8mφ Space Chamber

Users' Manual

Advanced Engineering Services Co., Ltd.

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tfcd_rikatsu@aes.co.jp

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tfcd_rikatsu@aes.co.jp

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1. Introduction

This users' manual is to provide necessary information to the users of 8mφ Space Chamber (referred to as "this facility" hereafter) located in the Space Simulation Test Laboratory.

This facility is used for "thermal vacuum tests" to verify the thermal design and environmental durability of satellites in simulated space environments on ground.

The major environments in outer space are high vacuum, cryogenic shade, intensive solar radiation, etc. On the geostationary orbit which is about 36,000 km above the surface of the earth, those environments reach the levels of about 10^{-11} Pa with high vacuum, 3K with cryogenic shade being an infinite heat absorber, and 1.4 kw/m^2 with solar radiation which is about twice the intensity of that on the earth's surface.

However, it is financially unfeasible to simulate such environments on ground as they are, and therefore this facility provides vacuum pressure of 1.3×10^{-3} Pa or less, shroud temperature of 100K or lower, and solar radiation of up to 2.2 kw/m^2 simulated by Xenon lamps.

While this facility is unable to simulate the actual environments imposed on satellites to verify their environmental durability, we can still verify the reliability of satellite behaviors in space by extrapolating them from the accuracy assessment on thermal designs under the simulated environments mentioned above.

2. Brief Overview of this Facility

2.1. System Outline

This facility consists of a vacuum vessel system that includes a vertical cylindrical self-supported type vacuum vessel as its main constituent, a vacuum equipment system made up of different kinds of vacuum pumps, an LN_2 system composed of a shroud that is cooled down to 100K or lower by liquid nitrogen, etc., a solar simulation system and an IR heater system for simulating thermal input, e. g., solar energy, for a test specimen (■abbreviated as TS hereafter), a measurement and control system that monitors and controls the entire space chamber, a TS supporter to mount and set a TS in the chamber, and a common system consisting of a cold water supply unit and an instrument air package.

The system/tree diagrams of 8mφ Space Chamber Facility are shown in Figures 2-1 and 2-2, respectively. Also, the external views of the access door and the vacuum vessel are shown in Figures 2-3 and 2-4, respectively.

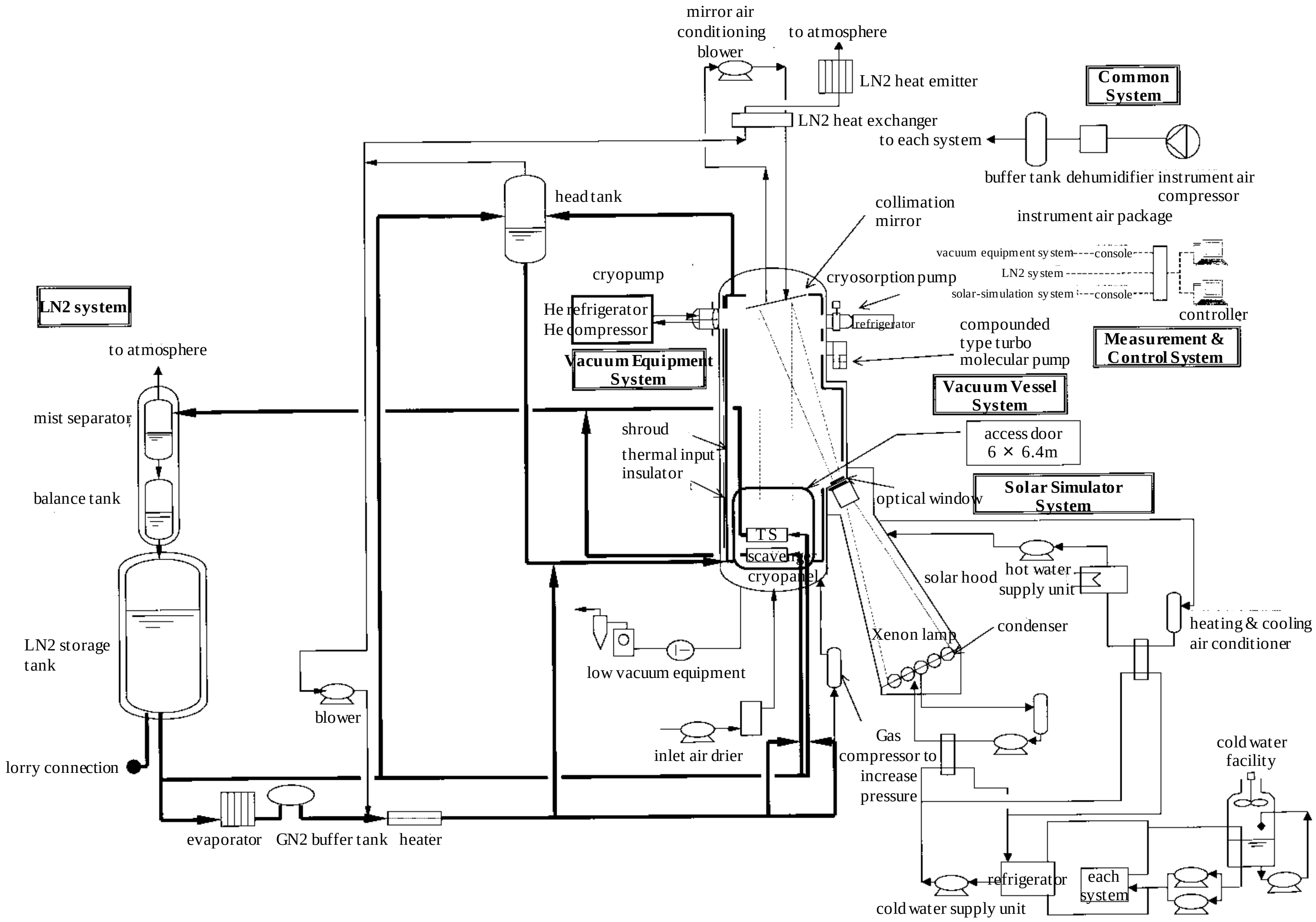


Figure 2-1 System Diagram of 8mφ Space Chamber Facility

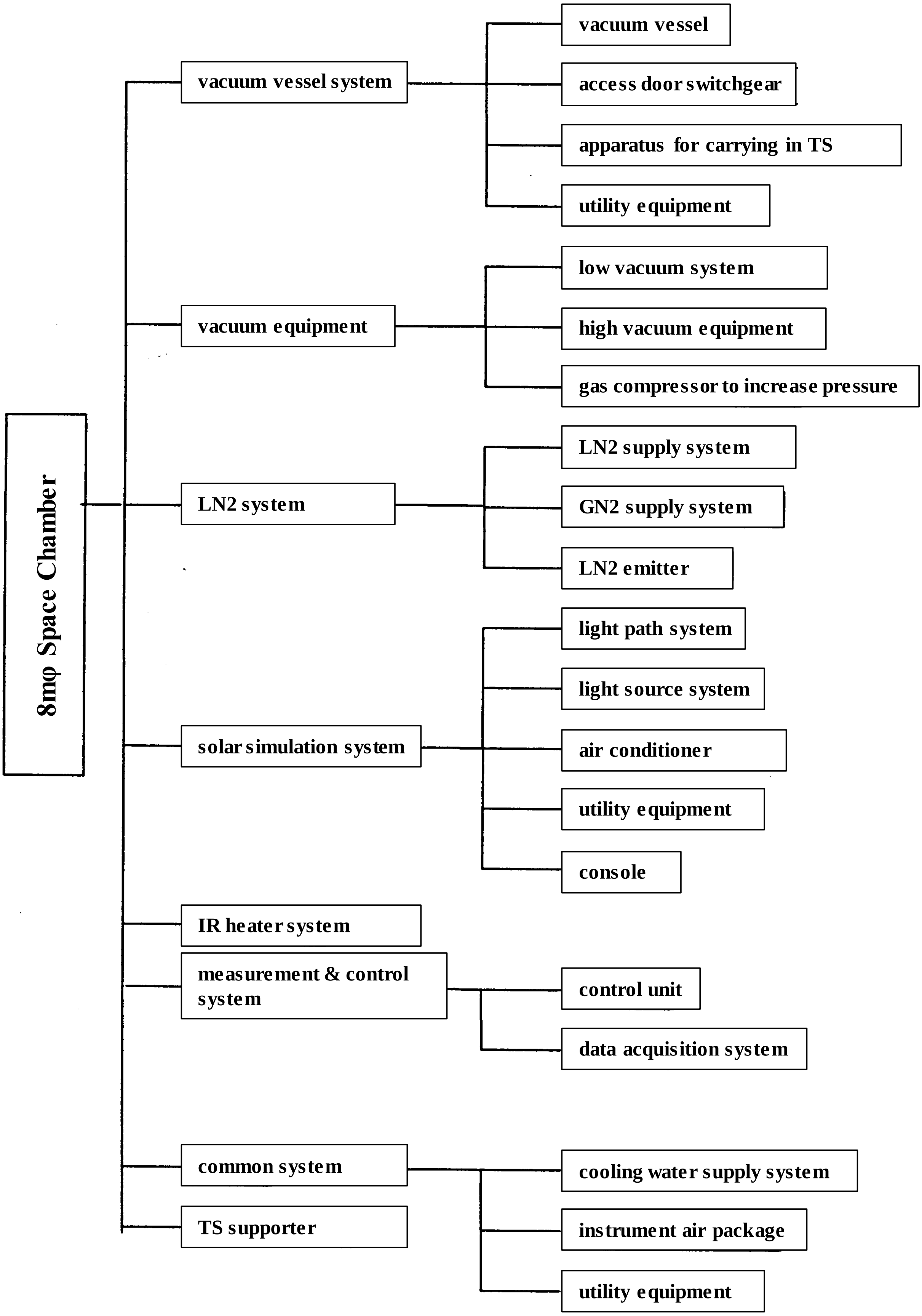
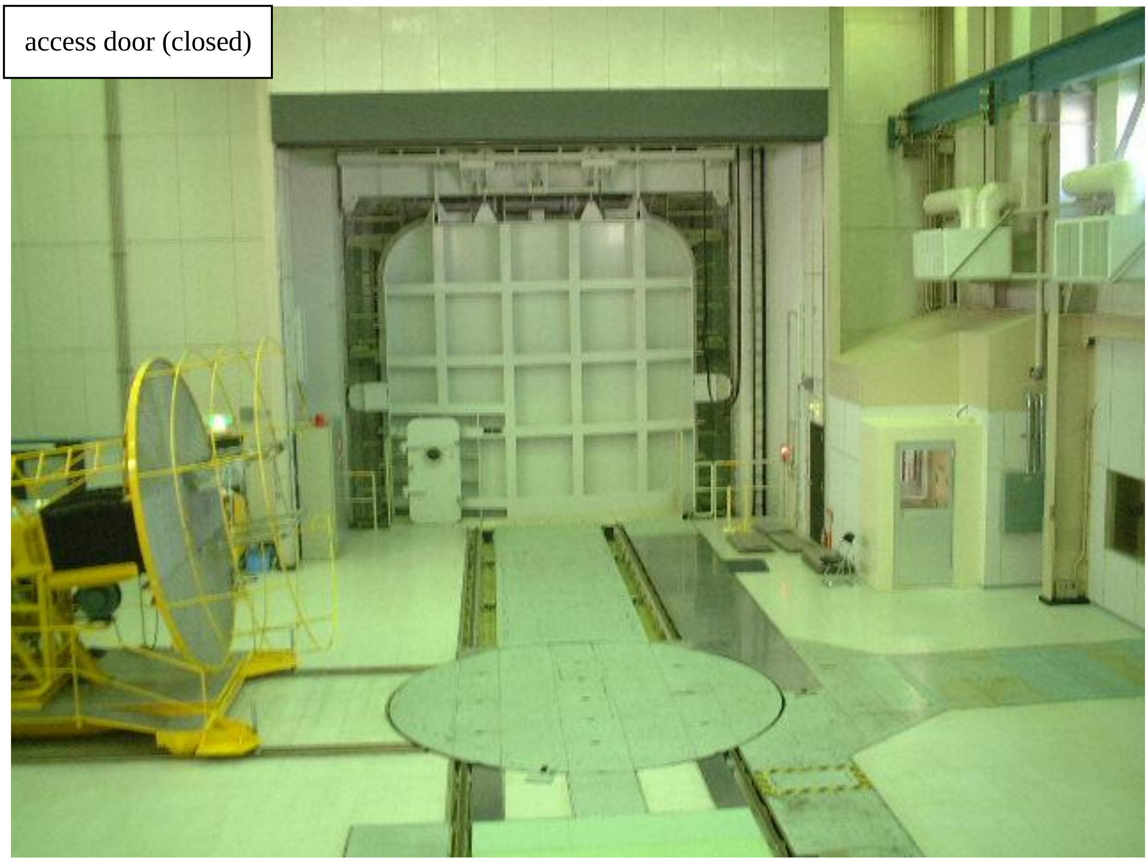


