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SICERA CRYOPUMP **SYSTEM OPERATION MANUAL**

(Cryopump System)

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INSTRUCTION PRIOR TO INSTALLATION & MAINTENANCE

- (1) This user's manual provides the information required to install and maintain the cryopump (including the cold trap or cold head; the same shall apply hereinafter in this section except the particular function and component) system.
- (2) Sumitomo Heavy Industries (SHI) requires all users to read this manual prior to the installation and operation of the system.
- (3) Using the system without following the directions in this user's manual may result in malfunction of the system or may be hazardous to the human body of the operator. SHI shall provide no warranty in case the system is used without following the directions recommended in this manual.
- (4) Copying or duplicating this user's manual in part or in whole is prohibited without expressed or written permission from SHI.
- (5) SHI reserves the right to change any or all information contained herein without prior written notice. Revisions may be issued at the time of such changes and/or deletions.
- (6) If you have any questions, please contact SHI.

PRECAUTIONS

This manual uses the following signs and expressions to describe items requiring strict observance to prevent injury to the operator and other persons, damage to the system, the mother system or property, etc.

<p><u>WARNING</u></p> 	<p>< WARNING > Indicates a potentially hazardous situation that may cause injury to the operator or people around the system in the event of improper handling without any account of this description. When using the system, be sure to adhere to this description.</p>
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<p><u>CAUTION</u></p> 	<p>< CAUTION > Indicates a potentially hazardous situation that may result in troubles such as malfunction and damage of the mother system in the event of improper handling without any account of this description. When using the system, be sure to adhere to this description.</p>
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WARNINGS

This cryopump accumulates and stores gases and reactive substances from the mother system at ultra low temperatures. These gases and substances can be toxic, corrosive, flammable (combustion promoting, combustible, hypergolic, explosive) or reactive.

Inhaling or swallowing toxic gases can be fatal or cause permanent disabilities. It is very important to know all the potential dangers involved.



< Warning of Toxic Substances >

This cryopump handles toxic gases, vapors and substances. Also, the substances formed by the mother system as well as gases or vapors made by chemical reaction can be toxic.

Inhaling or accidentally swallowing these substances can cause serious injury or even death.

Should the gas leak, safely and effectively ventilate the room. Until the danger passes, have all persons not sufficiently knowledgeable of emergency procedures or fully covered in proper protective gear leave the danger area.

Also, transport anyone who possibly inhaled a toxic gas out of the dangerous area before applying first-aid. See a physician as soon as possible.

When scrapping the cryopump, handle it as industrial waste and pass it over to legally qualified disposer. (Lead is included in the cold head of the cryopump.)



< Warning of Oxygen Deficiency >

If breathing air which contain less than 18% oxygen, humans succumb to oxygen deficiency. A lack of oxygen required by the body can lead to lost mental capacity, fainting, blackout and even permanent disabilities and death.

Inert gases such as N₂ are generally innocuous, but they can provoke an oxygen deficiency. Be aware and cautious of such conditions.

If gas leaks, it is important to ensure that oxygen concentration is 18% or higher.

Safely and effectively ventilate the room. Until the danger passes, have all persons not sufficiently knowledgeable of emergency procedures or fully covered in proper protective gear leave the danger area.

Also, transport anyone who is possibly suffering from an oxygen deficiency out of the dangerous area before applying first-aid. See a physician as soon as possible.



< Warning of Corrosive Substances >

When the cryopump exhausts corrosive substances, these substances can adhere to it and cause corrosion. Corrosion can lead to damage. Also, because the cold head contains high pressure helium gas, corroded parts can rupture under high pressure, which is extremely dangerous.

Contact SHI before using this cryopump in processes which use corrosive gases or from corrosive substances.

The cryopump cylinder is made of stainless steel and copper. Special attention is needed when cryopumping the gases and the substances which are corrosive to these materials. (Corrosive substances can form even inside vacuum chambers because of plasma reactions and ion implantation.)



