the main pump, then start up the Super Trap at the same time as starting the main pump operation. Refer to the main pump instruction manual for the appropriate roughing pressure.

4.3. Startup and Cooldown

1. Turn ON the compressor unit and start the Super Trap system. For the operation in conjunction with a main pump, start the Super Trap and the main pump at the same time.

† For Your Information †

Confirm the cold head motor is running smoothly by the sound of its internal devices. When the cooldown operation is steady state, the noise from cold head becomes silent. At the same time, the choo-choo sound from helium gas inlet and outlet becomes louder.

2. When the 80K cryopanel reaches 130K, the cooldown is completed. Refer to attached specifications for the cooldown time of your Super Trap.
3. Record the cooldown time to reach 130K and the gas pressure of the compressor unit at 130K in your operating log.

CAUTION

- 130K is roughly estimated temperature that cooldown completes. Set appropriate value between 90K and 130K according to the process conditions that are considered to give large thermal load, or the size of your Super Trap. Please contact our sales representatives if you are unaware of the proper value for your traps.
- Super Trap CRYO-T series are designed to remove water vapor. If the target temperature is set below 90K, the Super Trap may pump gases other than water (CO_2, Ar, etc.) depending on the pressure during the process. This might make the pressure inside the vacuum chamber unstable depending on the set temperature. If you wish to pump gases other than water vapor, please contact us for the information on the optimal operating conditions of your process.
- When one compressor runs multiple Super Traps, the helium pressure during operation might be outside of the desired range depending on the set temperature, which might affects the life of a Super Trap. Please contact our sales representatives for the temperature settings in such cases.

CAUTION

If the Super Trap becomes incapable of maintaining high-vacuum, water vapor will be condensed on the Super Trap case. It can cause short-circuit if there are electrical devices (such as electrical circuit) under the Super Trap.

† For Your Information †

In case the radiation heat load is high, the cooldown time will be longer.

4.4. Normal Operation

The CRYO-T Super Trap system is designed to operate without operator assistance.
Please keep your operating log regularly.

4.4.1. Operating Inline/Appendage Super Trap

1. Make sure that the 80K cryopanel has reached 130K or lower. Then turn ON the roughing pump and open the roughing valves（V4）.
2. When the pressure of vacuum chamber has reached 40Pa, close the roughing valves（V4）and then turn OFF the roughing pump.
3. Open the main valve（V1） and evacuate the vacuum chamber.
4. When the pressure of the vacuum chamber has reached the target pressure, proceed with vacuum process such as deposition or sputtering. The time required to reach the target pressure depends on the volume, contents, and the wall condition of the chamber, etc.

4.4.2. Operating In-Situ Super Trap

1. Make sure that the 80K cryopanel has reached 130K or lower.
2. When the pressure of the vacuum chamber has reached the target pressure, proceed with vacuum process such as deposition or sputtering. The time required to reach the target pressure depends on the volume, contents, and the wall condition of the chamber, etc.

Table 4-1 Super Trap Operating Parameter (Room Temperature : 20°C)

	UNIT	Stop	Normal Operation (*1)
K Thermocouple	mV	0	＜－5.5
(80K Cryopanel temp.)	K	293	＜130

(*1) Operation with no load

CAUTION

If the Super Trap becomes incapable of maintaining high-vacuum, water vapor will be condensed on the Super Trap case. It can cause short-circuit if there are electrical devices (such as electrical circuit) under the Super Trap.

4.5. Shutdown Procedures

4.5.1. Shutdown of Inline/Appendage Super Trap

1. Close the main valve（V1）.
2. Turn OFF the compressor unit and the cold head (the Super Trap).
3. After the 80K cryopanel has reached room temperature, rough pump the Super Trap to 10 to 100Pa.

   Take required procedures for the Super Trap regeneration until next process will begin.

   Keep the Super Trap in the best conditions so that it can work any time when needed.

4.5.2. Shutdown of In-Situ Super Trap

1. Turn OFF the compressor unit and the cold head (the Super Trap).
2. After the 80K cryopanel has reached room temperature, expose the vacuum chamber to atmosphere.

CAUTION

- Exposing vacuum chamber to air before 80K cryopanel has reached room temperature (273K or more) may cause water condensation on 80K cryopanel. It is recommended to place a tray or the like under 80K cryopanel to catch water droplet.
- When using a heater to remove the water vapor condensed on 80K cryopanel, ensure to keep the temperature of 80K cryopanel under 70°C by controlling the heater.

4.6. Storage

◆When the Super Trap is stored as it is attached to the vacuum system, the vacuum chamber should be kept in a vacuum state(10 to 100Pa), or filled with dry nitrogen with due temperature of -40°C or below or argon at a pressure which is a little higher than atmosphere.

◆When stored after removing from the vacuum system;

1. Before removing the Super Trap from vacuum chamber, make sure that the Super Trap has reached room temperature.
2. After the Super Trap has reached room temperature completely, disconnect the flexible hoses.
3. Put the protective cover on the mounting flange of the Super Trap.
   Put the protective cap on the helium gas connector of the Super Trap.
   Cover the entire body of the Super Trap with plastic sheet as it was shipped.
4. Super Traps should be kept away from direct sun light, high temperature, humidity, dust, vibration, radiation, wind and rain.

◆Shipment of the Super Trap

Put all covers and caps as it was shipped and avoid excessive shock.

◆Connect the refrigerator cable and operate the Super Trap for about 10 minutes once in six months.

It lubricates the bearing used inside of the cold head with grease.

If the Super Trap had been left for more than one year, perform cold head decontamination.

4.7. Handling of Hazardous Materials

WARNING

◆When pumping toxic gas, corrosive gas, combustible gas, or explosive gas, please be sure to take sufficient safety measures based on respectively required statute(s) and rule(s), and put it into effect under the user's responsibility.

In addition, ensure that the pressure inside the Super Trap does not exceed atmospheric pressure with those gases during regeneration.

Please refer to Safety Instructions of Cryopump manual for these hazardous gases.

◆When transporting the Super Trap which exhausted the hazardous materials, please take appropriate disposal according to the regulation system of each area and a country.

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5. REGENERATION

* The procedures described in this section is referring to an exhaust system showed in Figure 3-1, Example (1).

5.1. The General

The Super Trap requires periodical regeneration to maintain the performance before they reach the pumping capacity. Gases are condensed or adsorbed on the cryogenically-cooled surface and turn into ice. Therefore, the trapped gases should be released into the atmosphere through a vent valve by warming up the Super Trap to room temperature or higher.

WARNING

◆Always vent toxic, corrosive, dangerous gases to a safe location not to be harmful to humans.
◆Hot surface may cause burn injury.

5.2. Regeneration Time

Perform regeneration when one of the operating parameters becomes the following state:

- 80K cryopanel temperature becomes 130K or more.
- When the pressure of the vacuum system cannot reach the intended value in the specification after closing the main valve.
- When the amount of pumped gases has reached its pumping capacity.
- When the pumping performance does not meet its capacity described in the specification.

5.3. Regeneration Procedures

There are three processes for regeneration.

◇Warm-up

To warm-up 80K cryopanel to room temperature or higher.

There are “Unassisted Warm-up” and “Assisted Warm-up.” (Refer to Section 5.4.)

◇Pumping of released gases

◇Cooldown

5.3.1. Regeneration Procedures of Inline/Appendage Super Trap

1. Close the main valve (V1).
2. Turn OFF the Super Trap system.
3. Warm-up the Super Trap.

CAUTION

When warming up the Super Trap, water vapor will be condensed on the Super Trap case. It can cause short-circuit if there are electrical devices (such as electrical circuit) under the Super Trap.

4. When the 80K cryopanel temperature becomes 5 to 10°C, open the roughing valve (V2) and rough pump the Super Trap to 40Pa.
5. When the pressure inside reaches 40Pa, close the roughing valve (V2).
6. Run the Super Trap and cool down to the target temperature.
   This is the end of the regeneration procedure.

5.3.2. Regeneration Procedures of In-Situ Super Trap

1. Turn OFF the Super Trap system.
2. Warm-up the Super Trap.
   During warm-up, you may evacuate the vacuum chamber by the main pump.
   However it will take long to complete the warm-up in the vacuum atmosphere.
3. When the 80K cryopanel reaches to 5°C to 10°C, start roughing the vacuum chamber.

CAUTION

When evacuating large amount of water, it is recommended to place a tray underneath the 80K cryopanel so that the water vapor condensed on the 80K cryopanel will not drip off.
Also, the water vapor condensed on the trap case can cause short-circuit if there are electrical devices (such as electrical circuit) under the Super Trap.

† For Your Information †
Required warm-up time for 80K cryopanel depends on the amount of gas pumped.

5.4. Assisted Warm-up

◆Introducing Inert Purge Gas (use nitrogen gas that its dew point temperature is -40°C or below or argon.)