Figure 2-2 Tree Diagram of 8mφ Space Chamber Facility



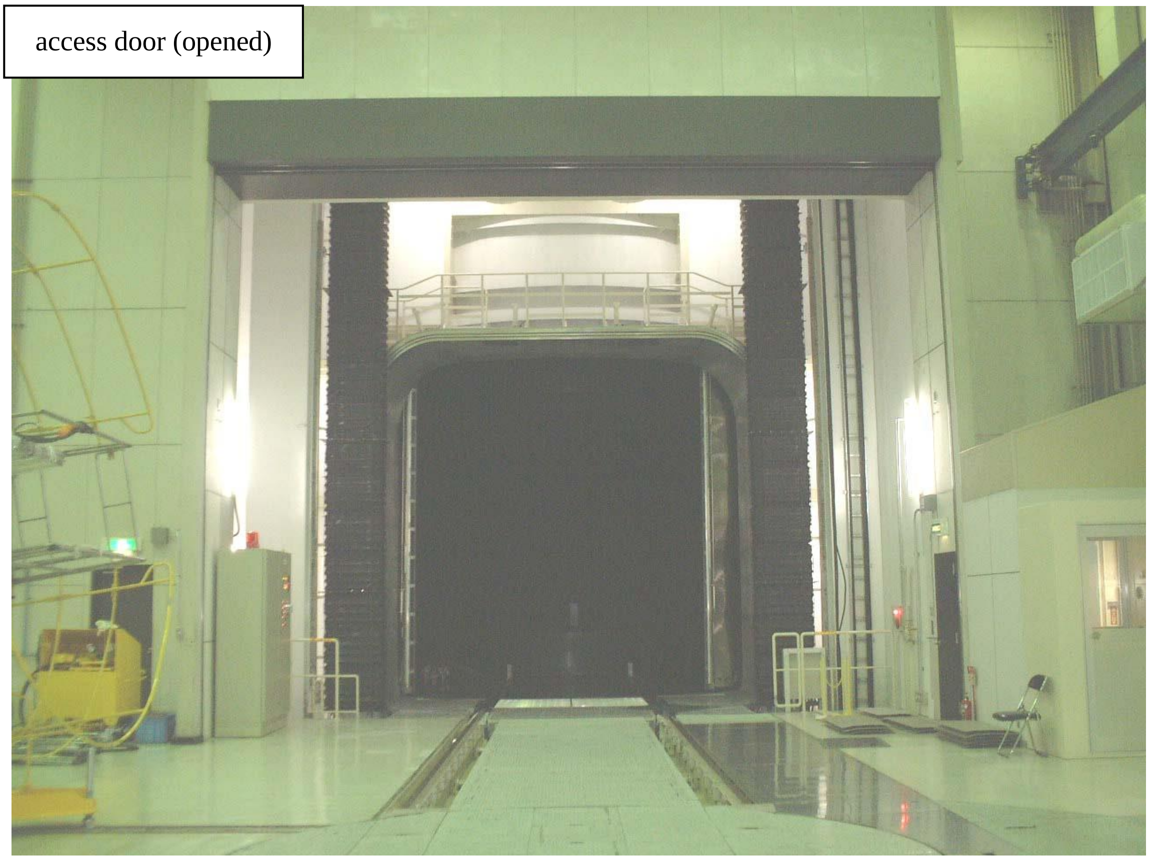
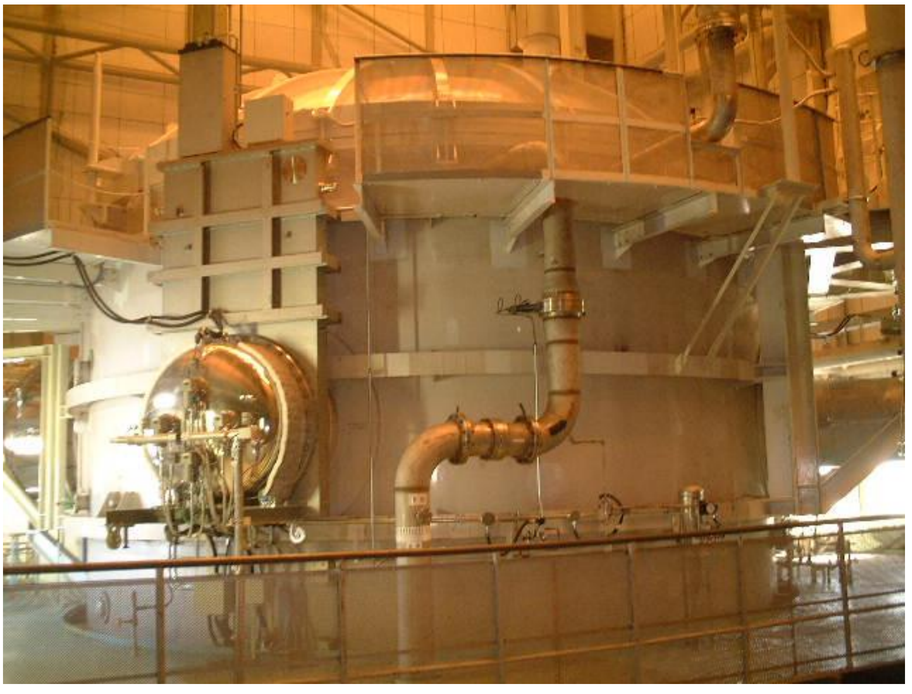


Figure 2-3 External View of Access Door

(vacuum vessel/piping system)



(pump stage)

Figure 2-4 External View of Vacuum Vessel

2.2. Main Specifications

The main specifications of the whole facility are shown in Table 2-1. The detailed specifications of each equipment are presented below.

2.2.1. Vacuum Vessel System

This cylindrical self-supported vertical vacuum vessel made of stainless-steel has a size of 8.5-meter inner diameter × 25-meter height.

The straight cylindrical shroud body part in which a TS is stored has a size of 7.5-meter maximum inner diameter × 5.5-meter height.

Its access door through which a TS is carried into the vessel is 6-meter wide × 6.4-meter high (which allows a TS of 5.4-meter wide × 5.0-meter high to be stored in the vessel.)

2.2.2. LN_2 System

This system consists of a shroud which is cooled down to 100K or lower to establish cryogenic dark environment by supplying LN_2 to a panel which is an assembly of aluminum-alloyed fin tubes, a scavenger cryopanel which prevents contamination on a TS, an LN_2 supplier for the shroud and the scavenger cryopanel, a GN_2 generator, etc.

Table 2-1 Main Performance and Facility Specifications of 8mφ Space Chamber

item	performance / specifications	notes
(1) space chamber	cylindrical self-supported vertical type /equipped with solar simulator	
(a) usable dimensions	7.5 m diameter × 19.6 m high (maximum)	effective diameter inside shroud
(b) access door of chamber	5.4 m wide × 5.0 m high (from upper plane of TS supporter)	including TS supporter
(c) shroud temperature	100K or lower	
(d) Max. solar radiation	2.2 kw/㎡ (1.8 solar)	
(e) ultimate vacuum pressure	1.33×10^{-4} Pa or less	
(f) LN_2 / GN_2 ports for TS	5 lines	Grayloc Connector
(2) TS supporter	for both solar radiation test and IR test	Its hard point positions are compatible with 6mφ radiometer space chamber and 13mφ space chamber.
(3) power supplies for heat sources		
(a) power supply racks	60W × 50 2 kW × 20 3 kW × 10 5 kW × 10	

2.2.3. Solar Simulation System

This system, which simulates the solar radiation, can irradiate light with effective flux diameter of 4 mφ on a TS. Its main specifications are shown below.

Table 2-2 Main Specifications of Solar Simulation System

item	specification
light source	water-cooled 30 kW xenon lamps
beam effective diameter*1	4mφ
test area*2	4mφ × 6mH*3
Max.. solar radiation*4	2.5 kW/m^2 (1.8 solar)
uniformity	within ±5％: plane
	within ±10％: volume
parallelism of light	within ±1.5°

*1 The actual flux making a hexagonal shape which can cover up to a 4-m-φ range for a TS, a TS that exceeds the range requires detailed consideration on the test configuration.

*2 Refer to Figure 2-5 for a schematic drawing of the test area.

*3 It denotes the height from the upper plane of the rails for carrying in a TS.

*4 Refer to Figure 2-6 for the correlation among uniformity property, solar flux, the test area, and the TS supporter.

Note)

One of the hard points on the TS supporting structure which come in the solar irradiation range is used for the supporting pole of the illuminometer. Therefore, please leave at least one hard point when fixing a TS jig, IR panel, etc., on the TS supporter, unless the illuminometer supporting pole can be set on a TS jig.

The I/F on the illuminometer supporting pole is shown in Figure 2-7. The pole is to be fixed using M20 bolts.

2.2.4. Vacuum Equipment System

The standard vacuum curve (without a TS) during a thermal vacuum test is shown in Figure 2-8.