< Warnings of Flammable Substances >

Flammable substances are categorized by their properties as combustion promoting, combustible, hypergolic, explosive, and so forth. Familiarize yourself with properties of the gases used before cryopumping them.



This cryopump accumulates and stores gases and reactive substances at ultra low temperatures. Hence, there is the danger of substances already accumulated inside becoming dangerously reactive if additional gases or substances are cryopumped through the cryopump. Always regenerate the cryopump before introducing new gases or reactive substances.



Keep flames away from this product.

Keep this product away from sources of heat.

During regeneration, switch off power to any equipment or sensors, which might possibly ignite regenerative gas upon contact.

If reacted with, flammable substances can cause fire or explosion.

Fire or flying fragments can injure or kill a person.

Gases or reactive substances can contain substances that burn or explode upon contact with air. Fire or flying fragments can injure or kill a person. Always check for leaks before use.

Example: Oxygen (O₂)

Make note of the fact that O₂ promotes combustion. Sometimes when substance burn in air, combustion can become rampant and cause explosions if O₂ concentration is high.

Example: Hydrogen (H₂)

H₂ is odorless, colorless, tasteless and readily flammable. It can catch fire, if ignited, when its concentration is 4 to 75% in air or 4.0 to 94% in oxygen. It can also explode upon ignition at a concentration of 18 to 59% in air or 15.5 to 92.6% in oxygen. When H₂ burns, most of the flames do not emit a visible light, so it is extremely hard to confirm fires visually. Therefore, use due caution to prevent fires from occurring. Dilute H₂ concentration levels to prevent combustion and explosion.

Example: Ozone (O₃)

Inhaling a large quantity of ozone (O₃) causes headaches, coughing, pulmonary edema or other disorders. An atmospheric concentration over 0.1 ppm can harm or kill a person. It is extremely dangerous. Should O₃ leak, have all persons not sufficiently knowledgeable of emergency procedures or fully covered in proper protective gear leave the dangerous area. Also, transport anyone who is possibly suffering from O₃ inhalation out of the dangerous area before applying first-aid. See a physician as soon as possible.

When releasing internally accumulated O₃ by regeneration, there is the possibility of liquefied O₃ exploding if it drips on the first-stage radiation shield panel. Keep O₃ from accumulating in large quantities inside the cryopump.

Example: Phosphorus (P)

The phosphorous oxides formed from the combustion of phosphorus (P) are highly corrosive when dissolved in water. There is a danger of burn injury upon contact or serious handicap if inhaled. In case P-started fire break out, have all persons leave the dangerous area who are not sufficiently knowledgeable of emergency procedures and not fully covered in proper protective gear. Also, transport anyone is possibly suffering from phosphorus burns out of the dangerous area before applying first-aid. See a physician as soon as possible.

If possibly cryopumping hyperbolic substances such as P through the cryopump, prepare a cap that isolates internal gases from the atmosphere (oxygen) whenever the cryopump is detached from the vacuum chamber. If fire breaks out when the cryopump is detached, put the fire out by shutting off air supply with the prepared cover. Do not leave the gas to naturally burn out. The cryopump uses high-pressure gas to generate ultra low temperatures. Combustion can rupture the pressure vessel, which would be extremely dangerous.

Here, only a few of the potentially dangerous gases and substances pumped with this cryopump have been explained, but these have other properties also. In fact, the cryopump can be used with many more substances depending on the objective or

process. Familiarize yourself with the properties of gases and substances, which may be present in the cryopump before installing, operation or performing maintenance on it.

< Combustion Range of Combustible Gases >

If exhausting combustible gases, set regeneration purge gas rate so that the concentration of the combustible gas is not within the combustion range even if the gas is revaporized. The gas can be revaporized by regeneration or rise of a cryopanel temperature.

*The cryopanel temperature rises, when the cryopump remains stopped for long periods of time due to power failures and so forth.