Using nitrogen gas with dew point temperature of -40°C or below (or argon) for warm-up made a regeneration procedure more efficient than unassisted warm-up, which means to stop a Super Trap and leave it until it warms up to a room temperature.

Perform inert purge gas as follows:

1. Close the main valve and shut down the Super Trap. Then, introduce inert gas (ambient temperature) into the Super Trap.
2. When 80K cryopanel reaches room temperature, stop inert purge gas.

◆Warm up by heaters

In addition to the method using inert gas described above, using an optional band heater or inner heater enables warm up time even shorter. (The band heater or inner heater is not applicable for certain types of cryopump.)

ULVAC CRYOGENICS offers different types of standard band heaters such as RBH type and silicon rubber type. The RBH band heaters self control the temperature around 70 to 80°C. The silicon rubber heater turns its power ON/OFF by its thermostat setting. Please refer to the instruction manual of each heater that you use for more information.

When using an inner heater, make sure to control the temperature with our Super Trap Heater Controller (optional) such as STC-2A. The warm-up completion temperature should be set at 300K. Please examine the temperature settings carefully, as sometimes, temperature overshoot may occur after turning off the electric power resulting in overheating the cold head unit. Please refer to the Super Trap Controller instruction manual for the detail.

When heaters are used after large amount of water is pumped, it is recommended to place a water tray underneath 80K cryopanel to avoid dripping off inside the vacuum chamber. With Inline Super Trap, please be careful not to damage the main pump by falling ice.

Please inform us in advance if you wish to control the temperature with your own regeneration procedure.



WARNING

Since the temperature of the inner heater surface and the heater port becomes very high, make sure to take necessary measures to prevent fire and burn injury and also display warnings to call attention for safety.

CAUTION

Maximum allowable temperature of the cold head unit is 70°C. If you use a heater, make sure to control the heater temperature so that the temperature of the cold stages of the refrigerator does not exceed 70°C. If it exceeds 70°C, inside of the cold head may be damaged by heat and the cold head may need to be replaced.

When warming up by baking or using a heater, always monitor and control the heater temperature so that the first or second stages do not exceed 70°C.

Our standard band heaters can control their own temperatures and can be used without an additional device to control the temperature. In addition, our Super Trap Controllers have overheat prevention function.

However, when using a heater other than our standard band heaters, make sure to have a measure to keep the temperature lower than 70°C such as using a temperature controller, overheat alarm function, or by observing and controlling the energizing time

◆ Water tray with heater

Following are the considerations when using a water tray with heater. Please contact our sales representatives for the detail information on operation.

CAUTION

- Make sure that water is below the maximum acceptable amount described in the drawings or specifications.
- Turn on the power around the temperature that the ice starts to fall on the water tray. If the power is turned on at the start of warm up, it may result in overheating due to heating an empty tray.

  The tray might be cooled below the freezing point (such as -20°C) due to radiant heat during the cooling down of cryopanels depending on where it is placed. If the heater is to be turned on at the higher temperature than this (such as -10°C), the heater might be turned on during the process despite you do not intend to. Please change the temperature setting or program interlocks in such a case.
- Refrain from turning ON and OFF the power to reduce the burden on the heater.
- The temperature settings should be lower than 70°C (343K). The overheat prevention should be set at 127°C (400K).
- Determine whether water or ice remains in the water tray by monitoring the temperature of the tray. When the temperature is below the freezing point during vacuum pumping, water or ice still remains and the heater should be turned on until roughing finishes. It is not recommended to use a software timer.
- The heater deteriorates over time and needs to be replaced on a regular basis depending on the frequency of usage. The heater should be replaced along with the tray.
- Start the maintenance service when long enough time passes after turning off the power and the temperature is below 40°C.
- Please be aware that the heater port can be as hot as 100°C.

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6. MAINTENANCE

6.1. Scheduled and Unscheduled Maintenance

Super Trap maintenance includes the following;

◇Scheduled Maintenance ： Cold Head Parts Replacement
Adsorber Replacement
Insulation performance check of heater for regeneration

◇Unscheduled Maintenance ： Super Trap Cleaning
Adding Helium Gas
Helium Gas Circuit Decontamination

Following equipments and helium gas are necessary for maintenance.

	Item	Volume	Item code
1	Helium charging adapter kit (Regulator, Charging hose 2.4M, Charging adopter)	1	A700B5101000
2	<Items independently available> Regulator (for helium gas) Charging hose 2.4M Charging adapter	 1 1 1	 A700A5101700 A700A5101800 A700B5101100
3	Helium gas (with purity of 99.999% or above)	—	—

Table 6-1 Maintenance Parts and Intervals

S: Scheduled maintenance U: Unscheduled maintenance or part replacement at fault

Item		Parts	Interval (h)						Remarks
Super Trap									
U	80K cryopanel replacement	80K cryopanel	At fault						Use new indium sheet when assembling.
U	Super Trap Cleaning		At fault						
S	Insulation performance check of the heater (*1)	Heater unit or panel assembly (*2)	Band heater, Rubber heater : Every month Cartridge heater, Sheathed heater : Every month						Replace when it is below 10MΩ.
U	Check heater bolts (*1)	Bracket, Heater, Bolts, etc.	Band heater, Rubber heater : At fault Cartridge heater, Sheath heater : At fault						Loosened bolts result in poor insulation or disconnection
U	Replace K thermocouple	K Thermocouple	When necessary						Time-related deterioration may result in inappropriate electromotive force.
Refrigerator unit			RS5	RS10 RS10T	RS50 RS50T	RMS10 RMS10T RMS50 RMS50T RMS503TK	RS80T RMS80T	RS150T RMS150T	
S	Replace Seal kit	Seal kit	10,000	12,000	12,000	16,000	20,000	10,000	Maintenance cycle may vary depending on the ways of operation. Contact us for details.
S	Driver assembly Replacement	Driver bearing Valve bearing Set screw							
S	Replace Motor bearing	Motor bearing							
S	Cylinder bolt replacement	Cylinder bolt	–						
S	Compression spring replacement	Compression spring					20,000		
S	Displacer replacement	1st /2nd stage of displacer	10,000	24,000	12,000	16,000	20,000	10,000	
S	Valve body replacement	Intake/Exhaust valve body	10,000	At fault	12,000	16,000	At fault	10,000	
U	Other parts replacement	Other parts	At fault						
Compressor Unit									
S	Adsorber Replacement	Adsorber	Refer to the compressor unit instruction manual.						

(*1) This is only applicable to a system with a heater.

(*2) Depending on the specification, panel assembly replacement may be required.

6.2. Super Trap Maintenance

The major reason of the Super Trap performance degradation is contamination of the 80K cryopanel. To check the time-related deterioration, it is recommended to verify the temperature of these parts with closed main valve once a week. When cold head maintenance is required, check the 80K cryopanel at the same time.

◆Cleaning of 80K Cryopanel

Perform the 80K cryopanel cleaning as follows:

1. Remove the Super Trap from the vacuum chamber and place it on a mat which is dust-free and metallic powder-free to prevent damaging the surface of the mounting flange. Support the Super Trap so as not to fall.
2. Wipe out the 80K cryopanel with clean cloth dipped in alcohol. If the stain will not come off, replace the 80K cryopanel.
3. Be sure to attach the K thermocouple firmly to the 80K cryopanel when cleaning or replacing the 80K cryopanel. Refer to Chapter 3, Section 1.

CAUTION

- When mounting the thermocouple crimping terminal on the panel, hold the base of the crimping terminal and tighten the screw. (M4 tightening torque:1.5N・m)
- Thermocouples are for temperature control and overheat protection (only Super Traps with heaters). Mount each thermocouple to the correct place.
- Do not pull the sheathed wire of thermocouple. It may break at the base.
- If the thermocouple is loose, it cannot measure an accurate temperature and cause overcooling or overheating which leads to a breakdown of the cryocooler or deterioration of pumping performance.

◆Maintenance of Heater for Regeneration

(Only applicable to the system with heater)

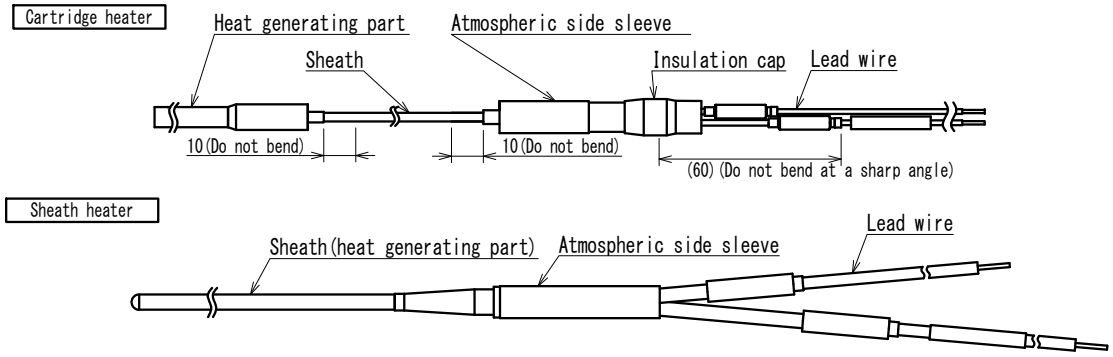

Figure 6-1 Heater components

There are two kinds of heater which can be used in a Super Trap system; a cartridge heater or a sheathed heater.

