Sumitomo Heavy Industries, Ltd.

MANUAL NUMBER: CD32ZZ-055D
DATE: March 17 / 2003

SRDK Cryocooler
S E R V I C E M A N U A L

Revision 1

GE PART NUMBER: 2262271

For Service Personnel Only

CONTENTS;

PART NUMBERS

MODEL	SHI PART No.	GE PART No.
RDK-408A2 COLD HEAD	RD42ZN1079	2218465-3
RDK-408 COLD HEAD	RD42ZN0617	2218465
RDK-408T COLD HEAD	RD42ZN0561	2200832
RDK-400 COLD HEAD	RD45ZN0722	2244334
CSA-71A COMPRESSOR UNIT	RE71ZH0136	2166592
CSW-71C COMPRESSOR UNIT	RE38ZH0156	2188184-2
CSW-71D COMPRESSOR UNIT	RE38ZH0157	2188440-2
BPU-01 BY PASS UNIT	RE38ZN0654	2266223

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CE

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-408, RDK-408T, RDK-400
- 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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REVISION CONTROL

Manual No.	GE Revision	SHI Revision	Remarks	Date
CD32ZZ-055	Revision 0	-A	Publication of first edition.	DEC. 20 / 1999
	Revision 0	-B	Add the description of BPU-01.	MAR. 30 / 2000
	Revision 0	-C	Change the SHI address.	JAN. 25 / 2001
	Revision 0	-D	Add the RDK-408A2 Cold Head.	MAR. 17 / 2003

Sumitomo Heavy Industries, Ltd.

MANUAL NUMBER: CD32ZZ-056G
DATE: March 17 / 2003

OPERATION MANUAL

SRDK Series CRYOCOOLER

Revision 2

For Service Personnel Only

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TABLE LIST

FIGURE LIST

CROSS REFERENCE

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

MANUAL NAME	MANUAL No.
TECHNICAL INSTRUCTION RDK-408A2 4K COLD HEAD*	CD32ZZ-098
TECHNICAL INSTRUCTION RDK-408 4K COLD HEAD*	CD32ZZ-057
TECHNICAL INSTRUCTION RDK-408T 10K COLD HEAD*	CD32ZZ-058
TECHNICAL INSTRUCTION RDK-400 SINGLE STAGE COLD HEAD*	CD32ZZ-059
TECHNICAL INSTRUCTION CSA-71A COMPRESSOR UNIT**	CD32ZZ-060
TECHNICAL INSTRUCTION CSW-71C COMPRESSOR UNIT**	CD32ZZ-061
TECHNICAL INSTRUCTION CSW-71D COMPRESSOR UNIT**	CD32ZZ-062
INSTALLATION MANUAL BPU-01 BY PASS UNIT***	CD32ZZ-075

* See the TECHNICAL INSTRUCTION of Cold Head used.
** See the TECHNICAL INSTRUCTION of Compressor Unit used.
*** See the INSTALLATION MANUAL of BPU-01, if BPU-01 is used in this system.

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 service 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

<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 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 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 and then remove the input power cable from the main power before connecting or disconnecting the input power cable to the Compressor Unit. 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

<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/cm^{2}G, 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.

WARNING

<Warning about rotating part>

If the compressor unit used is 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

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. Be careful of handling so that it may not get hurt when replace the adsorber.

"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 to 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 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 CSA-71A technical instruction, for details.)

If the compressor unit used is 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.

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.

This cryocooler (cold head, compressor unit, compressor adsorber, flex lines) is shipped with a helium gas at about 1.62 MPa (16.5 kgf/cm^{2}G, 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/cm^{2}G, 232 -239 psig) minimum at 20 deg.C (68 deg.F). If the gauge indicates less than 1.60 MPa (16.3 kgf/cm^{2}G, 232 psig), refill Helium gas as described in ***"TECHNICAL INSTRUCTION"*** of Compressor Unit used. If the gauge indicates 0 MPa (0 kgf/cm^{2}G, 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 30 cm (12 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 Cryocooler model SRDK-408, 408T and 400 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

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]**									

$1[\mathrm{MPa}] = 10.2[\mathrm{kgf/cm^2G}]$

$1[\mathrm{MPa}] = 144.9[\mathrm{psig}]$

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	GE PART NUMBER
COLD HEAD		
4K COLD HEAD	RDK-408A2	2218465-3
	RDK-408	2218465
10K COLD HEAD	RDK-408T	2200832
SINGLE STAGE COLD HEAD	RDK-400	2244334
COMPRESSOR UNIT		
AIR COOLED (Low Voltage)	CSA-71A	2166592
WATER COOLED (Low Voltage)	CSW-71C	2188184-2
WATER COOLED (High Voltage)	CSW-71D	2188440-2
FLEX LINE		
SUPPLY (Female - Female)	20 A x 6 m (19.7 feet)	2154502
	20 A x 20 m (65.6 feet)	2154502-2
RETURN (Female - Female)	20 A x 6 m (19.7 feet)	2154505
	20 A x 20 m (65.6 feet)	2154505-2
COLD HEAD POWER CABLE		
COLD HEAD TO PEN. PANEL (For Conversion Connector)	15 m (49.2 feet)	2218292
COLD HEAD TO PEN. PANEL	6 m (19.7 feet)	2172239
	15 m (49.2 feet)	2172239-2
COMPRESSOR TO PEN. PANEL	6 m (19.7 feet)	2155316
	15 m (49.2 feet)	2155316-2

1-2 SRDK SERIES CRYOCOOLER

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

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-408A2 and RDK-408 4K Cold Head is applied rare earth material for the second stage displacer to produce 4K temperature. The second stage cooling capacity of RDK-408A2 and RDK-408 Cold Head is approximately 1.0W at 4.2K.

RDK-408T 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-408T Cold Head is approximately 5W at 10K.

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

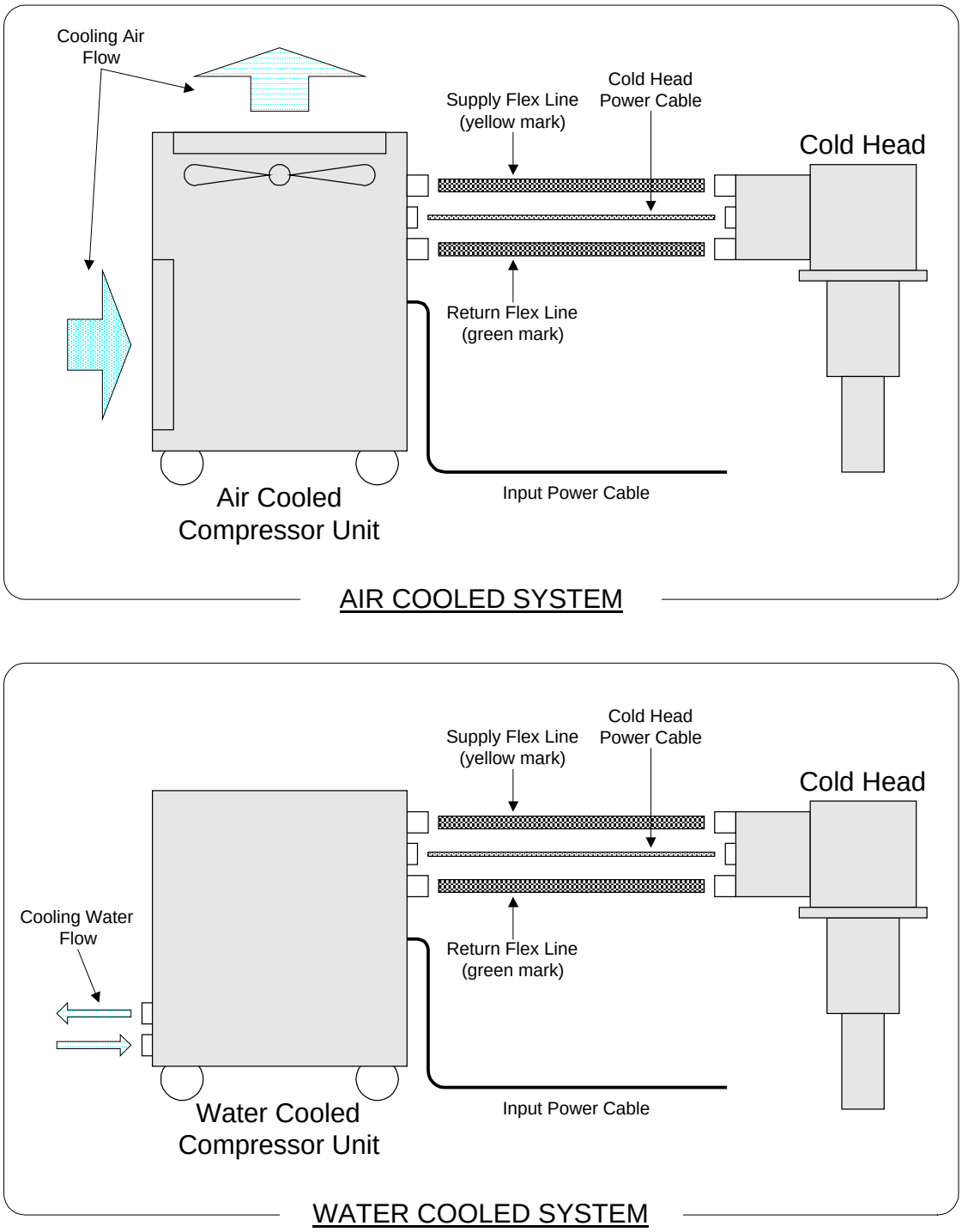


Figure 1.1 SRDK SERIES CRYOCOOLER SYSTEM

1-3 THEORY OF OPERATION

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

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.

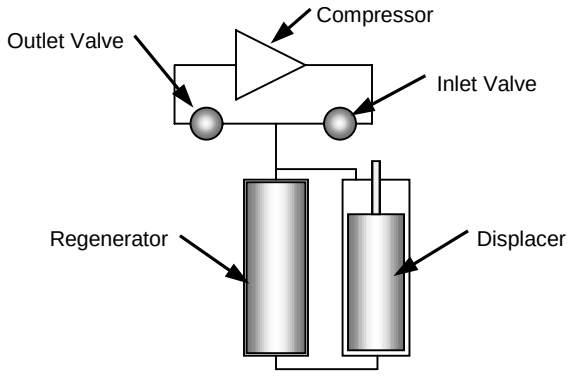


Figure 1.2 SCHEMATIC DIAGRAM OF GM CYCLE REFRIGERATOR

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.

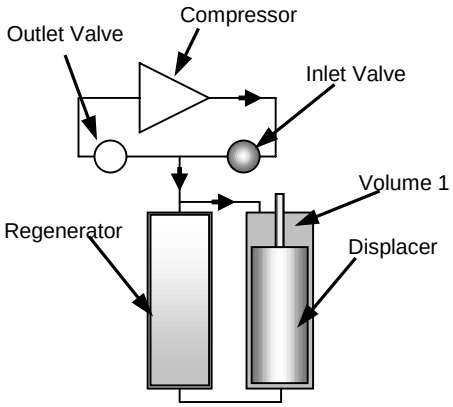
The displacer is fit loosely in the cylinder except at the top equipped with a dynamic (sliding) seal to prevent gas leakage through the space between displacer and cylinder.

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

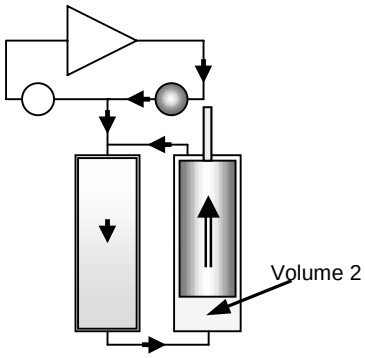
With the displacer at the bottom of the cylinder and the outlet valve closes and the inlet valve opens, increasing the pressure level in the system. Fluid will be led through the inlet valve to fill the regenerator and the space above the displacer, volume 1.



PRESSURE BUILD-UP

INTAKE STROKE

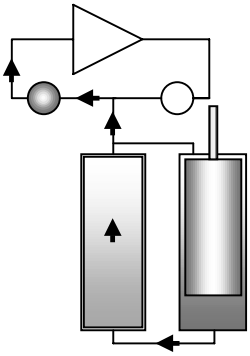
With the inlet valve open, the displacer is moved from the bottom to the top of the cylinder. This displaces high pressure fluid from the space above the displacer, volume 1, through the regenerator, to the space below the displacer, volume 2. In passing through the regenerator, the gas cools causing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



INTAKE STROKE

PRESSURE RELEASE AND EXPANSION

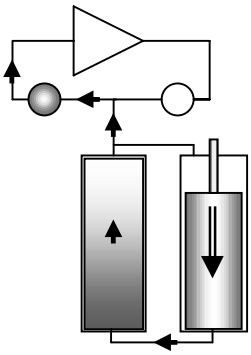
With the displacer at the top of the cylinder, the inlet valve closes and outlet valve opens. Fluid escapes and the pressure will decrease. The drop in pressure causes a reduction in the gas temperature level. The temperature decrease of gas in the bottom cylinder space, volume 2, is the useful refrigeration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

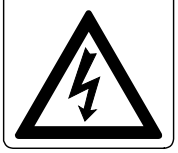


EXHAUST STROKE

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 Transition Flange
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 M6	For Cold Head Installation to Magnet

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/cm^{2}G, 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.

RDK-408A2 and RDK-408 4K Cold Head is attaching sensor lead wire. Care must be taken not to damage the wiring, or it will be impossible to monitor the temperature.

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 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 CSA-71A technical instruction, for details.)

If the compressor unit used is 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/cm^{2}G, 43 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/cm^{2}G, 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>

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:

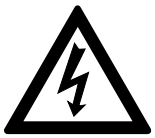
(1) Overall exterior.
(2) Bent or dent of cylinder.
(3) Supply and Return Aeroquip fittings.
(4) Cold Head power connector.
(5) Mounting flange and its sealing surface.
(6) Sealing surface or O-ring groove of User's vacuum chamber.

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/cm^{2}G, 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 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 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 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-408A2 --------- **1.60 - 1.65 MPa** at 20 deg.C (68 deg.F)
RDK-408 (16.3 - 16.8 kgf/cm^{2}G, 232 - 239 psig)

RDK-408T --------- **1.45 - 1.50 MPa** at 20 deg.C (68 deg.F)
RDK-400 (14.8 - 15.3 kgf/cm^{2}G, 210 - 217 psig)

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/cm^{2}G, 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/cm^{2}G, 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"

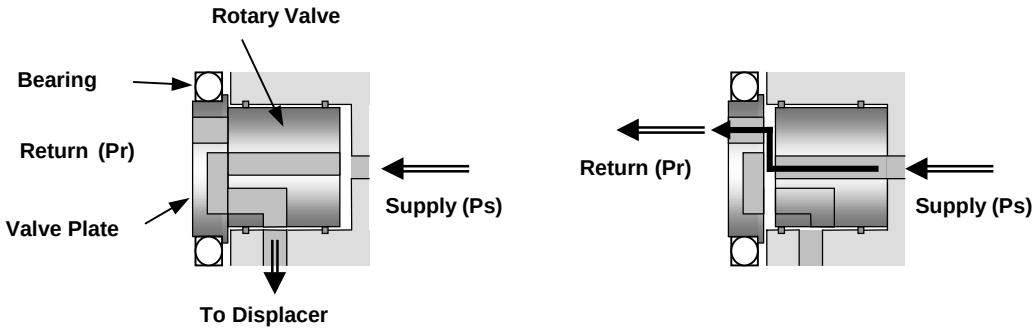
Tighten the self-seal coupling nut by hand at the first turn and finally tighten it firmly using 3 wrenches when connecting the flex lines. However, be careful not to tighten it excessively. The maximum allowable tightening torque is 45 N•m.

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 (Ps > Pr) **ABNORMAL CONDITION (Ps = Pr)**

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;

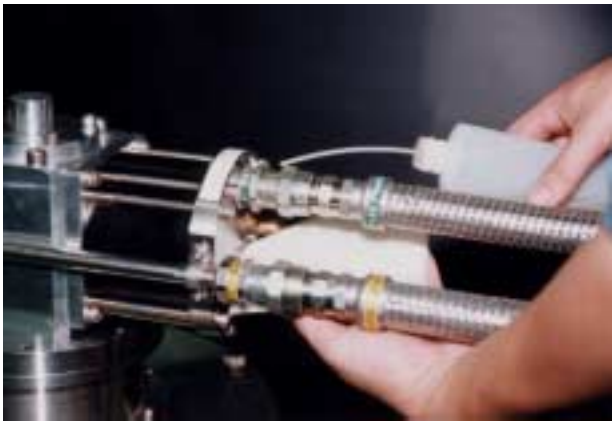
1. First, connect the ***Return*** Flex Line.

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

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.

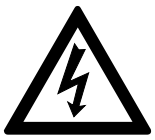


2) Keep watching carefully the sprinkled area and no gas leaking will be confirmed without any bubbling.

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 before 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.

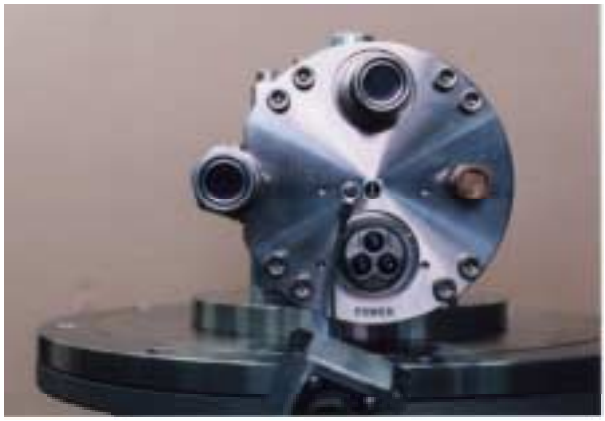
2) Connect the ground terminal of the Cold Head Cable (green color wire with ring terminal) to rear cover of Cold Head Drive Motor.

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.

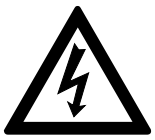
3) Mount the Terminal Cover on the Cold Head Motor with securing four(4) screws.

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 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 and then remove the input power cable from the main power before connecting or disconnecting the input power cable to the Compressor Unit. 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"

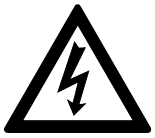
This cryocooler is provided with a phase reverse protection circuit for the input power. If the input power is connected with reverse phase, the cryocooler does not start.

"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 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/cm^{2}G, 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/cm^{2}G, 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-408A2 4K Cold Head RDK-408 4K Cold Head	1.60 - 1.65 MPa at 20 deg.C (68 deg.F) (16.3 - 16.8 kgf/cm^{2}G, 232 - 239 psig)
RDK-408T 10K Cold Head RDK-400 Single Stage Cold Head	1.45 - 1.50 MPa at 20 deg.C (68 deg.F) (14.8 - 15.3 kgf/cm^{2}G, 210 - 217 psig)

For RDK-408A2 & RDK-408

For RDK-408T & RDK-400

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 to 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 ***"Main Power Switch"***.

For Air Cooled Compressor Unit

For Water Cooled Compressor Unit

4) Turn on ***"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 to 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 ***"Drive Switch"***.

For Air Cooled Compressor Unit

For Water Cooled Compressor Unit

2) Turn off ***"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 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 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/cm^{2}G, 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/cm^{2}G, 304 and 349 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-408A2 4K Cold Head RDK-408 4K Cold Head	1.60 - 1.65 MPa at 20 deg.C (68 deg.F) (16.3 - 16.8 kgf/cm^{2}G, 232 - 239 psig)
RDK-408T 10K Cold Head RDK-400 Single Stage Cold Head	1.45 - 1.50 MPa at 20 deg.C (68 deg.F) (14.8 - 15.3 kgf/cm^{2}G, 210 - 217 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 ***"Drive Switch - ON"*** under ***"Main Power Switch - ON"***.

4-1-4 DIAGNOSIS OF PHASE FAILURE FOR INPUT POWER

WARNING

<Warning about 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.

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

"IMPOTANT"

See "TECHNICAL INSTRUCTION" of Compressor Unit used, to see the Pin order of External Connector.

- DC 24 V Power output of the External Connector (Pin No.7 - No.13) can be verified immediately in ***"Drive Switch - OFF"*** under ***"Main Power Switch - ON"*** condition.

- The phase failure for input power caused by miss-wiring can be suspected in the operation condition, if the DC power output can be measured as a specific DC 24 V for Drive Signal of the compressor unit on the External Connector (Pin No.7-No.13) terminal.

- ***"Drive Switch"*** can be pressed ***"OFF"*** and also ***"Main Power Switch"*** can be securely turned ***"OFF"*** to shut off the main power for the compressor unit, and the two(2) wires as any choice of the Main Power cable will be changed to connect with the each terminal for input power.

- The procedure for the Compressor Unit will be tried again to start up as ***"Main Power Switch - ON"*** and ***"Drive Switch - ON"*** sequentially, after the changing wires of the Main Power cable to a correct connecting of the Input Power Cable. The compressor unit can be operated smoothly in consequence of the start-up sequence, if the Phase Failure being recovered.

Any other cause of failure will be suspected for normal operation, if the compressor unit cannot be operated after treatment of recovering the phase failure on the Input Power.

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/cm^{2}G, 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.

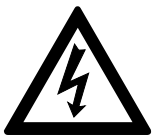
The Cold Head cannot be performed a required cooling power in normal operations, as the result of the He-gas pressure reducing gradually in the Cold Head in condition of occurring a He-gas Leak in the Cryocooler. The Compressor unit will be shut down as the function of the Low Pressure Switch to be sensed 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-408A2 4K Cold Head RDK-408 4K Cold Head	1.60 - 1.65 MPa at 20 deg.C (68 deg.F) (16.3 - 16.8 kgf/cm^{2}G, 232 - 239 psig)
RDK-408T 10K Cold Head RDK-400 Single Stage Cold Head	1.45 - 1.50 MPa at 20 deg.C (68 deg.F) (14.8 - 15.3 kgf/cm^{2}G, 210 - 217 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 and then remove the input power cable from the main power before connecting or disconnecting the input power cable to the Compressor Unit. 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/cm^{2}G, 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.

WARNING

<Warning about rotating part>

If the compressor unit used is 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. Be careful of handling so that it may not get hurt when replace the adsorber.

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 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 CSA-71A technical instruction, for details.)

If the compressor unit used is 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

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/cm^{2}G, 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 charging 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/cm^{2}G, 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.

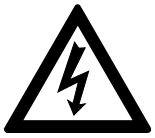
COLD HEAD MODEL	STATIC PRESSURE
RDK-408A2 4K Cold Head RDK-408 4K Cold Head	1.60 - 1.65 MPa at 20 deg.C (68 deg.F) (16.3 - 16.8 kgf/cm^{2}G, 232 - 239 psig)
RDK-408T 10K Cold Head RDK-400 Single Stage Cold Head	1.45 - 1.50 MPa at 20 deg.C (68 deg.F) (14.8 - 15.3 kgf/cm^{2}G, 210 - 217 psig)

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 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 and then remove the input power cable from the main power before connecting or disconnecting the input power cable to the Compressor Unit. 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/cm^{2}G, 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.

WARNING

<Warning about rotating part>

If the compressor unit used is 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. Be careful of handling so that it may not get hurt when replace the adsorber.

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 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 CSA-71A technical instruction, for details.)

If the compressor unit used is 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.

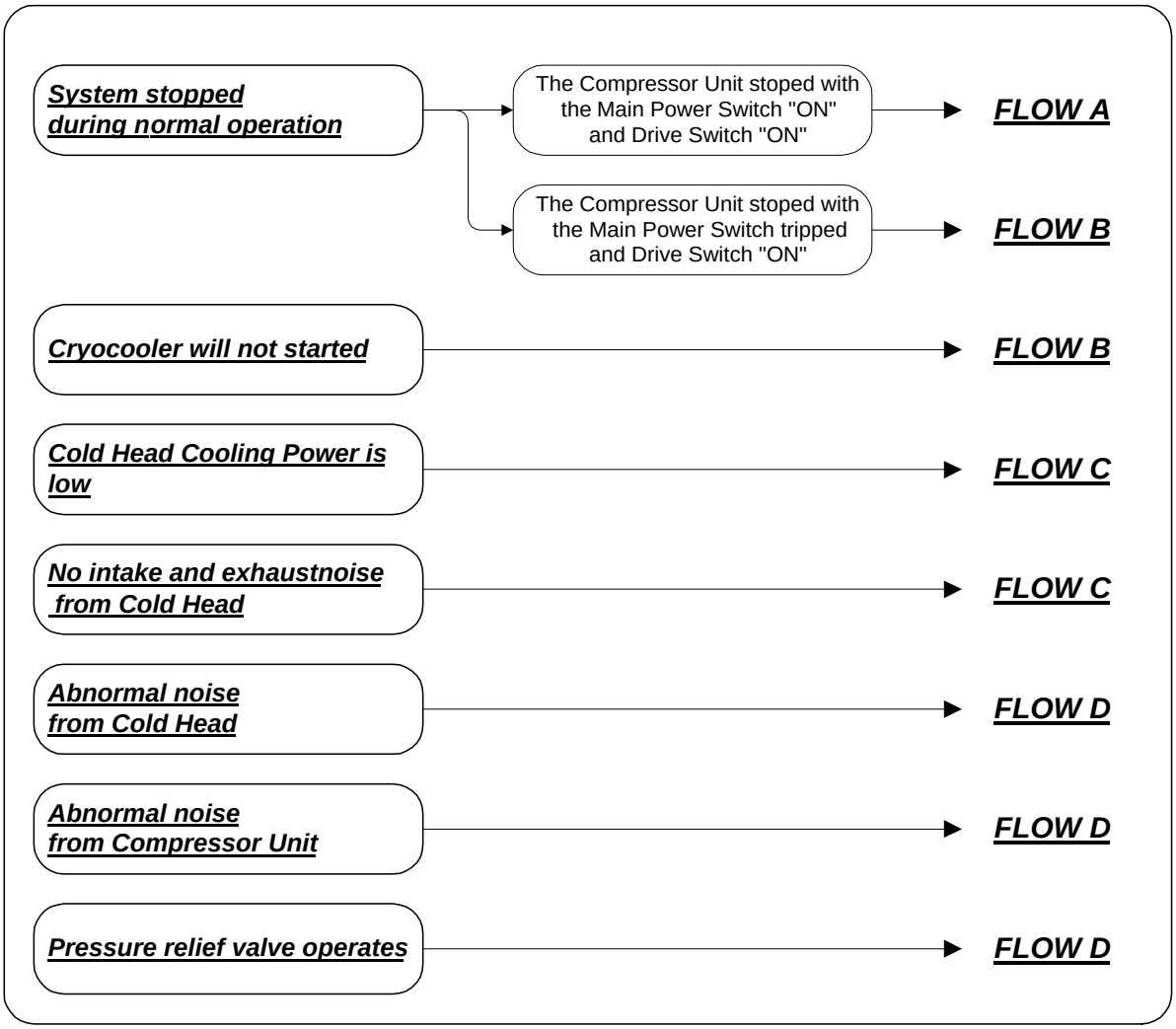
"IMPORTANT"

See "INSTALLATION MANUAL" of BPU-01 By Pass Unit, if BPU-01 is used in this system.

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.

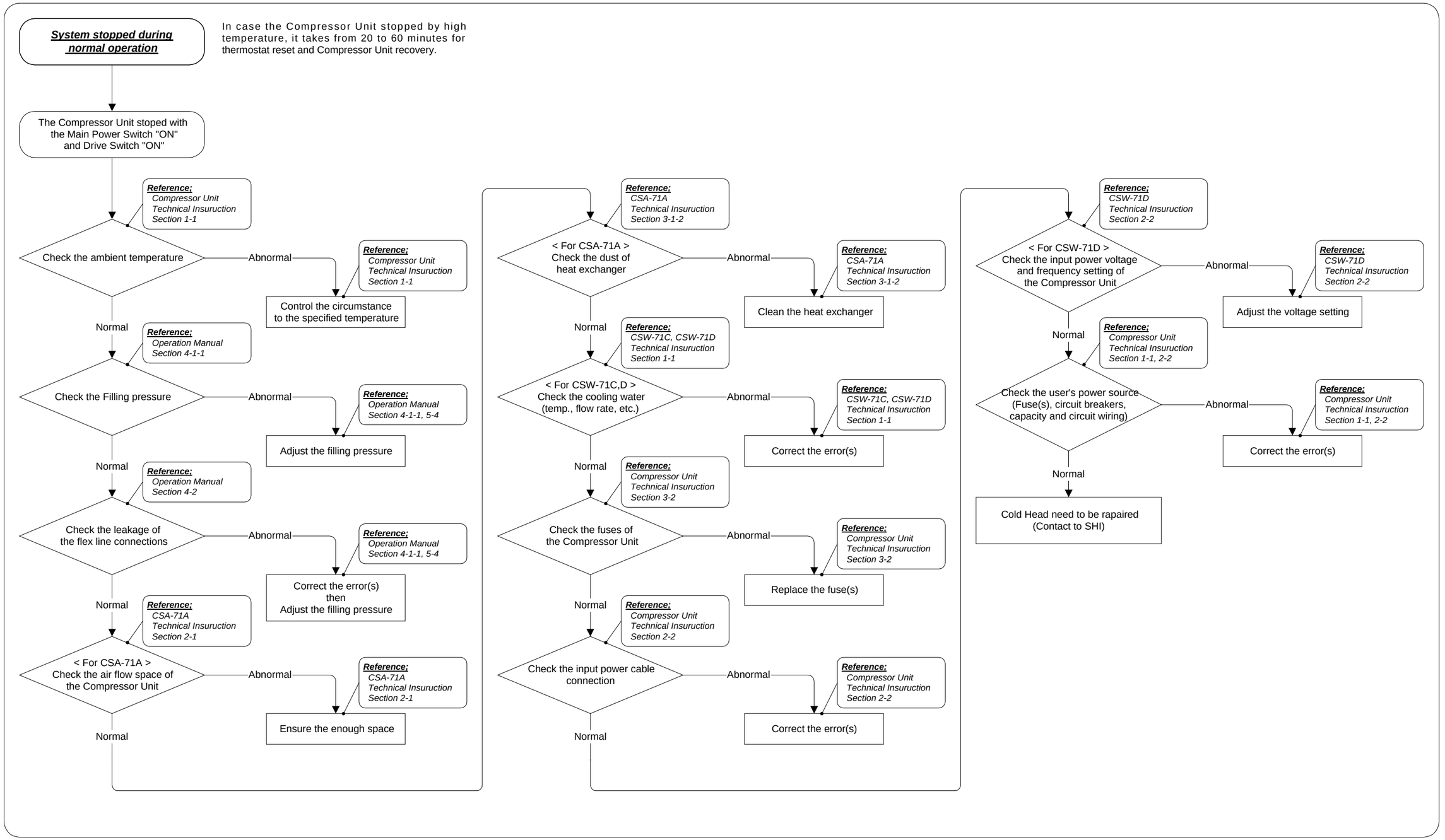
Sumitomo Heavy Industries, Ltd.
Cryogenics Department
Address; 2-1-1 Yato-cho, Nishitokyo-City,
Tokyo 188-8585, Japan
TEL No. +81-424-68-4240
FAX No. +81-424-68-4219
E-mail cryo@shi.co.jp

Case of Trouble

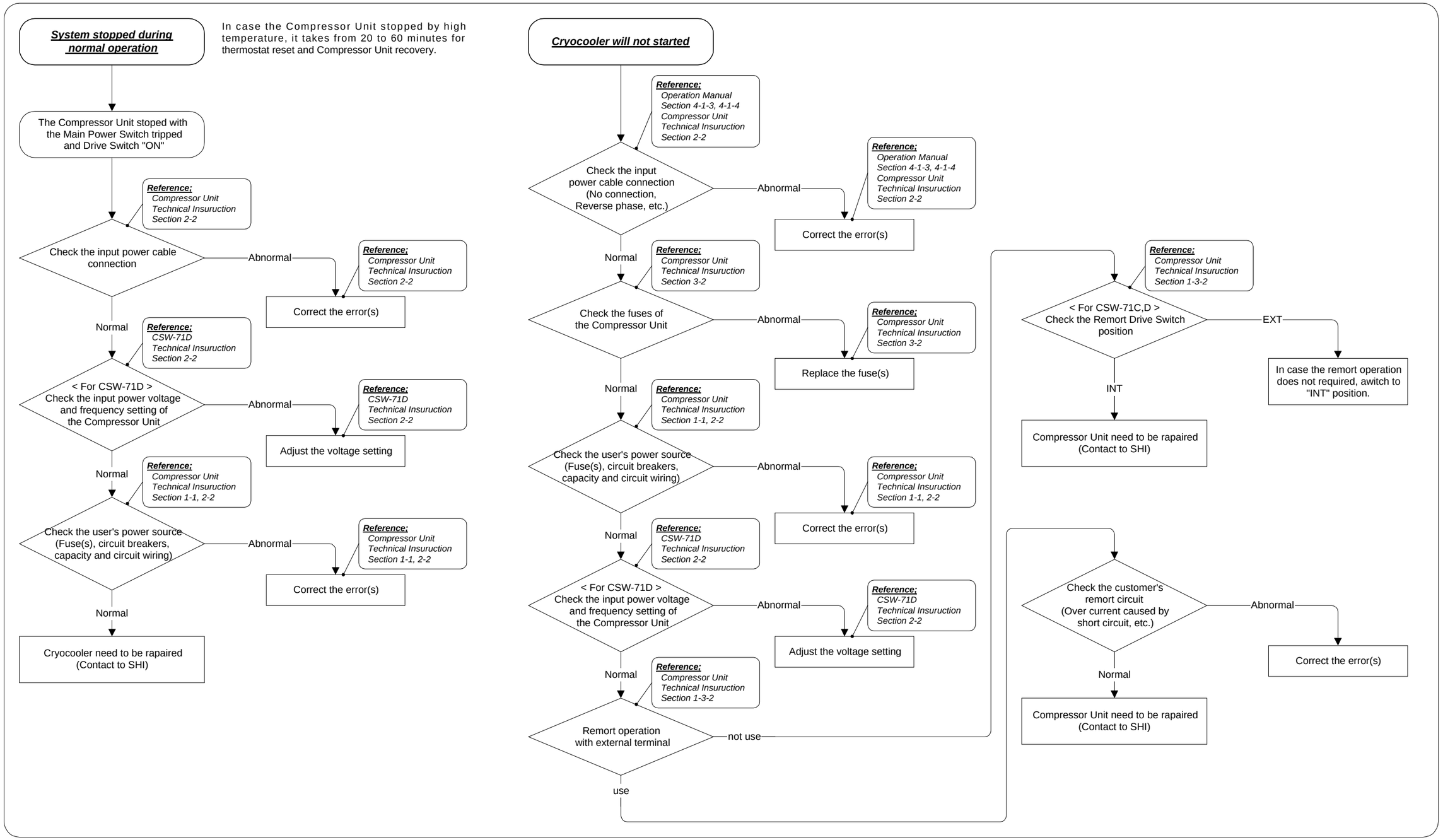


If BPU-01 BY PASS UNIT is used in this system, see the Trouble Shooting of “INSTALLATION MANUAL BPU-01 BY PASS UNIT”.

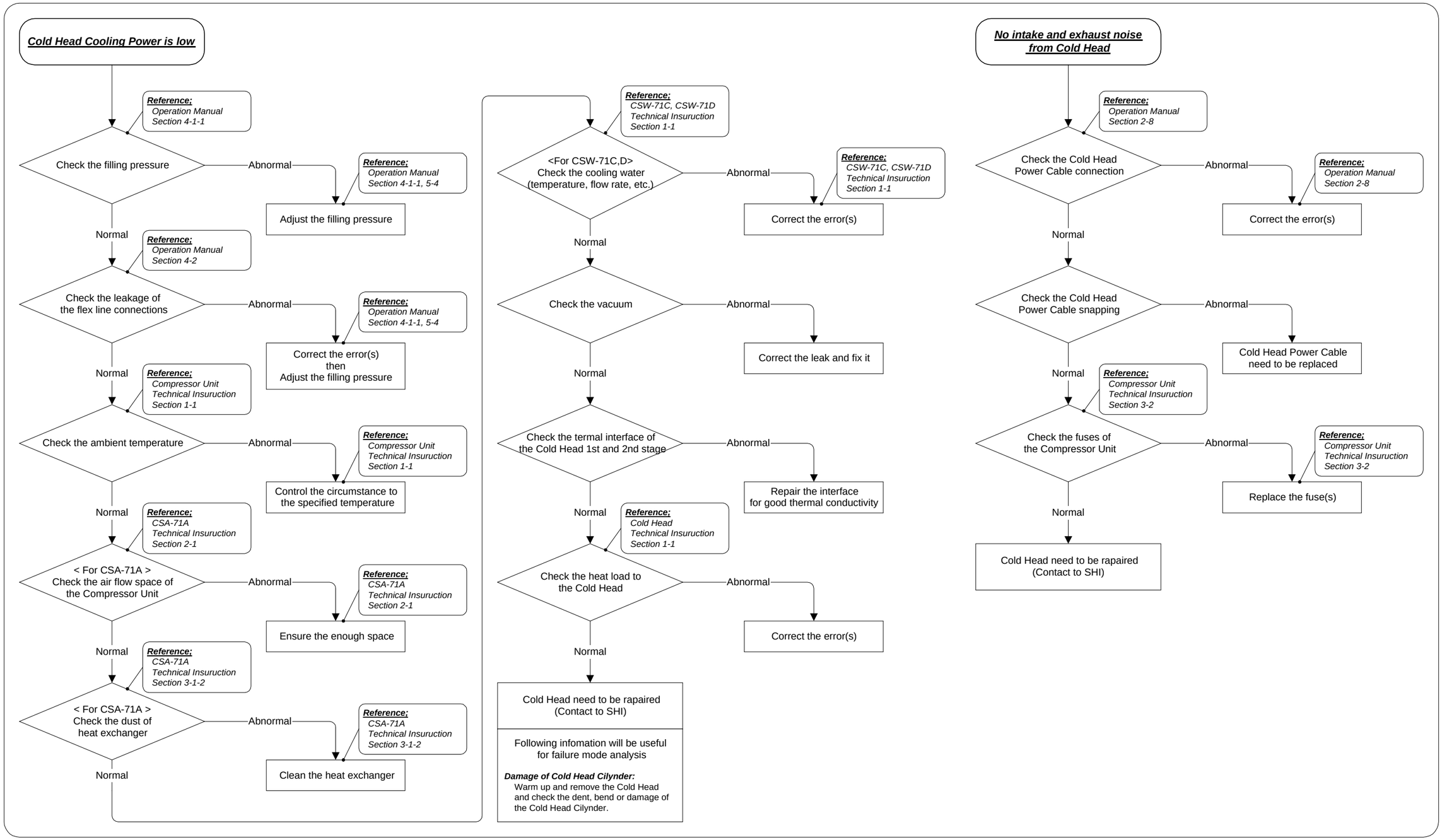
FLOW A


System stopped during normal operation
In case the Compressor Unit stopped by high temperature, it takes from 20 to 60 minutes for thermostat reset and Compressor Unit recovery.
The Compressor Unit stoped with the Main Power Switch "ON" and Drive Switch "ON"
Reference; Compressor Unit Technical Insuruction Section 1-1
Check the ambient temperature
Abnormal
Reference; Compressor Unit Technical Insuruction Section 1-1
Control the circumstance to the specified temperature
Normal
Reference; Operation Manual Section 4-1-1
Check the Filling pressure
Abnormal
Reference; Operation Manual Section 4-1-1, 5-4
Adjust the filling pressure
Normal
Reference; Operation Manual Section 4-2
Check the leakage of the flex line connections
Abnormal
Reference; Operation Manual Section 4-1-1, 5-4
Correct the error(s) then Adjust the filling pressure
Normal
Reference; CSA-71A Technical Insuruction Section 2-1
< For CSA-71A > Check the air flow space of the Compressor Unit
Abnormal
Reference; CSA-71A Technical Insuruction Section 2-1
Ensure the enough space
Normal
Reference; CSA-71A Technical Insuruction Section 3-1-2
< For CSA-71A > Check the dust of heat exchanger
Abnormal
Reference; CSA-71A Technical Insuruction Section 3-1-2
Clean the heat exchanger
Normal
Reference; CSW-71C, CSW-71D Technical Insuruction Section 1-1
< For CSW-71C,D > Check the cooling water (temp., flow rate, etc.)
Abnormal
Reference; CSW-71C, CSW-71D Technical Insuruction Section 1-1
Correct the error(s)
Normal
Reference; Compressor Unit Technical Insuruction Section 3-2
Check the fuses of the Compressor Unit
Abnormal
Reference; Compressor Unit Technical Insuruction Section 3-2
Replace the fuse(s)
Normal
Reference; Compressor Unit Technical Insuruction Section 2-2
Check the input power cable connection
Abnormal
Reference; Compressor Unit Technical Insuruction Section 2-2
Correct the error(s)
Normal
Reference; CSW-71D Technical Insuruction Section 2-2
< For CSW-71D > Check the input power voltage and frequency setting of the Compressor Unit
Abnormal
Reference; CSW-71D Technical Insuruction Section 2-2
Adjust the voltage setting
Normal
Reference; Compressor Unit Technical Insuruction Section 1-1, 2-2
Check the user's power source (Fuse(s), circuit breakers, capacity and circuit wiring)
Abnormal
Reference; Compressor Unit Technical Insuruction Section 1-1, 2-2
Correct the error(s)
Normal
Cold Head need to be rapaired (Contact to SHI)

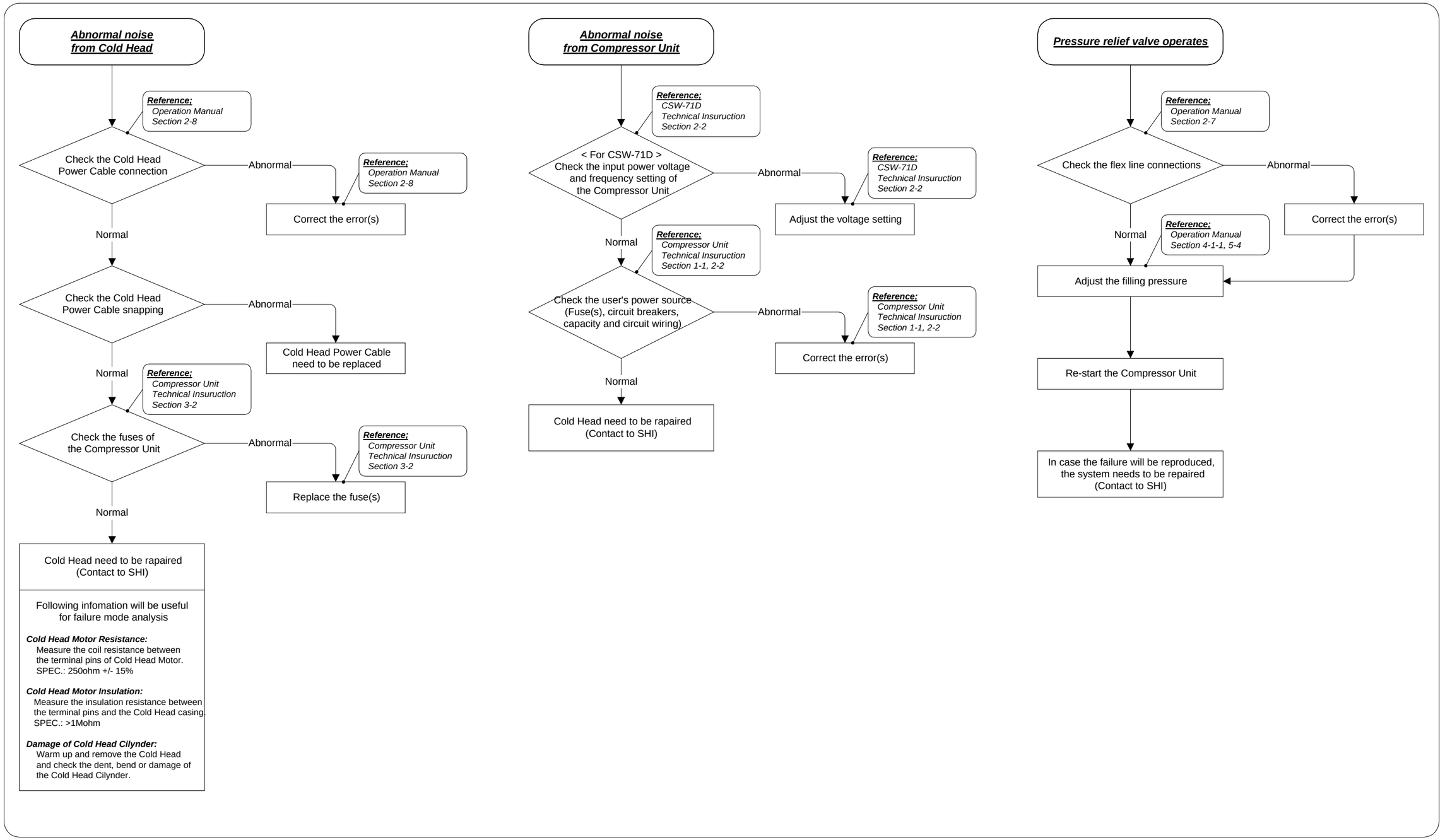
FLOW B


System stopped during normal operation
In case the Compressor Unit stopped by high temperature, it takes from 20 to 60 minutes for thermostat reset and Compressor Unit recovery.
The Compressor Unit stoped with the Main Power Switch tripped and Drive Switch "ON"
Reference; Compressor Unit Technical Insuruction Section 2-2
Check the input power cable connection
Abnormal
Reference; Compressor Unit Technical Insuruction Section 2-2
Correct the error(s)
Normal
Reference; CSW-71D Technical Insuruction Section 2-2
< For CSW-71D > Check the input power voltage and frequency setting of the Compressor Unit
Abnormal
Reference; CSW-71D Technical Insuruction Section 2-2
Adjust the voltage setting
Normal
Reference; Compressor Unit Technical Insuruction Section 1-1, 2-2
Check the user's power source (Fuse(s), circuit breakers, capacity and circuit wiring)
Abnormal
Reference; Compressor Unit Technical Insuruction Section 1-1, 2-2
Correct the error(s)
Normal
Cryocooler need to be rapaired (Contact to SHI)
Cryocooler will not started
Reference; Operation Manual Section 4-1-3, 4-1-4 Compressor Unit Technical Insuruction Section 2-2
Check the input power cable connection (No connection, Reverse phase, etc.)
Abnormal
Reference; Operation Manual Section 4-1-3, 4-1-4 Compressor Unit Technical Insuruction Section 2-2
Correct the error(s)
Normal
Reference; Compressor Unit Technical Insuruction Section 3-2
Check the fuses of the Compressor Unit
Abnormal
Reference; Compressor Unit Technical Insuruction Section 3-2
Replace the fuse(s)
Normal
Reference; Compressor Unit Technical Insuruction Section 1-1, 2-2
Check the user's power source (Fuse(s), circuit breakers, capacity and circuit wiring)
Abnormal
Reference; Compressor Unit Technical Insuruction Section 1-1, 2-2
Correct the error(s)
Normal
Reference; CSW-71D Technical Insuruction Section 2-2
< For CSW-71D > Check the input power voltage and frequency setting of the Compressor Unit
Abnormal
Reference; CSW-71D Technical Insuruction Section 2-2
Adjust the voltage setting
Normal
Reference; Compressor Unit Technical Insuruction Section 1-3-2
Remort operation with external terminal
not use
use
Reference; Compressor Unit Technical Insuruction Section 1-3-2
< For CSW-71C,D > Check the Remort Drive Switch position
EXT
In case the remort operation does not required, awitch to "INT" position.
INT
Compressor Unit need to be rapaired (Contact to SHI)
Check the customer's remort circuit (Over current caused by short circuit, etc.)
Abnormal
Correct the error(s)
Normal
Compressor Unit need to be rapaired (Contact to SHI)

FLOW C


Cold Head Cooling Power is low
Reference; Operation Manual Section 4-1-1
Check the filling pressure
Abnormal
Reference; Operation Manual Section 4-1-1, 5-4
Adjust the filling pressure
Normal
Reference; Operation Manual Section 4-2
Check the leakage of the flex line connections
Abnormal
Reference; Operation Manual Section 4-1-1, 5-4
Correct the error(s) then Adjust the filling pressure
Normal
Reference; Compressor Unit Technical Insuruction Section 1-1
Check the ambient temperature
Abnormal
Reference; Compressor Unit Technical Insuruction Section 1-1
Control the circumstance to the specified temperature
Normal
Reference; CSA-71A Technical Insuruction Section 2-1
< For CSA-71A > Check the air flow space of the Compressor Unit
Abnormal
Reference; CSA-71A Technical Insuruction Section 2-1
Ensure the enough space
Normal
Reference; CSA-71A Technical Insuruction Section 3-1-2
< For CSA-71A > Check the dust of heat exchanger
Abnormal
Reference; CSA-71A Technical Insuruction Section 3-1-2
Clean the heat exchanger
Normal
Reference; CSW-71C, CSW-71D Technical Insuruction Section 1-1
<For CSW-71C,D> Check the cooling water (temperature, flow rate, etc.)
Abnormal
Reference; CSW-71C, CSW-71D Technical Insuruction Section 1-1
Correct the error(s)
Normal
Check the vacuum
Abnormal
Correct the leak and fix it
Normal
Check the termal interface of the Cold Head 1st and 2nd stage
Abnormal
Repair the interface for good thermal conductivity
Normal
Reference; Cold Head Technical Insuruction Section 1-1
Check the heat load to the Cold Head
Abnormal
Correct the error(s)
Normal
Cold Head need to be rapaired (Contact to SHI)
Following infomation will be useful for failure mode analysis
Damage of Cold Head Cilynder:
Warm up and remove the Cold Head and check the dent, bend or damage of the Cold Head Cilynder.
No intake and exhaust noise from Cold Head
Reference; Operation Manual Section 2-8
Check the Cold Head Power Cable connection
Abnormal
Reference; Operation Manual Section 2-8
Correct the error(s)
Normal
Check the Cold Head Power Cable snapping
Abnormal
Cold Head Power Cable need to be replaced
Normal
Reference; Compressor Unit Technical Insuruction Section 3-2
Check the fuses of the Compressor Unit
Abnormal
Reference; Compressor Unit Technical Insuruction Section 3-2
Replace the fuse(s)
Normal
Cold Head need to be rapaired (Contact to SHI)

FLOW D


Abnormal noise from Cold Head
Reference; Operation Manual Section 2-8
Check the Cold Head Power Cable connection
Abnormal
Reference; Operation Manual Section 2-8
Correct the error(s)
Normal
Check the Cold Head Power Cable snapping
Abnormal
Cold Head Power Cable need to be replaced
Normal
Reference; Compressor Unit Technical Insuruction Section 3-2
Check the fuses of the Compressor Unit
Abnormal
Reference; Compressor Unit Technical Insuruction Section 3-2
Replace the fuse(s)
Normal
Cold Head need to be rapaired (Contact to SHI)
Following infomation will be useful for failure mode analysis
Cold Head Motor Resistance:
Measure the coil resistance between the terminal pins of Cold Head Motor.
SPEC.: 250ohm +/- 15%
Cold Head Motor Insulation:
Measure the insulation resistance between the terminal pins and the Cold Head casing.
SPEC.: >1Mohm
Damage of Cold Head Cilynder:
Warm up and remove the Cold Head and check the dent, bend or damage of the Cold Head Cilynder.
Abnormal noise from Compressor Unit
Reference; CSW-71D Technical Insuruction Section 2-2
< For CSW-71D > Check the input power voltage and frequency setting of the Compressor Unit
Abnormal
Reference; CSW-71D Technical Insuruction Section 2-2
Adjust the voltage setting
Normal
Reference; Compressor Unit Technical Insuruction Section 1-1, 2-2
Check the user's power source (Fuse(s), circuit breakers, capacity and circuit wiring)
Abnormal
Reference; Compressor Unit Technical Insuruction Section 1-1, 2-2
Correct the error(s)
Normal
Cold Head need to be rapaired (Contact to SHI)
Pressure relief valve operates
Reference; Operation Manual Section 2-7
Check the flex line connections
Abnormal
Correct the error(s)
Normal
Reference; Operation Manual Section 4-1-1, 5-4
Adjust the filling pressure
Re-start the Compressor Unit
In case the failure will be reproduced, the system needs to be repaired (Contact to SHI)

7 OPERATING LOG

Maintaining a log of the records of the temperature indication and pressure during normal operation is a valuable means for troubleshooting. A sample operating log is mentioned to **Figure 7.1**. It is highly advisable to create and maintain a detailed operating log for your Cryocooler.

page .