Table 1 Combustion Range of Major Gases

Stable Combustion Range of Combustible Gases

Range name of gas	Stable Combustion Range in the air		Stable Combustion Range in oxygen		Detonation Range in the air		Detonation Range in oxygen	
	lower point Vol%	upper point Vol%	lower point Vol%	upper point Vol%	lower point Vol%	upper point Vol%	lower point Vol%	upper point Vol%
hydrogen	4.0	75	4.0	94	18	59	15.5	92.6
carbon monoxide	12.5	74	12.5	94	15	70	38	90
acetylene	2.5	81	2.5	93	4.2	50	3.5	92
metane	5.0	15	5.1	59	6.5	12	6.3	53
propane	2.1	9.5	2.3	55			2.5	42.5
n-butane	1.8	8.4	1.8	49			2.1	38
propylene	2.4	11	2.1	53			2.5	50
ammonia	15.0	28	15.0	79			25.4	75
ethylene	2.7	36	2.7	80				

Depending on the conditions, acetylene, and ethylene oxide burn even in 100% concentration.

Table 2 Properties of Some Toxic Gases

Physical & Chemical Properties of Some Toxic Gases

material	chemical formula	boiling point °C 1atm	fusing point °C 1atm	gravity air=1	gas density g/l,0°C 1atm	stable combustion zone Vol %	color scent	property	solubility for water	succus density g/ml(b.p.)	causticity	
											Cu	SUS
monosilane	SiH ₄	-112	-186	1.12	1.44	0.8~98		naturalness toxicity	react	0.711 (m.p.)	○	○
silicon dichloride	SiH ₂ Cl ₂	8.2	-122	3.94	4.94 (8.4°C)	4.1~98.8			react	1.261	×	○
silane trichloride	SiHCl ₃	31.8	-126.5	4.7			pungent odor	combustibilit y	react	1.347 (20°C)		D
silicon tetrachloride	SiCl ₄	59	-70	5.9			pungent odor	combustibilit y	react	1.52 (0°C)		D
silicon tetrafluoride	SiF ₄	65	-90.2	3.61			suffocating	toxicity	react	1.59 (-80°C)		
arshin	AsH ₄	-62.48	-113.5	2.695	3.48	0.8~98	garlic odor colorless	combustibilit y toxicity	20ml/100 ml (20°C)	1.604 (-64.3°C)		
arsenic chloride(III)	AsCl ₃	130.21	-16	6.29				toxicity	react	2.1497 (25°C)		
phosphine	PH ₃	-87.74	-133	1.146 (20°C)	1.38 (20°C)	1.3~98	garlic odor colorless	combustibilit y toxicity	20ml/100 ml (20°C)	0.746 (-90°C)	×	
fluophosphorou s(III)	PF ₃	-101.2	-151.3	3.05			pungent odor colorless	toxicity	progressively disassembly			
fluophosphorou s(V)	PF ₅	-84.6	-93.8	4.37			pungent odor colorless	toxicity	react	1.636 (-84.5°C)		
phosphorous trichloride(III)	PCl ₃	76	-112	4.77			pungent odor colorless	toxicity	react	1.574 (21°C)		
phosphorous oxychloride	POCl ₃	105.8	1.25	5.32			pungent odor colorless	toxicity	react			
diborane	B ₂ H ₆	-92.8	-164.9	0.95	1.22	0.8~98	unpreasen t odor colorless	combustibilit y toxicity	react	0.470 (-120°C)		
boron trifluoride	BF ₃	-99.8	-128.1	2.37	3.077	—	pungent odor colorless	incombustibilit y toxicity	react	1.589	D	D
hydrogen selenide	H ₂ Se	-41.2	-64	2.81	3.615	—	garlic odor colorless	combustibilit y toxicity	377ml/10 0ml (4°C)	2.004		
monogermanium	GeH ₄	-90	-165	2.66	3.43	0.8~98	pungent odor colorless	naturalness toxicity	small reactivity	1.523 (-142°C)		
hydrogen telluride	H ₂ Te	-1.8	-49	4.5			garlic odor colorless		well dissolved	2.57 (20°C)		
stibine	SbH ₃	-17	-88	4.33			garlic odor colorless		500ml/ 100ml	2.26 (-25°C)		