Figure 6-1 shows a name of each component.

1. Measure value of insulation resistance and resistance value before disassemble the heater.
2. Check the installation condition of the heater.
   For cartridge heater: check that the mounting bolts are tightened properly (not loose).
   For sheathed heater: check if the sheathed wire is cracked or burnt.
3. If insulation property is deteriorated or breaking of wire, the heater must be replaced.
4. Connect the heater properly and do not forget to put the insulation cap (only for a cartridge heater).

WARNING

Both heaters for regeneration, sheathed type and cartridge type, have a possibility of aged deterioration of insulation properties. Be sure to install a ground-fault circuit interrupter, and conduct periodic inspections of the insulation properties to prevent a short circuit. If any insulation property is deteriorated, please replace the heater.

Inspection should be conducted before applying current and check that the insulation resistance between the outside of atmospheric side sleeve and the lead wire is 10MΩ or more (DC 500V megger).

CAUTION

The replacement of the heater must be undertaken by authorized and trained electrician/mechanical personnel familiar with the maintenance methods of cryopump and inner heater. Follow the precautions below when handling the heater. Servicing for the heater failure caused by an improper installation will be at your expense even within the warranty period.

- When conducting maintenance work after applying current, do not start the work until the temperatures of the panel and the heater are came down to the room temperature.
- Always use hands to bend the sheathed wire and do not straighten it back.
- Do not bend the sheathed wire either at the base of atmospheric sleeve or heat generation part.
- Do not bend the sheathed wire narrower than a specified minimum bending radius (cartridge heater: more than R10 / sheathed heater: more than 5 times of sheath diameter.)
- If the mounting block of the cartridge heater is loose, the heat generation part does not attach firmly to the block and overheat which causes disconnection or deterioration of insulation property. Tighten the bolts firmly at a specified torque.
- (M3 tightening torque: 1N・m)
- After maintenance work, check insulation resistance and electrical continuity and keep record of the result.

6.3. Charging Helium Gas

Customers are required to supply equipments for charging helium gas (regulators, charging hoses, adopters) that can be used at 2.0MPaG.

CAUTION

If the helium pressure gauge of the compressor unit shows 0 MPaG, contamination caused by air or moisture may occur in the system. If it occurs, contact our Service Engineering Division or customer support center.

CAUTION

If the helium pressure gauge of the compressor unit shows 0MPaG, contamination caused by air or moisture may occur in the system. If it occurs, contact our Service Engineering Division or customer support center.

When helium gas pressure declines, it is necessary to add helium gas. Check the cause of the pressure reduction before adding helium gas. If there is a leakage, take an adequate measure before charging. Improperly connected self-sealing coupling might be one of the causes of the leakage.

◇It is recommended to use the regulator designed for helium gas (left-hand screw) which shows the range of 4 - 6 MPaG as outlet pressure.

◇The gas charge inlet of the compressor unit is 1/4B male flare.

◇Use helium gas with purity of 99.999% or more.

Follow the procedures below to fill helium gas:

1. When mounting the regulator on a new helium bottle, perform the following procedures in order to purge the air and fill helium gas in the gas line between the regulator and the bottle valve.
   (1) Open the regulator a little. The regulator can be opened commonly by turning the handle clockwise.
   (2) Slowly open the bottle valve, and purge the air in the gas line for several seconds.
   (3) Close the regulator.

CAUTION

If the bottle valve is opened ignoring the above procedures (1), the air between the regulator and the bottle valve diffuses into the helium bottle and lowers the purity of helium gas.

2. Remove the front panel of the compressor unit.
3. Connect the helium charging hose as follows:
   (1) Connect the charging hose to the regulator.
   (2) Loosely connect the charging hose to the charge inlet on the compressor unit so that helium gas can be slightly blown out here.
   (3) Open the regulator until the outlet pressure reaches 0.1 to 0.2MPaG. Allow helium gas to flow out from the charging hose for about half a minute. Meanwhile, open the charge valve slightly in order to drive out the air that exists between the charge

valve and the charge inlet.

(4) Tighten the flair nut at the end of charging hose and close the charge valve. Helium gas charge in the line between the regulator and the charge valve on the compressor has been completed.

4. Adjust the outlet pressure of the regulator at 1.8MPaG. Pressure relief valve has to be mounted as well as the regulator. The set pressure of the pressure relief valve is 2.4MPaG.

5. Open the charge valve slowly and perform the following instruction according to the state of the compressor.

   a) If the compressor unit is running under normal operating conditions, replenish it with the pure helium gas until it reaches the operation pressure described in the compressor instruction manual.

   b) If the compressor unit is not running, replenish it with the pure helium gas until it reaches the static pressure described in the compressor instruction manual.

CAUTION

If helium gas has been charged more than the prescribed pressure of 1.9MPaG or more, the pressure relief valve on the refrigerator may be going to work. Therefore charge helium gas slowly so that the pressure relief valve should not operate. On the other hand, the pressure relief valve in the compressor unit is set at 2.5MPaG.

6. Close the charge valve after charging helium gas.

7. Close the regulator and remove the charging hose from the charge inlet.

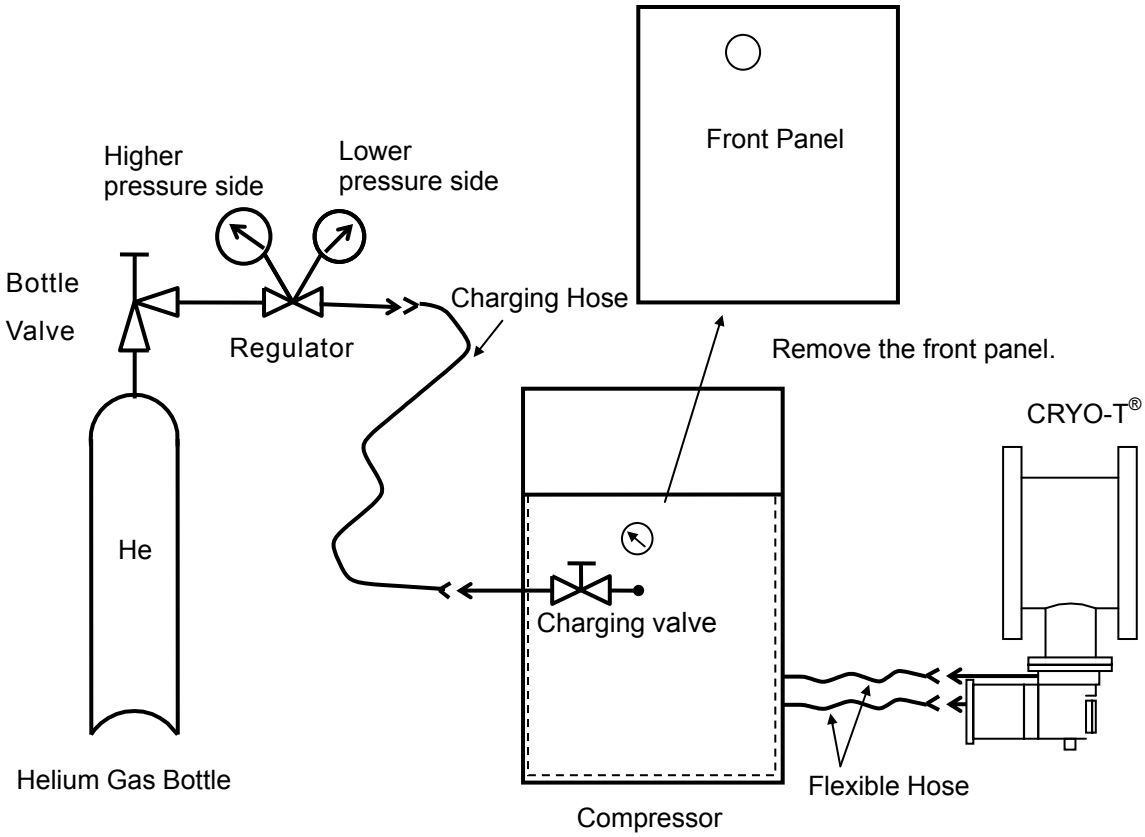

Figure 6-2 Charging Helium Gas

6.4. Helium Circuit Decontamination

Use equipments (regulator, charging hose) that can be used at 2.0MPaG or above to charge helium gas.

When helium gas in the Super Trap system is contaminated, it is necessary to replace with pure helium gas. Refer to Appendix A- Troubleshooting.

