

He-Compressor and Cold-Head Service

The AMI magnet (6T) in Osujilab is cryo-cooled by continuous Helium supply by a Sumitomo Compressor operating at a pressure of ~ 2.2 MPa. The superconductor in the magnet is cryo-cooled by a cold-head (Sumitomo Inc.) attached to the magnet. Continuous Helium supply is necessary to maintain the superconductivity in the system. There are two flux lines (supply and return), 6m long connecting the He-compressor and the cold-head. The flux lines, cold-head and the compressor have self-locks to isolate them to avoid contamination. When flux lines are disassembled from the cold-head or He-compressor the locks will automatically be locked. When the pressure in the He-compressor goes below 1.6 MPa, the compressor should be re-filled with Helium (UHP-300, 99.999% purity). Please follow the instructions before start refilling the He-compressor. If the He-compressor or flux lines are contaminated, the pressure reading in the He-compressor will drop (usually it will be zero), also when the He-gas leaks out of the system. Once the system is contaminated, it is advised to get in touch with Sumitomo Inc. to do a cleaning service.

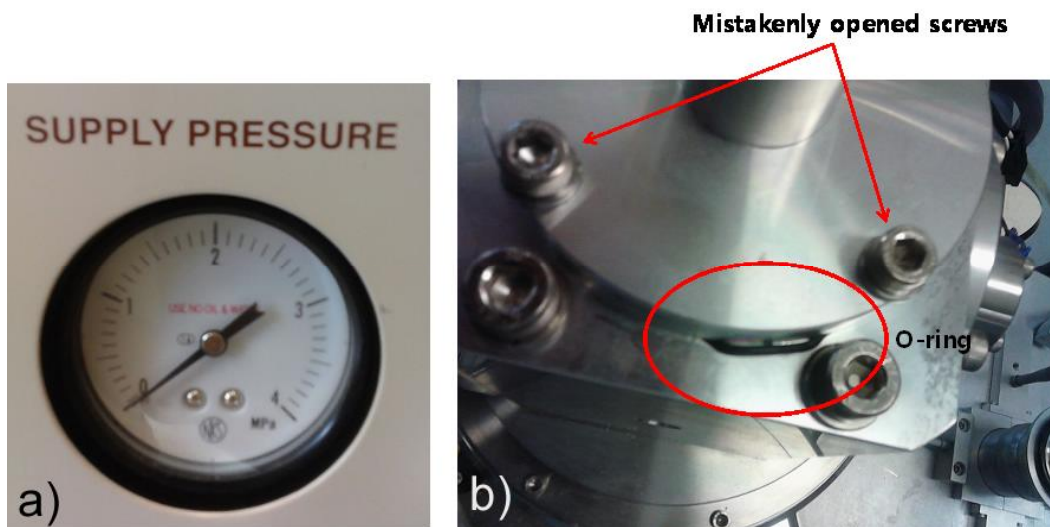


Figure1: (a) Zero pressure reading due to contamination of the system. In this case the He-gas was escaped through accidentally loosened screws (b). During operation the pressure reading is about 2-2.2 MPa. However, when the He-compressor or is switched off, the pressure reading is non-zero (~ 1.6 MPa). If the compressor pressure reads zero, it would not re-start.

Chilled-water supply is connected to the He-compressor to dissipate the heat from the return supply. When the temperature of the chilled-water supply rises, the He-compressor might shut down automatically, and subsequently the magnet temperature will rise. Sometimes, the main power-supply switch at the back panel will turn off by itself. Then it has to be turned back on as shown in Figure 2. Most often, switching OFF the drive switch and turning back ON will resume the He-compressor.

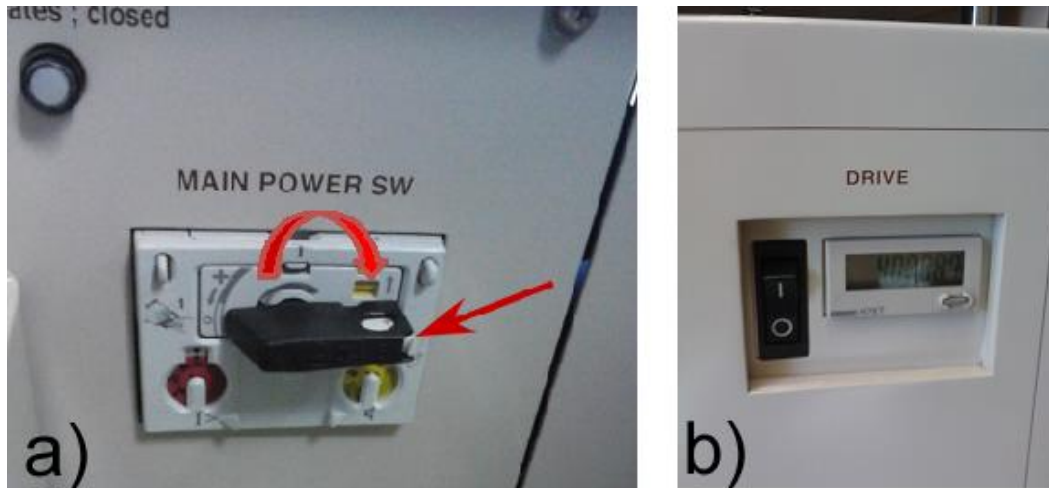


Figure2: (a) The main power switch is at the back-panel of the compressor is turned off. To turn it on, rotate the black switch by 90 deg (ref Figure 6). (b) Front panel switch and the operating hours of the He-compressor. 40088.7h are elapsed as shown in the front panel reading. The maximum operating hours of the instrument without maintenance is 30,000h. After that the regular service of the He-compressor is recommended-especially adsorber has to be replaced.

There are two ways to do service on He-compressor and cold-head servicing if the Cold-head or the He-compressor is contaminated or needs a service. If the compressor/cold-head parts are performing well and only if the parts are exposed to air, Sumitomo can do an onsite service. Also they can do the adsorber replacement. However if the motor capsule needs a replacement, then most likely the instrument has to go to the Sumitomo Chicago facility for service (but check with Roy Roub if they can replace the capsule also by an onsite service). Sumitomo can send a reconditioned and qualified end/displacer assembly upon request (contact Roy Roub for pricing). Prior to reconnecting flux lines and the He-compressor, make sure those parts are clean and not contaminated and also filled with Helium gas (99.999% purity). Please check the price quote prior to sending the parts to Sumitomo and making an onsite service (onsite service is pricy but faster).

Note: If the cold head or flux line is contaminated (or exposed to air) as judged by the pressure reading at the He-compressor, the compressor should not be switched on. Contact Roy Roub at Sumitomo Inc. to proceed further with the repair/service. The cold-head can be removed from the magnet and can be send out for repair (special care should be taken to release the excess He-gas residing inside the cold-head prior to unscrewing the 4 screws as shown in the Figure3, for that appropriate fittings should be used-contact Roy Roub to buy the fittings and couplings.

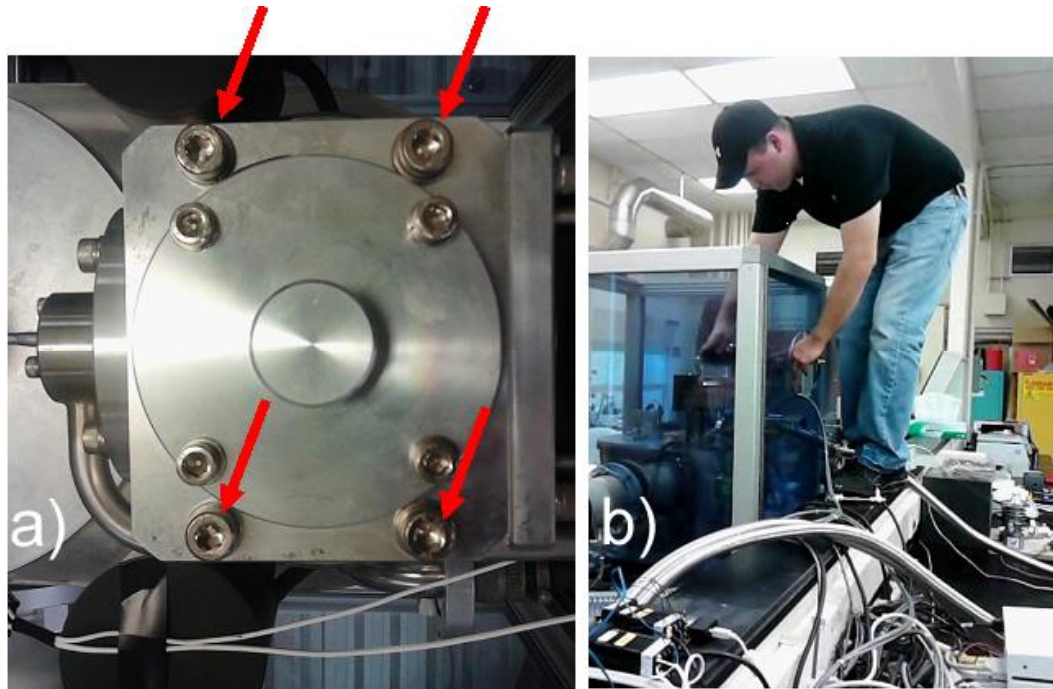


Figure3: (a) In order to pull the cold head unit out of the magnet, 4 hex screws (**OUTER ONES**) should be removed as shown in the cartoon. The cold-head should be taken out very slowly (b). Before disassembling the cold-head, the He-flux lines should be disconnected, and the excess gas should be vent using appropriate couplings, one by one, first for the supply line and then the return line.

Once the cold-head is carefully removed from the magnet, it has to be kept in a holder/shield provided by the Sumitomo and keep it safely. The old cold head should be sending back to Sumitomo.

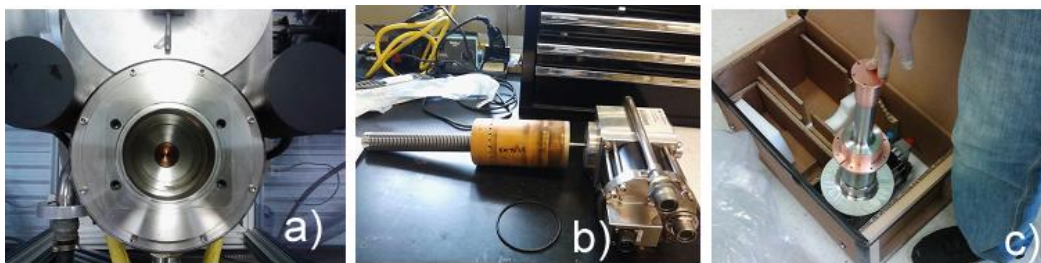


Figure 4: (a) A top view of magnet (helium chamber) after removing the cold head (c) New replacement coldhead, already cleaned by the Sumitomo. The coldhead can be taken out from the casing by unscrewing the 4 large hex-screws (same screws are being used to attach to the magnet). When we request exchange of cold head in the future, we will receive the same fully tested coldhead with attachments from Sumitomo. When it is taken out we need to purge it with He-gas. Also the inner portion (a) of the magnet also should be purged for some time with low pressure He-gas before assembling the cold-head to the magnet. (c) The refurbished cold-head sent by Sumitomo will be filled with He-gas, therefore it has to be vent before start connecting to the magnet (**Youngwoo please confirm this step-I am confused why it was not directly connected, then we did not need to re-purge the gas again? Confirm it with Roy, may be?**).



Figure 5: (a) The magnet chamber was cleaned with Kim wipe (ethanol) and then subsequently purging with He-gas prior to attaching the cold-head. (b) Disassembling the refurbished cold-head from the casing by unscrewing the 4 hex screws.

After connecting cold-head to the magnet, it has to be purged with He-gas prior to re-connecting the flux lines- otherwise the flux lines and the He-compressor will be contaminated.



Figure 6: (a) The He-compressor is powered off. (b) The main power is turned back on. For purging the cold head without connecting the flux-lines, the cold-head drive should be turned on (c): however in the image it is off). Cold-head drive switch should be turned off after reconnecting the flux lines and the He-compressor in the normal operational mode.

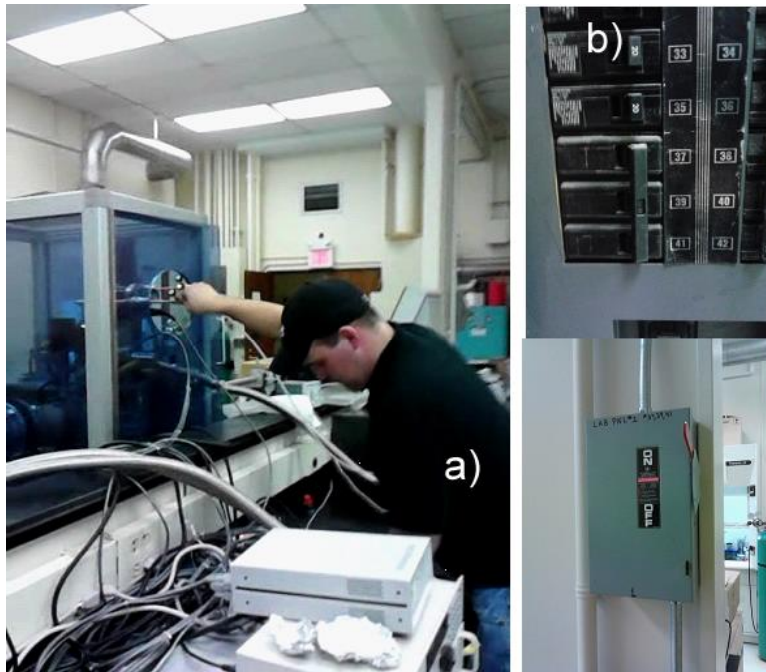


Figure 7: (a) For purging the cold-head, the gas inlet from helium gas cylinder (not from helium compressor) should be connected to supply inlet of the cold-head using appropriate fittings (gas connector). Outlet was kept opened using gas connector. The fuse and the **main power switch to the He-compressor should be kept in the ON position (b).**

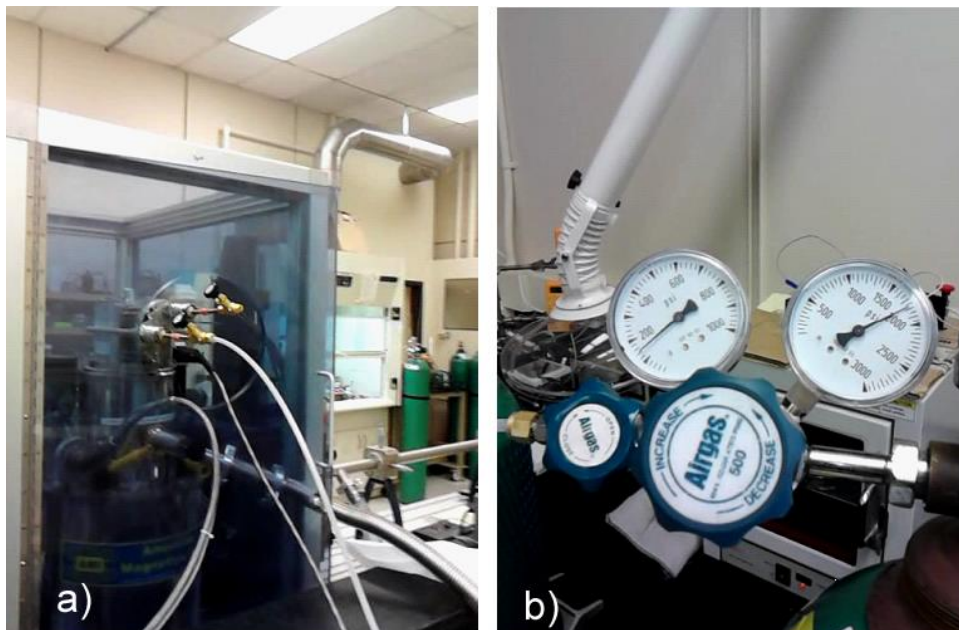


Figure 8: (a) After making all connections from the He-tank to the supply line and keeping the return open, and keeping the pressure around 10 Psi (for few min) and then to about 100 Psi as shown in (b), the cold-head has to be

purged. Before starting the automatic purging using the He-compressor, the compressor main power switch and the drive switch should be kept ON.

After purging the cold-head from the He-cylinder using He-compressor settings for about 20min, the return valve can be closed. Close the He-tank, and the supply inlet. Now the Cold-head is ready to be connected to the He-flux lines. First, connect the flux lines to the He-compressor and then to the cold-head. Make sure that the main power switch and the front panel switch of the compressor are turned off prior to re-connecting the flux lines. Then turn off the cold-head drive switch. Now the He-compressor is ready to operate. Switch on the front panel power switch, then the compressor will start operating. Initially the pressure reading will be around 2.6 MPa, but it will reduce slowly to 2.2 MPa over about 24h of operation.

SERVICE DETAILS OF THE COLD-HEAD AND THE HE-COMPRESSOR

Serial #

Cold head: Model# RDK-408D2, S/N: AJD 07016

He-compressor Model# CSW-71C, S/N: 47C07087D

Contact details of the IL, Sumitomo Inc. (SHI Cryogenics):

He-compressor service:

- Sumitomo (SHI) Cryogenics of America, Inc. • 1500-C Higgins Road, • Elk Grove Village, • IL 60007
PH # 847-290-5801 / Fax# 847-290-1984

Personal Contact: "Skica, Aya" <askica@shicryogenics.com>

The weight of the He-compressor is about 100 pounds and the wooden crate has about 250 Pounds. Therefore we need to contact Fed Ex-freight service for shipping.

Cold-head service:

- Sumitomo Cryogenics of America Inc. • 1833 Vultee Street • Allentown, PA 18103

- Tel: (610)791-6700 • Fax: (610)791-3904 • www.shicryogenics.com

Personal Contact: "Raub, Roy" <rraub@shicryogenics.com>

He-CSW-71 compressor service: ("Skica, Aya" <askica@shicryogenics.com>): Tasks and prices

1. Preventative maintenance: \$2,000 (includes oil change, replacement of minor electrical components, and sheet metal, if required.)
2. Absorber replacement: costs additional \$1,500. (The absorber needs a replacement: Sumitomo advises to do it since compressor is already been passed 40,000h. (max. usage of absorber is 30,000h), otherwise the oil will be contaminated soon, cause motor to malfunction..)
3. If the motor capsule, heat exchanger, oil separator, or control board require replacement there is additional cost.

4. Gasline service: \$300 each. Includes gas cleanup, leak check, and replace Aeroquip fittings.

5. Wooden crates: \$300

6. Shipping invoice (empty wooden crates to us and the shipping the instruments back to us) will be send to us separately. We will use our credit card to pay for the shipping from here to their Chicago facility.

The compressor performance will be fully tested prior to sending us.

Cold head service: ("Raub, Roy" <rraub@shicryogenics.com>): Tasks and Prices

1. Basic Fee for quantity 1 coldhead (RDK-408/415) \$8,700.00
2. Labor (1 day per engineer) Included
3. Travel & Living Expenses: Billed at actual

Tasks:

1. Removal of the expired/worn parts of the coldhead.
 - a. The warm housing and parts contained within which includes valves disc, valve stem, scotch yoke, guide bushings, all orings.
 - b. The 1st and 2nd stage displacer assembly.
 2. Solvent clean and inspect the cylinder assembly.
 3. Install a new oring on warm flange.
 4. Install a completely reconditioned and qualified warm end/displacer assembly consisting of the parts listed in 1a. & b. above.
 5. Reassemble the coldhead.
 6. Perform a gas cleanup on the coldhead.
 7. Reconnect gaslines.
 8. Leak check all disturbed joints and final testing of the He-compressor
- UHP 300 Grade 5 helium gas cylinder (purity 99.999%) from Airgas should be provided for the service.



Gas Lines

Technical Manual

**Sumitomo (SHI) Cryogenics of America, Inc.
1833 Vultee Street
Allentown, PA 18103-4783
U.S.A.**

TABLE OF CONTENTS

	<u>Page</u>
DESCRIPTION	1
SPECIFICATIONS	3
Minimum Bend Radius	3
Pressure and Temperature Ratings.....	3
Identification Labels.....	3
Installation Tools	4
MAINTENANCE	5
Disconnect Gas Lines	5
From the Compressor	5
From the Cold Head	6
Leak Check	6
Gas Line Repair	7
Venting.....	7
Repair Self-Sealing Couplings.....	8
Replace the Gasket Seal.....	8
Repair or Replace a Coupling.....	9
Charge Pressure Verification.....	10
Gas Cleanup and Recharging	11
PARTS	13
Ordering	13
Parts Identification and Numbers.....	13
ILLUSTRATIONS	
Figure 1 Typical Helically Corrugated Gas Line Construction	1
Figure 2 Break Gas Line Connection from Compressor.....	6
Figure 3 Disconnect Gas Line from Compressor	6
Figure 4 Break Gas Line Connection from Cold Head	6
Figure 5 Disconnect Gas Line from Cold Head.....	6
Figure 6 Aeroquip Male Coupling Parts	8
Figure 7 Remove Coupling from Gas Line.....	9
Figure 8 Aeroquip Female Coupling Parts	9
Figure 9 Parts Identification	13

(This page is intentionally blank.)

DESCRIPTION

Gas lines are needed to connect compressors to cold heads (expanders) to complete the system. Gas lines are constructed from helically corrugated stainless steel tubing covered with metal braid or from soft copper tubing. All gas lines are equipped with Aeroquip self-sealing couplings and are furnished cleaned, charged with helium gas and leak checked.

Each cryogenic system includes interconnecting gas lines to carry helium gas refrigerant to and from the components. A gas line carries high-pressure gas from the compressor to the cold head and another gas line returns lower pressure gas to the compressor.

Flexible gas lines simplify installation. The self-sealing couplings maintain the gas charge and purity by minimizing gas loss when connections are being made or broken and by preventing the entrance of contaminants. Dust plugs protect the coupling threads from damage and also help to maintain cleanliness.

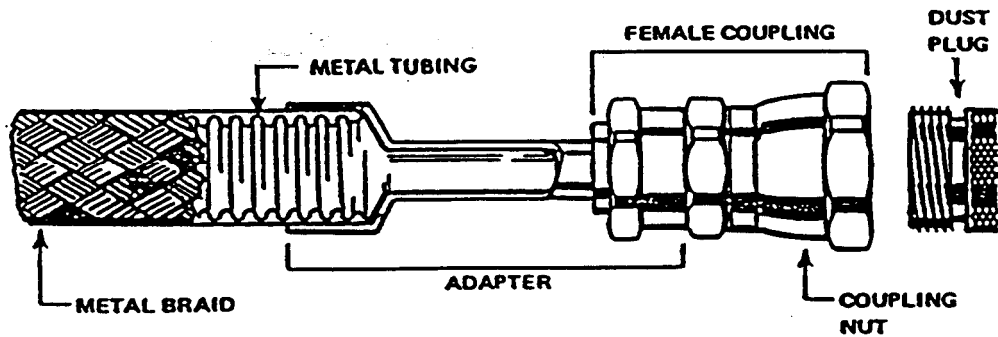


Figure 1 Typical Helically Corrugated Gas Line Construction

(This page is intentionally blank.)

SPECIFICATIONS

Minimum Bend Radius

<u>Gas Line Type</u>	<u>Diameter</u> mm (inches)	<u>Minimum bend radius</u> mm (inches)
Helically corrugated stainless steel	19 (3/4) I.D.	230 (9)
Helically corrugated stainless steel	13 (1/2) I.D.	180 (7)
Copper tubing using a tube bender	17 (5/8) O.D.	57 (2 1/4)
Copper tubing without using a tube bender	17 (5/8) O.D.	460 (18)

Pressure and Temperature Ratings

<u>Pressure and Temperature Ratings</u>	<u>Stainless Steel and Copper</u>
Design pressure, max.	2760 kPa (400 psig)
Operating pressure, max.	2410 kPa (350 psig)
Charge pressure, max.	1860 kPa (270 psig)
Operating temperature, max.	49° C (120° F)
Operating temperature, min.	4° C (40° F)

Identification Labels

Labels on the gas lines identify their function in the system as follows:

SUPPLY (color coded red)	Helium gas supply to the cold head from the compressor.
RETURN (color coded green)	Helium gas return from the cold head to the compressor.

Separate labels are furnished by SCAI with standard gas lines for the customer to attach to the gas lines. See the Installation section in the System manual.

Installation Tools

Properly sized open-end wrenches are needed to install and remove gas lines. SCAI can furnish (optional) one each:

Wrench, 1" open end x 3/4" open end	P/N SK30017C3
Wrench, 1 1/8" open end x 5/8" open end	P/N SK30017C2
Wrench, 1 3/16" open end x 1 3/16" ratchet	P/N SK30017C1

For MRI systems with an RF shield, gas feedthroughs may be furnished for gas line installation through the shield. Special wrenches may be required to fit the feedthroughs.

MAINTENANCE

Disconnect Gas Lines

WARNING

AVOID INJURY. Extreme cold can cause frostbite. When handling system components, be careful not to touch any frosted parts.

WARNING

AVOID INJURY. Disconnect gas lines only when the compressor is stopped. Disconnecting the cold head while it is cold can create excessively high internal pressure as the gas warms. Material failure and uncontrolled pressure release can cause injury.

WARNING

AVOID INJURY. Use two wrenches when disconnecting a gas line coupling to avoid loosening the compressor's or cold head's coupling. Gas pressure can project the coupling with enough force to cause injury.

CAUTION

AVOID GAS LEAKS. Keep the gas line couplings aligned when making or breaking a coupling connection. Leaks can occur due to the weight of the gas line or due to a sharp bend near the connection. Crimping from repeated bending and repositioning can cause damage to gas lines.

CAUTION

PREVENT EQUIPMENT DAMAGE. Do not use a clamp over hose section of flex gas line.

Disconnect from the Compressor

Tools required: Open-end wrenches

1. Always use two wrenches. Use one wrench to hold the compressor coupling. Use the second wrench on the gas line coupling nut to break the connection. See Figure 2.
2. After breaking the connection, hold the coupling adapter with one wrench. Remove the gas line coupling from the compressor coupling with the second wrench. See Figure 3.
3. Screw a dust cap finger tight on to the compressor coupling.

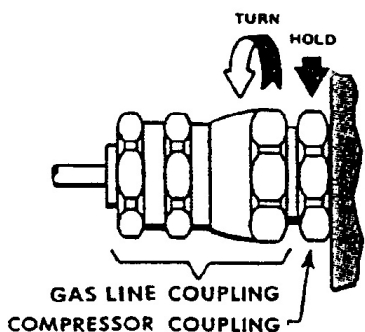


Figure 2 Break Gas Line Connection from Compressor

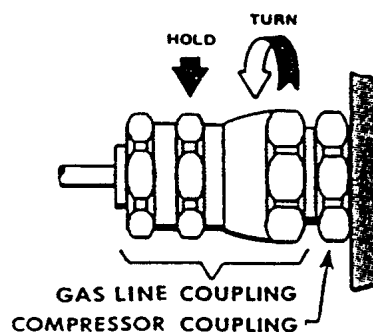


Figure 3 Disconnect Gas Line from Compressor

Disconnect from the Cold Head

Tools required: Open-end wrenches

1. Always use two wrenches. Use one wrench to hold the cold head coupling. Use the second wrench on the gas line coupling nut to break the connection. See Figure 4.
2. After breaking the connection, hold the coupling adapter with one wrench. Remove the gas line coupling from the cold head coupling with the second wrench. See Figure 5.
3. Screw a dust cap finger tight on to the cold head coupling.

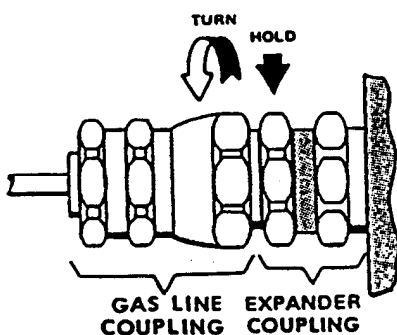


Figure 4 Break Gas Line Connection from Cold Head

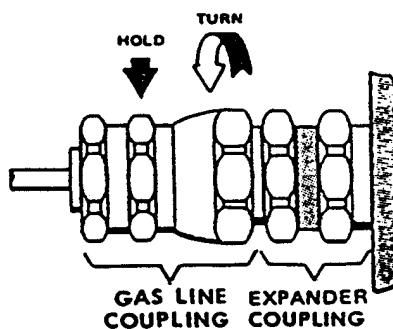


Figure 5 Disconnect Gas Line from Cold Head

Leak Check

Leakage of helium gas is the only likely problem to originate on a gas line. Use of a helium mass spectrometer leak detector is recommended. If no mass spectrometer is available, a liquid leak detector solution may be used on the coupling joints.

