



Sumitomo Heavy Industries, Ltd.

MANUAL NUMBER: CD32ZZ-063I

DATE: December 18 / 2003

OPERATION MANUAL

SRDK Series CRYOCOOLER

For Service Personnel Only

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 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

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



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Tokyo, 1 November 1999



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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/cm ² G]											[psig]									

1 [MPa] = 10.2 [kgf/cm²G]

1 [MPa] = 114.9 [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.

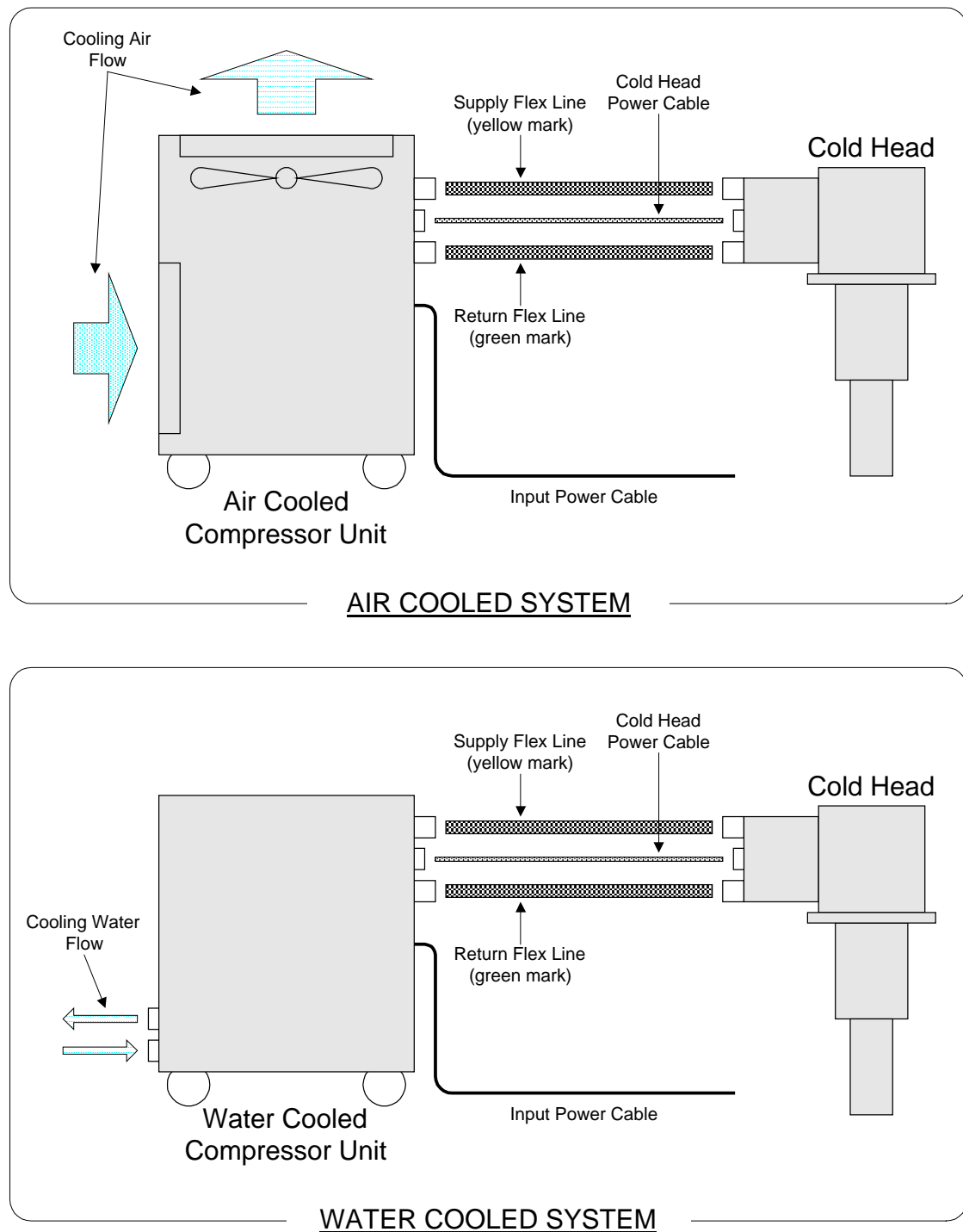


Figure 1.1 SRDK SERIES CRYOCOOLER SYSTEM

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.

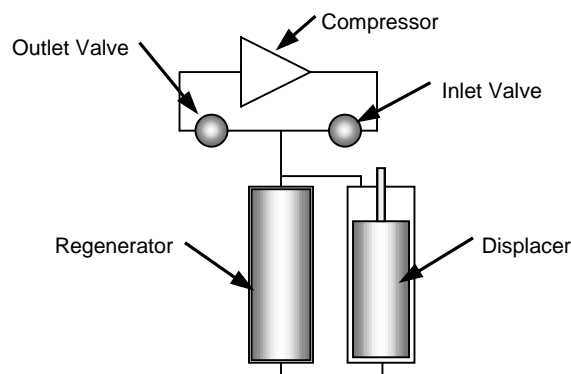


Figure 1.2 SCHEMATIC DIAGRAM OF GM CYCLE REFRIGERATOR

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.