Contamination of helium gas in the Super Trap system is caused by inadequacy of helium charge at the time of refrigerator unit maintenance. If impurities in helium gas are coagulated and deposited into the refrigerator, the coldhead performance will be sluggish or intermittent (Step-out*). Perform helium decontamination procedure as follows;

(*) Step-out: refers to irregular or intermittent operation of the coldhead drive mechanism.

1. Startup the Super Trap system (refrigerator unit) and keep running for three to four hours.

NOTE:

Since all impurities in the helium gas are condensed and solidified within the refrigerator during operation of the Super Trap (refrigerator), a certain amount of cooldown time is required before beginning the decontamination procedures. If an irregular and abnormal sound or a big vibration arises during the operation, proceed to step 2.

2. Shut down the Super Trap (refrigerator unit) as follows:
   a) Close the main valve of your vacuum system.
   b) Turn off the compressor unit.
3. Right after shutdown of the system, disconnect the helium SUPPLY and RETURN flexible hoses at rear of the compressor unit (see Figure 6-3).

   NOTE:

   It is important to remove the flexible hoses right after shutdown in order to prevent re-diffusion of the impurities that have been coagulated in the refrigerator unit.

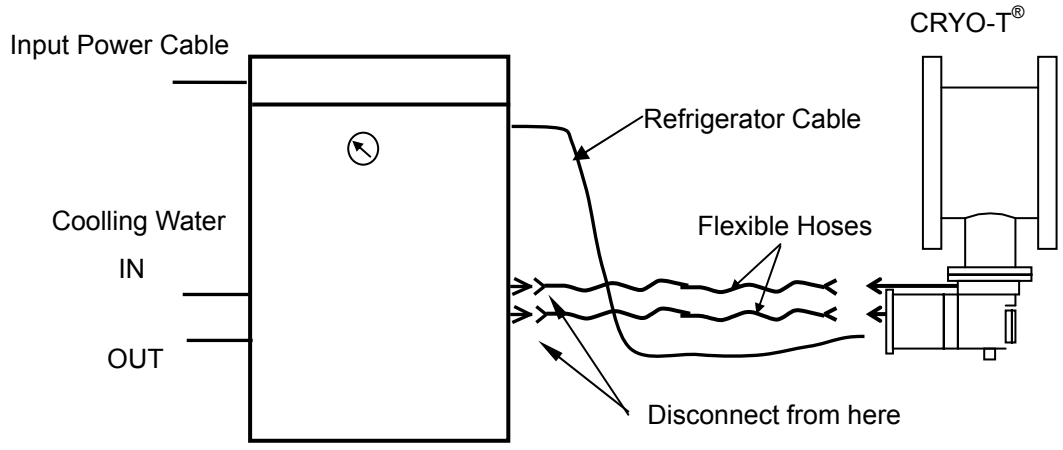

Figure 6-3 Disconnecting Flexible Hose

4. Attach the charging adaptor to the disconnected end of the helium SUPPLY and RETURN flexible hoses.(See Figure 6-4).
5. Reduce the pressure in the refrigerator unit and the flexible hoses to a level of 0.3MPaG by opening the valve (V1) of the charging adaptor.

NOTE:

As refrigeration lowers the temperature of helium gas in the refrigerator unit, the density of the gas increases. After shutdown of the refrigerator, the temperature of the helium gas in the refrigerator returns to room temperature from cryostatic temperature gradually, and the inner pressure rises at the same time. The unit has a pressure relief valve which opens at the inner pressure of 1.9MPaG and more. If once the pressure relief valve opens, it could cause a leakage that would depend on the surrounding environment such as dust. Therefore, ensure to reduce the inner pressure right after shutdown of the refrigerator in order not to work the pressure relief valve.

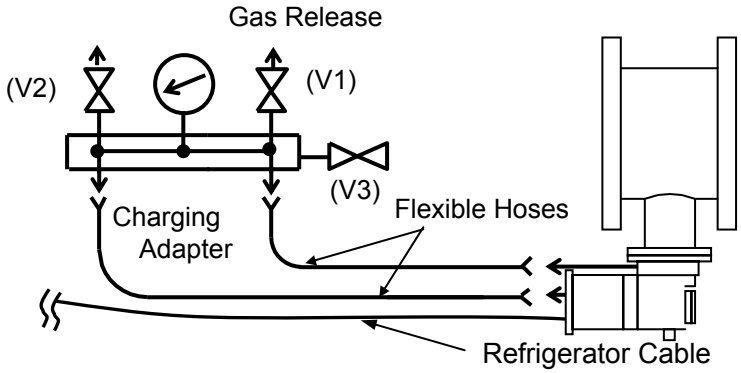

Figure 6-4 Connecting Charging Adapter

6. Warm up the Super Trap (refrigerator unit). Allow the 80K cryopanel (the second stage) of the Super Trap and the inside of the refrigerator to warm up to room temperature. It usually takes several hours for the inside of the refrigerator to warm up after the 80K cryopanel has reached the room temperature. The recommended warm up time is for eight hours or more.

CAUTION

If the Super Trap is open to the atmosphere while warming up, 80K cryopanel could adsorb large amount of moisture, resulting in longer regeneration time.

† For Your Information †

Performing assisted warm-up procedures described in Section 5.4 of this manual can reduce the warm-up time.

Before proceeding to the next step, make sure that the 80K cryopanel has reached room temperature.

7. Connect the helium bottle and the regulator. Replace the air remained between the helium bottle valve and the regulator with helium gas as instructed in Section 6.3 – Charging Helium Gas.

   Use helium gas with purity of 99.999% or more.

8. Perform decontamination procedures as follows:

   Before proceeding decontamination, prepare the rough pumping system as indicated in Figure 6-5. A roughing pump with the pumping speed of 20L/min or more and the ultimate pressure of 10Pa or less is recommended.

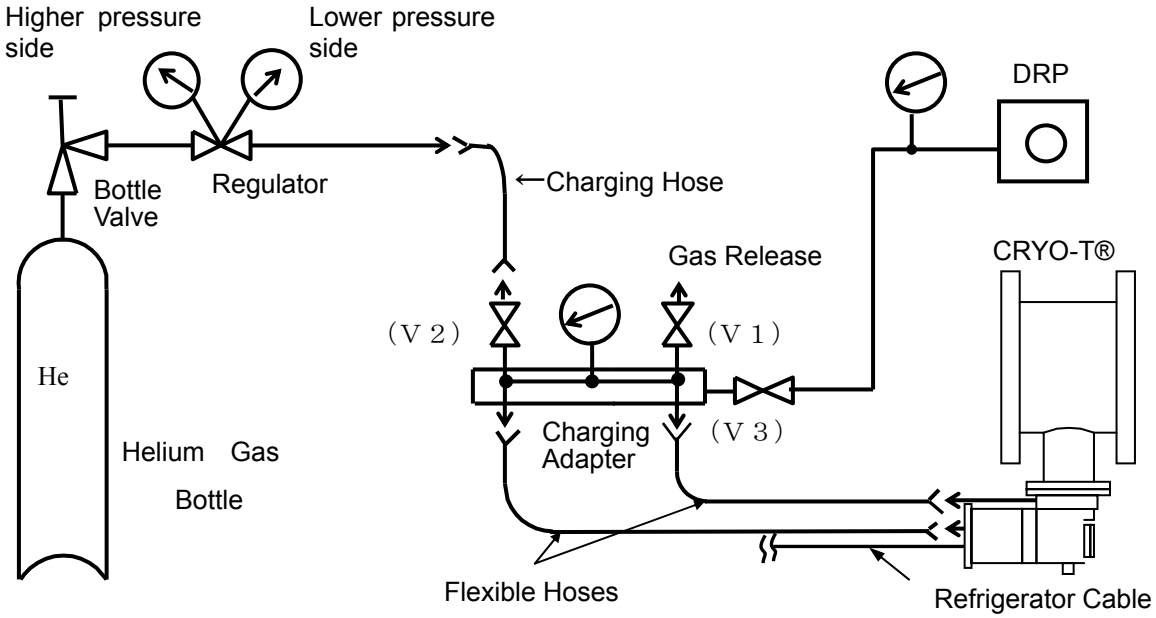

Figure 6-5 Super Trap Decontamination Procedures (1)

a) Loosely connect the charging hose to the charge valve (V2) on the charging adapter.

b) Open the regulator until the outlet pressure reaches 0.1 to 0.2 MPaG. Allow helium gas to flow out from the charging hose for about half a minute. Meanwhile, open the charge valve (V2) slightly in order to drive out the air trapped in the charge valve.

c) Tighten the flair nut at the end of charging hose and close the valve (V2).

d) Start the roughing pump and open the valve (V3) slowly. Rough pump helium gas inside the refrigerator unit while maintaining pressure below the maximum allowable value of the roughing pump. After the pressure reaches below the atmospheric pressure, the valve (V3) can be fully opened. Therefore, monitor the pressure of the roughing pump head with an appropriate pressure gauge. The maximum allowable pressure for ULVAC's small oil-sealed rotary pump and dry pump is 0.01MPaG.