With the gas lines connected to the compressor and to the cold head, leak check the connected coupling joints.

The flat gasket in the face of the male coupling seals the joint. A leak at this gasket seal can be detected only when a gas line is connected. A leak here can be caused by:

- the coupling not fully tightened
- a worn, damaged or missing gasket seal
- dirt on or under the gasket seal
- dirt on the female coupling's mating surface
- damaged parts on either coupling which prevent proper mating or sealing

Gas Line Repair

Leaks in the helically corrugated metal tubing cannot be repaired. Discard the damaged gas line and install a new one.

Leaks at welded joints require special skills to repair. Consult an SCAI Service Center.

Leaks at the self-sealing couplings can be repaired by replacing worn or damaged parts. Vent the gas line before beginning to disassemble it except when replacing a gasket seal.

When couplings are frequently disconnected and reconnected, it is important to wipe the mating parts (threads and faces) with a clean, lint-free tissue or cloth.

Venting

Tools required: Adapter fitting with valve, 8M Aeroquip, P/N SK8217A2.
Open-end wrenches

NOTE

Adapter fittings are available as optional accessories from SCAI.

1. Disconnect the gas line from the system. Install a dust cap on each of the male couplings of the compressor and cold head, or on the RF feedthroughs, if used in the system.
2. Be sure the valve on adapter fitting SK8217A2 is closed. If only one coupling on the gas line is to be repaired, install the adapter fitting on the good coupling. Use two wrenches.
3. Slowly open the valve on the adapter fitting to vent the entire charge of helium gas.
4. Close the adapter fitting's valve. Do not remove the adapter fitting. It will be used for gas cleanup and recharging.

NOTE

Gas cleanup and recharging of the gas line are always required if a coupling has been repaired. Instead of venting the gas line to atmospheric pressure, some operators prefer to connect an adapter fitting and a charge line to the coupling not being repaired, to purge the gas line with helium during repair. Set the helium gas regulator at 35 kPa (5 psig) or less to prevent air from entering the gas line and contaminating it.

Repair Self-sealing Couplings**WARNING**

AVOID INJURY. Always vent a gas charged component before beginning to disassemble its couplings. Gas pressure can launch a loose coupling with enough force to cause personal injury.

CAUTION

PRESERVE YOUR WARRANTY. Modification to equipment without the consent of the manufacturer will void the warranty.

Damaged threads, leaking seals or a leaking valve assembly may require replacement of coupling parts or replacement of the complete coupling half.

Replace the Gasket Seal

Tool required: Needle or a narrow, flat blade screwdriver
Cotton swabs
Isopropyl alcohol

From repeated connecting and disconnecting the coupling, the gasket face seal just inside the face of a male coupling may begin to leak and require replacement. The gasket seal is replaced while the gas line is disconnected.

1. Carefully pierce or pry the old gasket face seal and pull it from its recessed ring in the body of the coupling. Discard the face seal. See Figure 6.
2. Using isopropyl alcohol on a clean, cotton swab, carefully remove any remaining adhesive from the coupling's recess. Avoid getting alcohol on the face of the poppet.
3. Dry the recessed surface with a clean, lint free cloth.
4. Do not apply any adhesive. Press a new gasket seal into the recessed ring.

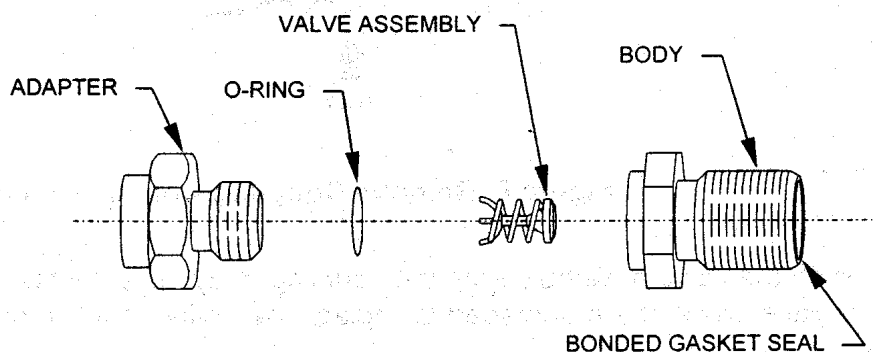


Figure 6 Aeroquip Male Coupling Parts

Repair or Replace a Coupling

Tools required: Open-end wrenches

This procedure applies to both male and female couplings on gas lines, compressor and cold head.

1. Vent the charged component using the venting procedure in this manual or in the Maintenance section of the appropriate manual.
2. If the coupling to be repaired has the venting adapter fitting attached, remove the adapter fitting. Use two wrenches.
3. Use two wrenches to disconnect the coupling body from the adapter. Hold the adapter with one wrench. Remove the coupling body with the other wrench. See Figure 7.
4. Push the valve assembly from the coupling body. It is not fastened. Examine all parts and replace any that are damaged or replace the entire coupling half. See Figures 6 or 8.

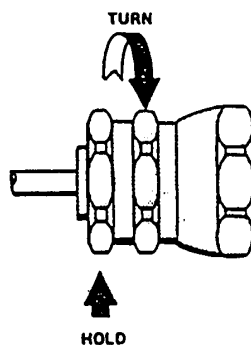


Figure 7 Remove Coupling from Gas Line

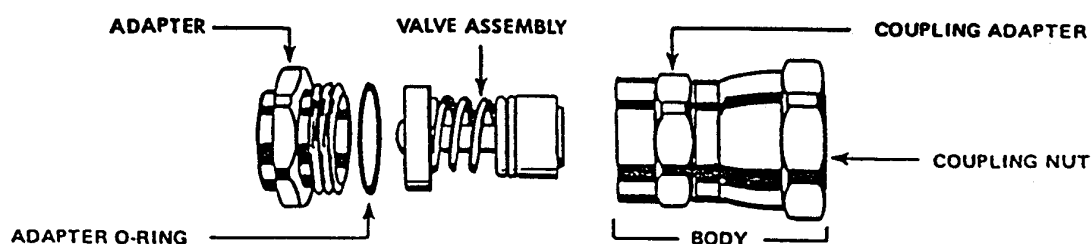


Figure 8 Aeroquip Female Coupling Parts

5. Remove the O-ring from the gas line adapter.
6. Wipe the O-ring groove to be sure it is clean. Lightly coat a new O-ring with vacuum grease. Install the O-ring in the gas line adapter.
7. Wipe the valve assembly with a clean, lint-free cloth. Insert the valve assembly into the coupling body from the rear.

8. Thoroughly degrease or apply Locquic Primer T (a degreasing agent) to the threads of the adapter and to the internal threads of the coupling body. Do not get Primer T on the O-ring or any of its seating surfaces.
9. Allow about 5 minutes for the primer to dry. Apply Loctite 242 to one full thread in the coupling adapter. Use a needle applicator. Start at the second thread from the lead thread and work toward the hexagon. Shake the Loctite before use.
10. Assemble the coupling body to the adapter. Use two wrenches. Hold the adapter with one wrench and screw the two parts together. Tighten the size 8 Aeroquip coupling parts to 4.85 – 6.25 kg_f m (35 – 45 ft. lbs.).
11. Allow at least a 6-hour curing period before applying gas pressure.

This completes the procedure for repairing or replacing a self-sealing coupling.

Charge Pressure Verification

Tools required: Tool Kit, P/N 268151A
Open-end wrenches

This procedure describes the process for checking and, if necessary, correcting the helium gas charge pressure in refrigeration system gas lines.

CAUTION

PRESERVE YOUR WARRANTY. Any helium gas used in this procedure should be of high purity. A purity level of 99.999% is required.

CAUTION

PREVENT EQUIPMENT DAMAGE. Keep the gas line couplings aligned when making or breaking a coupling connection. Leaks can occur due to the weight of the gas line or due to a sharp bend near the connection. Crimping from repeated bending and repositioning can cause damage to gas lines.

WARNING

AVOID INJURY. Use two wrenches when connecting or disconnecting a gas line coupling to avoid loosening the wrong joint. Gas pressure can project the coupling with enough force to cause injury.

1. Verify the pressure gauge tool [P/N 268150C2] has a minimum charge pressure of 20 psig.
2. If the charge pressure in the tool is too low, use the charge adapter tool [P/N 255919B2] to charge the pressure gauge tool to 50 psig. If the pressure gauge tool is completely empty, purge the pressure gauge tool with helium gas by “flushing through” with the exhaust valve open. After purging, close the exhaust valve and establish the proper charge pressure in the pressure gauge tool. Close the exhaust valve. Remove the charge adapter from the pressure gauge tool.

3. Unthread the dust cap from one end of the gas line to be checked. Be sure the valve on the pressure gauge tool is closed before it is connected. Connect the male Aeroquip end of the pressure gauge tool to the gas line using two wrenches.
4. Read the pressure.
 - 4.1. If the pressure is low, but ≥ 20 psig, use the charge adapter to add helium gas to the gas line to reach the specified equalization pressure.
 - 4.2. If pressure in the gas line is <20 psig, perform a clean-up on the gas line.
5. When finished checking or pressurizing the gas line, make sure the gauge tool is charged to 50 psig helium gas for storage.
6. Disconnect the male Aeroquip end of the pressure gauge tool from the gas line using two wrenches.
7. Screw the dust cap finger tight on to the gas line coupling.

This completes the procedure for checking the charge pressure in a gas line.

Gas Cleanup and Recharging

Tools required: Adapter fittings (2) P/N SK8217A2 or 255919B2 and 257246C5.
Open-end wrenches

Cleaning and recharging are always required when a gas line has been vented and repaired or if the gas pressure has dropped to less than 140 kPa (20 psig). Each gas line is cleaned and charged individually using adapter fittings.

1. Locate and connect adapter fitting P/N SK8217A2 to one gas line coupling. Connect adapter fittings P/N 255919B2 and 257246C5 to the other coupling. Be sure the valve on each adapter fitting is closed before it is connected.

NOTE

Adapter fittings are available as optional accessories from SCAI.

2. Connect a charge line to the pressure regulator of a helium gas cylinder containing 99.995% pure helium gas with a dew point less than -50°C (-58°F) at 2065 kPa (300 psig).

WARNING

AVOID INJURY. Never use compressed gas from a cylinder without a proper regulator. Overpressure can cause personal injury if the system equipment ruptures.

3. Open the gas cylinder valve. While connecting the charge line to the valve on one of the adapter fittings, thoroughly purge the charge line from the regulator. It is important to remove all air contaminants to prevent them from entering the gas line.
4. Adjust the gas cylinder regulator to 690 kPa (100 psig). Open the valve on the adapter fitting and charge the gas line to 690 kPa (100 psig).
5. Close the valve on the helium gas cylinder (not on the regulator).
6. Open the vent valve. Watch the regulator's pressure gauge. When the pressure falls to 35 – 70 kPa (5 – 10 psig), close the vent valve. Open the gas cylinder valve to increase the pressure to 690 kPa (100 psig). Close the gas cylinder valve.
7. Repeat step 6 five (5) times.
8. Close the valve on the adapter fitting used for charging. Open the gas cylinder valve. Adjust the pressure regulator to the equalization pressure of the system. Refer to the Specifications section in the System manual.
9. Open the valve on the adapter fitting and charge the gas line to the equalization pressure.
10. Close the valve on the adapter fitting. Close the gas cylinder valve. Disconnect the charge line from the adapter fitting. Store the charge line to keep it clean.
11. Remove the adapter fittings.

This completes the procedure for gas cleanup of a gas line.

PARTS

Ordering

Order parts by part number and name. See Figure 9.

Parts Identification and Number

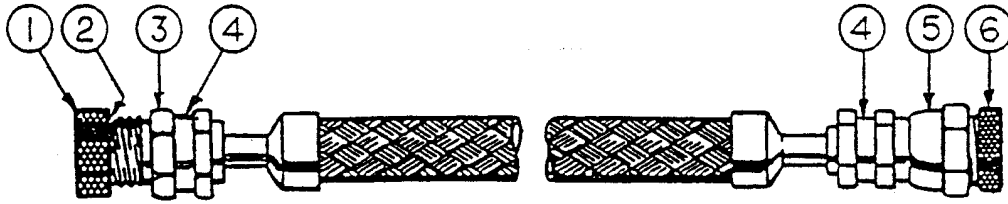


Figure 9 Parts Identification

Item	Part Name	Part Number	
		<u>Size 4</u>	<u>Size 8</u>
1.	Dust Cap	44639	44642
2.	Gasket Seal	77003	77002
3.	Coupling Half, Male	44601	44612
4.	O-ring	77005	47102
5.	Coupling Half, Female	44901	44614
6.	Dust Plug	44640	44643

NOTE

Gas lines used to carry refrigerant gas between the compressor and the cold heat typically are furnished with size 8 Aeroquip couplings.

(This page is intentionally blank.)



Sumitomo Heavy Industries, Ltd.

MANUAL NUMBER: CD32ZZ-063I

DATE: December 18 / 2003

OPERATION MANUAL

SRDK Series CRYOCOOLER

For Service Personnel Only

Sumitomo Heavy Industries, Ltd.
Cryogenics Division

**2-1-1 Yato-cho, Nishitokyo-City,
Tokyo 188-8585, Japan**

TEL: +81-424-68-4240

FAX: +81-424-68-4219

E-mail: cryo@shi.co.jp

URL: <http://www.shi.co.jp/cryopage>



Sumitomo Heavy Industries, Ltd.

EC DECLARATION OF CONFORMITY

We, Sumitomo Heavy Industries, Ltd., declare herewith that the cryocooler listed below, on the basis of its design and engineering as well as in the embodiment which we have placed on the market, comply with the applicable safety and health requirements set forth in EC directives.

This declaration becomes invalid if modifications are made to the product without consultation with us.


Designation of the Cryocooler;

Cryocooler Model SRDK series

Consists of

- Cold Head Model;
RDK-408D, RDK-408S,
RDK-400B, RDK-415D
- Compressor Unit Model;
CSA-71A, CSW-71C, CSW-71D

Tokyo, 1 November 1999



Tatsuo Koizumi, General Manager,
Cryogenics Department
Sumitomo Heavy Industries, Ltd.

The products comply with the following council directives:

- Machinery 98/37/EC
- Low Voltage 73/23/EEC
- EMC 89/336/EEC, 92/31/EEC
- Amendment Directive: 93/68/EEC

Applicable standards:

- Machinery EN60204-1 (1997)
- Low Voltage EN61010-1 (1993; +A2)
- EMC EN55011 (1991)
EN50082-2 (1995)

Applied national standards and technical specifications:

- MITI Directory No. 51*
- UL 471**

* MITI : Japan Ministry of Trade and Industry

**UL : Underwriters Laboratories Inc. (USA)

Tokyo, 1 November 1999



Kaoru Aoki, Manager,
Design Section
Cryogenics Department
Sumitomo Heavy Industries, Ltd.

TABLE OF CONTENTS

SECTION	ITEM	PAGE No.
	CROSS REFERANCE	1
	BEFORE USING EQUIPMENT	2
	SAFETY PRECAUTIONS	3
	INSPECTION	7
	PACKING AND RETURN	8
	REGULATORY REQUIREMENTS	9
	PRESSURE UNIT CONVERSION TABLE	10
1	INTRODUCTION	11
1-1	GENERAL INFORMATION	11
1-2	SRDK SERIES CRYOCOOLER	12
1-3	THEORY OF OPERATION	14
2	INSTALLATION	16
2-1	GENERAL	16
2-2	TOOLS FOR INSTALLATION	16
2-3	MOVING	17
2-4	SITE REQUIREMENT	18
2-4-1	REQUIRED FOR AIR COOLED COMPRESSOR UNIT	19
2-4-2	REQUIRED FOR WATER COOLED COMPRESSOR UNIT	20
2-5	COLD HEAD INSTALLATION	21
2-6	COMPRESSOR UNIT INSTALLATION	22
2-7	CONNECTING FLEX LINES	24
2-8	COLD HEAD POWER CABLE CONNECTION	31
2-9	INPUT POWER CABLE CONNECTION	35
3	OPERATION	36
3-1	PRELIMINARY CHECKS	37
3-2	START-UP OPERATION	38
3-3	SHUT-DOWN OPERATION	39
3-4	NORMAL OPERATION	40
4	FUNCTIONAL CHECK	41
4-1	SIMPLE PROBLEM	41
4-1-1	PRESSURE	41
4-1-2	ROOM TEMPERATURE	41
4-1-3	MAIN POWER PHASE	41
4-2	HELIUM LEAK	42

TABLE OF CONTENTS

5	MAINTENANCE	43
5-1	GENERAL INFORMATION FOR THE MAINTENANCE	44
5-2	COLD HEAD MAINTENANCE	45
5-3	COMPRESSOR UNIT MAINTENANCE	45
5-4	HELIUM GAS CHARGING	46
6	TROUBLE SHOOTING FLOW CHART	48
7	OPERATING LOG	55
	REVISION CONTROL	

CROSS REFERENCE

Thoroughly read this manual and following manuals before using this equipment.

MANUAL NAME	MANUAL No.
TECHNICAL INSTRUCTION RDK-408D2 4K COLD HEAD*	CD32ZZ-160
TECHNICAL INSTRUCTION RDK-408D 4K COLD HEAD*	CD32ZZ-064
TECHNICAL INSTRUCTION RDK-408S2 10K COLD HEAD*	CD32ZZ-161
TECHNICAL INSTRUCTION RDK-408S 10K COLD HEAD*	CD32ZZ-065
TECHNICAL INSTRUCTION RDK-400B SINGLE STAGE COLD HEAD*	CD32ZZ-066
TECHNICAL INSTRUCTION RDK-415D 4K COLD HEAD*	CD32ZZ-070
TECHNICAL INSTRUCTION CSA-71A COMPRESSOR UNIT**	CD32ZZ-067
TECHNICAL INSTRUCTION CSW-71C COMPRESSOR UNIT**	CD32ZZ-068
TECHNICAL INSTRUCTION CSW-71D COMPRESSOR UNIT**	CD32ZZ-069

* See TECHNICAL INSTRUCTION of Cold Head used.

** See TECHNICAL INSTRUCTION of Compressor Unit used.

BEFORE USING EQUIPMENT

- This service manual is intended only for the exclusive service personnel.
- Sumitomo Heavy Industries will not be responsible for any accidents, failures, non-conformities, etc. caused by operations by any persons other than service personnel according to the descriptions in this manual.
- This service manual describes important information such as the installation method, operation method and maintenance of this equipment.
- Be sure to read this service manual before using this cryocooler.
- Using the equipment without observing the descriptions in this manual may result in malfunction of the equipment or may be hazardous to the physical body of the operator. Sumitomo Heavy Industries will provide no guarantee in this case.
- No part of this manual may be reproduced without the consent of Sumitomo Heavy Industries, Ltd. The use of this manual for other purposes is prohibited.

SAFETY PRECAUTIONS

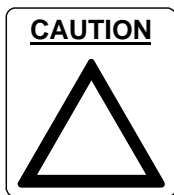
This service manual uses the following signs and expressions to describe items requiring strict observance to prevent injury to the operator and other persons, damage to this equipment, the customer's equipment and property, etc.



“WARNING”

Indicates a potentially hazardous situation that may cause injury to the operator or people around the equipment in the event of improper handling taking no account of this description.

When using this equipment, be sure to adhere to this description.



“CAUTION”

Indicates a potentially hazardous situation that may result in misoperation, malfunction, or damage of the customer's equipment, etc. in the event of improper handling taking no account of this description.

When using this equipment, be sure to adhere to this description.

“WARNINGS”**<Warning about electric shock>**

This cryocooler includes a high-voltage section. Touching it may result in electric shock. Handle it with extreme care.

Make sure no power is applied to the compressor unit before starting the installation. Failing to observe this precaution may result in electric shock.

Do not install the equipment near places subject to condensation such as a watering place. Failing to observe this precaution may result in electric shock or malfunction.

Do not install the equipment in a dusty environment. Failing to observe this precaution may result in electric shock or malfunction.

Make sure the power specification of the cryocooler used conforms to the customer's power supply before using the equipment. Using the cryocooler with a non-conforming power supply may result in electric shock or malfunction.

If the compressor unit used is the CSW-71D (water cooled, high voltage type), pay attention to the setting of the applicable input supply voltage. The product is shipped with the input supply voltage set to 480V. Before installing the equipment, be sure to check your supply voltage and change it to the appropriate setting if necessary. Operating the equipment with your supply voltage different from the setting of the compressor unit may result in electric shock or malfunction.

Make sure no power is applied to the compressor unit before starting operation when connecting or disconnecting the cold head power cable. Failing to observe this precaution may result in electric shock.

Be sure to turn off and Lock Out with OFF position the main power of the customer's power source before connecting or disconnecting the input power cable to the Compressor Unit, and then remove the input power cable from the main power. Failing to observe this precaution may result in electric shock.

Do not change the setting of the dial above the main power switch of the compressor unit under any circumstances. Failing to observe this precaution may result in electric shock.

Pay special attention to its wiring when using the external connector on the compressor unit. Connecting a jumper wire between Pins No.6 - No.8, No.6 - No.13 and No.6 - No.15 may result in misoperation in some of safety devices in the equipment, causing electric shock, burn or malfunction.

Be sure to turn off and Lock Out with OFF position the customer's main power before performing maintenance work such as replacement of fuses. Failing to observe this precaution may result in electric shock.

**<Warning about explosion, escape of gas>**

This cryocooler (cold head, compressor unit, compressor adsorber, flex lines) contains a high-pressure (about 1.62 MPa (16.5 kgf/cm²G, 235 psig)) helium gas sealed in. Hitting the equipment with a sharp edge or touching it with a pointed object may cause explosion or escape of gas. Handle the equipment with extreme care.

The minimum bending radius of the flex lines is 300 mm (11.81 inches). Bending the flex lines at a smaller angle may cause explosion or escape of gas, and so this should be avoided.

Do not disassemble the equipment for purposes other than maintenance specified in this service manual under any circumstances. Disassembling the equipment may result in electric shock, explosion or escape of gas.

The cold head, compressor unit, compressor adsorber and flex lines are pressurized with helium gas. Purge the helium gas from all pressurized components before disposing. Open the purging valve gradually or it may result in serious injury.

Do not break the vacuum with the low temperature of cold head second stage when removing the cold head from the vacuum chamber. Breaking the vacuum may result in serious damage, explosion or escape of gas. Keep the Flex Lines connected and maintain the high vacuum of the chamber and wait until the cold head second stage temperature rises up to 100K before removing the cold head.

**<Warning about rotating part>**

If the compressor unit used is the CSA-71A (air cooled, low voltage type), a venting fan is provided in the exhaust section at the top of the compressor unit. Do not insert foreign substances from the exhaust port under any circumstances. Failing to observe this precaution may result in injury or malfunction.



Do not touch the cooler fin of the Compressor Unit during fin cleaning. Touching the fin may cause the injury.

The Adsorber weight is about 11.0kg. When replace the adsorber, be careful of handling so that it may not get hurt.

“CAUTIONS”**<Caution against misoperation>**

Do not tilt it by more than 30 degrees when carrying the compressor unit. Tilting it by more than 30 degrees may cause oil sealed in the unit to move, preventing the cryocooler from operating normally.

This cryocooler is intended for the exclusive use indoors. It cannot be used outdoors. Failing to observe this precaution may prevent the cryocooler from operating normally.

Do not use inverter for the main power source of the compressor unit. Operating with inverter may result in the damage or malfunction of the compressor electric circuit.

Avoid using the transformer for the main power source of the compressor unit. If the transformer is installed at the upstream of the unit, lacking phase protection circuit with the cryocooler occurs in a malfunction. That may result in misoperation or malfunction. When using the transformer, install the other lacking phase protection device in upstream of the transformer.

The cryocooler ON/OFF frequency must be less than 6 times per hour, and the ON/OFF interval must be more than 3 minutes. The frequent ON/OFF operation may result in damage of compressor capsule or malfunction.

Do not get on the compressor unit or put an object on top of it. Failing to observe this precaution may prevent the cryocooler from operating normally or cause injury.

Secure enough space around the compressor unit for heat radiation and maintenance. Failing to secure enough space may result in misoperation or malfunction. (See the technical instruction of the compressor unit used, for details.)

If the compressor unit used is the CSA-71A (air cooled, low voltage type), sufficient space is required for venting. Failing to secure sufficient space may result in misoperation or malfunction. (See the CSA-71A technical instruction, for details.)

If the compressor unit used is the CSA-71A (air cooled, low voltage type), it should be installed in a clean environment. Installing it in a dusty environment such as inside a factory will require frequent cleaning of the cooler fins or may result in misoperation or malfunction.

If the compressor unit used is a water-cooled type (CSW-71C, CSW-71D), use cooling water with appropriate temperature, flow rate and water quality. Using inappropriate cooling water may result in misoperation or malfunction. (See the technical instruction of the compressor unit used, for details.)

If the compressor unit used is a water-cooled type (CSW-71C, CSW-71D), do not use the demineralized water for cooling water. Using demineralized water for cooling water may result in water leakage or malfunction.

Be extremely careful not to damage the cylinder when mounting the cold head. Damaging the cylinder may result in misoperation or malfunction.

Be sure to check the flat rubber gasket of the self seal coupling of the cold head and compressor unit for dirt, dust or to see whether the flat rubber gasket is attached correctly, before connecting the flex lines. Connecting the flex lines with an abnormal flat rubber gasket setting may cause escape of gas.

When connecting the flex lines to the cold head, be sure to start with the flex line on the "Return" side. Starting with the flex line on the "Supply" side may cause misoperation.

This cryocooler (cold head, compressor unit, compressor adsorber, flex lines) is shipped with a helium gas at about 1.62 MPa (16.5 kgf/cm²G, 235 psig) sealed in. Be sure to adjust the pressure to an appropriate value according to the cold head used before operating the equipment. Using the cryocooler at an improper pressure may cause misoperation.

The cold head drive switch provided with the compressor unit is only used for maintenance. Be sure to turn it OFF in normal operation. Using the compressor unit with the cold head drive switch turned ON may result in misoperation or malfunction.

The coldhead employs the special seal to the 2nd stage. The 2nd stage displacer is fit tightly in the cylinder. Make sure the 2nd stage temperature is less than 28 deg.C before starting up the cryocooler, or the coldhead may make grinding noise.

Pay attention to the contamination when charging a helium gas. The contamination may result in occurrence of the noise from the Cold Head or decreasing the cooling capacity.

INSPECTION

"IMPORTANT"

If any irrecoverable damage is found by a test at the time of reception of the equipment described in this service manual, please contact Sumitomo Heavy Industries.

The Cryocooler Model SRDK Series should be thoroughly inspected for evidence of damage upon receipt.

Proceed as follows to unpack and check the shipping damages as soon as you receive it.

- 1) Inspect the outside of each shipping container for visible damage. If you will be making a damage claim, keep the shipping container, packing materials.
- 2) Carefully unpack the Cold Head, Compressor Unit, Flex Lines and Cables and inspect them for damage.

COLD HEAD

Inspect the exterior of the Cold Head for evidence of damage.

- (a) Overall exterior.
- (b) Bent or dent of cylinder.
- (c) Mounting flange and its sealing surfaces.

COMPRESSOR UNIT

The compressor should not be tilted by more than 30 degree at any time. Tilting the Compressor Unit upside down causes damage of compressor capsule or oil contamination of the Helium gas line.

Inspect the exterior of the Compressor Unit for evidence of damage.

- (a) Overall exterior.
- (b) Oil leakage.
- (c) Filling pressure.

The pressure gauge will be indicated 1.60 - 1.65 MPa (16.3 - 16.8 kgf/cm²G, 232 -239 psig) minimum at 20 deg.C (68 deg.F). If the gauge indicates less than 1.60 MPa (16.3 kgf/cm²G, 232 psig), refill Helium gas as described in "**TECHNICAL INSTRUCTION**" of Compressor Unit used. If the gauge indicates 0 MPa (0 kgf/cm²G, 0 psig), there is a risk of helium contamination and Compressor Unit must be replaced.

FLEX LINES AND ELECTRICAL CABLES

Inspect the Flex Lines for evidence of damage. Do not bend the Flex Line to less than a 300 mm (11.81 inch) radius or damage may occur. Also, avoid twisting the Flex Line when making final connections.

Inspect the Cold Head Power Cable and Input Power Cable for evidence of damage.

PACKING AND RETURN

Reinstall the caps on all Aeroquip connector to protect from the damage during transportation or shipping.
Reuse the package that was used for shipping.

Pack the Compressor Unit and Cold Head securely and properly.
Attach the caution label to prevent the tilting the Compressor Unit or upside down during transportation.

“IMPOTANT”

If you return the water-cooling type compressor unit to Sumitomo Heavy Industries, please let out the cooling water.