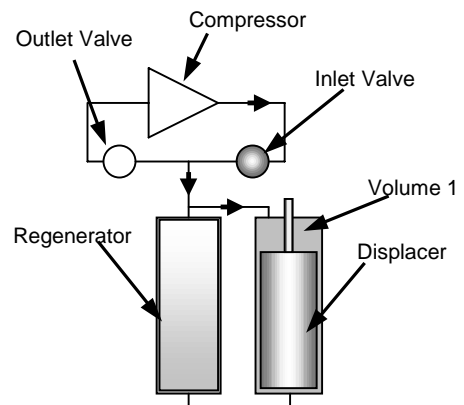
The displacer is fit loosely in the cylinder except at the top equipped with a dynamic (sliding) seal to prevent gas leakage through the space between displacer and cylinder.

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

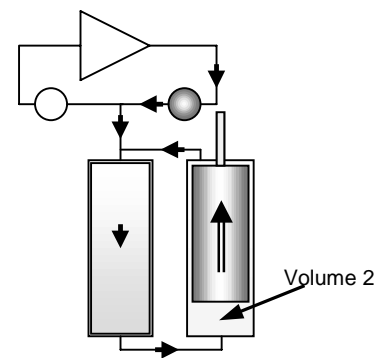
With the displacer at the bottom of the cylinder and the outlet valve closes and the inlet valve opens, increasing the pressure level in the system. Fluid will be led through the inlet valve to fill the regenerator and the space above the displacer, volume 1.



PRESSURE BUILD-UP

INTAKE STROKE

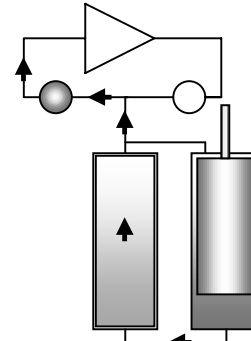
With the inlet valve open, the displacer is moved from the bottom to the top of the cylinder. This displaces high pressure fluid from the space above the displacer, volume 1, through the regenerator, to the space below the displacer, volume 2. In passing through the regenerator, the gas cools causing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



INTAKE STROKE

PRESSURE RELEASE AND EXPANSION

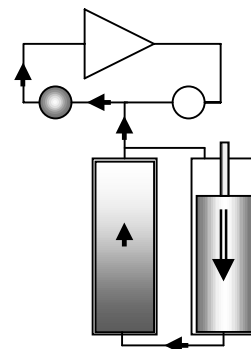
With the displacer at the top of the cylinder, the inlet valve closes and outlet valve opens. Fluid escapes and the pressure will decrease. The drop in pressure causes a reduction in the gas temperature level. The temperature decrease of gas in the bottom cylinder space, volume 2, is the useful refrigeration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

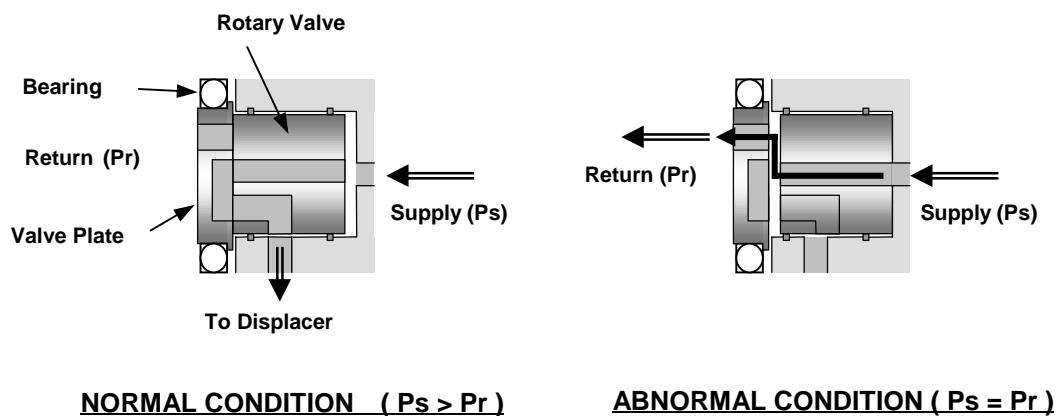
When connecting the flex lines, tighten the self-seal coupling nut by hand at the first turn and finally tighten it firmly using 3 wrenches. However, be careful not to tighten it excessively. The maximum allowable tightening torque is 45 N·m.

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.