CAUTION

Make sure to open the valve slowly when exhausting the gas beyond the atmospheric pressure in order to maintain the pressure of the pump head below an allowable value. If you open it quickly and widely, the roughing pump may break down.

e) After rough pumping for more than 30 minutes, close the valve (V3). Shut down the roughing pump to bring it back to atmospheric pressure.

f) Adjust the outlet pressure of the regulator at 1.8MPaG. Then open the valve (V2). Charge helium gas until the pressure gauge on the charging adopter reaches 1.5MPaG and then close the valve (V2).

g) Start the compressor unit to operate the refrigerator unit.
When operating the refrigerator unit, helium gas is circulated through the refrigerator, the flexible hoses, and the charging adopter. See Figure 6-6.

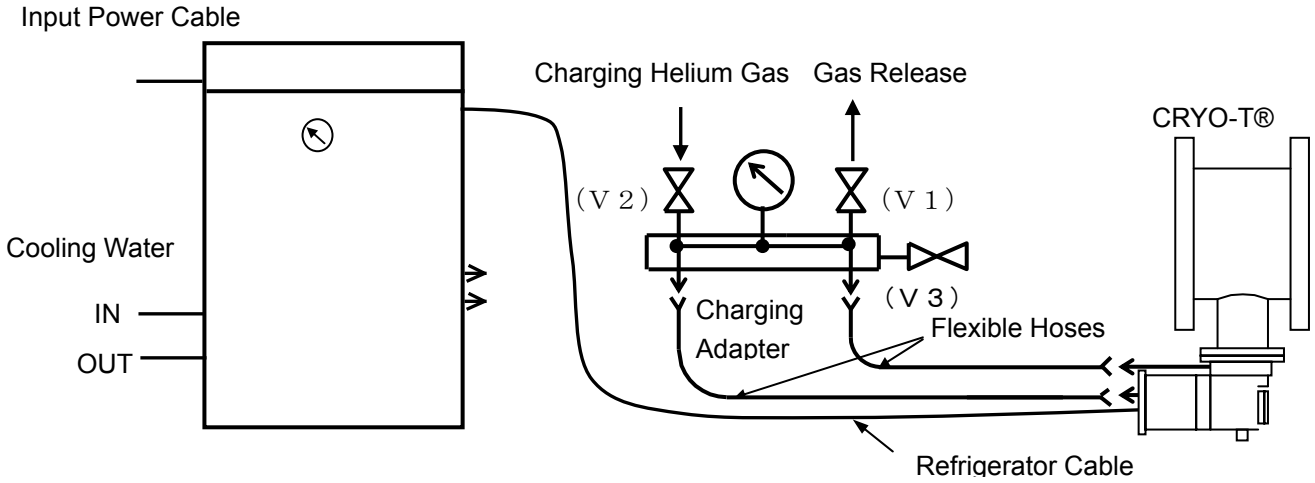

Figure 6-6 Super Trap Decontamination Procedures (2)

CAUTION

Do not operate the refrigerator unit when it is at a negative pressure. It may cause a vacuum discharge in the refrigerator motor, resulting in equipment damage.
Helium gas charge has to be completed before starting the refrigerator.

h) Depressurize to 0.4MPaG by opening the valve (V1) during operating the refrigerator unit, and then close the valve (V1).

i) While running a refrigerator, repeat the following operation 25 times surely slowly.

1) Charge helium gas until the pressure gauge shows 1.5MPaG by opening the valve (V2) and close the valve (V2).

2) Depressurize to 0.4MPaG by opening the valve (V1) and close the valve (V1).

By taking the helium gas in and out 25 times, the purity of helium gas within the refrigerator unit and the flexible hose should be increased.

9. Shut down the refrigerator unit. Charge helium gas to the refrigerator unit and the flexible hose up to the fill pressure of the compressor unit.
10. Remove both SUPPLY and RETURN flexible hoses from the charging adopter.
11. Make sure that the flat rubber gasket of the self-sealing coupling is properly mounted. Then reconnect each flexible hoses to the compressor unit. (See Figure 6-7)

CAUTION

The pressure relief valve on the refrigerator may work when the SUPPLY/RETURN of flexible hoses do not correspond to the charge inlet of the compressor unit. If the pressure relief valve works, maintenance work is required. Make sure that they are connected to appropriate ports.

12. Confirm that the pressure gauge of the compressor unit indicates the specified pressure. If not, charge helium gas through the charging valve of the compressor unit, or adjust the pressure by discharging the helium gas.
13. Restart the Super Trap (refrigerator unit).

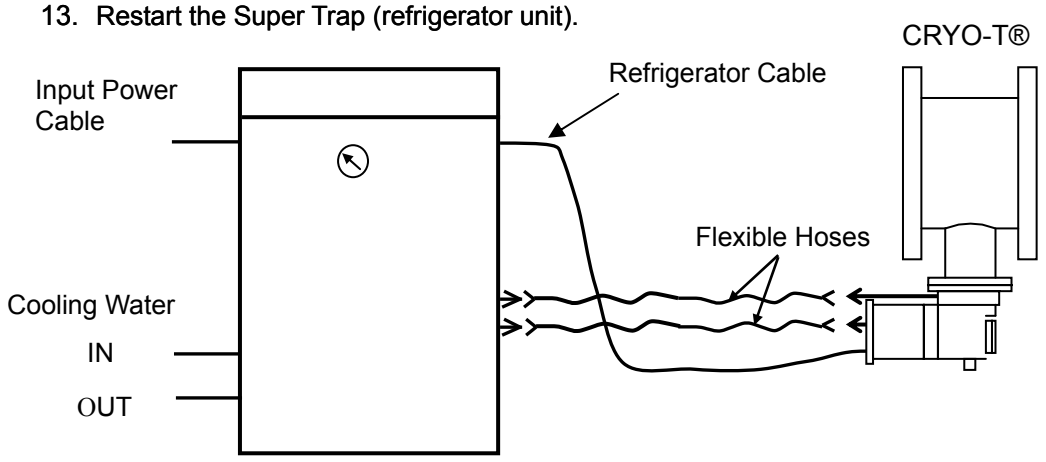

Figure 6-7 Connecting Flexible Hoses

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Appendix A

TROUBLESHOOTING

1. TROUBLESHOOTING

The major factors of CRYO-T Super Trap failure are temperature rise and pressure rise. Those failures are caused by different reasons as following.

(1)Cold head failure→Lowered cold head performance→Temperature rise→Pressure rise
(Occurs in minutes or hours)

(2)Contamination of 80K cryopanel→Thermal load increase→Temperature rise
→Pressure rise
(Varies according to the usage, nevertheless generally occurs in months or years.)

Refer to Table A-1 for detailed troubleshooting procedures.

2. CUSTOMER SUPPORT

If you need more information or servicing, please contact us.
Please refer to the “SERVICE NETWORK” at the end of this manual for our contact information.

Table A-1 Super Trap Troubleshooting Procedures

Problem	Possible Cause	Corrective Action
I. Both Super Trap and compressor unit do not start up.		Consult the instruction manual of compressor unit for details.
II. Compressor unit starts up but Super Trap does not start up. Or, Super Trap stops while compressor unit is running.	1) Cold head power cable is not connected to cold head.	Turn off the compressor unit and connect the cold head power cable to the cold head. ⚠ CAUTION Do not connect the cold head power cable to the cold head without turning OFF the compressor unit. The cold head motor may be damaged.
	2) Helium gas is heavily contaminated.	Perform decontamination procedures described in Sec.6.4. Use helium with purity of 99.999% or more.
	3) Mechanical defects on the cold head drive motor. ① Motor shaft failure or bearing defects ② Drive motor circuit failure ③ Bearing defect	Contact your local customer support center.
III. Super Trap fails to cool down to 130K or lower.	1) Helium Supply/Return line incorrectly connected.	Check that helium gas supply flexible hose is connected to supply connector.
	2) Self-seal couplings are not connected properly.	Check that all self-sealing coupling are fully seated.
	3)Refrigerator unit breaks down	Contact your local customer support center.
	4)Electromotive force of K thermocouple has changed.	Aging of K thermocouple is the possible cause if there is nothing wrong with refrigerator units or cryopanels. Please contact us.