REGULATORY REQUIREMENTS

The SRDK Series Cryocooler is designed and manufactured in accordance with following standards.

EC Directives (EC)

- EN60204-1 (1997)
- EN61010-1 (1993; +A2)
- EN55011 (1991)
- EN50082-2 (1995)

Underwriters Laboratories Inc. (USA)

- UL-471 (Miscellaneous Refrigeration Equipment)

Japan Ministry of Trade and Industry

- MITI Directory No.51

PRESSURE UNIT CONVERSION TABLE

PRESSURE UNIT CONVERSION TABLE

0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	[MPa]	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	0.0	0	1	3	4	6	7	9	10	12	13
1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	0.1	14	16	17	19	20	22	23	25	26	28
2.0	2.1	2.2	2.3	2.4	2.6	2.7	2.8	2.9	3.0	0.2	29	30	32	33	35	36	38	39	41	42
3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	0.3	43	45	46	48	49	51	52	54	55	57
4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	0.4	58	59	61	62	64	65	67	68	70	71
5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	0.5	72	74	75	77	78	80	81	83	84	85
6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.8	6.9	7.0	0.6	87	88	90	91	93	94	96	97	99	100
7.1	7.2	7.3	7.4	7.5	7.7	7.8	7.9	8.0	8.1	0.7	101	103	104	106	107	109	110	112	113	114
8.2	8.3	8.4	8.5	8.6	8.7	8.8	8.9	9.0	9.1	0.8	116	117	119	120	122	123	125	126	128	129
9.2	9.3	9.4	9.5	9.6	9.7	9.8	9.9	10.0	10.1	0.9	130	132	133	135	136	138	139	141	142	143
10.2	10.3	10.4	10.5	10.6	10.7	10.8	10.9	11.0	11.1	1.0	145	146	148	149	151	152	154	155	156	158
11.2	11.3	11.4	11.5	11.6	11.7	11.8	11.9	12.0	12.1	1.1	159	161	162	164	165	167	168	170	171	172
12.2	12.3	12.4	12.5	12.6	12.8	12.9	13.0	13.1	13.2	1.2	174	175	177	178	180	181	183	184	185	187
13.3	13.4	13.5	13.6	13.7	13.8	13.9	14.0	14.1	14.2	1.3	188	190	191	193	194	196	197	199	200	201
14.3	14.4	14.5	14.6	14.7	14.8	14.9	15.0	15.1	15.2	1.4	203	204	206	207	209	210	212	213	214	216
15.3	15.4	15.5	15.6	15.7	15.8	15.9	16.0	16.1	16.2	1.5	217	219	220	222	223	225	226	227	229	230
16.3	16.4	16.5	16.6	16.7	16.8	16.9	17.0	17.1	17.2	1.6	232	233	235	236	238	239	241	242	243	245
17.3	17.4	17.5	17.6	17.7	17.9	18.0	18.1	18.2	18.3	1.7	246	248	249	251	252	254	255	256	258	259
18.4	18.5	18.6	18.7	18.8	18.9	19.0	19.1	19.2	19.3	1.8	261	262	264	265	267	268	270	271	272	274
19.4	19.5	19.6	19.7	19.8	19.9	20.0	20.1	20.2	20.3	1.9	275	277	278	280	281	283	284	285	287	288
20.4	20.5	20.6	20.7	20.8	20.9	21.0	21.1	21.2	21.3	2.0	290	291	293	294	296	297	298	300	301	303
21.4	21.5	21.6	21.7	21.8	21.9	22.0	22.1	22.2	22.3	2.1	304	306	307	309	310	312	313	314	316	317
22.4	22.5	22.6	22.7	22.8	23.0	23.1	23.2	23.3	23.4	2.2	319	320	322	323	325	326	327	329	330	332
23.5	23.6	23.7	23.8	23.9	24.0	24.1	24.2	24.3	24.4	2.3	333	335	336	338	339	341	342	343	345	346
24.5	24.6	24.7	24.8	24.9	25.0	25.1	25.2	25.3	25.4	2.4	348	349	351	352	354	355	356	358	359	361
25.5	25.6	25.7	25.8	25.9	26.0	26.1	26.2	26.3	26.4	2.5	362	364	365	367	368	369	371	372	374	375
26.5	26.6	26.7	26.8	26.9	27.0	27.1	27.2	27.3	27.4	2.6	377	378	380	381	383	384	385	387	388	390
27.5	27.6	27.7	27.8	27.9	28.1	28.2	28.3	28.4	28.5	2.7	391	393	394	396	397	398	400	401	403	404
28.6	28.7	28.8	28.9	29.0	29.1	29.2	29.3	29.4	29.5	2.8	406	407	409	410	412	413	414	416	417	419
29.6	29.7	29.8	29.9	30.0	30.1	30.2	30.3	30.4	30.5	2.9	420	422	423	425	426	427	429	430	432	433
[kgf/cm²G]											[psig]									

1 [MPa] = 10.2 [kgf/cm²G]

1 [MPa] = 144.9 [psig]

1 INTRODUCTION

1-1 GENERAL INFORMATION

This manual provides instructions for initial inspection, installation, operation and service for the component of SRDK Series Cryocooler system in **Table 1.1**.

Table 1.1 CRYOCOOLER MODELS COVERED IN THIS MANUAL

COMPONENT	MODEL
COLD HEAD	
4K COLD HEAD	RDK-408D2
	RDK-408D
	RDK-415D
10K COLD HEAD	RDK-408S2
	RDK-408S
SINGLE STAGE COLD HEAD	RDK-400B
COMPRESSOR UNIT	
AIR COOLED (Low Voltage)	CSA-71A
WATER COOLED (Low Voltage)	CSW-71C
WATER COOLED (High Voltage)	CSW-71D
FLEX LINE*	
SUPPLY (Female - Female)	20 A x 6 m (19.7 feet)
	20 A x 20 m (69.6 feet)
	20 A x 6 m (19.7 feet) + Buffer Tank
RETURN (Female - Female)	20 A x 6 m (19.7 feet)
	20 A x 20 m (69.6 feet)
	20 A x 6 m (19.7 feet) + Buffer Tank
COLD HEAD POWER CABLE	6 m (19.7 feet)

* To operate the RDK-415D and RDK-400B (including the special flange model) with specified cooling capacity, use the 20A x 20m flex line or 20A x 6m flex line + Buffer Tank.

1-2 SRDK SERIES CRYOCOOLER

The SRDK Series Cryocooler consists of a Cold Head, Compressor Unit, Flex Lines, and Cold Head Power Cable.

The RDK series Cold Head is a GM cycle cryo-refrigerator. The function of the Cold Head is to produce continuous closed-cycle refrigeration at temperatures, depending upon the heat load imposed.

The Cold Head has three (3) major components: the drive unit; the cylinder; and the displacer-regenerator assembly, which is located inside the cylinder.

RDK-408D2 & RDK-408D & RDK-415D 4K Cold Heads are applied rare earth material for the second stage displacer to produce 4K temperature. The second stage cooling capacity is approximately 1.0W at 4.2K for RDK-408D2 & RDK-408D, and 1.5W at 4.2K for RDK-415D.

RDK-408S2 & RDK-408S 10K Cold Head is the standard type Cold Head which are modified to produce more cooling capacity for the second stage cold station compared with SHI previous standard type Cold Head.

The second stage cooling capacity of RDK-408S2 & RDK-408S Cold Head is approximately 5W at 10K.

RDK-400B Single Stage Cold Head has only first stage displacer for cooling the shield.

The cooling capacity of RDK-400B is approximately 54W at 40K.

The Compressor Unit is required to operate the Cold Head. The Compressor Unit will provide the power and the high-pressure helium gas for the Cold Head, and consisted of a compressor capsule, a cooling system and lubricating oil mist Adsorber.

Functionally, the high-pressure helium gas from the Compressor Unit will be supplied to the Cold Head through the helium gas supply connector. The supply gas will be passed into the displacer-regenerator assembly, come out through the displacer-regenerator assembly to the crankcase through the motor housing, and finally will be returned to the Compressor Unit through the helium gas return connector. The helium gas expansion in the displacer-regenerator assembly will provide cooling condition for the first and second-stage cold stations.

The Cryocooler requires the routine maintenance to keep the performance. The Adsorber replacement of the Compressor Unit is required every 20,000 operating hours. The acting parts replacement of the Cold Head is required to maintain every 10,000 operating hours.

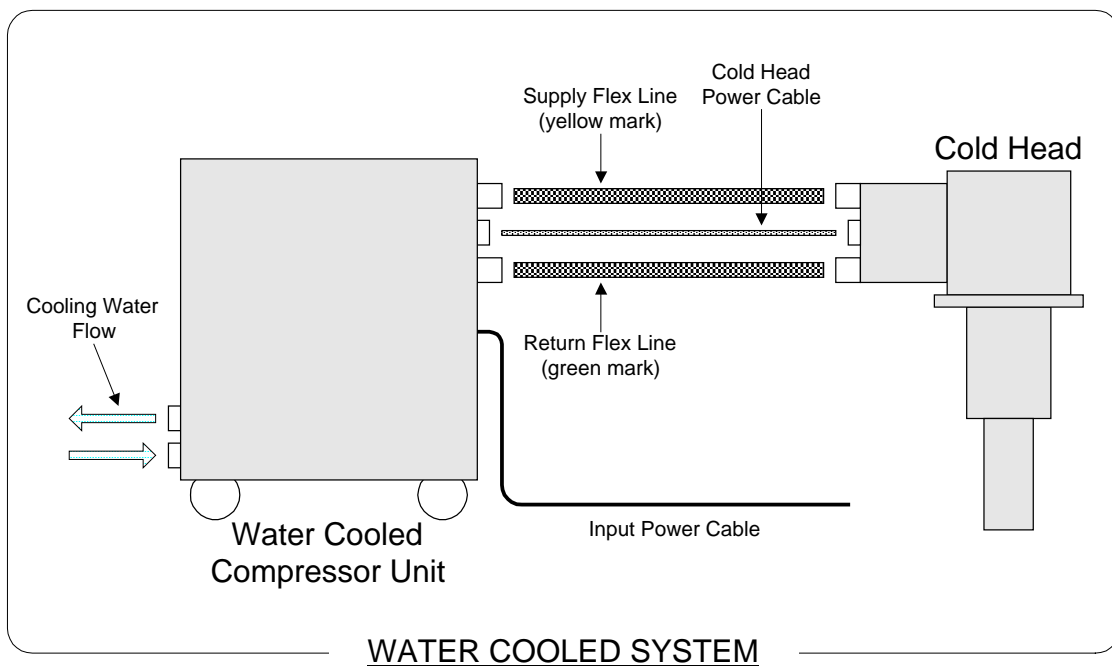
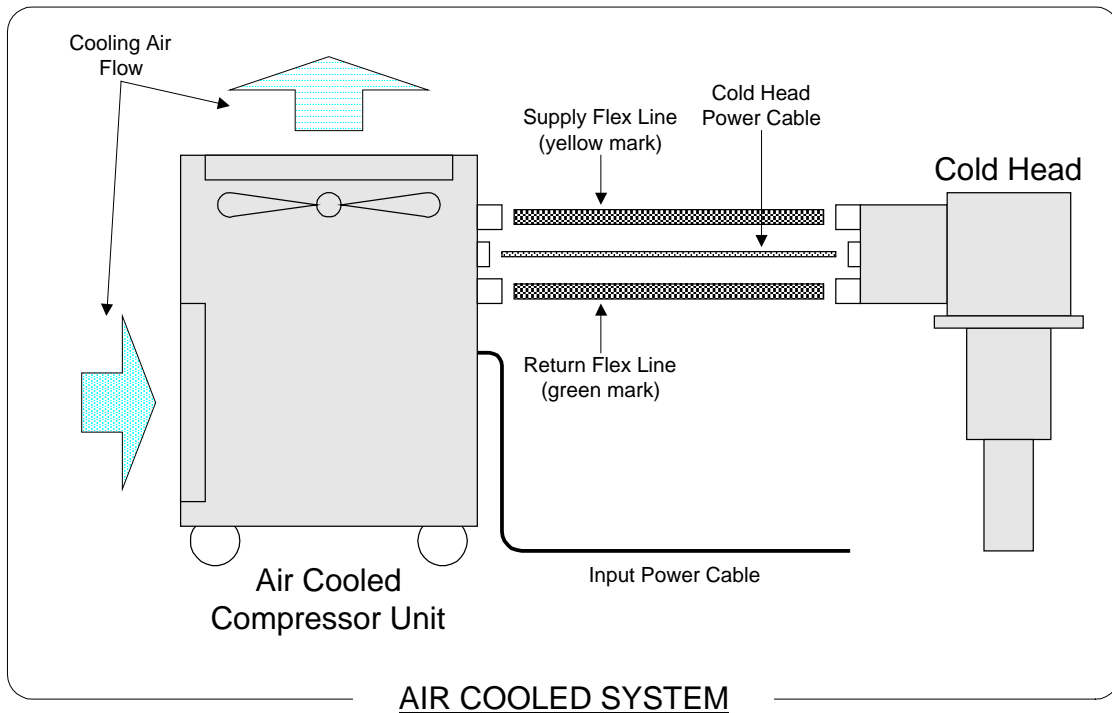


Figure 1.1 SRDK SERIES CRYOCOOLER SYSTEM

1-3 THEORY OF OPERATION

The SUMITOMO Helium Refrigerator operates on the GM (Gifford-McMahon) cycle.

The GM cycle is shown schematically in **Figure 1.2** and consisted of a cylinder, closed at both ends, and containing a displacer of a length about three quarters of the cylinder. The displacer is connected to a drive mechanism so that it can be operated reciprocating action in the cylinder. The two volumes, one for above and another for below the displacer, can be varied from zero to maximum but the total volume remains constantly.

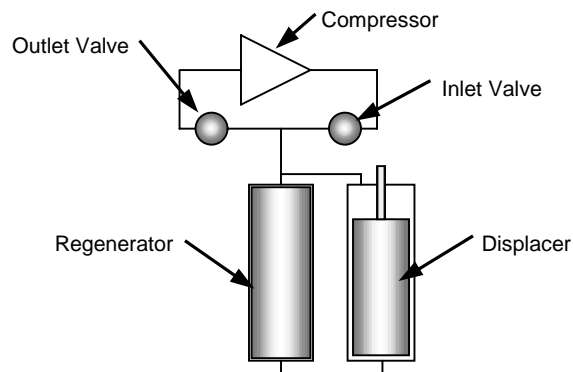


Figure 1.2 SCHEMATIC DIAGRAM OF GM CYCLE REFRIGERATOR

The two spaces are connected through a thermal regenerator and to a gas supply. The gas supply system is consisted of inlet and outlet valves, a helium gas compressor and high and low pressure reservoirs. The valves are coupled to the rotary drive mechanism and their operation is synchronized with the position of the displacer. A heat exchanger is included downstream of the helium gas compressor to cool down the gas to ambient temperature after compression.

The pressure above and below the displacer will be the same level except for small pressure drops across the regenerator when gas is flowing through it. The basic function for the displacer will be required to displace a volume in the cylinder so that the gas will be moved up and down in the cylinder without mechanical work.

Pressure in the system is increased or decreased by operation of the inlet or outlet valves.

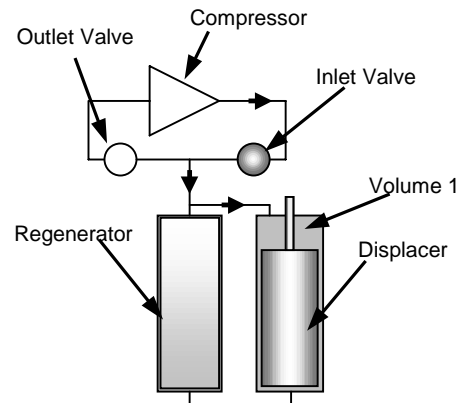
The displacer is fit loosely in the cylinder except at the top equipped with a dynamic (sliding) seal to prevent gas leakage through the space between displacer and cylinder.

The regenerator will be consisted of metallic material divided finely will cool the gas passing downward to the cold space and heat the gas passing upward from the cold space.

The refrigerator operates as follows;

PRESSURE BUILD-UP

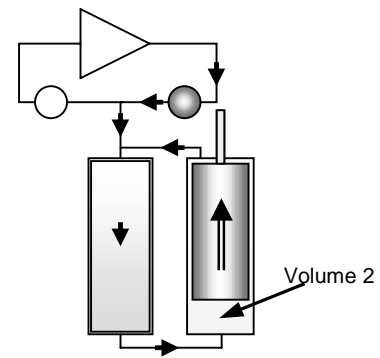
With the displacer at the bottom of the cylinder and the outlet valve closes and the inlet valve opens, increasing the pressure level in the system. Fluid will be led through the inlet valve to fill the regenerator and the space above the displacer, volume 1.



PRESSURE BUILD-UP

INTAKE STROKE

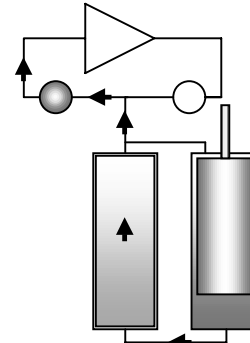
With the inlet valve open, the displacer is moved from the bottom to the top of the cylinder. This displaces high pressure fluid from the space above the displacer, volume 1, through the regenerator, to the space below the displacer, volume 2. In passing through the regenerator, the gas cools causing the pressure to decrease and further gas to enter the system to maintain the maximum cycle pressure.



INTAKE STROKE

PRESSURE RELEASE AND EXPANSION

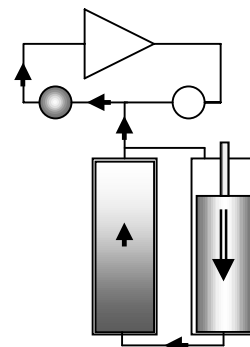
With the displacer at the top of the cylinder, the inlet valve closes and outlet valve opens. Fluid escapes and the pressure will decrease. The drop in pressure causes a reduction in the gas temperature level. The temperature decrease of gas in the bottom cylinder space, volume 2, is the useful refrigeration process of the cycle.



PRESSURE RELEASE AND EXPANSION

EXHAUST STROKE

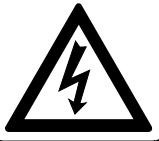
With outlet valve open, the displacer moves from the top to bottom of the cylinder, displacing fluid from volume 2 (below) to volume 1, above the displacer. As it flows through the regenerator, the fluid is heated to near ambient temperature by the matrix. This process, can be produced the cool in the matrix ready for the gas entering in the succeeding cycle.



EXHAUST STROKE

Figure 1.3 PRINCIPLE OF GM CYCLE

2 INSTALLATION

WARNING

<Warning about electric shock>

This cryocooler includes a high-voltage section. Touching it may result in electric shock. Handle it with extreme care.

Make sure no power is applied to the compressor unit before starting the installation. Failing to observe this precaution may result in electric shock.

2-1 GENERAL

This section describes the installation of the Cold Head and the Compressor Unit, and how to connect the Flex Lines and electrical cables. Be sure to read this section before installing the cryocooler.

2-2 TOOLS FOR INSTALLATION

The following tools are required for SRDK Series Cryocooler Installation.

Table 2.1 REQUIRED TOOLS FOR INSTALLATION

	TOOLS	REMARK
1	1" Open-end wrench	For Flex Line connection
2	1-1/8" Open-end wrench	For Flex Line connection
3	1-3/16" Open-end wrench	For Flex Line connection
4	Vacuum grease	For O-ring of Vacuum Chamber
5	Screwdriver (phillips(+), flathead(-))	For Cold Head Cable and Input Power Cable connection
6	Liquid Leak Detector	For leak check
7	Cotton wipers	For leak check
8	Bar wrench for M4	For Cold Head Installation to Vacuum Chamber

2-3 MOVING**WARNING****<Warning about explosion, escape of gas>**

This cryocooler (cold head, compressor unit, compressor adsorber, flex lines) contains a high-pressure (about 1.62 MPa (16.5 kgf/cm²G, 235 psig)) helium gas sealed in. Hitting the equipment with a sharp edge or touching it with a pointed object may cause explosion or escape of gas. Handle the equipment with extreme care.

CAUTION**<Caution against misoperation>**

Do not tilt it by more than 30 degrees when carrying the compressor unit. Tilting it by more than 30 degrees may cause oil sealed in the unit to move, preventing the cryocooler from operating normally.

COMPRESSOR UNIT

The compressor should not be tilted by more than 30 degrees at any time.

Tilting the Compressor Unit causes damage of Compressor Capsule or oil contamination of the Helium Gas Line.

COLD HEAD

The Cold Head Cylinder should not be bent or dent. The surface flatness of the Cold Head heat station is critical to the thermal contact. Damage of the surface will cause performance loss.

2-4 SITE REQUIREMENT

CAUTION**<Caution against misoperation>**

Do not use inverter for the main power source of the compressor unit. Operating with inverter may result in the damage or malfunction of the compressor electric circuit.

Avoid using the transformer for the main power source of the compressor unit. If the transformer is installed at the upstream of the unit, lacking phase protection circuit with the cryocooler occurs in a malfunction. That may result in misoperation or malfunction. When using the transformer, install the other lacking phase protection device in upstream of the transformer.

Secure enough space around the compressor unit for heat radiation and maintenance. Failing to secure enough space may result in misoperation or malfunction. (See the technical instruction of the compressor unit used, for details.)

If the compressor unit used is the CSA-71A (air cooled, low voltage type), sufficient space is required for venting. Failing to secure sufficient space may result in misoperation or malfunction. (See the CSA-71A technical instruction, for details.)

If the compressor unit used is the CSA-71A (air cooled, low voltage type), it should be installed in a clean environment. Installing it in a dusty environment such as inside a factory will require frequent cleaning of the cooler fins or may result in misoperation or malfunction.

If the compressor unit used is a water-cooled type (CSW-71C, CSW-71D), use cooling water with appropriate temperature, flow rate and water quality. Using inappropriate cooling water may result in misoperation or malfunction. (See the technical instruction of the compressor unit used, for details.)

If the compressor unit used is a water-cooled type (CSW-71C, CSW-71D), do not use the demineralized water for cooling water. Using demineralized water for cooling water may result in water leakage or malfunction.

“IMPORTANT”

See “TECHNICAL INSTRUCTION” of Compressor Unit used, for detail of Site Requirement.

The Compressor Unit can be installed at the field as complying with the Site Requirement;

2-4-1 REQUIRED FOR AIR COOLED COMPRESSOR UNIT

- An almost level and even area in the field will be selected to install the Compressor Unit.
- An area to be influenced by splashing water and/or dusts will not be selected to install the Compressor Unit.
- A clean environmental condition without dirt and/or free from an exhausted heat will be selected to install the Compressor Unit in the field.
- An efficient ventilated area will be required to free from an exhausted heat of the Compressor Unit in the field.
- A suitable air conditioning capacity will be secured for an installing area for the Compressor Unit in the field.
- Any object and/or obstacle cannot be positioned on a ventilation fan outlet in a top area of the enclosure and/or on surroundings of the Compressor Cooler.
- Any heat sensitive object cannot be positioned on surroundings of the Compressor Unit.

AMBIENT TEMPERATURE CONDITION

The ambient temperature must be between 5 deg.C (41 deg.F) and 28 deg.C (82.4 deg.F) to get the specified cooling capacity. The system can operate up to 35 deg.C (95 deg.F) with less than 5% cooling capacity down. The maximum relative air humidity is 85%RH.

HELIUM SUPPLY SYSTEM

A helium supply system is necessary if you need to decontaminate the helium gas, or to charge the helium gas that has leaked out of the system. A helium supply system includes a Grade 5 (99.999% up pure) helium gas bottle, a regulator, an outlet valve, and a charging hose or equivalent delivery line.

POWER SOURCE

Ensure the correct AC power source is available for the Compressor Unit. See "TECHNICAL INSTRUCTION" of CSA-71A, for AC power source requirement.

SAFETY / SEISMIC REQUIREMENT

Secure to lock the locking device of compressor castor.

SERVICE AREA

Air-cooled Compressor Unit should have enough space for air-flow as shown in "TECHNICAL INSTRUCTION" of CSA-71A.

2-4-2 REQUIRED FOR WATER COOLED COMPRESSOR UNIT

- An almost level and even area in the field will be selected to install the Compressor Unit.
- An area to be influenced by splashing water and/or dusts will not be selected to install the Compressor Unit.
- A clean environmental condition without dirt and/or free from an exhausted heat will be selected to install the Compressor Unit in the field.
- A quality of cooling water will be secured to use for an appropriate cooling of the Compressor Unit.
- Any heat sensitive object cannot be positioned on surroundings of the Compressor Unit.

AMBIENT TEMPERATURE CONDITION

The ambient temperature must be between 5 deg.C (41 deg.F) and 28 deg.C (82.4 deg.F) to get the specified cooling capacity. The system can operate up to 35 deg.C (95 deg.F) with less than 5% cooling capacity down. The maximum relative air humidity is 85%RH.

HELIUM SUPPLY SYSTEM

A helium supply system is necessary if you need to decontaminate the helium gas, or charge the helium gas that has leaked out of the system. A helium supply system includes a Grade 5 (99.999% up pure) helium gas bottle, a regulator, an outlet valve, and a charging hose or equivalent delivery line.

POWER SOURCE

Ensure the correct AC power source is available for the Compressor Unit. See "TECHNICAL INSTRUCTION" of Compressor Unit used, for AC power source requirement.

COOLING WATER

Ensure the correct cooling water is available for the Compressor Unit. See "TECHNICAL INSTRUCTION" of Compressor Unit used, for the cooling water requirements.

ANTIFREEZE

Operating with Antifreeze (50/50 % mixture of water and ethylene glycol), the flow rate shall be 10% larger than water flow rate and the pressure drop through the cooling water line will be 40% larger. The larger circulating pump will be required for the Antifreeze. The admissible capacity range for circulation pump will be more than 8 liter/min (2.1 gal./min) for flow rate and 0.29 MPa (3 kgf/cm²G, 42 psig) for the pressure drop.

SAFETY / SEISMIC REQUIREMENT

Secure to lock the locking device of compressor castor.

SERVICE AREA

The Compressor Unit should have enough space as shown in "TECHNICAL INSTRUCTION" of Compressor Unit used.

2-5 COLD HEAD INSTALLATION

WARNING**<Warning about explosion, escape of gas>**

This cryocooler (cold head, compressor unit, compressor adsorber, flex lines) contains a high-pressure (about 1.62 MPa (16.5 kgf/cm²G, 235 psig)) helium gas sealed in. Hitting the equipment with a sharp edge or touching it with a pointed object may cause explosion or escape of gas. Handle the equipment with extreme care.

Do not break the vacuum with the low temperature of cold head second stage when removing the cold head from the vacuum chamber. Breaking the vacuum may result in serious damage, explosion or escape of gas. Keep the Flex Lines connected and maintain the high vacuum of the chamber and wait until the cold head second stage temperature rises up to 100K before removing the cold head.

CAUTION**<Caution against misoperation>**

Be extremely careful not to damage the cylinder when mounting the cold head. Damaging the cylinder may result in misoperation or malfunction.

The following procedures describe the inspection and installation of the Cold Head.

INSPECTION

Inspect the following parts of the Cold Head before installation for evidence of damage:

- (1) Overall exterior.
- (2) Bent or dent of cylinder.
- (3) Supply and Return Aeroquip fittings.
- (4) Cold Head power connector.
- (5) Mounting flange and its sealing surface.
- (6) Sealing surface or O-ring groove of User's vacuum chamber.

INSTALLATION

The Cold Head can be mounted in any desired position and orientation.

Install the Cold Head into User's cryostat or vacuum chamber with a prudent care.

2-6 COMPRESSOR UNIT INSTALLATION

WARNING**<Warning about electric shock>**

Do not install the equipment near places subject to condensation such as a watering place. Failing to observe this precaution may result in electric shock or malfunction.

Do not install the equipment in a dusty environment. Failing to observe this precaution may result in electric shock or malfunction.

WARNING**<Warning about explosion, escape of gas>**

This cryocooler (cold head, compressor unit, compressor adsorber, flex lines) contains a high-pressure (about 1.62 MPa (16.5 kgf/cm²G, 235 psig)) helium gas sealed in. Hitting the equipment with a sharp edge or touching it with a pointed object may cause explosion or escape of gas. Handle the equipment with extreme care.

CAUTION**<Caution against misoperation>**

This cryocooler is intended for the exclusive use indoors. It cannot be used outdoors. Failing to observe this precaution may prevent the cryocooler from operating normally.

Do not get onto the compressor unit or put an object on top of it. Failing to observe this precaution may prevent the cryocooler from operating normally or cause injury.