**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

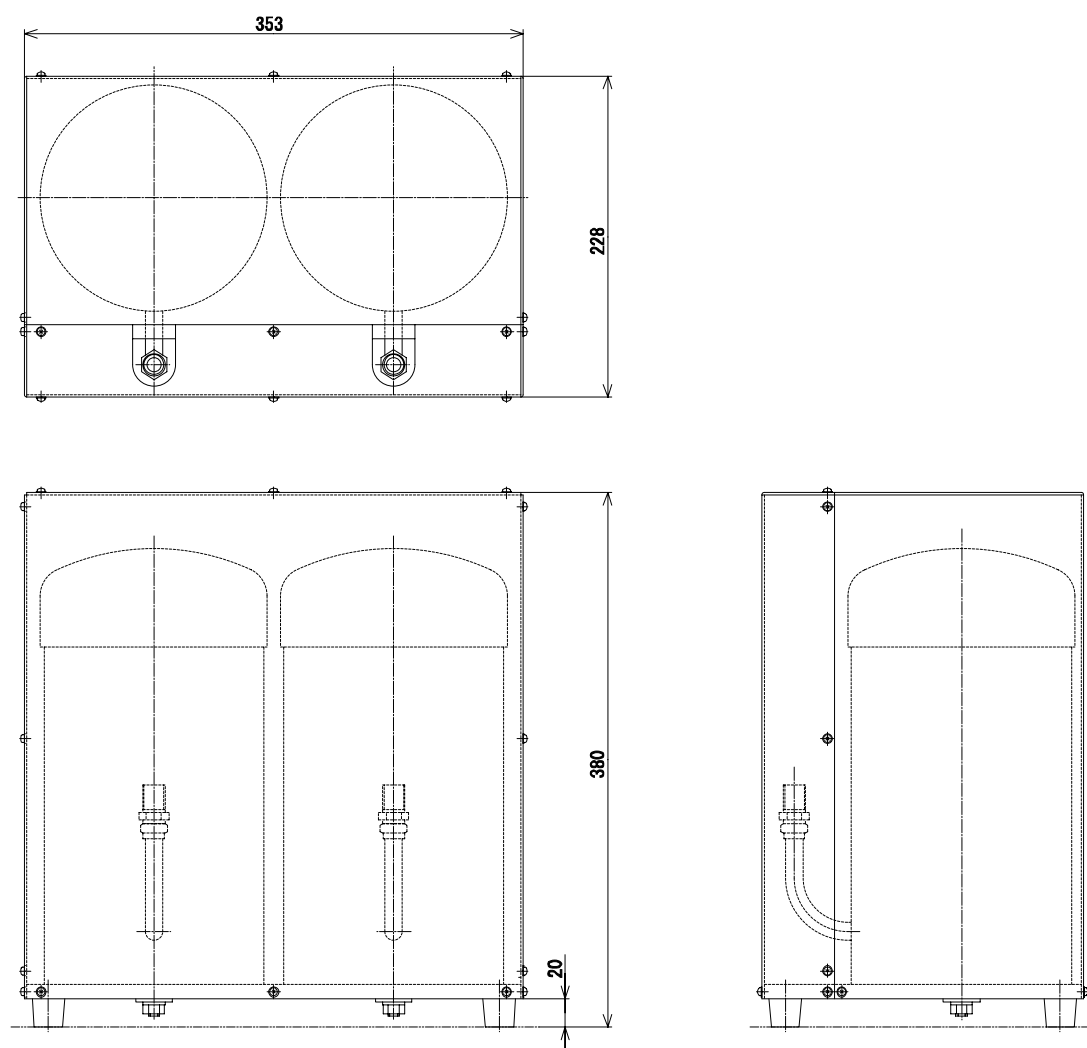


Figure 2.1 OUTLINE VIEW OF THE “BUFFER TANK”