○:usable X:nonusable D:usable if in a dry form
(Reference: The safety data of the special material gas /The High Pressure Gas Safety Institute of Japan)



< Warning of Voltage and Electric Current >

Electric dangers exist when power to the system is turned on. They include electric shock or combustion by contact with live parts, or fire from leakage current.

The cryopump contains internal high voltage parts. Contact with them can result in electric shock.

Always set the ON/OFF switch and main breaker at the OFF position before installation or maintenance.

Use only a power supply of the specified voltage rating. Unspecified voltages can result in fire, electric shock, and/or system damage.

If cooling water or other liquid infiltrates the electrical system, shut power off immediately and wipe up all liquid.

Before detaching the outside panels of the compressor unit, always set the ON/OFF switch and the main breaker at the OFF position. In any case, do not detach panels unless specified herein. Contact with live parts can result in electric shock, burns, and/or equipment damage.

Be sure to turn off the customer's main power and lock the compressor breaker with OFF position before maintenance work. It may result in electric shock to fail to obey this precaution.



< Warning of High Pressure Gas >

This system uses high pressure gas, 2.30-2.35 MPaG. Strike at a sharp edge or contact with the pointed tool can result in gas leak and/or explosion. Pay special attention to handling the system.

The following table shows the minimum bending radius of the flexible hoses. Bending them at smaller angle can result in gas leak and/or explosion.

Do not disassemble anything not so specified in this manual. Disassembling the system can result in electric shock, explosion or gas leak.

The cryopump, compressor, flexible hoses, and compressor adsorber are pressurized with helium gas. Purge the helium gas from all pressurized components before disposing them. Open the purge valve gradually. Quick operation of the valve can cause serious injury or even death.

When scrapping the cryopump system, handle it as industrial waste and pass it over to legally qualified disposer. (Lead is included in the cold head of the cryopump.)

Table 3 Minimum Bending Radius of Flexible Hose

Size (for TM series compressor)	Minimum bending radius	
	Middle point	End point
15A	150 mm (5.91 inch)	300 mm (11.8 inch)
20A	200 mm (7.87 inch)	400 mm (15.7 inch)
25A	225 mm (8.86 inch)	450 mm (17.7 inch)

CAUTIONS



< Caution about Heavy Unit >

The cryopump unit is heavy, therefore one person alone should not carry or install the cryopump.

Installing or carrying the cryopump unit by one person alone may cause back injury. Use a lifter or some other lifting tools properly.



< Caution about Cold Surface >

There is a risk of frostbite due to low temperature of a cold surface in the cryopump unit.

Do not touch the cryopump vessel during regeneration.



< Cautions of Malfunction >

Do not touch or meddle with the inverter for the main power source of the compressor unit. Meddling with the inverter can result in damage or bungle of the compressor electric circuit.

When the cryopumps and the compressors are running, do not touch any of the RS-485 communication cable connectors (D-sub9) on the CP controller, the cryopump IO module, or the compressor, by hand or any tools such as a screwdriver.

Accidental disconnection of the communication cable connectors will result in unexpected stoppage of the compressors, or the whole cryopump system.

Do not connect any cables to the maintenance port of D-sub9, mini USB, or D-sub25 on both of the compressor and the CP controller. Connecting any cables to these maintenance ports may cause unexpected stoppage of the compressor or the cryopumps. These maintenance ports are meant to be handled by SHI authorized personnel only.

Do not put any objects on the surface of the compressor unit. It may disturb the unit operation and may cause hazard.

Enough space is required around the compressor unit for heat radiation and maintenance.

Failure to take this precaution can result in performance down or breakdown.