OPERATING LOG
SRDK Series CRYOCOOLER

Installation Date .

Cold Head Serial Number : .
Compressor Unit Serial Number : .

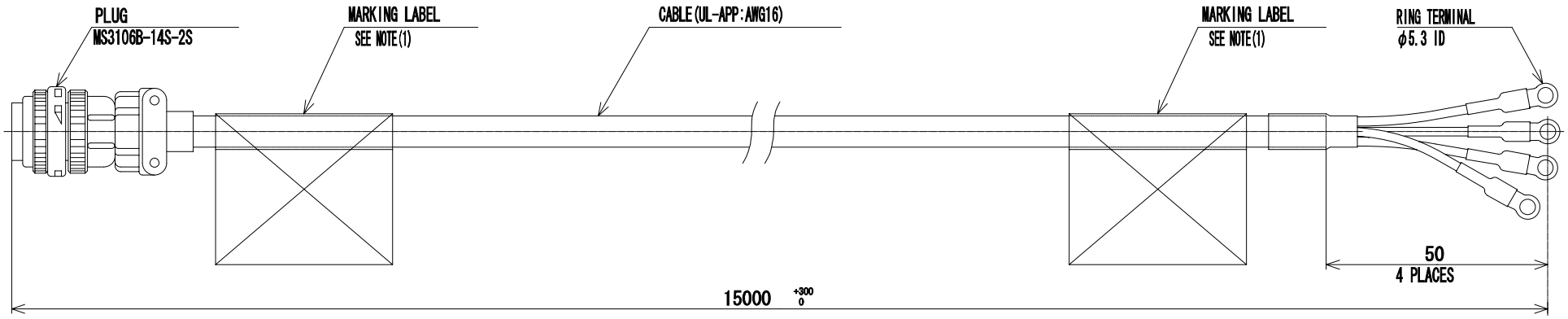
Date	Time	Elapsed Time	Lowest Temperature	Supply Pressure	Remarks

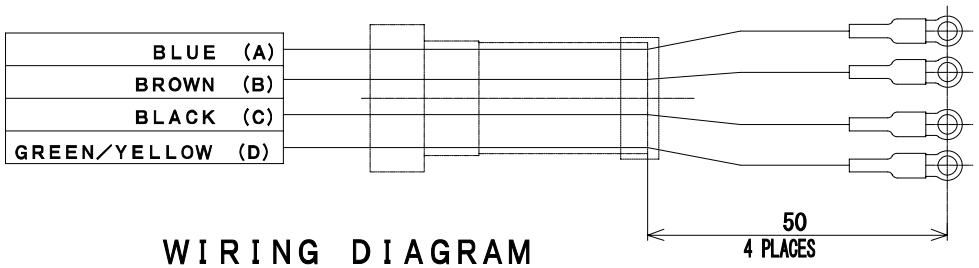
Figure 7.1 OPERATING LOG

APPENDIX

DRAWINGS

No.	PART NAME	GE PART No.	SHI PART No.
1	COLD HEAD POWER CABLE (15 m / 49.2 feet) Cold Head to Penetration Panel	2172239-2	RV21ZN0135
2	COLD HEAD POWER CABLE (15 m / 49.2 feet) Compressor to Penetration Panel	2155316-2	RV21ZN0136
3	COLD HEAD POWER CABLE (15 m / 49.2 feet + 15 m / 49.2 feet)	2259837	RV21ZN0257
4	CONVERSION CONNECTOR	2212590	RV21ZN0201
5	COLD HEAD POWER CABLE (15 m / 49.2 feet) Cold Head to Penetration Panel (for CONVERSION CONNECTOR)	2218292	RV21ZN0202
6	SUPPLY FLEX LINE 20A x 20m (65.6 feet) F-F (S)	2154502-2	RW20ZN0674
7	RETURN FLEX LINE 20A x 20m (65.6 feet) F-F (R)	2154505-2	RW20ZN0675





WIRING DIAGRAM

NOTE

1) CABLES ARE TO BE MARKED WITH G. E. PART NUMBER AND RUN NUMBER NEAR EACH END.

COLD HEAD CABLE
(COLD HEAD TO PEN. PANEL)
Type 15m
PART No, 2218292 (Rev. ***)
RUN No, 624/628
Sumitomo Heavy Industries, Ltd.

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

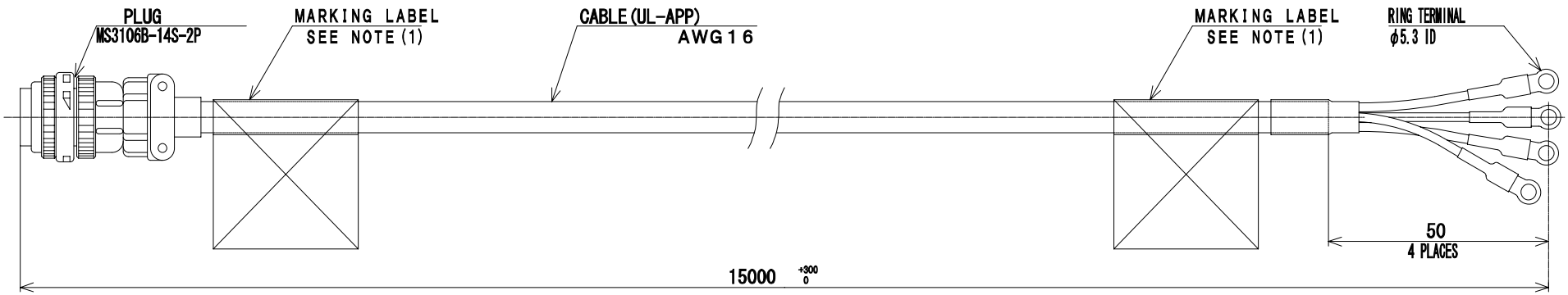
3) PART MUST CONFORM TO CRYOCOOLER SPECIFICATION 2136066GSP.

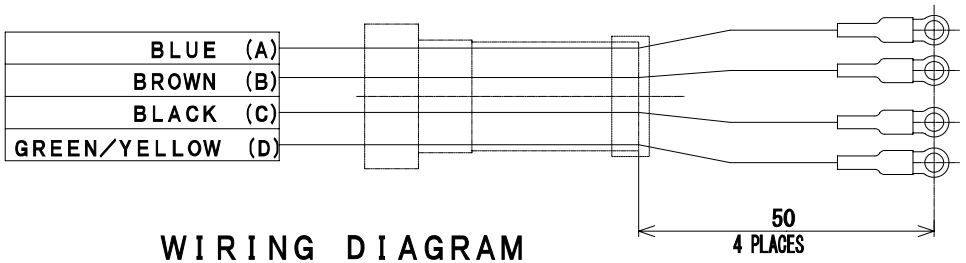
4) PART IS A COMPONENT OF UL APPROVED SRDK-408 CRYOCOOLER.

XRZ31Z0022AQ

COLD HEAD POWER CABLE (15 m)

Cold Head to Penetration Panel





WIRING DIAGRAM

NOTE

1) CABLES ARE TO BE MARKED WITH G. E. PART NUMBER AND RUN NUMBER NEAR EACH END.

COLD HEAD CABLE (COMPRESSOR TO PEN. PANEL) Type 15m PART No. 2155316-2 (Rev. ***) RUN No. 623/627 Sumitomo Heavy Industries, Ltd.

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

4) PART MUST CONFORM TO CRYOCOOLER SPECIFICATION 2136066GSP.

5) PART IS A COMPONENT OF UL APPROVED SRDK-408 CRYOCOOLER.

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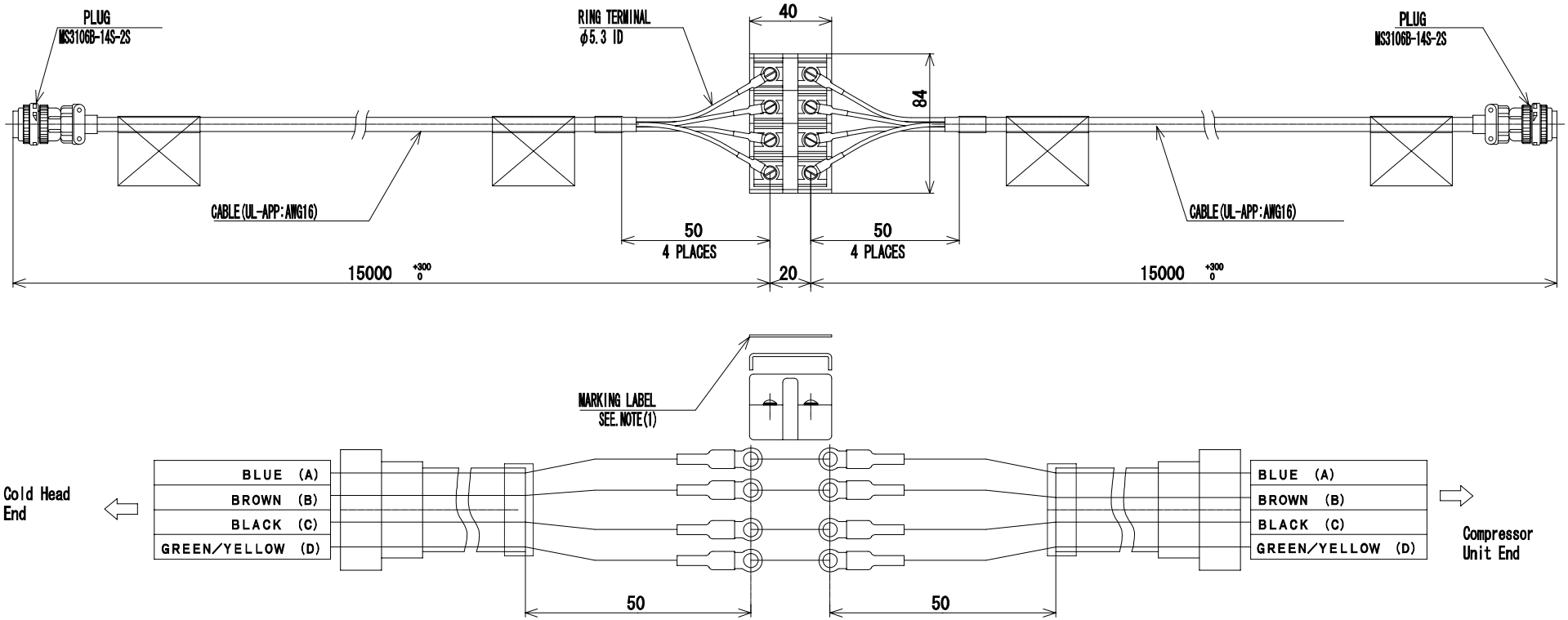
COLD HEAD POWER CABLE (15 m)

Compressor to Penetration Panel



WIRING DIAGRAM

NOTE

1) CABLES ARE TO BE MARKED WITH G. E. PART NUMBER.

COLD HEAD CABLE (COMPRESSOR TO COLDHEAD) Type 15m+15m PART No, 2259837 (Rev. ***) Sumitomo Heavy Industries, Ltd.

2) EACH CABLES TO BE CONNECTED WITH 4P TERMINAL CONNECTOR.

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

4) PART MUST CONFORM TO CRYOCOOLER SPECIFICATION 2136066GSP..

5) PART IS A COMPONENT OF UL APPROVED SRDK-408 CRYOCOOLER.

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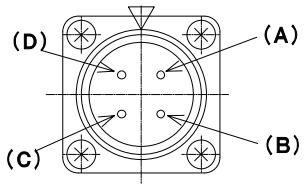
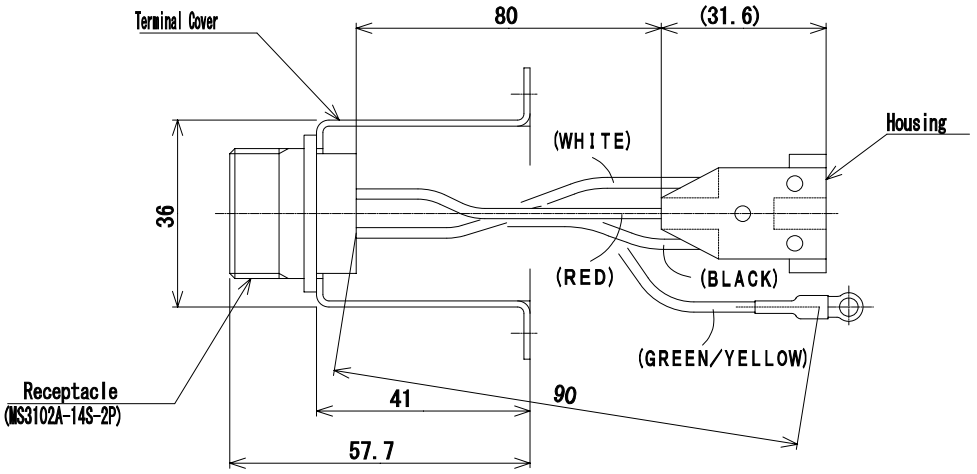
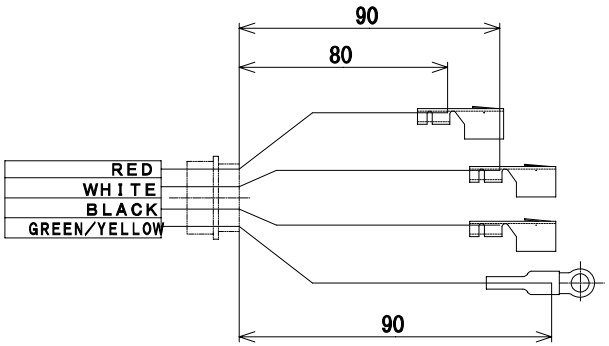
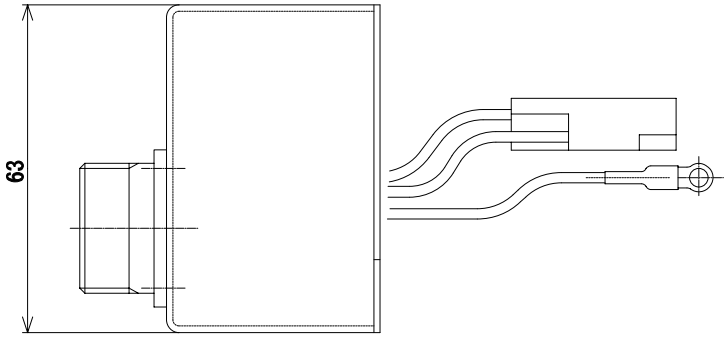
COLD HEAD POWER CABLE (15 m + 15m)









WIRING DIAGRAM

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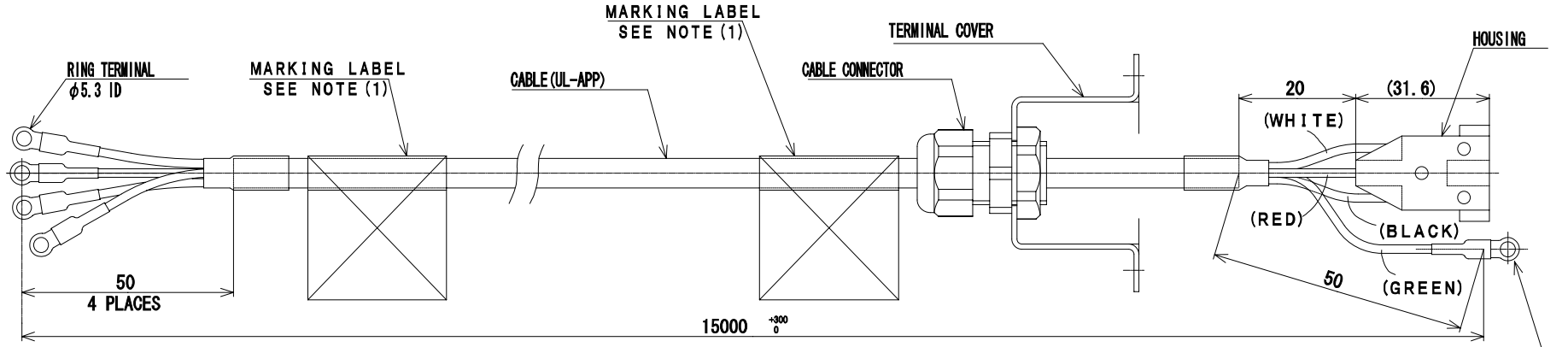
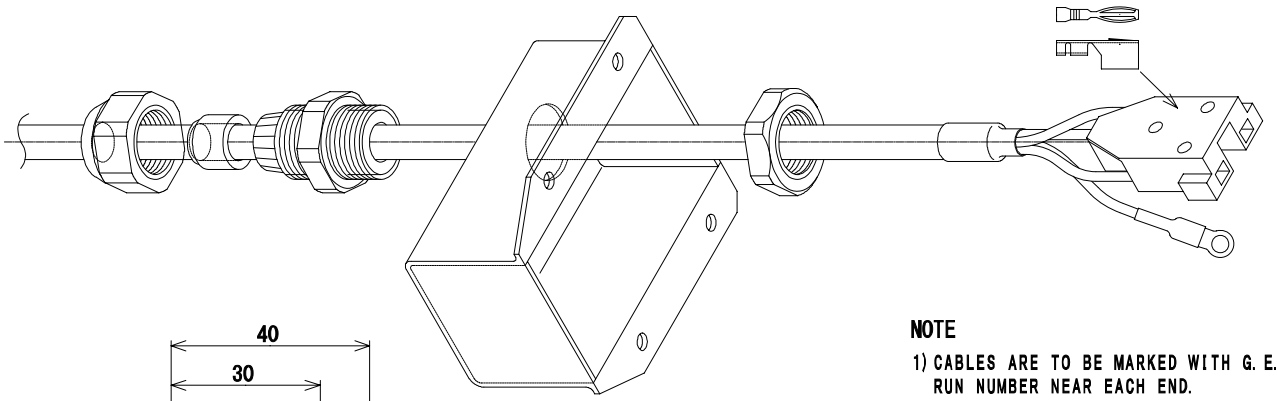
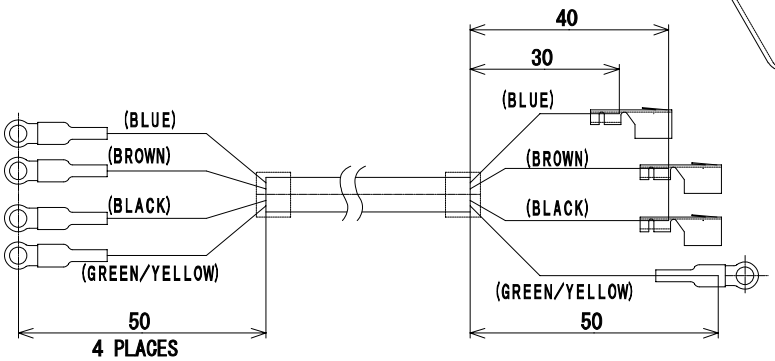
CONVERSION CONNECTOR







WIRING DIAGRAM

NOTE

1) CABLES ARE TO BE MARKED WITH G. E. PART NUMBER AND RUN NUMBER NEAR EACH END.

COLD HEAD CABLE
(COLD HEAD TO PEN. PANEL)
Type 15m
PART No. 2172239-2 (Rev. ***)
RUN No. 624/628
Sumitomo Heavy Industries, Ltd.

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

4) PART MUST CONFORM TO CRYOCOOLER SPECIFICATION 2136066GSP.

5) PART IS A COMPONENT OF UL APPROVED SRDK-408 CRYOCOOLER.

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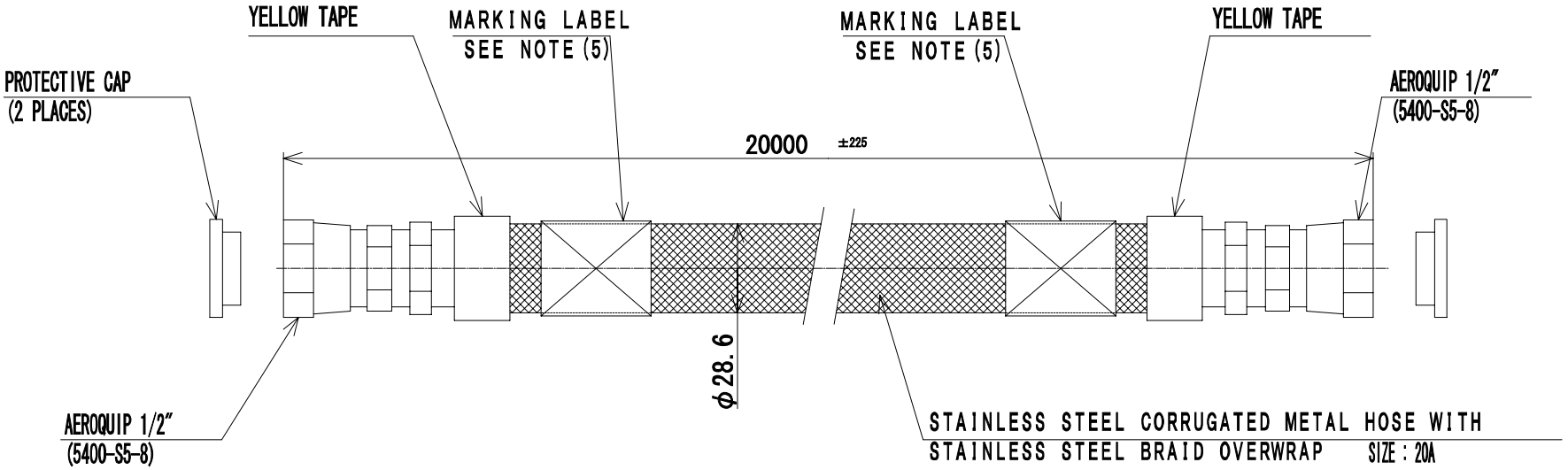
COLD HEAD POWER CABLE (15 m)

Cold Head to Penetration Panel
(for CONVERSION CONNECTOR)



NOTE

1) MAXIMUM WORKING PRESSURE 2.75MPa (28kgf/cm^{2}G).

2) CHARGED HELIUM GAS 1.62MPa (16.5kgf/cm^{2}G).

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

4) PART MUST CONFORM TO CRYOCOOLER SPECIFICATION 2136066GSP.

5) HOSES ARE TO BE MARKED WITH G.E. PART NUMBER AND RUN NUMBER NEAR EACH END.

SUPPLY FLEX LINE
Type 20A x 20m
PART No. 2154502-2 (Rev. ***)
RUN No. 621/625
Sumitomo Heavy Industries, Ltd.

6) PART IS A COMPONENT OF UL APPROVED SRDK-408 CRYOCOOLER.

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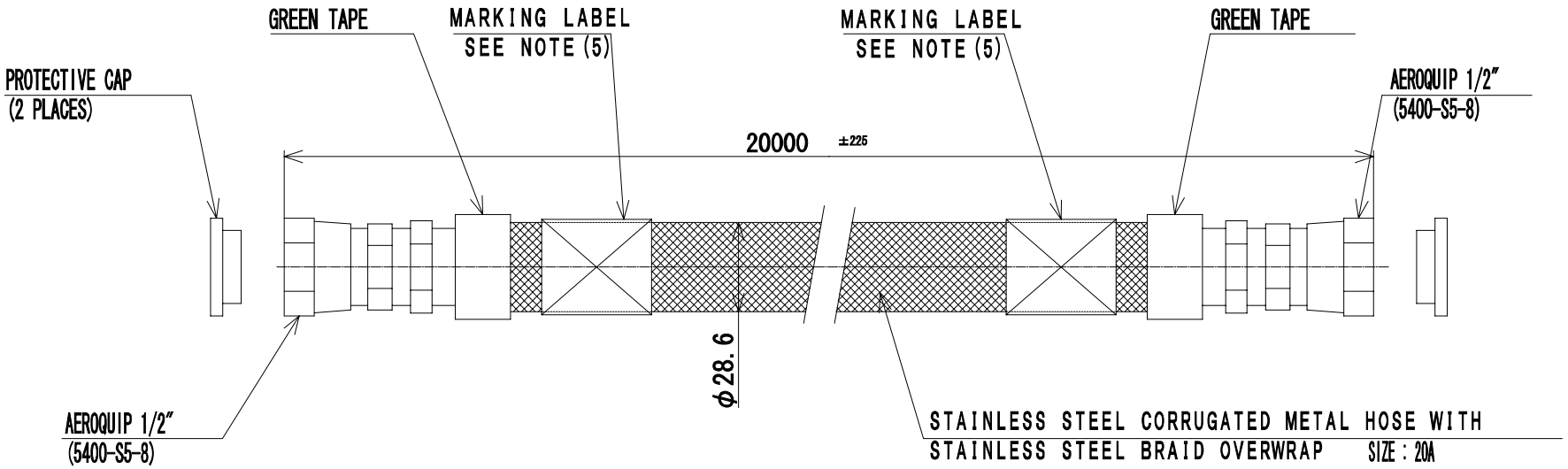
SUPPLY FLEX LINE 20A x 20m (F-F)



NOTE

1) MAXIMUM WORKING PRESSURE 2.75MPa (28kgf/cm^{2}G).

2) CHARGED HELIUM GAS 1.62MPa (16.5kgf/cm^{2}G).

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

4) PART MUST CONFORM TO CRYOCOOLER SPECIFICATION 2136066GSP.

5) HOSES ARE TO BE MARKED WITH G.E. PART NUMBER AND RUN NUMBER NEAR EACH END.

RETURN FLEX LINE
Type 20A x 20m
PART No. 2154505-2 (Rev. ***)
RUN No. 622/626
Sumitomo Heavy Industries, Ltd.

6) PART IS A COMPONENT OF UL APPROVED SRDK-408 CRYOCOOLER.

XRW20Z0011AQ

RETURN FLEX LINE 20A x 20m (F-F)

REVISION CONTROL

Manual No.	GE Revision	SHI Revision	Remarks	Date
CD32ZZ-056	Revision 2	-A	Publication of first edition.	DEC. 20 / 1999
	Revision 2	-B	Add the description of BPU-01.	MAR. 30 / 2000
	Revision 2	-C	Change the SHI address.	JAN. 25 / 2001
	Revision 2	-D	Add the start-up temperature CAUTION.	JAN. 21 / 2002
	Revision 2	-E	Add the description of helium gas charging.	APR. 1 / 2002
	Revision 2	-F	Change the WARNING descriptions.	JUL. 11 / 2002
	Revision 2	-G	Add the RDK-408A2 Cold Head. Add the transformer-use CAUTION.	MAR. 17 / 2003

Sumitomo Heavy Industries, Ltd.

MANUAL NUMBER: CD32ZZ-057C
DATE: JAN. 25 / 2001

TECHNICAL INSTRUCTION

RDK-408
4K COLD HEAD
Revision 2

For Service Personnel Only

PART NUMBERS

MODEL	SHI PART No.	GE PART No.
RDK-408 4K COLD HEAD	RD42ZN0617	2218465

Sumitomo Heavy Industries, Ltd.
Cryogenics Department

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

TABLE OF CONTENTS

TABLE LIST

FIGURE LIST

CROSS REFERENCE

Before using this equipment, thoroughly read this manual and following manuals.

MANUAL NAME	MANUAL No.
OPERATION MANUAL SRDK Series CRYOCOOLER	CD32ZZ-056
TECHNICAL INSTRUCTION CSA-71A COMPRESSOR UNIT*	CD32ZZ-060
TECHNICAL INSTRUCTION CSW-71C COMPRESSOR UNIT*	CD32ZZ-061
TECHNICAL INSTRUCTION CSW-71D COMPRESSOR UNIT*	CD32ZZ-062
INSTALLATION MANUAL BPU-01 BY PASS UNIT**	CD32ZZ-075

* See the TECHNICAL INSTRUCTION of Compressor Unit used.
** See the INSTALLATION MANUAL of BPU-01, if the BPU-01 is used in this system.

1 GENERAL INFORMATION

The RDK-408 Cold Head is a two-stage 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, in the range of 25 K to 40 K for the first-stage cold station and in the range of 3.5 K to 4.2 K for the second-stage cold station.
The Cold Head has three major components: the drive unit; the cylinder; and the displacer-regenerator assembly, which is located inside the cylinder.
With newly developed rare earth regenerator material and with very unique structure, the model RDK-408 Cold Head has its 2nd stage refrigeration capacity of 1W at 4.2K.

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 be provided cooling condition for the first and second-stage cold stations.

1-1 SPECIFICATIONS

The specifications of the RDK-408 Cold Head are summarized in **Table 1.1**
Figure 1.1 shows the outline view of Cold Head.

Table 1.1 RDK-408 COLD HEAD SPECIFICATION

Refrigeration Capacity	
1. First Stage	37 W at 40 K
Second Stage	0.9 W at 4.2 K
2. First Stage	37 W at 43 K
Second Stage	1.0 W at 4.2 K
Orientation	Any Capacity Loss: Max. 15%
Ambient Operating Temperature	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
Helium Gas Pressure	
Static	1.60 - 1.65 MPa at 20 deg.C (68 deg.F) (16.3 - 16.8 kgf/cm^{2}G, 232 - 239 psig)
Operating (High Side)*	2.10 - 2.30 MPa --- approx. (21.4 - 23.5 kgf/cm^{2}G, 319 - 333 psig)
Pressure Relief Valve Setting	1.86 - 1.96 MPa (19.0 - 20.0 kgf/cm^{2}G, 270 - 284 psig)
Gas Supply Connector	1/2-inch Coupling
Gas Return Connector	1/2-inch Coupling
Dimension	
Width	180 mm (7.09')
Length	294 mm (11.58')
Height	557 mm (21.93')
Weight	19.8 kg (43.6 LBS) --- approx. (Including Transition Flange)

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

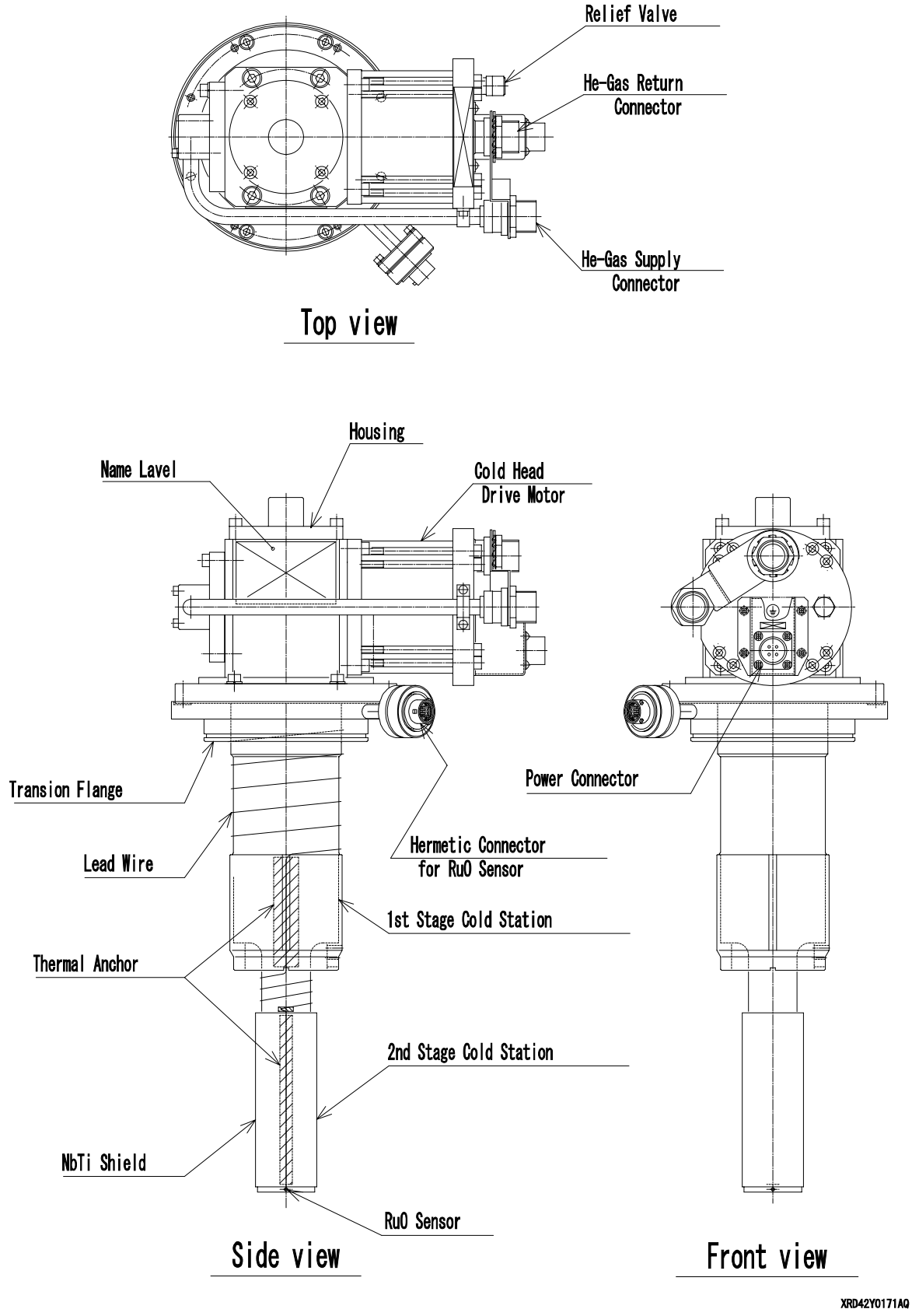


Figure 1.1 OUTLINE VIEW OF COLD HEAD MODEL RDK-408

1-2 CONSTRUCTION

The cross section of the RDK-408 Cold Head is shown in **Figure 1.2.** It consists of a Cylinder, No. 1 Displacer, No. 2 Displacer, drive mechanism, and Cold Head Drive Motor. No. 1 Displacer is connected to the Scotch Yoke which can be driven by the Cold Head Drive Motor through the Crank with Bush so that the rotation of the Cold Head Drive Motor can be varied to reciprocating motion of Scotch Yoke and Displacers.

The Rotary Valve system is furnished to control the helium gas intake and exhaust timing. The Rotary Valve is also coupled to the Cold Head Drive Motor through Crank, so intake and exhaust operation is synchronized with the position of the Displacer.

The Displacer is a loose fit in the Cylinder except at the top and where it is equipped with a dynamic(sliding) seal to prevent leakage passed through the clearance between the Displacer and Cylinder.

The Displacers consist of regenerator material which cool the gas when passing downwards to the cold space and heats the gas when passing upwards from the cold space. Rear earth regenerator material is used in the 2nd stage Displacer to produce the cooling capacity at the temperature of 4.2K.

The pressure above and below the Displacer is the same except for small pressure drops across the regenerator when gas is flowing trough it. Virtually no physical work is required to move the Displacer in the Cylinder. No work is done on the gas and the gas does no work on the Displacer. The pressure in the system is increased or decreased by operation of the inlet or outlet valves.

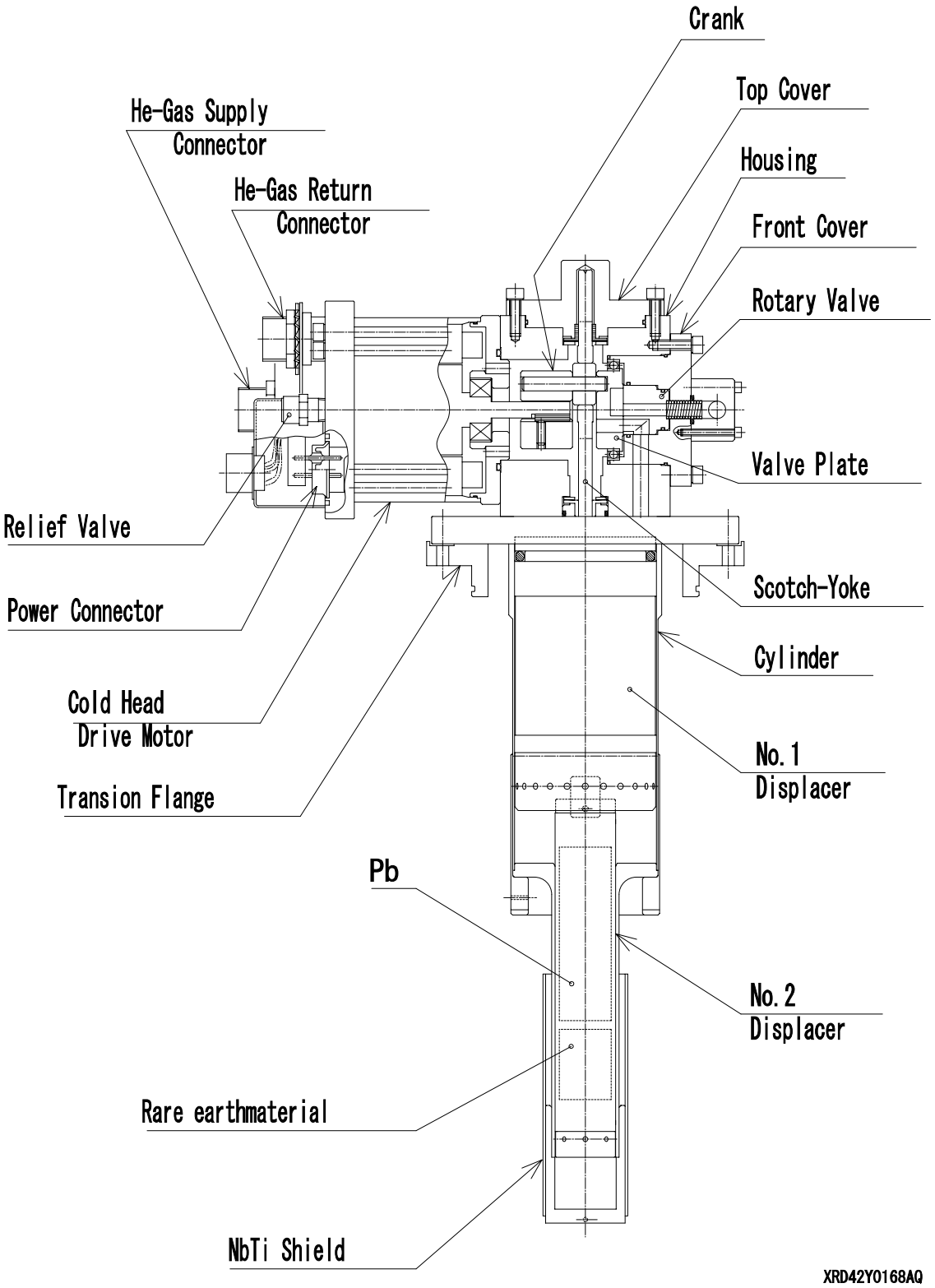


Figure 1.2 CROSS SECTION OF THE RDK-408 COLD HEAD

2 MAINTENANCE

The RDK-408 Cold Head is to be required to replace the sliding parts inside every 10,000 Hrs.
The maintenance work is not a Use's maintenance. Replace the Cold Head completely at site and return it to Sumitomo Heavy Industries, Ltd. for refurbishment.

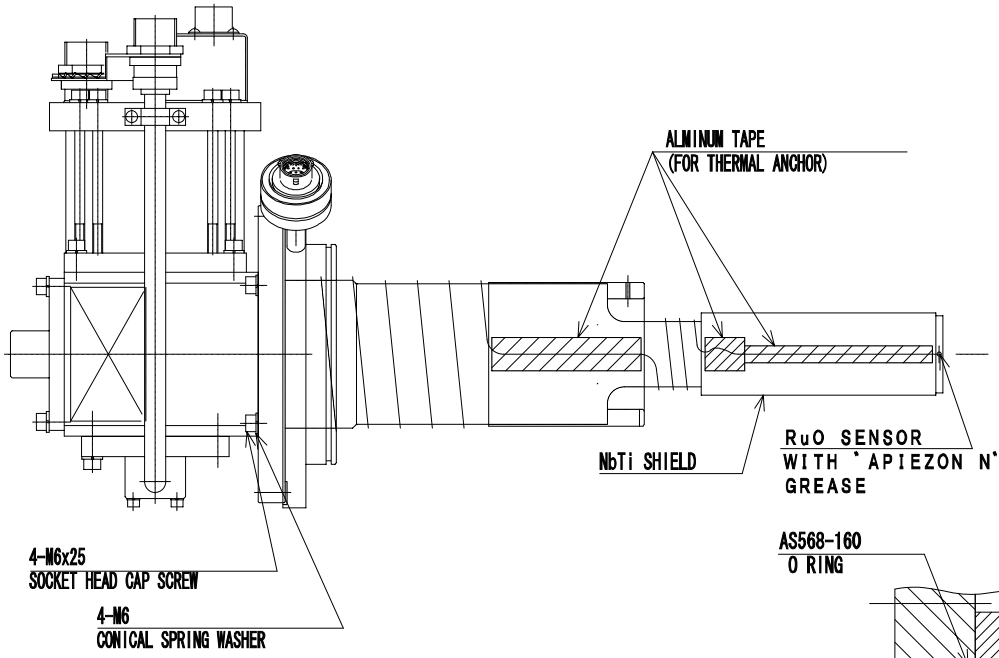
APPENDIX

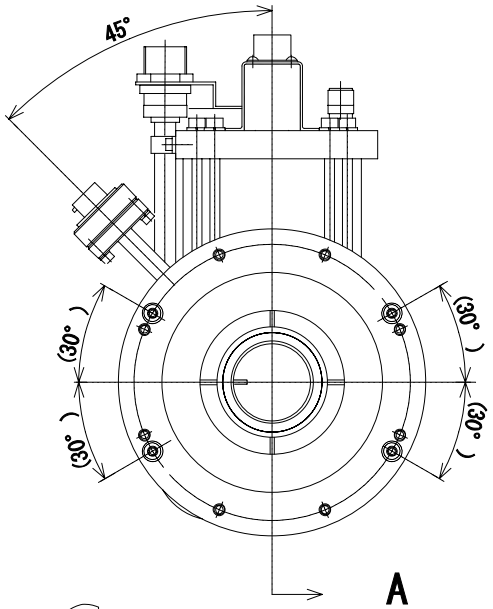
DRAWINGS

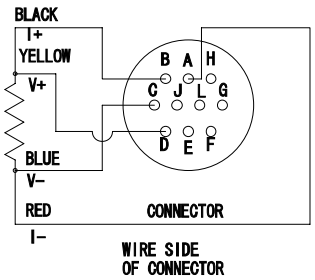
No.	PART NAME	GE PART No.	SHI PART No.
1	RDK-408 COLD HEAD ASSEMBLY	2218465	RD42ZN0617
2	RDK-408 COLD HEAD	2218291	-
3	TRANSITION FLANGE	2153638	RD42ZN0517

NOTE

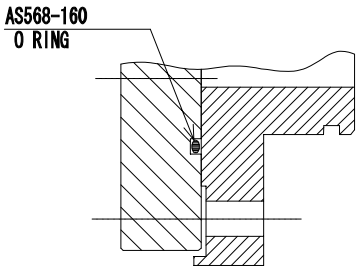
1. ASSEMBLY IS TO BE CLEAN AND FREE FROM DIRT, OIL.
2. RuO SENSOR IS TO BE INSTALLED WITH 'APIEZON N' GREASE.
3. RuO SENSOR AND WIRING TO CONNECTOR PINS ARE TO BE INSPECTED.
4. OVERALL WIRE LENGTH APPROX. 1600mm.
5. ASSEMBLYS ARE TO BE BAGGED OR BOXED AND SEALED FROM DIRT AND MOISTURE.
6. ASSEMBLY IS TO BE MARKED WITH G. E. PART NUMBER, 2218465.