Secure enough space around the compressor unit for heat radiation and maintenance. Failing to secure enough space may result in misoperation or malfunction. (See the technical instruction of the compressor unit used, for details.)

If the compressor unit used is the CSA-71A (air cooled, low voltage type), sufficient space is required for venting. Failing to secure sufficient space may result in misoperation or malfunction. (See the CSA-71A technical instruction, for details.)

The procedures including the inspection and installation of the Compressor Unit will be mentioned below.

INSPECTION

Prior to the installation, inspect the Compressor Unit as describe below;

- 1) Inspect the compressor overall exterior for damage, and evidence of oil leakage.
- 2) Make sure that the static pressure is specified value with supply pressure gauge of the Compressor Unit. The static pressure needs to be adjusted for the type of Cold Head as described follows;

RDK-408D2	-----	1.60 - 1.65 MPa	at 20 deg.C (68 deg.F)
RDK-408D		(16.3 - 16.8 kgf/cm ² G,	232 - 239 psig)
RDK-415D			

RDK-408S2	-----	1.45 - 1.50 MPa	at 20 deg.C (68 deg.F)
RDK-408S		(14.8 - 15.3 kgf/cm ² G,	210 - 217 psig)
RDK-400B			

If the gauge reads less than specified value, refill Helium gas as described in **Section 5-4**.

If the gauge reads 0 MPa (0 kgf/cm²G, 0 psig), there is a risk of helium contamination and the Compressor Unit must be replaced.

- 3) Inspect following parts of the Compressor Unit before installation for evidence of damage.
 - (a) Overall exterior.
 - (b) Supply and Return Aero-quip type fittings.
 - (c) Gas charge Aero-quip type fittings.
 - (d) Oil leakage around the base panel.

INSTALLATION

Install the Compressor Unit to a level surface (less than 5 degrees). During installation, do not tilt the Compressor Unit more than 30 degrees. The Compressor Unit can travel with 4 casters, and two of them are with lock-devices. After positioning the Compressor Unit, the casters can be locked.

Check the site conditions as described in **Section 2-4**.

2-7 CONNECTING FLEX LINES

WARNING**<Warning about explosion, escape of gas>**

This cryocooler (cold head, compressor unit, compressor adsorber, flex lines) contains a high-pressure (about 1.62 MPa (16.5 kgf/cm²G, 235 psig)) helium gas sealed in. Hitting the equipment with a sharp edge or touching it with a pointed object may cause explosion or escape of gas. Handle the equipment with extreme care.

The minimum bending radius of the flex lines is 300 mm (11.81 inches). Bending the flex lines at a smaller angle may cause explosion or escape of gas, and so this should be avoided.

CAUTION**<Caution against misoperation>**

Be sure to check the flat rubber gasket of the self seal coupling of the cold head and compressor unit for dirt, dust or to see whether the flat rubber gasket is attached correctly, before connecting the flex lines. Connecting the flex lines with an abnormal flat rubber gasket setting may cause escape of gas.

Be sure to start with the flex line on the "Return" side when connecting the flex lines to the cold head. Starting with the flex line on the "Supply" side may cause misoperation.

"IMPORTANT"

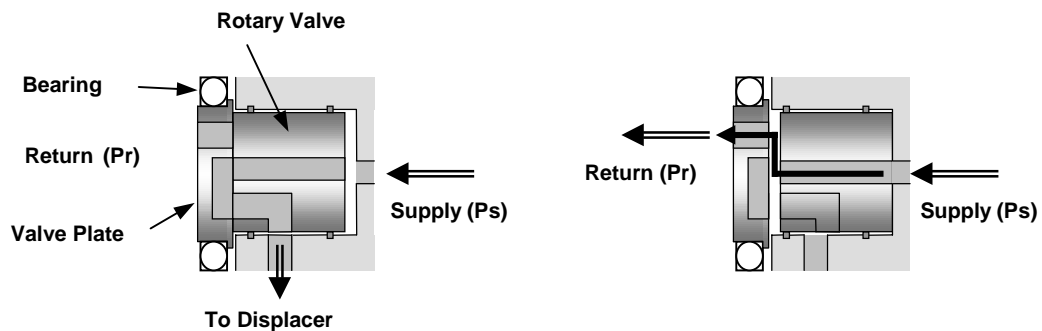
When connecting the flex lines, tighten the self-seal coupling nut by hand at the first turn and finally tighten it firmly using 3 wrenches. However, be careful not to tighten it excessively. The maximum allowable tightening torque is 45 N·m.

Make the connections between the Cold Head and Compressor Unit as follows;

FUNDAMENTAL

The Cold Head can be operated with a rotary valve to control the gas inlet / outlet timing of the refrigeration cycle. The pressure difference between the supply and the return can be available to get the seal between the rotary valve and the valve plate (as shown in the Figure). The return pressure must be less than supply pressure in connecting the Flex Line. To avoid the malfunction of the Cold Head, careful handling must be taken in connecting Flex Line.

In case the Cold Head will be operated with miss-connected flex lines, for example "Supply line" to "Return connector" and "Return line" to "Supply connector", the Rotary Valve will be pushed back by the Supply pressure and the Cold Head will malfunction with no intake/exhaust noise.

**NORMAL CONDITION ($P_s > P_r$)****ABNORMAL CONDITION ($P_s = P_r$)****CONNECTING PROCEDURE**

- 1) Remove all protective caps of the supply and return Flex Lines, Cold Head and Compressor Unit.
- 2) Check all the flat rubber gaskets of self-sealing connectors to make sure of being clean and properly positioned.



3) Connect the Flex Lines (both Supply and Return) to the Compressor Unit.



4) Connect the Flex Lines to the Cold Head as follows;

1. First, connect the **Return** Flex Line.



2. Then connect the **Supply** Flex Line.



CONNECTING PROCEDURE (in case of using the “Buffer Tank”)

In case of using the “Buffer Tank”, insert the “Buffer Tank” between the Compressor Unit and Flex Lines. Refer to the **Figure 2.1**, outline view of the “Buffer Tank”, and the **Figure 2.2**, “Buffer Tank” interconnecting diagram.

Connect the “Buffer Tank” with following procedure.

- 1) Connect the female coupling of “Tee-Adapter” to the male connector of the Compressor Unit for both “Supply” and “Return”.
- 2) Place the “Buffer Tank” at the right side of the Compressor Unit.
- 3) Connect the “Tee-Adapter” and “Buffer Tank” by two “8A x 1m Flex Line”.
- 4) Connect the Flex Lines to the Tee-Adapters. Do not miss-match the “Supply” and “Return” marking for both Flex Lines and Compressor Unit

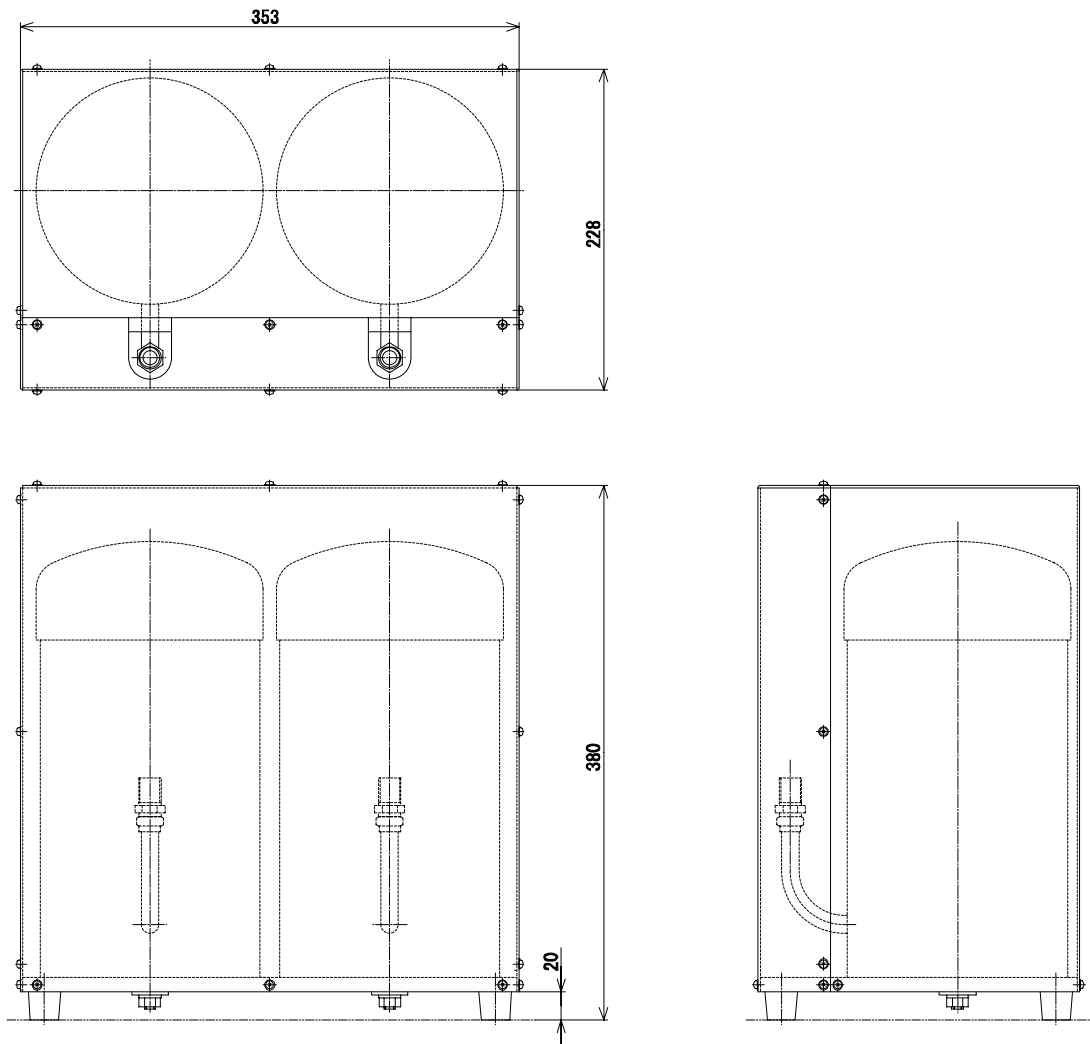


Figure 2.1 OUTLINE VIEW OF THE “BUFFER TANK”

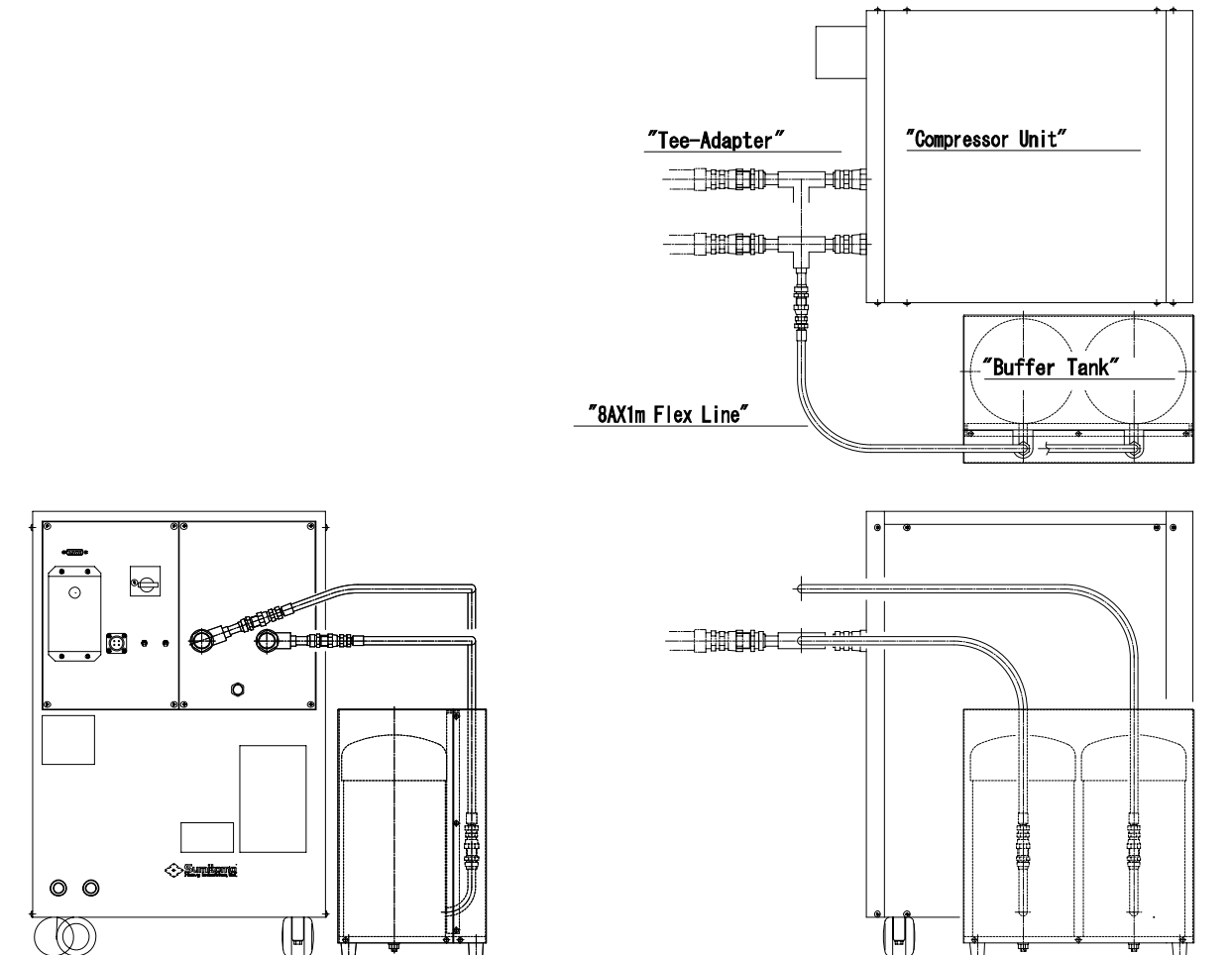


Figure 2.2 "BUFFER TANK" INTERCONNECTING DIAGRAM

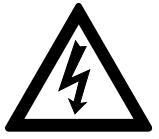
LEAK CHECK

Check the helium gas leak of all connecting coupling as following procedure after connecting all Flex Lines.

- 1) Sprinkle "Liquid Leak Detector" on the Flex line connecting coupling.



- 2) Keep watching carefully the sprinkled area and no gas leaking will be confirmed without any bubbling.
- 3) In case the bubbling is found, tighten the connecting coupling again and re-check the leakage. Do not over tighten the connector.

2-8 COLD HEAD POWER CABLE CONNECTION**WARNING****<Warning about electric shock>**

Make sure no power is applied to the compressor unit before starting operation when connecting or disconnecting the cold head power cable. Failing to observe this precaution may result in electric shock.

Make the Cold Head Power Cable connection as follows;
Phillips Screwdriver(+) is required to connect the Cold Head Power Cable.

CONNECTION TO THE COLD HEAD**1. FOR CONVERSION CONNECTOR TYPE**

Connect the Cold head Cable to the Conversion Connector directly.

**2. FOR LIQUID TIGHT CONNECTOR TYPE**

- 1) Set the connector of the Cold Head Cable to the terminal pins on the Cold Head Drive Motor.



2-8 COLD HEAD POWER CABLE CONNECTION

- 2) Connect the ground terminal of the Cold Head Cable (green color wire with ring terminal) to rear cover of Cold Head Drive Motor.



- 3) Mount the Terminal Cover on the Cold Head Motor with securing four(4) screws.



- 4) Tighten the Cable Clamp of the Terminal Cover.

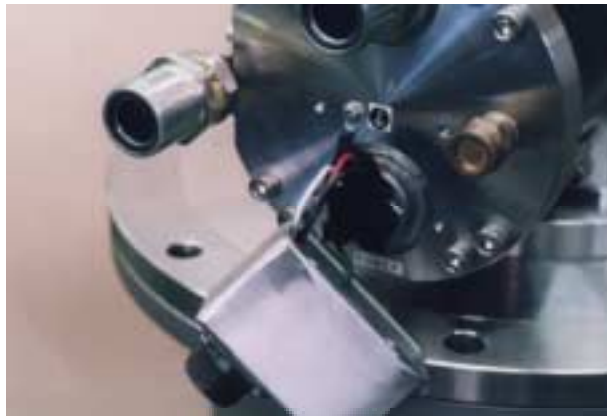


3. CONVERTING THE COLD HEAD CONNECTION

- 1) Connect the ground terminal of the Conversion Connector (green color wire with ring terminal) to rear cover of Cold Head Drive Motor.



- 2) Set the connector of the Conversion Connector to the terminal pins on the Cold Head Drive Motor.



- 3) Mount the Terminal Cover on the Cold Head Motor with securing four(4) screws.

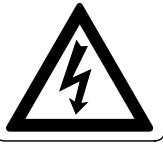


CONNECTION TO THE COMPRESSOR UNIT

Connect the other end of the Cold Head Power Cable to the Cold Head Power Connector on the rear panel of the Compressor Unit.



2-9 INPUT POWER CABLE CONNECTION

WARNING**<Warning about electric shock>**

Make sure the power specification of the cryocooler used conforms to the customer's power supply before using the equipment. Using the cryocooler with a non-conforming power supply may result in electric shock or malfunction.

If the compressor unit used is the CSW-71D (water cooled, high voltage type), pay attention to the setting of the applicable input supply voltage. The product is shipped with the input supply voltage set to 480V. Before installing the equipment, be sure to check your supply voltage and change it to the appropriate setting if necessary. Operating the equipment with your supply voltage different from the setting of the compressor unit may result in electric shock or malfunction.

Be sure to turn off and Lock Out with OFF position the main power of the customer's power source before connecting or disconnecting the input power cable to the Compressor Unit, and then remove the input power cable from the main power. Failing to observe this precaution may result in electric shock.

Do not change the setting of the dial above the main power switch of the compressor unit under any circumstances. Failing to observe this precaution may result in electric shock.

CAUTION**<Caution against misoperation>**

Do not use inverter for the main power source of the compressor unit. Operating with inverter may result in the damage or malfunction of the compressor electric circuit.

Avoid using the transformer for the main power source of the compressor unit. If the transformer is installed at the upstream of the unit, lacking phase protection circuit with the cryocooler occurs in a malfunction. That may result in misoperation or malfunction.

When using the transformer, install the other lacking phase protection device in upstream of the transformer.

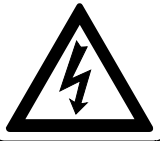
"IMPORTANT"

This cryocooler is provided with a phase reverse protection circuit for the input power. If the input power is connected with reverse phase, the cryocooler does not start.

"IMPORTANT"

See "TECHNICAL INSTRUCTION" of Compressor Unit used, for detail of Input Power Connection.

3 OPERATION

WARNING**<Warning about electric shock>**

This cryocooler includes a high-voltage section. Touching it may result in electric shock. Handle it with extreme care.

Make sure the power specification of the cryocooler used conforms to the customer's power supply before using the equipment. Using the cryocooler with a non-conforming power supply may result in electric shock or malfunction.

If the compressor unit used is the CSW-71D (water cooled, high voltage type), pay attention to the setting of the applicable input supply voltage. The product is shipped with the input supply voltage set to 480V. Before installing the equipment, be sure to check your supply voltage and change it to the appropriate setting if necessary. Operating the equipment with your supply voltage different from the setting of the compressor unit may result in electric shock or malfunction.


Do not change the setting of the dial above the main power switch of the compressor unit under any circumstances. Failing to observe this precaution may result in electric shock.

WARNING**<Warning about explosion, escape of gas>**

This cryocooler (cold head, compressor unit, compressor adsorber, flex lines) contains a high-pressure (about 1.62 MPa (16.5 kgf/cm²G, 235 psig)) helium gas sealed in. Hitting the equipment with a sharp edge or touching it with a pointed object may cause explosion or escape of gas. Handle the equipment with extreme care.

3-1 PRELIMINARY CHECKS

CAUTION



<Caution against misoperation>

This cryocooler (cold head, compressor unit, compressor adsorber, flex lines) is shipped with a helium gas at about 1.62 MPa (16.5 kgf/cm²G, 235 psig) sealed in. Be sure to adjust the pressure to an appropriate value according to the cold head used before operating the equipment. Using the cryocooler at an improper pressure may cause misoperation.

The coldhead employs the special seal to the 2nd stage. The 2nd stage displacer is fit tightly in the cylinder. Make sure the 2nd stage temperature is less than 28 deg.C before starting up the cryocooler, or the coldhead may make grinding noise.

“IMPORTANT”

This cryocooler is provided with a phase reverse protection circuit for the input power. If the input power is connected with reverse phase, the cryocooler does not start.

Prior to starting Cryocooler, confirm that the Compressor Unit and the Cold Head are installed correctly as described in **Section 2**.

CHECKING HELIUM GAS PRESSURE

Make sure that the static pressure is specified value with supply pressure gauge of the Compressor Unit.

The static pressure needs to be adjusted for Cold Head as described follows;

COLD HEAD MODEL	STATIC PRESSURE
RDK-408D2 4K Cold Head RDK-408D 4K Cold Head RDK-415D 4K Cold Head	1.60 - 1.70 MPa at 20 deg.C (68 deg.F) (16.3 - 17.3 kgf/cm ² G, 232 - 246 psig)
RDK-408S2 10K Cold Head RDK-408S 10K Cold Head RDK-400B Single Stage Cold Head	1.45 - 1.55 MPa at 20 deg.C (68 deg.F) (14.8 - 15.8 kgf/cm ² G, 210 - 225 psig)



For RDK-408D2 & 408D & 415D



For RDK-408S2 & 408S & 400B

CHECKING ELECTRIC POWER, VOLTAGE AND PHASE

Check the line to line voltage and confirm it is ± 10% of the specified value to meet the specification described in each “TECHNICAL INSTRUCTION” for Compressor Unit used.

Confirm the phase of Input power and cable with correctly wired.

3-2 START-UP OPERATION

CAUTION**<Caution against misoperation>**

The cryocooler ON/OFF frequency must be less than 6 times per hour, and the ON/OFF interval must be more than 3 minutes. The frequent ON/OFF operation may result in damage of compressor capsule or malfunction.

The cold head drive switch provided with the compressor unit is only used for maintenance. Be sure to turn it OFF in normal operation. Using the compressor unit with the cold head drive switch turned ON may result in misoperation or malfunction.

The coldhead employs the special seal to the 2nd stage. The 2nd stage displacer is fit tightly in the cylinder. Make sure the 2nd stage temperature is less than 28 deg.C before starting up the cryocooler, or the coldhead may make grinding noise.

"IMPORTANT"

This cryocooler is provided with a phase reverse protection circuit for the input power. If the input power is connected with reverse phase, the cryocooler does not start.

Start up the Cryocooler as mentioned below;

- 1) Make sure that the pressure gauge of the Compressor Unit is indicating correct static pressure of your system with supply pressure gauge.
- 2) Check the setting of **"Drive Switch"**, **"Cold Head Drive Switch"** and **"Remote Drive Switch"**.
 - "Drive Switch"** --- OFF Position
 - "Cold Head Drive Switch"** --- OFF Position
 - "Remote Drive Switch"** --- INT Position (for Water Cooled Compressor Unit only)

- 3) Turn on the **"Main Power Switch"**.



For Air Cooled Compressor Unit



For Water Cooled Compressor Unit

- 4) Turn on the **"Drive Switch"**.



For Air Cooled Compressor Unit



For Water Cooled Compressor Unit

3-3 SHUT-DOWN OPERATION

WARNING**<Warning about explosion, escape of gas>**

Do not break the vacuum with the low temperature of cold head second stage when removing the cold head from the vacuum chamber. Breaking the vacuum may result in serious damage, explosion or escape of gas. Keep the Flex Lines connected and maintain the high vacuum of the chamber and wait until the cold head second stage temperature rises up to 100K before removing the cold head.

CAUTION**<Caution against misoperation>**

The cryocooler ON/OFF frequency must be less than 6 times per hour, and the ON/OFF interval must be more than 3 minutes. The frequent ON/OFF operation may result in damage of compressor capsule or malfunction.

The cold head drive switch provided with the compressor unit is only used for maintenance. Be sure to turn it OFF in normal operation. Using the compressor unit with the cold head drive switch turned ON may result in misoperation or malfunction.

The coldhead employs the special seal to the 2nd stage. The 2nd stage displacer is fit tightly in the cylinder. Make sure the 2nd stage temperature is less than 28 deg.C before starting up the cryocooler, or the coldhead may make grinding noise.

Shut down operation for the Cryocooler as mentioned below;

- 1) Turn off the **“Drive Switch”**.



For Air Cooled Compressor Unit



For Water Cooled Compressor Unit

- 2) Turn off the **“Main Power Switch”**.



For Air Cooled Compressor Unit



For Water Cooled Compressor Unit

3-4 NORMAL OPERATION

WARNING**<Warning about rotating part>**

If the compressor unit used is the CSA-71A (air cooled, low voltage type), a venting fan is provided in the exhaust section at the top of the compressor unit. Do not insert foreign substances from the exhaust port under any circumstances. Failing to observe this precaution may result in injury or malfunction.

“IMPOTANT”

If the compressor unit used is the CSA-71A (air cooled, low voltage type), note that the noise level of the whole equipment may exceed 70 dBA depending on the environment it is used in.

EXHAUST SOUND

Starting Cryocooler, you can hear the gas inlet/outlet sound from the Cold Head. The sound of the Cold Head is 60 rpm at 50 Hz and 72 rpm at 60 Hz respectively. During this checking, the Compressor operating pressure will be around 2.5 MPa (25.5 kgf/cm²G, 362 psig).

SUPPLY PRESSURE INDICATION

Monitor the compressor's supply He gas pressure. In the normal operation with adequate heat loads, the supply helium gas pressure indicates between 2.1 and 2.3 MPa (21.4 and 23.5 kgf/cm²G, 304 and 333 psig). The operating pressure varies according to the heat load of cold head and temperature around the equipment.

COLD STAGE TEMPERATURE

Monitor the Cold Head 1st and 2nd stage temperature. The final temperature of the Cold Head depends on the heat load such as radiation heat, applied heat load and convection caused by bad vacuum of the chamber. If the temperature becomes steady state but high, the total heat loads to the Cold Head is too much. Check the heat loads.

FLEX LINES TEMPERATURE

Make sure that the temperature of the supply Flex Line from the Compressor to the Cold Head does not exceed 40 deg.C (104 deg.F). If the Flex Line temperature is higher, check the conditions of air flow and cooler fins for Air Cooled Compressor Unit, and water flow for Water Cooled Compressor Unit.

COOLING AIR FLOW (for Air Cooled Compressor Unit)

If the system is with Air-Cooled Compressor Unit, identify that the forced draught Fan located at the top of the Compressor Unit is continuously operating and that cooling air is drawn in through the heat exchanger and flows out from the top cover of the Compressor Unit. It is required to keep the enough space around the compressor and the room temperature should be less than 28 deg.C (82.4 deg.F) to get the refrigeration capacity. The maximum heat output from Compressor is 8.3 kW or 28,320 BTU/h, therefore, a suitable air-conditioning should be prepared.

COOLING WATER FLOW (for Water Cooled Compressor Unit)

If the system is with Water-Cooled Compressor Unit, make sure that the sufficient cooling water is flowing as shown in the specification described in **“TECHNICAL INSTRUCTION”** of Compressor Unit used. The quality of the water should meet the specification (The specification is also described in **“TECHNICAL INSTRUCTION”** of Compressor Unit used.) to prevent plugging or calcification.

4 FUNCTIONAL CHECK

4-1 SIMPLE PROBLEM

This section describes several simple problems that usually occurred. If you have trouble that you cannot fix according to the following procedure, proceed to "TROUBLE SHOOTING FLOW CHART" described in **Section 6**.

4-1-1 PRESSURE

Cryocooler is designed and manufactured to get cooling capacity with specified Helium Gas Pressure. It is highly recommended to check the pressure. If the indicated pressure is higher than specified value, reduce the pressure. If it is lower, charge the helium gas. See "**TECHNICAL INSTRUCTION**" of Cold Head used, to see the specified pressure of your system.

COLD HEAD MODEL	STATIC PRESSURE
RDK-408D2 4K Cold Head RDK-408D 4K Cold Head RDK-415D 4K Cold Head	1.60 - 1.70 MPa at 20 deg.C (68 deg.F) (16.3 - 17.3 kgf/cm ² G, 232 - 246 psig)
RDK-408S2 10K Cold Head RDK-408S 10K Cold Head RDK-400B Single Stage Cold Head	1.45 - 1.55 MPa at 20 deg.C (68 deg.F) (14.8 - 15.8 kgf/cm ² G, 210 - 225 psig)

After replacing Cold Head, it will be necessary to charge the Helium Gas because the temperature of the Cold Head is usually lower than room temperature, therefore the system always lose helium gas.