Problem	Possible Cause	Corrective Action
IV. Super Trap pumping capacity is deteriorated. Examples ・Pressure rise ・Electromotive force of K thermocouple shows high value. ・Decrease in pumping speed. ・High temperature ・Vacuum down caused by the temperature rise of Super Trap even though the Super Trap is running.	1) A large amount of gas has been captured.	Regenerate the Super Trap referring to Sec.5.
	2) Low helium pressure in compressor unit.	Add helium gas.
	3) Leakage ①Air-to-vacuum leakage in vacuum system ②Helium leakage in helium line (Helium is leaking to atmosphere)	Detect the leakage with helium leak detector or mass analyzer. ・Detect the leak point using soap bubbling or sniffer method of helium leak detector. ・Pressurize each equipment separated from each other and check the pressure decrease of each equipment.
	4) Excessive thermal load on the Super Trap.	Reduce the thermal radiation load by shielding the Super Trap as described in Figure 3-2.
	5) Internal equipments of the Super Trap become loose. ①Thermocouple mounting ②Mounting of 80K cryopanel	 Disassemble Super Trap and fasten the thermal measuring part. Replace indium sheet if necessary. Disassemble Super Trap and fasten all the bolts and screws. Replace indium sheet if necessary.
	6) Helium gas is heavily contaminated. (Decrease in refrigeration performance)	Perform Super Trap decontamination procedures as described in Sec.6.4. **Use helium with purity of 99.999% or more.**
	7) Failure of the cryocooler unit.	Contact your local customer support center.
	8) Failure of the compressor unit.	Consult the instruction manual of compressor unit for details.

Problem	Possible Cause	Corrective Action
	9) Electromotive force of K thermocouple has changed.	Aging of K thermocouple is the possible cause if there is nothing wrong with refrigerator units or cryopanels. Please contact us.
V. Frequent regeneration is required at short intervals.	1) Regeneration temperature is too low.	①Perform regeneration as described in Sec.5. ②Repeat introducing dry nitrogen that its dew-point temperature is -40°C or lower and rough pumping.
	2) Leakage in vacuum system.	Detect the leakage point and stop the leakage. If there is damage to the cold head cylinder, contact us.
VI. Cold head drive motor is making irregular or intermittent motion.	1) Helium gas is heavily contaminated.	Perform Super Trap decontamination procedures as described in Sec.6.4. **Use helium with purity of 99.999% or more.**
	2) Input voltage to the motor is low.	Contact your local customer support center.
VII. The panel temperature does not rise at warm-up time during regeneration. (Apply only to a Super Trap with a heater)	1) Insulation failure (The breaker works.)	① Measure insulation resistance regularly and replace it when deteriorated. ② Keep the atmospheric side sleeve of the heater dry.
	2) Disconnection (The breaker works.)	① Measure insulation resistance regularly and replace it when deteriorated. ② Check regularly that the mounting bolt and/or screw are tightened properly

Table A-2 Operating Log

SUPER TRAP S/N	**CRYO-T® OPERATING LOG**	POWER V × ϕ
COMPRESSOR S/N		
REFRIGERATOR S/N		

Measuring condition					Compressor unit				Super Trap				Remarks
									Temperature			Pressure	
Date	Time	Measurer	Room temp.【℃】	Humidity【%】	ETM	High pressure helium gas【MPaG】	Current【A】	Cooling water flow rate【L/min(*)】	1st stage	2nd stage		【Pa】	
									K thermocouple	MBS-C	H_2VP etc		

(*) Install a flow meter on each compressor unit to measure cooling water flow rate.

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Appendix B

FLEXIBLE HOSE

1. Specifications

- Gas : Helium Gas（Purity：99.999% or more）
- Pressure : Max. 2.45MPaG
- Temperature : 0 to 70°C
- Material : SUS304
- Length : 3000mm (standard)
- Minimum Bending Radius : 250mm
- Recommended Torque for Connecting : 20N･m

※Tighten until the self seal coupling will not turn any more.

- Connection : 1/2B self-sealing coupling

2. Precaution in Handling

CAUTION

- When carrying flexible hoses, hold the braid support of the hose. The hoses may be damaged if they are bent forcibly at an acute angle.
- Avoid twisting the flexible hose especially when making final connection.
- Keep away from water and salt to prevent corrosion. Do not put heavy things on the flexible hoses in order to prevent modification and crushing of them.

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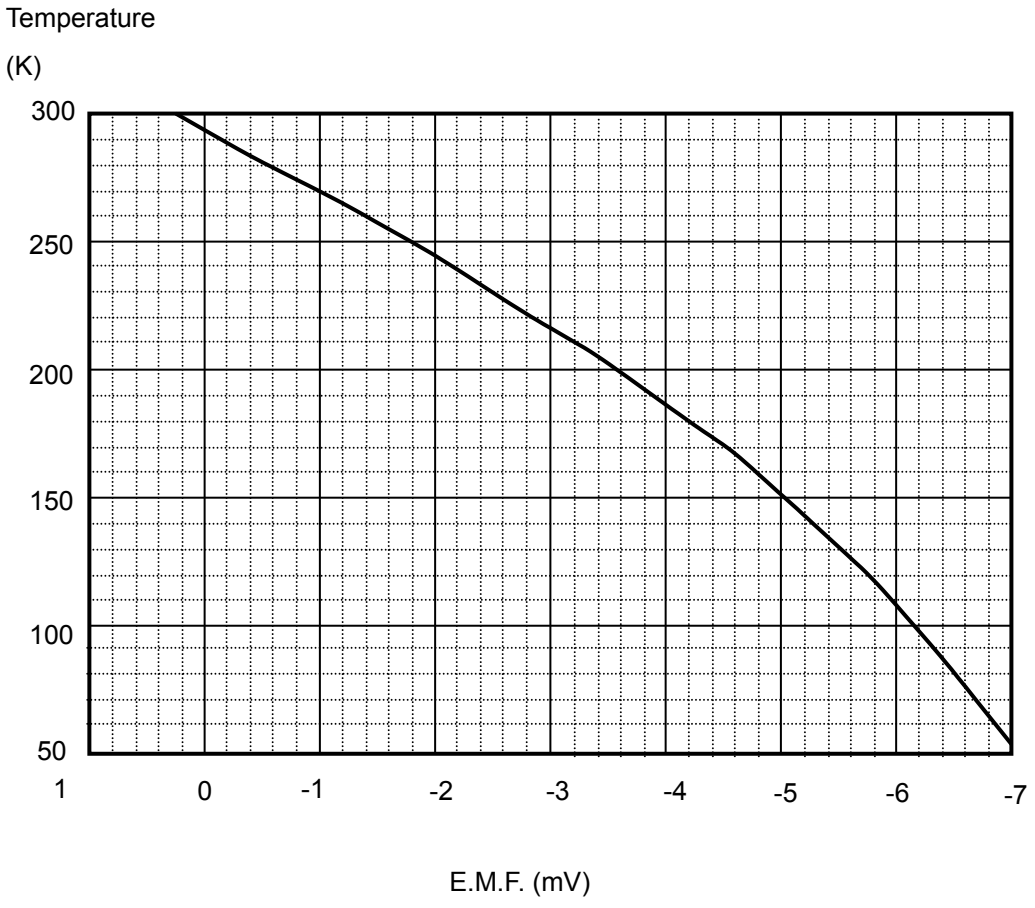
Appendix C

CONVERSION OF THERMOMETER READINGS

1. K(CA) Thermocouple Electromotive Force



K thermocouple electromotive force
(Ambient Temperature: 20°C)

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Appendix D

PRINCIPLES OF SUPER TRAP OPERATION

The Super Trap operation is based on the principle that gas molecules travel into a Super Trap are condensed or adsorbed on the cryogenically-cooled surface and thereby are removed from the vacuum chamber. Our CRYO-T series Super Trap use helium refrigeration system for cooling the cryo-surface. Accordingly, clean and ultrahigh vacuum can be obtained through much easier operation without using either liquid nitrogen nor liquid helium.