Do not damage the cryopumps in installing it to the customer tool. Damaged cryopumps can cause malfunction.

Before connecting the flexible lines, ensure that surface of the self-seal coupling is free from dust and dirt, and then check attachment with the flat rubber gasket. Incorrect attachment can cause gas leak.

The return side of the flexible line should be connected to the cold head first. Connecting the supply side flexible gas hose to the cold head prior to connecting the return side flexible gas hose to the cold head can result in improper.

The system is shipped with helium gas at 2.30-2.35 MPaG under static conditions. Degradation of cooling power or cryopump malfunction can result if the system helium gas pressure is not in the specified pressure range.

Avoid to the contamination when helium gas is charged. Contamination can result in noisy operation of the cryopump and also a reduction in the cooling capacity of the cold head.

1 INTRODUCTION

1-1 CRYOPUMP SYSTEM

The cryopump is a vacuum pump that traps gases and vapor by condensing or adsorbing them on a cold surface. The cryopump uses helium gas as refrigerant. Helium is supplied from a compressor.

SICERA system is composed of one or two compressors, multiple numbers of cryopumps, and one CP controller. SICERA system can be mounted to a customer tool and be operated from the tool.

All electric power to compressor and the individual cryopump is supplied from the customer tool. The power source for the CP controller is supplied from the customer UPS.

(See INSTALLATION/MAINTENANCE MANUAL POWER CABLE CONNECTION about the detail.)

Operation commands are communicated to the CP controller via RS-232C cable from the customer controller. The compressor and the cryopumps are controlled by the CP controller.