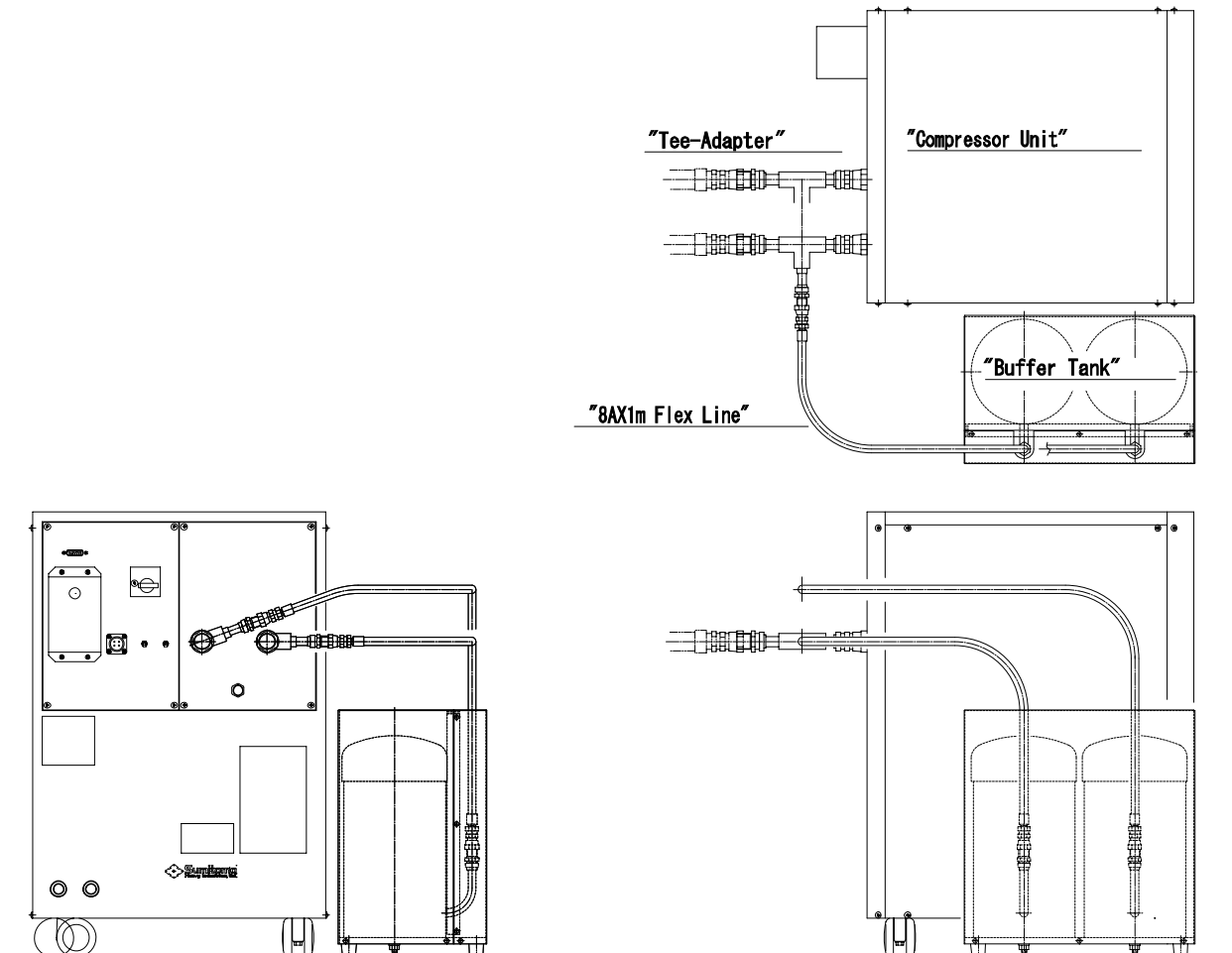
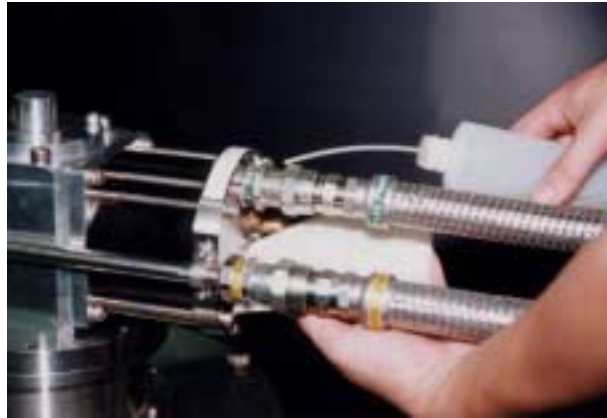


Figure 2.2 “BUFFER TANK” INTERCONNECTING DIAGRAM

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.

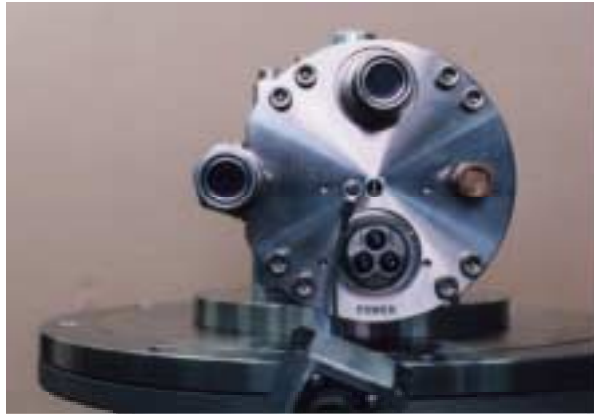


- 4) Tighten the Cable Clamp of the Terminal Cover.

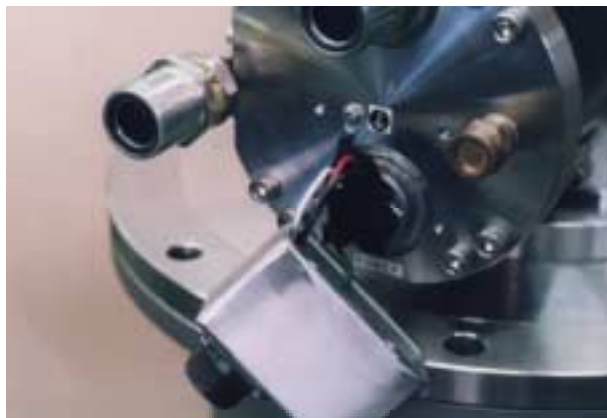


3. CONVERTING THE COLD HEAD CONNECTION

- 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.

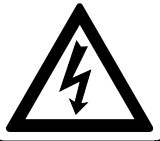
"IMPORTANT"

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 $\pm 10\%$ 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>**

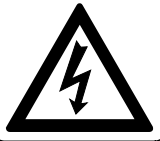
This cryocooler (cold head, compressor unit, compressor adsorber, flex lines) contains a high-pressure (about 1.62 MPa (16.5 kgf/cm²G, 235 psig)) helium gas sealed in. Hitting the equipment with a sharp edge or touching it with a pointed object may cause explosion or escape of gas. Handle the equipment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

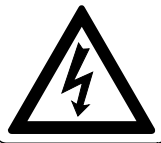


- 2) Open the valve of pressure regulator slightly and slowly. Purge a Helium Gas for about 30 seconds to vent the contamination in the charging line. Reduce the helium gas flow by controlling the valve of pressure regulator and keep the slight helium gas flow.
- 3) Purge the air in the gas charging 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

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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.