To pump water from the vacuum chamber effectively, the water vapor pressure condensed on the 80K cryopanel must be 10^{-8}Pa or lower. Therefore, the maximum temperature of 80K cryopanel must be below 130K. (See Figure D-1)

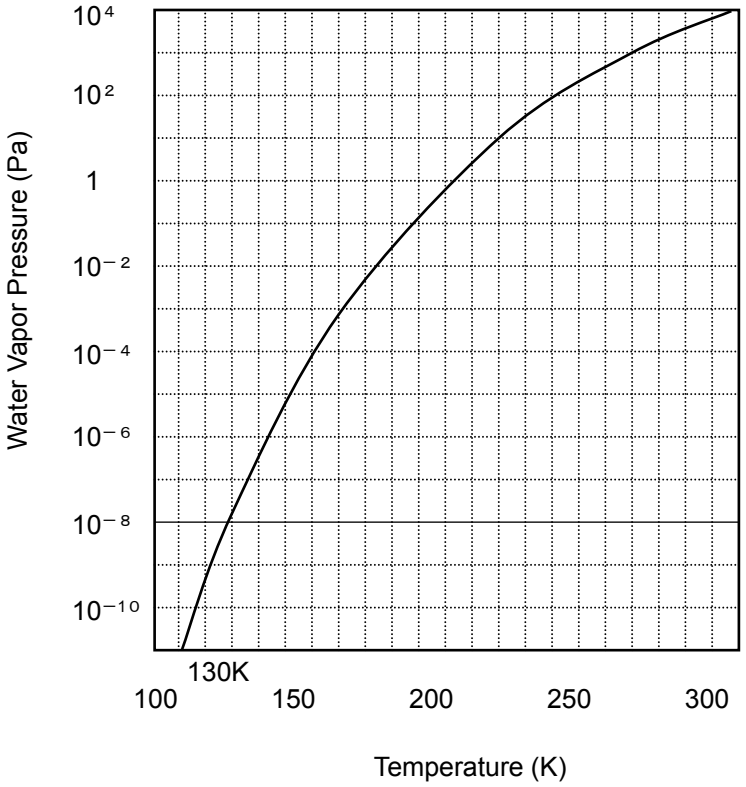

Figure D-1 Water Vapor Pressure and Temperature

The probability(Cn) of trapping water molecules falling on cryo-surface can be given by the formula below.

$$Cn = Cg - Cs\,(Ps/Pg)\,(Tg/Ts)^{1/2}$$

Cg : Condensing Coefficient Pg : Pressure (Pa) of the Water Vapor

Cs : Evaporating Probability Ps : Vapor Pressure (Pa) of the Water at Temperature Ts

Tg : Temperature (K) of Water Vapor

Ts : Temperature (K) of Cryo-Surface

Normally, Cs can safely be regarded as 1, and Cg is not less than 0.99 at 150K or less. For the purpose of simplicity, let suppose Cg to be 1 over the temperature range. Then Cn can be given as follows:

$$Cn = 1 - (Ps/Pg)\,(Tg/Ts)^{1/2} \cdots\cdots\cdots (1)$$

The equation (1) is plotted in Figure D-2. You can see that the Super Trap temperature should be 130K or lower from the graph. The temperature of the Super Trap depends on the performance of cold head (which is determined by the combination of cold head and compressor), and the cryopanel sizes, the structure, and the thermal load (the radiant heat and construction of the gas). It is possible to keep the Super Trap below 130K if the pressure of Argon, presents in spattering process, is less than 2.7Pa and the radiant heat from the heat source is shielded completely.

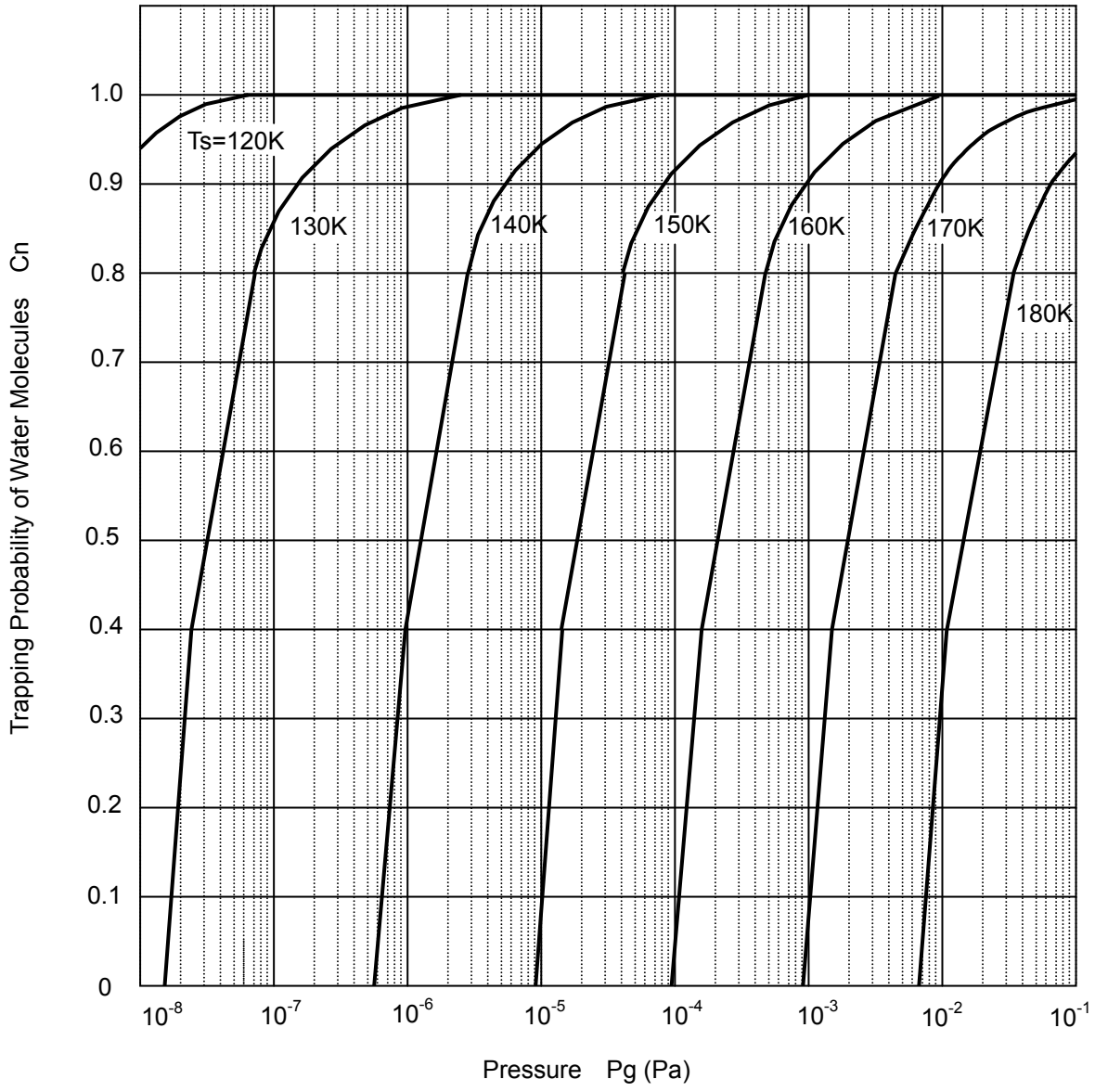

Figure D-2 Trapping Probability of Water Molecules and Pressure
(at Tg = 300K)

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Appendix E

PRINCIPLE OF REFRIGERATOR OPERATION

Helium gas is used as heat-medium gas of a refrigeration cycle in refrigerator system, because it does not liquefy even 10K.

First, after the helium gas is compressed into high pressure and being continuously cooled by water-cooling or air cooling to room temperature within the compressor unit, it will be introduced into the refrigerator when the valve A opens. Then the helium gas is cooled by heat exchange between the regenerator and led to an expansion chamber with a rise of a displacer. Next, because the valve B opens at the same time the valve A closes, the high-pressure helium gas in the expansion chamber is exhaled toward the low pressure part of the compressor unit with the differential pressure. During this process, the pressure and temperature of the helium gas in the expansion chamber decreases (called Simon expansion). The cooled low-pressure helium gas is discharged completely from the expansion chamber by the descent of the displacer. As the helium gas passes through the regenerator again, it will be warmed up to room temperature and return to the compressor. At this moment, however, the regenerator is cooled down conversely. In this way, a refrigeration cycle returns to the first state. By repeating this refrigeration cycle, cryogenic temperature is obtained.

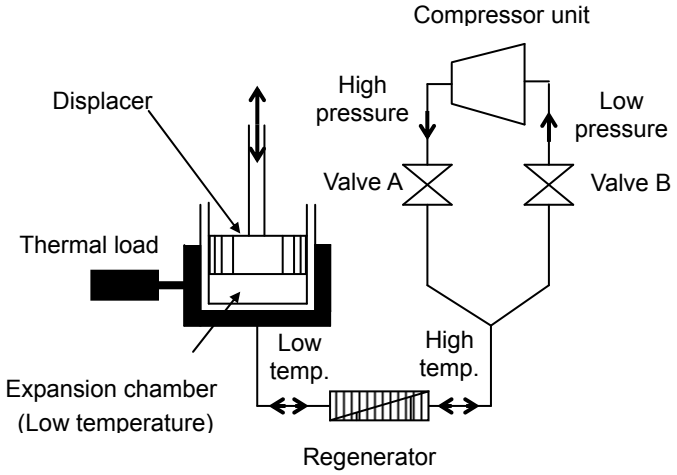

Figure E-1 Principle of Refrigeration

G-M Cycle

Gifford and McMahon developed the concept of G-M cycle in the late 1950's. In the driving method of G-M cycle, there are a way which drives mechanically and a way which drives using the differential-pressure of the operational gas. Since the GM cycle is efficient, it can make drive speed late. Moreover, the load concerning the seal currently used for an inside is also light. Therefore, it is a highly efficient and reliable refrigeration cycle. In this manual, the refrigeration cycle with the mechanical driving system adopted by ULVAC CRYOGENICS INC is explained.