4-1-2 ROOM TEMPERATURE

Room temperature affects the Cryocooler performance. It is highly recommended to keep the room temperature in the specified range. See "**TECHNICAL INSTRUCTION**" of Compressor Unit used, for details.

COMPRESSOR UNIT MODEL	ROOM TEMPERATURE RANGE
CSA-71A, CSW-71C, CSW-71D	5 to 28 deg.C (41 to 82.4 deg.F) 28 to 35 deg.C (82.4 to 95 deg.F) with 5% Capacity Loss

4-1-3 MAIN POWER PHASE

The Cryocooler operates with 3 phase mains frequency. The Compressor Units are equipped with phase reverse protection circuit to protect the Compressor Unit from reverse revolution. The Compressor Unit will not start, in case the main power is reverse phase. A procedure for the diagnosis of phase failure for input power caused by miss-wiring will be performed, if the Compressor Unit cannot be operated as normal in a condition of the "**Drive Switch - ON**" under the "**Main Power Switch - ON**".

4-2 HELIUM LEAK

WARNING**<Warning about explosion, escape of gas>**

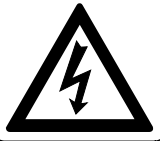
This cryocooler (cold head, compressor unit, compressor adsorber, flex lines) contains a high-pressure (about 1.62 MPa (16.5 kgf/cm²G, 235 psig)) helium gas sealed in. Hitting the equipment with a sharp edge or touching it with a pointed object may cause explosion or escape of gas. Handle the equipment with extreme care.

The Cold Head cannot be performed a required cooling power in normal operations, as the result of the He-gas pressure reducing gradually in the Cold Head in condition of occurring a He-gas Leak in the Cryocooler. The Compressor unit will be shut down as the function of the Low Pressure Switch to be sensed and excessive lower He-gas pressure, and verify the charged He-gas pressure in the Compressor Unit as specified pressure. The charged He-gas pressure will be indicated individually for each application, and see “**TECHNICAL INSTRUCTION**” of the Cold Head used.

COLD HEAD MODEL	STATIC PRESSURE
RDK-408D2 4K Cold Head RDK-408D 4K Cold Head RDK-415D 4K Cold Head	1.60 - 1.70 MPa at 20 deg.C (68 deg.F) (16.3 - 17.3 kgf/cm ² G, 232 - 246 psig)
RDK-408S2 10K Cold Head RDK-408S 10K Cold Head RDK-400B Single Stage Cold Head	1.45 - 1.55 MPa at 20 deg.C (68 deg.F) (14.8 - 15.8 kgf/cm ² G, 210 - 225 psig)

A Leak detector will be applied to leak area hunting for convenience, and “Liquid Leak Detector” also will be useful to check the He-gas leaking of couplings for the Flex Line by watching any bubbling carefully, if the Leak Detector not in use at the field.

5 MAINTENANCE

WARNING**<Warning about electric shock>**

This cryocooler includes a high-voltage section. Touching it may result in electric shock. Handle it with extreme care.

Make sure no power is applied to the compressor unit before connecting or disconnecting the cold head power cable. Failing to observe this precaution may result in electric shock.

Be sure to turn off and Lock Out with OFF position the main power of the customer's power source before connecting or disconnecting the input power cable to the Compressor Unit, and then remove the input power cable from the main power. Failing to observe this precaution may result in electric shock.

Do not change the setting of the dial above the main power switch of the compressor unit under any circumstances. Failing to observe this precaution may result in electric shock.

Be sure to turn off and Lock Out with OFF position the customer's main power before performing maintenance work such as replacement of fuses. Failing to observe this precaution may result in electric shock.

WARNING**<Warning about explosion, escape of gas>**

This cryocooler (cold head, compressor unit, compressor adsorber, flex lines) contains a high-pressure (about 1.62 MPa (16.5 kgf/cm²G, 235 psig)) helium gas sealed in. Hitting the equipment with a sharp edge or touching it with a pointed object may cause explosion or escape of gas. Handle the equipment with extreme care.

Do not disassemble the equipment for purposes other than maintenance specified in this service manual under any circumstances. Disassembling the equipment may result in electric shock, explosion or escape of gas.

The cold head, compressor unit, compressor adsorber and flex lines are pressurized with helium gas. Purge the helium gas from all pressurized components before disposing. Open the purging valve gradually or it may result in serious injury.

Do not break the vacuum with the low temperature of cold head second stage when removing the cold head from the vacuum chamber. Breaking the vacuum may result in serious damage, explosion or escape of gas. Keep the Flex Lines connected and maintain the high vacuum of the chamber and wait until the cold head second stage temperature rises up to 100K before removing the cold head.

WARNING**<Warning about rotating part>**

If the compressor unit used is the CSA-71A (air cooled, low voltage type), a venting fan is provided in the exhaust section at the top of the compressor unit. Do not insert foreign substances from the exhaust port under any circumstances. Failing to observe this precaution may result in injury or malfunction.

WARNING

The Adsorber weight is about 11.0kg. When replace the adsorber, be careful of handling so that it may not get hurt.

5-1 GENERAL INFORMATION FOR THE MAINTENANCE

CAUTION**<Caution against misoperation>**

Do not get on the compressor unit or put an object on top of it. Failing to observe this precaution may prevent the cryocooler from operating normally or cause injury.

Secure enough space around the compressor unit for heat radiation and maintenance. Failing to secure enough space may result in misoperation or malfunction. (See the technical instruction of the compressor unit used, for details.)

If the compressor unit used is the CSA-71A (air cooled, low voltage type), sufficient space is required for venting. Failing to secure sufficient space may result in misoperation or malfunction. (See the CSA-71A technical instruction, for details.)

If the compressor unit used is the CSA-71A (air cooled, low voltage type), it should be installed in a clean environment. Installing it in a dusty environment such as inside a factory will require frequent cleaning of the cooler fins or may result in misoperation or malfunction.

If the compressor unit used is a water-cooled type (CSW-71C, CSW-71D), use cooling water with appropriate temperature, flow rate and water quality. Using inappropriate cooling water may result in misoperation or malfunction. (See the technical instruction of the compressor unit used, for details.)

The cold head drive switch provided with the compressor unit is only used for maintenance. Be sure to turn it OFF in normal operation. Using the compressor unit with the cold head drive switch turned ON may result in misoperation or malfunction.

5-1 GENERAL INFORMATION FOR THE MAINTENANCE

The SRDK CRYOCOOLER system is to be required the routine maintenance for long term and continuous as every 10,000 Hrs on an actual installation.

The basic maintenance work is to replace the existing Cold Head composed of acting parts for every 10,000 Hrs operation and additional replacement of oil mist Adsorber of the Compressor Unit for every 20,000 Hrs operation as mentioned in **Table 5.1**.

Table 5.1 MAINTENANCE SCHEDULE

MAINTENANCE	FREQUENCY	REMARKS
Replace Cold Head's parts (Parts inside Cold Head)	Every 10,000 Hrs.	Not a User's Maintenance Return the Cold Head to SHI.
Replace Compressor Adsorber	Every 20,000 Hrs.	
Charge Helium Gas to Compressor	As required	
Compressor Fuse Replacement	As required	
Cleaning Air Cooler (Air-Cooled Compressor)	At least one time per year	Depending on the Compressor site conditions.
Cleaning Water Line (Water-Cooled Compressor)	As required	Depending on the Water Quality

5-2 COLD HEAD MAINTENANCE

The Cold Head is required to replace the sliding parts inside every 10,000 Hrs. This is not a user's Maintenance. Replace the Cold Head completely at site and return it to Sumitomo Heavy Industries, Ltd. for refurbishment.

5-3 COMPRESSOR UNIT MAINTENANCE

"IMPORTANT"

See "TECHNICAL INSTRUCTION" of Compressor Unit used, for detail of the Compressor Unit maintenance.

The Compressor Units are required to replace Adsorber every 20,000 Hrs. The Adsorber is compatible for both air-cooled and water-cooled Compressor.

FOR "AIR COOLED" COMPRESSOR

It is important to keep the heat exchanger clean. It is required to clean the heat exchanger once a year. However, if the room is dirty and/or dusty, it will be required to clean the heat exchanger more than once a year.

FOR "WATER COOLED" COMPRESSOR

The Compressor requires cooling water. The quality of the cooling water should meet the specification described "***TECHNICAL INSTRUCTION***" of Compressor Unit used. It can be required to clean the cooling water line inside/outside the Compressor, if the cooling water is insufficient.

5-4 HELIUM GAS CHARGING

WARNING**<Warning about explosion, escape of gas>**

This cryocooler (cold head, compressor unit, compressor adsorber, flex lines) contains a high-pressure (about 1.62 MPa (16.5 kgf/cm²G, 235 psig)) helium gas sealed in. Hitting the equipment with a sharp edge or touching it with a pointed object may cause explosion or escape of gas. Handle the equipment with extreme care.

CAUTION**<Caution against misoperation>**

Pay attention to the contamination when charging a helium gas. The contamination may result in occurrence of the noise from the Cold Head or decreasing the cooling capacity.

“IMPORTANT”

The filling pressure of the cryocooler varies in accordance with the compressor and coldhead temperature. Make sure the cryocooler is powered off and compressor and coldhead temperatures are almost same as room temperature before adjusting the helium gas pressure.

Charge helium gas, if the pressure indication of the Compressor Unit is lower than specified value.

After stopping the cryocooler, the pressure indication on the Indoor Unit pressure gauge shows lower than actual filling pressure, because of the low temperature of the coldhead. The coldhead temperature and compressor unit temperature needs to be equal to ambient temperature to check the actual filling pressure.

The filling pressure indication depends on the temperature of cryocooler components, such as Coldhead, Outdoor Unit, Indoor Unit and Flex Lines. In case the room temperature is relatively low, the filling pressure indicates lower. In case the room temperature is relatively high, the filling pressure indicates higher. Refer to the ambient temperature to adjust the filling pressure precisely.

REQUIRED TOOLS

The following tools are required to charge helium gas to the Cryocooler system.

Table 5.2 REQUIRED TOOLS FOR HELIUM GAS CHARGE

	TOOLS	REMARK
1	Gas charging tool for the Compressor Unit.	
2	3/4" Open-end wrench.	
3	5/8" Open-end wrench.	
4	Pressure regulator for helium gas bottle	
5	Helium gas bottle	Purity of 99.999% up

PROCEDURE

- 1) Remove the protective cap from the gas charge coupling on the Compressor Unit. Connect a pressure regulator and charging line to a helium bottle (purity 99.999% up). Connect a gas charging tool to the Compressor Unit after closing the valve of gas charging tool.

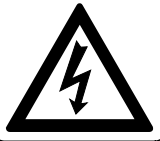


- 2) Open the valve of pressure regulator slightly and slowly. Purge a Helium Gas for about 30 seconds to vent the contamination in the charging line. Reduce the helium gas flow by controlling the valve of pressure regulator and keep the slight helium gas flow.
- 3) Purge the air in the gas charging tool for about 5 seconds by opening the valve of gas charging tool. Reduce the helium gas flow by controlling the valve of gas charging tool and keep the slight helium gas flow.
- 4) Connect a charging line to a gas charging tool. Shut the valve of gas charging tool immediately.
- 5) Set the pressure regulator around 1.65 - 1.70 MPa (16.8 - 17.3 kgf/cm²G, 239 - 246 psig).
- 6) Open the valve of gas charging tool slightly and slowly. Charge Helium gas till the pressure gauge of the Compressor Unit indicates specified filling pressure and shut the valve. See **“TECHNICAL INSTRUCTION”** for more detail of the pressure, Cold Head used.

COLD HEAD MODEL	STATIC PRESSURE
RDK-408D2 4K Cold Head RDK-408D 4K Cold Head RDK-415D 4K Cold Head	1.60 - 1.70 MPa at 20 deg.C (68 deg.F) (16.3 - 17.3 kgf/cm ² G, 232 - 246 psig)
RDK-408S2 10K Cold Head RDK-408S 10K Cold Head RDK-400B Single Stage Cold Head	1.45 - 1.55 MPa at 20 deg.C (68 deg.F) (14.8 - 15.8 kgf/cm ² G, 210 - 225 psig)

- 7) Shut the valve of gas charging tool and pressure regulator. Disconnect the charging line and gas charging tool from the Compressor Unit.
- 8) Set the protective cap to gas charge coupling on the Compressor Unit.

6 TROUBLE SHOOTING FLOW CHART

WARNING**<Warning about electric shock>**

This cryocooler includes a high-voltage section. Touching it may result in electric shock. Handle it with extreme care.

Make sure no power is applied to the compressor unit before starting operation when connecting or disconnecting the cold head power cable. Failing to observe this precaution may result in electric shock.

Be sure to turn off and Lock Out with OFF position the main power of the customer's power b connecting or disconnecting the input power cable to the Compressor Unit, and then remove the input power cable from the main power. Failing to observe this precaution may result in electric shock.

Pay special attention to its wiring when using the external connector on the compressor unit. Connecting a jumper wire between Pins No.6 - No.8, No.6 - No.13 and No.6 - No.15 may result in misoperation in some of safety devices in the equipment, causing electric shock, burn or malfunction.

Be sure to turn off and Lock Out with OFF position the customer's main power before performing maintenance work such as replacement of fuses. Failing to observe this precaution may result in electric shock.

WARNING**<Warning about explosion, escape of gas>**

This cryocooler (cold head, compressor unit, compressor adsorber, flex lines) contains a high-pressure (about 1.62 MPa (16.5 kgf/cm²G, 235 psig)) helium gas sealed in. Hitting the equipment with a sharp edge or touching it with a pointed object may cause explosion or escape of gas. Handle the equipment with extreme care.

Do not disassemble the equipment for purposes other than maintenance specified in this service manual under any circumstances. Disassembling the equipment may result in electric shock, explosion or escape of gas.

Do not break the vacuum with the low temperature of cold head second stage when removing the cold head from the vacuum chamber. Breaking the vacuum may result in serious damage, explosion or escape of gas. Keep the Flex Lines connected and maintain the high vacuum of the chamber and wait until the cold head second stage temperature rises up to 100K before removing the cold head.

WARNING**<Warning about rotating part>**

If the compressor unit used is the CSA-71A (air cooled, low voltage type), a venting fan is provided in the exhaust section at the top of the compressor unit. Do not insert foreign substances from the exhaust port under any circumstances. Failing to observe this precaution may result in injury or malfunction.

WARNING

The Adsorber weight is about 11.0kg. When replace the adsorber, be careful of handling so that it may not get hurt.

CAUTION**<Caution against misoperation>**

Secure enough space around the compressor unit for heat radiation and maintenance. Failing to secure enough space may result in misoperation or malfunction. (See the technical instruction of the compressor unit used, for details.)

If the compressor unit used is the CSA-71A (air cooled, low voltage type), sufficient space is required for venting. Failing to secure sufficient space may result in misoperation or malfunction. (See the CSA-71A technical instruction, for details.)

If the compressor unit used is the CSA-71A (air cooled, low voltage type), it should be installed in a clean environment. Installing it in a dusty environment such as inside a factory will require frequent cleaning of the cooler fins or may result in misoperation or malfunction.

If the compressor unit used is a water-cooled type (CSW-71C, CSW-71D), use cooling water with appropriate temperature, flow rate and water quality. Using inappropriate cooling water may result in misoperation or malfunction. (See the technical instruction of the compressor unit used, for details.)

The cold head drive switch provided with the compressor unit is only used for maintenance. Be sure to turn it OFF in normal operation. Using the compressor unit with the cold head drive switch turned ON may result in misoperation or malfunction.

The major trouble at the customer site can be solved by following trouble shooting flow chart.
In case, the trouble can not be solved by these flows, please make contact to SHI.

Sumitomo Heavy Industries, Ltd.

Cryogenics Division

Address; 2-1-1 Yato-cho, Nishitokyo-City,
Tokyo 188-8585, Japan
TEL No. +81-424-68-4240
FAX No. +81-424-68-4219
E-mail cryo@shi.co.jp
URL <http://www.shi.co.jp/cryopage>

Customer Support

TEL No. +81-424-68-4264
FAX No. +81-424-68-4462

Oversea Bases

SHI-APD Cryogenics, Inc.

Adress; 1833 Vultee Street, Allentown, PA 18103-4783, USA
TEL No. +1-610-791-6700
FAX No. +1-610-791-0440
E-mail sales@apdcryogenics.com
URL <http://www.apdcryogenics.com>

Sumitomo (SHI) Cryogenics of America, Inc.

Adress; 870 Cambridge Dr., Elk Grove Village, IL 60007, USA
TEL No. +1-847-290-5801
FAX No. +1-847-290-1084
E-mail scaimain@aol.com

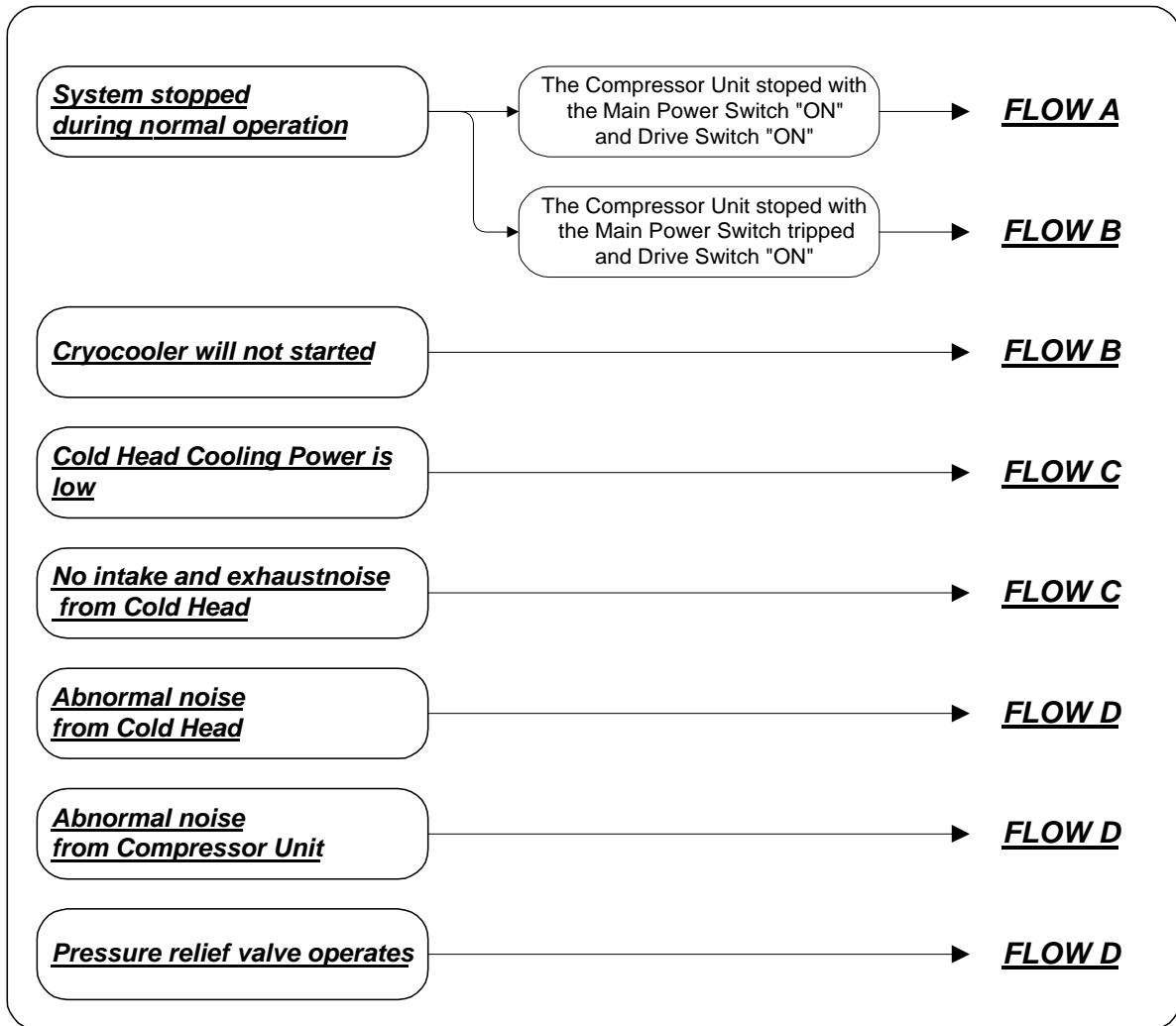
SHI-APD Cryogenics (Europe), Ltd.

Adress; 2 Eros House, Calleva Industrial Park Aldermaston, Berkshire RG7 8LN, UK
TEL No. +44-118 981 9373
FAX No. +44-118 981 7601
E-mail marketing@apd-cryo.demon.co.uk

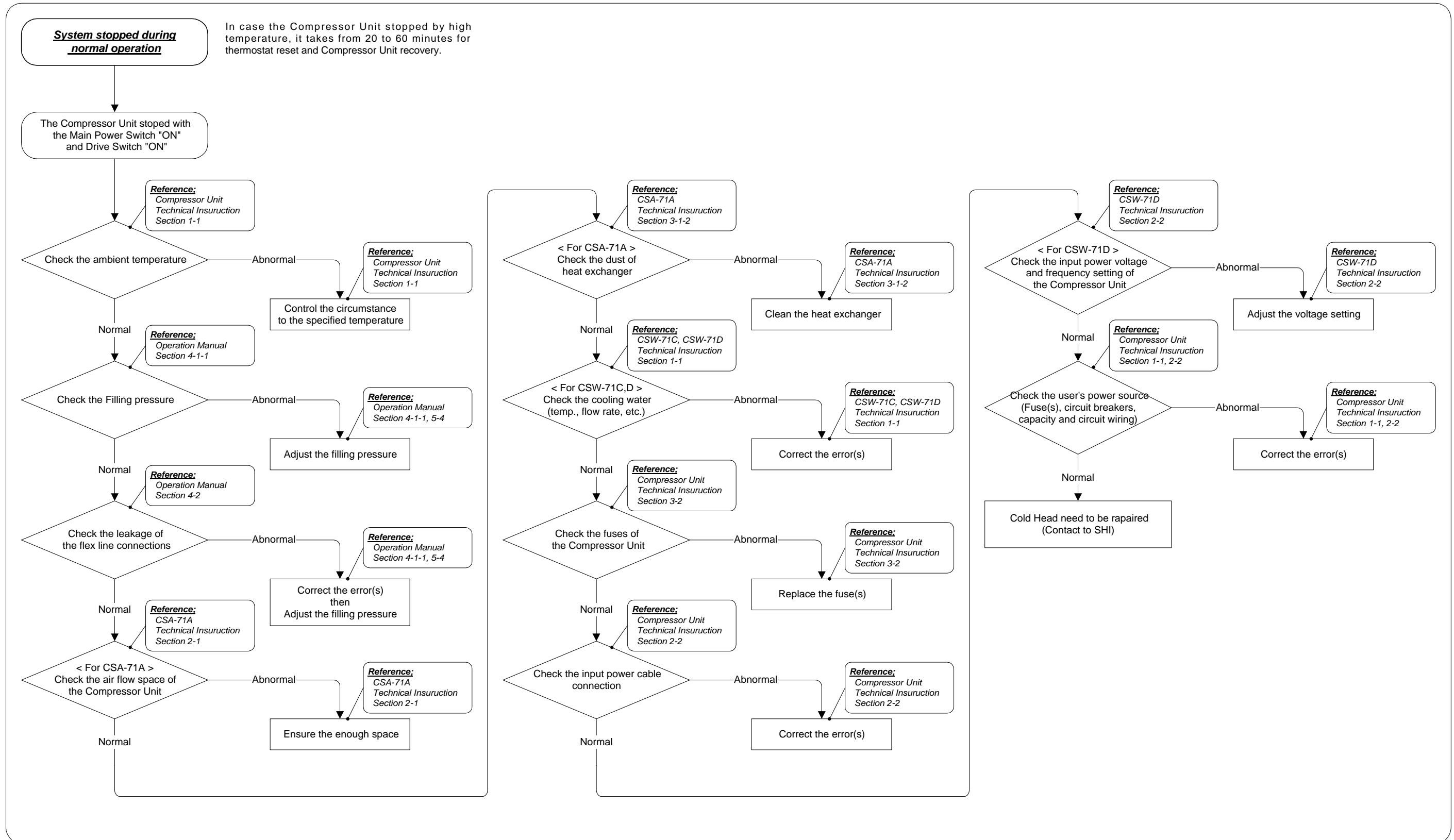
SHI Cryogenics Europe GmbH

Adress; Dolivostrasse 9, D-64293 Darmstadt, Germany
TEL +49-(0) 6151-86061-0
FAX +49-(0) 6151-800252
E-mail Yst_Taguchi@shi.co.jp
H.Fontes@shicryo-e.de