CONNECTOR IS A 10 PIN CONNECTOR WHICH MEETS DIMENSION REQUIREMENTS OF MIL-C-26482 AND MIL STD3116



Section A-A

S=1/1

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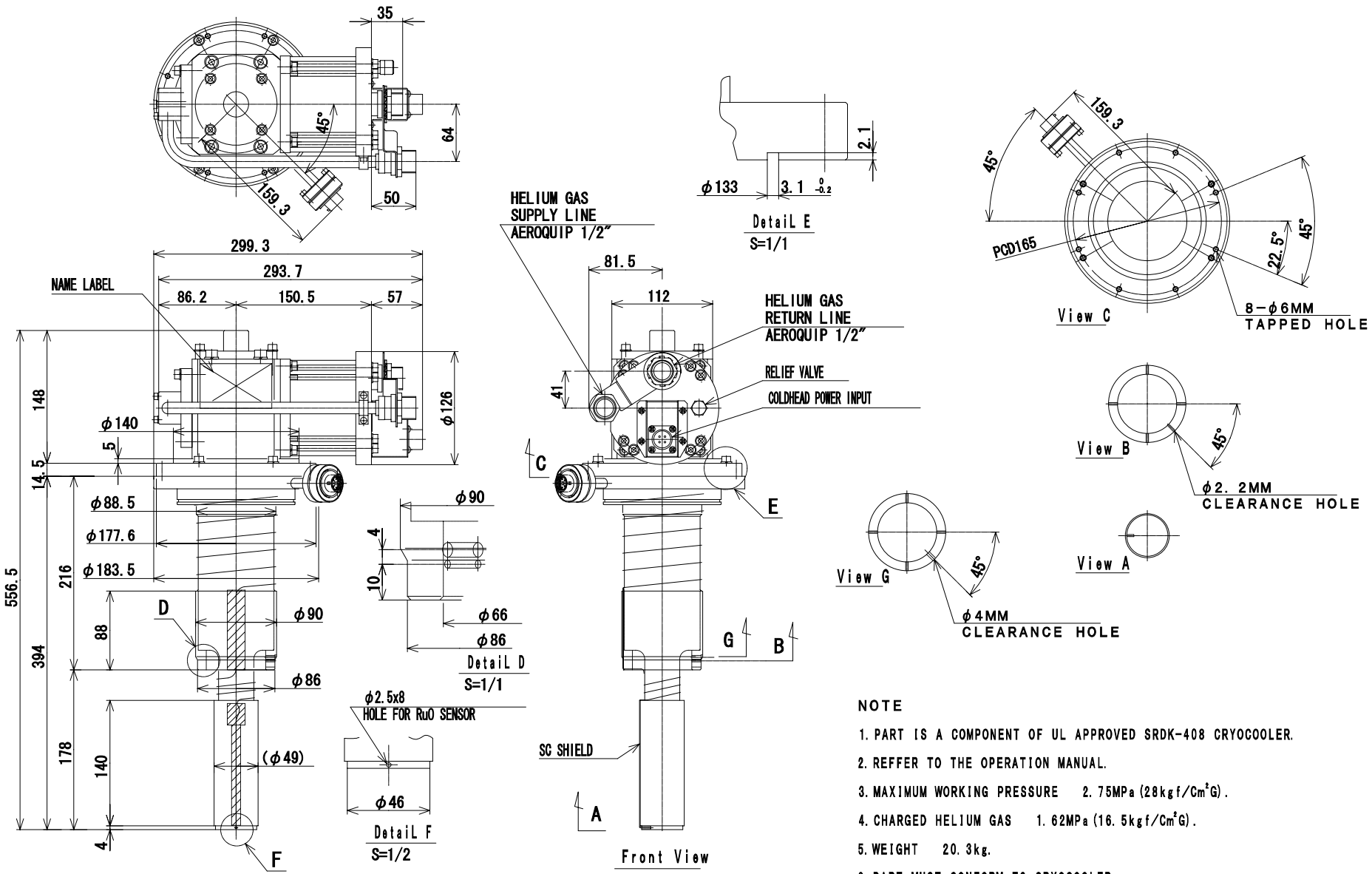
RDK-408 COLD HEAD ASSEMBLY

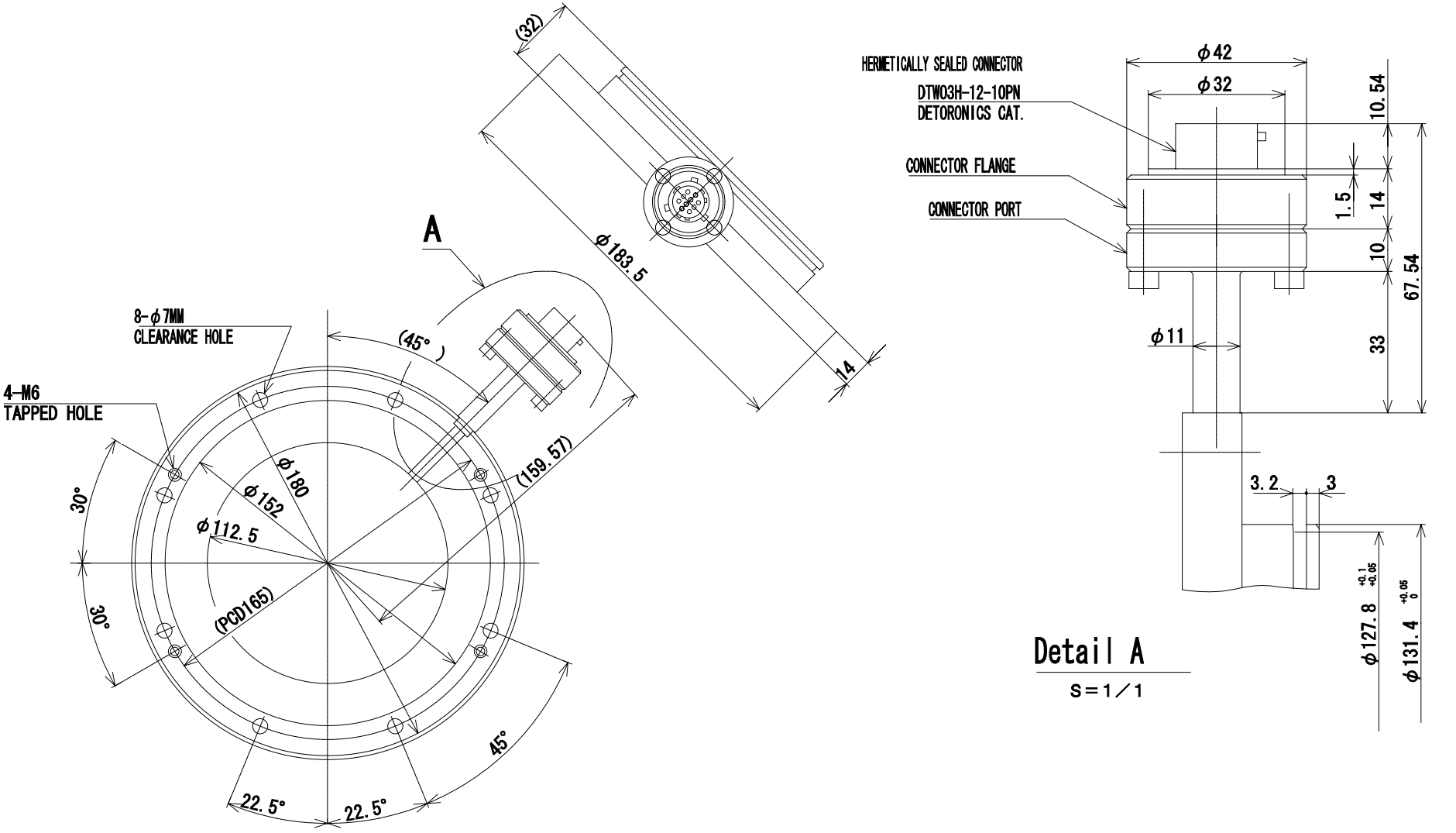


NOTE

1. PART IS A COMPONENT OF UL APPROVED SRDK-408 CRYOCOOLER.
2. REFFER TO THE OPERATION MANUAL.
3. MAXIMUM WORKING PRESSURE 2.75MPa (28kgf/Cm^{2}G).
4. CHARGED HELIUM GAS 1.62MPa (16.5kgf/Cm^{2}G).
5. WEIGHT 20.3kg.
6. PART MUST CONFORM TO CRYOCOOLER SPECIFICATION 2136066GSP.

XRD42Y0182AQ

RDK-408 COLD HEAD



NOTE.

1. PART TO BE ASSEMBLED WITH RDK-408 COLDHEAD.
2. PART TO BE CLEAND AND FREE FROM DIRT AND GREASE.

XRD42Y0175AQ

TRANSITION FRANGE

REVISION CONTROL

Manual No.	GE Revision	SHI Revision	Remarks	Date
CD32ZZ-057	Revision 2	-A	Publication of first edition.	DEC. 20 / 1999
	Revision 2	-B	Add the description of BPU-01.	MAR. 30 / 2000
	Revision 2	-C	Change the SHI address.	JAN. 25 / 2001

Sumitomo Heavy Industries, Ltd.

MANUAL NUMBER: CD32ZZ-098D
DATE: March 17 / 2003

TECHNICAL INSTRUCTION

RDK-408A2
4K COLD HEAD
Revision 0

For Service Personnel Only

PART NUMBERS

MODEL	SHI PART No.	GE PART No.
RDK-408A2 4K COLD HEAD	RD42ZN1079	2218465-3

Sumitomo Heavy Industries, Ltd.
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2-1-1 Yato-cho, Nishitokyo-City,
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E-mail: cryo@shi.co.jp

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CROSS REFERENCE

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

MANUAL NAME	MANUAL No.
OPERATION MANUAL SRDK Series CRYOCOOLER	CD32ZZ-056
TECHNICAL INSTRUCTION CSA-71A COMPRESSOR UNIT*	CD32ZZ-060
TECHNICAL INSTRUCTION CSW-71C COMPRESSOR UNIT*	CD32ZZ-061
TECHNICAL INSTRUCTION CSW-71D COMPRESSOR UNIT*	CD32ZZ-062
INSTALLATION MANUAL BPU-01 BY PASS UNIT**	CD32ZZ-075

* See the TECHNICAL INSTRUCTION of Compressor Unit used.
** See the INSTALLATION MANUAL of BPU-01, if BPU-01 is used in this system.

1 GENERAL INFORMATION

RDK-408A2 Cold Head is a two-stage 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, in the range of 25 K to 40 K for the first-stage cold station and in the range of 3.5 K to 4.2 K for the second-stage cold station.
The Cold Head has three major components: the drive unit; the cylinder; and the displacer-regenerator assembly, which is located inside the cylinder.
With newly developed rare earth regenerator material and with very unique structure, the model RDK-408A2 Cold Head has its 2nd stage refrigeration capacity of 1W at 4.2K.

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 be provided cooling condition for the first and second-stage cold stations.

1-1 SPECIFICATIONS

The specifications of RDK-408A2 Cold Head are summarized in **Table 1.1**
Figure 1.1 shows the outline view of Cold Head.

Table 1.1 RDK-408A2 COLD HEAD SPECIFICATION

Refrigeration Capacity	
First Stage	44 W at 43 K (50 / 60 Hz)
Second Stage	1.0 W at 4.2 K (50 / 60 Hz)
Orientation	Any Capacity Loss: Max. 15 %
Ambient Operating Temperature	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
Helium Gas Pressure	
Static	1.60 - 1.65 MPa at 20 deg.C (68 deg.F) (16.3 - 16.8 kgf/cm^{2}G, 232 - 239 psig)
Operating (High Side)*	2.10 - 2.30 MPa --- approx. (21.4 - 23.5 kgf/cm^{2}G, 319 - 333 psig)
Pressure Relief Valve Setting	1.86 - 1.96 MPa (19.0 - 20.0 kgf/cm^{2}G, 270 - 284 psig)
Gas Supply Connector	1/2-inch Coupling
Gas Return Connector	1/2-inch Coupling
Dimension	
Width	180 mm (7.09')
Length	294 mm (11.58')
Height	557 mm (21.93')
Weight	20.3 kg (44.7 LBS) --- approx.

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

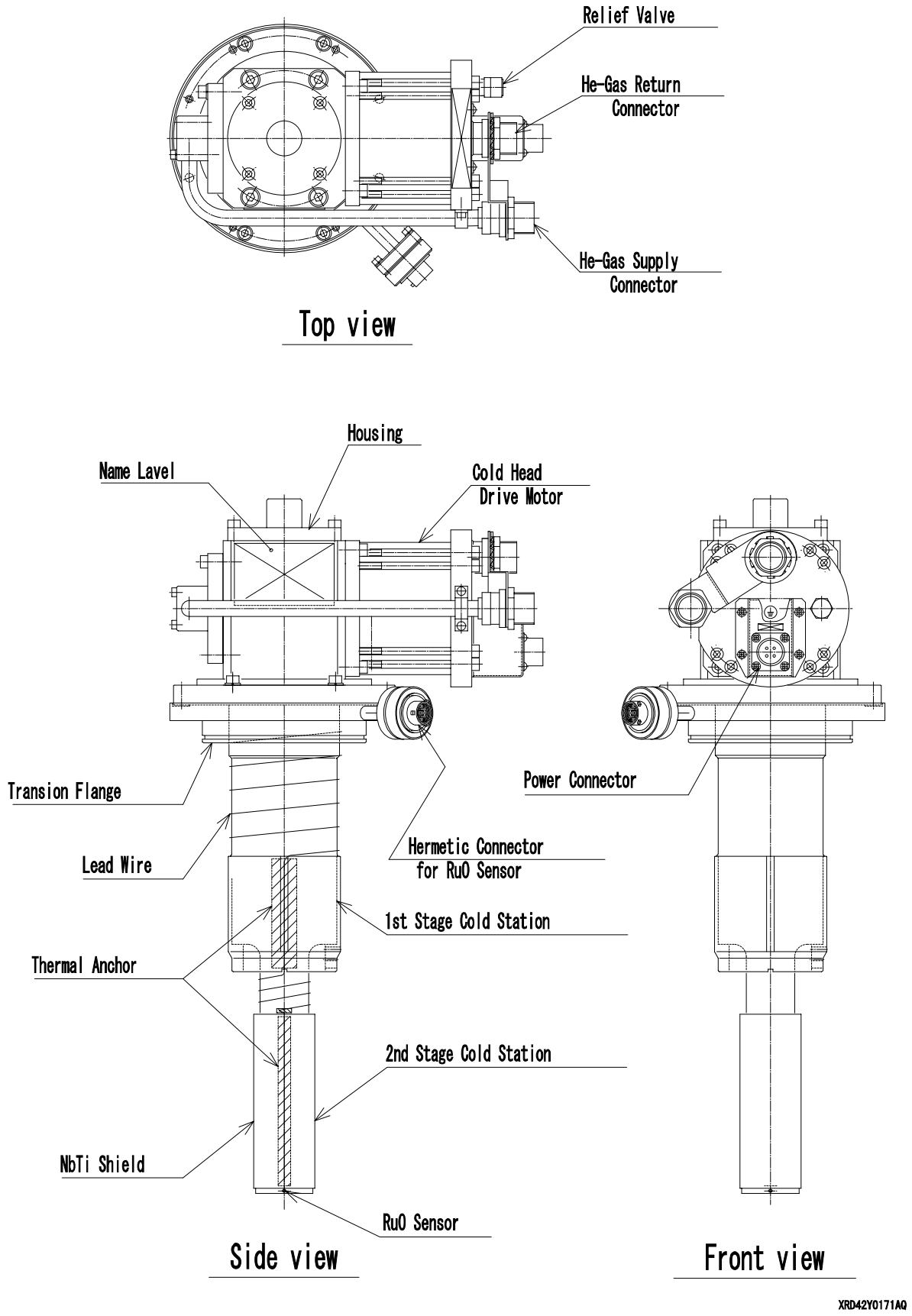


Figure 1.1 OUTLINE VIEW OF COLD HEAD MODEL RDK-408A2

1-2 CONSTRUCTION

The cross section of RDK-408A2 Cold Head is shown in **Figure 1.2.** It consists of a Cylinder, No. 1 Displacer, No. 2 Displacer, drive mechanism, and Cold Head Drive Motor. No. 1 Displacer is connected to the Scotch Yoke which can be driven by the Cold Head Drive Motor through the Crank with Bush so that the rotation of the Cold Head Drive Motor can be varied to reciprocating motion of Scotch Yoke and Displacers.

The Rotary Valve system is furnished to control the helium gas intake and exhaust timing. The Rotary Valve is also coupled to the Cold Head Drive Motor through Crank, so intake and exhaust operation is synchronized with the position of the Displacer.

The Displacer is a loose fit in the Cylinder except at the top and where it is equipped with a dynamic(sliding) seal to prevent leakage passed through the clearance between the Displacer and Cylinder.

The Displacers consist of regenerator material which cool the gas when passing downwards to the cold space and heats the gas when passing upwards from the cold space. Rear earth regenerator material is used in the 2nd stage Displacer to produce the cooling capacity at the temperature of 4.2K.

The pressure above and below the Displacer is the same except for small pressure drops across the regenerator when gas is flowing trough it. Virtually no physical work is required to move the Displacer in the Cylinder. No work is done on the gas and the gas does no work on the Displacer. The pressure in the system is increased or decreased by operation of the inlet or outlet valves.

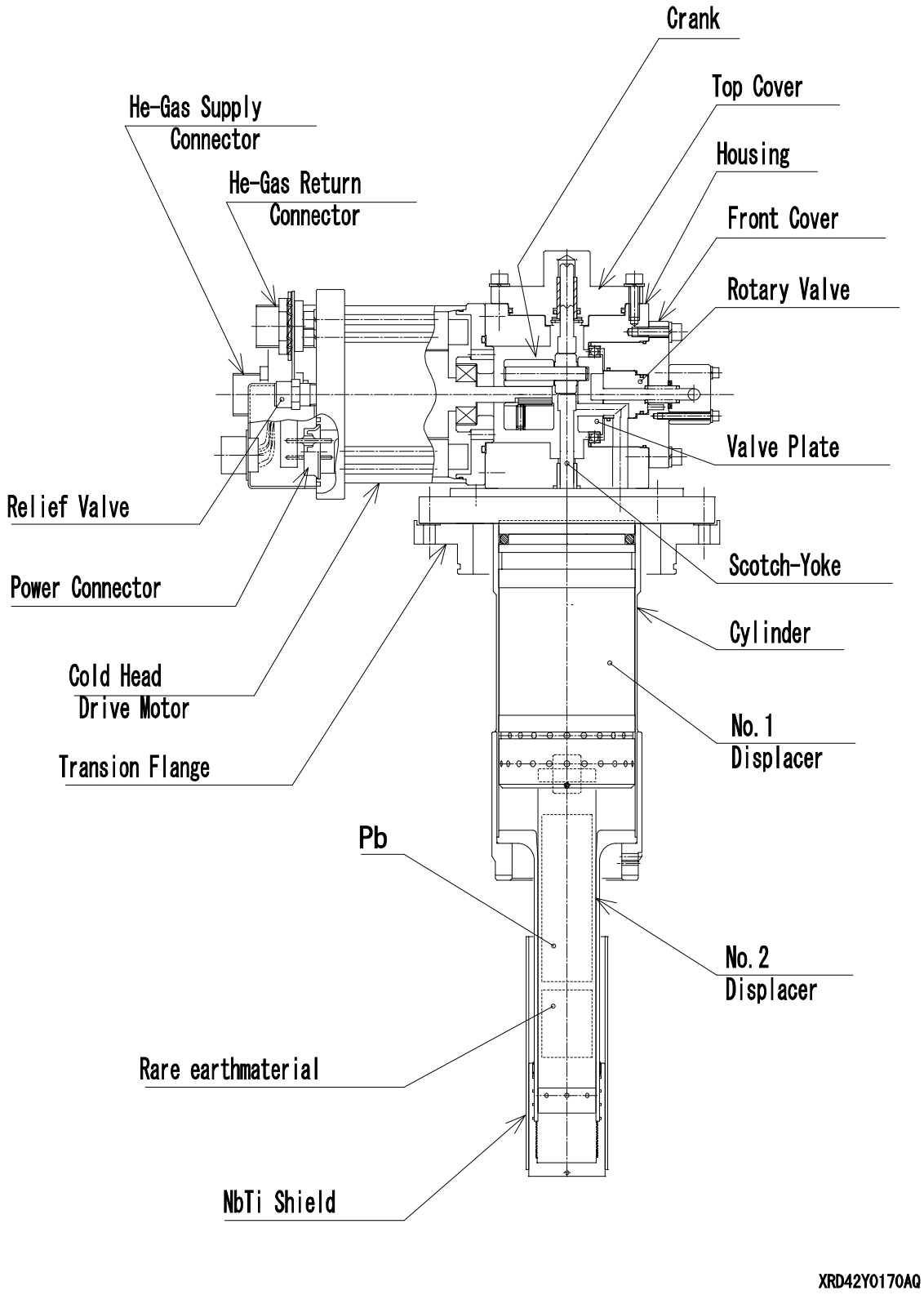


Figure 1.2 CROSS SECTION OF RDK-408A2 COLD HEAD

2 MAINTENANCE

RDK-408A2 Cold Head is to be required to replace the sliding parts inside every 10,000 Hrs.
The maintenance work is not a Use's maintenance. Replace the Cold Head completely at site and return it to Sumitomo Heavy Industries, Ltd. for refurbishment.

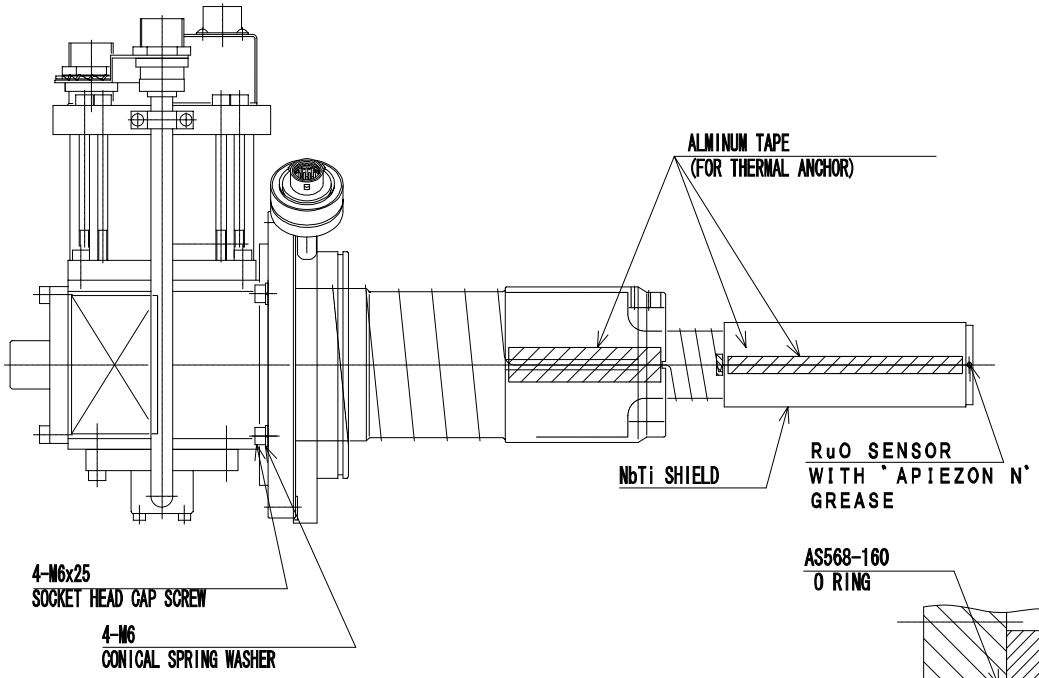
APPENDIX

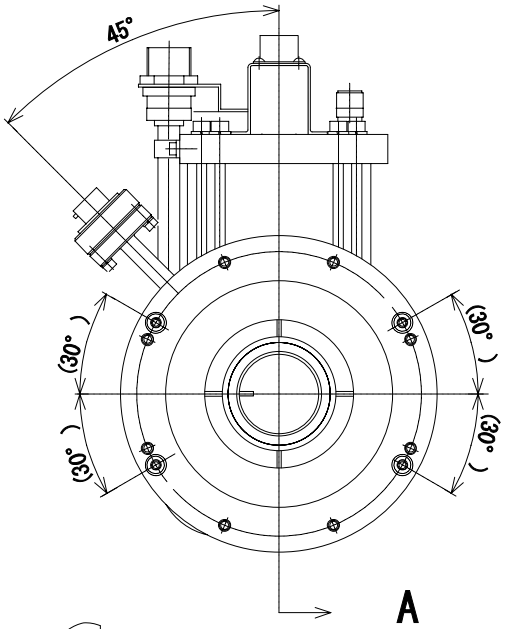
DRAWINGS

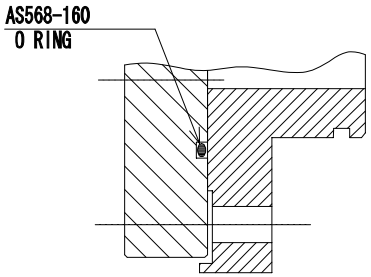
No.	PART NAME	GE PART No.	SHI PART No.
1	RDK-408A2 COLD HEAD ASSEMBLY	2218465-3	RD42ZN1079
2	RDK-408A2 COLD HEAD	-	-

NOTE

1. ASSEMBLY IS TO BE CLEAN AND FREE FROM DIRT, OIL.
2. RuO SENSOR IS TO BE INSTALLED WITH 'APIEZON N' GREASE.
3. RuO SENSOR AND WIRING TO CONNECTOR PINS ARE TO BE INSPECTED.
4. OVERALL WIRE LENGTH APPROX. 1600mm.
5. ASSEMBLYS ARE TO BE BAGGED OR BOXED AND SEALED FROM DIRT AND MOISTURE.
6. ASSEMBLY IS TO BE MARKED WITH G. E. PART NUMBER, 2218465-3.







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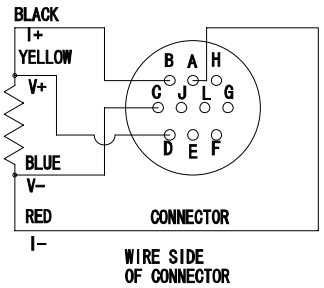
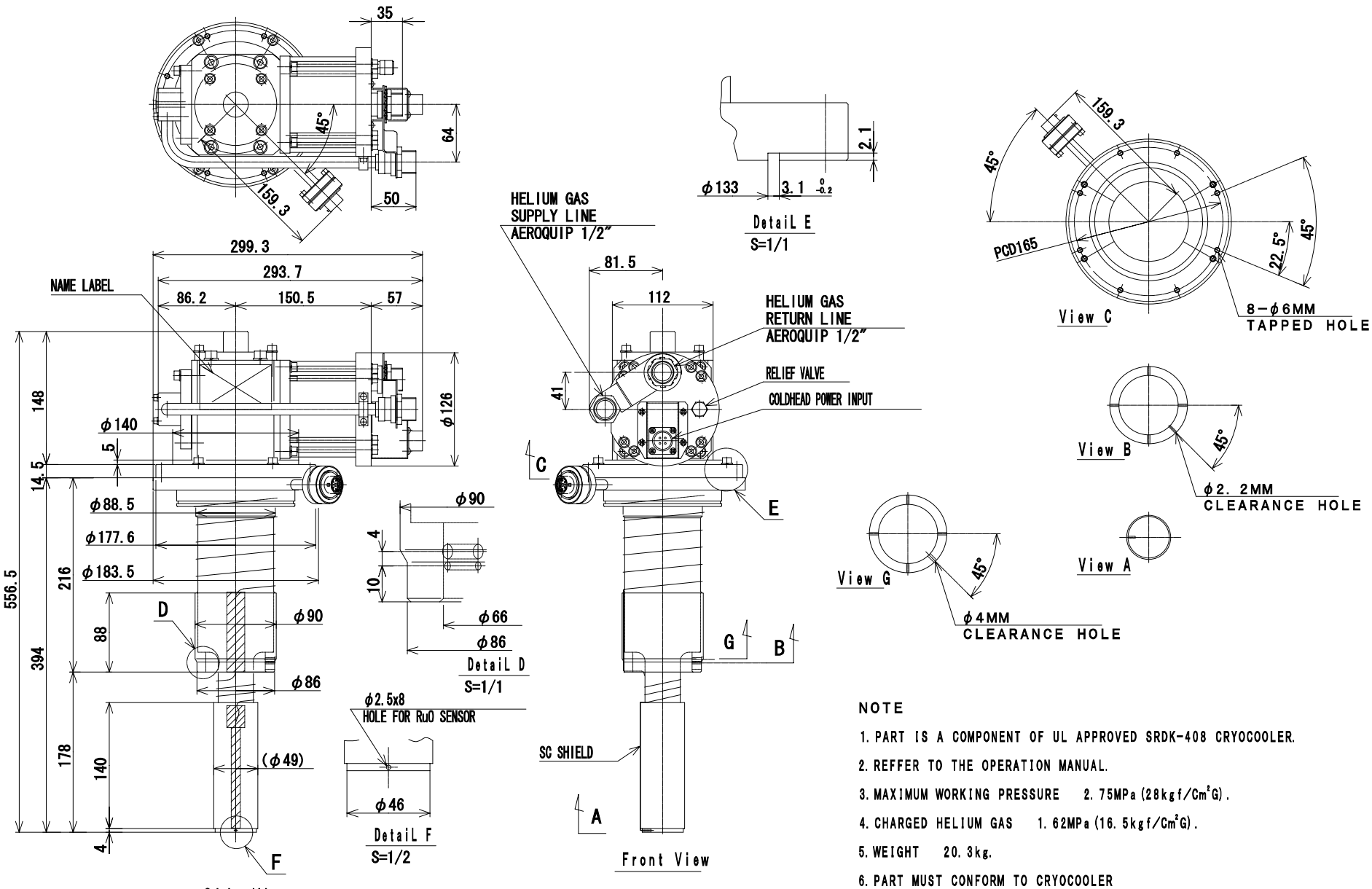


CONNECTOR IS A 10 PIN CONNECTOR WHICH MEETS DIMENSION REQUIREMENTS OF MIL-C-26482 AND MIL STD3116

XRD42Y0173AQ

RDK-408A2 COLD HEAD ASSEMBLY



NOTE

1. PART IS A COMPONENT OF UL APPROVED SRDK-408 CRYOCOOLER.
2. REFFER TO THE OPERATION MANUAL.
3. MAXIMUM WORKING PRESSURE 2.75MPa (28kgf/Cm^{2}G).
4. CHARGED HELIUM GAS 1.62MPa (16.5kgf/Cm^{2}G).
5. WEIGHT 20.3kg.
6. PART MUST CONFORM TO CRYOCOOLER SPECIFICATION 2136066GSP.

XRD42Y0182AQ

RDK-408A2 COLD HEAD

REVISION CONTROL

Manual No.	GE Revision	SHI Revision	Remarks	Date
CD32ZZ-098	Preliminary	-A	Publication of first edition.	MAY 16 / 2002
	Preliminary	-B	Change cooling capacity specification.	OCT. 31 / 2002
	Preliminary	-C	Change the outline drawing and SHI parts number.	JAN. 14 / 2003
	Revision 0	-D	This manual is included in the composite manual.	MAR. 17 / 2003

Sumitomo Heavy Industries, Ltd.

MANUAL NUMBER: CD32ZZ-058D
DATE: March 27 / 2003

TECHNICAL INSTRUCTION

RDK-408T
10K COLD HEAD
Revision 2

For Service Personnel Only

PART NUMBERS

MODEL	SHI PART No.	GE PART No.
RDK-408T 10K COLD HEAD	RD42ZN0561	2200832

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CROSS REFERENCE

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OPERATION MANUAL SRDK Series CRYOCOOLER	CD32ZZ-056
TECHNICAL INSTRUCTION CSA-71A COMPRESSOR UNIT*	CD32ZZ-060
TECHNICAL INSTRUCTION CSW-71C COMPRESSOR UNIT*	CD32ZZ-061
TECHNICAL INSTRUCTION CSW-71D COMPRESSOR UNIT*	CD32ZZ-062
INSTALLATION MANUAL BPU-01 BY PASS UNIT**	CD32ZZ-075

* See the TECHNICAL INSTRUCTION of Compressor Unit used.
** See the INSTALLATION MANUAL of BPU-01, if the BPU-01 is used in this system.

1 GENERAL INFORMATION

The RDK-408T Cold Head is a two-stage 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, in the range of 25 K to 40 K for the first-stage cold station and in the range of 6 K to 10 K for the second-stage cold station.
The Cold Head has three major components: the drive unit; the cylinder; and the displacer-regenerator assembly, which is located inside the cylinder.
With newly developed very unique 2nd stage structure, the model RDK-408T Cold Head has its 2nd stage refrigeration capacity of 5W at 10K.

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 be provided cooling condition for the first and second-stage cold stations.

1-1 SPECIFICATIONS

The specifications of the RDK-408T Cold Head are summarized in **Table 1.1**
Figure 1.1 shows the outline view of Cold Head.

Table 1.1 RDK-408T COLD HEAD SPECIFICATION

Refrigeration Capacity	
First Stage	30 W at 45 K
Second Stage	5 W at 10 K
Orientation	Any Capacity Loss: Max. 15%
Ambient Operating Temperature	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
Helium Gas Pressure	
Static	1.45 - 1.50 MPa at 20 deg.C (68 deg.F) (14.8 - 15.3 kgf/cm^{2}G, 210 - 217 psig)
Operating (High Side)*	2.10 - 2.30 MPa --- approx. (21.4 - 23.5 kgf/cm^{2}G, 319 - 333 psig)
Pressure Relief Valve Setting	1.86 - 1.96 MPa (19.0 - 20.0 kgf/cm^{2}G, 270 - 284 psig)
Gas Supply Connector	1/2-inch Coupling
Gas Return Connector	1/2-inch Coupling
Dimension	
Width	180 mm (7.09')
Length	288 mm (11.33')
Height	520 mm (20.47')
Weight	17.2 kg (37.9 LBS) --- approx.

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

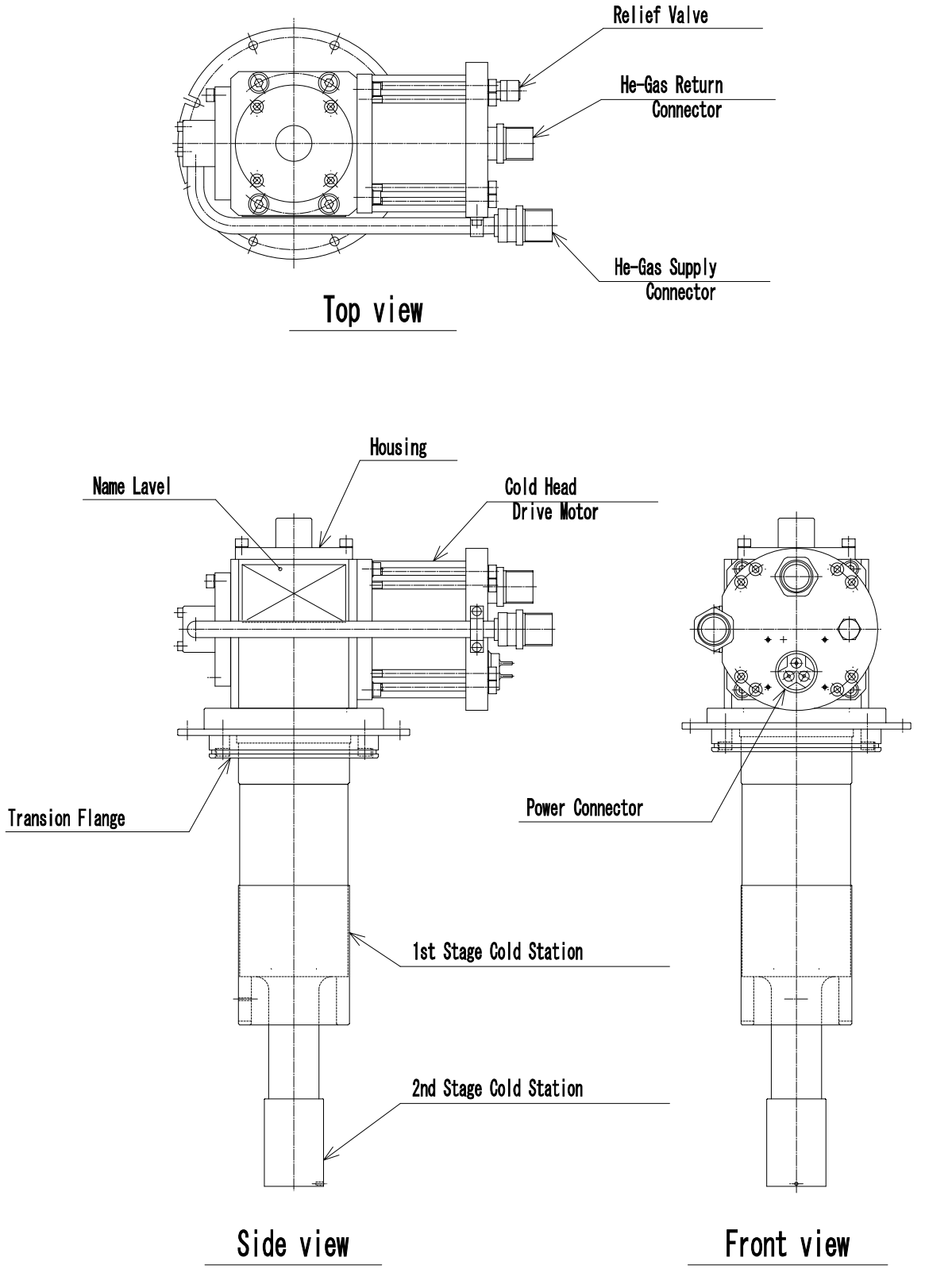


Figure 1.1 OUTLINE VIEW OF COLD HEAD MODEL RDK-408T

1-2 CONSTRUCTION

The cross section of the RDK-408T Cold Head is shown in **Figure 1.2.** It consists of a Cylinder, No.1 Displacer, No.2 Displacer, drive mechanism, and Cold Head Drive Motor. No.1 Displacer is connected to the Scotch Yoke which can be driven by the Cold Head Drive Motor through the Crank with Bush so that the rotation of the Cold Head Drive Motor can be varied to reciprocating motion of Scotch Yoke and Displacers.

The Rotary Valve system is furnished to control the helium gas intake and exhaust timing. The Rotary Valve is also coupled to the Cold Head Drive Motor through Crank, so intake and exhaust operation is synchronized with the position of the Displacer.

The Displacer is a loose fit in the Cylinder except at the top and where it is equipped with a dynamic(sliding) seal to prevent leakage passed through the clearance between the Displacer and Cylinder.

The Displacers consist of regenerator material which cool the gas when passing downwards to the cold space and heats the gas when passing upwards from the cold space.

The pressure above and below the Displacer is the same except for small pressure drops across the regenerator when gas is flowing trough it. Virtually no physical work is required to move the Displacer in the Cylinder. No work is done on the gas and the gas does no work on the Displacer. The pressure in the system is increased or decreased by operation of the inlet or outlet valves.

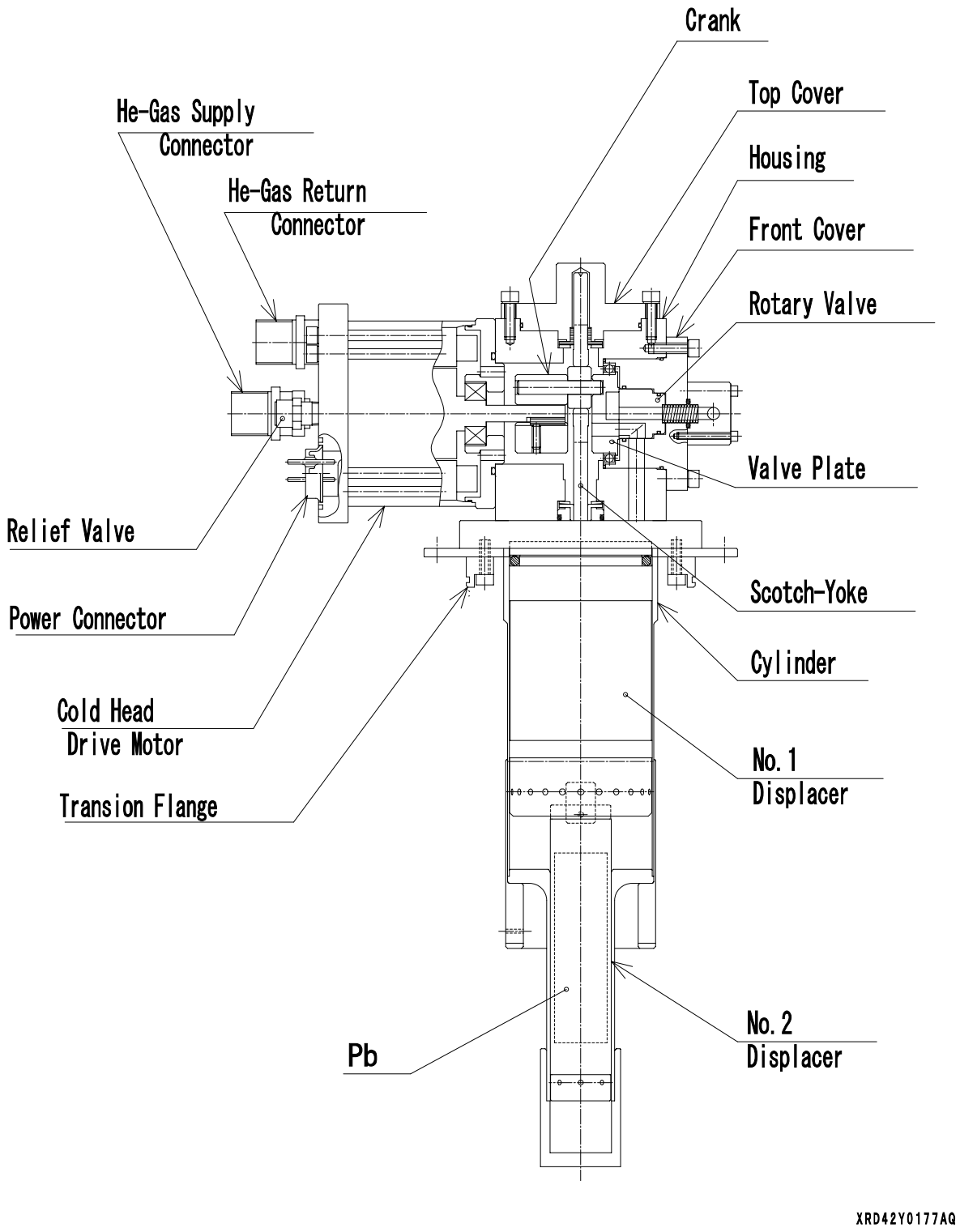


Figure 1.2 CROSS SECTION OF THE RDK-408T COLD HEAD

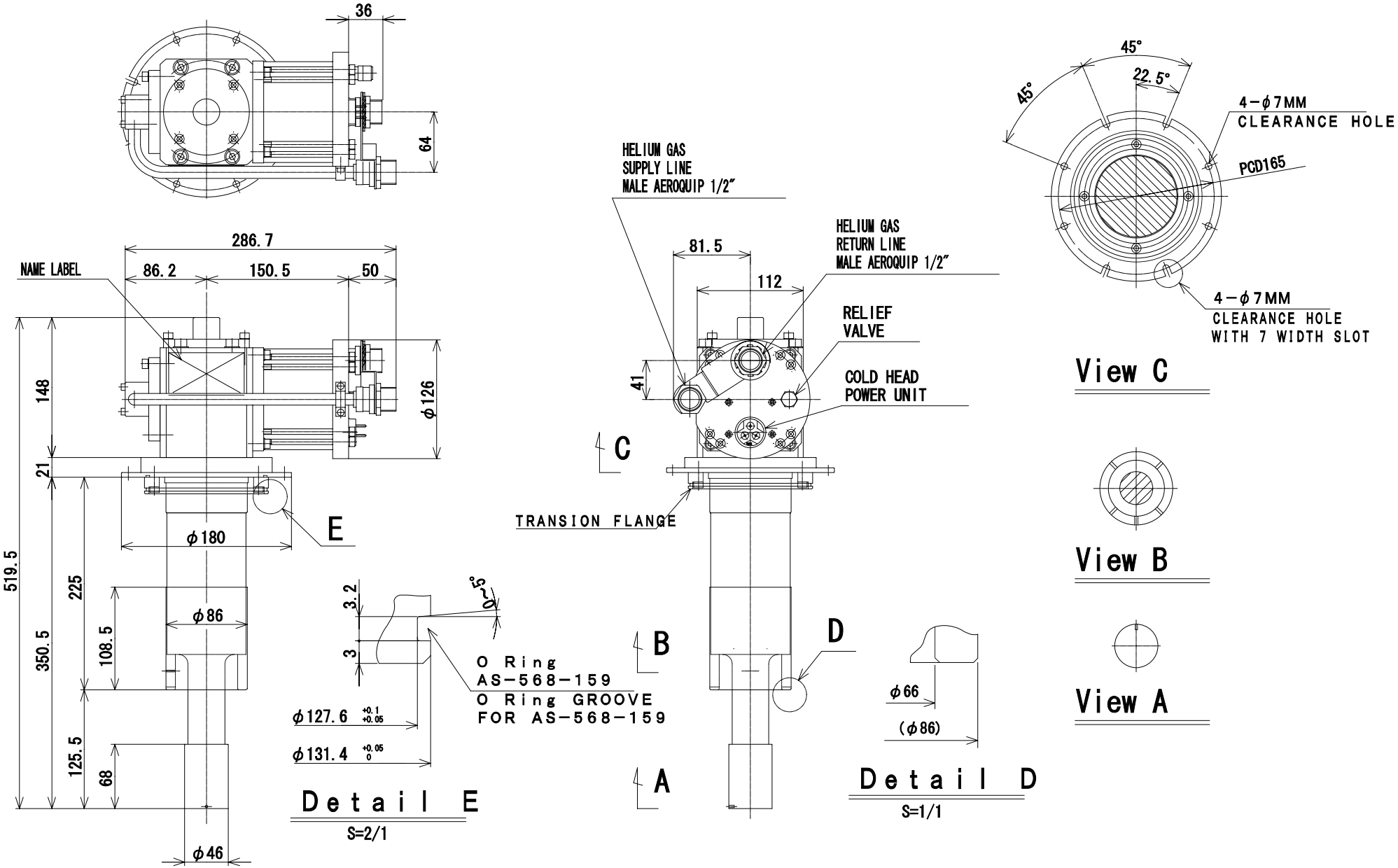
2 MAINTENANCE

The RDK-408T Cold Head is to be required to replace the sliding parts inside every 10,000 Hrs.
The maintenance work is not a Use's maintenance. Replace the Cold Head completely at site and return it to Sumitomo Heavy Industries, Ltd. for refurbishment.

APPENDIX

DRAWINGS

No.	PART NAME	GE PART No.	SHI PART No.
1	RDK-408T COLD HEAD	2200832	RD42ZN0561



XRD42Y0178AQ

RDK-408T COLD HEAD

REVISION CONTROL

Manual No.	GE Revision	SHI Revision	Remarks	Date
CD32ZZ-058	Revision 2	-A	Publication of first edition.	DEC. 20 / 1999
	Revision 2	-B	Add the description of BPU-01.	MAR. 30 / 2000
	Revision 2	-C	Change the SHI address.	JAN. 25 / 2001
	Revision 2	-D	Correct the Spec. of 1st Stage Cooling Capacity.	MAR. 27 / 2003

Sumitomo Heavy Industries, Ltd.

MANUAL NUMBER: CD32ZZ-059D
DATE: September 25 / 2001

TECHNICAL INSTRUCTION

RDK-400
SINGLE STAGE COLD HEAD

Revision 0

For Service Personnel Only

PART NUMBERS

MODEL	SHI PART No.	GE PART No.
RDK-400 SINGLE STAGE COLD HEAD	RD45ZN0722	2244334

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CROSS REFERENCE

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OPERATION MANUAL SRDK Series CRYOCOOLER	CD32ZZ-056
TECHNICAL INSTRUCTION CSA-71A COMPRESSOR UNIT*	CD32ZZ-060
TECHNICAL INSTRUCTION CSW-71C COMPRESSOR UNIT*	CD32ZZ-061
TECHNICAL INSTRUCTION CSW-71D COMPRESSOR UNIT*	CD32ZZ-062
INSTALLATION MANUAL BPU-01 BY PASS UNIT**	CD32ZZ-075

* See the TECHNICAL INSTRUCTION of Compressor Unit used.
** See the INSTALLATION MANUAL of BPU-01, if the BPU-01 is used in this system.