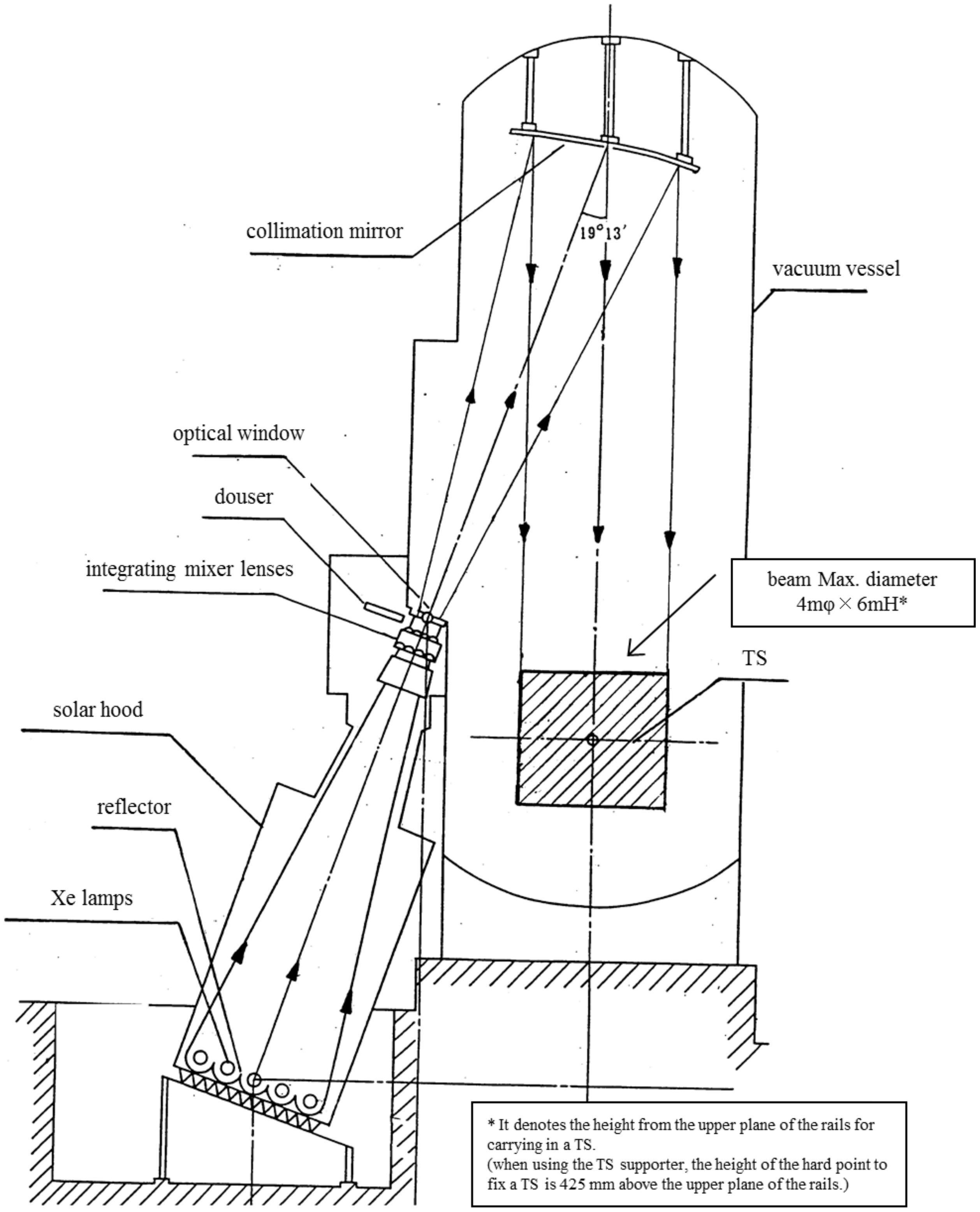
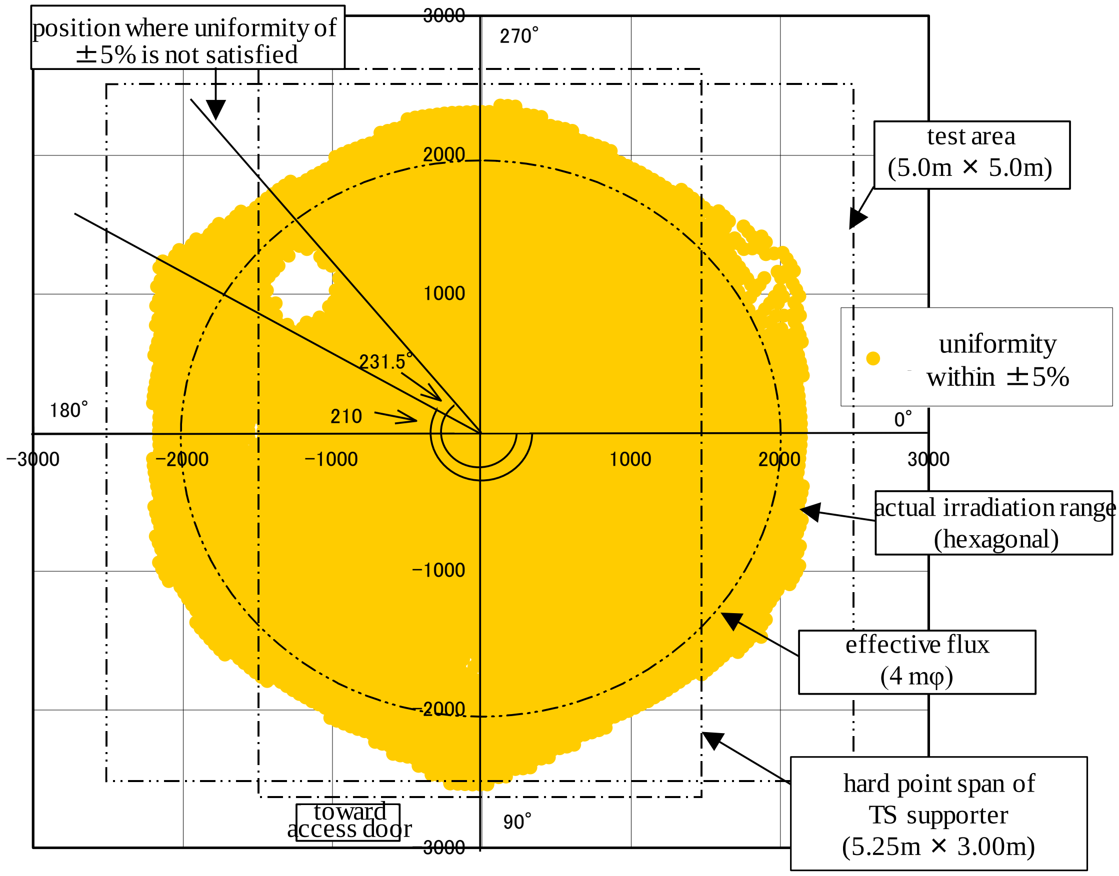


Figure 2-5 Diagram of Solar Simulation System



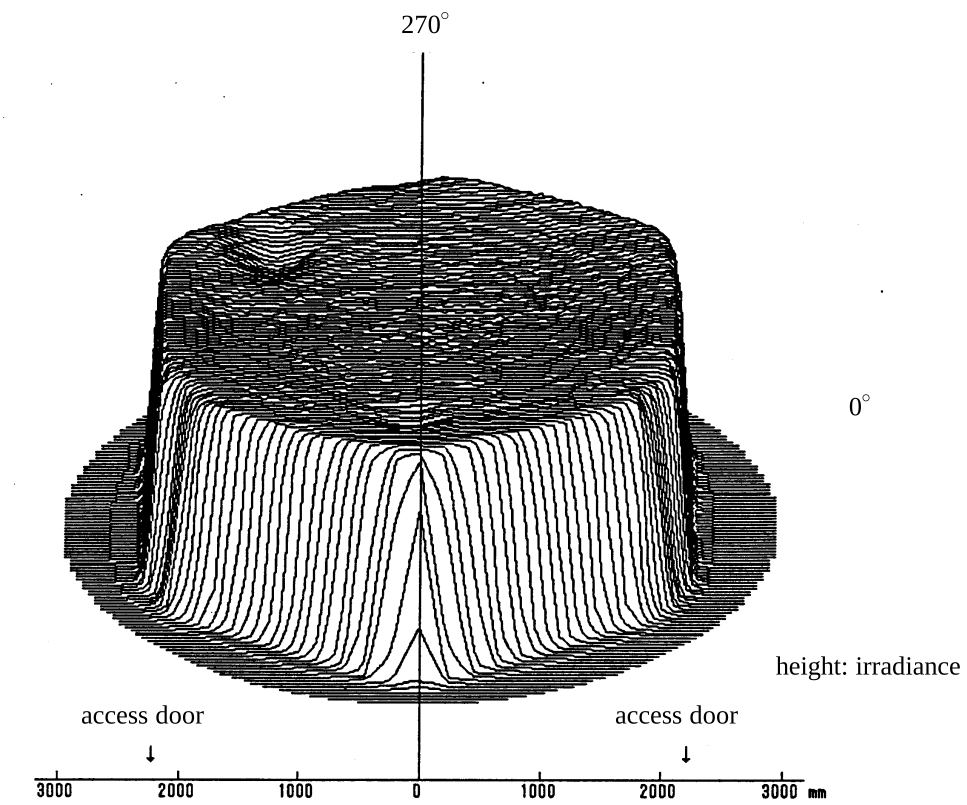


Figure 2-6 Uniformity Property

Figure 2-7 I/F on Illuminometer Supporting Pole

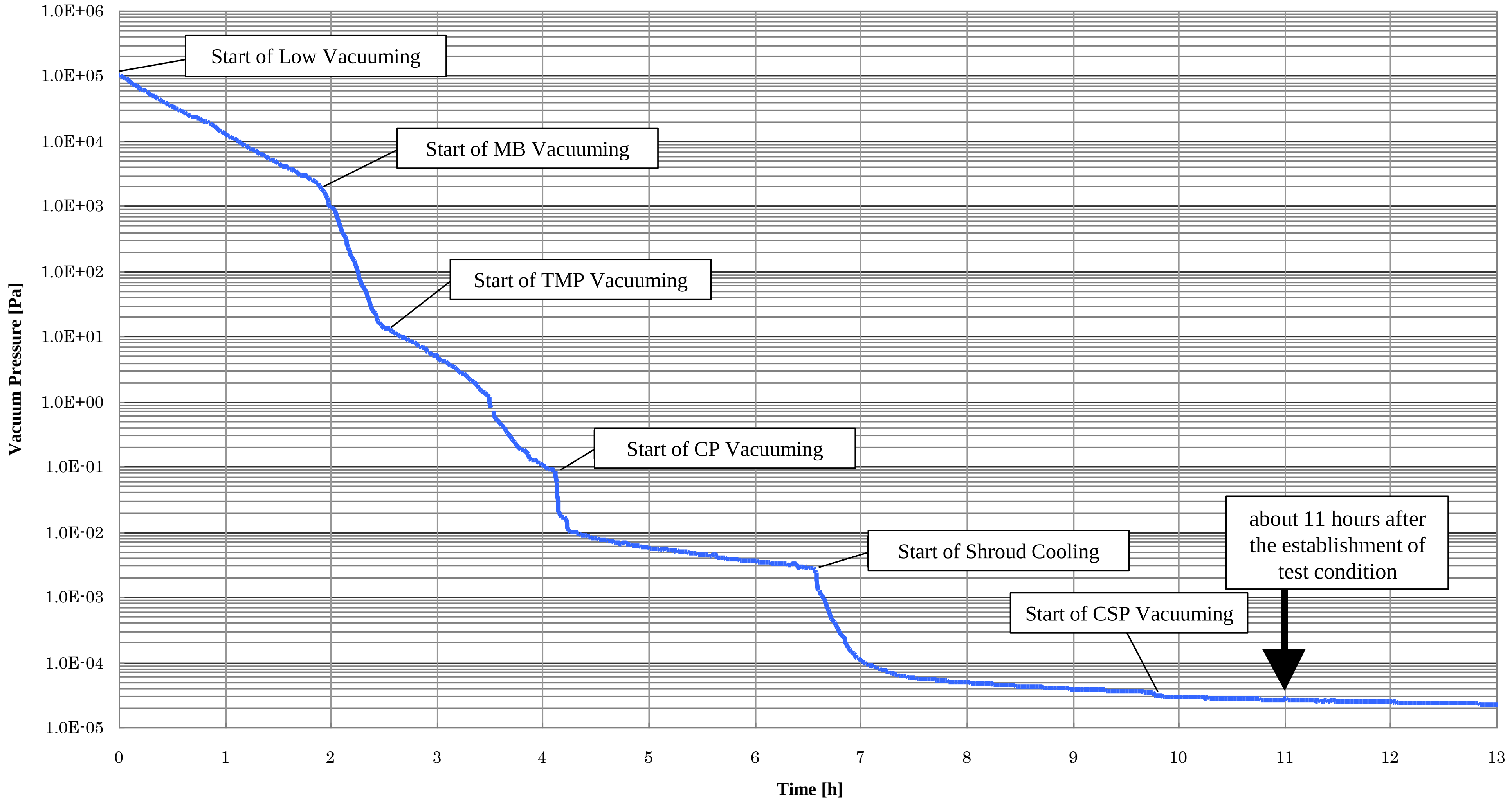


Figure 2-8 Vacuum Curve (1/2)