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

Sumitomo (SHI) Cryogenics of America, Inc.

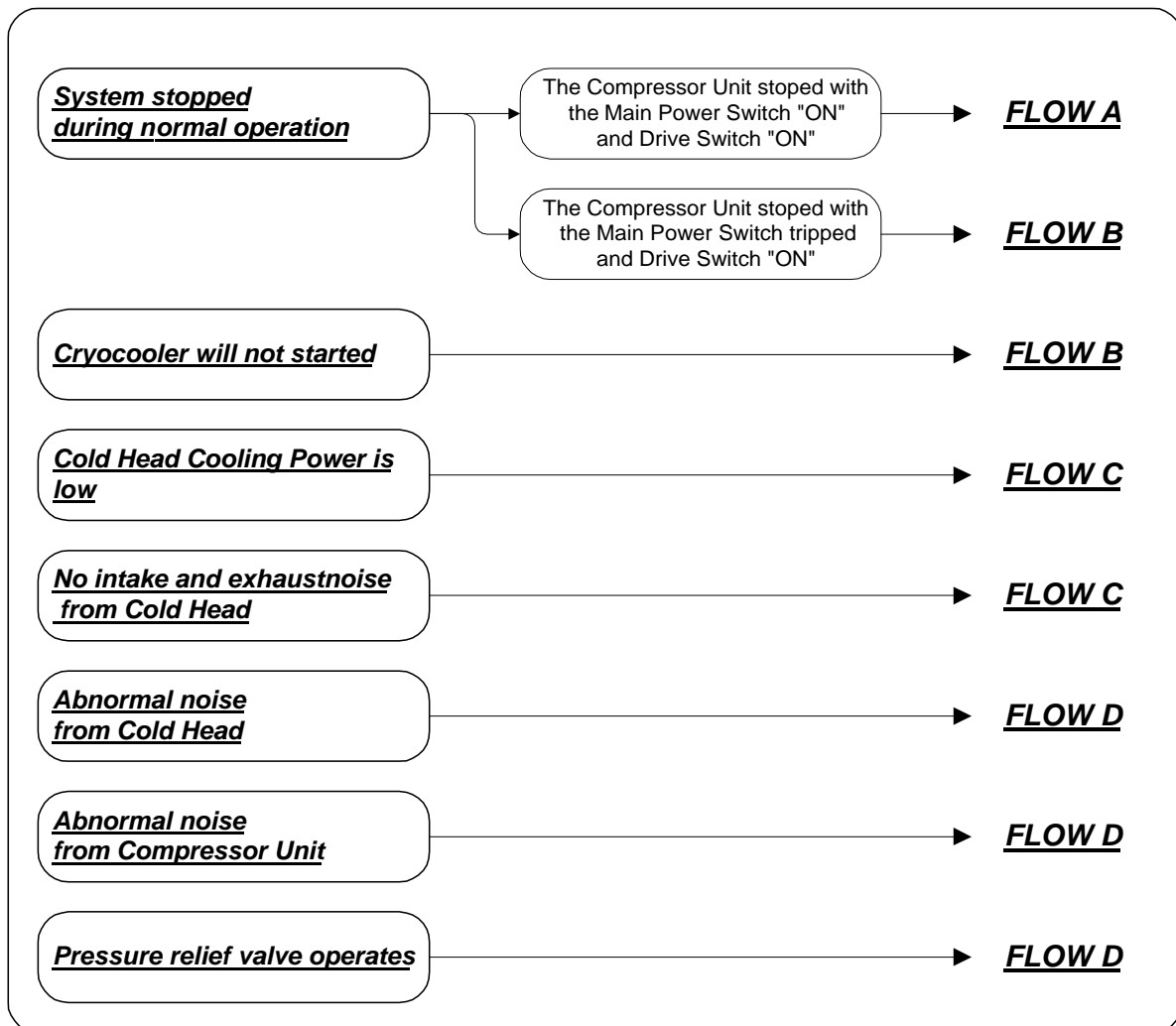
Address; 870 Cambridge Dr., Elk Grove Village, IL 60007, USA
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SHI-APD Cryogenics (Europe), Ltd.