1 GENERAL INFORMATION

The RDK-400 Cold Head is a single-stage 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, in the range of 25 K to 40 K for the first-stage cold station.

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

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 be provided cooling condition for the first and second-stage cold stations.

1-1 SPECIFICATIONS

The specifications of the RDK-400 Cold Head are summarized in **Table 1.1**
Figure 1.1 shows the outline view of Cold Head.

Table 1.1 RDK-400 COLD HEAD SPECIFICATION

Refrigeration Capacity First Stage	 54 W at 40 K
Orientation	Any Capacity Loss: Max. 15%
Ambient Operating Temperature	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
Helium Gas Pressure Static Operating (High Side)*	 1.45 - 1.50 MPa at 20 deg.C (68 deg.F) (14.8 - 15.3 kgf/cm^{2}G, 210 - 217 psig) 2.10 - 2.30 MPa --- approx. (21.4 - 23.5 kgf/cm^{2}G, 319 - 333 psig)
Pressure Relief Valve Setting	1.86 - 1.96 MPa (19.0 - 20.0 kgf/cm^{2}G, 270 - 284 psig)
Gas Supply Connector **Gas Return Connector**	1/2-inch Coupling 1/2-inch Coupling
Dimension Width Length Height	 180 mm (7.09') 294 mm (11.58') 380 mm (14.97')
Weight	17.8 kg (37.9 LBS) --- approx. (Including Transition Flange)

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

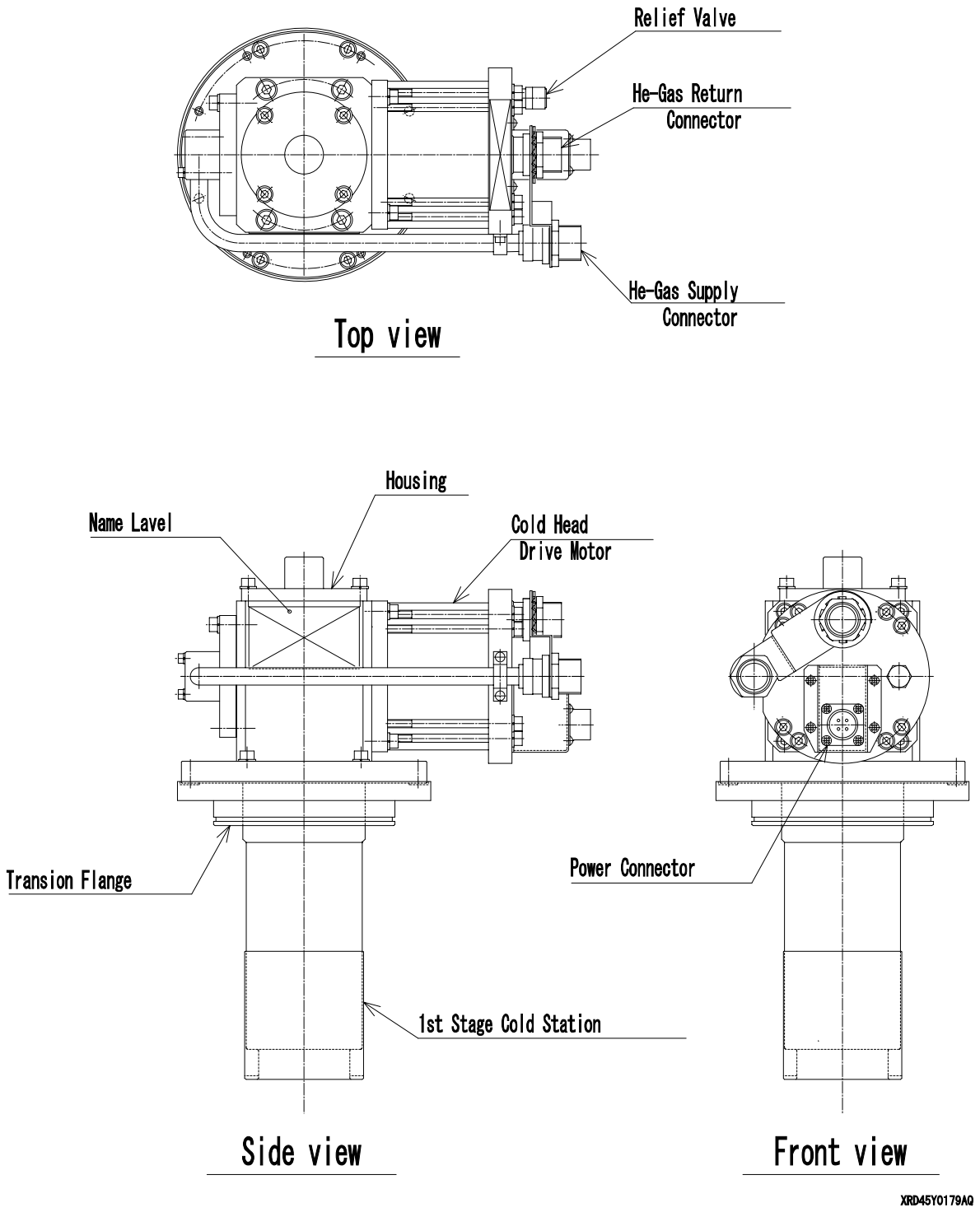


Figure 1.1 OUTLINE VIEW OF COLD HEAD MODEL RDK-400

1-2 CONSTRUCTION

The cross section of the RDK-400 Cold Head is shown in **Figure 1.2.** It consists of a Cylinder, Displacer, drive mechanism, and Cold Head Drive Motor. Displacer is connected to the Scotch Yoke which can be driven by the Cold Head Drive Motor through the Crank with Bush so that the rotation of the Cold Head Drive Motor can be varied to reciprocating motion of Scotch Yoke and Displacers.

The Rotary Valve system is furnished to control the helium gas intake and exhaust timing. The Rotary Valve is also coupled to the Cold Head Drive Motor through Crank, so intake and exhaust operation is synchronized with the position of the Displacer.

The Displacer is a loose fit in the Cylinder except at the top and where it is equipped with a dynamic(sliding) seal to prevent leakage passed through the clearance between the Displacer and Cylinder.

The Displacers consist of regenerator material which cool the gas when passing downwards to the cold space and heats the gas when passing upwards from the cold space.

The pressure above and below the Displacer is the same except for small pressure drops across the regenerator when gas is flowing trough it. Virtually no physical work is required to move the Displacer in the Cylinder. No work is done on the gas and the gas does no work on the Displacer. The pressure in the system is increased or decreased by operation of the inlet or outlet valves.

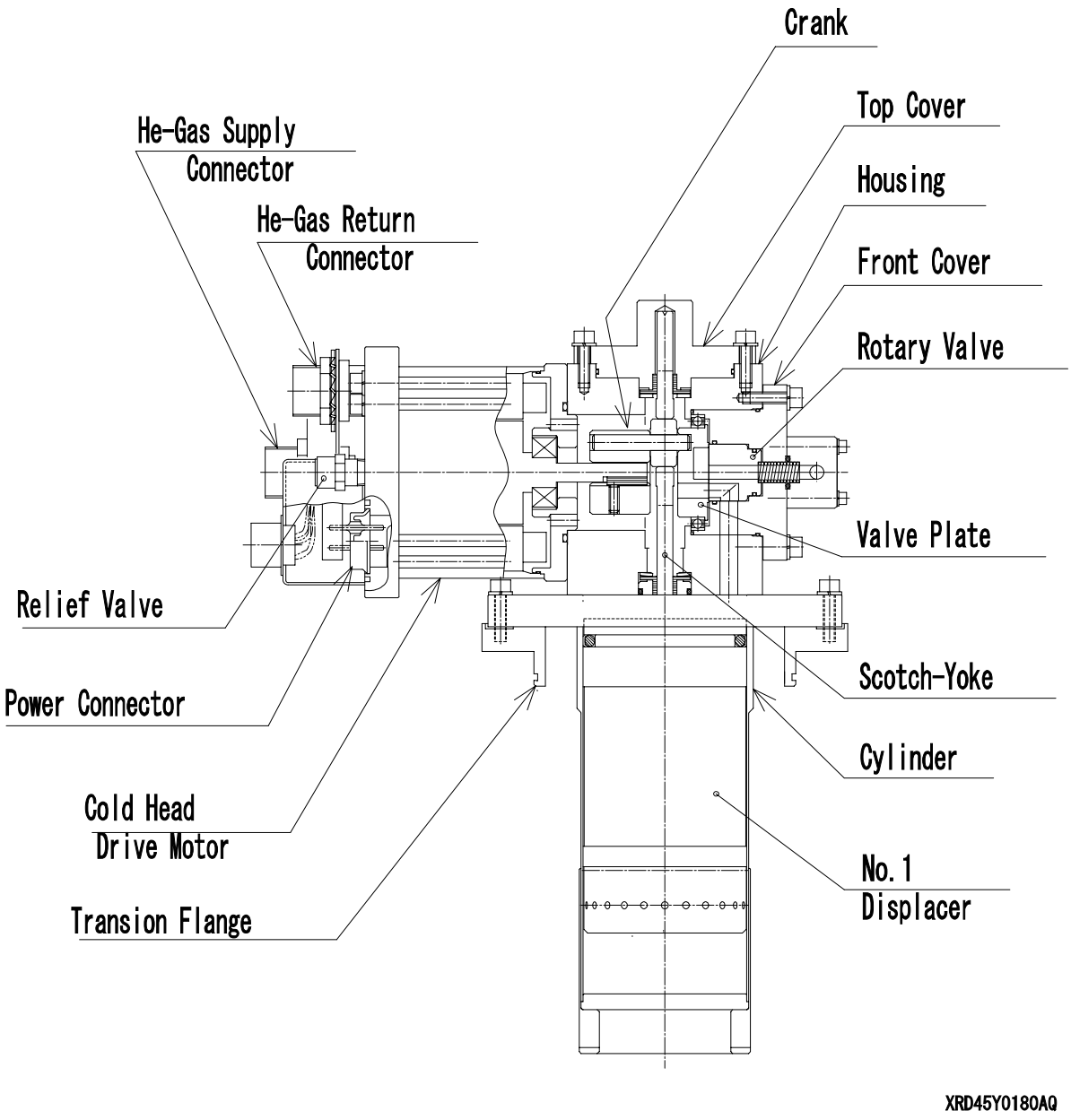


Figure 1.2 CROSS SECTION OF THE RDK-400 COLD HEAD

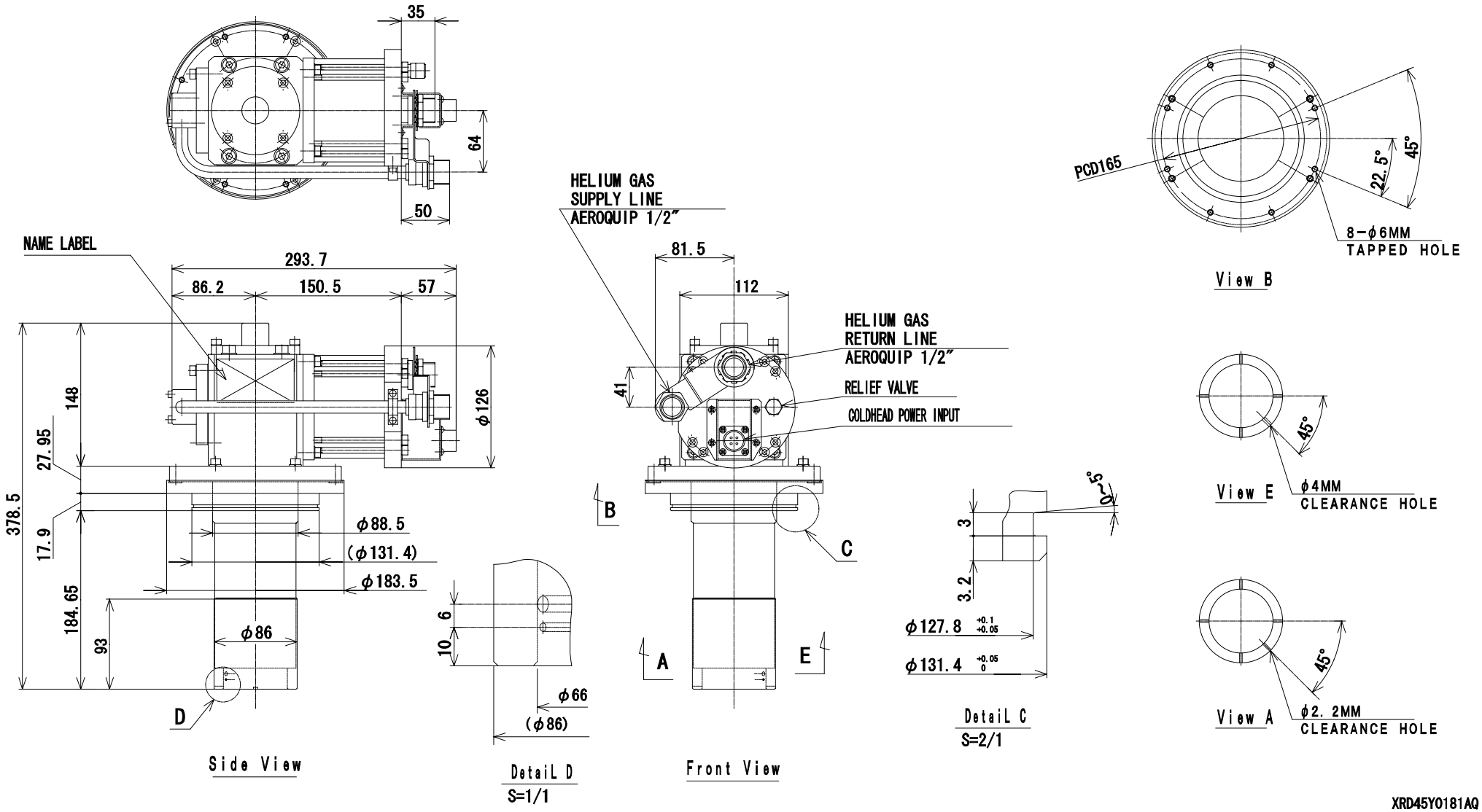
2 MAINTENANCE

The RDK-400 Cold Head is to be required to replace the sliding parts inside every 10,000 Hrs.
The maintenance work is not a Use's maintenance. Replace the Cold Head completely at site and return it to Sumitomo Heavy Industries, Ltd. for refurbishment.

APPENDIX

DRAWINGS

No.	PART NAME	GE PART No.	SHI PART No.
1	RDK-400 COLD HEAD	2244334	RD45ZN0722



RDK-400 COLD HEAD

REVISION CONTROL

Manual No.	GE Revision	SHI Revision	Remarks	Date
CD32ZZ-059	Revision 0	-A	Publication of first edition.	DEC. 20 / 1999
	Revision 0	-B	Add the description of BPU-01.	MAR. 30 / 2000
	Revision 0	-C	Change the SHI address.	JAN. 25 / 2001
	Revision 0	-D	Change the drawing of RDK-400	SEP. 25 / 2001

Sumitomo Heavy Industries, Ltd.

MANUAL NUMBER: CD32ZZ-060H
DATE: March 17 / 2003

TECHNICAL INSTRUCTION

CSA-71A
COMPRESSOR UNIT
Revision 2

For Service Personnel Only

PART NUMBERS

MODEL	SHI PART No.	GE PART No.
CSA-71A COMPRESSOR UNIT	RE71ZH0136	2166592

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E-mail: cryo@shi.co.jp

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CROSS REFERENCE

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

MANUAL NAME	MANUAL No.
OPERATION MANUAL SRDK Series CRYOCOOLER	CD32ZZ-056
TECHNICAL INSTRUCTION RDK-408A2 4K COLD HEAD*	CD32ZZ-098
TECHNICAL INSTRUCTION RDK-408 4K COLD HEAD*	CD32ZZ-057
TECHNICAL INSTRUCTION RDK-408T 10K COLD HEAD*	CD32ZZ-058
TECHNICAL INSTRUCTION RDK-400 SINGLE STAGE COLD HEAD*	CD32ZZ-059
INSTALLATION MANUAL BPU-01 BY PASS UNIT**	CD32ZZ-075

* See the TECHNICAL INSTRUCTION of Cold Head used.

** See the INSTALLATION MANUAL of BPU-01, if BPU-01 is used in this system.

1 GENERAL INFORMATION

1-1 SPECIFICATIONS

The specifications of CSA-71A Helium Compressor Unit are summarized in **Table 1.1**.

Table 1.1 CSA-71A COMPRESSOR UNIT SPECIFICATION

	For **RDK-408A2** For **RDK-408**	For **RDK-408T** For **RDK-400**
Dimension		
Width	550.0 mm (21.7')	
Length	550.0 mm (21.7')*	
Height	885.0 mm (34.8')	
Helium Gas Pressure		
Static	1.60 - 1.65 MPa at 20 deg.C (68 deg.F) (16.3 - 16.8 kgf/cm^{2}G) (232 - 239 psig)	1.45 - 1.50 MPa at 20 deg.C (68 deg.F) (14.8 - 15.3 kgf/cm^{2}G) (210 - 217 psig)
Operating (High Side)**	2.10 - 2.30 MPa --- approx. (21.4 - 23.5 kgf/cm^{2}G) (319 - 333 psig)	2.10 - 2.30 MPa --- approx. (21.4 - 23.5 kgf/cm^{2}G) (319 - 333 psig)
Ambient Operating Temperature	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	
Weight	140 kg (309 LBS) --- approx.	
Electrical Requirement		
Power Line Voltage (+/-10%)	AC 200V / 50, 60 Hz, 3 phase (3W+PE) (**Δ** ground, Commercial Power Source) ***"WARNING"*** ***Do not use inverter for the main power source.***	
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 ***See the ELECTRICAL SCHEMATIC of "APPENDIX" for detail.***	
BTU Output	Max. 28,320 BTU/H / Steady State 25,590 BTU/H at 60Hz Max. 24,570 BTU/H / Steady State 22,180 BTU/H at 50Hz	
Pressure Relief Valve Setting	2.61 - 2.75 MPa (26.6 - 28.0 kgf/cm^{2}G, 378 - 398 psig)	
Gas Supply Connector **Gas Return Connector**	1/2-inch Coupling 1/2-inch Coupling	

* Input Power Cable Terminal Cover is 98.0 mm (3.9'). See the **Figure 1.1**.

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

"IMPOTANT"

Note that the noise level of the whole equipment may exceed 70 dBA depending on the environment it is used in.

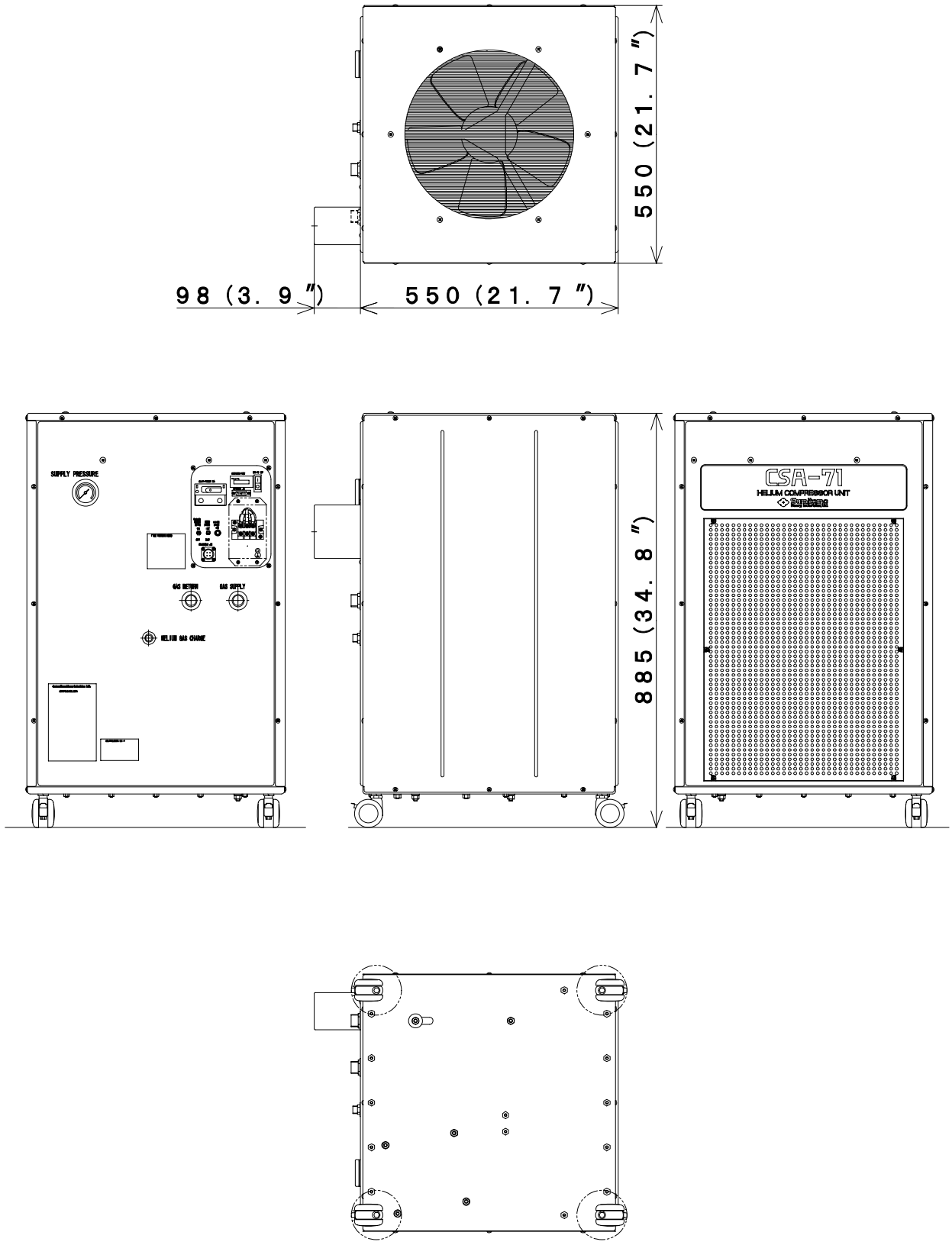


Figure 1.1 OUTLINE VIEW FOR CSA-71A COMPRESSOR UNIT

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 couplings for CSA-71A are described in **Table 1.2** and **Figure 1.2**.

Table 1.2 CONTROLS AND COUPLINGS FOR CSA-71A COMPRESSOR UNIT

No.	ITEM	FUNCTIONS
1	MAIN POWER SWITCH : (DS)	A twist handle for main electric power supply and for protection from over-current and short-circuit.
2	DRIVE SWITCH : (S1)	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 : (S2)	A switch for operating the COLD HEAD maintenance only. Under the MAIN POWER SWITCH "ON" and the DRIVE SWITCH "OFF". ***Caution;*** *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.*
4	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.
5	HOUR METER : (HM)	To indicate a total operating hour of the compressor unit, and the hour counting will be referred for maintenance interval.
6	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.
7	GROUND TERMINAL	A connector for the earth wiring, and verify the tight connecting for earth wiring as well as power cable.
8	COLD HEAD CONNECTOR : (JC)	To use for connecting the Cold Head Cable to supply a Cold Head driving power.
9	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;*** *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.*
10	HE-GAS SUPPLY CONNECTOR	To use for connecting a Flex Line (for Supply He-gas line)
11	HE-GAS RETURN CONNECTOR	To use for connecting a Flex Line (for Return He-gas line)
12	HE-GAS CHARGE CONNECTOR	To use for charging and refilling a He-gas.

Table 1.2 CONTROLS AND COUPLINGS FOR CSA-71A COMPRESSOR UNIT (Continued)

13	AIR SUCTION GRID	An inlet of cooling air for the Compressor Unit.
14	AIR DISCHARGE GRID	An outlet of cooling air for the Compressor Unit.
15	REMOTE DRIVE SWITCH : (S3)	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.
16	INDICATING LAMP : (HL)	To indicate an Open/Shut condition of the Solenoid Valve (SV) ; Solenoid Valve : “Shut” ----- the Lamp “ON” “Open” ----- the Lamp “OFF”

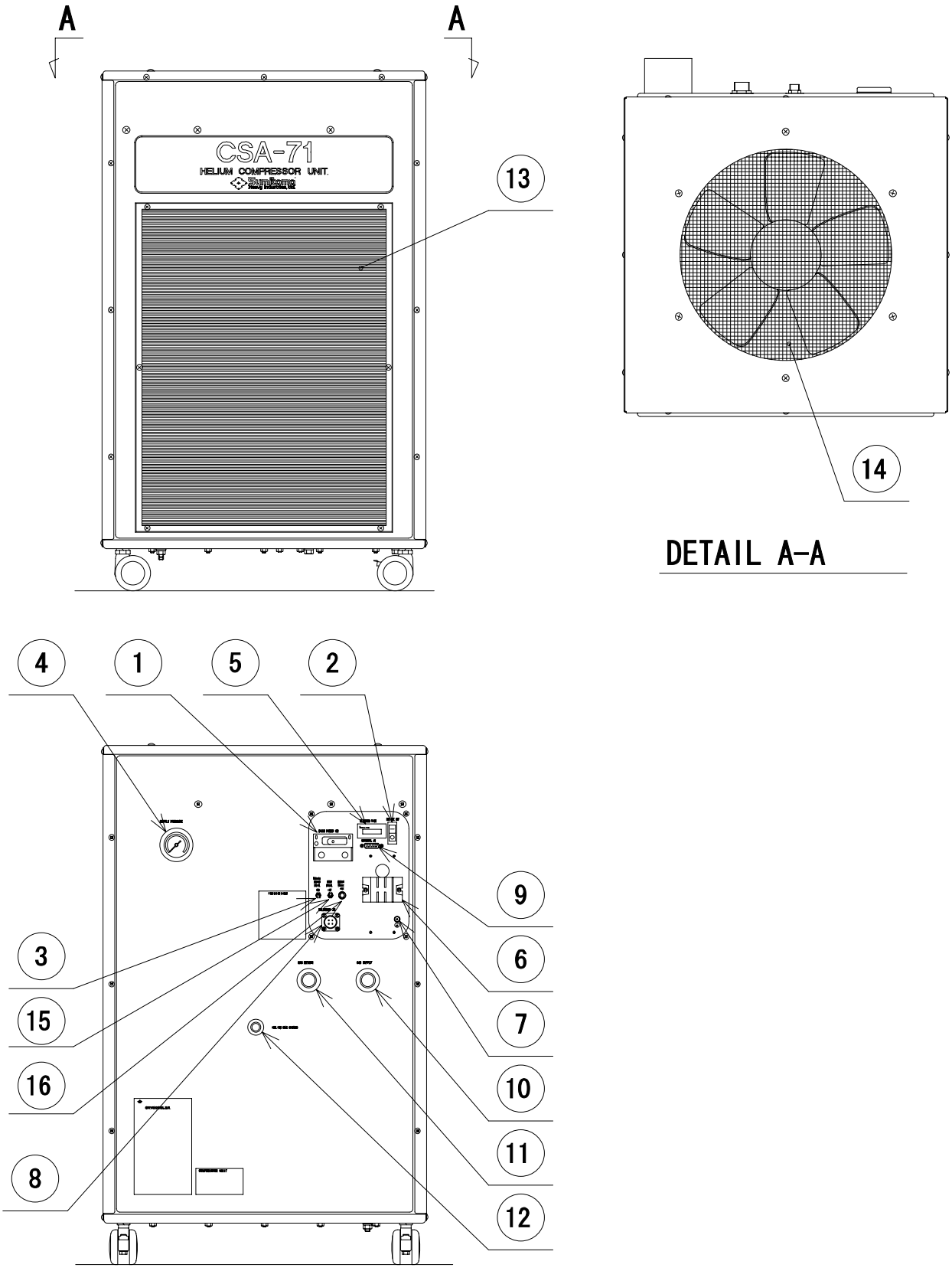


Figure 1.2 CONTROLS AND COUPLINGS FOR CSA-71A COMPRESSOR UNIT

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

The flow diagram for CSA-71A Compressor Unit is shown in **Figure 1.3**.
Internal components diagram and its functions are described in **Figure 1.4** and **Table 1.3**.

The Compressor Unit works as follows;

1) Low pressure He gas (Press.: 0.59 MPa (6.0 kgf/cm^{2}G, 85psig) & below) 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 an air 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**.

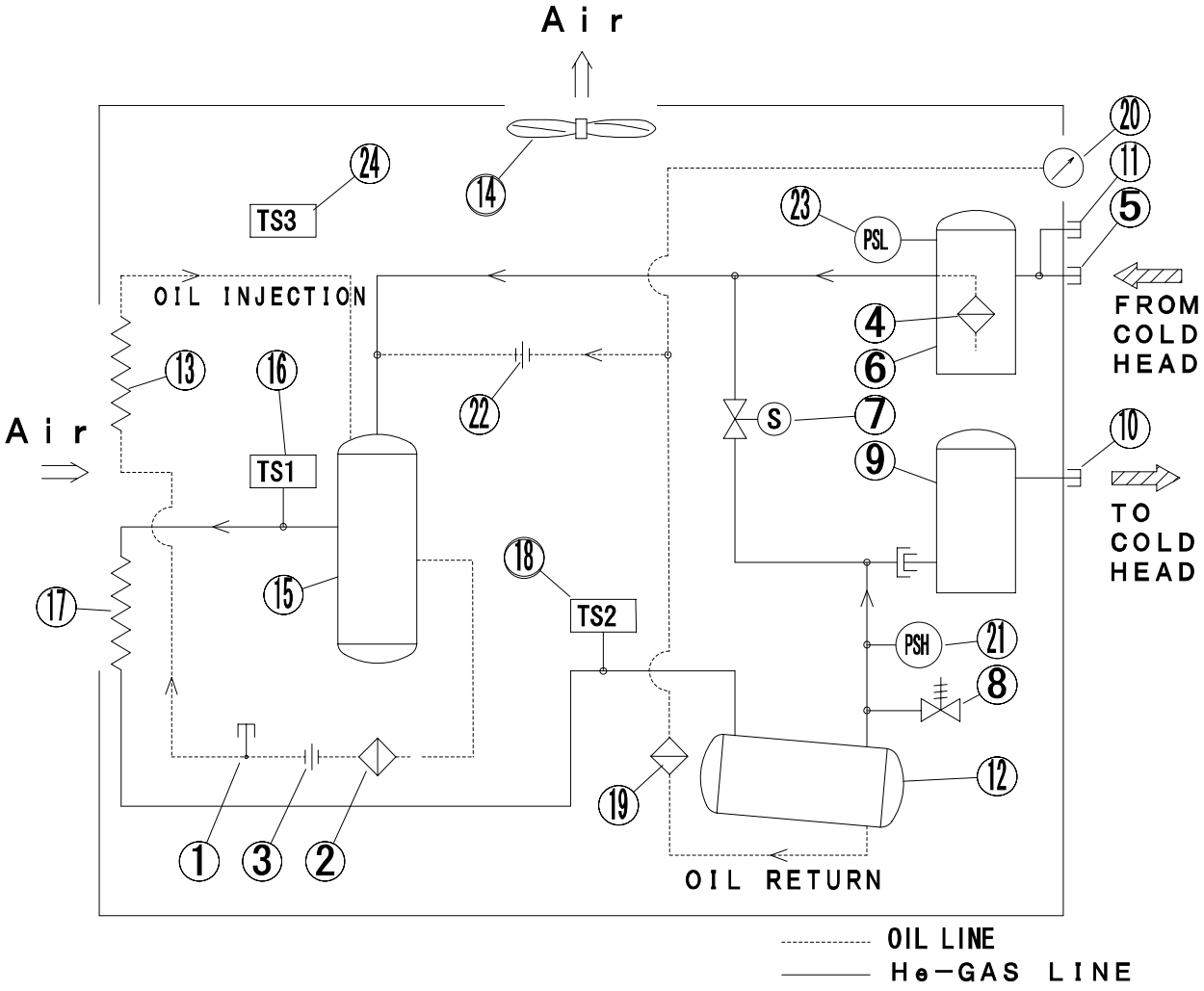


Figure 1.3 HELIUM GAS FLOW DIAGRAM FOR CSA-71A COMPRESSOR UNIT

1-2-3 INTERNAL COMPONENTS

The parts list and its functions are described in **Table 1.3**.
The He-gas flow diagram and internal components are shown in **Figure 1.3** and **Figure 1.4**.

Table 1.3 FUNCTIONS OF THE INTERNAL COMPONENTS FOR CSA-71A 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.
3	ORIFICE	To use for adjusting a recirculating lub flow.
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	An air cooled type heat exchanger for recirculating lub oil.
14	FAN	A cooling forced draft fan for a Compressor Unit.
15	COMPRESSOR CAPSULE	A He-gas compressed for the unit.
16	THERMOSTAT : TS1 110 deg.C (230 deg.F)	A thermal sensor & controller for the compressed He-gas temperature of compressor capsule outlet.
17	HE-GAS COOLER	An air cooled type heat exchanger for compressed He-gas.
18	THERMOSTAT : TS2 60 deg.C (140 deg.F)	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 55 deg.C (131 deg.F)	A thermal sensor & controller for the air temperature inside an enclosure of the unit.
28	CONTROL BOX	An electronic control, surveillance and alarming system for the He-gas Compressor Unit.

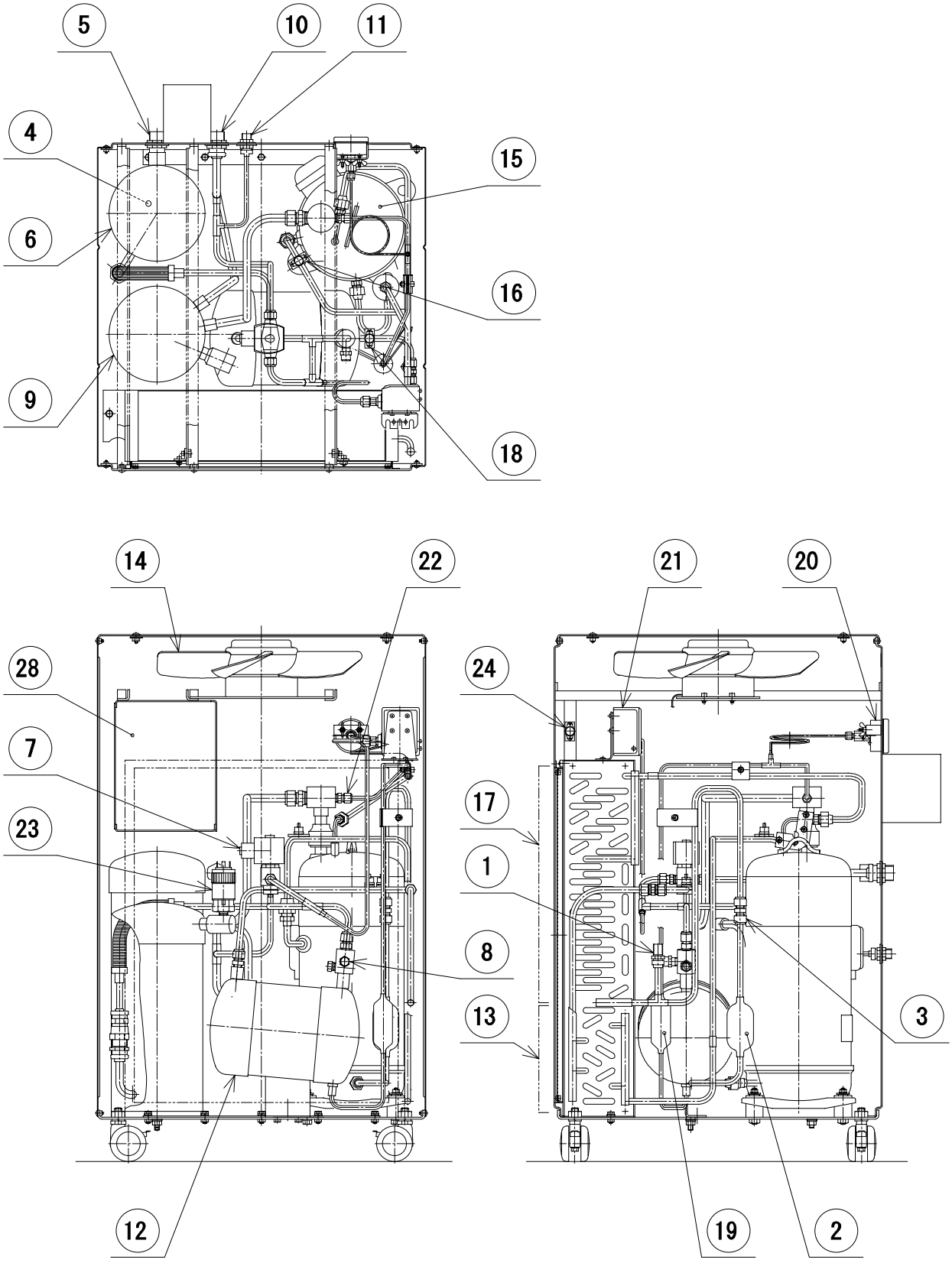
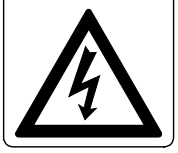


Figure 1.4 COMPONENTS OF CSA-71A COMPRESSOR UNIT

1-3 ELECTRICAL DESCRIPTION

1-3-1 EXTERNAL CONNECTOR

WARNING



<Warning about 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.

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

"IMPORTANT"

See "ELECTRICAL SCHEMATIC" of CSA-71A Compressor Unit, for detail.

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 1.4**.
"D-sub" pins indicated in **Figure 1.5** 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 1.4** can be identified simply an actual operation condition of the Compressor Unit in the field.

Table 1.4 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	Room Temp. Alarm Signal	Contact	Normal	Close	9, 10	> 10^6 ohm
			Alarm	Open		
4	Drive Indication	DC Power	Normal	24VDC(0.15A max.)	6, 7	0 V
			Alarm	0V		
5	Control Voltage	DC Power	Normal	24VDC(0.15A max.)	7, 13	0 V
			Alarm	0V		
6	Remote Reset	Relay	Pulsed 24VDC for 1 second to be furnished by user.		12, 14	
7	Remote Drive	Contact	Drive	Close	8, 15	
			Stop	Open		

* Digital Volt./Ohm Meter Reading

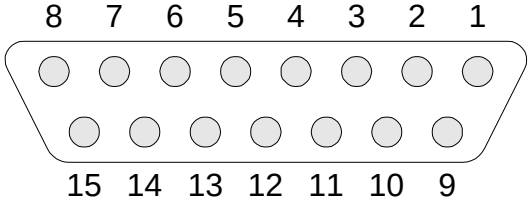


Figure 1.5 EXTERNAL CONNECTOR WIRING ON THE COMPRESSOR UNIT

1-3-2 SAFETY DEVICES

The safety devices list for Compressor Unit is shown in **Table 1.5**.

Table 1.5 SAFETY DEVICES OF CSA-71A

ITEM	FUNCTIONS
THERMOSTAT : (TS1)	Setting temperature; 110 deg.C (230 deg.F) ---- 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 (140 deg.F) ---- 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; 55 deg.C (131 deg.F) ---- approx. To signal a higher temperature alarm to the External Connector, in case of higher temperature of ambient inside the unit enclosure than the setting temperature.
SOLENOID VALVE : (SV)	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. (26.0 kgf/cm^{2}G, 370 psig) "Reset" 2.26 MPa ---- approx. (23.0 kgf/cm^{2}G, 327 psig) 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. (1.5 kgf/cm^{2}G, 21 psig) 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 (26.6 - 28.0 kgf/cm^{2}G, 378 - 398 psig) "Reset" 2.50 MPa ---- minimum (25.5 kgf/cm^{2}G, 362 psig) 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.

Table 1.5 SAFETY DEVICES OF CSA-71A (Continued)

MAIN POWER SWITCH : (DS)	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 RELAY : (RPR)	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 : (F1, F2, F3)	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 Phase Failure Relay.
FUSE : (F4, F5, F6)	To protect the Compressor Unit from the over-load caused by short-circuit and/or any other electrical failure in the Cooling Fan assembly.
FUSE : (F7, F8, F9)	To protect the Compressor Unit from the over-load caused by short-circuit and/or any other electrical failure in the Cold Head assembly.
THERMAL PROTECTOR : (for Cooling Fan)	Setting temperature; 135 deg.C (275 deg.F) ---- approx. To terminate the Cooling Fan operation by a function of disconnecting the Input Power at the setting temperature, in case of higher temperature than the normal condition caused by over-load and/or any other electrical failure in the Cooling Fan assembly.

2 INSTALLATION

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.

For CSA-71A (air cooled, low voltage type), sufficient space is required for venting. Failing to secure sufficient space may result in misoperation or malfunction.

CSA-71A (air cooled, low voltage type) 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.

- 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.
- 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 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 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.

ROOM TEMPERATURE

Ensure the room temperature to meet the specification shown in **Table 1.1**. Air conditioning shall be capable of handling heat load. Keep the room temperature shown in **Table 1.1**.

SAFETY / SEISMIC REQUIREMENT

Secure to lock the locking device of compressor castor.

SERVICE AREA

The Compressor Unit is air-cooled and should have enough space for air flow as shown in **Figure 2.1**.

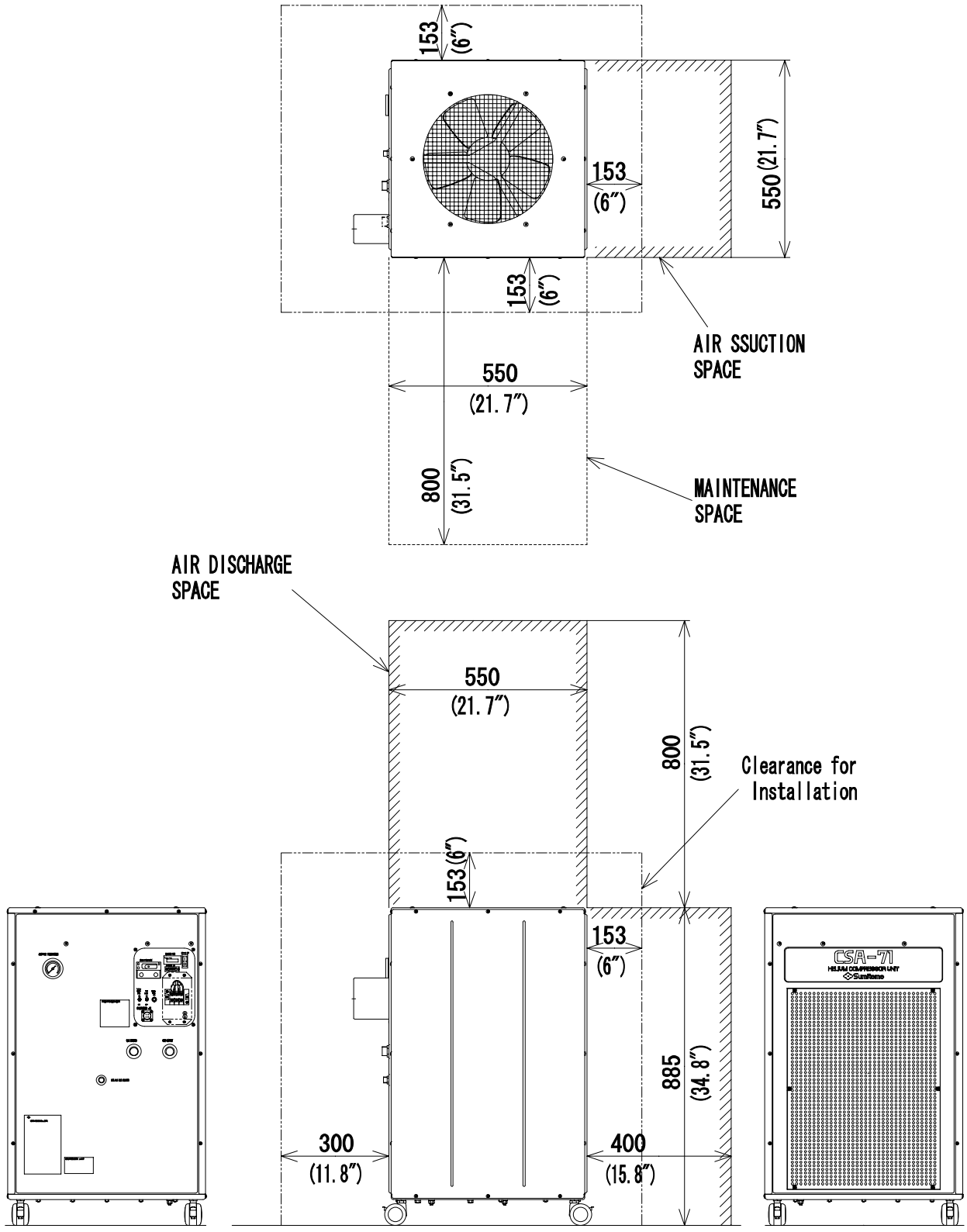
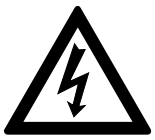


Figure 2.1 AIR COOLED COMPRESSOR UNIT CSA-71A AND ITS REQUIRED SPACE FOR AIR FLOW

2-2 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.

Be sure to turn off and Lock Out with OFF position the main power of the customer's power source and then remove the input power cable from the main power before connecting or disconnecting the input power cable to the Compressor Unit. 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 "ELECTRICAL SCHEMATIC" of CSA-71A Compressor Unit, 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 mm^2) or larger.

Compressor Unit Side

Power Supply Conductors
Ring Terminal: ϕ4.2mm ID (approx.)
Tightening Torque: 1.3 N・m (13 kgf・cm)

Protective Earth Conductor
Ring Terminal: ϕ5.2mm ID (approx.)
Tightening Torque: 1.8 N・m (18 kgf・*cm)*

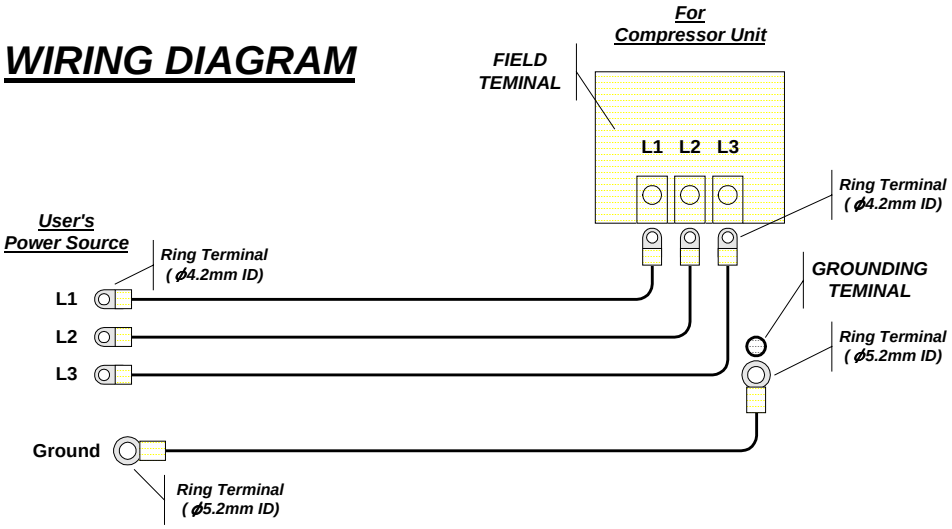
User's Power Source Side

Power Supply Conductors
Ring Terminal: ϕ4.2mm ID (approx.)

Protective Earth Conductor
Ring Terminal: ϕ5.2mm ID (approx.)

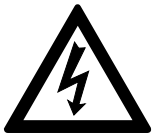
See the **Table 1.1** for power requirements. The cables are marked with label and connect as follows;

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 operation 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 and then remove the input power cable from the main power before connecting or disconnecting the input power cable to the Compressor Unit. 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/cm^{2}G, 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.