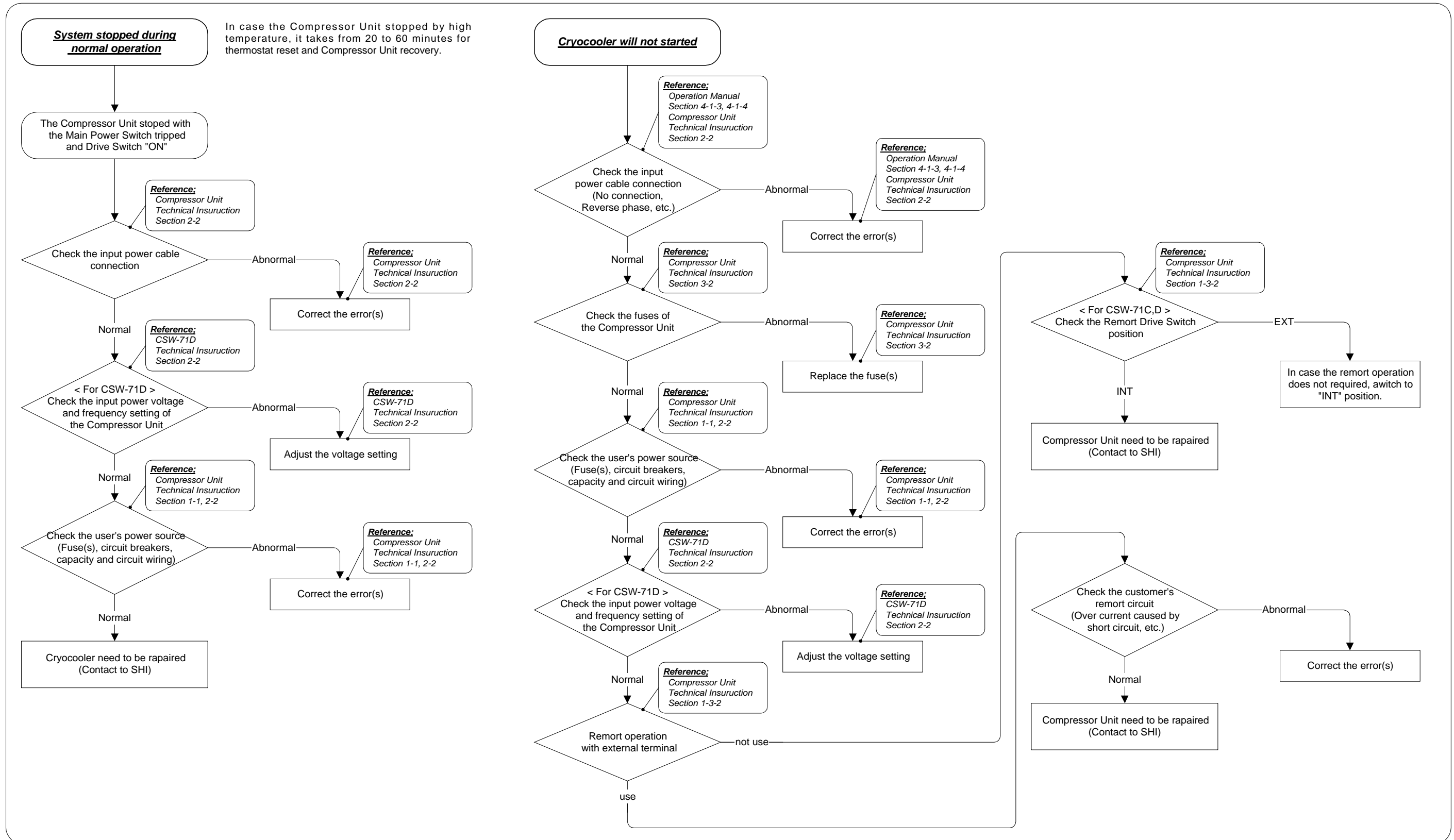
Case of Trouble



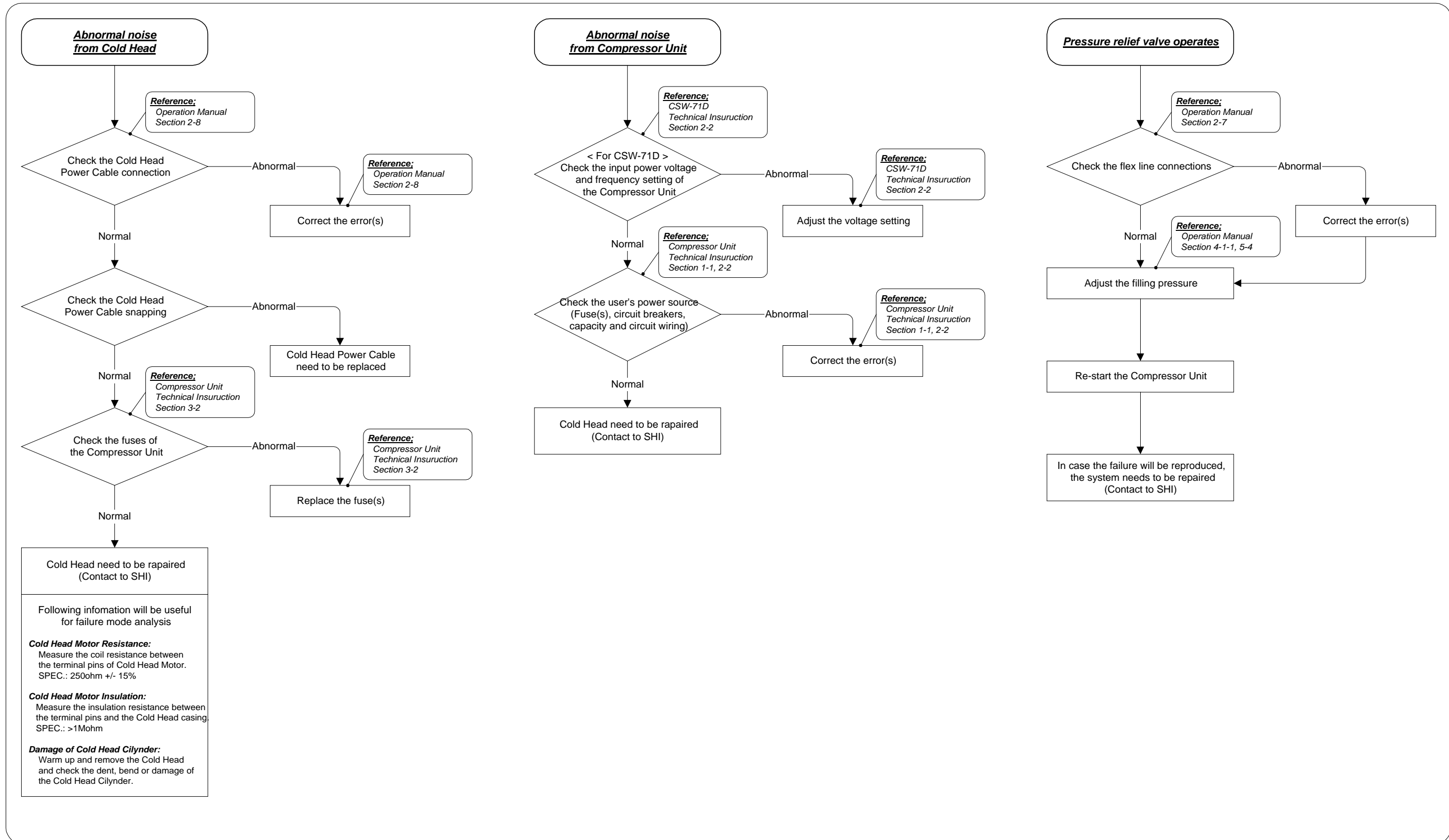
FLOW A



FLOW B



FLOW D



REVISION CONTROL

Manual No.	Revision	Remarks	Date
CD32ZZ-063	-A	Publication of first edition.	DEC. 10 / 1999
	-B	Change the SHI address.	JAN. 25 / 2001
	-C	Change the description of start up operation.	MAR. 21 / 2001
	-D	Add the start-up temperature CAUTION.	JAN. 21 / 2002
	-E	Add the description of helium gas charging.	APR. 1 / 2002
	-F	Change the WARNING descriptions.	JUL. 11 / 2002
	-G	Add the transformer-use CAUTION.	FEB. 28 / 2003
	-H	Change the division name.	JUN. 9 / 2003
	-I	Add the description for the RDK-408D2 and S2 Cold Head.	DEC. 18 / 2003



Sumitomo Heavy Industries, Ltd.

MANUAL NUMBER: CD32ZZ-068Q

DATE: December 1 / 2009

TECHNICAL INSTRUCTION

CSW-71C COMPRESSOR UNIT

For Service Personnel Only

Sumitomo Heavy Industries, Ltd.
Cryogenics Division

**2-1-1 Yato-cho, Nishitokyo-City,
Tokyo 188-8585, Japan**

**E-mail: cryo@shi.co.jp
URL: <http://www.shicryogenics.com>**

TABLE OF CONTENTS

SECTION	ITEM	PAGE No.
	CROSS REFERANCE	1
1	GENERAL INFORMATION	2
1-1	SPECIFICATIONS	2
1-2	CONSTRUCTION	6
1-2-1	CONTROLS AND COUPLINGS	6
1-2-2	GAS AND OIL FLOW IN THE COMPRESSOR UNIT	9
1-2-3	INTERNAL COMPONENTS	11
1-3	ELECTRICAL DESCRIPTION	13
1-3-1	EXTERNAL CONNECTOR	13
1-3-2	SAFETY DEVICES	14
2	INSTALLATION	15
2-1	SITE REQUIREMENT	17
2-2	INPUT POWER CABLE CONNECTION	19
3	MAINTENANCE	21
3-1	PERIODICAL MAINTENANCE	22
3-1-1	REPLACEMENT OF THE COMPRESSOR ADSORBER	23
3-2	FUSE REPLACEMENT	27
	APPENDIX	28
	ELECTRICAL SCHEMATIC	
	DRAWINGS	
	REVISION CONTROL	

CROSS REFERENCE

Thoroughly read this manual and following manuals before using this equipment.

MANUAL NAME	MANUAL No.
OPERATION MANUAL SRDK Series CRYOCOOLER	CD32ZZ-063
TECHNICAL INSTRUCTION RDK-408D2 4K COLD HEAD*	CD32ZZ-160
TECHNICAL INSTRUCTION RDK-408S2 10K COLD HEAD*	CD32ZZ-161
TECHNICAL INSTRUCTION RDK-408S 10K COLD HEAD*	CD32ZZ-065
TECHNICAL INSTRUCTION RDK-400B SINGLE STAGE COLD HEAD*	CD32ZZ-066
TECHNICAL INSTRUCTION RDK-415D 4K COLD HEAD*	CD32ZZ-070

* See TECHNICAL INSTRUCTION of Cold Head used.

1 GENERAL INFORMATION

1-1 SPECIFICATIONS

The specifications of CSW-71C Helium Compressor Unit are summarized in **Table 1.1**.

Table 1.1 CSW-71C COMPRESSOR UNIT SPECIFICATION

	for RDK-408D2, 415D	for RDK-408S2, 408S, 400B
Dimension		
Width	450.0 mm	
Length	500.0 mm*	
Height	686.5 mm	
Helium Gas Pressure		
Static	1.60 - 1.65 MPa at 20 deg.C	1.45 - 1.50 MPa at 20 deg.C
Operating (High Side)** (for Reference)	2.00 - 2.20 MPa --- approx.	2.00 - 2.20 MPa --- approx.
Ambient Temperature Range	5 to 35 deg.C (28 to 35 deg.C with 5% Capacity Loss)	
Humidity Range	25 to 85 %RH (without dew)	
Mass	117 kg --- approx.	
Electrical Requirement		
Power Line Voltage (+/-10%)	AC 200V / 50, 60 Hz, 3 phase (3W+PE) (delta:ground, Commercial Power Source) “WARNING” <u>Do not use inverter for the main power source.</u>	
Operating Current	Max. 25 A	
Min. Circuit Ampacity	35 A	
Max. Fuse or Circuit Breaker Size	60 A	
Power Requirement	Minimum 9 kVA Recommended 12 kVA	
Power Consumption	Max. 8.3 kW / Steady State 7.5kW at 60Hz Max. 7.2 kW / Steady State 6.5kW at 50Hz <u>See the ELECTRICAL SCHEMATIC of “APPENDIX” for detail.</u>	
Cooling water requirement	“CAUTION” <u>Do not use the demineralized water for cooling water.</u>	
Temperature Range	4 to 28 deg.C <u>See the Figure 1.1 and Table 1.2</u>	
Flow Rate	7 to 10 liter/min at 28deg.C <u>See the Figure 1.1 and Table 1.2</u>	
Quality	<u>See the Table 1.2</u>	
Pressure Relief Valve Setting	2.61 - 2.75 MPa	
Gas Supply Connector	1/2-inch Coupling	
Gas Return Connector	1/2-inch Coupling	

* Input Power Cable Terminal Cover is 98.0 mm. See the **Figure 1.2**.

** The operating pressure varies according to the heat load of cold head and temperature around the equipment.

COOLING WATER REQUIREMENT

The typical flow characteristics are shown in **Figure 1.1**, and cooling water requirement are shown in **Table 1.2**.

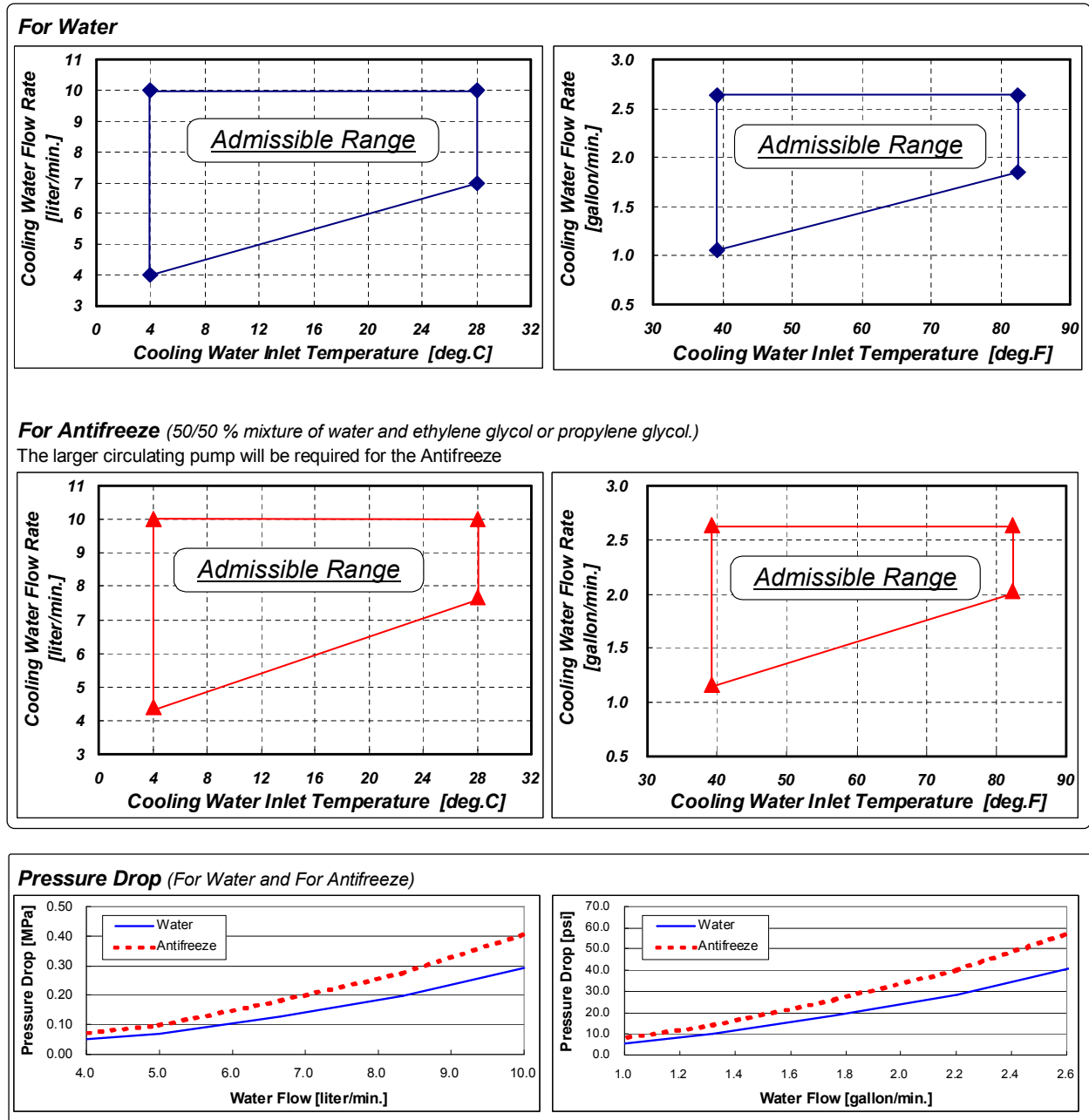


Figure 1.1 COOLING WATER TYPICAL FLOW CHARACTERISTICS

Table 1.2 COOLING WATER SPECIFICATIONS

CHARACTERISTICS	Inlet Temperature Range [deg.C]	[4.0 ~ 28.0]
	Inlet Pressure Range [MPa]	[0.10 ~ 0.69]
	Flow Rate [liter/min.]	[4.0 ~ 10.0]
	Pressure Drop [MPa]	[0.025 ~ 0.085]
	Heat Output [kW]	<Steady State> [< 6.5] for 50Hz [< 7.5] for 60Hz <Maximum> [< 7.2] for 50Hz [< 8.3] for 60Hz
QUALITY	pH Value	6.5 to 8.2 at 25 deg.C
	Electrical Conductivity	< 80 mS / m
	Chloride Ion	< 200 mg/liter
	Sulfate Ion	< 200 mg/liter
	M-Alkalinity	< 100 mg/liter
	Total Hardness	< 200 mg/liter
	Calcium Hardness	< 150 mg/liter
	Ionic Silica	< 50 mg/liter
	Iron	< 1.0 mg/liter
	Copper	< 0.3 mg/liter
	Sulfide Ion	None, Not detectable
	Ammonium ion	< 1.0 mg/liter
	Residual Chlorine	< 0.3 mg/liter
	Free Carbon Dioxide	< 4.0 mg/liter
	Stability Index	6.0 to 7.0
	Suspended Matter	< 10 mg/liter
Particle Size	< 100 μm	

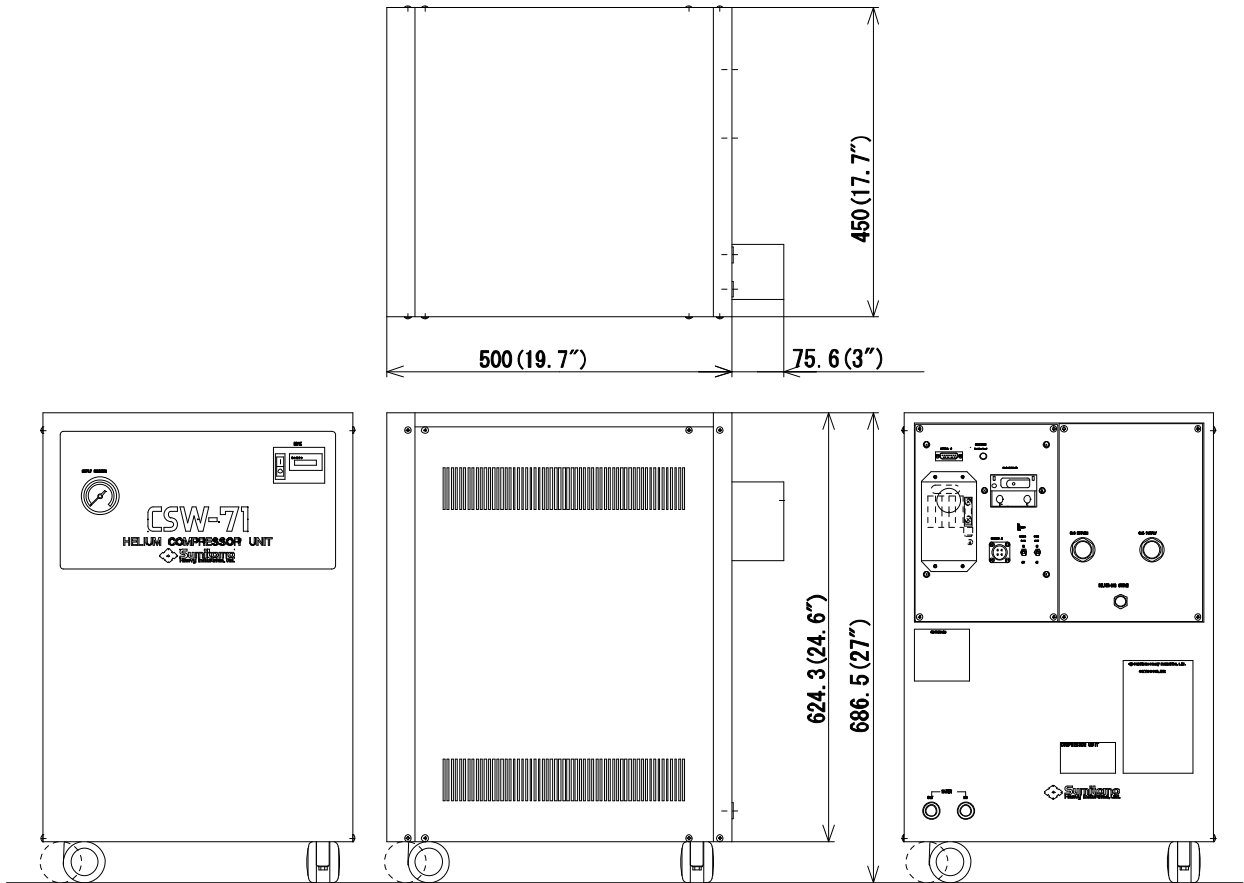


Figure 1.2 OUTLINE VIEW FOR COMPRESSOR UNIT MODEL CSW-71C

1-2 CONSTRUCTION

The function of the Compressor Unit is to supply high pressure He gas to the Cold Head and re-compress the returned He gas from the Cold Head. The Compressor Unit consists of the following major components: a Compressor Capsule, a Cooling system, Oil separation and injection system, and Adsorber.

1-2-1 CONTROLS AND COUPLINGS

The controls and coupling for CSW-71C are described in **Table 1.3** and **Figure 1.3**.

Table 1.3 CONTROLS AND COUPLINGS FOR CSW-71C COMPRESSOR UNIT

No.	ITEM	FUNCTIONS
1	MAIN POWER SWITCH : (QF1)	A twist handle for main electric power supply and for protection from over-current and short-circuit.
2	DRIVE SWITCH : (SA1)	A seesaw switch for start-up and shut-down operation for the compressor unit. The refrigerating system can be in a operating condition by the DRIVE SWITCH "ON" after switching the MAIN POWER SWITCH "ON" condition.
3	COLD HEAD DRIVE SWITCH : (SA2)	A switch for operating the COLD HEAD maintenance only. Under the MAIN POWER SWITCH "ON" and the DRIVE SWITCH "OFF". <i>Caution; Be sure to turn it OFF in normal operation.</i> <i>Using the compressor unit with the cold head drive switch turned ON may result in misoperation or malfunction.</i>
4	REMOTE DRIVE SWITCH : (SA3)	The compressor unit can be operated remotely with the external control by switching "EXT", and cannot be started up in condition of switching "EXT" after the Drive Switch operated.
5	INDICATING LAMP : (HL)	To indicate an Open/Shut condition of the Solenoid Valve (YV) ; Solenoid Valve : "Shut" ----- the Lamp "ON" "Open" ----- the Lamp "OFF"
6	SUPPLY PRESSURE GAUGE	To indicate a filled He-gas pressure in the compressor unit, during not in operation of the compressor unit, and a compressed He-gas pressure (Supply Pressure) can be indicated under the operating condition.
7	HOUR METER : (HM)	To indicate a total operating hour of the compressor unit, and the hour counting will be referred for maintenance interval.
8	FIELD TERMINAL : (TB0)	To use for connecting of input power supply cable. At a connecting power cable, verify the phase label markings L1, L2 and L3. The compressor unit cannot be operated in case of miss-connecting the power cable.
9	GROUND TERMINAL : (PE)	A connector for the earth wiring, and verify the tight connecting for earth wiring as well as Input Power Cable.

**Table 1.3 CONTROLS AND COUPLINGS FOR CSW-71C COMPRESSOR UNIT
(Continued)**

10	COLD HEAD CONNECTOR : (JC)	To use for connecting the Cold Head Cable to supply a Cold Head driving power.
11	EXTERNAL CONNECTOR : (JR)	To use for the external signal output of condition monitoring for the compressor unit. The connector to be "D-Sub 15 Pins (Female type)" in use. Warning; <u>Pay special attention to its wiring when using the external connector on the Compressor Unit.</u> <u>Connecting a jumper wire between Pins No.6 - No.8, No.6 - No.13 and No.6 - No.15 may result in misoperation in some of safety devices in the equipment, causing electric shock, burn or malfunction.</u>
12	HE-GAS SUPPLY CONNECTOR	To use for connecting a Flex Line (for Supply He-gas line)
13	HE-GAS RETURN CONNECTOR	To use for connecting a Flex Line (for Return He-gas line)
14	HE-GAS CHARGE CONNECTOR	To use for charging and refilling a He-gas.
15	COOLING WATER INPUT CONNECTOR	A connector for cooling water inlet. (PT3/8 inch, Female type)
16	COOLING WATER OUTPUT CONNECTOR	A connector for cooling water outlet. (PT3/8 inch, Female type)

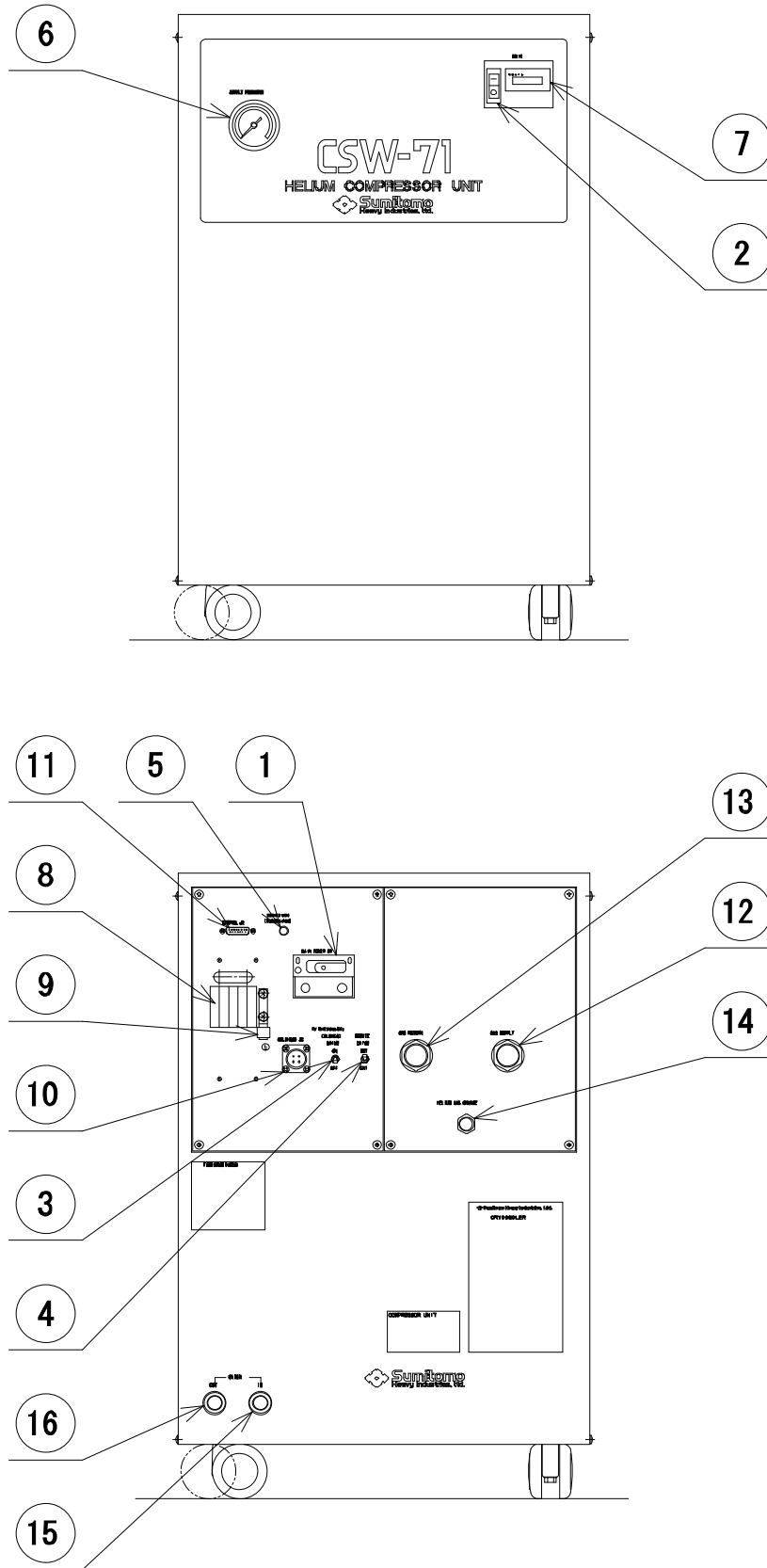


Figure 1.3 CONTROLS AND COUPLINGS FOR CSW-71C COMPRESSOR UNIT

1-2-2 GAS AND OIL FLOW IN THE COMPRESSOR UNIT

The flow diagram for CSW-71C Compressor Unit is shown in **Figure 1.4**.

Internal components diagram and its functions are described in **Figure 1.5** and **Table 1.4**.

The Compressor Unit works as follows;

- 1) Low pressure He gas discharged from a Cold Head can be led through a **HE-GAS RETURN CONNECTOR** to the Compressor Unit.
- 2) The low pressure (Return) He gas can pass through a **STORAGE TANK** and a **FILTER**, and flow into a **COMPRESSOR CAPSULE**.
- 3) The low pressure He gas will be compressed and pressurized in the **COMPRESSOR CAPSULE**, and the high pressure with high temperature He gas after the compression will be discharged from the **COMPRESSOR CAPSULE** outlet.
- 4) The high pressure with high temperature He gas will be led to a water cooled **HE-GAS COOLER** and cooled down in the cooler.
- 5) The high pressure He gas after cooling will flow into an **OIL SEPARATOR** to separate an almost all of lubricating oil mist from the high pressure He gas.
- 6) The separated lubricating oil can be returned to the **COMPRESSOR CAPSULE** through a lub oil return pipings.
- 7) The high pressure He gas discharged from the **OIL SEPARATOR** will be led to an **ADSORBER**.
- 8) The remained lub oil contents in the high pressure He gas can be adsorbed through an active charcoal layer to make the high pressure He gas being pure.
- 9) The pure high pressure He gas can be supplied to the Cold Head through a **HE-GAS SUPPLY CONNECTOR**.