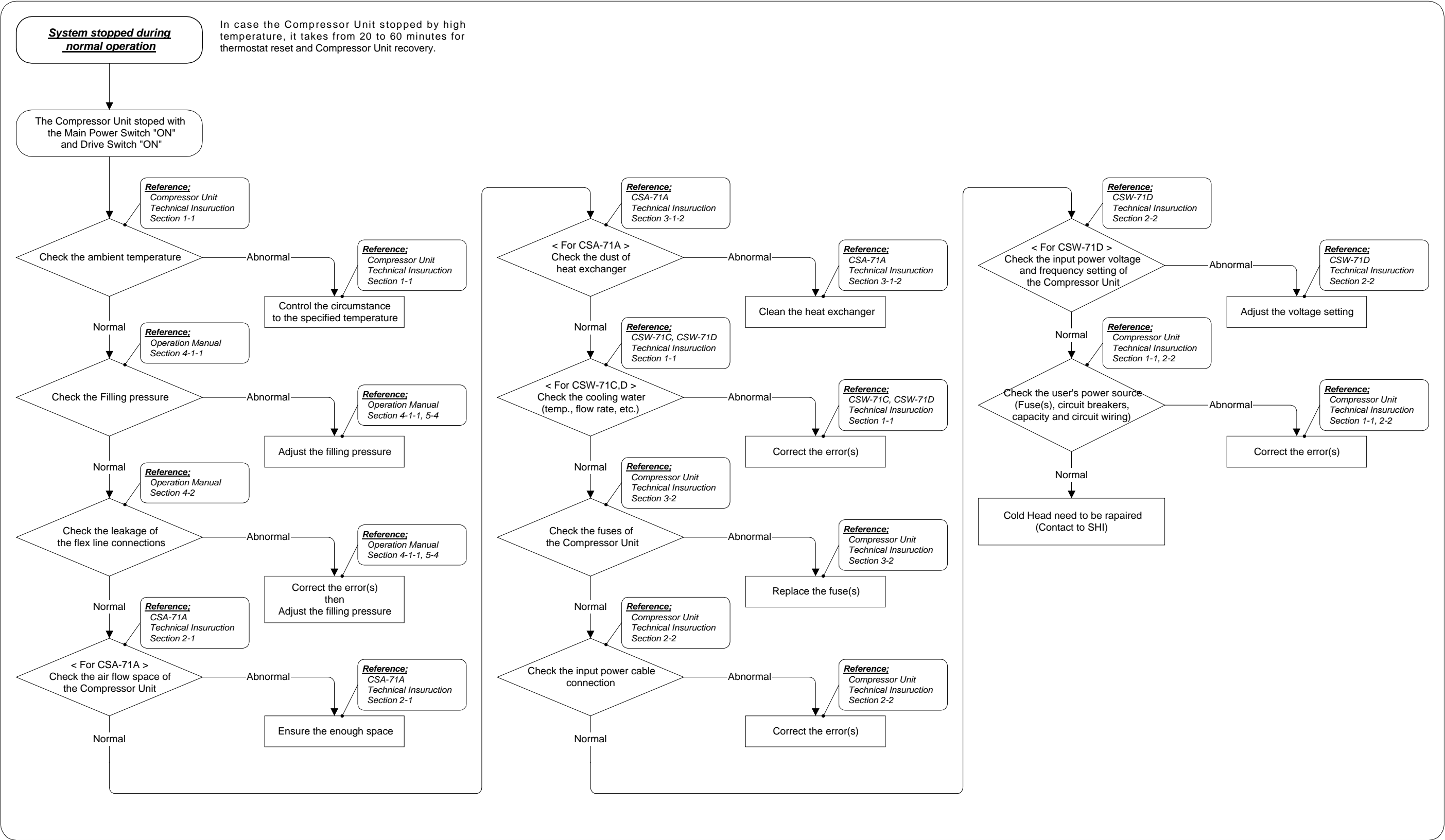
Address; 2 Eros House, Calleva Industrial Park Aldermaston, Berkshire RG7 8LN, UK
TEL No. +44-118 981 9373
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SHI Cryogenics Europe GmbH