WARNING

<Warning about rotating part>

For 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.

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 preven 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.

For CSA-71A (air cooled, low voltage type), sufficient space is required for venting. Failing to secure sufficient space may result in misoperation or malfunction.

CSA-71A (air cooled, low voltage type) 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.

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

CSA-71A 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	REMARK
Replace Compressor Adsorber	Every 20,000 Hrs.	
Charge Helium Gas to Compressor	As required	
Cleaning Air Cooler	At least one time in one year	Depending on the Compressor site conditions.
Compressor Fuse Replacement	As required	

Table 3.2 RENEWAL PARTS LIST (FRU'S)

ITEM	DESCRIPTION	Q'TY	DIMENSIONS	GE PART NUMBER	SHI PART NUMBER
1	Adsorber	1	OD155×H447	2172241	RE71TN0408
2	Glass Body Fuse 2A	3		2191112	RE71WT0600
3	Class G Fuse 3A	3		2191112-3	RE71WT0601
4	Class G Fuse 2A	3		2191112-2	RE71WT0602

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 (16.5 kgf/cm^{2}G, 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.

WARNING

<Warning about rotating part>

For 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. Be careful of handling so that it may not get hurt when replace the adsorber.

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	REMARK
1	Adsorber	1	RE71TN0408	OD155×H447

Table 3.4 REQUIRED TOOLS FOR ADSORBER REPLACEMENT

	TOOLS	REMARK
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.

3) Secure the Adsorber to Rear Panel by tightening Nut.

4) Connect the Adsorber Self-Sealing Coupling.

5) Reinstall the panels and secure them by tightening the screws.

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

3-1-2 CLEANING THE COMPRESSOR COOLER

WARNING

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

Periodical cleaning for the air cooled heat exchanger for lub. oil / gas cooler of the Compressor Unit is essential part to maintain the Cryocooler performance and reliability. The cooler for the Compressor Unit has a minimum operating life of around one year in the computer / equipment room.
The period of the cleaning will be depended on the environment conditions of the Compressor Unit.

CLEANING PROCEDURE

1) Loosen the screws that hold the Cooler Cover Panel and remove the panel.

2) Clean up the adherent dusts on the surface of Compressor Cooling Fins using portable Vacuum Cleaner.

3) Replace the Cooler Cover Front Panel and secure 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.

Be sure to turn off the customer's main power and remove the input power cable from the compressor unit 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 Control Box for the Compressor Unit.

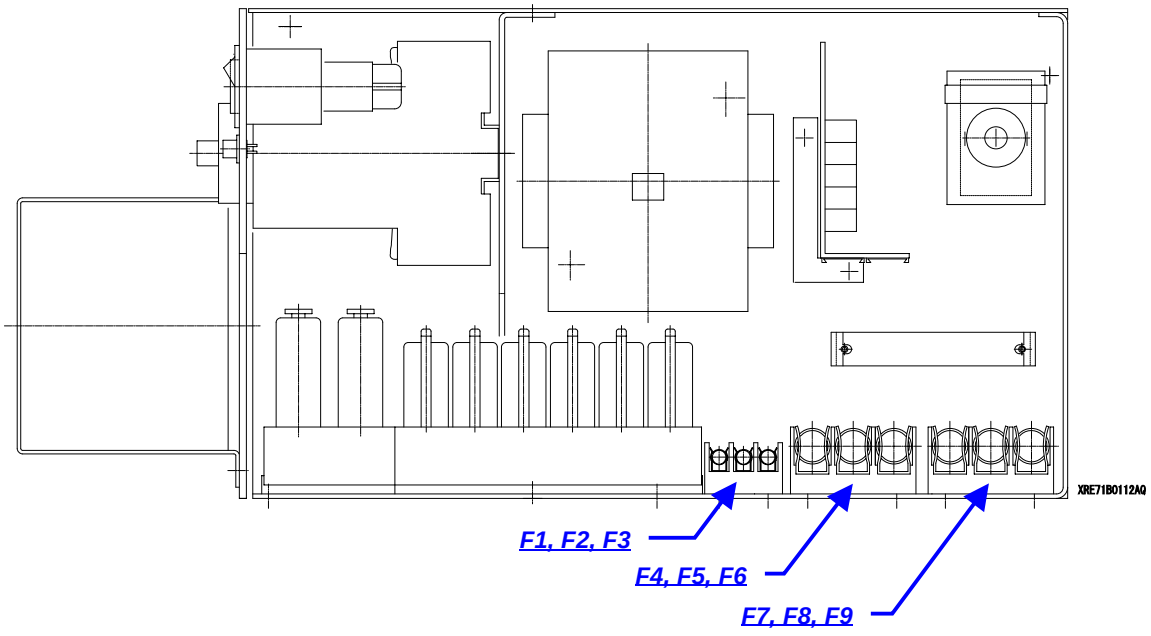
Table 3.5 LIST OF FUSES (Spare fuses are attached to this Manual)

Fuse No.	Description	Part Number	GE Part Number	Remarks
F1 F2 F3	Glass Body Fuse 2A	RE71WT0600	2191112	For DC Circuit
F4 F5 F6	Class G Fuse 3A	RE71WT0601	2191112-3	For Compressor Fan
F7 F8 F9	Class G Fuse 2A	RE71WT0602	2191112-2	For Cold Head Motor

FUSE REPLACING PROCEDURE

1) Loosen the screws that hold the Compressor Unit side panel, and remove the panel.

2) Replace the Fuses.



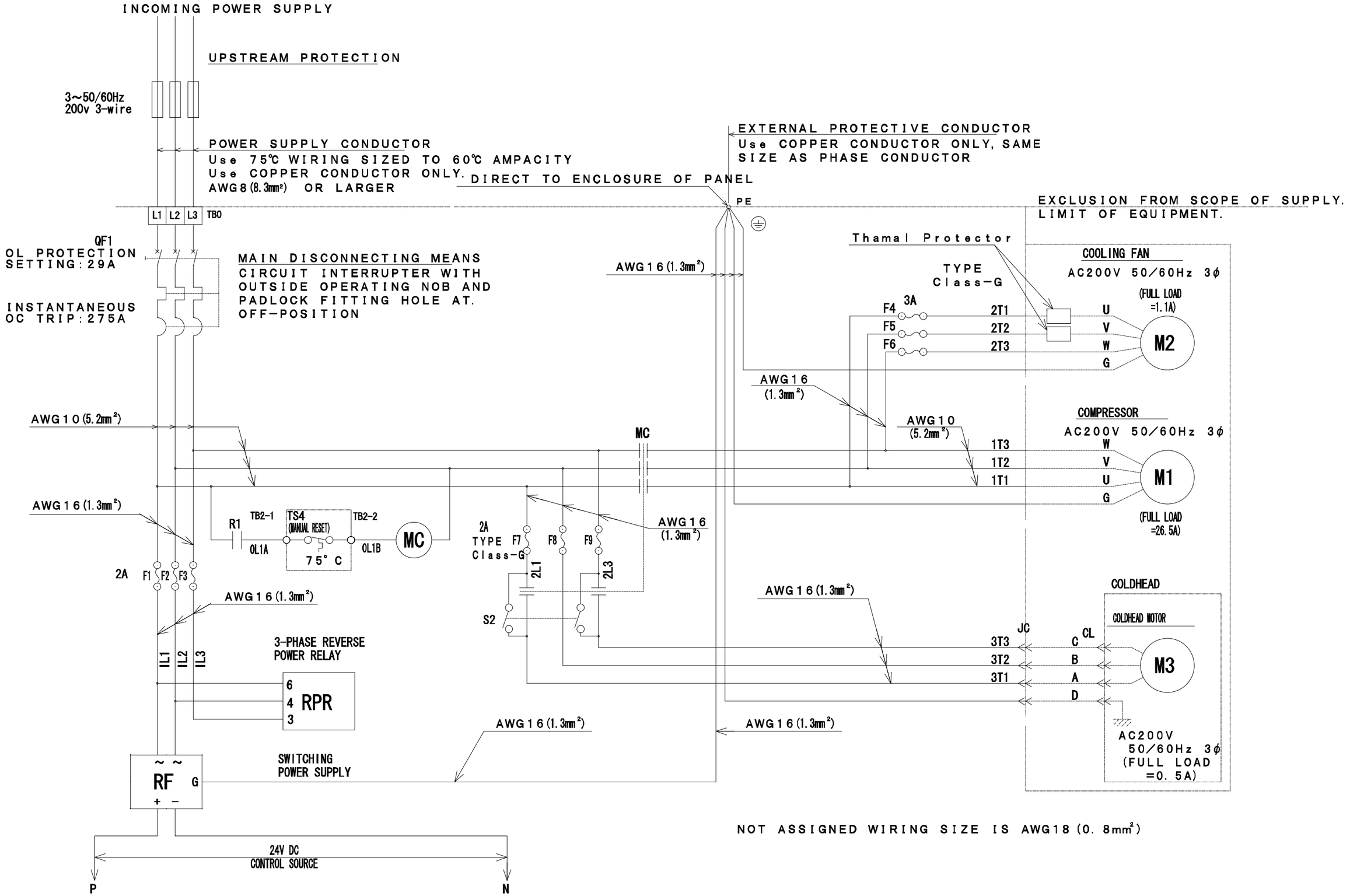
APPENDIX

ELECTRICAL SCHEMATIC

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

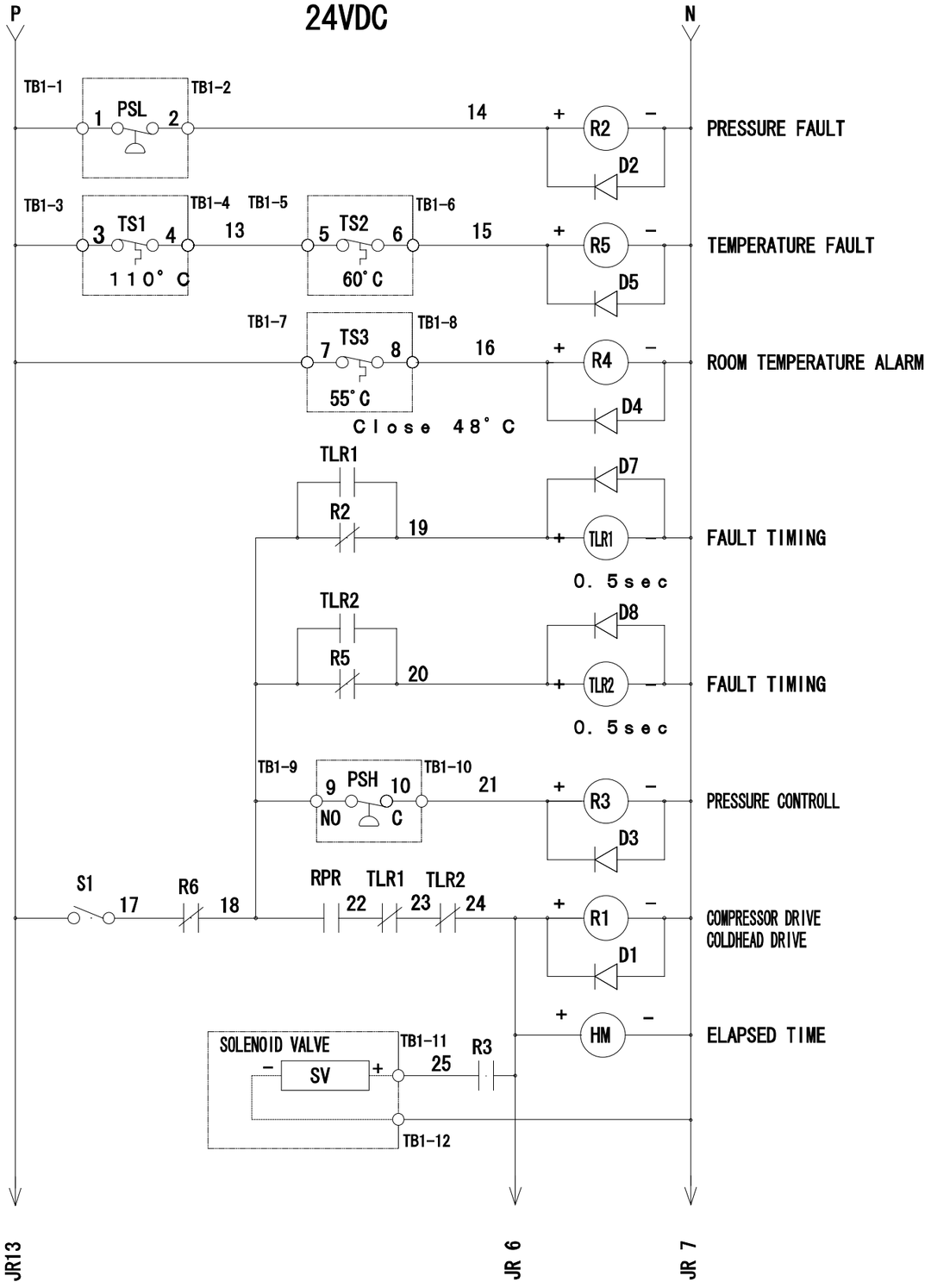
DRAWINGS

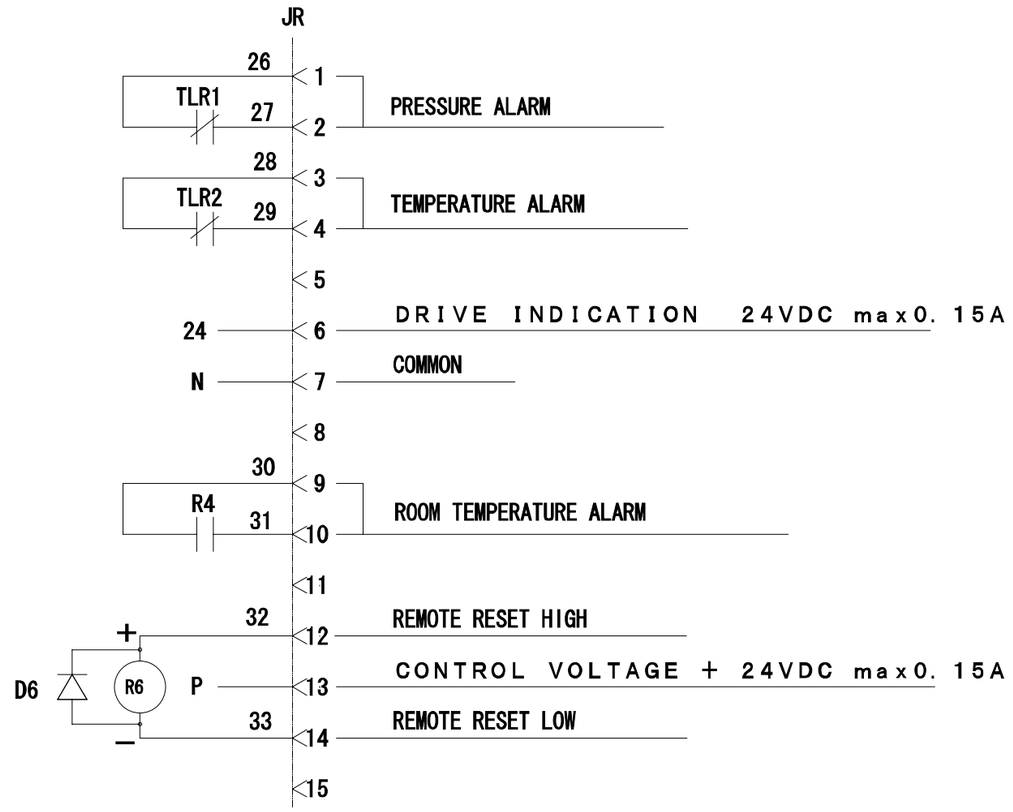
No.	PART NAME	GE PART No.	SHI PART No.
1	CSA-71A COMPRESSOR UNIT	2166592	RE71ZH0136
2	CSA-71A INPUT POWER CABLE	2172240	RV21ZN0132
3	ADSORBER	2172241	RE71TN0408
4	GLASS BODY FUSE 2A	2191112	RE71WT0600
5	CLASS G FUSE 3A	2191112-3	RE71WT0601
6	CLASS G FUSE 2A	2191112-2	RE71WT0602



NOT ASSIGNED WIRING SIZE IS AWG18(0.8mm²)

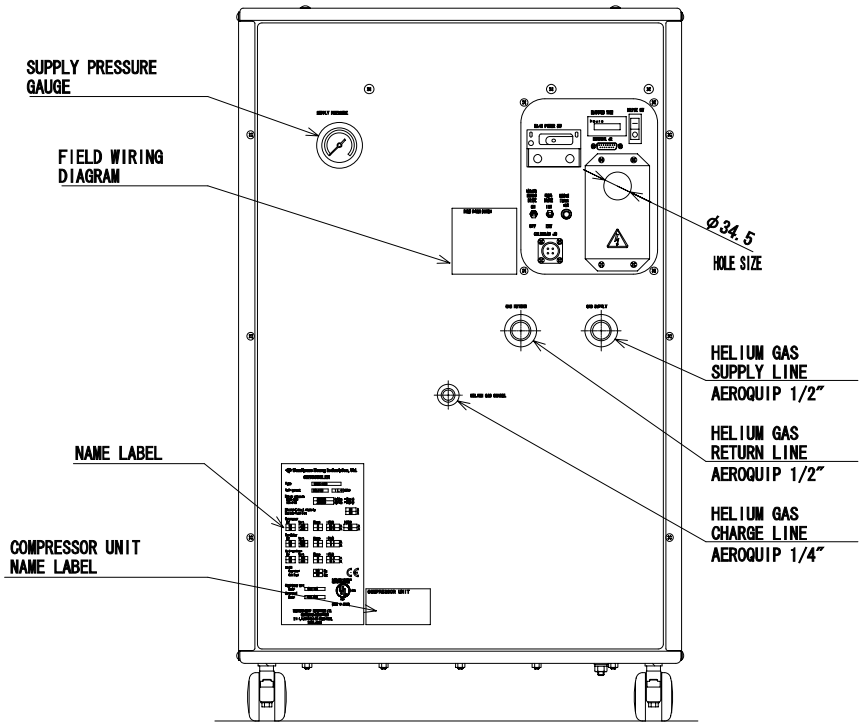
CSA-71A CONTROL PANEL　SCHEMATIC DIAGRAM 1/2



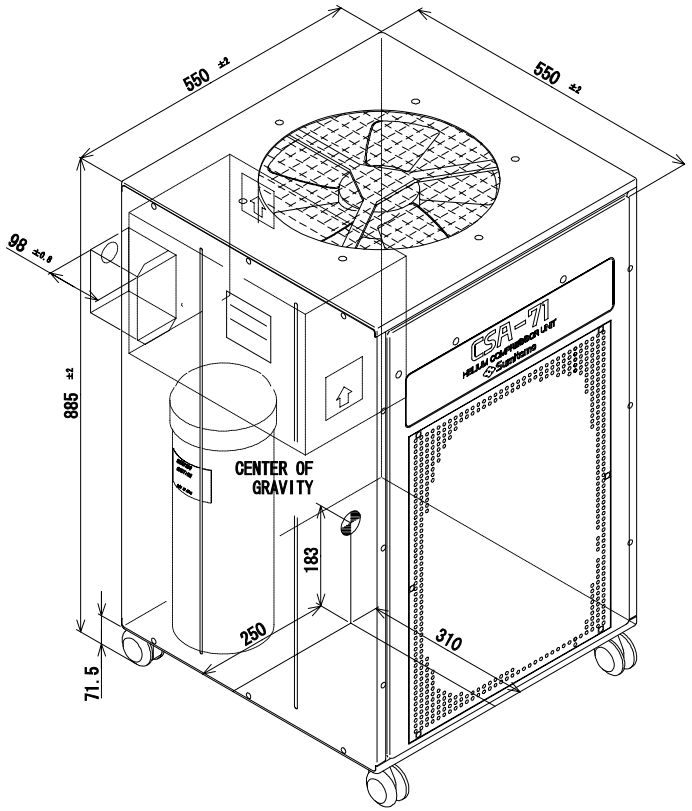


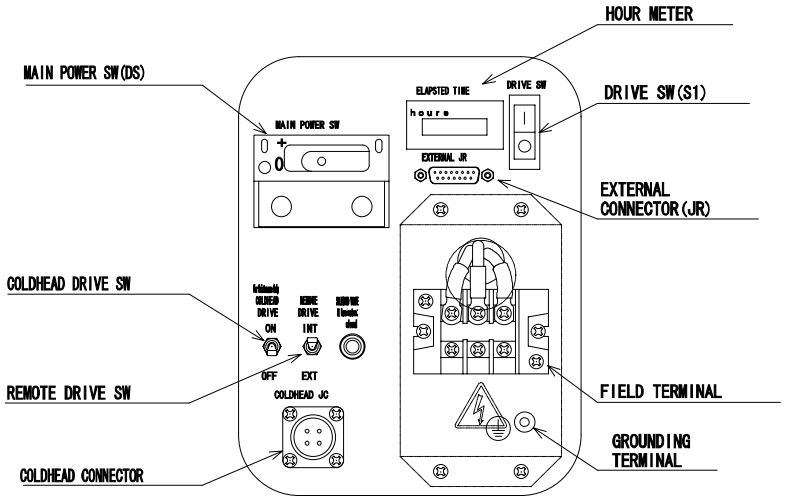
NOT ASSIGNED WIRING SIZE IS AWG18 (0. 8mm²)

CSA-71A CONTROL PANEL SCHEMATIC DIAGRAM 2/2



REAR SIDE





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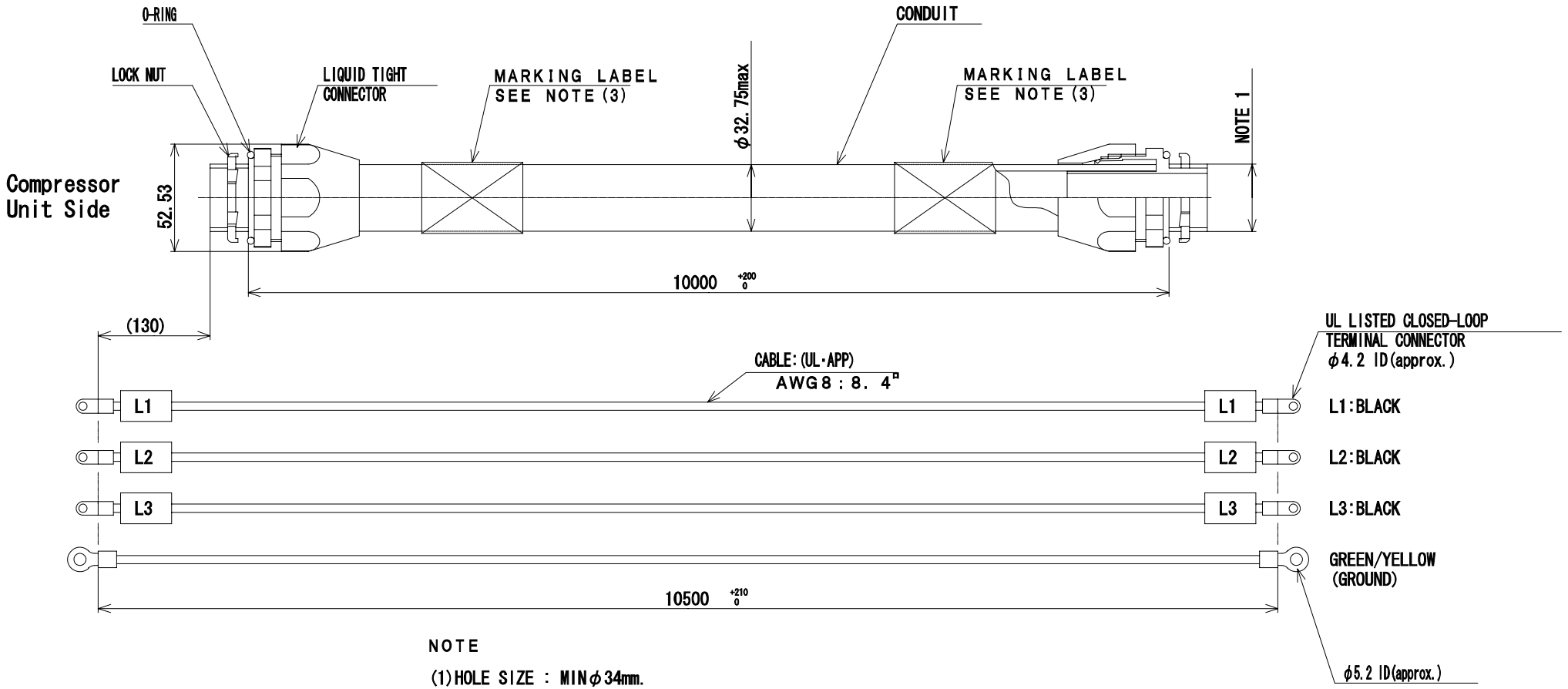


NOTE

(1) HOLE SIZE : MIN φ34mm.

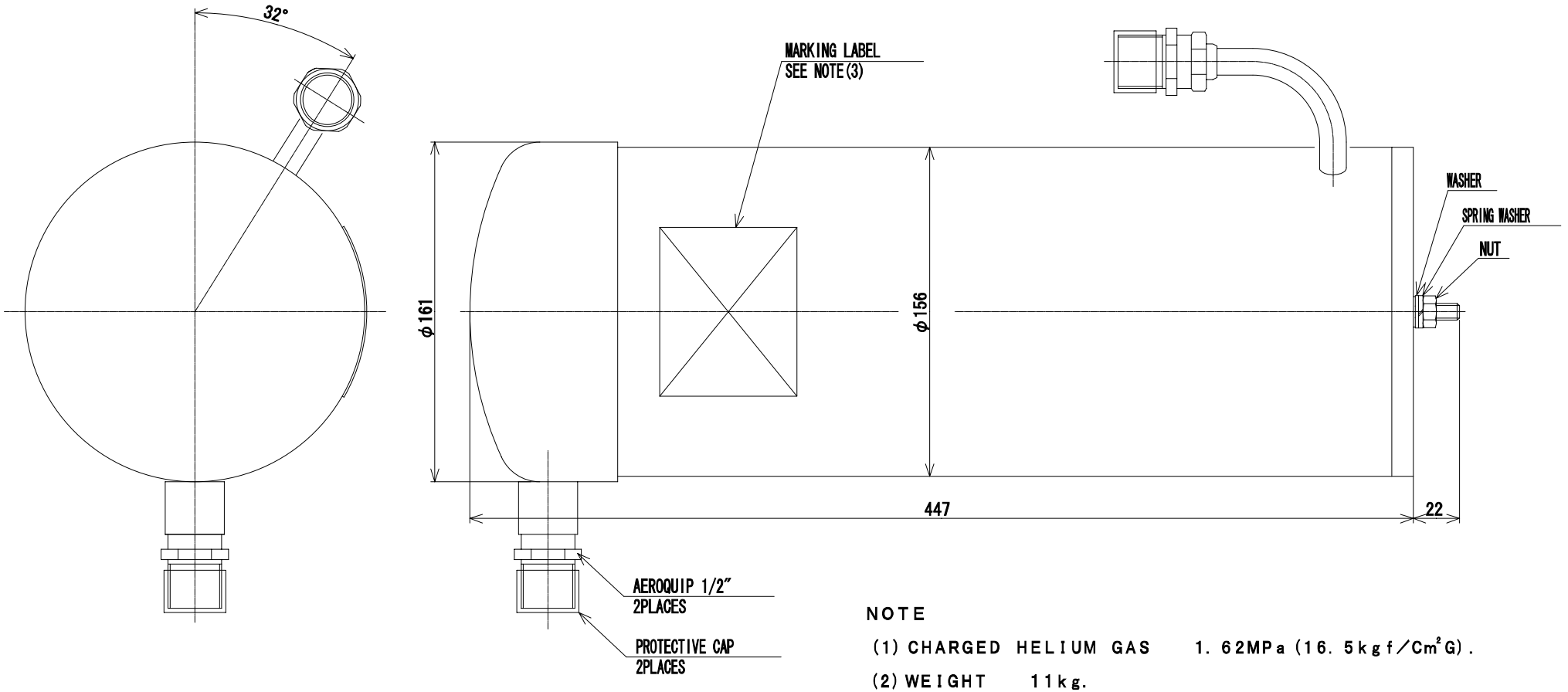
(2) PART TO BE BAGGED OR BOXED AND SEALED FROM DIRT AND MOISTURE.

(3) CABLES ARE TO BE MARKED WITH G. E. PART NUMBER NEAR EACH END.

INPUT POWER CABLE Type 10m PART No. 2215657 (Rev. ***) Sumitomo Heavy Industries, Ltd.

(4) PART MUST CONFORM TO CRYOCOOLER SPECIFICATION 2136066GSP.

XRZ32Z0013AQ



NOTE

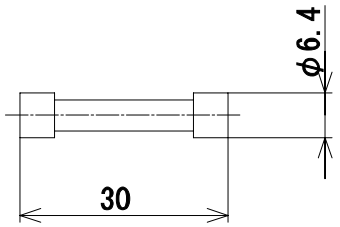
(1) CHARGED HELIUM GAS 1.62MPa (16.5kgf/Cm^{2}G).

(2) WEIGHT 11kg.

(3) PART TO BE MARKED WITH G.E. PART NUMBER.

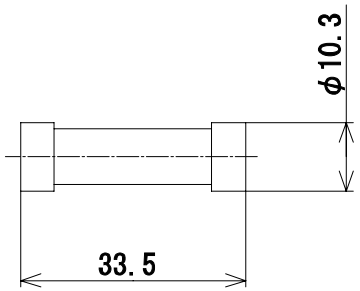
ADSORBER
PART No. 2172241 (Rev. ***)

XRE71B0050AQ



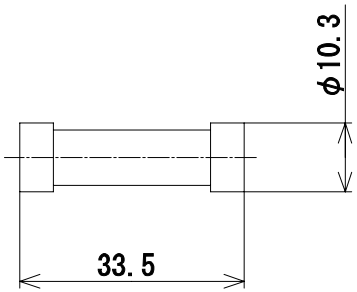
NOTE
1. CURRENT RATING 2A.

GLASS BODY FUSE 2A



NOTE
1. CLASS G.
2. CURRENT RATING 3A.

CLASS G FUSE 3A



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

CLASS G FUSE 2A

REVISION CONTROL

Manual No.	GE Revision	SHI Revision	Remarks	Date
CD32ZZ-060	Revision 2	-A	Publication of first edition.	DEC. 20 / 1999
	Revision 2	-B	Add the description of BPU-01.	MAR. 30 / 2000
	Revision 2	-C	Change the SHI address.	JAN. 25 / 2001
	Revision 2	-D	Change the Electrical Schematic Diagram.	FEB. 19 / 2001
	Revision 2	-E	Add the specification of recommended power requirement.	APR. 1 / 2002
	Revision 2	-F	Add the remote drive function.	MAY 31 / 2002
	Revision 2	-G	Correct the descriptions of Input Power Cable Connection.	JUL 11 / 2002
	Revision 2	-H	Add the RDK-408A2 Cold Head. Add the transformer-use CAUTION.	MAR. 17 / 2003

Sumitomo Heavy Industries, Ltd.

MANUAL NUMBER: CD32ZZ-061K
DATE: March 17 / 2003

TECHNICAL INSTRUCTION

CSW-71C
COMPRESSOR UNIT
Revision 2

For Service Personnel Only

PART NUMBERS

MODEL	SHI PART No.	GE PART No.
CSW-71C COMPRESSOR UNIT	RE38ZH0156	2188184-2

Sumitomo Heavy Industries, Ltd.
Cryogenics Department

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E-mail: cryo@shi.co.jp

TABLE OF CONTENTS

TABLE LIST

FIGURE LIST

CROSS REFERENCE

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

MANUAL NAME	MANUAL No.
OPERATION MANUAL SRDK Series CRYOCOOLER	CD32ZZ-056
TECHNICAL INSTRUCTION RDK-408A2 4K COLD HEAD*	CD32ZZ-098
TECHNICAL INSTRUCTION RDK-408 4K COLD HEAD*	CD32ZZ-057
TECHNICAL INSTRUCTION RDK-408T 10K COLD HEAD*	CD32ZZ-058
TECHNICAL INSTRUCTION RDK-400 SINGLE STAGE COLD HEAD*	CD32ZZ-059
INSTALLATION MANUAL BPU-01 BY PASS UNIT**	CD32ZZ-075

* See the TECHNICAL INSTRUCTION of Cold Head used.

** See the INSTALLATION MANUAL of BPU-01, if BPU-01 is used in this system.

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-408A2** For **RDK-408**	For **RDK-408S** For **RDK-400B**
Dimension		
Width	450.0 mm (17.72')	
Length	500.0 mm (19.69')*	
Height	686.5 mm (27.03')	
Helium Gas Pressure		
Static	1.60 - 1.65 MPa at 20 deg.C (68 deg.F) (16.3 - 16.8 kgf/cm^{2}G) (232 - 239 psig)	1.45 - 1.50 MPa at 20 deg.C (68 deg.F) (14.8 - 15.3 kgf/cm^{2}G) (210 - 217 psig)
Operating (High Side)**	2.10 - 2.30 MPa --- approx. (21.4 - 23.5 kgf/cm^{2}G) (319 - 333 psig)	2.10 - 2.30 MPa --- approx. (21.4 - 23.5 kgf/cm^{2}G) (319 - 333 psig)
Ambient Operating Temperature	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	
Weight	117 kg (258 LBS) --- approx.	
Electrical Requirement		
Power Line Voltage (+/-10%)	AC 200V / 50, 60 Hz, 3 phase (3W+PE) (**Δ** ground, Commercial Power Source) ***"WARNING"*** ***Do not use inverter for the main power source.***	
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 ***See the ELECTRICAL SCHEMATIC of "APPENDIX" for detail.***	
Cooling water requirement	***"CAUTION"*** ***Do not use the demineralized water for cooling water.***	
Min. Flow Rate	7 liter/min @ 28deg.C (1.85 gal./min @ 82.4 deg.F) ***See the Figure 1.1***	
Temperature Range	4 to 28 deg.C (39.2 to 82.4 deg.F) ***See the Figure 1.1***	
pH Value	6.5 to 8.2	
Hardness	Max. 200 mg$CaCo_3$/liter	
Molybdate-Reactive Silica	Max. 50 mg/liter	
Suspended Matter	Max. 10 mg/liter (Less than 100 micron)	
Pressure Relief Valve Setting	2.61 - 2.75 MPa (26.6 - 28.0 kgf/cm^{2}G, 378 - 398 psig)	
Gas Supply Connector **Gas Return Connector**	1/2-inch Coupling 1/2-inch Coupling	

* Input Power Cable Terminal Cover is 98.0 mm (3.9'). See the **Figure 1.2**.

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

COOLING WATER FLOW RATE AND PRESSURE DROP

For Water

The typical flow characteristics are shown in **Figure 1.1**.

The maximum pressure drop through the cooling water line will be approx. 0.32 MPa (3.3kgf/cm^{2}G, 47 psig) at the flow rate of 10 liter/min (2.6 gal./min).

The maximum inlet pressure must be less than 0.69 MPa (7.0kgf/cm^{2}G, 99 psig).

For 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 (3.0 kgf/cm^{2}G, 43 psig) for the pressure drop.

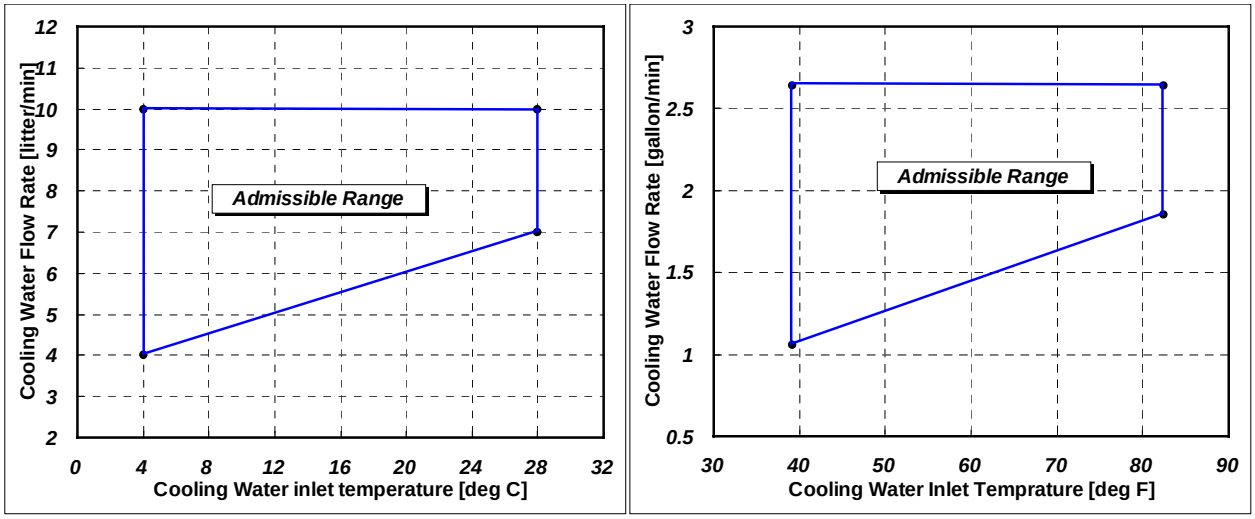


Figure 1.1 COOLING WATER REQUIREMENT

Table 1.2 WATER COOLING SPECIFICATIONS

Inlet Temperature Range [deg.C] (deg.F)	Inlet Pressure Range [MPa] (psig)	Recommend Flow Rate [liter/min] (gal/min)	Pressure Drop [MPa] (psig)	Temperature Rise <Typical> [deg.C] (deg.F)	Temperature Rise <Maximum> [deg.C] (deg.F)	Typical Heat Output [kW] (BTU/Hr)	Maximum Heat Output [kW] (BTU/Hr)
[4.0 ~ 28.0] (39.2 ~ 82.4)	[0.20 ~ 0.69] (29 ~ 100)	minimum [4.0] (1.1)	[0.05] (8) at minimum flow rate	[26.9] (48.4) for 60Hz [21.9] (39.4) for 50Hz at minimum flow rate	[29.6] (53.3) for 60Hz [23.9] (43.0) for 50Hz at minimum flow rate	[7.5] (25590) for 60Hz Operation	[8.3] (28320) for 60Hz Operation
		maximum [10.0] (2.6)	[0.29] (43) at maximum flow rate	[10.8] (19.4) for 60Hz [8.7] (15.7) for 50Hz at maximum flow rate	[11.9] (21.4) for 60Hz [9.6] (17.3) for 50Hz at maximum flow rate	[6.1] (20728) for 50Hz Operation	[6.7] (23222) for 50Hz Operation

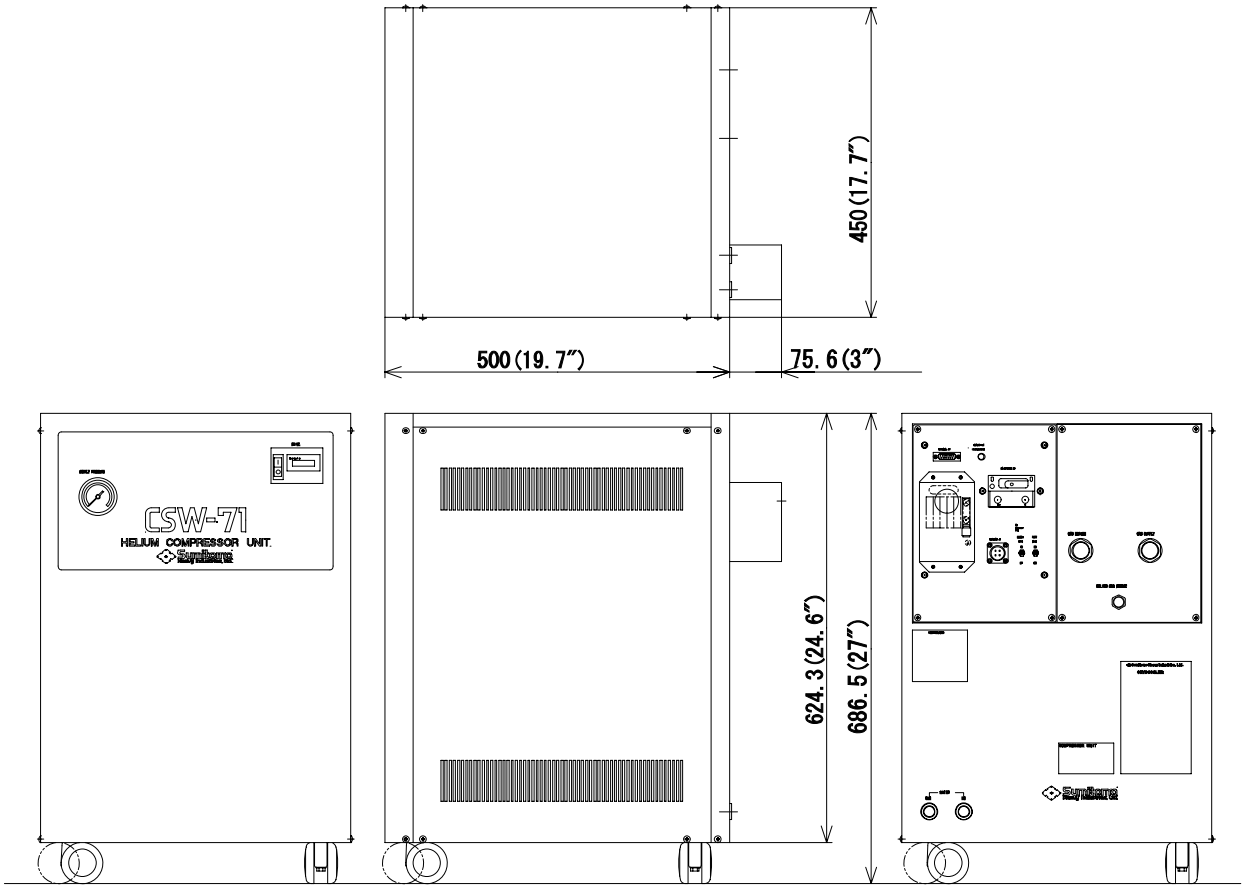


Figure 1.2 OUTLINE VIEW FOR COMPRESSOR UNIT MODEL CSW-71C

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”. ***Caution;*** *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.*
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;*** *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.*
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)

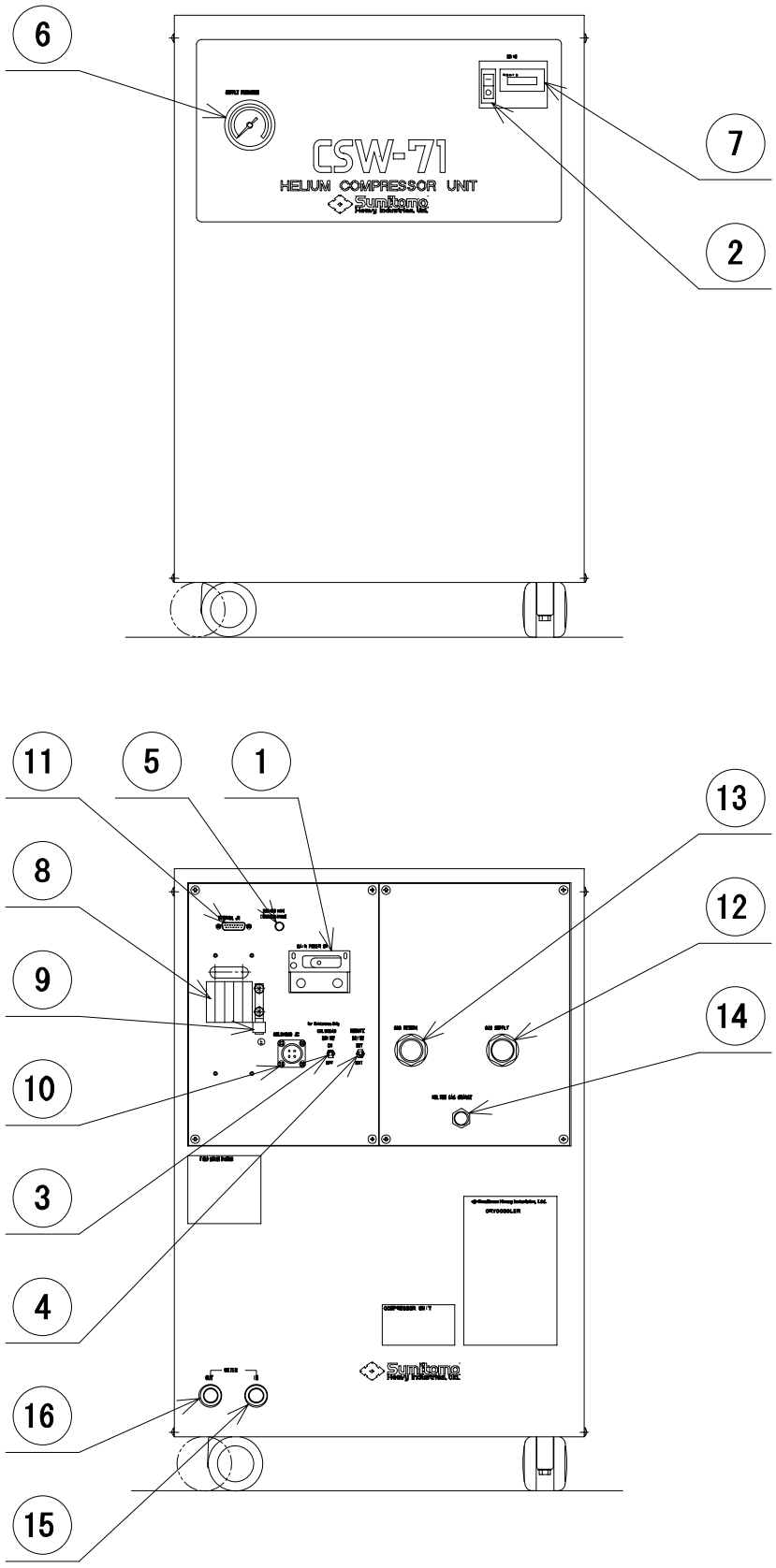


Figure 1.3 CONTROLS AND COUPLINGS FOR CSW-71C COMPRESSOR UNIT

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 (Press.: 0.59 MPa (6.0 kgf/cm^{2}G, 85psig) & below) 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**.