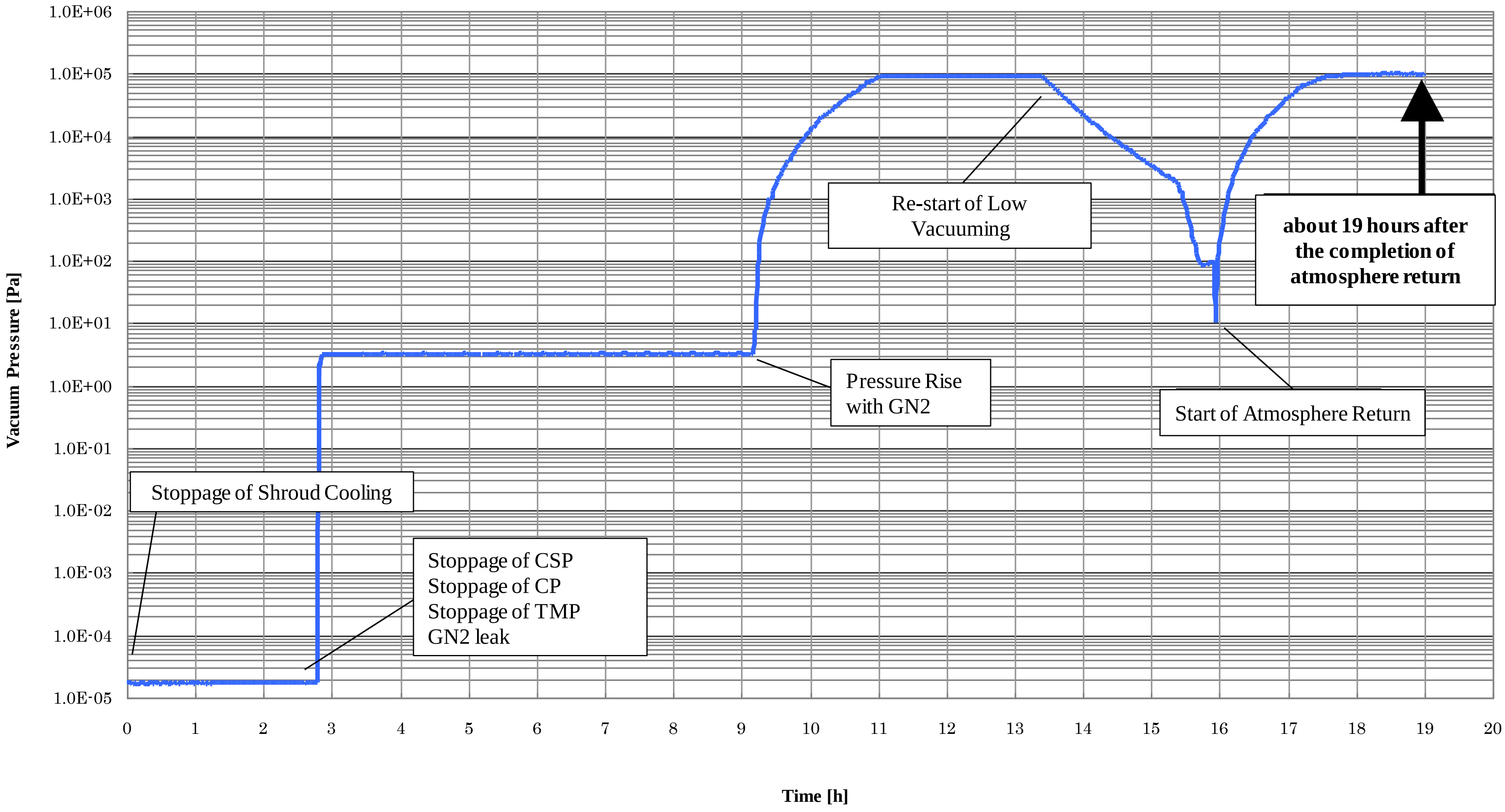


Figure 2-8 Vacuum Curve (2/2)

2.2.5. Power Supplies for Heat Sources

These devices (called "power supplies for heat sources" hereafter) are stationary equipment in the facility to supply specified electric power (abbreviated as EP hereafter) to IR lamps or heaters which provide external thermal input to a TS, or to simulation heaters for the heat from a TS. Their basic specifications and external appearance are shown in Table 2-3 and Figure 2-9, respectively.

Table 2-3 Basic Specifications of Power Supplies for Heat Sources

item	specification						
name	8mφ 5 kW power supply rack-1	8mφ 5 kW power supply rack-2	8mφ 3 kW power supply rack-1	8mφ 2 kW power supply rack-1	8mφ 2 kW power supply rack-2	8mφ 60W power supply rack-1	8mφ 60W power supply rack-1
qty of DC-stabilized power supplies	5	5	10	10	10	25	25
output voltage	DC 0 ~ 100V	DC 0 ~ 100V	DC 0 ~ 100V	DC 0 ~ 100V	DC 0 ~ 100V	DC 0 ~ 60V	DC 0 ~ 60V
output current	0 ~ 50A	0 ~ 50A	0 ~ 30A	0 ~ 20A	0 ~ 20A	0 ~ 1A	0 ~ 1A
output EP	5 kW	5 kW	3 kW	2 kW	2 kW	60W	60W
output control method	(1) temperature control (via the setting PC) (2) constant power control (via the setting PC) (3) manual voltage output control (via the setting PC) (4) local control (via a single DC power supply)						

The heat source power supplies for 13mφ/6mφ space chambers can be moved to 8mφ space chamber and used. Refer to the users' manuals of 13mφ/6mφ space chambers for their specifications.

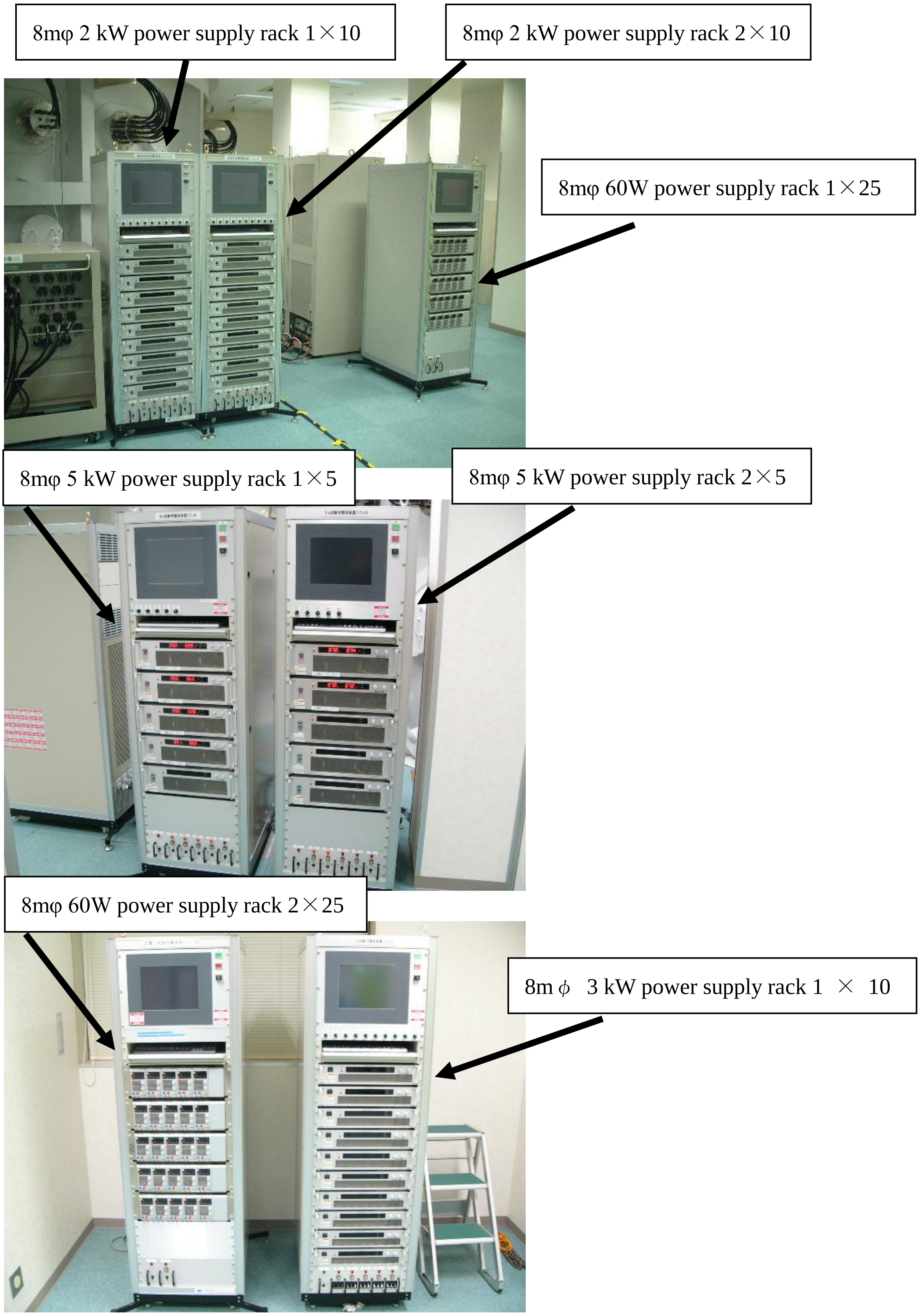


Figure 2-9 External View of Power Supply Racks

2.2.6. Data Acquisition System

This device is capable of acquiring and processing the signals from the thermocouples on parts of a TS and calorimeters, or the data from the test facility during a test. Its basic specifications and external appearance are shown in Table 2-4 and Figure 2-10, respectively.

Also, the system diagrams of the measurement instrument and the software program are shown in Figures 2-11 and 2-12, respectively.

Table 2-4 Basic Specifications of Data Acquisition Facility

item	specification
Max. consecutive test days	45 days
number of measurement points	157 chs (including calorimeters)
sampling rate	1 time/min OR 1 time/2 mins
compatible thermocouple	T-type (copper-constantan)
resolution	0.1℃
power failure protective measures	The system is connected via uninterruptible power supply (UPS)