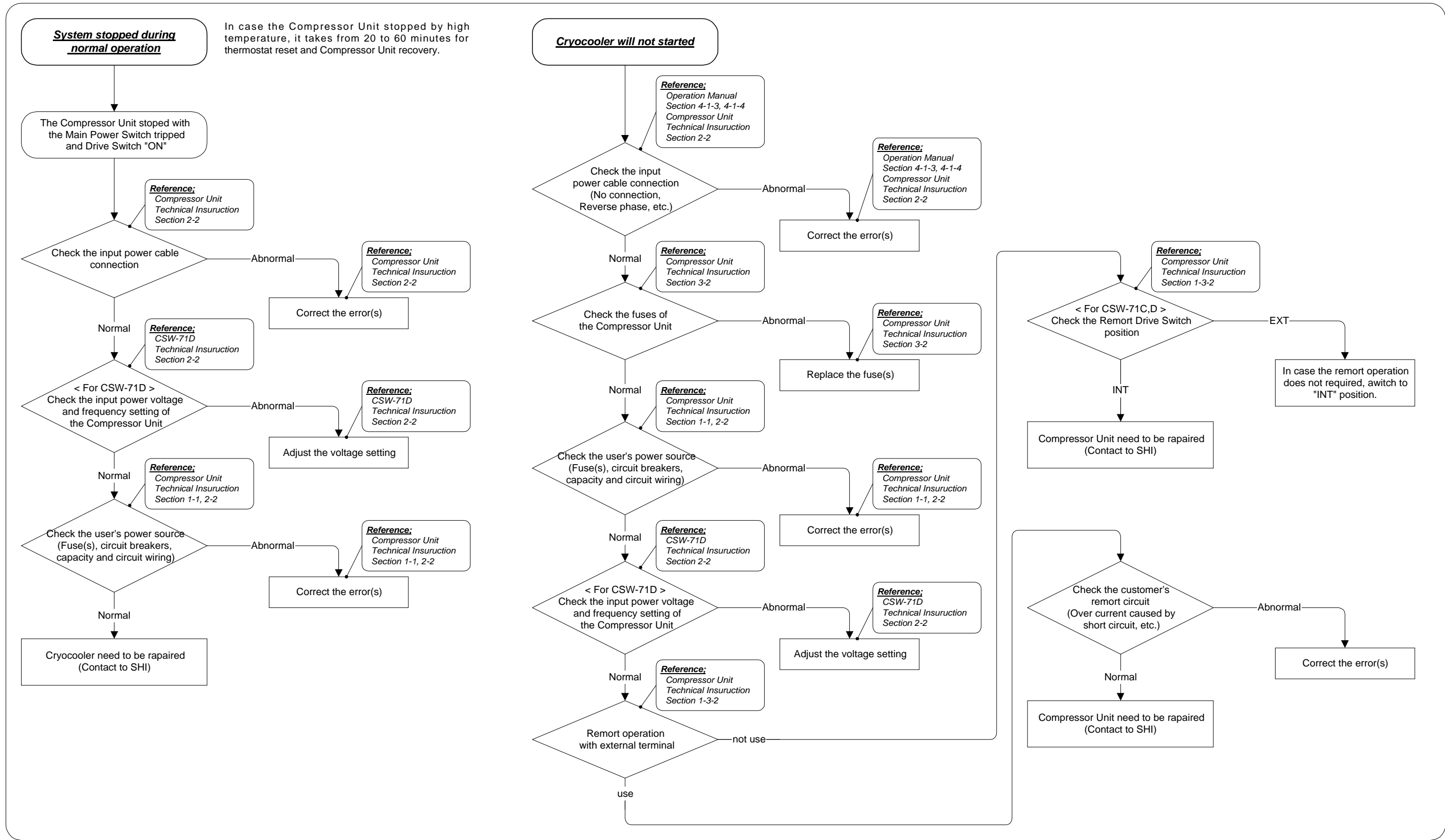
Address; Dolivostrasse 9, D-64293 Darmstadt, Germany
TEL +49-(0) 6151-86061-0
FAX +49-(0) 6151-800252
E-mail Yst_Taguchi@shi.co.jp
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Case of Trouble