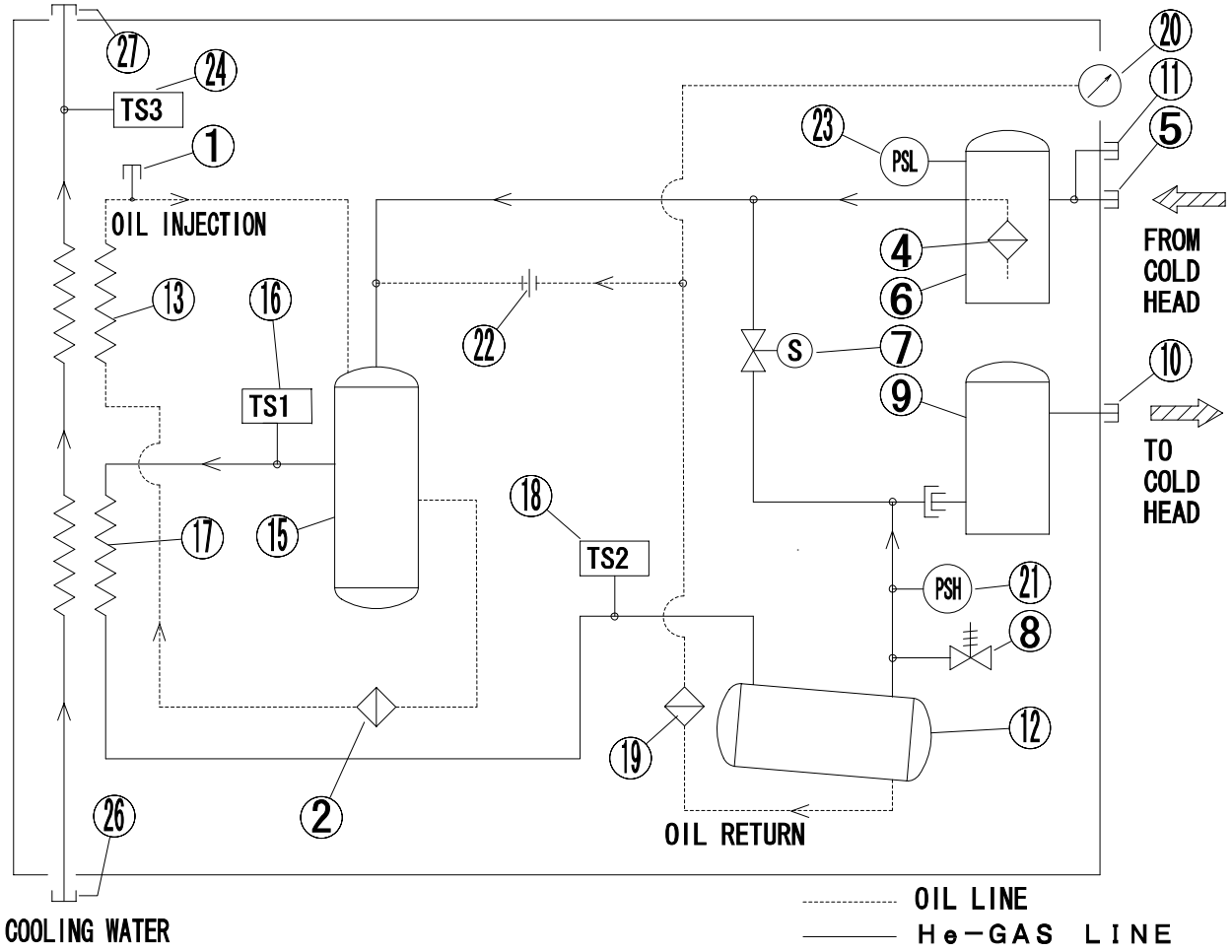


Figure 1.4 HELIUM GAS FLOW DIAGRAM FOR CSW-71C COMPRESSOR UNIT

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 (230 deg.F)	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 (140 deg.F)	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 (140 deg.F)	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.

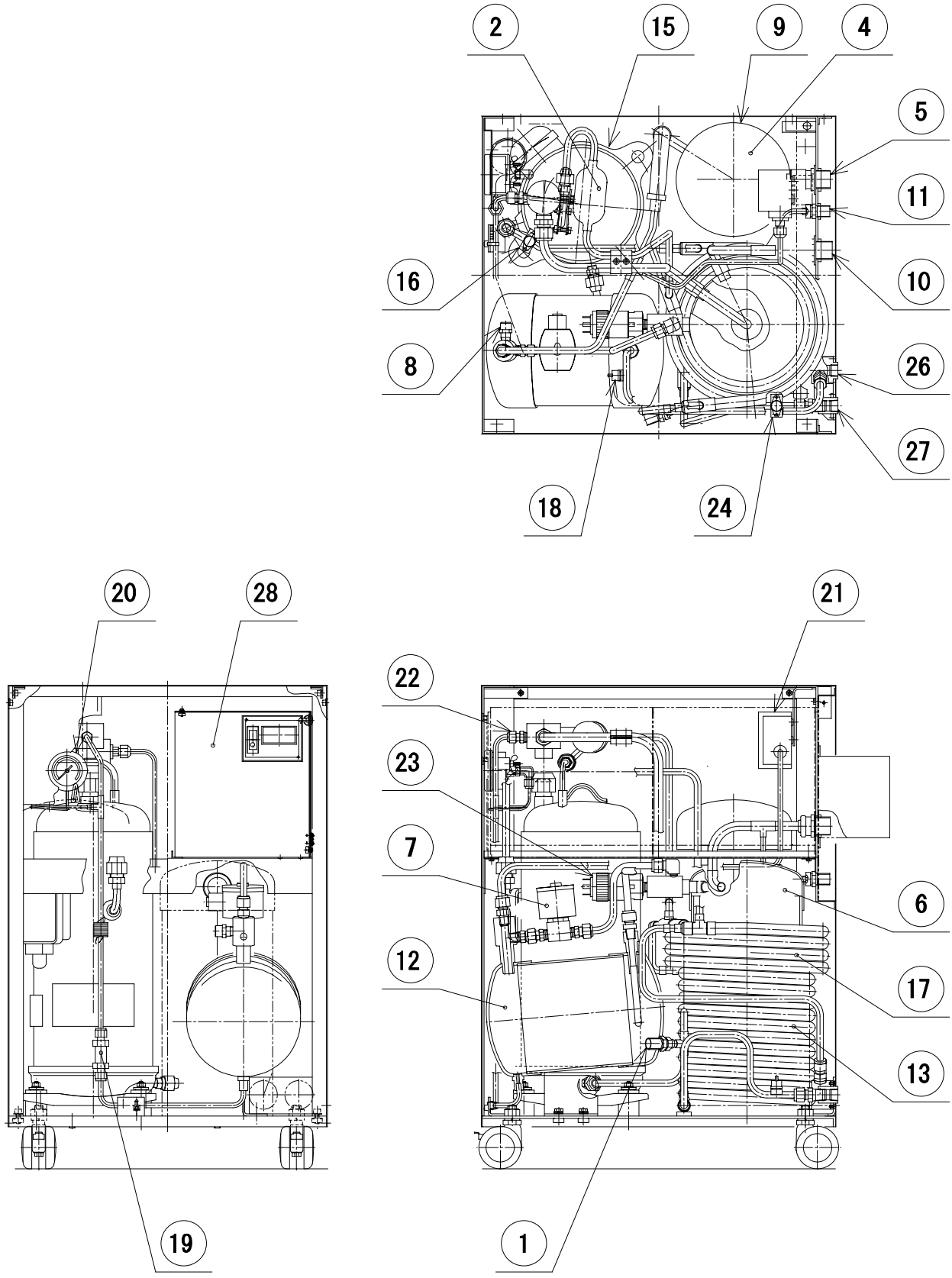
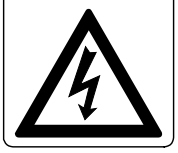


Figure 1.5 COMPONENTS OF CSW-71C COMPRESSOR UNIT

1-3 ELECTRICAL DESCRIPTION

1-3-1 EXTERNAL CONNECTOR

WARNING



<Warning about electric shock>

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.

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

"IMPORTANT"

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

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	Normal	24VDC(0.15A max.)	6, 7	0 V
			Alarm	0V		
4	Control Voltage	DC Power	Normal	24VDC(0.15A max.)	7, 13	0 V
			Alarm	0V		
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

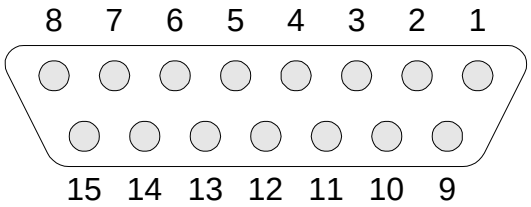


Figure 1.6 EXTERNAL CONNECTOR WIRING ON THE COMPRESSOR UNIT

1-3-2 SAFETY DEVICES

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

Table 1.6 SAFETY DEVICES OF CSW-71C

ITEM	FUNCTIONS
THERMOSTAT : (TS1)	Setting temperature; 110 deg.C (230 deg.F) ---- 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 (140 deg.F) ---- 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 (140 deg.F) ---- 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. (26.0 kgf/cm^{2}G, 370 psig) "Reset" 2.26 MPa ---- approx. (23.0 kgf/cm^{2}G, 327 psig) 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. (1.5 kgf/cm^{2}G, 21 psig) 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 (26.6 - 28.0 kgf/cm^{2}G, 378 - 398 psig) "Reset" 2.50 MPa ---- minimum (25.5 kgf/cm^{2}G, 362 psig) 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

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. (

Use cooling water with appropriate temperature, flow rate and water quality. Using inappropriate cooling water may result in misoperation or malfunction.

- 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 (41 deg.F) and 28 deg.C (82.4 deg.F) to get the specified 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 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 **Table 1.1.** for the cooling water requirements for your system.

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 (3.0 kgf/cm^{2}G, 43 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 **Figure 2.1**.

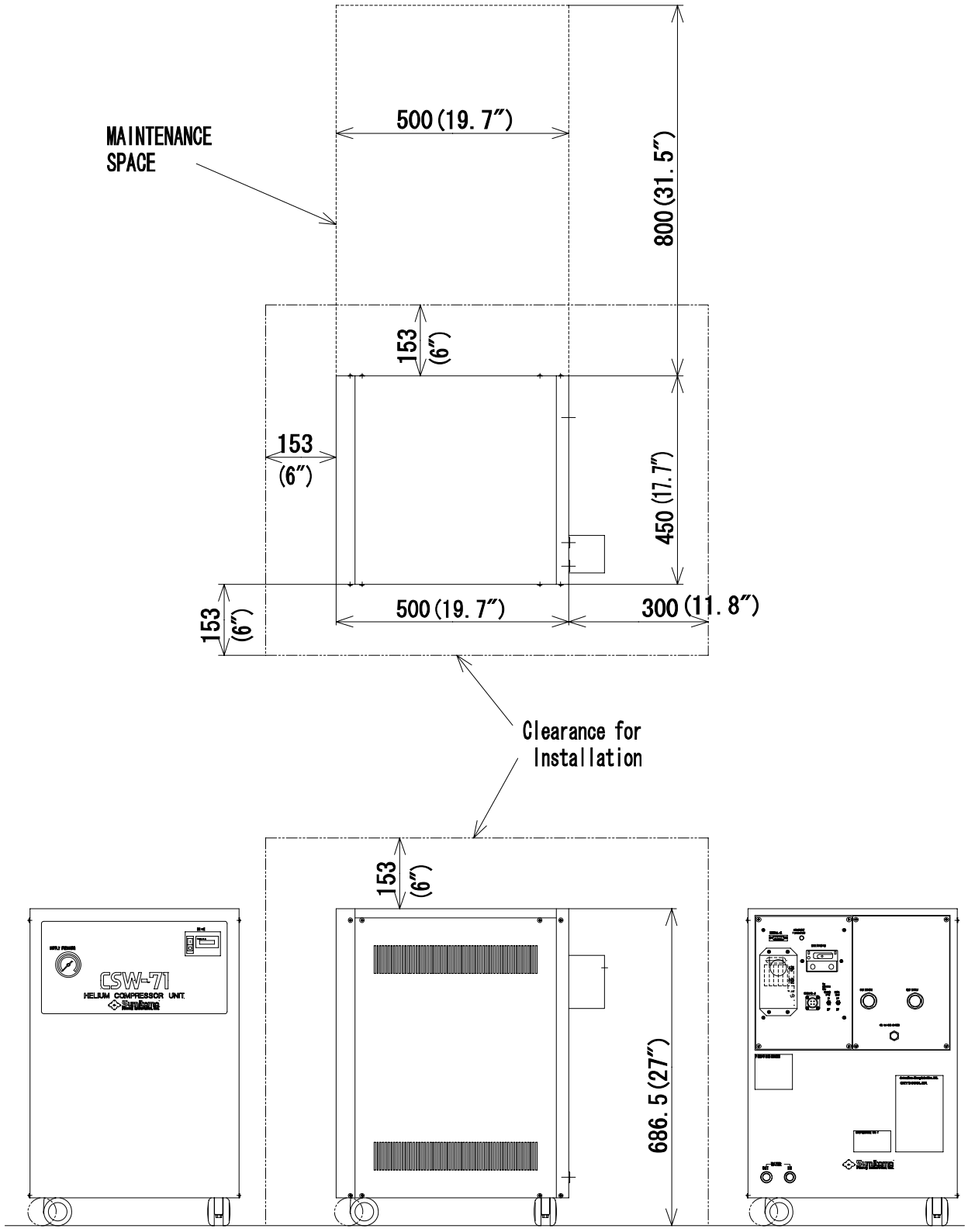
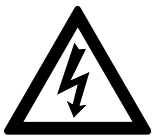


Figure 2.1 WATER COOLED COMPRESSOR UNIT CSW-71C AND ITS REQUIRED SPACE

2-2 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.

Be sure to turn off and Lock Out with OFF position the main power of the customer's power source and then remove the input power cable from the main power before connecting or disconnecting the input power cable to the Compressor Unit. 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 "ELECTRICAL SCHEMATIC" of CSW-71C Compressor Unit, 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 mm^2) or larger.

Compressor Unit Side

Power Supply Conductors
Striping Length: 12 mm
Tightening Torque: 1.3 N・m (13 kgf・cm)

Protective Earth Conductor
Striping Length: 12 mm
Tightening Torque: 1.8 N・m (18 kgf・*cm)*

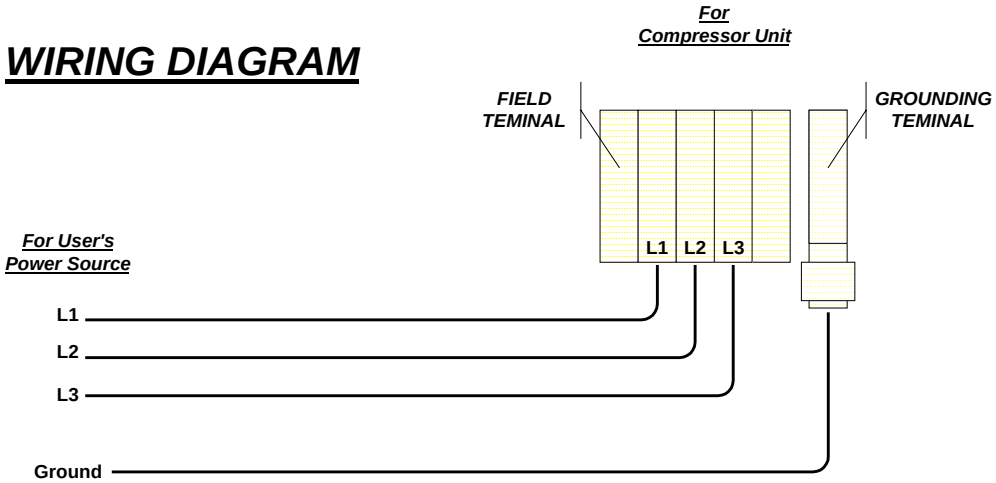
User's Power Source Side

Power Supply Conductors
Striping Length: 12 mm

Protective Earth Conductor
Striping Length: 12 mm

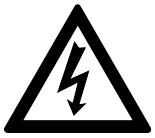
See the **Table 1.1** for power requirements. The cables are marked with label and connect as follows:

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 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 and then remove the input power cable from the main power before connecting or disconnecting the input power cable to the Compressor Unit. 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/cm^{2}G, 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.

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.

Use cooling water with appropriate temperature, flow rate and water quality. Using inappropriate cooling water may result in misoperation 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.

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	REMARK
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	DIMENSIONS	GE PART NUMBER	SHI PART NUMBER
1	Adsorber	1	OD155×H447	2172241	RE71TN0408
2	Class G Fuse 5A	3		2191112-4	RE71WT0603
3	Hose Nipple	2	12.0×3/8	2205309	RE38VT0689
4	Hose Nipple	2	12.7×3/8	2302167	RE38VT0814

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 (16.5 kgf/cm^{2}G, 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.

WARNING

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

CAUTION

<Caution against misoperation>

Do not get on the compressor unit or put an object on top of it. Failing to ovserve 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	REMARK
1	Adsorber	1	RE71TN0408	OD155×H447

Table 3.4 REQUIRED TOOLS FOR ADSORBER REPLACEMENT

	TOOLS	REMARK
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.

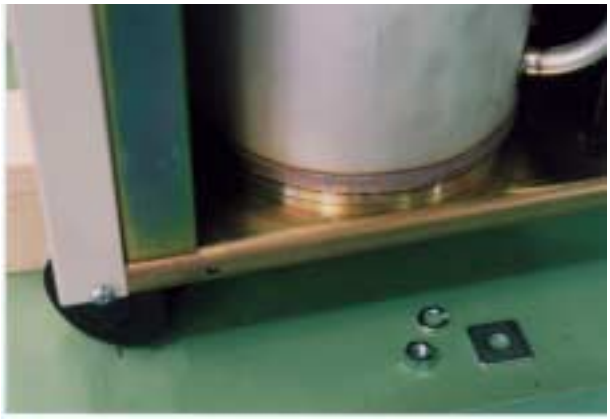
REMOVING THE USED ADSORBER

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.

3) Secure the Adsorber to Rear Panel by tightening Nut.

4) Connect the Adsorber Self-Sealing Coupling.

5) Reinstall the panels and secure them by tightening the screws.

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

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.

Be sure to turn off the customer's main power and remove the input power cable from the compressor unit 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.

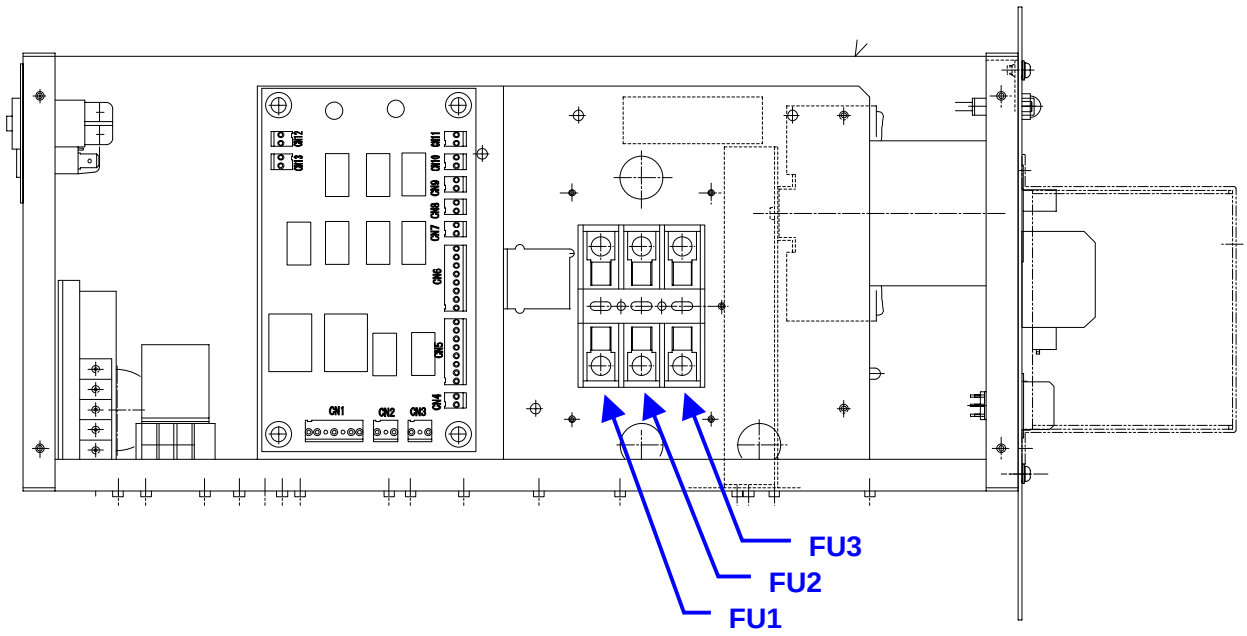
Table 3.5 LIST OF FUSES (Spare fuses are attached to this Manual)

Fuse No.	Description	Part Number	GE Part Number	Remarks
FU1 FU2 FU3	Class G Fuse 5A	RE71WT0603	2191112-4	For Cold Head Motor, Solenoid Valve and DC circuit

FUSE REPLACING PROCEDURE

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

2) Replace the Fuses.



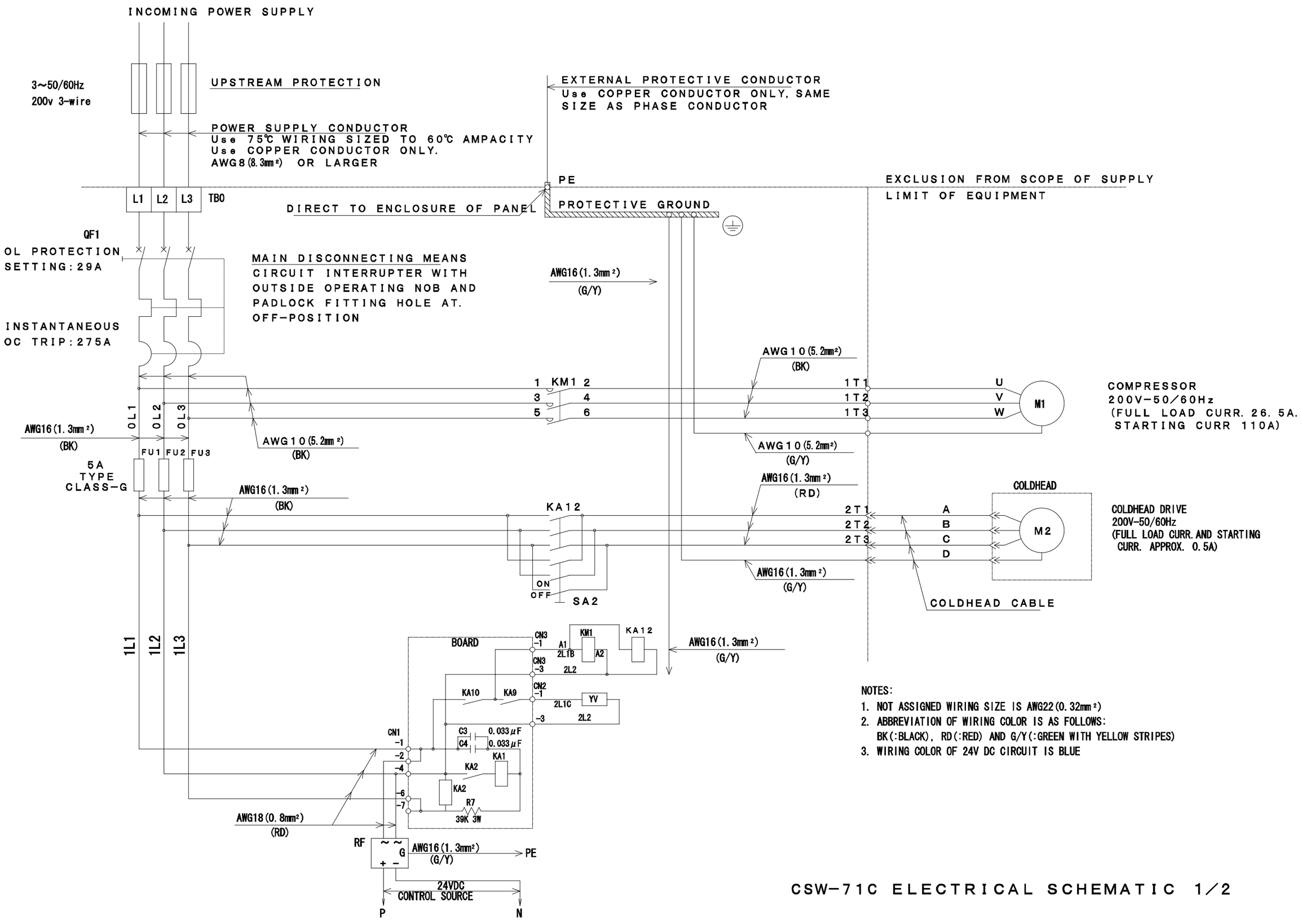
APPENDIX

ELECTRICAL SCHEMATIC

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

DRAWINGS

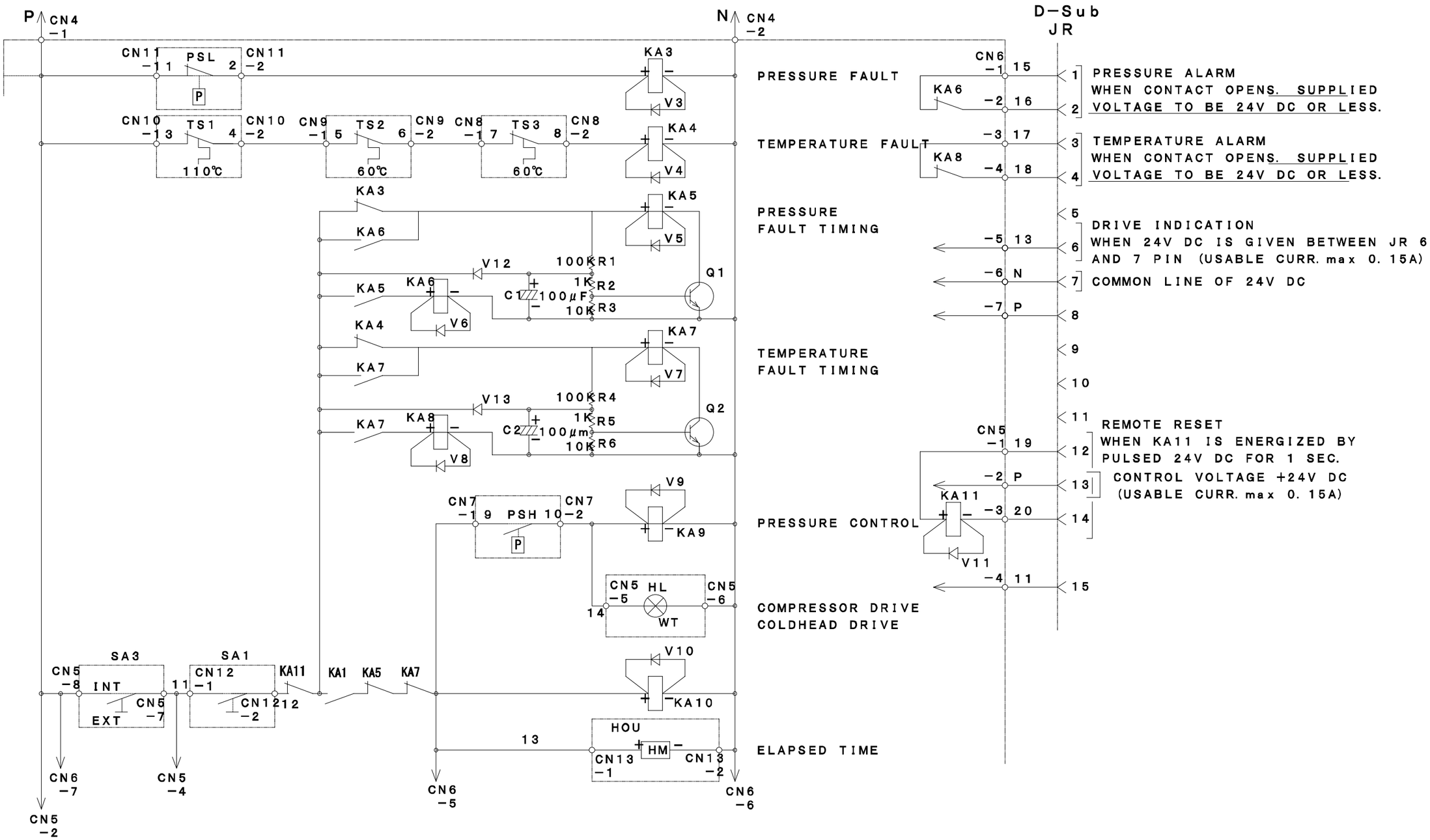
No.	PART NAME	GE PART No.	SHI PART No.
1	CSW-71C COMPRESSOR UNIT	2188184-2	RE38ZH0156
2	INPUT POWER CABLE LV	2200834	RV21ZN0182
3	ADSORBER	2172241	RE71TN0408
4	CLASS G FUSE 5A	2191112-4	RE71WT0603
5	HOSE NIPPLE 12.0 X 3/8	2205309	RE38VT0689
6	HOSE NIPPLE 12.7 X 3/8	2302167	RE38VT0814



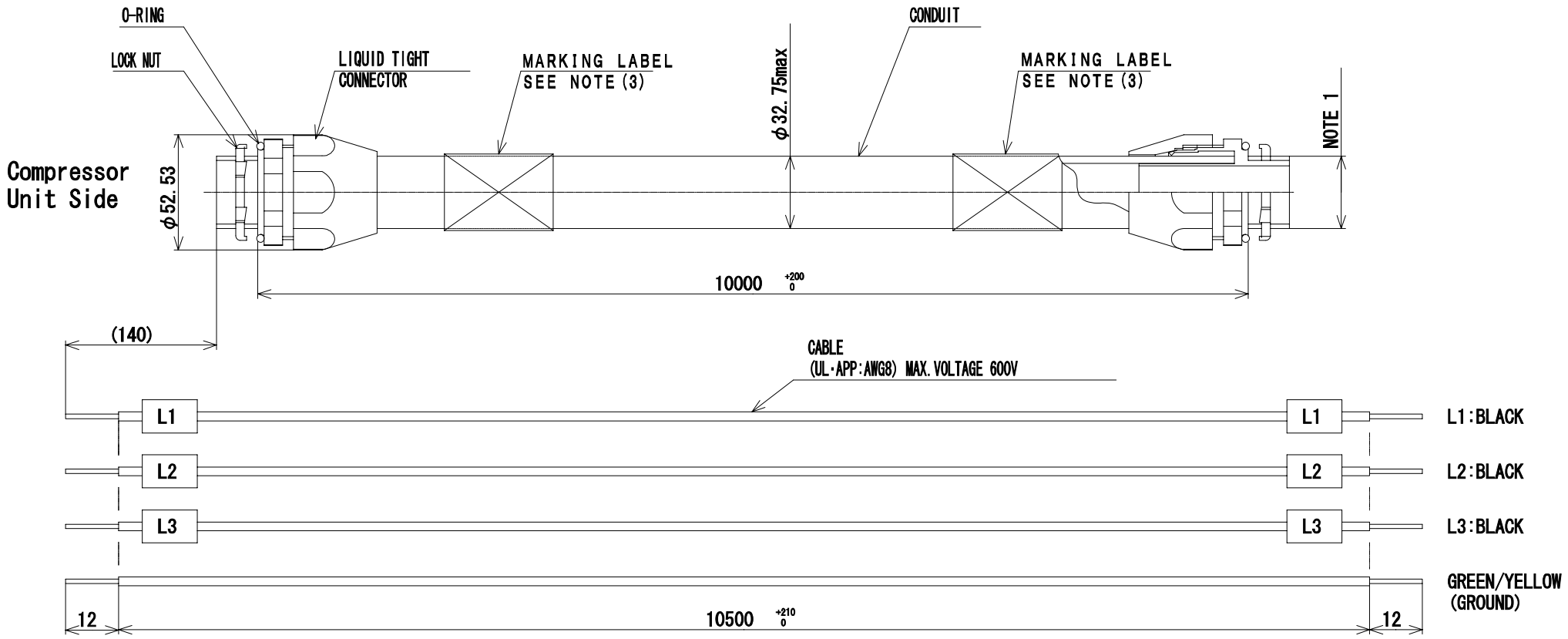
NOTES:

1. NOT ASSIGNED WIRING SIZE IS AWG22(0.32mm²)
2. ABBREVIATION OF WIRING COLOR IS AS FOLLOWS:
   BK(:BLACK), RD(:RED) AND G/Y(:GREEN WITH YELLOW STRIPES)
3. WIRING COLOR OF 24V DC CIRCUIT IS BLUE

CSW-71C ELECTRICAL SCHEMATIC 1/2



CSW71C/D ELECTRICAL SCHEMATIC 2/2



NOTE

(1) HOLE SIZE : MIN φ34mm.

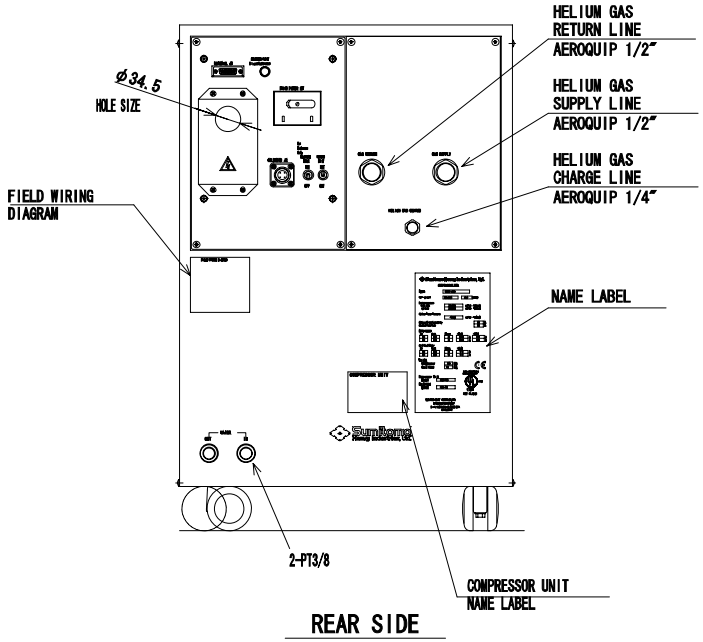
(2) PART TO BE BAGGED OR BOXED AND SEALED FROM DIRT AND MOISTURE.

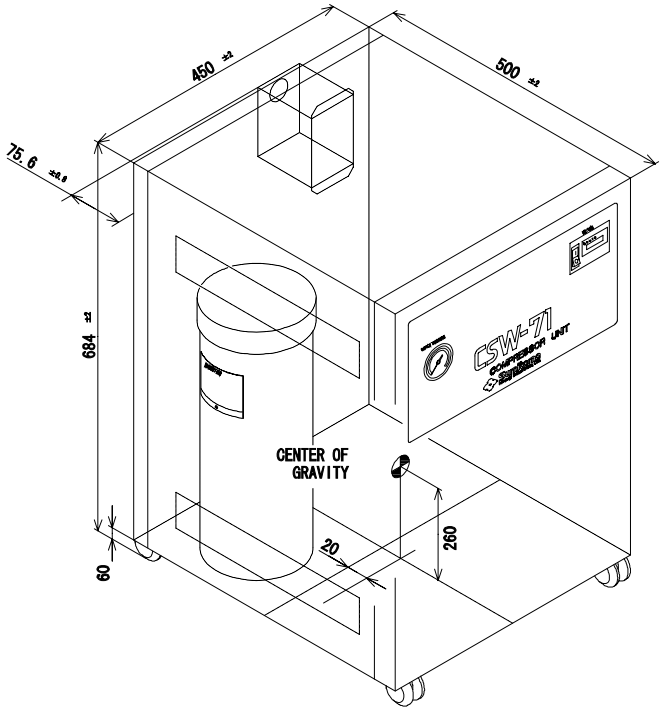
(3) CABLES ARE TO BE MARKED WITH G. E. PART NUMBER NEAR EACH END.

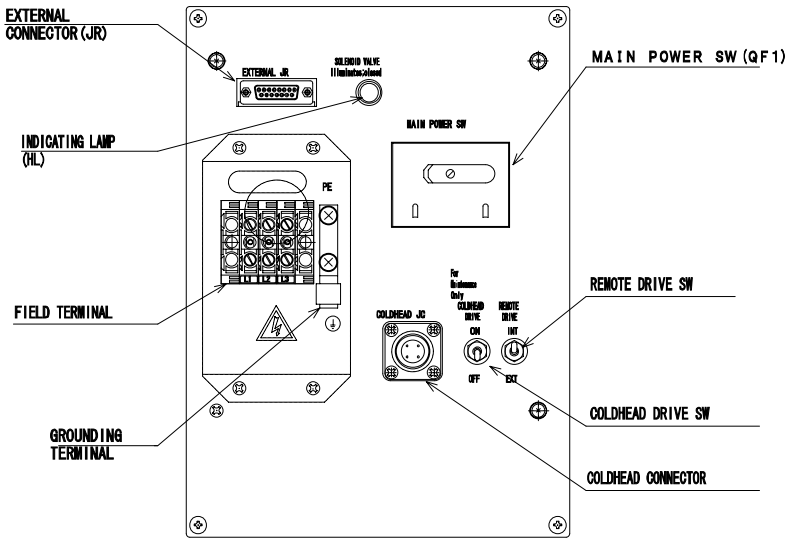
INPUT POWER CABLE LV Type 10m PART No. 2200834 (Rev. ***) Sumitomo Heavy Industries, Ltd.

(4) PART MUST CONFORM TO CRYOCOOLER SPECIFICATION 2136066GSP.

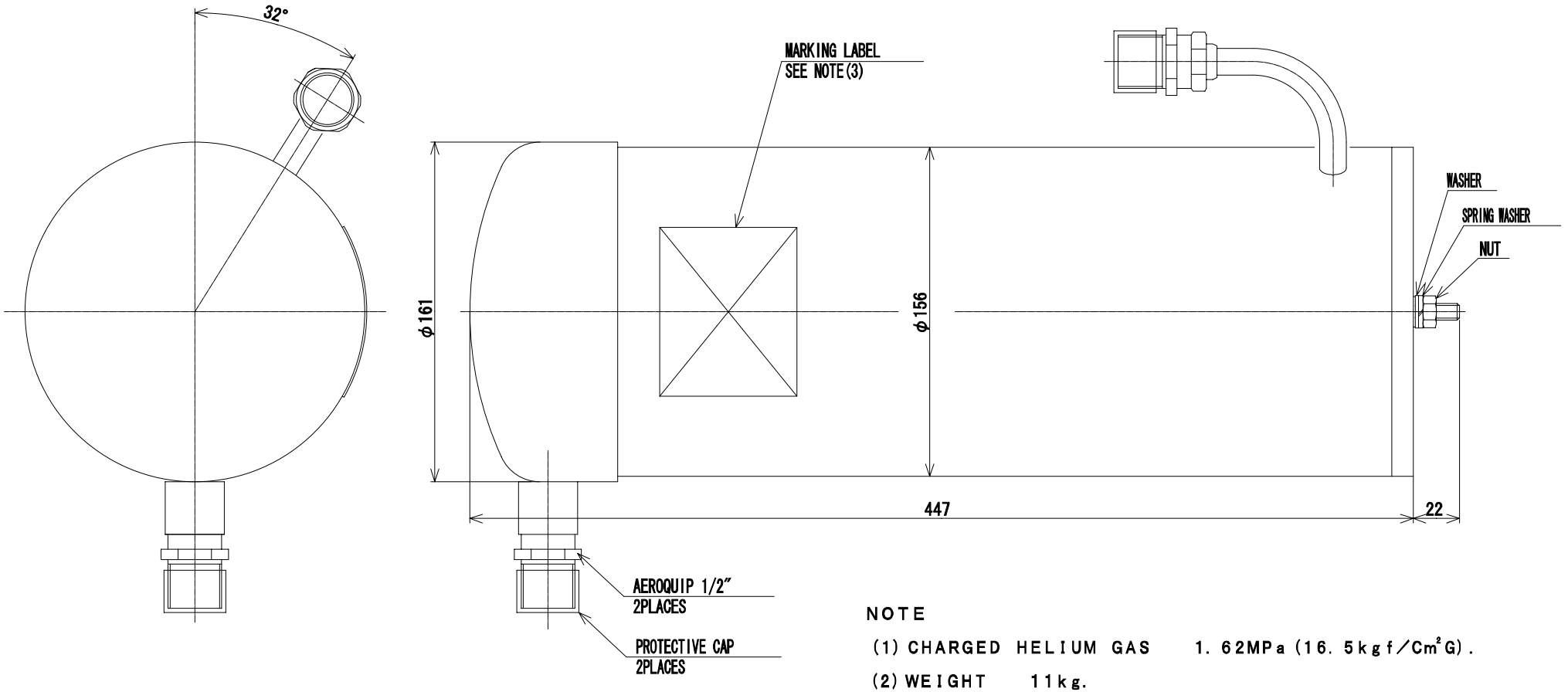
XRZ32Z0014AQ







XRE38B1015AQ



NOTE

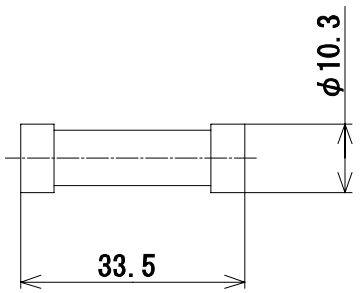
(1) CHARGED HELIUM GAS 1.62MPa (16.5kgf/Cm^{2}G).

(2) WEIGHT 11kg.

(3) PART TO BE MARKED WITH G.E. PART NUMBER.

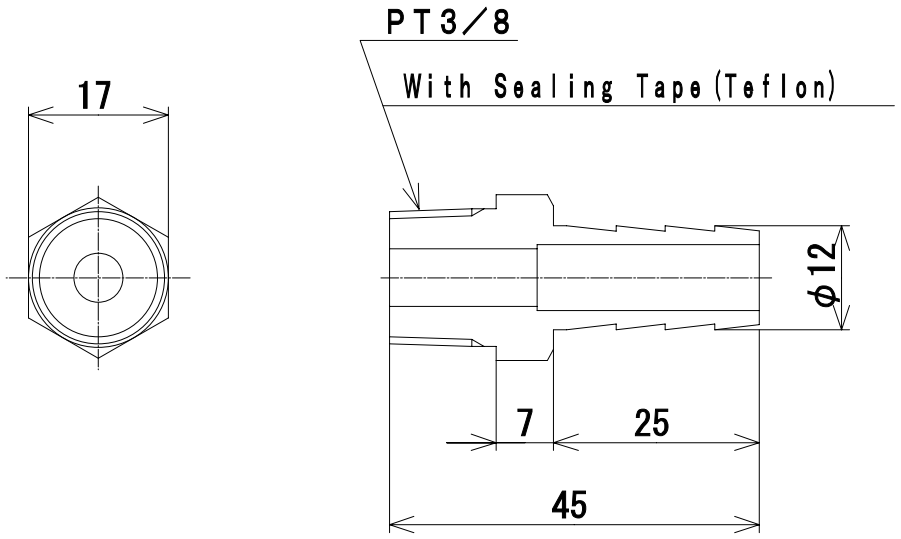
ADSORBER
PART No. 2172241 (Rev. ***)

XRE71B0050AQ



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

CLASS G FUSE 5A



Material : Brass

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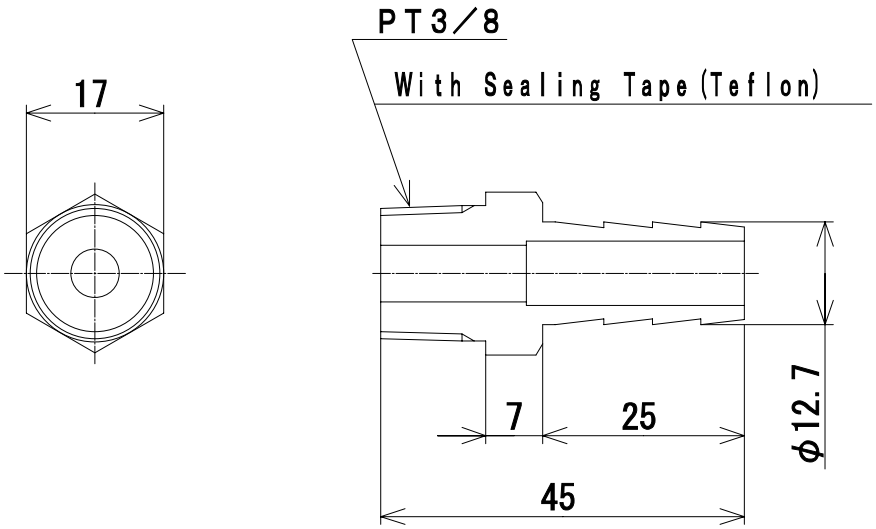

Material : Brass

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REVISION CONTROL

Manual No.	GE Revision	SHI Revision	Remarks	Date
CD32ZZ-061	Revision 2	-A	Publication of first edition.	DEC. 20 / 1999
	Revision 2	-B	Change the Electrical Schematic Diagram.	APR. 4 / 2000
	Revision 2	-C	Add the description of BPU-01.	APR. 10 / 2000
	Revision 2	-D	Delete the description of “water temp. alarm signal“.	JAN. 11 / 2001
	Revision 2	-E	Change the SHI address.	JAN. 25 / 2001
	Revision 2	-F	Change the Electrical Schematic Diagram.	FEB. 19 / 2001
	Revision 2	-G	Add the 12.7mm Hose Nipple.	AUG. 22 / 2001
	Revision 2	-H	Add the specification of recommended power requirement and description of demineralized water.	APR. 1 / 2002
	Revision 2	-I	Change the dimension.	MAY 31 / 2002
	Revision 2	-J	Correct the descriptions of Input Power Cable Connection.	JUL 11 / 2002
	Revision 2	-K	Add the RDK-408A2 Cold Head. Add the transformer-use CAUTION.	MAR. 17 / 2003

Sumitomo Heavy Industries, Ltd.

MANUAL NUMBER: CD32ZZ-062L
DATE: March 17 / 2003

TECHNICAL INSTRUCTION

CSW-71D
COMPRESSOR UNIT
Revision 2

For Service Personnel Only

PART NUMBERS

MODEL	SHI PART No.	GE PART No.
CSW-71D COMPRESSOR UNIT	RE38ZH0157	2188440-2

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TABLE LIST

FIGURE LIST

CROSS REFERENCE

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

MANUAL NAME	MANUAL No.
OPERATION MANUAL SRDK Series CRYOCOOLER	CD32ZZ-056
TECHNICAL INSTRUCTION RDK-408A2 4K COLD HEAD*	CD32ZZ-098
TECHNICAL INSTRUCTION RDK-408 4K COLD HEAD*	CD32ZZ-057
TECHNICAL INSTRUCTION RDK-408T 10K COLD HEAD*	CD32ZZ-058
TECHNICAL INSTRUCTION RDK-400 SINGLE STAGE COLD HEAD*	CD32ZZ-059
INSTALLATION MANUAL BPU-01 BY PASS UNIT**	CD32ZZ-075

* See the TECHNICAL INSTRUCTION of Cold Head used.
** See the INSTALLATION MANUAL of BPU-01, if BPU-01 is used in this system.

1 GENERAL INFORMATION

1-1 SPECIFICATIONS

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

Table 1.1 CSW-71D COMPRESSOR UNIT SPECIFICATION

	For **RDK-408A2** For **RDK-408**	For **RDK-408S** For **RDK-400B**
Dimension		
Width	450.0 mm (17.72')	
Length	500.0 mm (19.69')*	
Height	686.5 mm (27.03')	
Helium Gas Pressure		
Static	1.60 - 1.65 MPa at 20 deg.C (68 deg.F) (16.3 - 16.8 kgf/cm^{2}G) (232 - 239 psig)	1.45 - 1.50 MPa at 20 deg.C (68 deg.F) (14.8 - 15.3 kgf/cm^{2}G) (210 - 217 psig)
Operating (High Side)**	2.10 - 2.30 MPa --- approx. (21.4 - 23.5 kgf/cm^{2}G) (319 - 333 psig)	2.10 - 2.30 MPa --- approx. (21.4 - 23.5 kgf/cm^{2}G) (319 - 333 psig)
Ambient Operating Temperature	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	
Weight	120 kg (264 LBS) --- approx.	
Electrical Requirement		
Power Line Voltage (+/-10%)	AC 380, 400, 415 V / 50 Hz, 3 phase (3W+PE) AC 460, 480 V / 60Hz, 3 phase (3W+PE) (**Δ** ground, Commercial Power Source) ***"WARNING"*** ***Do not use inverter for the main power source.***	
Operating Current	Max. 12 A	
Min. Circuit Ampacity	15 A	
Max. Fuse or Circuit Breaker Size	30 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 ***See the ELECTRICAL SCHEMATIC of "APPENDIX" for detail.***	
Cooling water requirement	***"CAUTION"*** ***Do not use the demineralized water for cooling water.***	
Min. Flow Rate	7 liter/min @ 28deg.C (1.85 gal./min @ 82.4 deg.F) ***See the Figure 1.1***	
Temperature Range	4 to 28 deg.C (39.2 to 82.4 deg.F) ***See the Figure 1.1***	
pH Value	6.5 to 8.2	
Hardness	Max. 200 mg$CaCo_3$/liter	
Molybdate-Reactive Silica	Max. 50 mg/liter	
Suspended Matter	Max. 10 mg/liter (Less than 100 micron)	
Pressure Relief Valve Setting	2.61 - 2.75 MPa (26.6 - 28.0 kgf/cm^{2}G, 378 - 398 psig)	
Gas Supply Connector **Gas Return Connector**	1/2-inch Coupling 1/2-inch Coupling	

* Input Power Cable Terminal Cover is 98.0 mm (3.9'). See the **Figure 1.2**.