Figure 2-10 Data Acquisition Facility

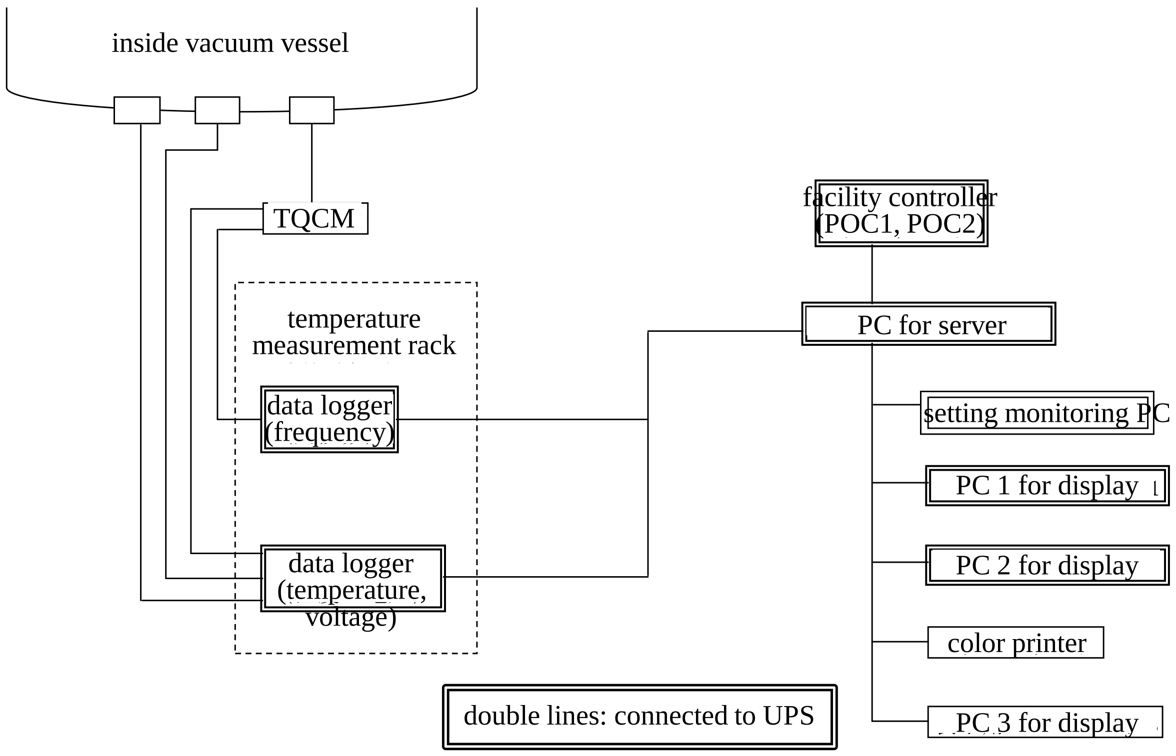


Figure 2-11 System Diagram of Measurement Instrument

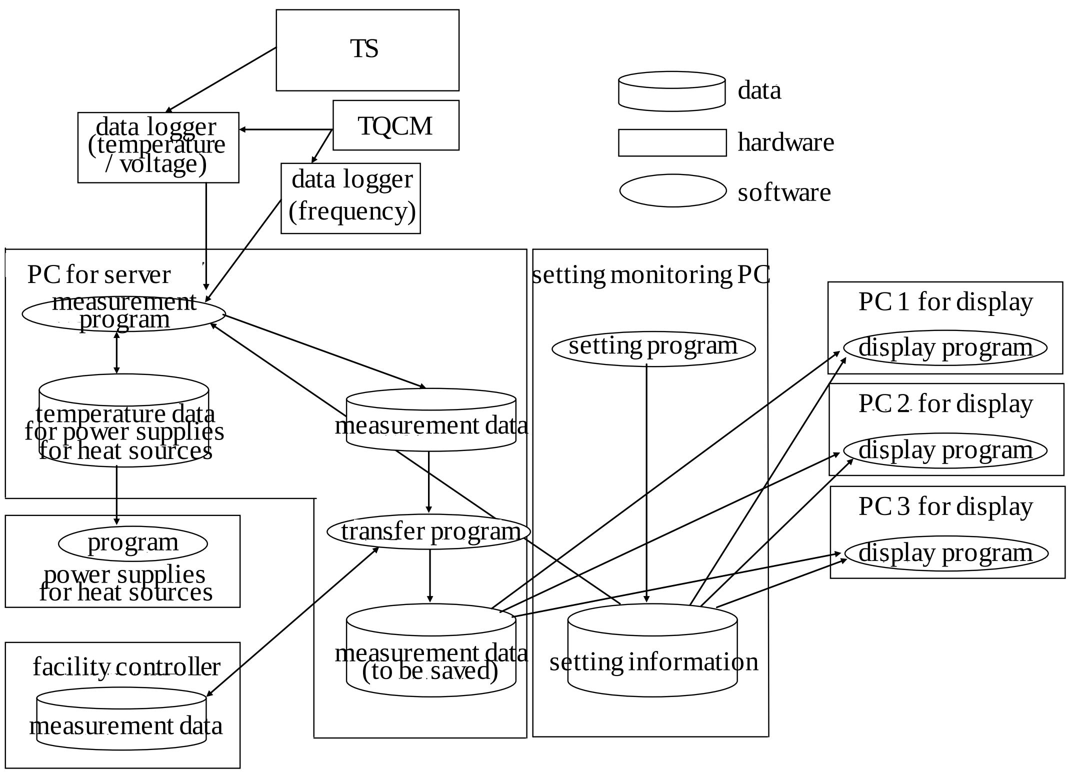


Figure 2-12 System Diagram of Software Programs

2.2.7. Others

(1) ITV facility

The ITV facility is a TV system to monitor the first preparation room, the outdoor tank yard, etc., from the monitor and control room.

(2) Communication system for operation

This is a system for mutual communication among test-concerned personnel and announcement of instructions during the operation of the facility or preparation for testing on a TS.

System components (available to users)

- Command station (master unit, fixed)
- Mobile terminal (slave unit, wireless)

Functions

- Individual call (one-to-one)
- Group communication
- Simultaneous broadcast in 8mφ space chamber facility

(3) Specifications of cranes

These cranes are used for operating the facility, carrying in a TS, etc.

When using them, they are to be operated only by qualified people, who are always to fill in the specified record form with the track record of use. The specifications of the cranes are shown in Table 2-5.

Table 2-5 Specifications of Cranes

	rated load	lifting height	below hook
1st preparation room	7.5 t	14.45m	7.23m
2nd preparation room	5.0 t	19.00m	11.87m
lifting room			18.87m
unpacking room	5.0 t	12.59m	12.44m
chamber room	1.0 t	-	1F : 10.00m
			3F : 2.50m

(4) Mass-filter-type mass spectrometer

This device measures and analyzes the remnant gas components inside the vacuum vessel.

mass measurement range, M/e = 1 ~ 100 (M: mass number, e: electrical charge)

(5) Absolute illuminometer (MK-V)

An absolute illuminometer is a sensor that measures the irradiance of simulated solar with high accuracy during the usage of the solar simulator. Its basic specifications are shown below.

measurement range: 0.02 ~ 2.8 kW/m2
accuracy: ±0.001 kW/m2 (reading error ±0.5%)
response time: 6 seconds

(6) Calorimeter

A calorimeter measures the heat flux irradiated on a TS from external heat sources (solar simulator/IR lamp), for the purposes of setting, monitoring, and controlling test conditions. Since they are shared by the 6mφ radiometer space chamber and the 13mφ space chamber, those who wish to use them are to contact us beforehand to coordinate schedules.

measurement range: 0.1 ~ 2.0 kW/m^2
compatible thermocouple: type T (copper-constantan)

Figure 2-13 shows the diagram of a calorimeter.

Note) Calorimeters are to be used only after thoroughly reading the users' manual accompanying them. In addition, keep in mind the following matters when using them in this facility.

- The functions (accuracy) of calorimeters are to be checked by users.
- Calorimeters are to be set, connected, and removed by users.
- Contact the operation company of the facility with the information on the S/N and connection channels of the installed calorimeters.
- The final checking of calorimeter settings (calorimeter S/N, conductance values, channels for optical receiver/disc temperature measurement, etc.) in the data acquisition system is to be completed by users without fail.

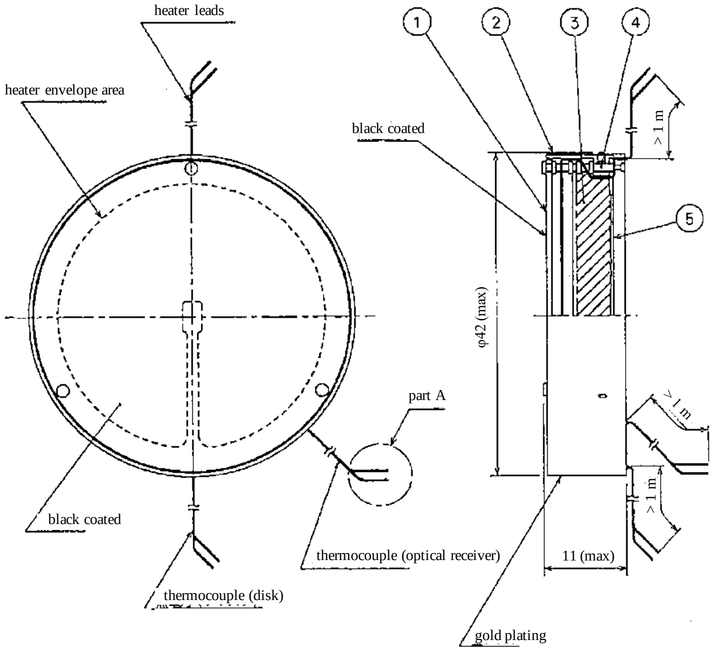
(7) TQCM (Thermoelectric Quartz Crystal Microbalance)

TQCM monitors contamination during a thermal vacuum test.

model #: MK-10 (sensor), M-1900 (processor), M-1800A (controller)
manufacturer: QCM Research Corp.

Note) Cautions for using TQCM

- Only one line in this facility is dedicated to the connection of a TQCM. When using 2 or more TQCMs, use P05 (DC100V/5A line) for connecting them.
- When using TQCM with its HEAT PUMP (Peltier device) turned on, use it at – 110℃ or higher.



specification
measurement range: 0.1~2.0 kW/m2
view angle: hemisphere
reproducibility: within ±0.5% (note 1)
accuracy: within ±0.3% (note 1)
response time: within 10 sec (note 2)
output level: -5 ~ + 7 mV
weight: 10 g or less (note 4)
applied thermocouple: copper-constantan
solar absorptivity: 0.96 ±0.0.2 (note 6)
hemisphere IR emissivity: 0.88 ±0.04 (note 6)

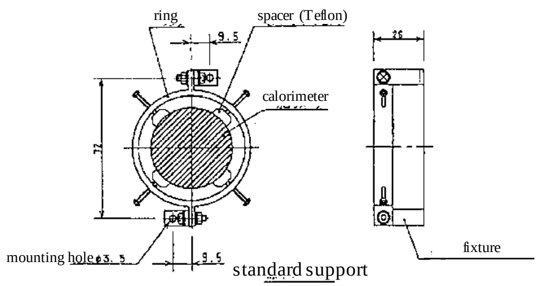
note

1. It denotes the tolerance to the full scale in measurement range.
2. It denotes the time to take for temperature on the optical receiver to change by 10 ℃ when 1 solar is radiated on it with the initial temperature of -180℃~-100℃.
3. Size tolerance shown below is to be followed when not specified.

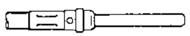
classification by nominal size	tolerance
~ 6	±0.6
over 6 ~ 18	±1
over 18 ~ 50	±1.3
over 50 ~ 120	±2
over 120 ~ 250	±2.5
over 250 ~ 500	±3.2
over 500 ~ 1000	±5
over 1000 ~ 2000	±8
over 2000 ~ 3150	±10

4. Heater leads, thermocouple wires, contact pins, and standard supports are excluded.
5. Heater leads and thermocouple wires are to have a 0.1-mm-φ central line and 1-m length or more.
6. The measurement values are based on the sample coating.

	name	material	quantity
1	optical receiver	alumina	1
2	case	Al	1
3	insulation	Al Mylar	1
4	support	polyimide resin	3
5	disk	Al	1



standard support



enlarged view of part A
(appearance of contact pin)
non scale

manufactured by Japan Deutsches co. 0603-34-2039 (Cu) 105372 (Co)

Figure 2-13 Structure of Calorimeter

3. User I/F

3.1. Vacuum Vessel

The I/Fs related to the nozzles and terminal boards inside and outside the vacuum vessel are explained below.

3.1.1. Nozzle Configuration

There are feed-throughs all over the vacuum vessel as the I/Fs to connect the inside and outside of the vessel. The nozzles not being used by the facility are available to users.

In case feed-throughs other than the ones prepared by the facility are necessary, users are to prepare the ones to satisfy their designated purposes. The feed-throughs available to users are shown in Figure 3-1.

3.2. Terminal Board

The cabling and connector WBD, etc. between a TS inside the chamber and inner-vessel permanent terminal boards, and between the external input terminal boards outside the chamber and checkout devices, etc., are to be facilitated by referring to Tables 3-1 ~ 3-7 so as to satisfy their individual purposes. Also, a system diagram of the measurement system, pictures of inner-vessel permanent terminal boards and external input terminal boards, the system diagram of terminal boards, and the contact pin arrangement for thermocouple connectors, are respectively shown in Figures 3-2, 3-3, 3-4, 3-5, and 3-6.