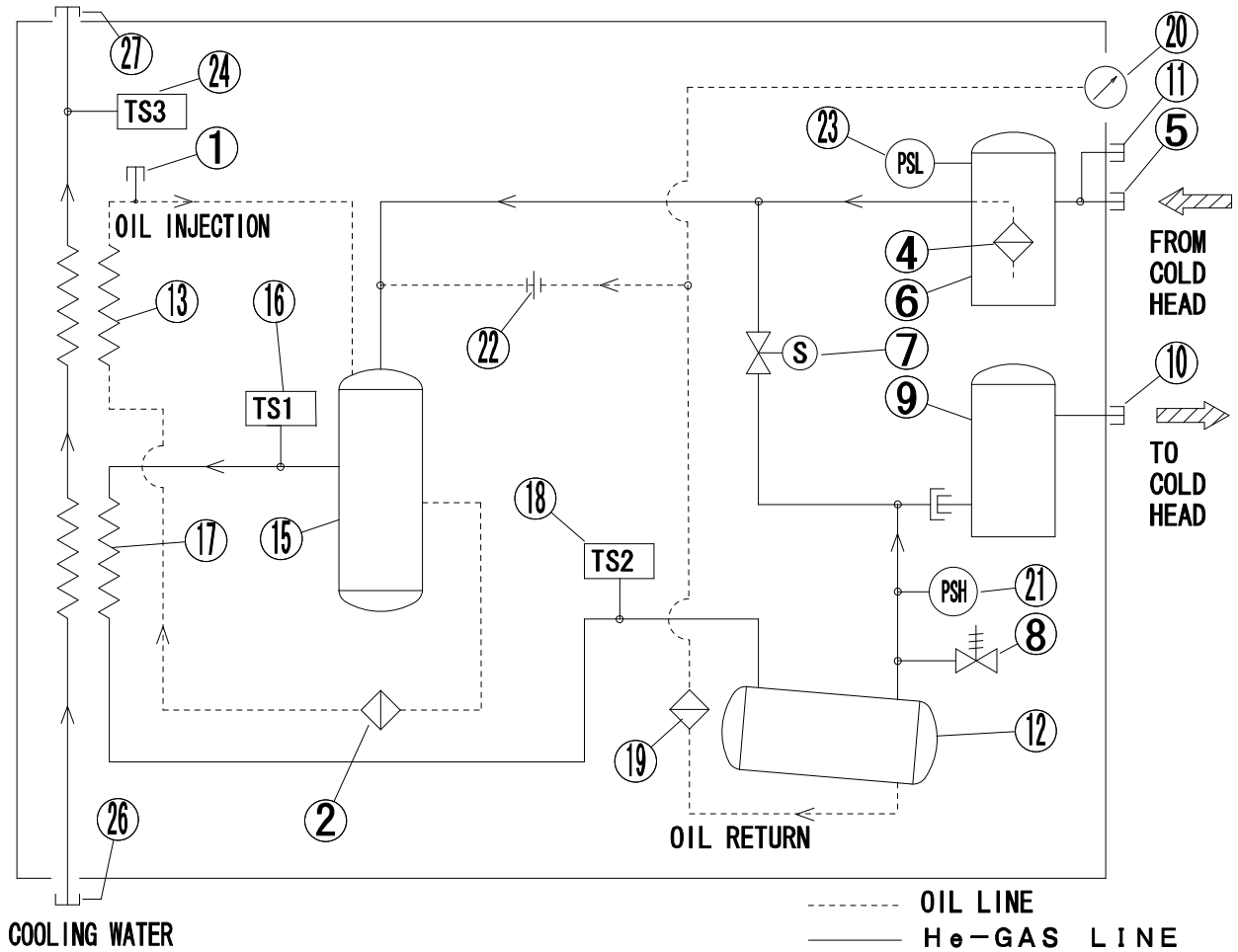


Figure 1.4 HELIUM GAS FLOW DIAGRAM FOR CSW-71C COMPRESSOR UNIT

1-2-3 INTERNAL COMPONENTS

The parts list and its functions are described in **Table 1.4**.

The He-gas flow diagram and internal components are shown in **Figure 1.4** and **Figure 1.5**.

Table 1.4 FUNCTIONS OF THE INTERNAL COMPONENTS FOR CSW-71C COMPRESSOR UNIT

No.	PARTS	FUNCTIONS
1	OIL CHARGE CONNECTOR	To use for refilling a lubricating oil.
2	FILTER	To eliminate contaminators and debris from a recirculating lub oil.
4	FILTER	To eliminate contaminators and debris from a He-gas suction for a Compressor Capsule.
5	HE-GAS RETURN CONNECTOR	To use for connecting a Flex Line (for Return He-gas line).
6	STORAGE TANK	A He-gas reservoir for piping to Compressor Capsule.
7	SOLENOID VALVE	An electro-magnetic operation valve for He-gas piping.
8	RELIEF VALVE	To keep a maximum high pressure for the He-gas piping safely.
9	ADSORBER	To use for eliminating a remained oil mist in the compressed He-gas after treatment by the Oil Separator.
10	HE-GAS SUPPLY CONNECTOR	To use for connecting a Flex Line (for Supply He-gas line).
11	HE-GAS CHARGE CONNECTOR	To use for charging and refilling a He-gas.
12	OIL SEPARATOR	To eliminate oil contamination from the compressed He-gas.
13	OIL COOLER	A water cooled type heat exchanger for recirculating lub oil.
15	COMPRESSOR CAPSULE	A He-gas compressed for the unit.
16	THERMOSTAT : TS1 110 deg.C	A thermal sensor & controller for the compressed He-gas temperature of compressor outlet.
17	HE-GAS COOLER	A water cooled type heat exchanger for compressed He-gas.
18	THERMOSTAT : TS2 60 deg.C	A thermal sensor & controller for the compressed He-gas temperature of He-gas cooler outlet.
19	FILTER	To eliminate contaminators and debris from a lub oil return of Oil Separator.
20	PRESSURE GAUGE	To indicate a filled He-gas pressure and compressed He-gas pressure of the unit.
21	HIGH SIDE PRESSURE SWITCH : PSH	A pressure sensor for compressed He-gas pressure control.
22	ORIFICE	To use for adjusting a recirculating lub oil flow.
23	LOW SIDE PRESSURE SWITCH : PSL	A pressure sensor for compressed He-gas pressure control.
24	THERMOSTAT : TS3 60 deg.C	A thermal sensor & controller for the water temperature of cooling water outlet.
26	COOLING WATER INLET CONNECTOR	To use for connecting a cooling water piping (for War Supply)
27	COOLING WATER OUTLET CONNECTOR	To use for connecting a cooling water piping (for Water Discharge)
28	CONTROL BOX	An electronic control, surveillance and alarming system for the He-gas Compressor Unit.

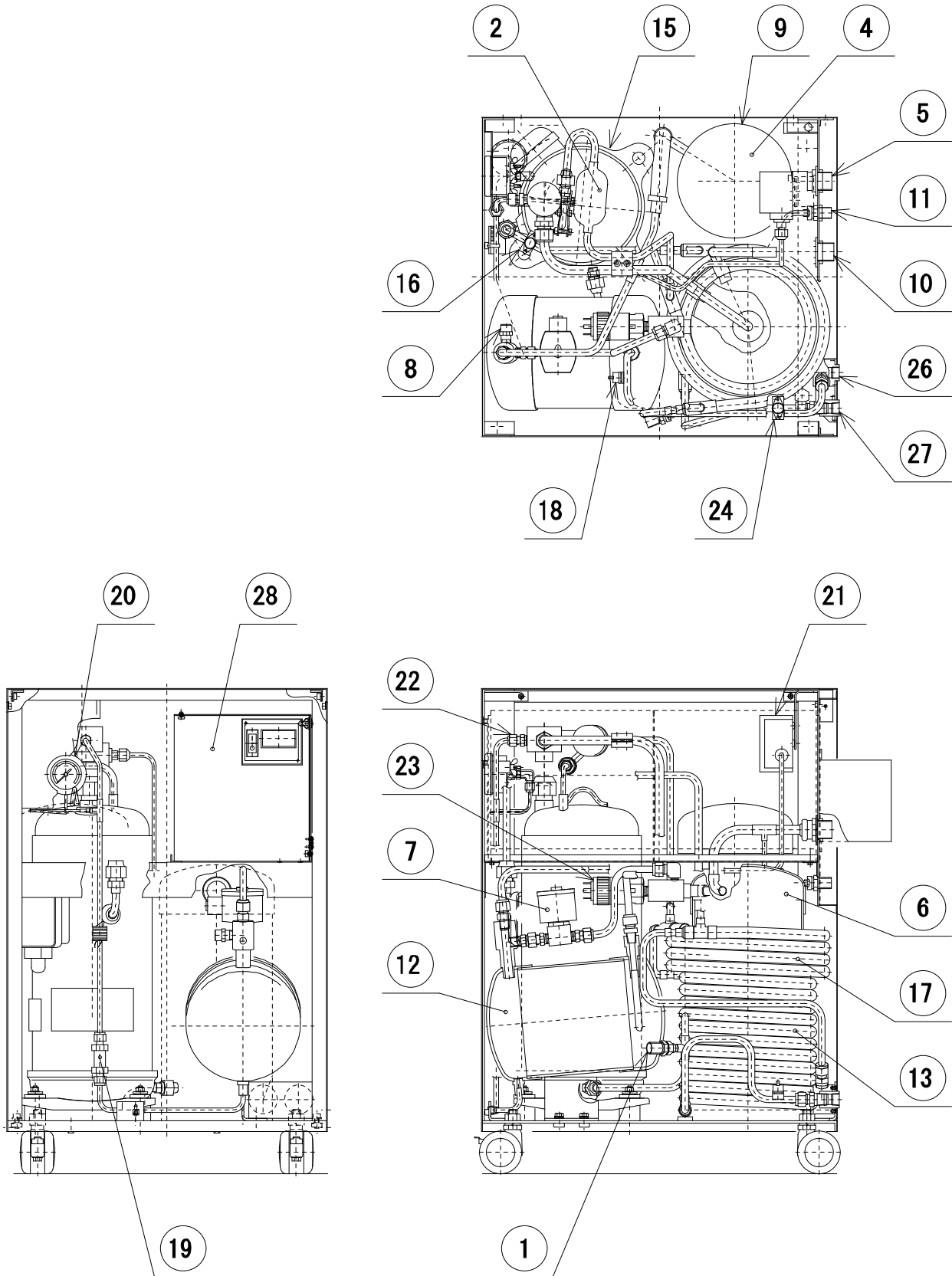



Figure 1.5 COMPONENTS OF CSW-71C COMPRESSOR UNIT

1-3 ELECTRICAL DESCRIPTION

1-3-1 EXTERNAL CONNECTOR

WARNING



<Warning about electric shock>
 This cryocooler includes a high-voltage section. Touching it may result in electric shock. Handle it with extreme care.

Pay special attention to its wiring when using the external connector on the compressor unit. Connecting a jumper wire between Pins No.6 - No.8, No.6 - No.13 and No.6 - No.15 may result in misoperation in some of safety devices in the equipment, causing electric shock, burn or malfunction.

“IMPORTANT”

See **“ELECTRICAL SCHEMATIC”** of CSW-71C Compressor Unit, for detail.

“IMPORTANT”

The maximum allowable tightening torque of the D-Sub Connector lock screw (#4-40UNC) is 0.17 Nm.

External Connector can be used monitoring the status of the Compressor Unit and the remote control sequences of the Compressor Unit are described in **Table 1.5**.

The “D-sub” pins indicated in **Figure 1.6** on the control panel for the Compressor Unit can be applied to an initial condition monitoring for a first-aid diagnostics of the Compressor Unit by means of measuring the each item with a digital Volt/Ohm Meter. The Fault Condition classified the digital meter reading as referred to the **Table 1.5** can be identified simply an actual operation condition of the Compressor Unit in the field.

Table 1.5 EXTERNAL CONTROL / ALARM

No.	ITEM	OPERATION		PIN No.	FAULT CONDITION*	
1	Pressure Alarm Signal	Contact	Normal	Close	1, 2	> 10 ⁶ ohm
			Alarm	Open		
2	Temp. Alarm Signal	Contact	Normal	Close	3, 4	> 10 ⁶ ohm
			Alarm	Open		
3	Drive Indication	DC Power	Operate	24V DC(0.15A max.)	6, 7	0 V
			Stop	0V		
4	Control Voltage	DC Power	Output 24V DC(0.15A max.), when Main Power SW is “ON”		7, 13	
5	Remote Reset	Relay	Pulsed 24VDC for 1 second to be furnished by user.		12, 14	
6	Remote Drive	Contact	Drive	Close	8, 15	
			Stop	Open		

* Digital Volt./Ohm Meter Reading

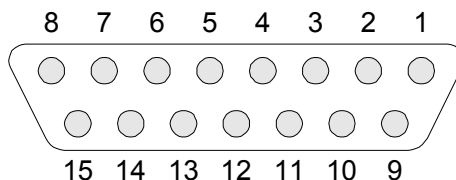


Figure 1.5 EXTERNAL CONNECTOR WIRING ON THE COMPRESSOR UNIT

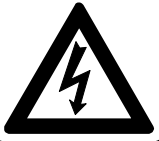
1-3-2 SAFETY DEVICES

The safety devices list for Compressor Unit is shown in **Table.1.6**.

Table 1.6 SAFETY DEVICES OF CSW-71C

ITEM	FUNCTIONS
THERMOSTAT : (TS1)	Setting temperature; 110 deg.C ---- approx. To shut down the Compressor Unit and signal a high temperature alarm to the External Connector, in case of higher temperature of a compressed He-gas at a compressor outlet than the setting temperature.
THERMOSTAT : (TS2)	Setting temperature; 60 deg.C ---- approx. To shut down the Compressor Unit and signal a high temperature alarm to the External Connector, in case of higher temperature of a compressed He-gas at a He-gas cooler outlet than the setting temperature.
THERMOSTAT : (TS3)	Setting temperature; 60 deg.C ---- approx. To shut down the Compressor Unit and signal a higher temperature alarm to the External Connector, in case of higher temperature of a water at a cooling water outlet than the setting temperature.
SOLENOID VALVE : (YV)	To stabilize a pressure for even of the He-gas between the Supply and Return piping, at a shut off the Compressor Unit.
HIGH PRESSURE SWITCH : (PSH)	Setting pressure; "Operate" 2.55 MPa ---- approx. "Reset" 2.26 MPa ---- approx. To adjust a Supply He-gas pressure smoothly by a function of the pressure switch for Open and/or Shut, in case of higher pressure of the Supply He-gas than the setting pressure.
LOW PRESSURE SWITCH : (PSL)	Setting Pressure; "Operate" 0.15 MPa ---- approx. To shut down the Compressor Unit and signal a Low pressure alarm to the External Connector, in case of lower pressure of a compressed He-gas caused by a smaller quantity of He-gas than original filling in the compressor unit.
RELIEF VALVE	Setting pressure; "Operate" 2.61 - 2.75 MPa "Reset" 2.50 MPa ---- minimum To adjust a Supply He-gas pressure smoothly by a function of the Relief Valve for blowing off the He-gas to the atmosphere, in case of higher pressure of Supply He-gas than the setting pressure.
MAIN POWER SWITCH : (QF1)	Setting current; 29 A To shut down the Compressor Unit, in case of occurring over-current and/or short-circuit than the setting current.
PHASE FAILURE PROTECTION CIRCUIT :	To avoid starting-up of the Compressor Unit in case of an abnormal operation caused by irregular connecting of Input Power Cable such as failure connecting.
FUSE : (FU1, FU2, FU3)	To protect the Compressor Unit from the over-load caused by short-circuit and/or any other electrical failure in the DC power or the Solenoid Valve.

2 INSTALLATION

WARNING**<Warning about electric shock>**

This cryocooler includes a high-voltage section. Touching it may result in electric shock. Handle it with extreme care.

Make sure no power is applied to the compressor unit before starting the installation. Failing to observe this precaution may result in electric shock.

Do not install the equipment near places subject to condensation such as a watering place. Failing to observe this precaution may result in electric shock or malfunction.

Do not install the equipment in a dusty environment. Failing to observe this precaution may result in electric shock or malfunction.

Make sure the power specification of the cryocooler used conforms to the customer's power supply before using the equipment. Using the cryocooler with a non-conforming power supply may result in electric shock or malfunction.

If the compressor unit used is the CSW-71D (water cooled, high voltage type), pay attention to the setting of the applicable input supply voltage. The product is shipped with the input supply voltage set to 480V. Before installing the equipment, be sure to check your supply voltage and change it to the appropriate setting if necessary. Operating the equipment with your supply voltage different from the setting of the compressor unit may result in electric shock or malfunction.

Make sure no power is applied to the compressor unit before starting operation when connecting or disconnecting the cold head power cable. Failing to observe this precaution may result in electric shock.

Be sure to turn off and Lock Out with OFF position the main power of the customer's power source before connecting or disconnecting the input power cable to the Compressor Unit, and then remove the input power cable from the main power. Failing to observe this precaution may result in electric shock.

Do not change the setting of the dial above the main power switch of the compressor unit under any circumstances. Failing to observe this precaution may result in electric shock.

WARNING**<Warning about explosion, escape of gas>**

This cryocooler (cold head, compressor unit, compressor adsorber, flex lines) contains a high-pressure (about 1.62 MPa) helium gas sealed in. Hitting the equipment with a sharp edge or touching it with a pointed object may cause explosion or escape of gas. Handle the equipment with extreme care.

The minimum bending radius of the flex lines is 150mm (intermediate), 300 mm (terminal). Bending the flex lines at a smaller angle may cause explosion or escape of gas, and so this should be avoided.

Do not disassemble the equipment for purposes other than maintenance specified in this service manual under any circumstances. Disassembling the equipment may result in electric shock, explosion or escape of gas.

Install the cryocooler in the ventilated area, otherwise it may result in asphyxiation in case the helium gas is purged or leaked.

WARNING

Do not put the heat sensitive or flammable object near the Compressor Unit, or result in fire, injury or malfunction of the system.

CAUTION**<Caution against misoperation>**

Do not tilt it by more than 30 degrees when carrying the compressor unit. Tilting it by more than 30 degrees may cause oil sealed in the unit to move, preventing the cryocooler from operating normally.

This cryocooler is intended for the exclusive use indoors. It cannot be used outdoors. Failing to observe this precaution may prevent the cryocooler from operating normally.

Do not use inverter for the main power source of the compressor unit. Operating with inverter may result in the damage or malfunction of the compressor electric circuit.

Avoid using the transformer for the main power source of the compressor unit. If the transformer is installed at the upstream of the unit, lacking phase protection circuit with the cryocooler occurs in a malfunction. That may result in misoperation or malfunction. When using the transformer, install the other lacking phase protection device in upstream of the transformer.

Do not get on the compressor unit or put an object on top of it. Failing to observe this precaution may prevent the cryocooler from operating normally or cause injury.

Secure enough space around the compressor unit for heat radiation and maintenance. Failing to secure enough space may result in misoperation or malfunction. (See the technical instruction of the compressor unit used, for details.)

If the compressor unit used is a water-cooled type (CSW-71C, CSW-71D), use cooling water with appropriate temperature, flow rate and water quality. Using inappropriate cooling water may result in misoperation or malfunction. (See the technical instruction of the compressor unit used, for details.)

If the compressor unit used is a water-cooled type (CSW-71C, CSW-71D), do not use the demineralized water for cooling water. Using demineralized water for cooling water may result in water leakage or malfunction. (See the technical instruction of the compressor unit used, for details.)

Be sure to check the flat rubber gasket of the self seal coupling of the cold head and compressor unit for dirt, dust or to see whether the flat rubber gasket is attached correctly, before connecting the flex lines. Connecting the flex lines with an abnormal flat rubber gasket setting may cause escape of gas.

This cryocooler (cold head, compressor unit, compressor adsorber, flex lines) is shipped with a helium gas at about 1.62 MPa sealed in. Be sure to adjust the pressure to an appropriate value according to the cold head used before operating the equipment. Using the cryocooler at an improper pressure may cause misoperation.

Pay attention to the contamination when charging a helium gas. The contamination may result in occurrence of the noise from the Cold Head or decreasing the cooling capacity.

2-1 SITE REQUIREMENT

CAUTION**<Caution against misoperation>**

Do not use inverter for the main power source of the compressor unit. Operating with inverter may result in the damage or malfunction of the compressor electric circuit.

Avoid using the transformer for the main power source of the compressor unit. If the transformer is installed at the upstream of the unit, lacking phase protection circuit with the cryocooler occurs in a malfunction. That may result in misoperation or malfunction. When using the transformer, install the other lacking phase protection device in upstream of the transformer.

Secure enough space around the compressor unit for heat radiation and maintenance. Failing to secure enough space may result in misoperation or malfunction. (See the technical instruction of the compressor unit used, for details.)

If the compressor unit used is a water-cooled type (CSW-71C, CSW-71D), use cooling water with appropriate temperature, flow rate and water quality. Using inappropriate cooling water may result in misoperation or malfunction. (See the technical instruction of the compressor unit used, for details.)

If the compressor unit used is a water-cooled type (CSW-71C, CSW-71D), do not use the demineralized water for cooling water. Using demineralized water for cooling water may result in water leakage or malfunction. (See the technical instruction of the compressor unit used, for details.)

- An almost level and even area in the field will be selected to install the Compressor Unit.
- An area to be influenced by splashing water and/or dusts will not be selected to install the Compressor Unit installation area.
- A clean environmental condition without dirt and/or free from an exhausted heat will be selected to install the Compressor Unit in the field.
- A quality of cooling water will be secured to use for an appropriate coolant for the Compressor Unit.
- Any heat sensitive object cannot be positioned on surroundings of the Compressor Unit.

AMBIENT TEMPERATURE CONDITION

The ambient temperature must be between 5 deg.C and 28 deg.C to get the specified capacity. The system can operate up to 35 deg.C with less than 5% cooling capacity down. The maximum relative air humidity is 85%RH.

HELIUM SUPPLY SYSTEM

A helium supply system is necessary if you need to decontaminate the helium gas, or charging the helium gas that has leaked out of the system. A helium supply system includes a Grade 5 (99.999% up pure) helium gas bottle, a regulator, an outlet valve, and a charging hose or equivalent delivery line.

POWER SOURCE

Ensure the correct AC power source is available for the compressor. See **Table 1.1** for the power requirements for your system.

COOLING WATER

Ensure the correct cooling water is available for the compressor. See **Figure 1.1** and **Table 1.2.** for the cooling water requirements for your system.

Operating with Antifreeze (50/50 % mixture of water and ethylene glycol), the flow rate shall be larger than the water. See **Figure 1.1** and **Table 1.2.** for the cooling water requirements for your system.

SAFETY / SEISMIC REQUIREMENT

Secure to lock the locking device of compressor castor.

SERVICE AREA

The Compressor Unit should have enough space as shown in **Figure 2.1.**

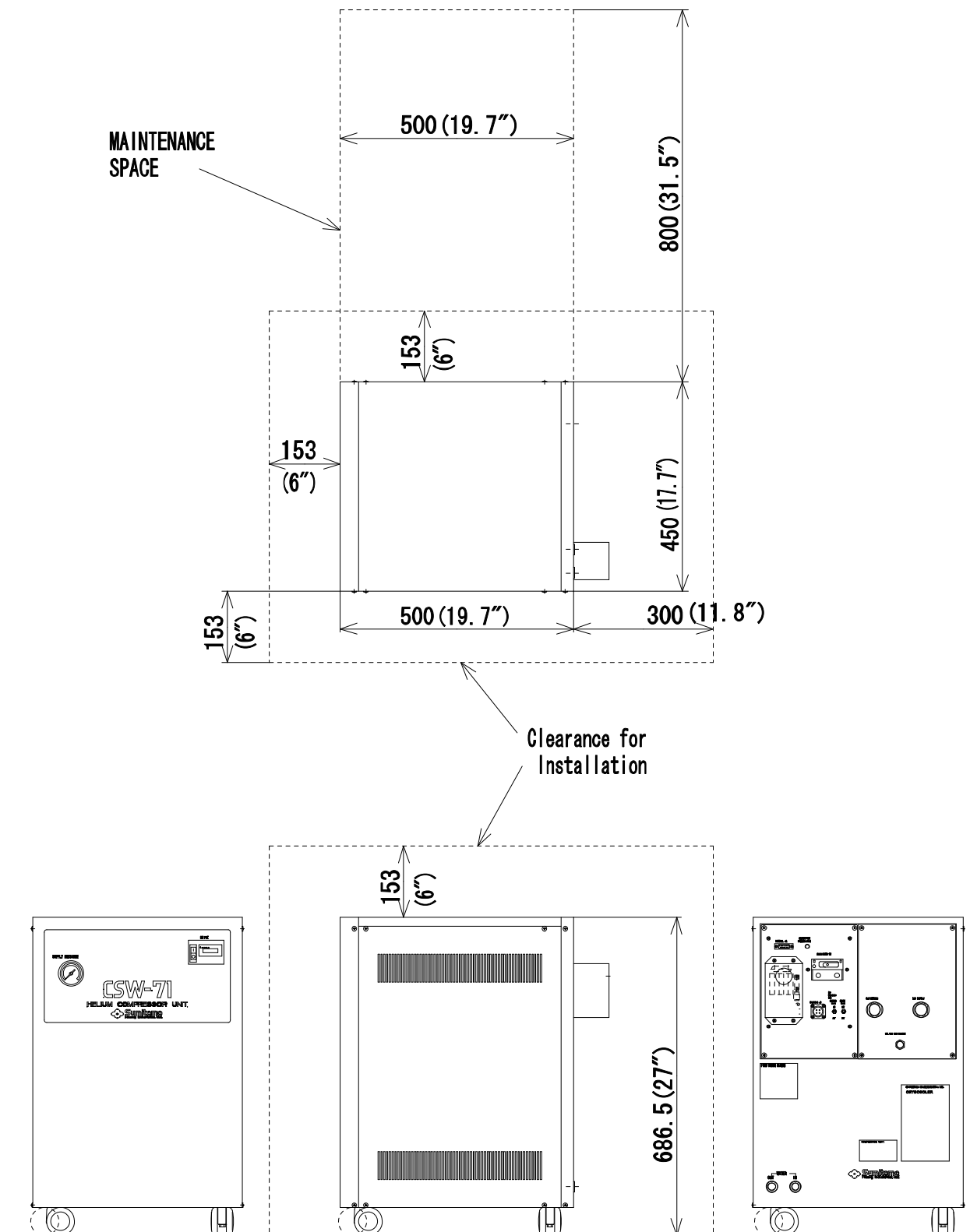




Figure 2.1 WATER COOLED COMPRESSOR UNIT CSW-71C AND ITS REQUIRED SPACE

2-2 INPUT POWER CABLE CONNECTION

 <p>WARNING</p>	<p><Warning about electric shock> Make sure the power specification of the cryocooler used conforms to the customer's power supply before using the equipment. Using the cryocooler with a non-conforming power supply may result in electric shock or malfunction.</p> <p>Be sure to turn off and Lock Out with OFF position the main power of the customer's power source before connecting or disconnecting the input power cable to the Compressor Unit, and then remove the input power cable from the main power. Failing to observe this precaution may result in electric shock.</p> <p>Do not change the setting of the dial above the main power switch of the compressor unit under any circumstances. Failing to observe this precaution may result in electric shock.</p>
---	--

 <p>CAUTION</p>	<p><Caution against misoperation> Do not use inverter for the main power source of the compressor unit. Operating with inverter may result in the damage or malfunction of the compressor electric circuit.</p> <p>Avoid using the transformer for the main power source of the compressor unit. If the transformer is installed at the upstream of the unit, lacking phase protection circuit with the cryocooler occurs in a malfunction. That may result in misoperation or malfunction. When using the transformer, install the other lacking phase protection device in upstream of the transformer.</p>
---	---

"IMPORTANT"

This cryocooler is provided with a phase reverse protection circuit for the input power. If the input power is connected with reverse phase, the cryocooler does not start.

"IMPORTANT"

See "ELECTRICAL SCHEMATIC" of CSW-71C Compressor Unit, for detail.

"IMPORTANT"

See "INPUT POWER CABLE LV" of "DRAWINGS" for detail.

Make electrical connection as follows;

Upstream Protection

Use the fuses or circuit breakers as upstream protection of L1, L2, L3. The recommended rating of the protection is maximum 60A.

Power Supply Conductor and Protective Earth Conductor

Use 75 deg.C wiring sized to 60 deg.C ampacity.
 Use copper conductor only. AWG 8 (8.3 mm²) or larger.

Compressor Unit Side

Power Supply Conductors
 Striping Length: 12 mm
 Tightening Torque: 1.3 Nm

Protective Earth Conductor
 Striping Length: 12 mm
 Tightening Torque: 1.8 Nm

User's Power Source Side

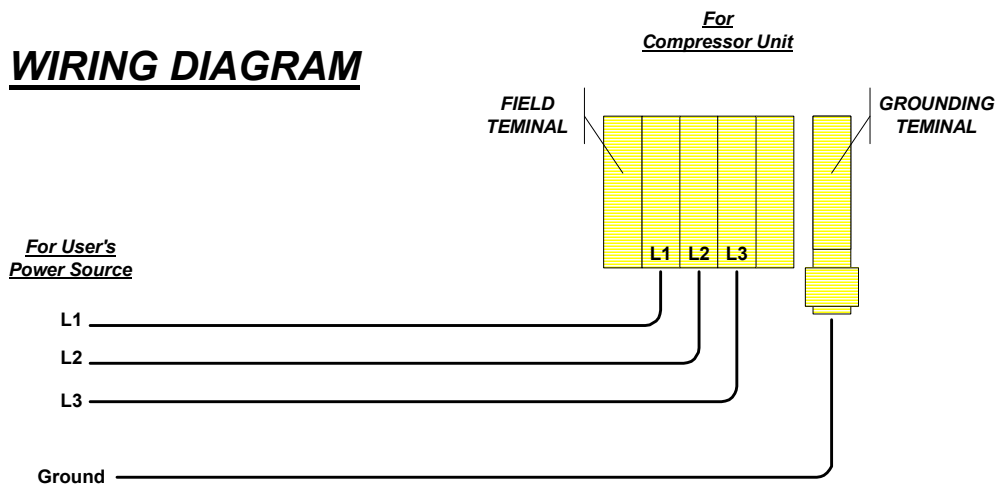
Power Supply Conductors
 Striping Length: 12 mm

Protective Earth Conductor
 Striping Length: 12 mm

2-2 INPUT POWER CABLE CONNECTION


See the **Table 1.1** for power requirements. The cables are marked with label and connect as follows:

WIRING DIAGRAM



3 MAINTENANCE

WARNING



<Warning about electric shock>
 This cryocooler includes a high-voltage section. Touching it may result in electric shock. Handle it with extreme care.