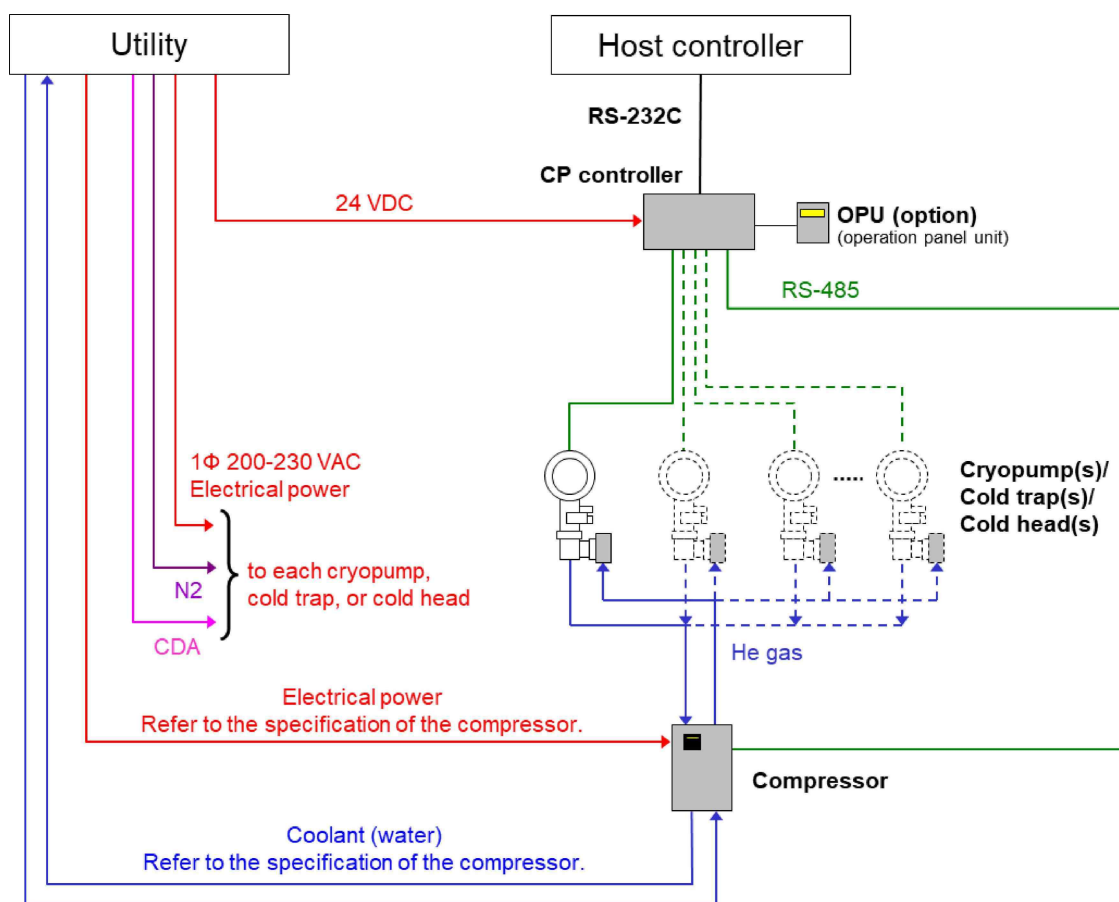


Figure 1 Cryopump System Flow

(Please refer to

Table 4 Cryopump Model and Maximum Number of Cryopumps Connected to One Compressor.)

2-4 COMPRESSOR UNIT

2-4-1 TM-50L-AA

Table 9 Compressor Unit (TM-50L-AA) Specification

Item	Specification	
Model	TM-50L-AA	
Cooling system	Water cooling	
Environmental condition	<ul style="list-style-type: none"> - Indoor use - Altitude up to 1000 m - Temperature 5 to 35 degrees C (28 to 35 degrees C with 5% cooling capacity loss) - Humidity: 20 – 80% (without dew) - Transient over voltage: Category 2 (IEC60664-1) - Applicable rated pollution degree: Category 2 (IEC60664-1) 	
Storage environmental condition	<ul style="list-style-type: none"> - Indoor - Temperature: 0 to 40 degrees C - Humidity: 20 – 80% (without dew) 	
Outside dimension	593 mm L x 451 mm W x 1177 mm H	
Weight	170 kg	
Sound pressure	less than 70 dBA	
Mechanical interface	Helium line fitting:	Supply Aeroquip – 8 (male) Return Aeroquip – 8 (female)
	Helium charge fitting:	45 degrees flare (male) and 7/16" x 20 threads/inch
	Cooling water fitting: (supply and return)	NPT 1/2 (female, Material: Stainless steel)
Electrical interface	Rated demand power:	3 ϕ 200 – 230 VAC ($\pm 10\%$) 50/60 Hz (The minimum voltage is 180 V and the maximum voltage is 253 V with zero tolerance)
	Rating current:	44 A
	Compressor unit built-in circuit breaker setting value (ELB):	50 A (interrupting rating 35 kAIC)/30mA
	SCCR:	5 kA
	Ground system:	TN
	Terminal size:	L1, L2, L3: M5, GND: M8
	Wire size:	AWG4 or more
	Cable clamp type:	ST-M50 (LAPP)
	Communication interface	Communication form:
Connector type:		D-sub 9pin (male)
Other Interfaces	Communication form:	RS-232C serial communication (between compressor and maintenance PC)
	Connector type:	D-sub 9pin (male)
	Communication form:	AI, DI/O signal
	Connector type:	D-sub 25pin (female)
	Communication form:	Unused connector (J1)
	Connector type:	206430-1 (AMP)
	Communication form:	Unused connector (P2)
Connector type:	206061-1 (AMP)	
Helium gas pressure	Static:	2.30 – 2.35 MPaG (at 20 degrees C)
	Operating:	2.9 – 3.1 MPaG (supply pressure) *
Cooling water requirement	Maximum pressure:	0.70 MPaG
	Min. flow rate:	4 – 10 L/min
	Temperature range:	4 – 32 degrees C
	Water quality:	Refer to the cooling water specification
SEMI F47	Compliant	
Standards	UL	Recognized
	CE	Compliant

*This is recommendation value. It is no problem to go out of the range temporarily.