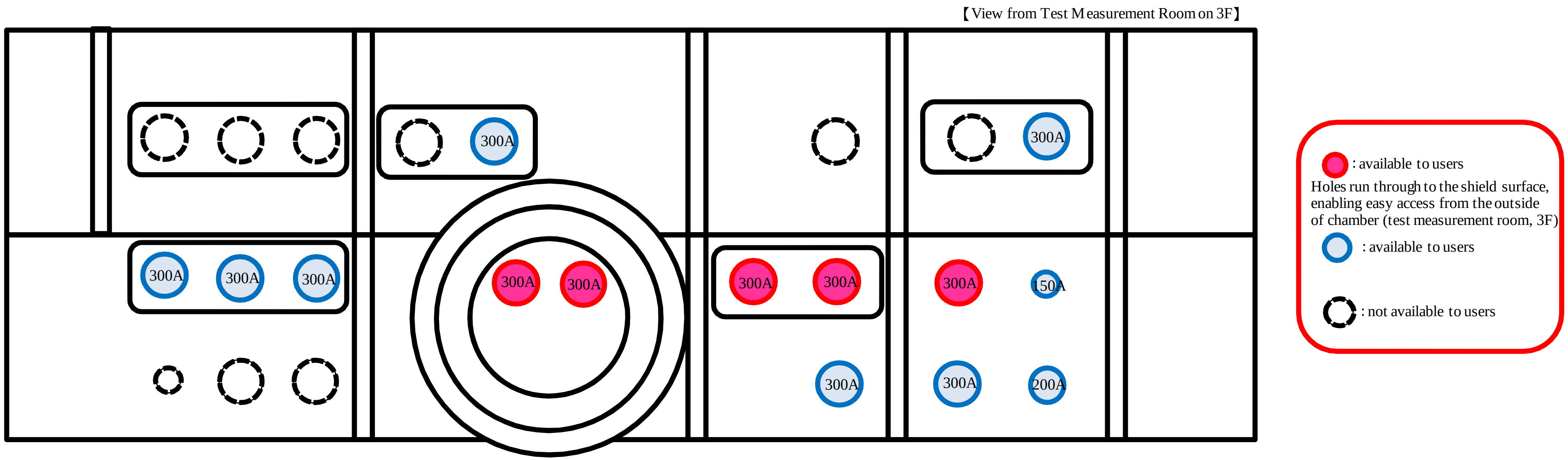


Figure 3-1 Positions of Feed-throughs Available to Users

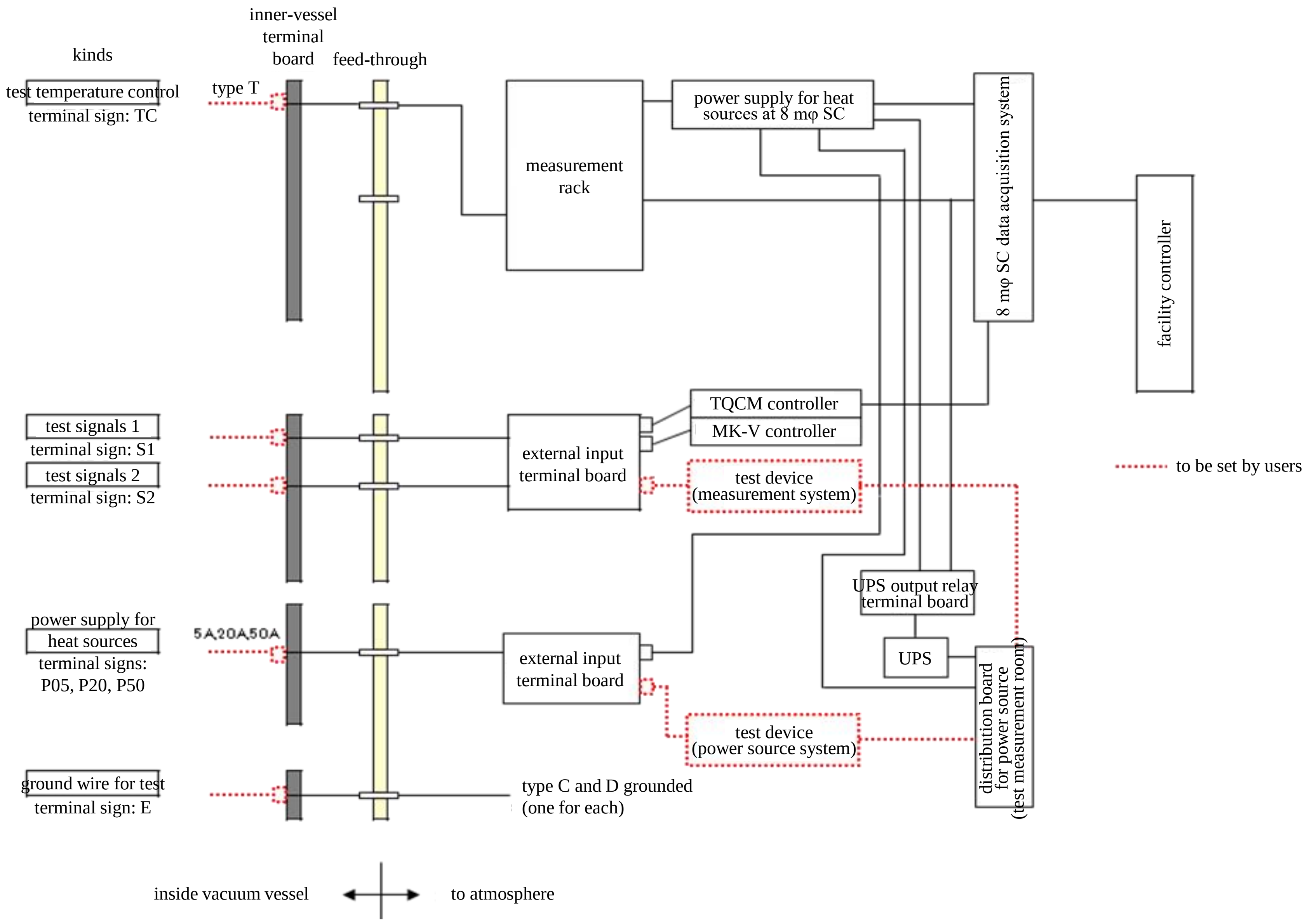
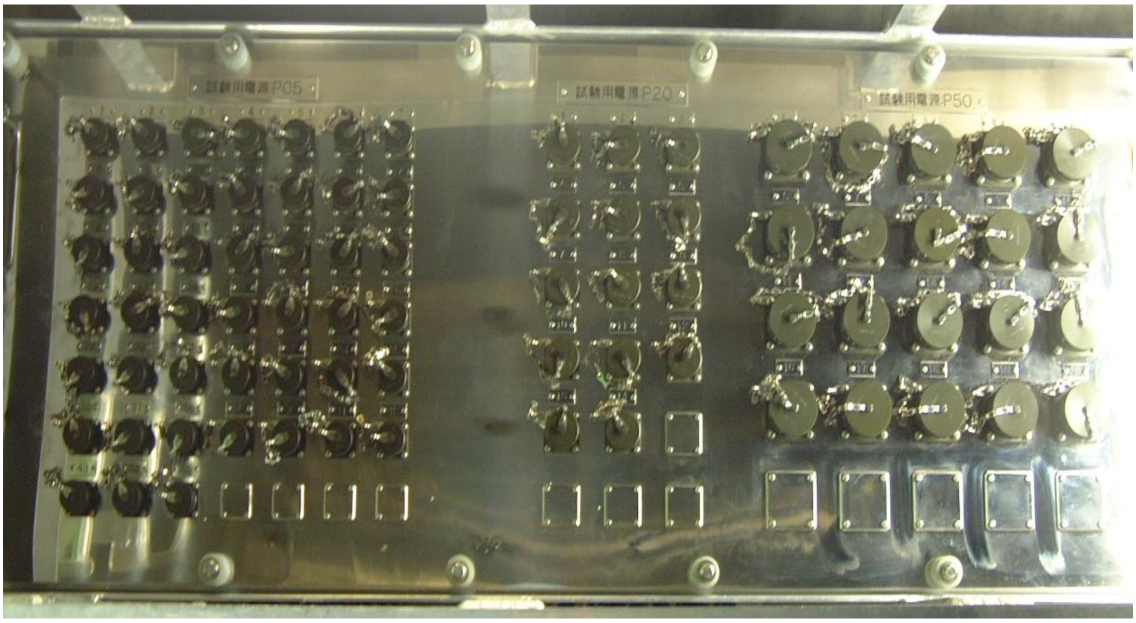