Figure E-2 shows the principle of G-M cycle & P-V chart (P: pressure, V: volume in the expansion chamber).

A The displacer is first positioned at the bottom of the cylinder.
The low-pressure valve is closed and the high- pressure valve is opened.

↓

a The compressed helium is introduced into the warm end and the cold end (the expansion chamber) of the cylinder.

↓

B Pressure inside the cylinder increases.

↓

b When moving a displacer up, the clod end (expansion room) is filled up with the helium gas of room temperature, being cooled by the regenerator.

↓

C The volume of the cold end (the expansion chamber) is now maximum.
At this time the high- pressure valve is closed and low-pressure exhaust valve opened.

↓

c The compressed helium in the cold end (the expansion chamber) is expelled through the regenerator causing a temperature decrease by Simon expansion.

↓

D The cold end obtains the lowest pressure.

↓

d The displacer is moved to the initial lower position and the low-temperature helium is transferred to the compressor. The temperature of the gas returns to room temperature by heat exchange between the regenerator.

↓

A One cycle of the helium gas circulation is completed.
The P-V diagram of idealized G-M cycle shows a quadrangle.

The ideal refrigeration ability "Q_{ideal}" is as follows when indicating the period of one cycle as "t" minutes:

$$Q_{ideal} = W / t$$

In the actual refrigerator, regenerator is built inside of displacer to simplify structure. In addition, it is designed so that differential pressure is not applied to the 1st stage sealing and thus the load to the sealing is light. This brings long life and high reliability.

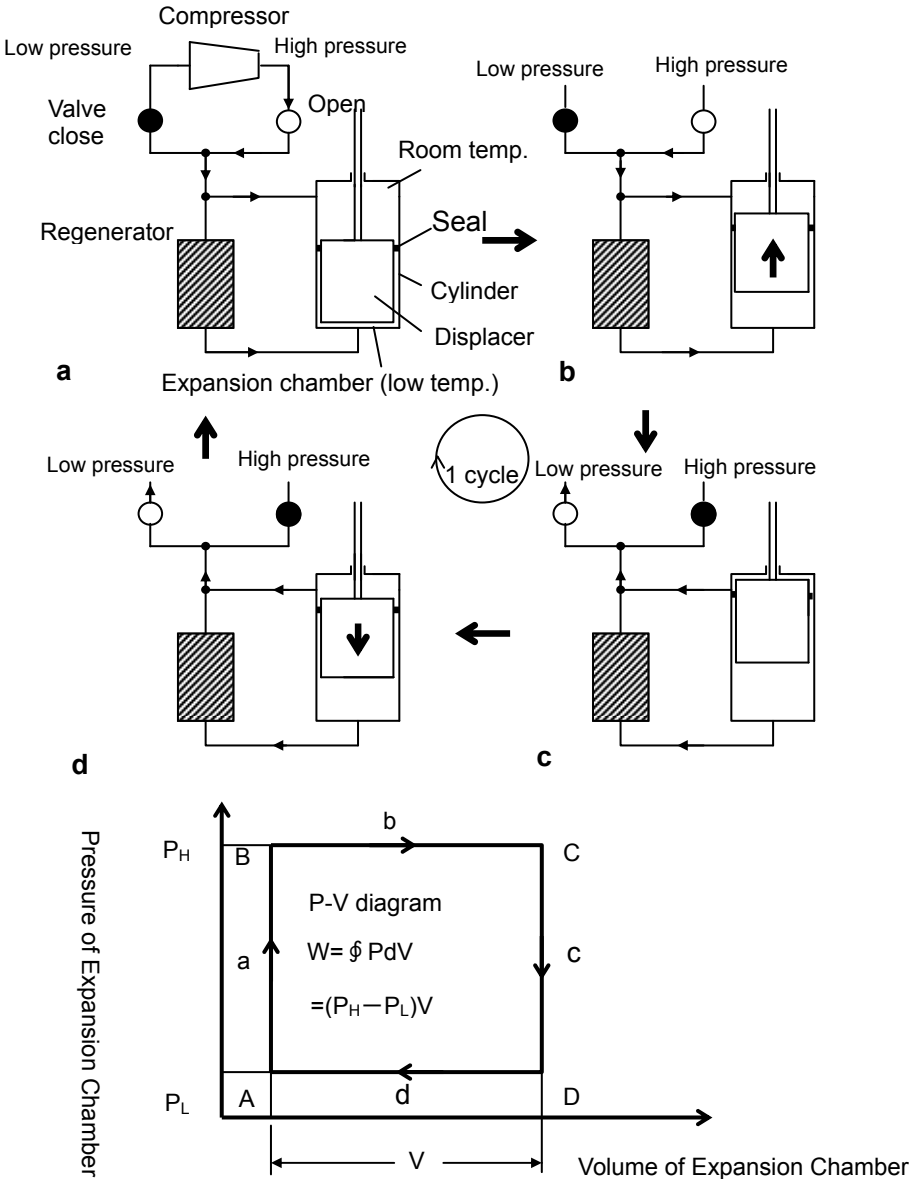

Figure E-2 Principle of G-M Cycle Operation

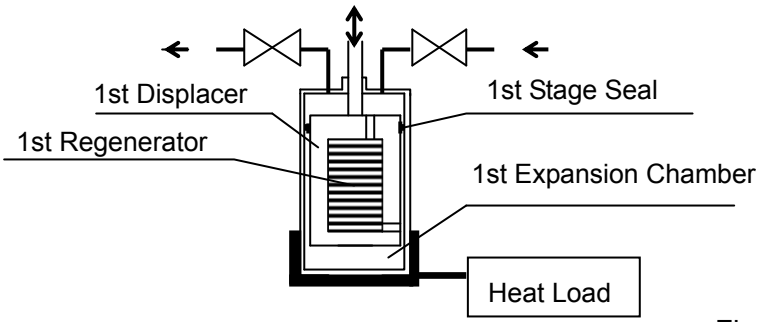

Figure E-3 Single-Stage Cryocooler

SERVICE NETWORK

- For technical support, servicing or additional contact information, visit us at www.ulvac-cryo.com.

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Revision History

Date	Revision No.	Contents
2006-11-28	2006.11	First edition
2007-05-28	2007MY01	Added an item to be maintained.
2010-02-05	2010FY02	“Introduction” has been revised. UCN address has been changed. Table 6-1 has been revised for maintenance interval and parts changed. “SERVICE NETWORK” has been revised.
2011-10-25	2011OR03	Full-fledged revision
2011-12-05	2011DR04	Figure 1 in Safety Instructions has been revised.
2013-02-19	2013FY05	P.4-4 Section 4.5 Shutdown procedure The content of the caution section has been revised. P.4-5 Section 4.6 Storage A description about dry nitrogen has been added. P.5-3 Section5-4 Assisted warm-up Descriptions of inert gas have been added. Descriptions about heater have been added. CAUTION and WARNING for using heater have been added. Service Network has been revised.
2013-07-12	2013JU06	Cover: Export control policy has been revised. Section 6-1 Insulation performance check has been added to “Scheduled Maintenance”. Table 6-1 Description about insulation performance check and a note (*2) have been added. P6-3 Cleaning of 80K Cryopanel CAUTION section has been added. P6-4/5 Maintenance of Heater for Regeneration Figure 6-1 has been added. Maintenance procedures have been added. WARNING section has been added. Table A-1 Super Trap Troubleshooting Procedure Problem and its possible cause and corrective action have been added. “SERVICE NETWORK” has been revised.

2013-11-08	2013NR07	Cover: Export control policy has been revised. "Introduction" and "SERVICE NETWORK" has been revised.
2014-06-10	2014JE08	P.1-1 "1-1 The General" The descriptions on "Refrigerator Unit" have been modified. P.1-5 "Figure 1-4" has been modified. P.3-6 "Figure 3-4" and P.3-11 "Figure 3-9" - Refrigerator model names have been changed. - Installation and maintenance space is shown in a table P.6-2 "Table 6-1" Some models have been added to the "refrigerator unit" P.A-1 The descriptions on "Customer Support" have been modified.
2014-06-19	2014JE09	P.4-3 "Caution" on the temperature settings has been added. P.5-3, P.5-4 "5.4 Assisted Warm-Up" Cautions when warming up with heaters have been added. P.6-2 "Table 6-1" Descriptions on maintenance of heaters have been added. P.A-1 "Table A-1" Descriptions on K thermocouple have been added.
2014-11-10	2014NR10	P.3-12 Description on the flexible hose connections has been modified.
2017-03-03	2017MH11	Cover "Export Control Policy" has been modified. "6. MAINTENANCE" has been revised.
2017-06-08	2017JE12	"Safety Instructions" has been modified. "Appendix E" Figure E-3 has been modified. Overall: The Super Trap type descriptions have been changed to "Inline", "Appendage" and "In-Situ".
2017-08-21	2017AT13	"Service Network" has been revised

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