Make sure no power is applied to the compressor unit before starting the installation. Failing to observe this precaution may result in electric shock.

Be sure to turn off and Lock Out with OFF position the main power of the customer's power source before connecting or disconnecting the input power cable to the Compressor Unit, and then remove the input power cable from the main power. Failing to observe this precaution may result in electric shock.

Do not change the setting of the dial above the main power switch of the compressor unit under any circumstances. Failing to observe this precaution may result in electric shock.

Be sure to turn off and Lock Out with OFF position the customer's main power before performing maintenance work such as replacement of fuses. Failing to observe this precaution may result in electric shock.

WARNING



<Warning about explosion, escape of gas>
 This cryocooler (cold head, compressor unit, compressor adsorber, flex lines) contains a high-pressure (about 1.62 MPa helium gas sealed in. Hitting the equipment with a sharp edge or touching it with a pointed object may cause explosion or escape of gas. Handle the equipment with extreme care.


Do not disassemble the equipment for purposes other than maintenance specified in this service manual under any circumstances. Disassembling the equipment may result in electric shock, explosion or escape of gas.

The cold head, compressor unit, compressor adsorber and flex lines are pressurized with helium gas. Purge the helium gas from all pressurized components before disposing. Open the purging valve gradually or it may result in serious injury.

When scrapping the CryoCooler, handle it as Industrial Waste and pass it over to legally qualified disposer.


Install the cryocooler in the ventilated area, otherwise it may result in asphyxiation in case the helium gas is purged or leaked.

WARNING



The Adsorber weight is about 11.0kg. When replace the adsorber, be careful of handling so that it may not get hurt.

CAUTION



<Caution against misoperation>
 Do not get on the compressor unit or put an object on top of it. Failing to observe this precaution may prevent the cryocooler from operating normally or cause injury.

Secure enough space around the compressor unit for heat radiation and maintenance. Failing to secure enough space may result in misoperation or malfunction. (See the technical instruction of the compressor unit used, for details.)

If the compressor unit used is a water-cooled type (CSW-71C, CSW-71D), use cooling water with appropriate temperature, flow rate and water quality. Using inappropriate cooling water may result in misoperation or malfunction. (See the technical instruction of the compressor unit used, for details.)

The cold head drive switch provided with the compressor unit is only used for maintenance. Be sure to turn it OFF in normal operation. Using the compressor unit with the cold head drive switch turned ON may result in misoperation or malfunction.

3-1 PERIODICAL MAINTENANCE

CSW-71C Compressor Unit is to be required the routine maintenance. The basic maintenance work is to replace the oil mist Adsorber of the Compressor Unit for every 20,000 Hrs operation as mentioned **Table 3.1**.

Table 3.1 MAINTENANCE SCHEDULE


MAINTENANCE	FREQUENCY	REMARKS
Replace Compressor Adsorber	Every 20,000 Hrs.	
Charge Helium Gas to Compressor	As required	
Cleaning Water Cooler	As required	Depending on the water conditions.
Compressor Fuse Replacement	As required	

Table 3.2 RENEWAL PARTS LIST (FRU'S)

ITEM	DESCRIPTION	Q'TY	PART NUMBER	REMARKS
1	Adsorber	1	RE71TN0408	
2	Fuse (FU1, FU2, Fu3)	3	RE71WT0603	Class G Fuse 5A
3	Hose Nipple	2	RE38VT0689	OD:12.7mm x PT3/8 (male)

3-1-1 REPLACEMENT OF THE COMPRESSOR ADSORBER

WARNING



<Warning about explosion, escape of gas>

This cryocooler (cold head, compressor unit, compressor adsorber, flex lines) contains a high-pressure (about 1.62 MPa) helium gas sealed in. Hitting the equipment with a sharp edge or touching it with a pointed object may cause explosion or escape of gas. Handle the equipment with extreme care.


Do not disassemble the equipment for purposes other than maintenance specified in this service manual under any circumstances. Disassembling the equipment may result in electric shock, explosion or escape of gas.

The cold head, compressor unit, compressor adsorber and flex lines are pressurized with helium gas. Purge the helium gas from all pressurized components before disposing. Open the purging valve gradually or it may result in serious injury.

When scrapping the CryoCooler, handle it as Industrial Waste and pass it over to legally qualified disposer.


Install the cryocooler in the ventilated area, otherwise it may result in asphyxiation in case the helium gas is purged or leaked.

WARNING



The Adsorber weight is about 11.0kg. When replace the adsorber, be careful of handling so that it may not get hurt.

CAUTION



<Caution against misoperation>

Do not get on the compressor unit or put an object on top of it. Failing to observe this precaution may prevent the cryocooler from operating normally or cause injury.

The Oil Mist Adsorber is required to replace for every 20,000 Hrs operation.

Table 3.3 ADSORBER FOR COMPRESSOR UNIT

	DESCRIPTION	Q'TY	PART NUMBER	REMARKS
1	Adsorber	1	RE71TN0408	

Table 3.4 REQUIRED TOOLS FOR ADSORBER REPLACEMENT

	TOOLS	REMARKS
1	1" open-end wrench	For Aero-quip coupling
2	1-1/8" Open-end wrench	For Aero-quip coupling
3	1-3/16" Open-end wrench	For Aero-quip coupling
4	Snoop liquid	For leak check
5	Cotton wipers	For leak check
6	13 mm Open-end wrench	For fixing nut for Adsorber
7	Screw driver (phillips(+))	For side panel of Compressor Unit.

Replace the Adsorber instructed as follows;

PREPARATION

- 1) Shut down the Cryocooler.
- 2) Disconnect the Input Power Cable from the Compressor Unit.
- 3) Disconnect the Supply and Return Flex Lines from the Compressor Unit.

REMOVING THE USED ADSORBER

- 1) Loosen the screws that hold the compressor side panel and remove the panel.



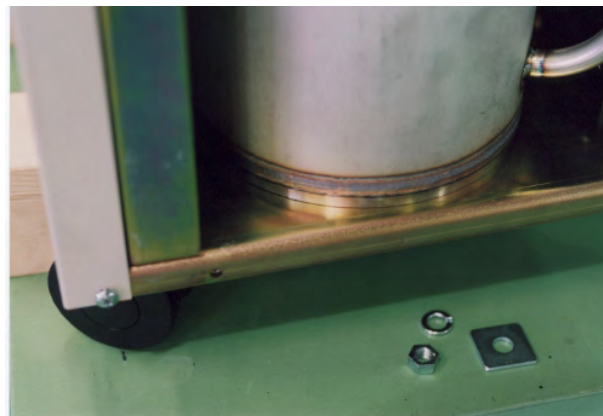
- 2) Disconnect the Adsorber Self-Sealing Coupling. Use three wrenches.



- 3) Remove the Nut secured the Adsorber to Rear Panel. Use two wrenches.



- 4) Remove the Nut and Washer secured the Adsorber to the base panel of the Compressor Unit.



- 5) Remove the used Adsorber from the Compressor frame.



INSTALLING NEW ADSORBER


- 1) Set a new Adsorber.
- 2) Secure the Adsorber to the base panel of the Compressor Unit by tightened Nut and Washer.
Tightening Torque: 14.5 Nm
- 3) Secure the Adsorber to Rear Panel by tightening Nut.
Tightening Torque: 23 Nm
- 4) Connect the Adsorber Self-Sealing Coupling.
Tightening Torque: 50 Nm
- 5) Sprinkle "Liquid Leak Detector" on the Flex line connecting coupling, in case the bubbling is found, tighten the connecting coupling again and re-check the leakage.

Ensure that the pressure gauge indication is specified value for the type of Cold Head. Charge the helium gas, in case of low pressure indicating.

- 6) Reinstall the panels and secure them by tightening the screws.

3-2 FUSE REPLACEMENT

WARNING



<Warning about electric shock>
 This cryocooler includes a high-voltage section. Touching it may result in electric shock. Handle it with extreme care.

Do not change the setting of the dial above the main power switch of the compressor unit under any circumstances. Failing to observe this precaution may result in electric shock.

Be sure to turn off and Lock Out with OFF position the customer's main power before performing maintenance work such as replacement of fuses. Failing to observe this precaution may result in electric shock.

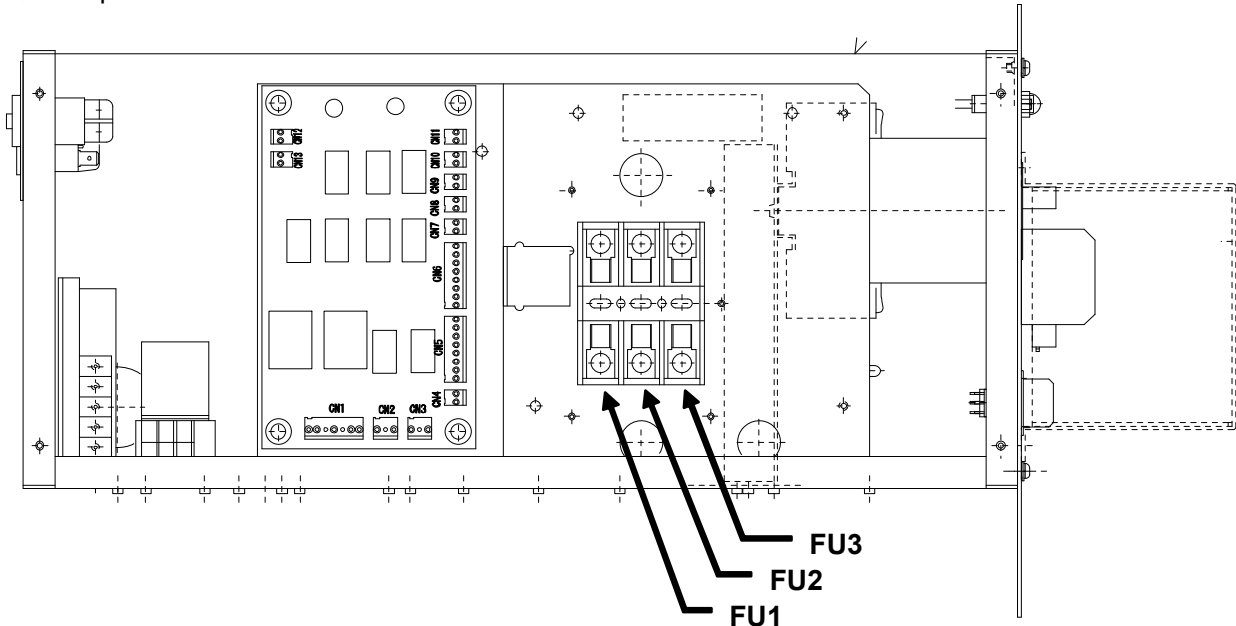
Fuses are equipped inside of the Fuse Box for the Control Box.

Table 3.5 LIST OF FUSES

Fuse No.	Description	Part Number	Remarks
FU1	Class G Fuse 5A	RE71WT0603	For Cold Head Motor, Solenoid Valve and DC circuit
FU2			
FU3			

FUSE REPLACING PROCEDURE

- 1) Loosen the screws that hold the compressor side panel, and remove the panel.
- 2) Replace the Fuses.

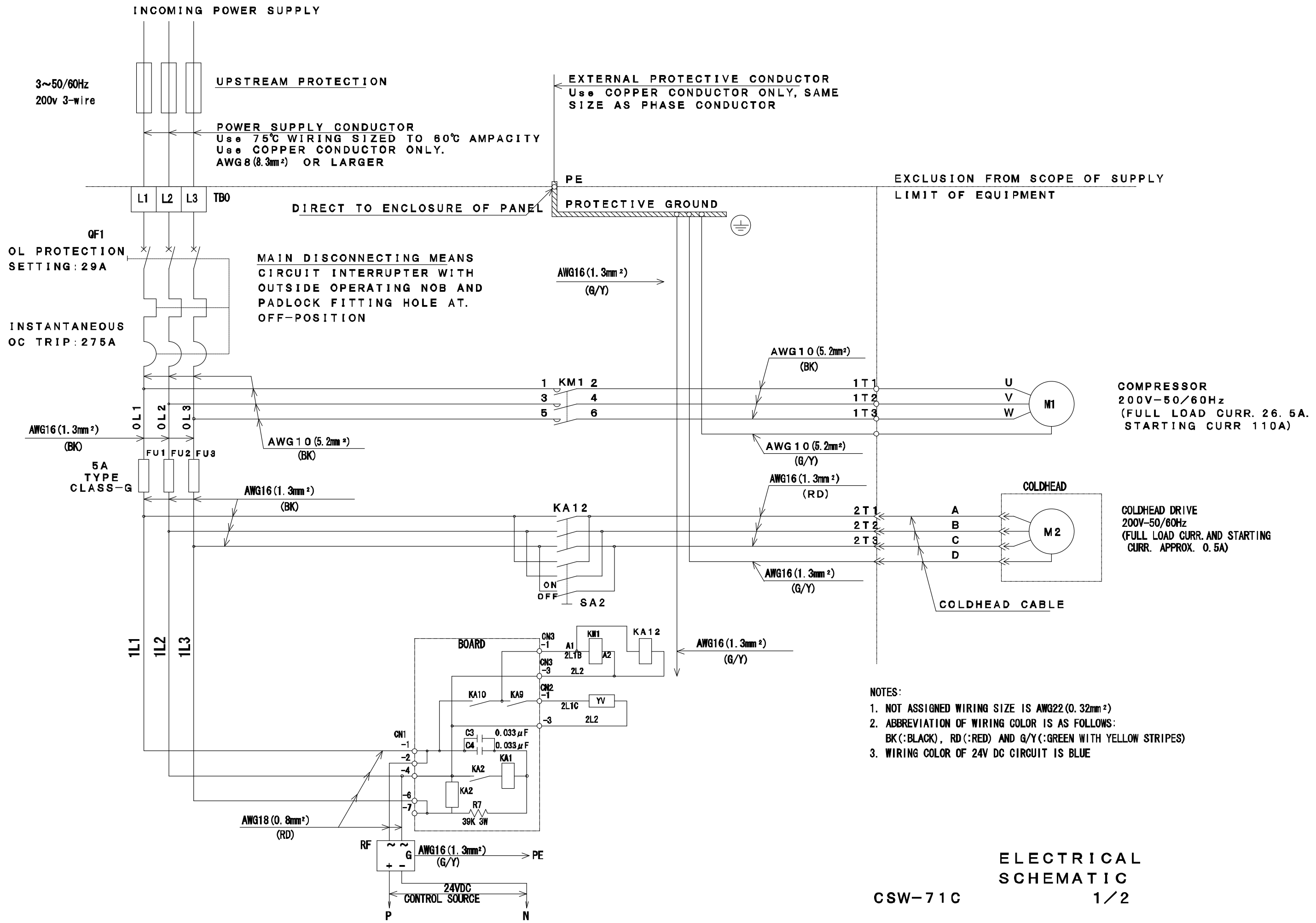


APPENDIX**ELECTRICAL SCHEMATIC**

No.	PART NAME
1	ELECTRICAL SCHEMATIC of CSW-71C (FOR AC CIRCUIT)
2	ELECTRICAL SCHEMATIC of CSW-71C (FOR DC CIRCUIT)

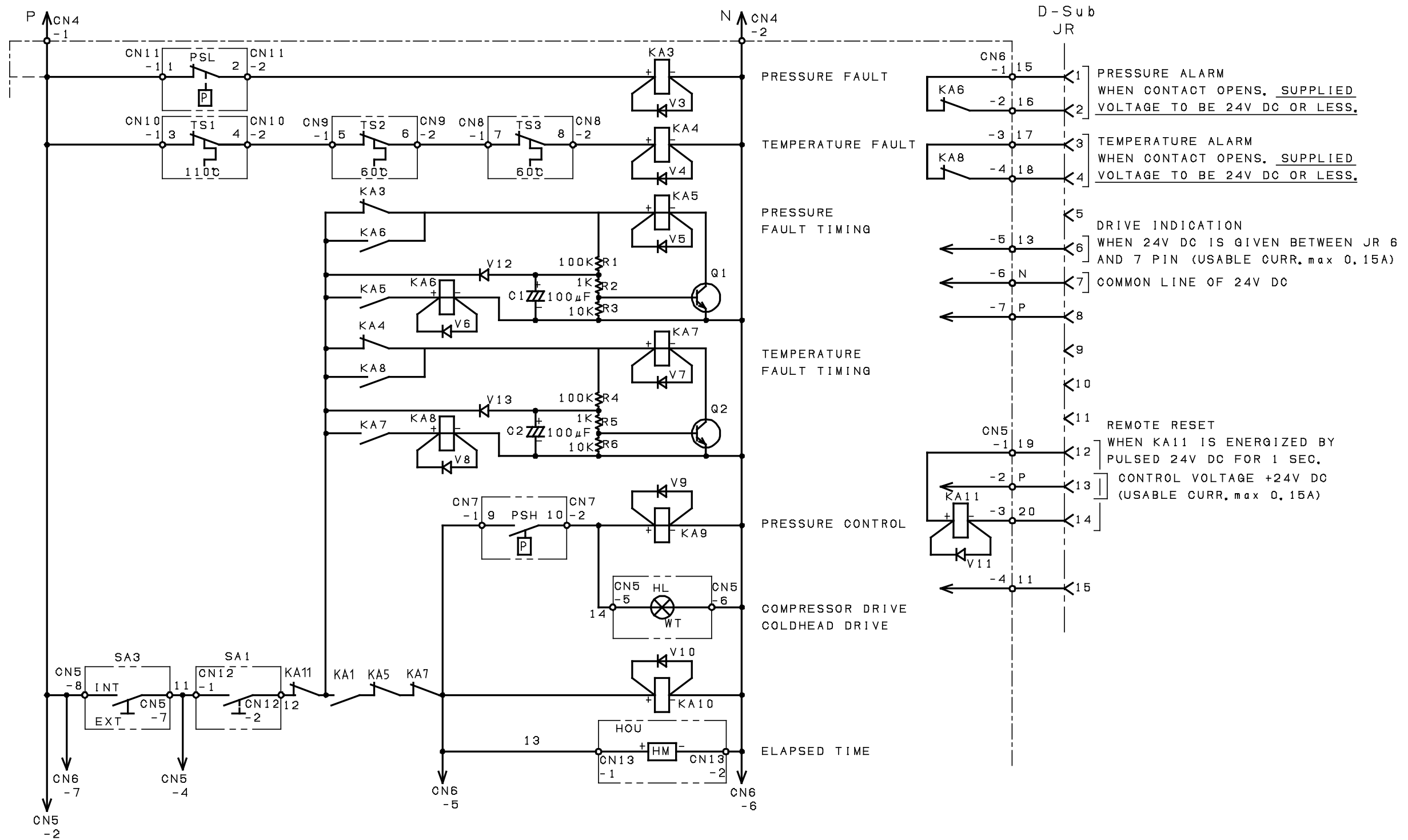
DRAWINGS

No.	PART NAME
1	ADSORBER
2	CLASS G FUSE 5A
3	INPUT POWER CABLE LV

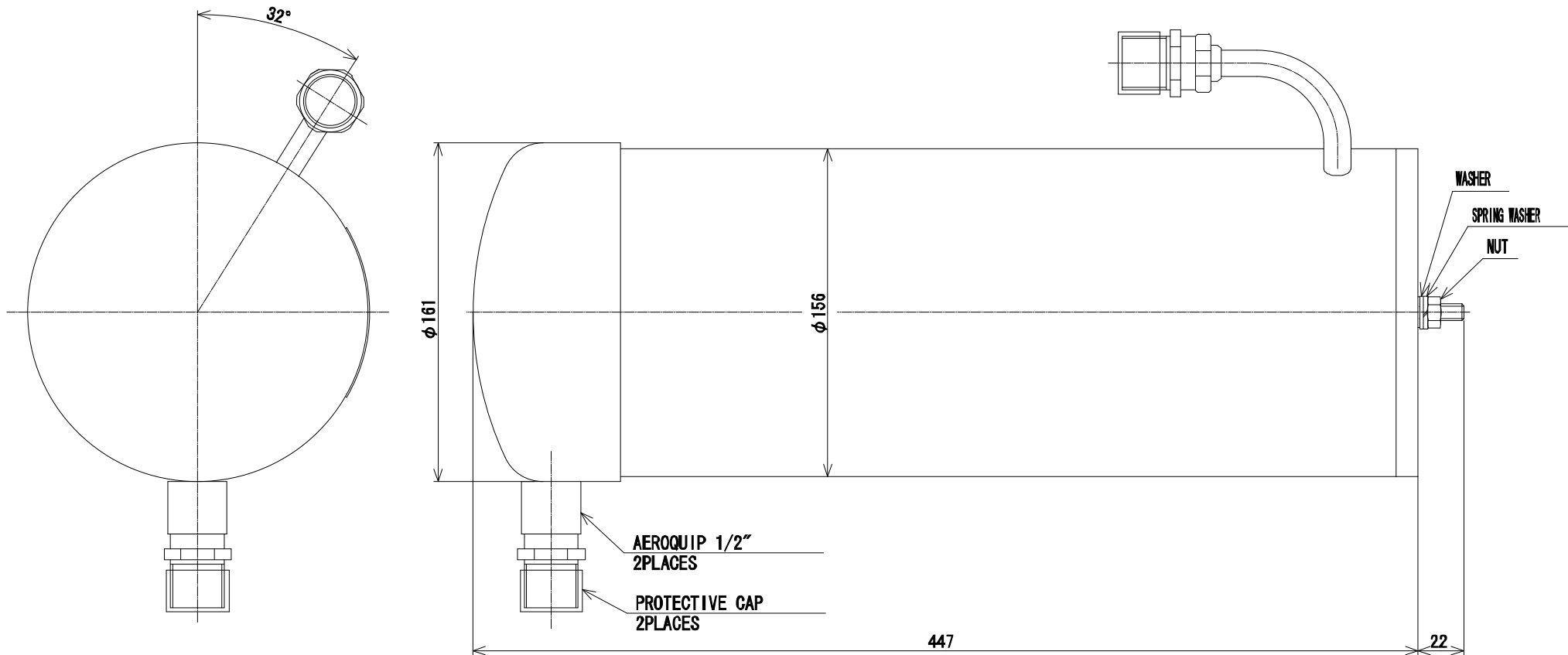


ELECTRICAL SCHEMATIC
1/2

CSW-71C



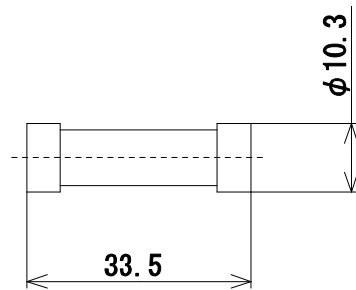
CSW-71C,D
ELECTRICAL SCHEMATIC 2/2



NOTE

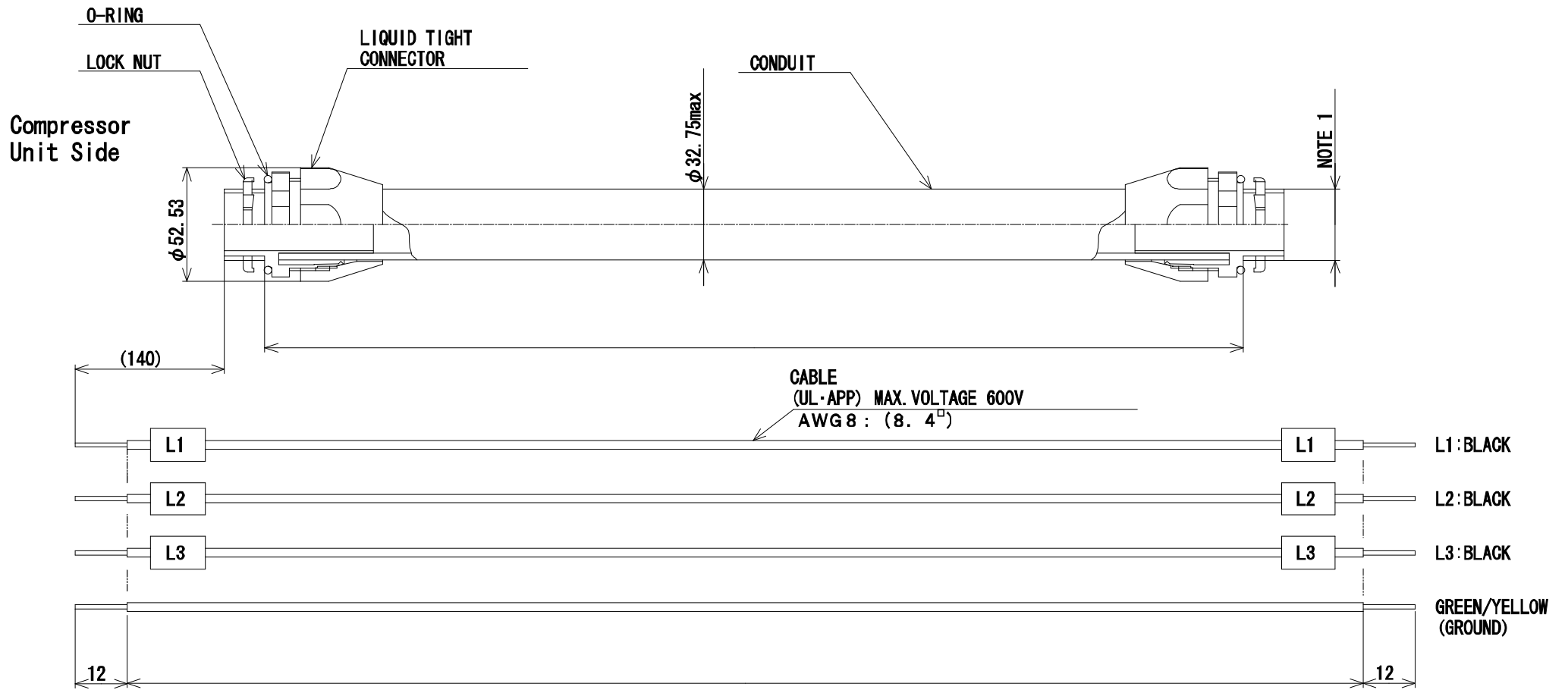
- (1) CHARGED HELIUM GAS 16.5 kg (at 6.2 MPa).
- (2) WEIGHT 11 kg.

ADSORBER



NOTE
1. CLASS G.
2. CURRENT RATING 5A.

CLASS G FUSE 5A



NOTE

(1) HOLE SIZE : MIN $\phi 34mm$.

(2) PART TO BE BAGGED OR BOXED AND SEALED FROM DIRT AND MOISTURE.

**INPUT POWER CABLE LV
CSW-71C**

REVISION CONTROL

Manual No.	Revision	Remarks	Date
CD32ZZ-068	-A	Publication of first edition.	DEC. 10 / 1999
	-B	Change the Electrical Schematic Diagram.	APR. 4 / 2000
	-C	Delete the description of "water temp. alarm signal".	JAN. 11 / 2001
	-D	Change the SHI address.	JAN. 25 / 2001
	-E	Delete the description of spare fuse.	JAN. 30 / 2001
	-F	Change the Electrical Schematic Diagram.	FEB. 19 / 2001
	-G	Change the specification of power requirement.	MAR. 21 / 2001
	-H	Add the specification of recommended power requirement and description of demineralized water.	APR. 1 / 2002
	-I	Change the dimension.	MAY 31 / 2002
	-J	Correct the descriptions of Input Power Cable Connection.	JUL 11 / 2002
	-K	Add the transformer-use CAUTION	FEB. 28 / 2003
	-L	Change the division name.	JUNE 9 / 2003
	-M	Add the description for the RDK-408D2 and S2 Cold Head.	DEC. 18 / 2003
	-N	The information of the SHI inquiries and typographical error was corrected. The description of the Cooling Water requirement was revised.	JAN. 12 / 2006
	-P	Electrical Schematic (2/2) was corrected. Add the specification for the D-Sub Connector lock screw tighten torque.	AUG 21 / 2008
-Q	The Humidity Range was added.	DEC. 1 / 2009	