Figure 3-2 System Diagram of Measurement System



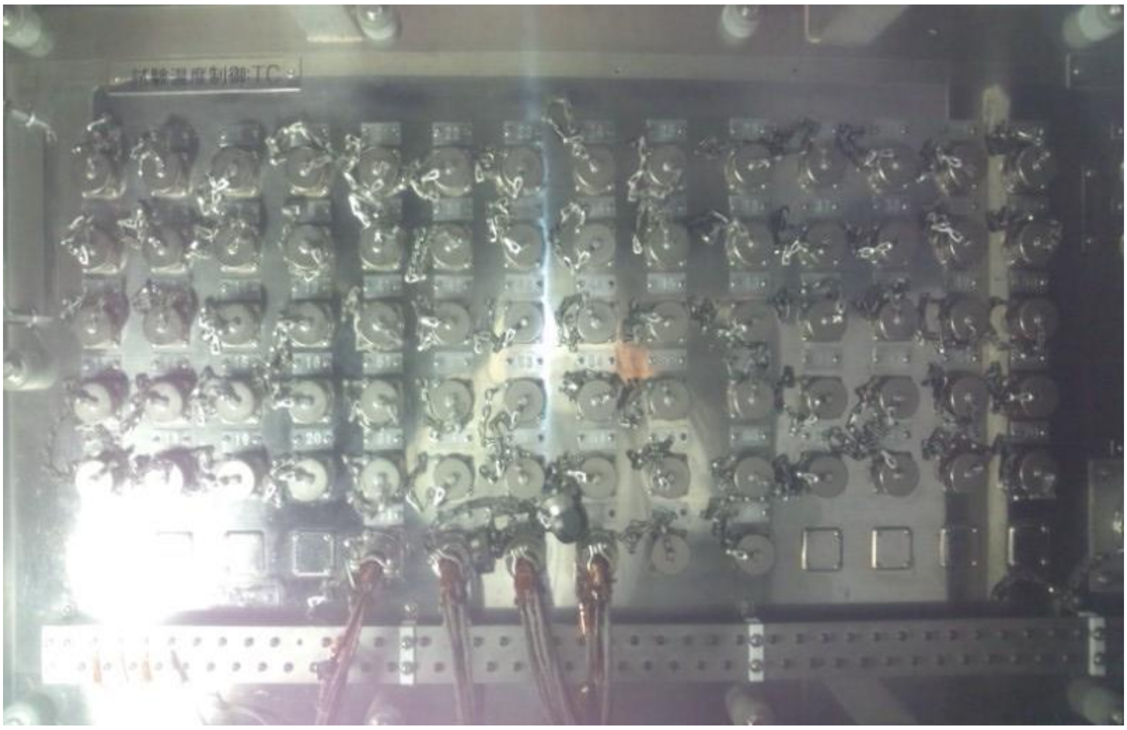
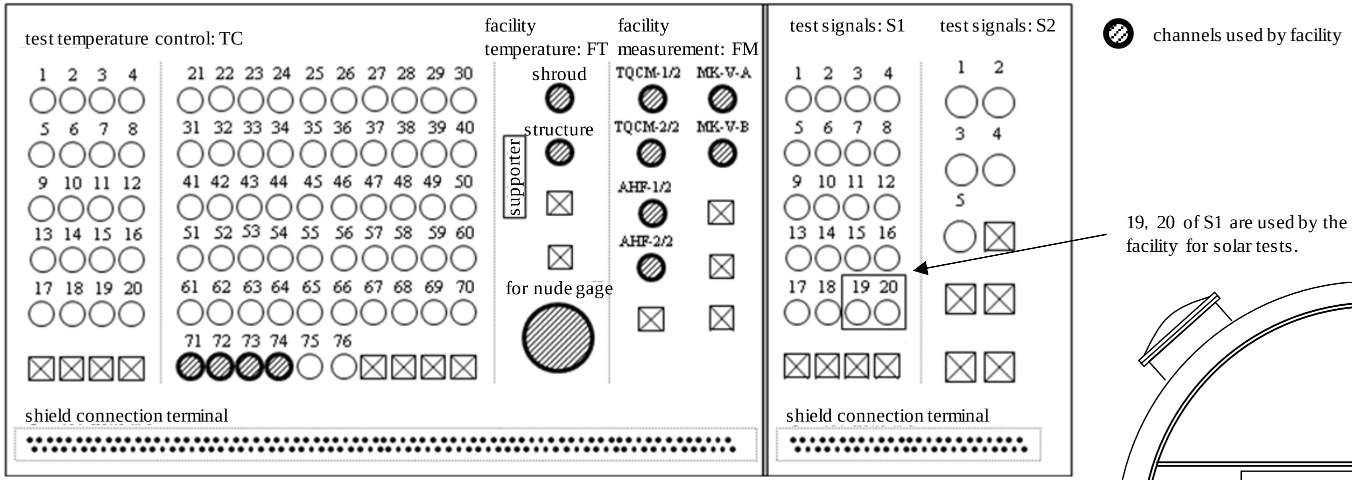
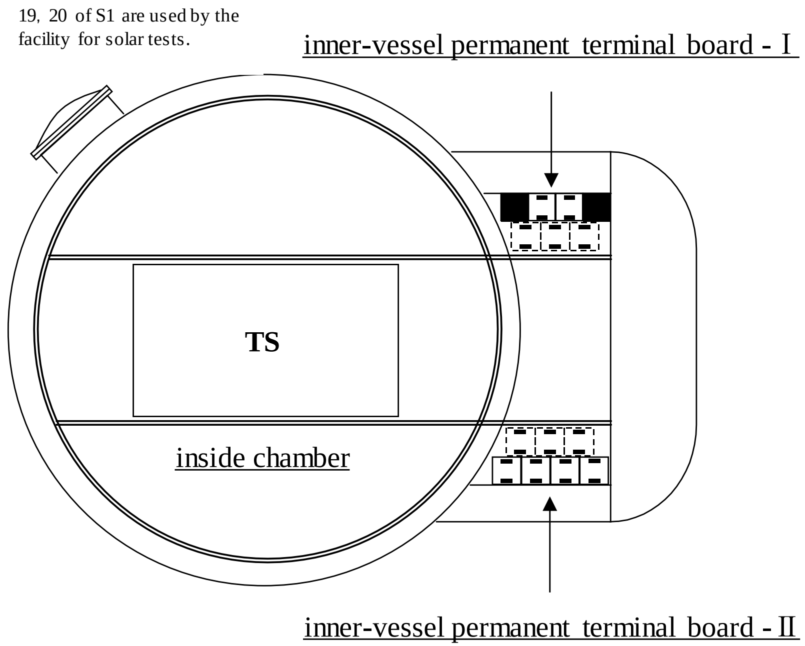
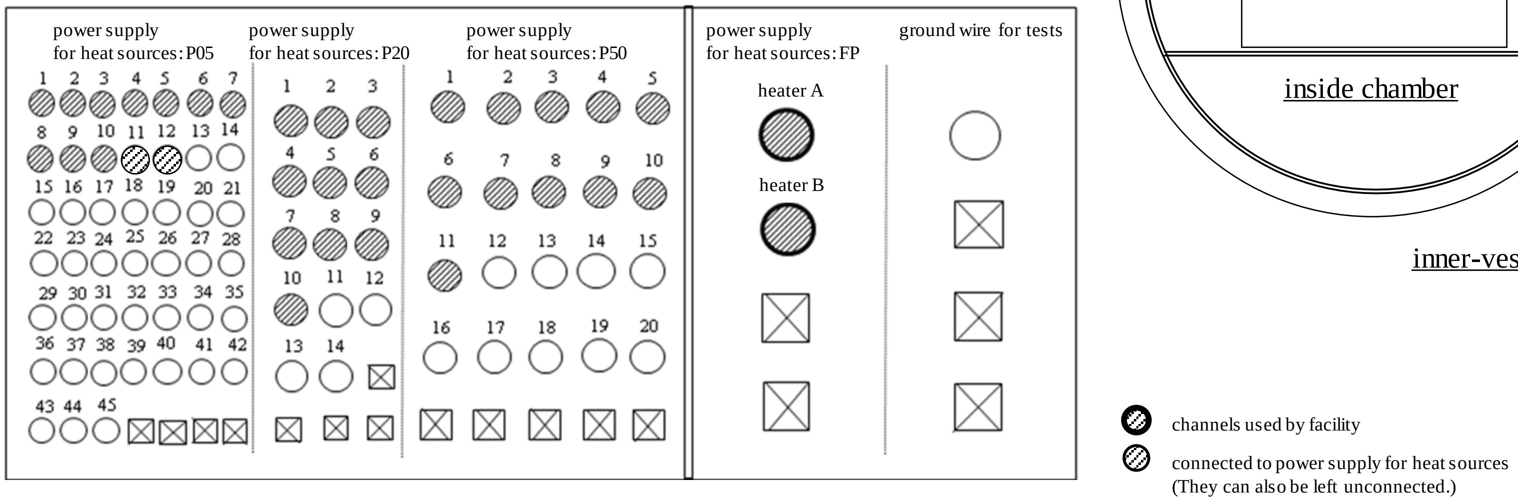


Figure 3-3 Permanent Terminal Board inside Vessel (1/2)



inner-vessel permanent terminal board - I

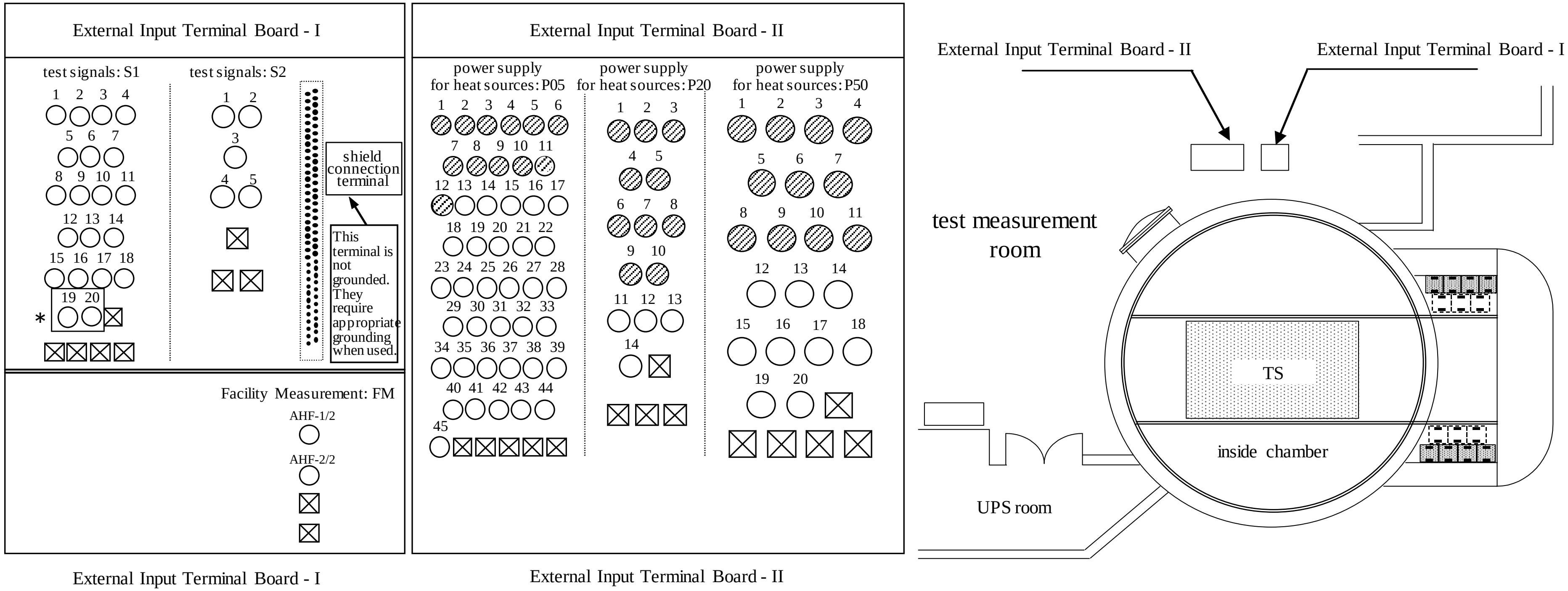




inner-vessel permanent terminal board - II

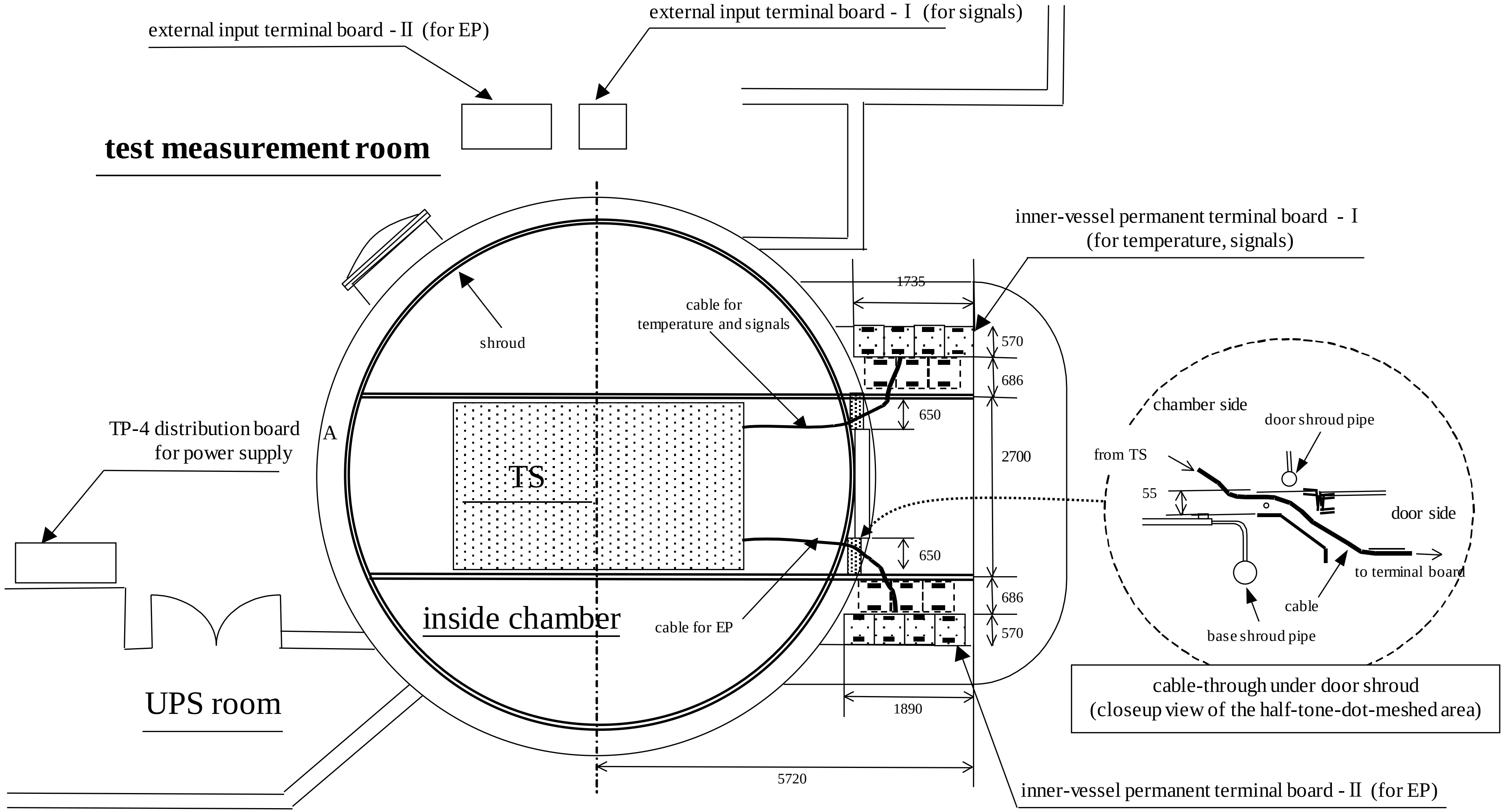
Figure 3-3 Permanent Terminal Board inside Vessel (2/2)

Figure 3-4 External Input Terminal Board (1/2)



Note) The shaded terminals are used for the permanent power supply for heat sources in the facility.
* They are used by the facility in solar tests (for MK-V.)