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

COOLING WATER FLOW RATE AND PRESSURE DROP

For Water

The typical flow characteristics are shown in **Figure 1.1**.

The maximum pressure drop through the cooling water line will be approx. 0.32 MPa (3.3kgf/cm^{2}G, 47 psig) at the flow rate of 10 liter/min (2.6 gal./min).

The maximum inlet pressure must be less than 0.69 MPa (7.0kgf/cm^{2}G, 99 psig).

For 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 (3.0 kgf/cm^{2}G, 43 psig) for the pressure drop.

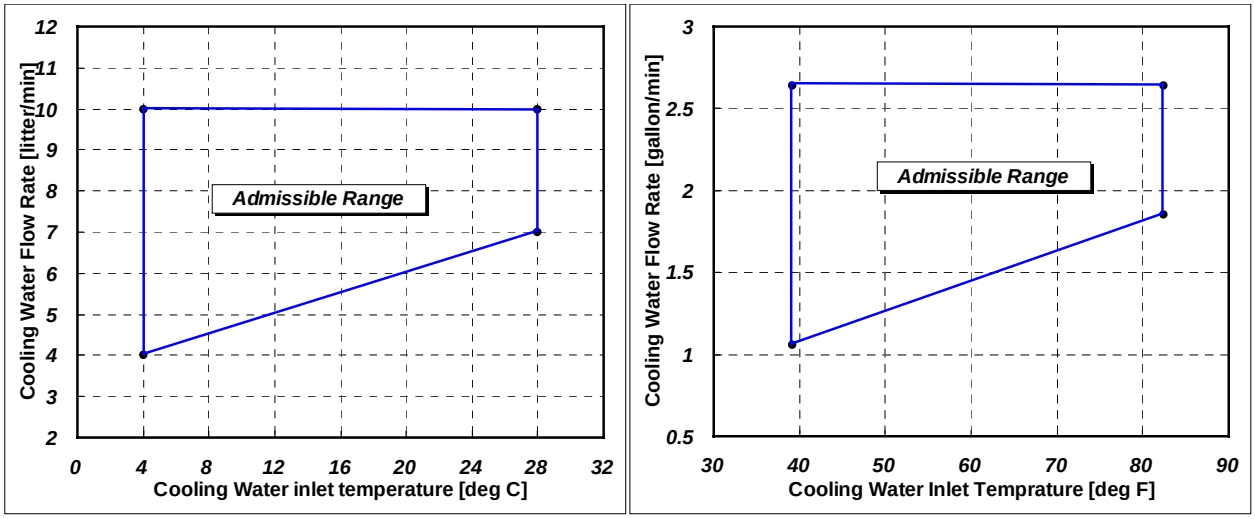


Figure 1.1 COOLING WATER REQUIREMENT

Table 1.2 WATER COOLING SPECIFICATIONS

Inlet Temperature Range [deg.C] (deg.F)	Inlet Pressure Range [MPa] (psig)	Recommend Flow Rate [liter/min] (gal/min)	Pressure Drop [MPa] (psig)	Temperature Rise <Typical> [deg.C] (deg.F)	Temperature Rise <Maximum> [deg.C] (deg.F)	Typical Heat Output [kW] (BTU/Hr)	Maximum Heat Output [kW] (BTU/Hr)
[4.0 ~ 28.0] (39.2 ~ 82.4)	[0.20 ~ 0.69] (29 ~ 100)	minimum [4.0] (1.1)	[0.05] (8) at minimum flow rate	[26.9] (48.4) for 60Hz [21.9] (39.4) for 50Hz at minimum flow rate	[29.6] (53.3) for 60Hz [23.9] (43.0) for 50Hz at minimum flow rate	[7.5] (25590) for 60Hz Operation	[8.3] (28320) for 60Hz Operation
		maximum [10.0] (2.6)	[0.29] (43) at maximum flow rate	[10.8] (19.4) for 60Hz [8.7] (15.7) for 50Hz at maximum flow rate	[11.9] (21.4) for 60Hz [9.6] (17.3) for 50Hz at maximum flow rate	[6.1] (20728) for 50Hz Operation	[6.7] (23222) for 50Hz Operation

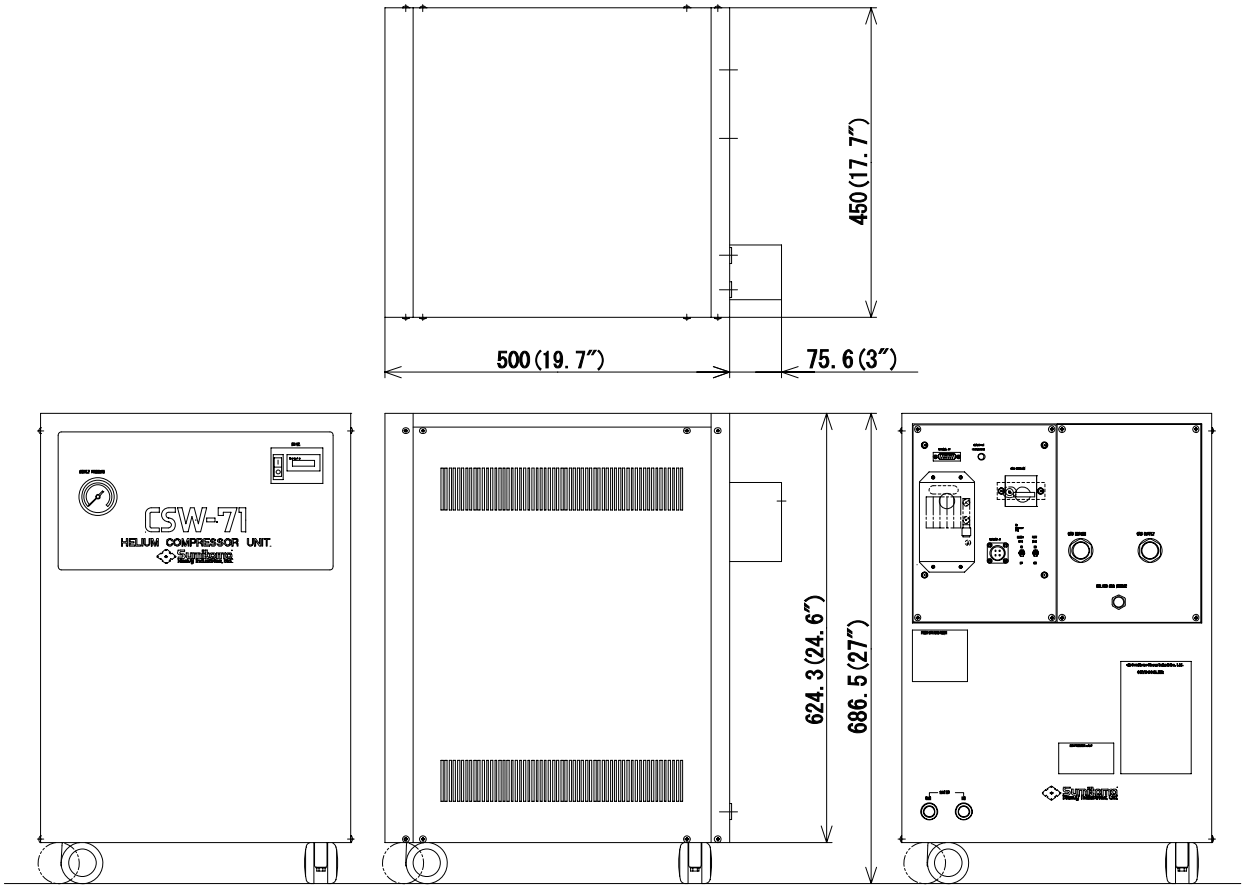


Figure 1.2 OUTLINE VIEW FOR CSW-71D COMPRESSOR UNIT

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-71D are described in **Table 1.3** and **Figure 1.3.**

Table 1.3 CONTROLS AND COUPLINGS FOR CSW-71D 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". ***Caution;*** *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.*
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-71D 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;*** *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.*
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)

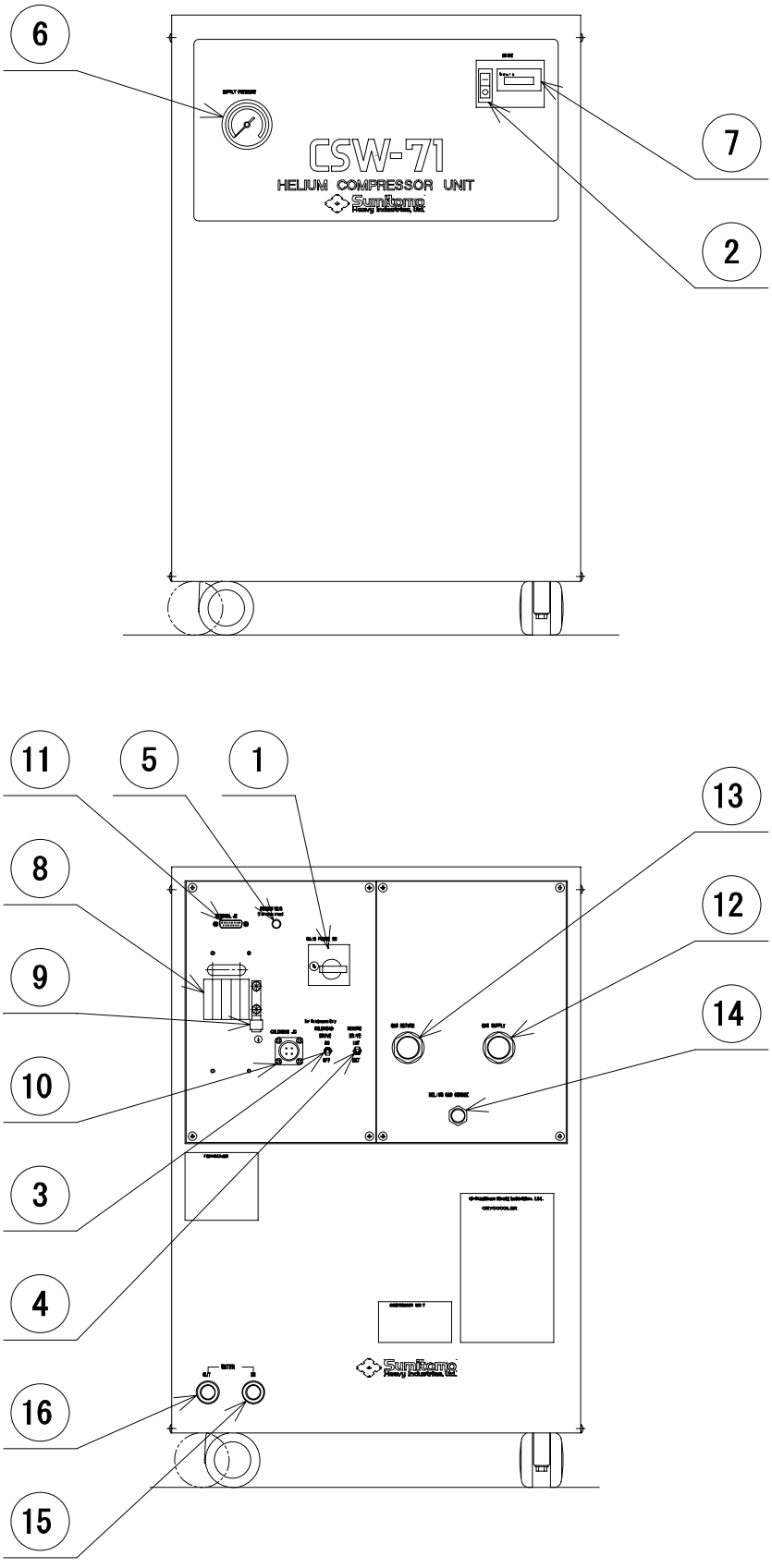


Figure 1.3 CONTROLS AND COUPLINGS FOR CSW-71D COMPRESSOR UNIT

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

The flow diagram for CSW-71D 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 (Press.: 0.59 MPa (6.0 kgf/cm^{2}G, 85psig) & below) 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**.

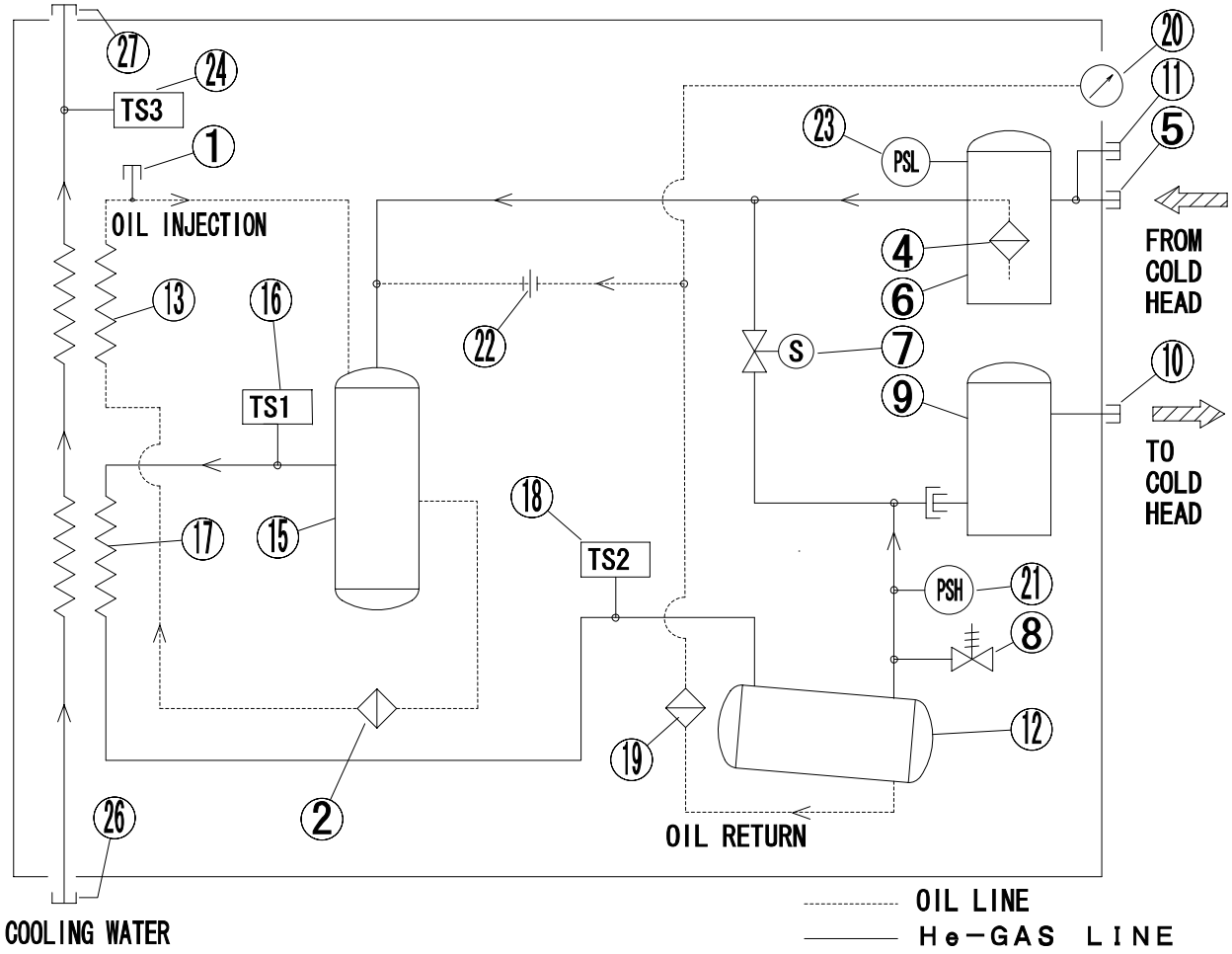


Figure 1.4 HELIUM GAS FLOW DIAGRAM FOR CSW-71D COMPRESSOR UNIT

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-71D 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 (230 deg.F)	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 (140 deg.F)	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 (140 deg.F)	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.

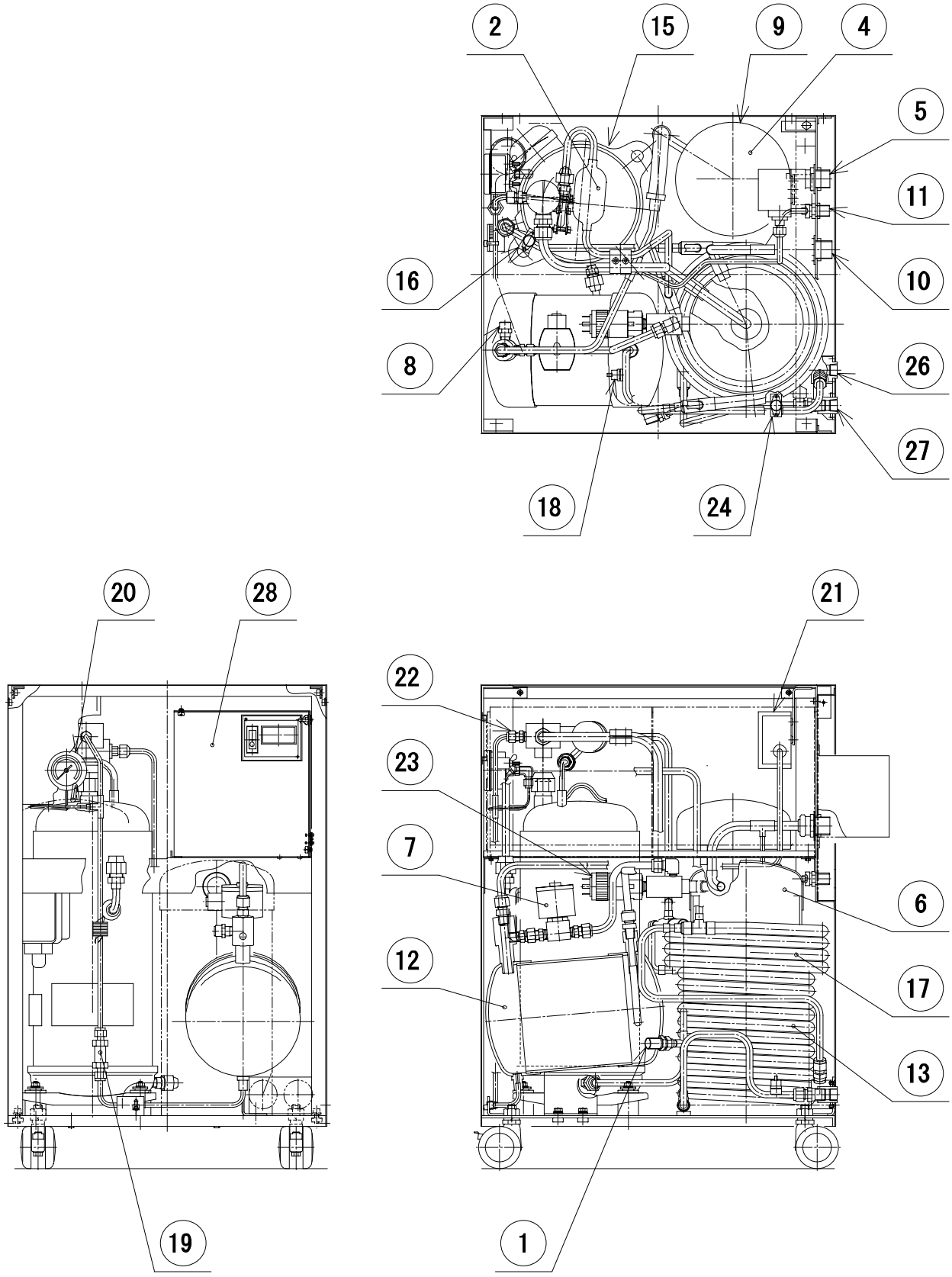
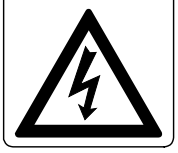


Figure 1.5 COMPONENTS OF CSW-71D COMPRESSOR UNIT

1-3 ELECTRICAL DESCRIPTION

1-3-1 EXTERNAL CONNECTOR

WARNING



<Warning about 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.

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

"IMPORTANT"

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

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**.
"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	Normal	24VDC(0.15A max.)	6, 7	0 V
			Alarm	0V		
4	Control Voltage	DC Power	Normal	24VDC(0.15A max.)	7, 13	0 V
			Alarm	0V		
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

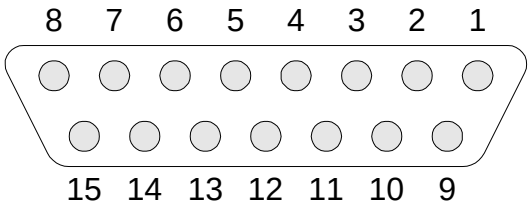


Figure 1.6 EXTERNAL CONNECTOR WIRING ON THE COMPRESSOR UNIT

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-71D

ITEM	FUNCTIONS
THERMOSTAT : (TS1)	Setting temperature; 110 deg.C (230 deg.F) ---- 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 (140 deg.F) ---- 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 (140 deg.F) ---- 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. (26.0 kgf/cm^{2}G, 370 psig) "Reset" 2.26 MPa ---- approx. (23.0 kgf/cm^{2}G, 327 psig) 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. (1.5 kgf/cm^{2}G, 21 psig) 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 (26.6 - 28.0 kgf/cm^{2}G, 378 - 398 psig) "Reset" 2.50 MPa ---- minimum (25.5 kgf/cm^{2}G, 362 psig) 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; 13 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, FU4)	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

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.

Use cooling water with appropriate temperature, flow rate and water quality. Using inappropriate cooling water may result in misoperation or malfunction.

- 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 (41 deg.F) and 28 deg.C (82.4 deg.F) to get the specified 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 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 **Table 1.1.** for the cooling water requirements for your system.

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 (3.0 kgf/cm^{2}G, 43 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 **Figure 2.1**.

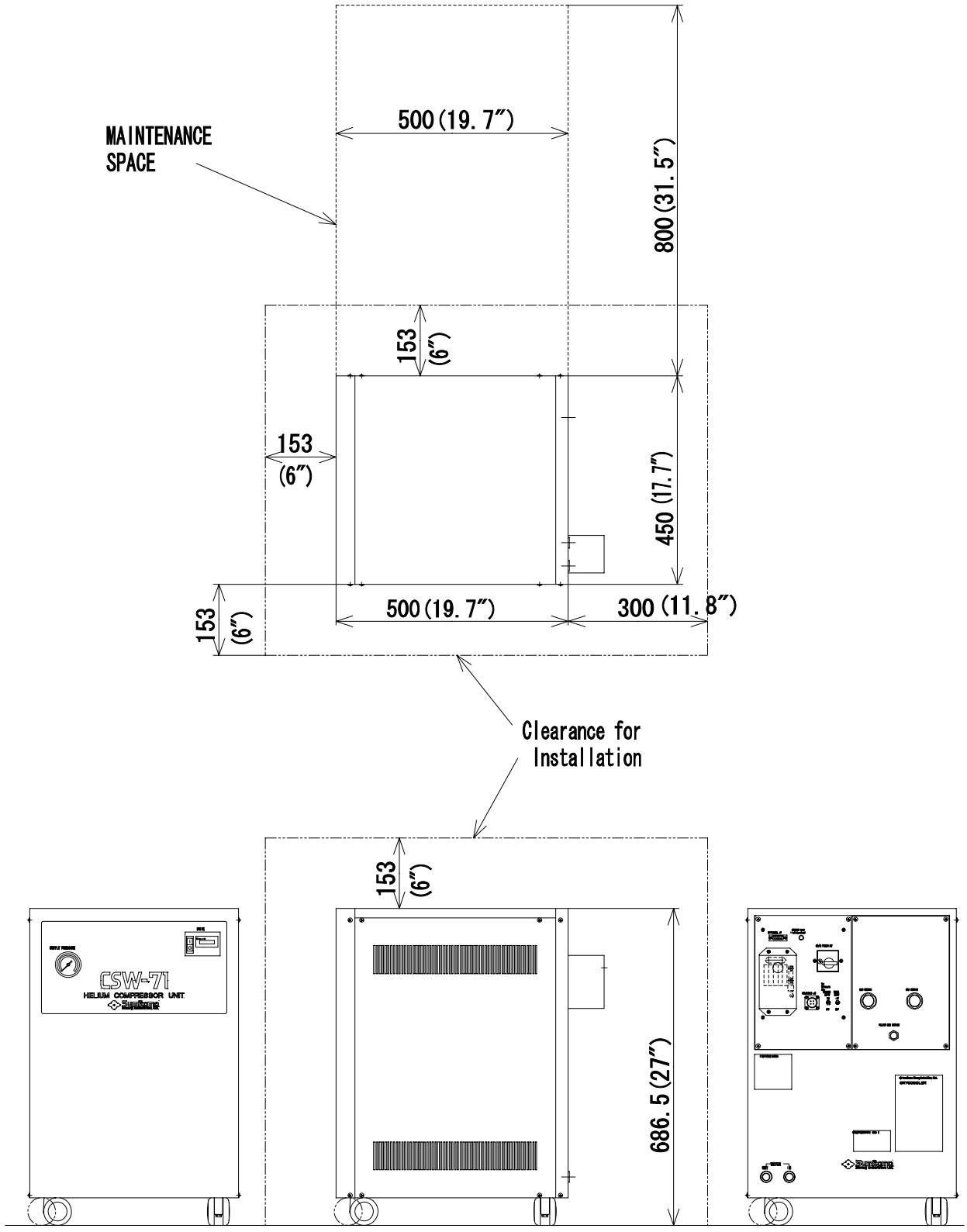
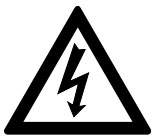


Figure 2.1 WATER-COOLED COMPRESSOR UNIT CSW-71D AND ITS REQUIRED SPACE

2-2 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.

For 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 and then remove the input power cable from the main power before connecting or disconnecting the input power cable to the Compressor Unit. 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 "ELECTRICAL SCHEMATIC" of CSW-71D Compressor Unit, 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 30A.

Power Supply Conductor and Protective Earth Conductor

Use 75 deg.C wiring sized to 60 deg.C ampacity.
Use copper conductor only. AWG 12 (3.3 mm^2) or larger.

Compressor Unit Side

Power Supply Conductors
Striping Length: 12 mm
Tightening Torque: 1.3 N・m (13 kgf・cm)

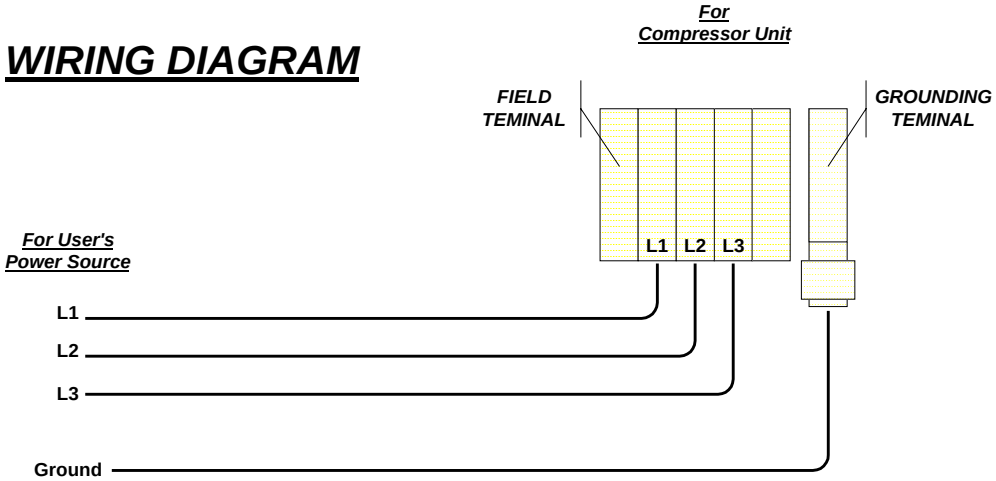
Protective Earth Conductor
Striping Length: 12 mm
Tightening Torque: 1.8 N・m (18 kgf・*cm)*

User's Power Source Side

Power Supply Conductors
Striping Length: 12 mm

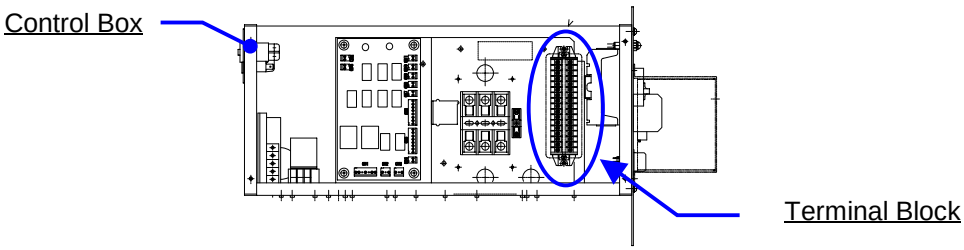
Protective Earth Conductor
Striping Length: 12 mm

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



Input Power Voltage Setting

The Compressor Unit can be operated on various input power voltages by changing the terminal wiring in the Compressor Unit. This terminal is located inside of the Control Box. See the Figure 2.2 for voltage setting. ***Initial factory setting is AC480V / 60Hz.***



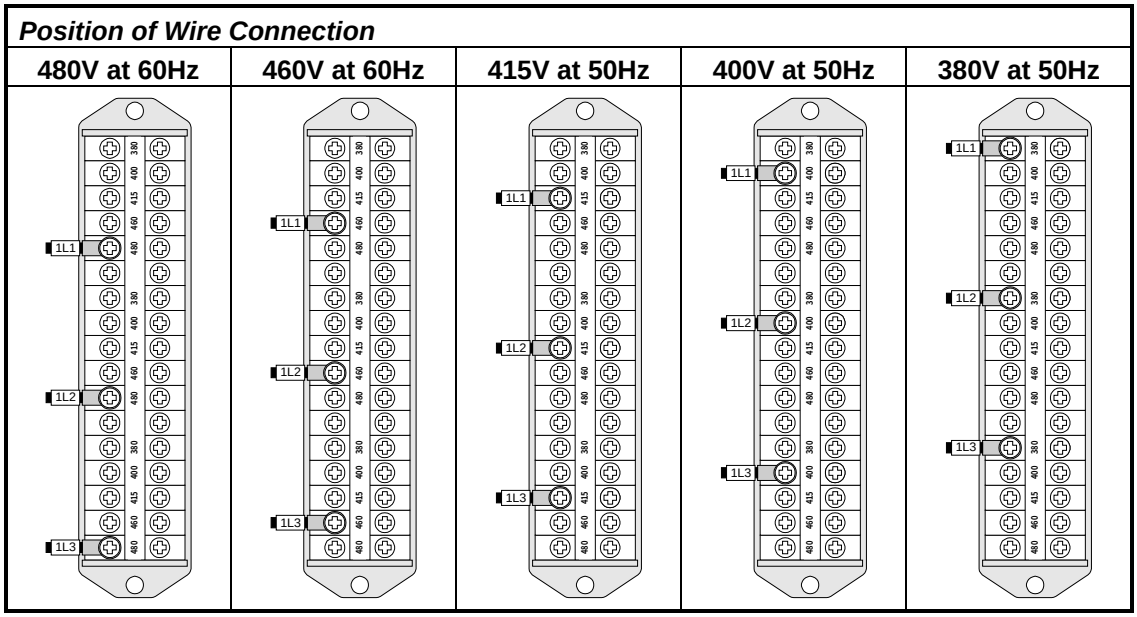
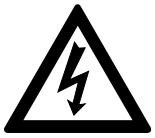


Figure 2.2 TERMINAL WIRING FOR INPUT POWER VOLTAGE

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 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 and then remove the input power cable from the main power before connecting or disconnecting the input power cable to the Compressor Unit. 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/cm^{2}G, 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.

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.

Use cooling water with appropriate temperature, flow rate and water quality. Using inappropriate cooling water may result in misoperation 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.

3-1 PERIODICAL MAINTENANCE

CSW-71D 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	REMARK
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	DIMENSIONS	GE PART NUMBER	SHI PART NUMBER
1	Adsorber	1	OD155×H447	2172241	RE71TN0408
2	Class G Fuse 1A	3		2191112-9	RE71WT0768
3	Glass Body Fuse 1A	1		2191112-10	RE71WT0767
4	Hose Nipple	2	12.0×3/8	2205309	RE38VT0689
5	Hose Nipple	2	12.7×3/8	2302167	RE38VT0814

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 (16.5 kgf/cm^{2}G, 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.

WARNING

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

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	REMARK
1	Adsorber	1	RE71TN0408	OD155×H447

Table 3.4 REQUIRED TOOLS FOR ADSORBER REPLACEMENT

	TOOLS	REMARK
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.

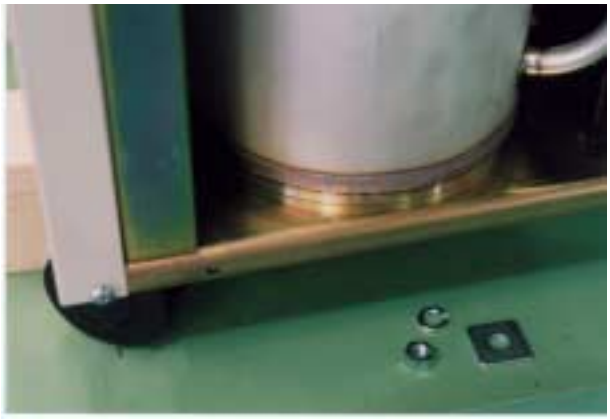
REMOVING THE USED ADSORBER

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.

3) Secure the Adsorber to Rear Panel by tightening Nut.

4) Connect the Adsorber Self-Sealing Coupling.

5) Reinstall the panels and secure them by tightening the screws.

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

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.

Be sure to turn off the customer's main power and remove the input power cable from the compressor unit 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.

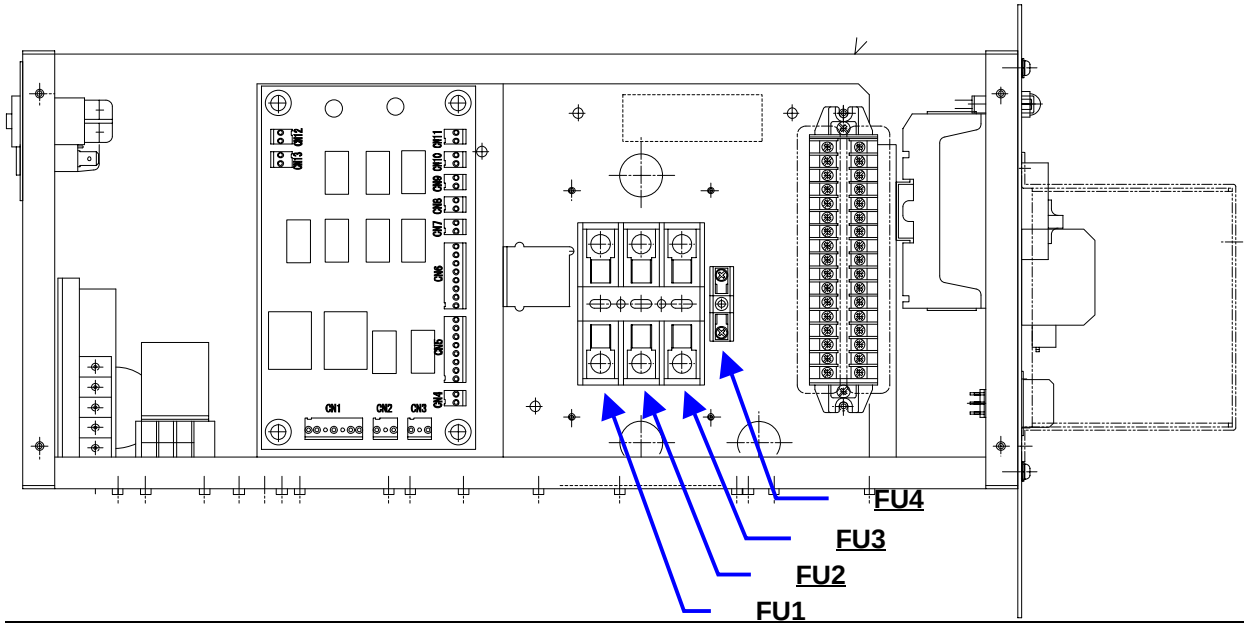
Table 3.5 LIST OF FUSES (Spare fuses are attached to this Manual)

Fuse No.	Description	Part Number	GE Part Number	Remarks
FU1, 2, 3	Class G Fuse 1A	RE71WT0768	2191112-9	For Cold Head Motor, Solenoid Valve and DC Circuit.
FU4	Glass Body Fuse 1A	RE71WT0767	2191112-10	

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-71D (FOR AC CIRCUIT)
2	ELECTRICAL SCHEMATIC of CSW-71D (FOR DC CIRCUIT)

DRAWINGS

No.	PART NAME	GE PART No.	SHI PART No.
1	CSW-71D COMPRESSOR UNIT	2188440-2	RE38ZH0157
2	INPUT POWER CABLE HV	2200835	RV21ZN0183
3	ADSORBER	2172241	RE71TN0408
4	CLASS G FUSE 1A	2191112-9	RE71WT0768
5	GLASS BODY FUSE 1A	2191112-10	RE71WT0767
6	HOSE NIPPLE 12.0 X 3/8	2205309	RE38VT0689
7	HOSE NIPPLE 12.7 X 3/8	2302167	RE38VT0814

INCOMING POWER SUPPLY

UPSTREAM PROTECTION

3～50Hz 380/400/415V
3～60Hz 460/480V
3-wire sys.

EXTERNAL PROTECTIVE CONDUCTOR
Use COPPER CONDUCTOR ONLY, SAME SIZE AS PHASE CONDUCTOR

POWER SUPPLY CONDUCTOR
Use 75℃ WIRING SIZED TO 60℃ AMPACITY
Use COPPER CONDUCTOR ONLY.
AWG12(3.3mm²) OR LARGER

PE

EXCLUSION FROM SCOPE OF SUPPLY
LIMIT OF EQUIPMENT

L1 L2 L3 TB0

DIRECT TO ENCLOSURE OF PANEL

PROTECTIVE GROUND

QF1
OL PROTECTION SETTING:13A

INSTANTANEOUS OC TRIP:224A

MAIN DISCONNECTING MEANS
CIRCUIT INTERRUPTER WITH OUTSIDE OPERATING NOB AND PADLOCK FITTING HOLE AT. OFF-POSITION

AWG16(1.3mm²) (G/Y)

AWG14(2.0mm²) (BK)

1 KM1 2
3 4
5 6

1T1 U
1T2 V
1T3 W

M1

COMPRESSOR
380/400/415V-50Hz
460/480V-60Hz
(FULL LOAD CURR. 12A.
STARTING CURR 60A)

AWG14(2.0mm²) (G/Y)

AWG16(1.3mm²) (BK)

OL1 OL2 OL3

FU1 FU2 FU3
TYPE CLASS-G
1A 1A 1A

T1 200VA

200V FU4 1A

2L1A

1L1 480 1L1A 480
460 1L1B 460
415 1L1C 415
400 1L1D 400
380 1L1E 380

1L2 480 1L2A 480
460 1L2B 460
415 1L2C 415
400 1L2D 400
380 1L2E 380

1L3 480 1L3A 480
460 1L3B 460
415 1L3C 415
400 1L3D 400
380 1L3E 380

TB1

200
200
0

AWG16(1.3mm²) (RD)

KA12

2L1
2L2
2L3

ON
OFF
SA2

AWG16(1.3mm²) (RD)

2T1 A
2T2 B
2T3 C
D

AWG16(1.3mm²) (G/Y)

COLDHEAD

M2

COLDHEAD DRIVE
200V-50/60Hz
(FULL LOAD AND STARTING CURR. APPROX. 0.5A)

COLDHEAD CABLE

BOARD

CN3 -1
CN3 -3
CN2 -1
CN2 -3
CN1 -1
CN1 -2
CN1 -4
CN1 -6
CN1 -7

KM1
A1 2L1B A2
2L2

KA12

AWG16(1.3mm²) (G/Y)

KA10 KA9

2L1C YV
2L2

C3 0.033μF
C4 0.033μF

KA1

KA2

KA2

R7
39K 3W

AWG18(0.8mm²) (RD)

RF ~ ~ G + −

AWG16(1.3mm²) (G/Y)

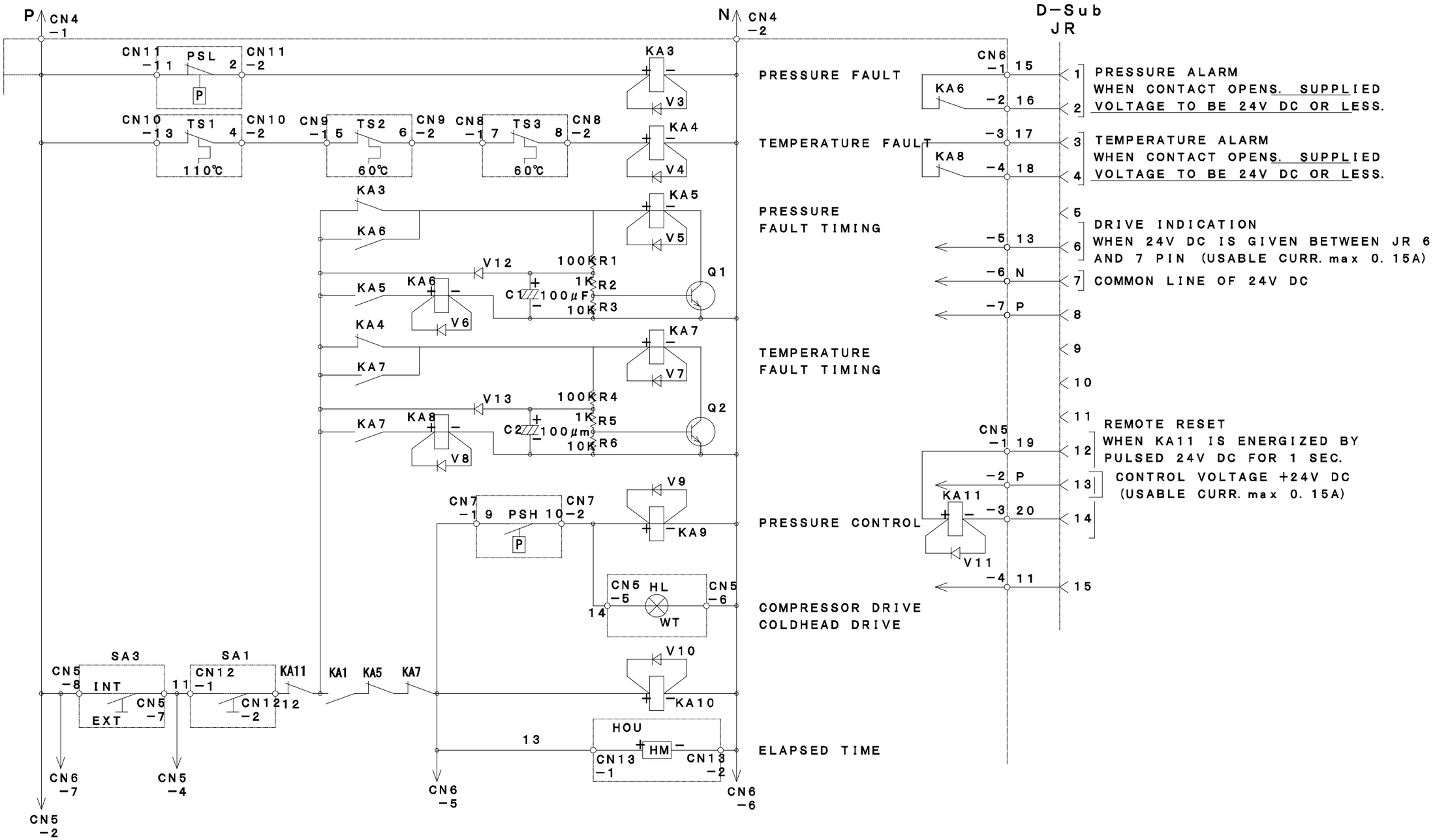
PE

24VDC
CONTROL SOURCE

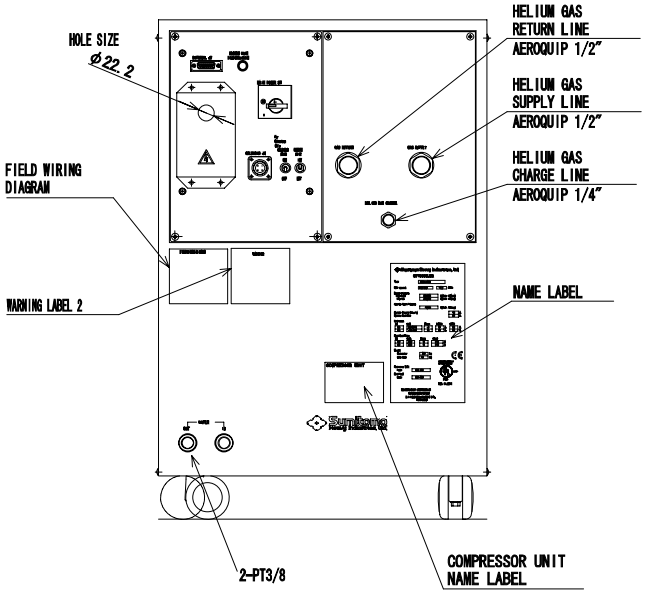
P N

NOTES:
1. NOT ASSIGNED WIRING SIZE IS AWG22(0.32mm²)
2. ABBREVIATION OF WIRING COLOR IS AS FOLLOWS:
   BK(:BLACK), RD(:RED) AND G/Y(:GREEN WITH YELLOW STRIPES)
3. WIRING COLOR OF 24V DC CIRCUIT IS BLUE

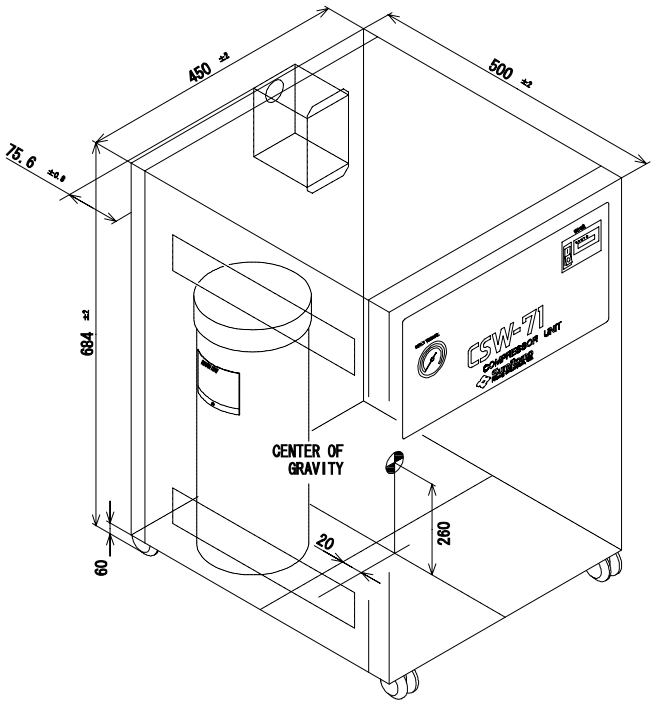
CSW-71D ELECTRICAL SCHEMATIC 1/2

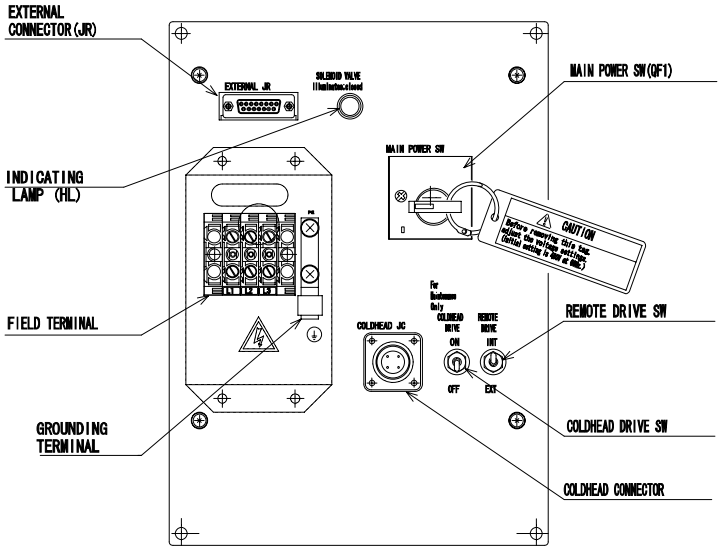


CSW71C/D ELECTRICAL SCHEMATIC 2/2

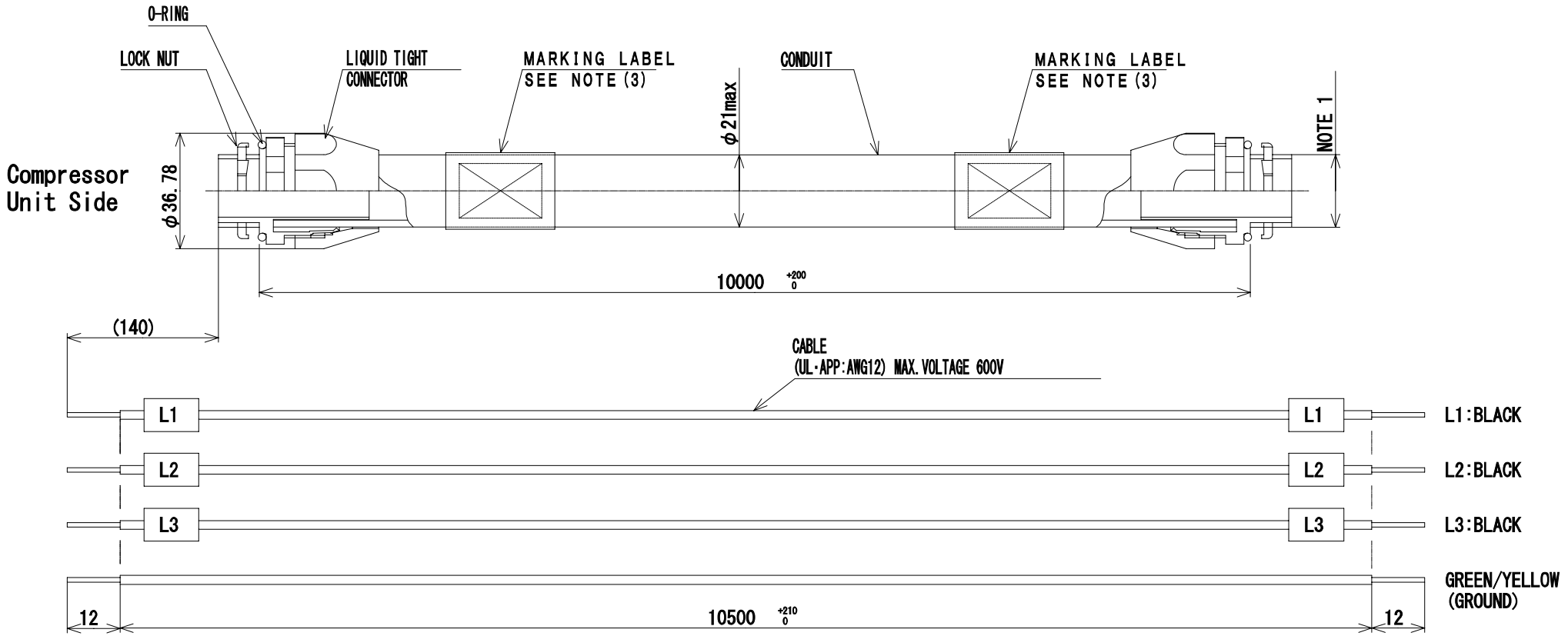


REAR SIDE





XRE38B0116AQ



NOTE

(1) HOLE SIZE : MIN φ22mm.