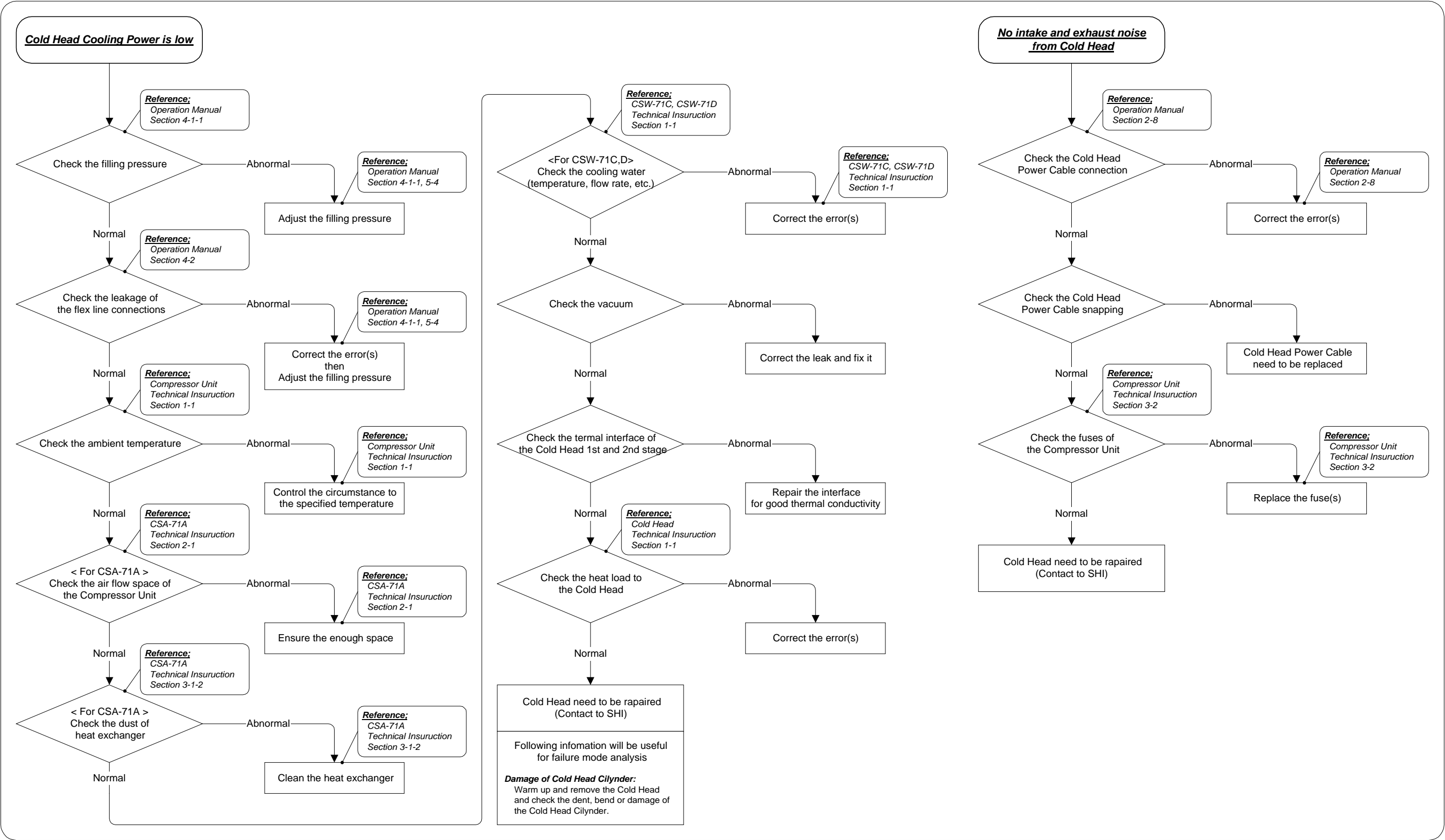
FLOW A



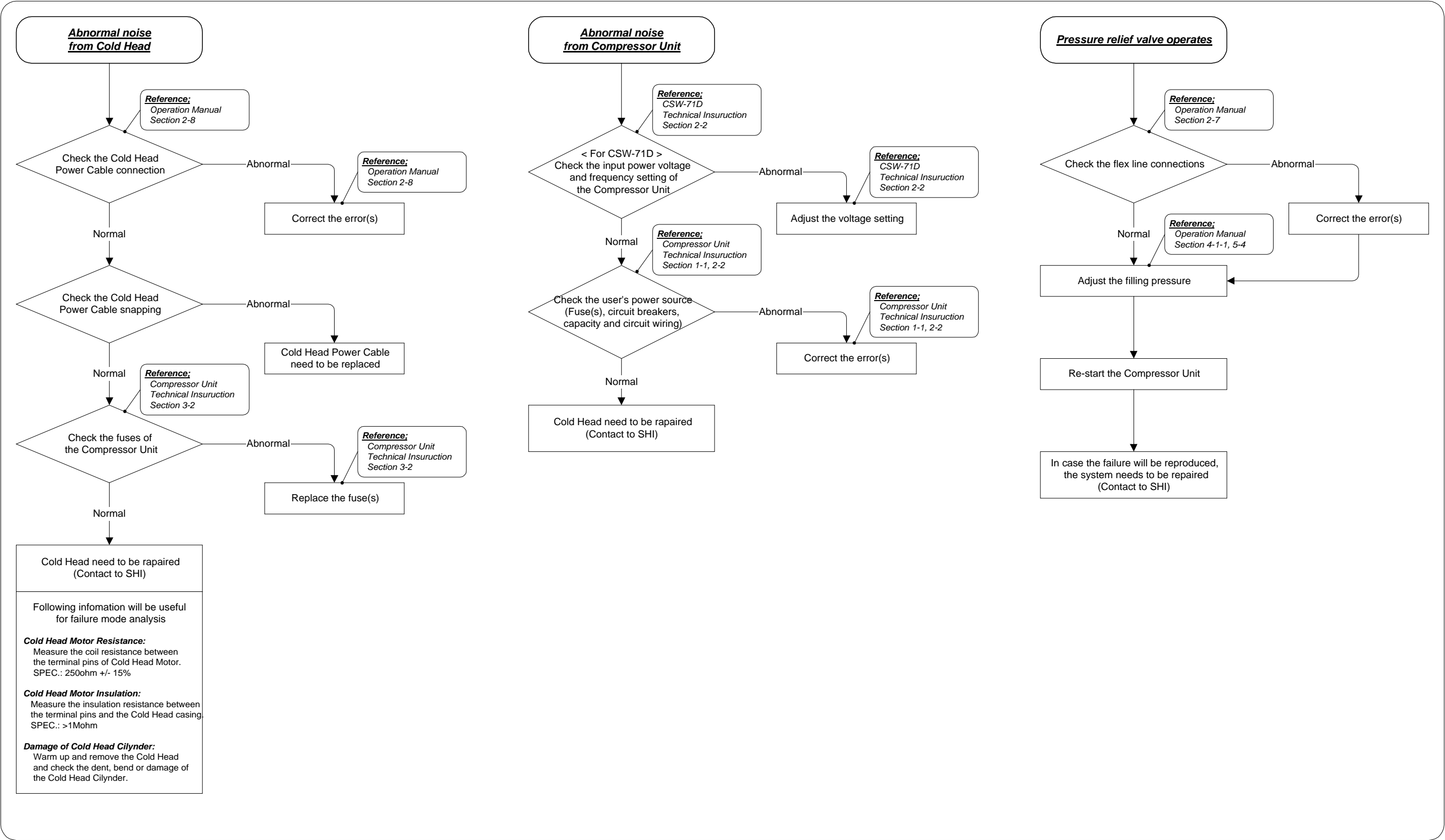
FLOW B



FLOW C



FLOW D



REVISION CONTROL**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