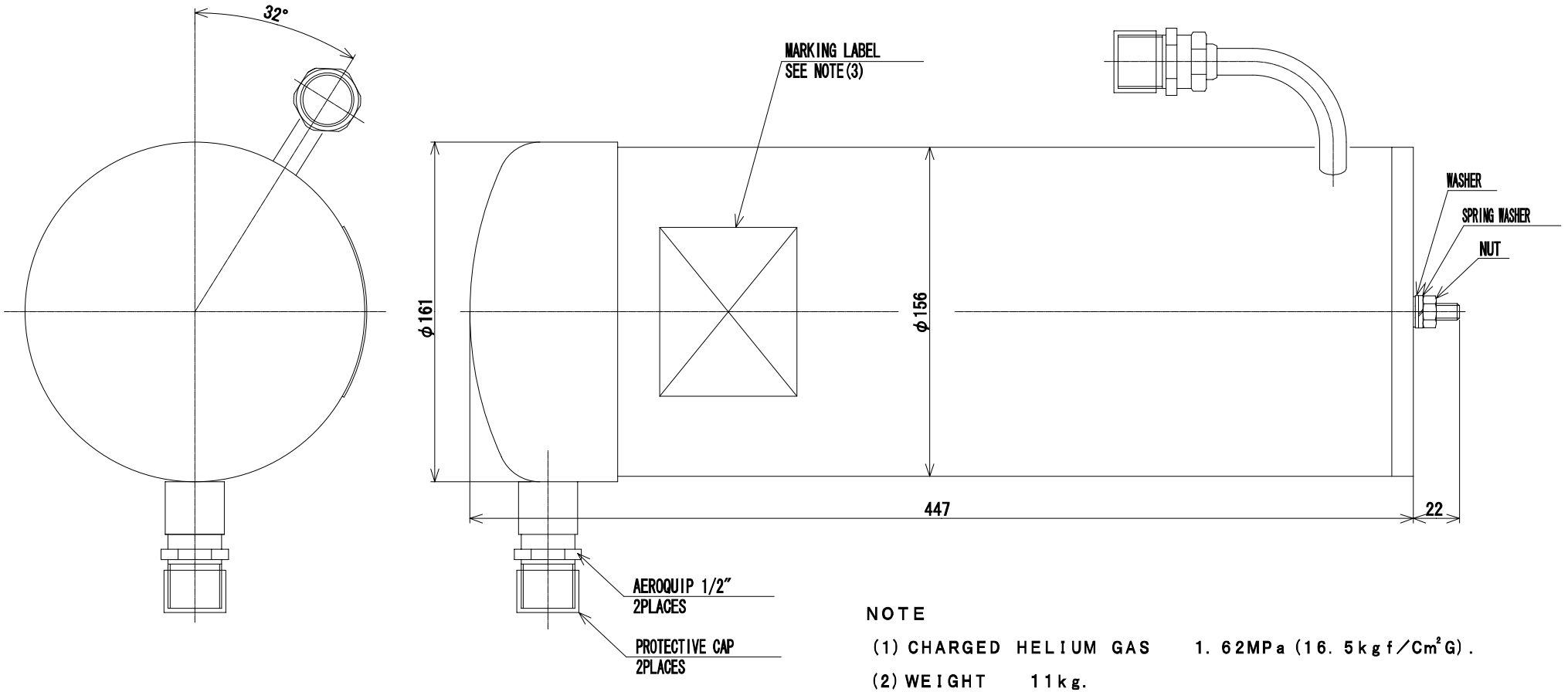
(2) PART TO BE BAGGED OR BOXED AND SEALED FROM DIRT AND MOISTURE.

(3) CABLES ARE TO BE MARKED WITH G.E. PART NUMBER NEAR EACH END.

INPUT POWER CABLE HV Type 10m PART No. 2200835 (Rev***) Sumitomo Heavy Industries, Ltd.

(4) PART MUST CONFORM TO CRYOCOOLER SPECIFICATION 2136066GSP.

XRZ32Z0015AQ



NOTE

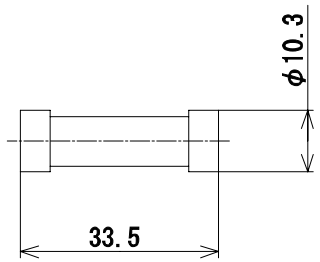
(1) CHARGED HELIUM GAS 1.62MPa (16.5kgf/Cm^{2}G).

(2) WEIGHT 11kg.

(3) PART TO BE MARKED WITH G.E. PART NUMBER.

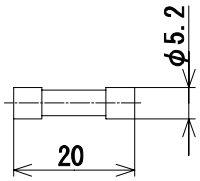
ADSORBER
PART No. 2172241 (Rev. ***)

XRE71B0050AQ



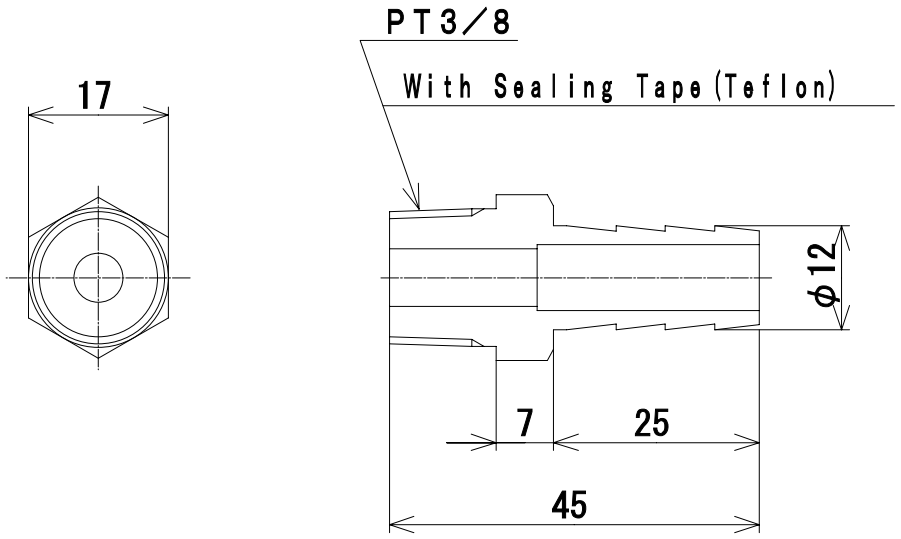
NOTE
1. CLASS G.
2. CURRENT RATING 1A.

CLASS G FUSE 1A



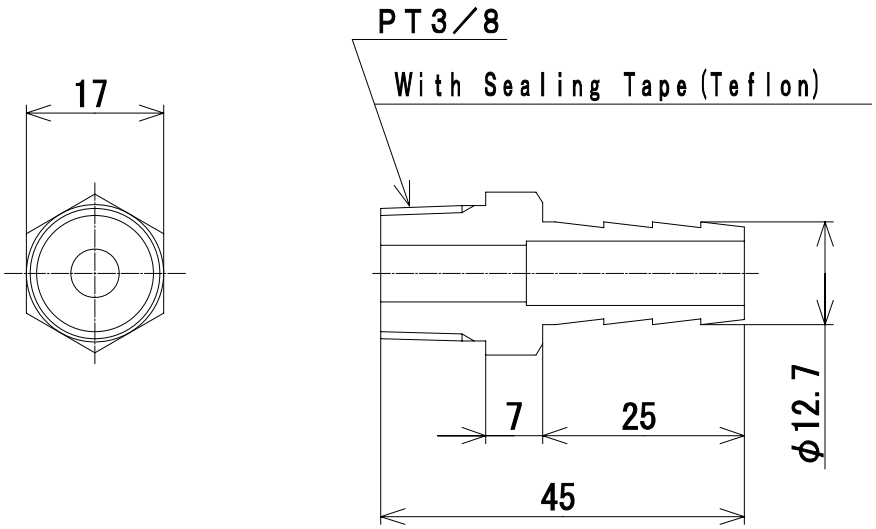
NOTE
1. CURRENT RATING 1A.

GLASS BODY FUSE 1A



Material : Brass

XRE99Z0107AQ



Material : Brass

XRE99Z0106AQ

REVISION CONTROL

Manual No.	GE Revision	SHI Revision	Remarks	Date
CD32ZZ-062	Revision 2	-A	Publication of first edition.	DEC. 20 / 1999
	Revision 2	-B	Change fuse GE Parts No.	FEB. 25 / 2000
	Revision 2	-C	Change the Electrical Schematic Diagram.	APR. 4 / 2000
	Revision 2	-D	Add the description of BPU-01.	APR. 10 / 2000
	Revision 2	-E	Delete the description of “water temp. alarm signal“.	JAN. 11 / 2001
	Revision 2	-F	Change the SHI address.	JAN. 25 / 2001
	Revision 2	-G	Change the Electrical Schematic Diagram.	FEB. 19 / 2001
	Revision 2	-H	Add the 12.7mm Hose Nipple.	AUG. 22 / 2001
	Revision 2	-I	Add the specification of recommended power requirement and description of demineralized water.	APR. 1 / 2002
	Revision 2	-J	Change the dimension.	MAY 31 / 2002
	Revision 2	-K	Correct the descriptions of Input Power Cable Connection.	JUL 11 / 2002
	Revision 2	-L	Add the RDK-408A2 Cold Head. Add the transformer-use CAUTION.	MAR. 17 / 2003

Sumitomo Heavy Industries, Ltd.

MANUAL NUMBER: CD32ZZ-075E
DATE: March 17 / 2003

INSTALLATION MANUAL

BPU-01
BY PASS UNIT
for SRDK Series CRYOCOOLER
Revision 0

For Service Personnel Only

PART NUMBERS

MODEL	SHI PART No.	GE PART No.
BPU-01 BY PASS UNIT	RE38ZN0654	2266223

Sumitomo Heavy Industries, Ltd.
Cryogenics Department

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

CE

SHI

Sumitomo Heavy Industries, Ltd.

EC DECLARATION OF CONFORMITY

(according to Annex II B of the Machinery Directive, for machinery which can not function independently or machinery parts)

We, Sumitomo Heavy Industries, Ltd., herewith declare, on our own responsibility that the following product conforms to the relevant provisions.

Product Name:
Bypass Unit

Model No.:
BPU-01

Council Directives:

Machinery	**98/37/EC**
Low Voltage	**73/23/EEC**
EMC	**89/336/EEC, 92/31/EEC**

Amendment Directive of above directives:
93/68/EEC

Applicable standards:

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

Year to begin affixing CE Marking: 2000

The product covered by this declaration is intended to be installed or assembled with other machinery to constitute machinery covered by Machinery Directive (98/37/EC), and shall not be put into service until the machinery into which it is to be installed or assembled has been declared in conformity with the provision of the applicable Directive.

Tokyo, 10 May 2000

T. Koizumi

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

Tokyo, 10 May 2000

Toshihisa Kimura, Manager,
Design Section
Cryogenics Department
Sumitomo Heavy Industries, Ltd.

TABLE OF CONTENTS

CROSS REFERENCE

Before using this equipment, thoroughly read this manual and following manuals.

MANUAL NAME	MANUAL No.
OPERATION MANUAL SRDK SERIES CRYO COOLER	CD32ZZ-056
TECHNICAL INSTRUCTION RDK-408A2 4K COLD HEAD*	CD32ZZ-098
TECHNICAL INSTRUCTION RDK-408 4K COLD HEAD*	CD32ZZ-057
TECHNICAL INSTRUCTION RDK-408T 10K COLD HEAD*	CD32ZZ-058
TECHNICAL INSTRUCTION RDK-400 SINGLE STAGE COLD HEAD*	CD32ZZ-059
TECHNICAL INSTRUCTION CSA-71A COMPRESSOR UNIT**	CD32ZZ-060
TECHNICAL INSTRUCTION CSW-71C COMPRESSOR UNIT**	CD32ZZ-061
TECHNICAL INSTRUCTION CSW-71D COMPRESSOR UNIT**	CD32ZZ-062

* See the TECHNICAL INSTRUCTION of Cold Head used.

** See the TECHNICAL INSTRUCTION of Compressor Unit used.

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 By Pass Unit Model BPU-01 should be thoroughly inspected for evidence of damage upon receipt. Inspect the outside of shipping container for visible damage. Carefully unpack the BPU-01 and inspect them for damage.

BPU-01 contains a high-pressure (about 1.62MPa (16.5kgf/cm2, 235psig)) 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.

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 BPU-01 securely and properly.

REGULATORY REQUIREMENTS

The BPU-01 with SRDK Series Cryocooler is designed and manufactured in accordance with following standards.

EC Directives (EC)
- EN60204-1 (1997)
- EN61010-1 (1993; +A2)
- EN55011 (1991)

Underwriters Laboratories Inc. (USA)
- UL-471 (Miscellaneous Refrigeration Equipment)

Japan Ministry of Trade and Industry
- MITI Directory No.51

SAFETY PRECAUTIONS

"WARNINGS"

<Warning about electric shock>

This BPU-01 includes a high-voltage section. Touching it may result in electric shock. Handle it with extreme care.

Before starting the installation, make sure no power is applied to the compressor unit. 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.

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

<Warning about explosion, escape of gas>

This BPU-01 contains a high-pressure (about 1.62 MPa (16.5 kgf/cm^{2}G, 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. Disassembling the equipment may result in electric shock, explosion or escape of gas.

The BPU-01 is 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.

"CAUTIONS"

<Caution against misoperation>

This BPU-01 is intended for the exclusive use indoors. It cannot be used outdoors. This may prevent the cryocooler from operating normally.

Do not put an object on top of it. This may prevent the BPU-01 from operating normally or cause injury.

Do not block the air ventilation slit of BPU-01. This may prevent the BPU-01 from operating normally.

Before connecting the flex lines, be sure to check the flat rubber gasket of the self seal coupling of the BPU-01 for dirt, dust or to see whether the flat rubber gasket is attached correctly. Connecting the flex lines with an abnormal flat rubber gasket setting may cause escape of gas.

Do not mismatch the "Supply" and "Return" connections of BPU-01 and Flex Lines.
"Supply" with yellow and "Return" with green markings are labeled on all couplings of BPU-01 body and tee connectors. Check the "Supply" and "Return" markings of before installation.
Misconnecting the gas lines may prevent the cryocooler from operating normally.

1 GENERAL INFORMATION

This manual provides instructions for installation and operation of By-Pass Unit Model BPU-01.

The coldhead makes small vibration caused by displacer reciprocation in the coldhead cylinder. In case the vibration will be the problem for the customer's equipment, the coldhead can be stopped by turning off the Compressor Unit. However, the Compressor Unit does not designed for the frequent on/off operation and may cause the malfunction of the Compressor Unit.

Using the By-Pass Unit Model BPU-01, the coldhead can be stopped and re-started frequently with the Compressor Unit operated by charging the Control voltage (3 to 32VDC) supplied from the customer side.

Figure1.1 is the internal connecting diagram for SRDK Series Cryocooler.
The BPU-01 is designed for both Air-cooled Compressor Unit and Water-cooled Compressor Unit. The BPU-01 will be inserted between the Helium Gas inlet/outlet connector of the Compressor Unit and Supply and Return Flex Lines. The coldhead power line will be connected to the BPU-01 and to the Compressor Unit with the Junction Cable.

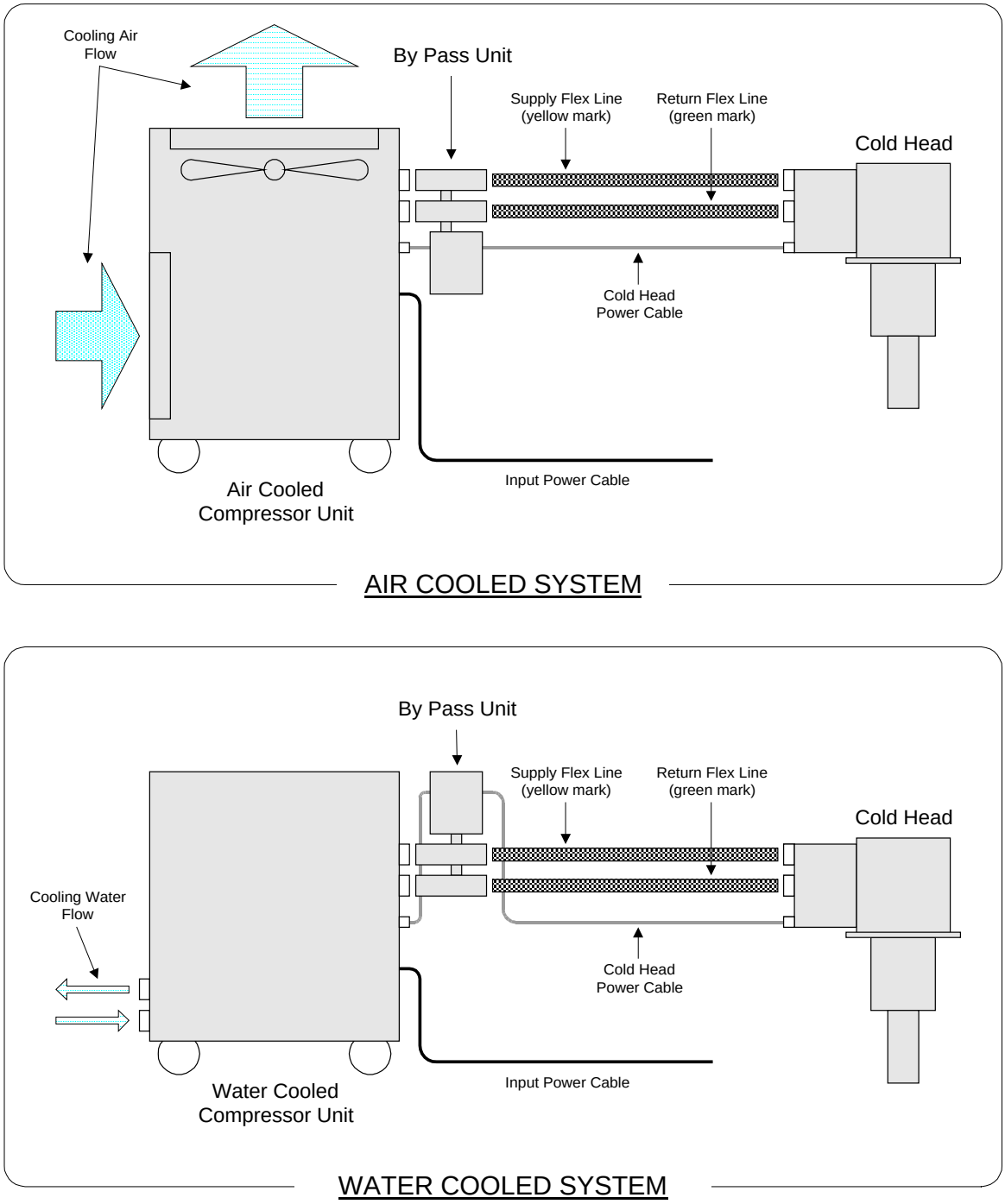


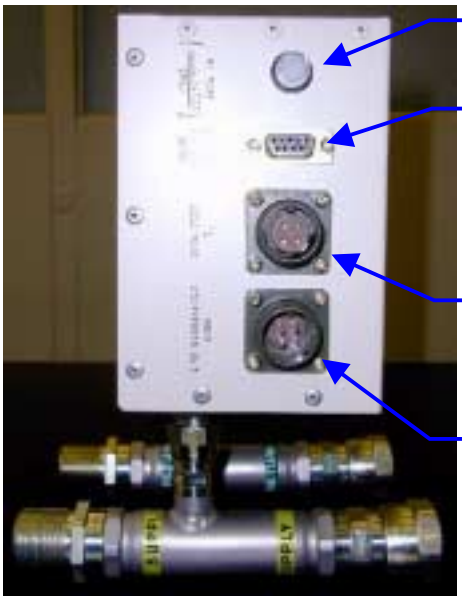
Figure 1.1 INTERNAL CONNECTING DIAGRAM

Table1.1 shows the operation of BPU-01.
The BPU-01 will stop the coldhead operation and release the high-pressure supply gas to the Return connector of Compressor Unit through the electrically operated solenoid valve by charging the Control Voltage supplied from customer side. No cooling power is generated from coldhead during by-pass operation. If the control voltage will be 0V, the coldhead will re-start and continue normal operation generating specified cooling power.

Figure1.2 shows the out line view of BPU-01.
By-Pass Unit BPU-01 consists of electric circuit, solenoid valve and internal gas tubing. All electric connectors and indicator are located at the side of enclosure. Two Tee-connectors and one Junction Cable are attached to BPU-01 By-Pass Unit.

Table 1.1 BY PASS UNIT OPERATION

Control Voltage Input	Cold Head	Compressor Unit	By Pass Unit
3~32 VDC	Stop	Operate	Operate (Valve Open)
0 V	Operate	Operate	Stop (Valve Close)



By Pass Valve Operation Indicator

Control Voltage Input Connector
(D-Sub 9pin Female)
(Control Voltage : 3~32VDC)
(pin No.1:+, No.6:-)

Cold Head Power Cable Connector
(To Cold Head)

Cold Head Power Cable Connector
(From Compressor Unit)

Figure 1.2 OUTLINE VIEW OF BPU-01

1-1 SPECIFICATIONS

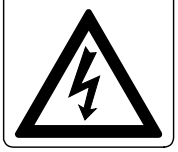
The specifications of the BPU-01 By-Pass Unit are summarized in **Table 1.2**.

Table 1.2 BPU-01 BY-PASS UNIT SPECIFICATION

Ambient Operating Temperature	5 to 35 deg.C (41 to 95 deg.F)
Dimension (without junction cable) Width Length Height	 178 mm (7.01') 166 mm (6.54') 216 mm (8.51')
Weight	3.1 kg (6.8 LBS) --- approx. (Including Junction Cable)
Control Voltage Range	DC 3 ~ 32V (Pin No.1:+, Pin No.6:-)
Frequency of By-Pass Operation **Normal Operation** **Maximum Operation**	 1 time @ 1 hour (ON:40%, OFF60%) 1 time @ 20 min. (ON:40%, OFF60%)

2 INSTALLATION

WARNING



<Warning about electric shock>

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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 BPU-01 contains a high-pressure (about 1.62 MPa (16.5 kgf/cm^{2}G, 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. Disassembling the equipment may result in electric shock, explosion or escape of gas.

The BPU-01 is 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.

CAUTION

<Caution against misoperation>

This BPU-01 is intended for the exclusive use indoors. It cannot be used outdoors. This may prevent the cryocooler from operating normally.

Do not put an object on top of it. This may prevent the BPU-01 from operating normally or cause injury.

Do not block the air ventilation slit of BPU-01. This may prevent the BPU-01 from operating normally.

Do not mismatch the "Supply" and "Return" connections of BPU-01 and Flex Lines.
"Supply" with yellow and "Return" with green markings are labeled on all couplings of BPU-01 body and tee connectors. Check the "Supply" and "Return" markings of before installation.
Misconnecting the gas lines may prevent the cryocooler from operating normally.

This section describes the installation of BPU-01. Be sure to read this section before installing the cryocooler.

2-1 TOOLS FOR INSTALLATION

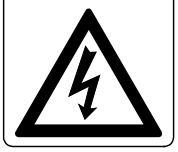
The following tools are required for BPU-01 Installation.

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	5/8“ Open-end wrench	For BPU-01 connection
5	3/4“ Open-end wrench	For BPU-01 connection
6	Liquid Leak Detector	For leak check
7	Cotton wipers	For leak check

2-2 BPU-01 INSTALLATION

WARNING



<Warning about electric shock>

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

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

WARNING

<Warning about explosion, escape of gas>

This BPU-01 contains a high-pressure (about 1.62 MPa (16.5 kgf/cm^{2}G, 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>

Before connecting the flex lines, be sure to check the flat rubber gasket of the self seal coupling of the BPU-01 for dirt, dust or to see whether the flat rubber gasket is attached correctly. Connecting the flex lines with an abnormal flat rubber gasket setting may cause escape of gas.

Do not mismatch the "Supply" and "Return" connections of BPU-01 and Flex Lines.
"Supply" with yellow and "Return" with green markings are labeled on all couplings of BPU-01 body and tee connectors. Check the "Supply" and "Return" markings of before installation.
Misconnecting the gas lines may prevent the cryocooler from operating normally.

"IMPORTANT"

When connecting the BPU-01 and 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 installation of BPU-01 as follows;

CONNECTING PROCEDURE

1) Remove all protective caps of the self-sealing connectors.

2) Check all the flat rubber gaskets of self-sealing connectors to make sure of being clean and properly positioned.

3) Disconnect the Flex Lines (both Supply and Return) from the Compressor Unit.

For Air Cooled Compressor Unit

For Water Cooled Compressor Unit

4) Connect the Tee Connectors (both Supply side and Return side) to the Compressor Unit.
(Do not mismatch the "Supply" and "Return" connections)

For Air Cooled Compressor Unit

For Water Cooled Compressor Unit

5) Connect the BPU-01.
(Do not mismatch the "Supply" and "Return" connections)

For Air Cooled Compressor Unit

For Water Cooled Compressor Unit

6) Connect the Flex Lines to the Cold Head as follows;
(Do not mismatch the "Supply" and "Return" connections)

1. First, connect the ***Return*** Flex Line.
2. Then connect the ***Supply*** Flex Line.

For Air Cooled Compressor Unit

For Water Cooled Compressor Unit

7) Connect the Cold Head Power Cable to BPU-01.

For Air Cooled Compressor Unit

For Water Cooled Compressor Unit

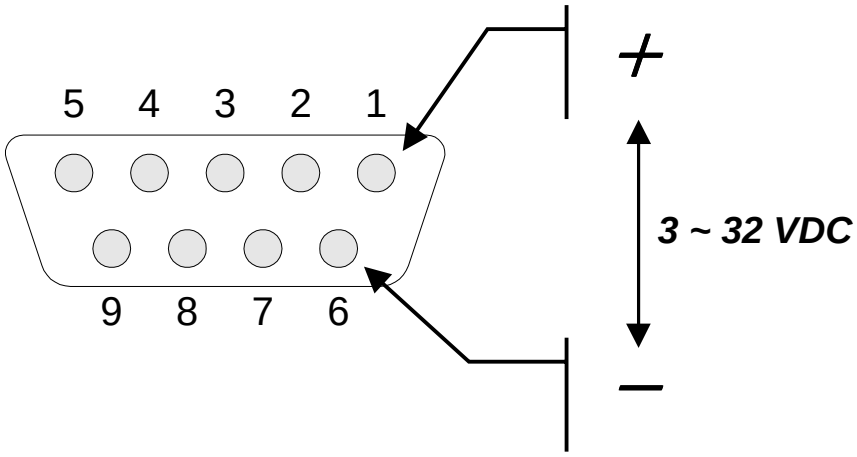
8) Connect the Junction Cable between Compressor Unit and BPU-01.

For Air Cooled Compressor Unit

For Water Cooled Compressor Unit

9) Connect the Control Voltage Input Cable (Customer Side) to Control Voltage Input Connector.

Control Voltage Input Connector
(D-Sub 9pin Female)



For Air Cooled Compressor Unit

For Water Cooled Compressor Unit

LEAK CHECK

After connecting all self-sealing connectors, check the helium gas leak of all connecting coupling as following procedure.

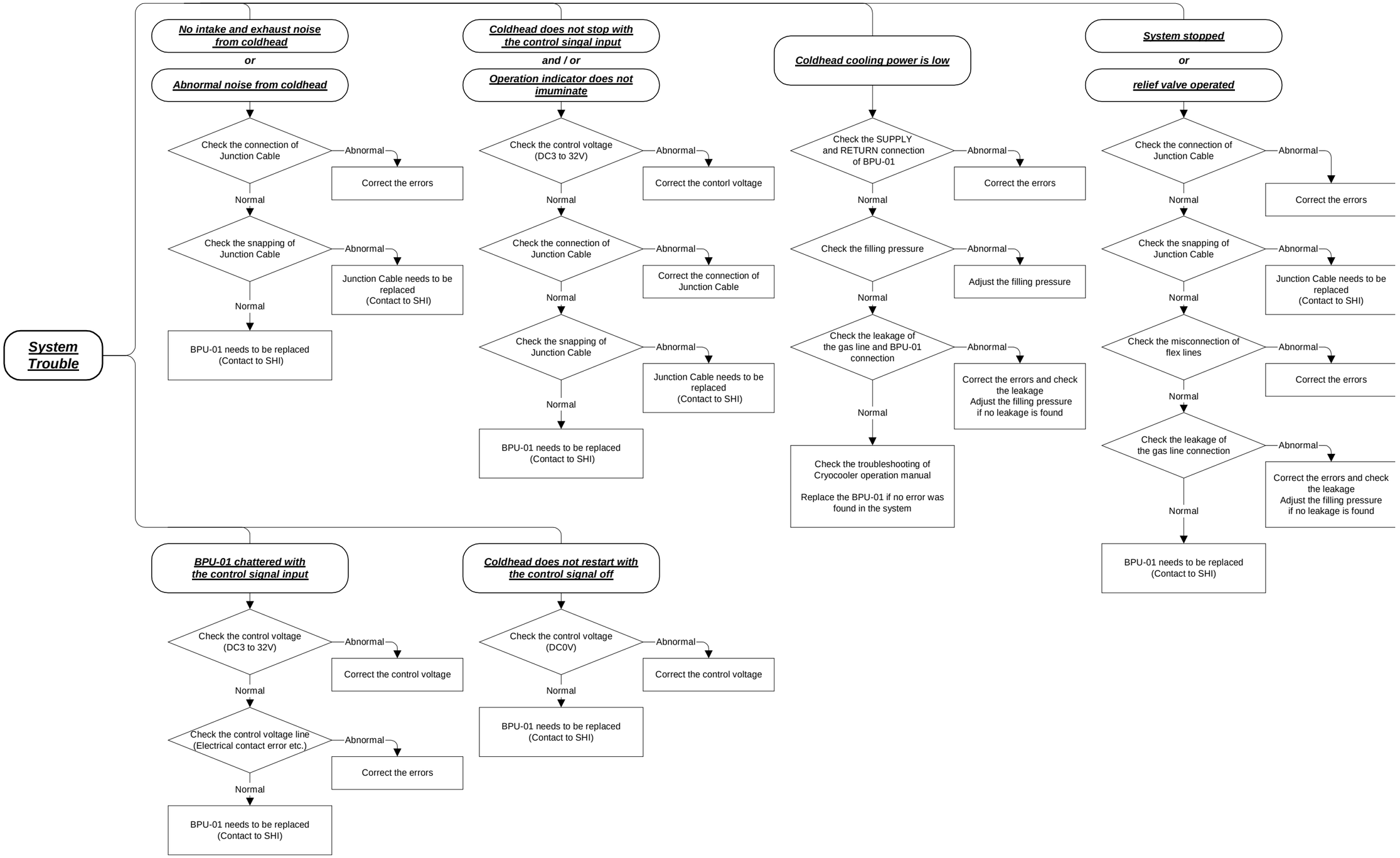
1) Sprinkle “Liquid Leak Detector” on the self-sealing connectors.

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 again and re-check the leakage. Do not over tighten the connector.

3 TROUBLE SHOOTING

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, see the trouble shooting of OPERATION MANUAL.



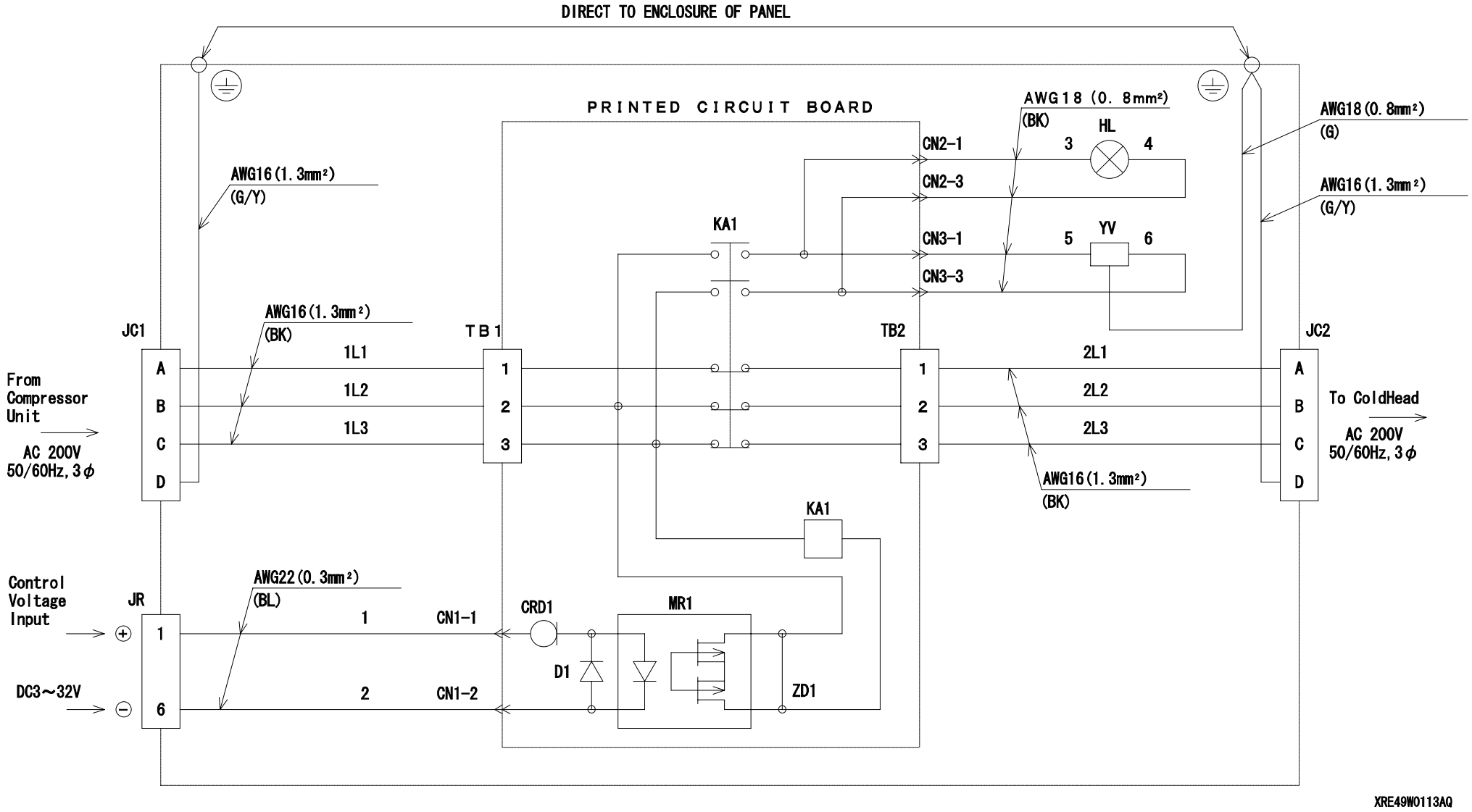
APPENDIX

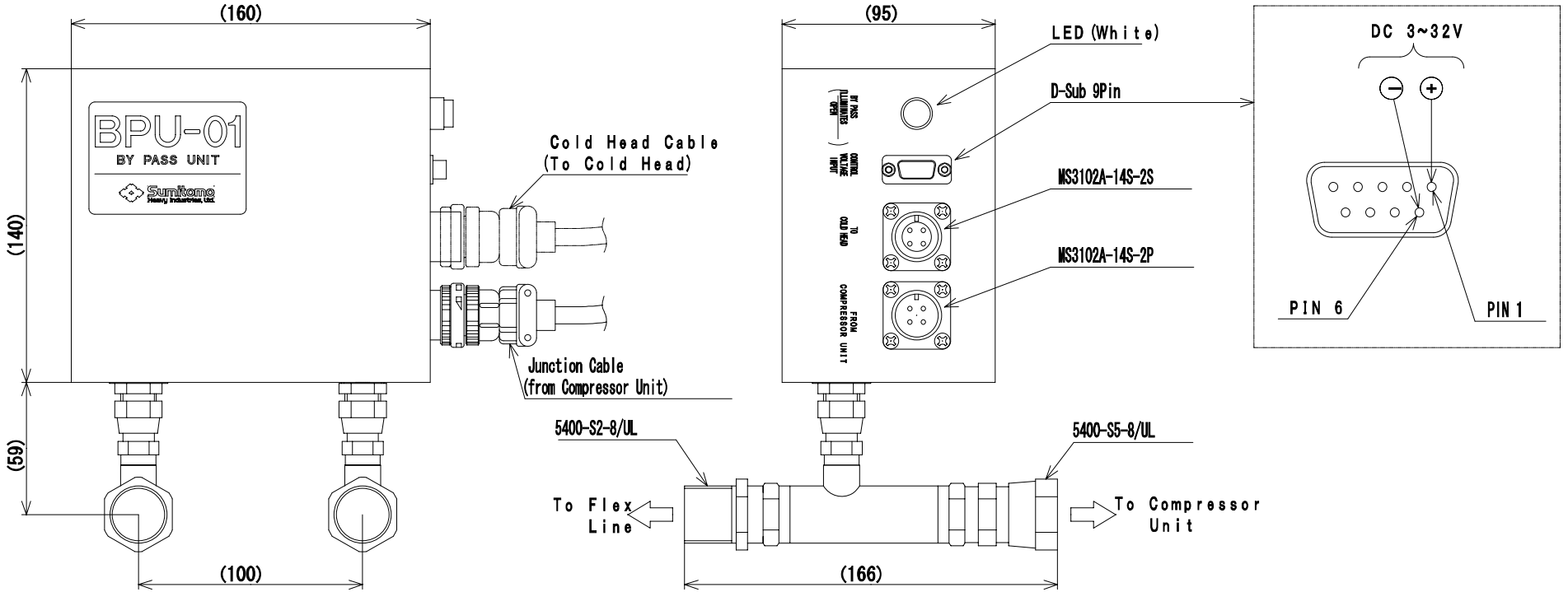
ELECTRICAL SCHEMATIC

No.	PART NAME
1	ELECTRICAL SCHEMATIC of BPU-01

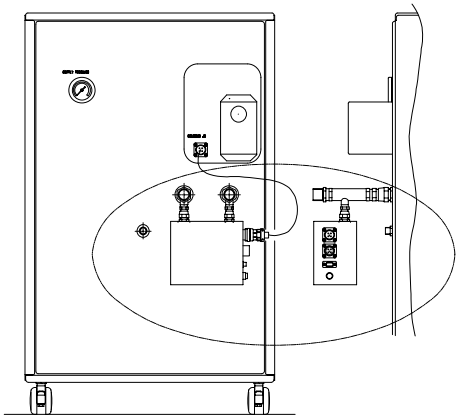
DRAWINGS

No.	PART NAME	GE PART No.	SHI PART No.
1	BPU-01 BY PASS UNIT	2266223	RE38ZN0654
2	JUNCTION CABLE	2266223-2	RV21ZN0299

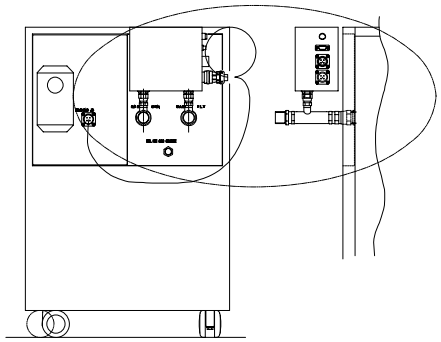

DIRECT TO ENCLOSURE OF PANEL
PRINTED CIRCUIT BOARD
AWG18 (0.8mm²)
(BK)
HL
3
4
CN2-1
CN2-3
AWG18(0.8mm²)
(G)
AWG16(1.3mm²)
(G/Y)
AWG16(1.3mm²)
(G/Y)
KA1
CN3-1
5
YV
6
CN3-3
AWG16(1.3mm²)
(BK)
JC1
TB1
TB2
JC2
From
Compressor
Unit
AC 200V
50/60Hz,3φ
A
B
C
D
1L1
1L2
1L3
1
2
3
2L1
2L2
2L3
To ColdHead
AC 200V
50/60Hz,3φ
AWG16(1.3mm²)
(BK)
KA1
Control
Voltage
Input
JR
AWG22(0.3mm²)
(BL)
1
6
CN1-1
CN1-2
CRD1
D1
MR1
ZD1
DC3～32V
XRE49W0113AQ



BPU-01 LAYOUT

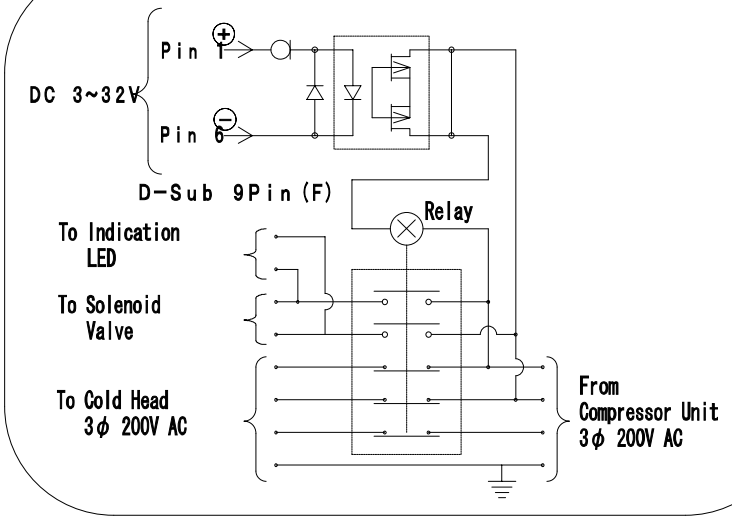


for CSA-71A

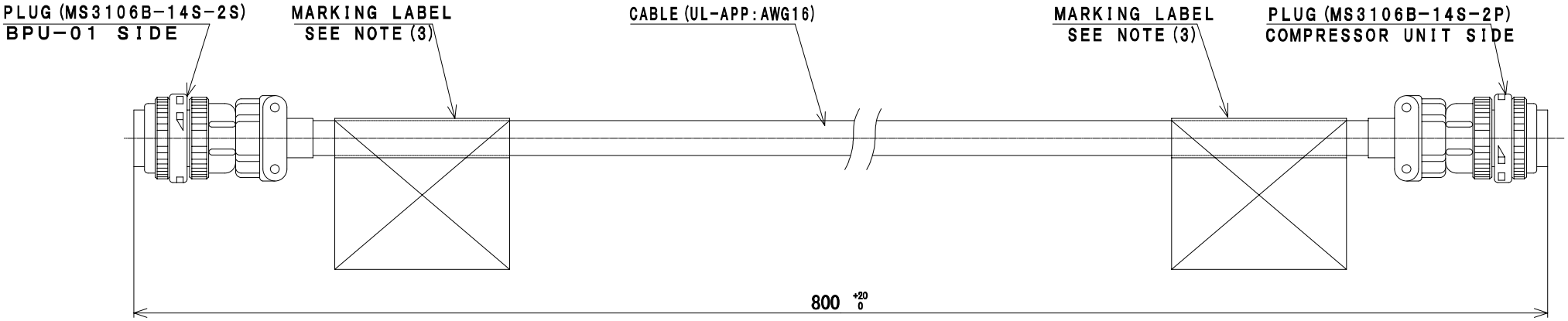


for CSW-71C, D

ELECTRIC CIRCUIT



XRE49W0114AQ



WIRING DIAGRAM

NOTE
(1) PART IS A COMPONENT OF BPU-01.
(2) PART IS BAGGED TO PREVENT DIRT OR MOISTURE.
(3) CABLES ARE TO BE MARKED WITH G. E. PART NUMBER.

JUNCTION CABLE
(BPU-01 TO COMPRESSOR)
Type 0.8m
PART No. 2266223-2 (Rev. ***)
Sumitomo Heavy Industries, Ltd.

XRZ33Z0016AQ

REVISION CONTROL

Manual No.	GE Revision	SHI Revision	Remarks	Date
CD32ZZ-075	Revision 0	-A	Publication of first edition.	MAR. 10 / 2000
	Revision 0	-B	Add trouble shooting flow chart.	APR. 10 / 2000
	Revision 0	-C	Change the Electrical Schematic Diagram.	MAY. 10 / 2000
	Revision 0	-D	Change the SHI address.	JAN. 25 / 2001
	Revision 0	-E	Correct the Electrical Schematic.	SEP. 25 / 2001
	Revision 0	- **F**	Add the RDK-408A2 Cold Head.	MAR. 17 / 2003