Figure 3-4 External Input Terminal Board (2/2)



Note) Inner-vessel permanent terminal boards are set on the under-floor pits shown with half-tone dot meshing.

Figure 3-5 Configuration of Terminal Boards

Table 3-1 Number of Circuits on List

sign	application purpose	specification of feed-through	number of circuits	connection line	model # of connectors for inner-vessel permanent / external input terminal boards (prepared by users)
TC ～ 70, 75, 76	temperature measurement and control	thermocouple, Type T	840	inner-vessel permanent terminal board ~ data logger	AFD56-16-26SN
S1-1～18, S1-19, 20*3	signals	1A, DC100V	160	inner-vessel permanent terminal board ~ external input terminal board	MS3106B18-1S、 JA3106B24-J28SC*1
P05-1～45	power source	5A, DC100V	225	inner-vessel permanent terminal board ~ external input terminal board (50 chs are previously connected to 60W power supply rack.*2)	MS3106B18-1S
P20-1～14	power source	20A, DC150V	28	inner-vessel permanent terminal board ~ external input terminal board (20 chs are previously connected to 2 kW power supply rack.*2)	MS3106B22-22S
P50-1～20	power source	50A, DC100V	40	inner-vessel permanent terminal board ~ external input terminal board (22 chs are previously connected to 3 kW and 5 kW power supply racks.*2)	MS3106B32-17S
-	high frequency	coaxial	50	feed-throughs only	SMA
-	waveguide	all nozzles at 5 places (300A, with a blind flange)			
-	grounding		2	inner-vessel permanent terminal board ~ C-type grounding board	MS3106B32-17S

*1 Two kinds of connectors are used for signals.

*2 It is also possible to disconnect the cables of the permanent power supplies for heat sources in the facility connected to the external input terminal boards and connect them to the power supplies brought in by users.

*3 S1-19 and 20 are occupied by the facility during solar tests.

Caution

(1) The chamber is equipped with some connectors, etc., shown in Table 3-1 as accessories, which can be leased (except for MS3106B22-22S.) They are, however, shared by the 6mφ Radiometer Space Chamber and the 13mφ Space Chamber, and therefore previous confirmation is necessary to make sure they are not being used by other facilities.

(2) The socket contacts for thermocouples are crimp-type, and are therefore not reusable. Users are to prepare them by themselves. It may take 2 ~ 3 months before the date of delivery depending on the stock status of manufacturers.

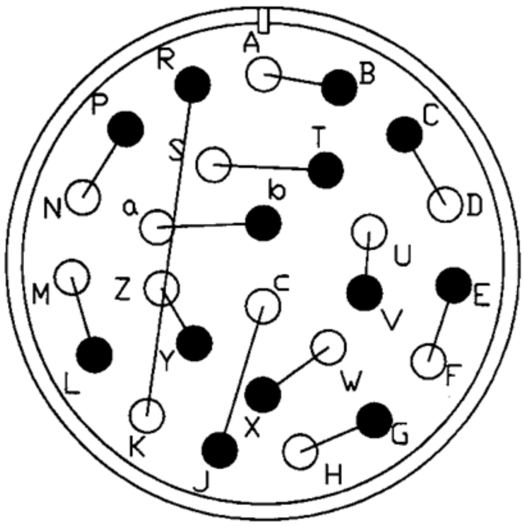
(3) The inner-vessel permanent terminal boards in the 8mφ Space Chamber do not become cryogenic, and therefore their connectors do not have to be made of Teflon.

Table 3-2 Temperature Measurement Lines, Table of Connection (1/2)

channel #	outside vessel			inside vessel				notes
	data logger			inner-vessel permanent terminal board				
	measurement rack #	logger #	logger port #	receptacle				
				receptacle #	receptacle pin #	pin material	connector model #	
1	1	1-1	0	TC1	A	copper	AFD56-16-26SN	
					B	constantan		
2			1		D	copper		
					C	constantan		
3			2		F	copper		
					E	constantan		
4			3		H	copper		
					G	constantan		
5			4		c	copper		
					J	constantan		
6			5		K	copper		
					R	constantan		
7			6		M	copper		
					L	constantan		
8			7		N	copper		
					P	constantan		
9			8		S	copper		
					T	constantan		
10			9		U	copper		
					V	constantan		
11			10		W	copper		
					X	constantan		
12			11		Z	copper		
					Y	constantan		
13～24			12～23	TC2	A～Y	copper/constantan	AFD56-16-26SN	
25～36			24～35	TC3	A～Y	copper/constantan	AFD56-16-26SN	
37～48			36～47	TC4	A～Y	copper/constantan	AFD56-16-26SN	
49～60		1-2	0～11	TC5	A～Y	copper/constantan	AFD56-16-26SN	
61～72			12～23	TC6	A～Y	copper/constantan	AFD56-16-26SN	
73～84			24～35	TC7	A～Y	copper/constantan	AFD56-16-26SN	
85～96			36～47	TC8	A～Y	copper/constantan	AFD56-16-26SN	
97～108		1-3	0～11	TC9	A～Y	copper/constantan	AFD56-16-26SN	
109～120			12～23	TC10	A～Y	copper/constantan	AFD56-16-26SN	
121～132			24～35	TC11	A～Y	copper/constantan	AFD56-16-26SN	
133～144			36～47	TC12	A～Y	copper/constantan	AFD56-16-26SN	
145～156		1-4	0～11	TC13	A～Y	copper/constantan	AFD56-16-26SN	
157～168			12～23	TC14	A～Y	copper/constantan	AFD56-16-26SN	
169～180			24～35	TC15	A～Y	copper/constantan	AFD56-16-26SN	
181～192			36～47	TC16	A～Y	copper/constantan	AFD56-16-26SN	
193～204		1-5	0～11	TC17	A～Y	copper/constantan	AFD56-16-26SN	
205～216			12～23	TC18	A～Y	copper/constantan	AFD56-16-26SN	
217～228			24～35	TC19	A～Y	copper/constantan	AFD56-16-26SN	
229～240			36～47	TC20	A～Y	copper/constantan	AFD56-16-26SN	
241～252		1-6	0～11	TC21	A～Y	copper/constantan	AFD56-16-26SN	
253～264			12～23	TC22	A～Y	copper/constantan	AFD56-16-26SN	
265～276			24～35	TC23	A～Y	copper/constantan	AFD56-16-26SN	
277～288			36～47	TC24	A～Y	copper/constantan	AFD56-16-26SN	
289～300		1-7	0～11	TC25	A～Y	copper/constantan	AFD56-16-26SN	
301～312			12～23	TC26	A～Y	copper/constantan	AFD56-16-26SN	
313～324			24～35	TC27	A～Y	copper/constantan	AFD56-16-26SN	
325～336			36～47	TC28	A～Y	copper/constantan	AFD56-16-26SN	
337～348		1-8	0～11	TC29	A～Y	copper/constantan	AFD56-16-26SN	
349～360			12～23	TC30	A～Y	copper/constantan	AFD56-16-26SN	
361～372			24～35	TC31	A～Y	copper/constantan	AFD56-16-26SN	
373～384			36～47	TC32	A～Y	copper/constantan	AFD56-16-26SN	
385～396		1-9	0～11	TC33	A～Y	copper/constantan	AFD56-16-26SN	
397～408			12～23	TC34	A～Y	copper/constantan	AFD56-16-26SN	
409～420			24～35	TC35	A～Y	copper/constantan	AFD56-16-26SN	
421～432			36～47	TC36	A～Y	copper/constantan	AFD56-16-26SN	
433～444		1-10	0～11	TC37	A～Y	copper/constantan	AFD56-16-26SN	
445～456			12～23	TC38	A～Y	copper/constantan	AFD56-16-26SN	
457～468			24～35	TC39	A～Y	copper/constantan	AFD56-16-26SN	
469～480			36～47	TC40	A～Y	copper/constantan	AFD56-16-26SN	

Table 3-2 Temperature Measurement Lines, Table of Connection (2/2)

channel #	outside vessel			inside vessel				notes
	data logger			inner-vessel permanent terminal board				
				receptacle				
	measurement rack #	logger #	logger port #	receptacle #	receptacle pin #	pin material	connector model #	
481～492	2	2-1	0～11	TC41	A～Y	copper/constantan	AFD56-16-26SN	
493～504			12～23	TC42	A～Y	copper/constantan	AFD56-16-26SN	
505～516			24～35	TC43	A～Y	copper/constantan	AFD56-16-26SN	
517～528			36～47	TC44	A～Y	copper/constantan	AFD56-16-26SN	
529～540		2-2	0～11	TC45	A～Y	copper/constantan	AFD56-16-26SN	
541～552			12～23	TC46	A～Y	copper/constantan	AFD56-16-26SN	
553～564			24～35	TC47	A～Y	copper/constantan	AFD56-16-26SN	
565～576			36～47	TC48	A～Y	copper/constantan	AFD56-16-26SN	
577～588		2-3	0～11	TC49	A～Y	copper/constantan	AFD56-16-26SN	
589～600			12～23	TC50	A～Y	copper/constantan	AFD56-16-26SN	
601～612			24～35	TC51	A～Y	copper/constantan	AFD56-16-26SN	
613～624			36～47	TC52	A～Y	copper/constantan	AFD56-16-26SN	
625～636		2-4	0～11	TC53	A～Y	copper/constantan	AFD56-16-26SN	
637～648			12～23	TC54	A～Y	copper/constantan	AFD56-16-26SN	
649～660			24～35	TC55	A～Y	copper/constantan	AFD56-16-26SN	
661～672			36～47	TC56	A～Y	copper/constantan	AFD56-16-26SN	
673～684		2-5	0～11	TC57	A～Y	copper/constantan	AFD56-16-26SN	
685～696			12～23	TC58	A～Y	copper/constantan	AFD56-16-26SN	
697～708			24～35	TC59	A～Y	copper/constantan	AFD56-16-26SN	
709～720			36～47	TC60	A～Y	copper/constantan	AFD56-16-26SN	
721～732		2-6	0～11	TC61	A～Y	copper/constantan	AFD56-16-26SN	
733～744			12～23	TC62	A～Y	copper/constantan	AFD56-16-26SN	
745～756			24～35	TC63	A～Y	copper/constantan	AFD56-16-26SN	
757～768			36～47	TC64	A～Y	copper/constantan	AFD56-16-26SN	
769～780		2-7	0～11	TC65	A～Y	copper/constantan	AFD56-16-26SN	
781～792			12～23	TC66	A～Y	copper/constantan	AFD56-16-26SN	
793～804			24～35	TC67	A～Y	copper/constantan	AFD56-16-26SN	
805～816			36～47	TC68	A～Y	copper/constantan	AFD56-16-26SN	
817～828		2-8	0～11	TC69	A～Y	copper/constantan	AFD56-16-26SN	
829～840			12～23	TC70	A～Y	copper/constantan	AFD56-16-26SN	



note) view on the fitting plane (viz. the surface on the connector's end to be connected to the terminal board inside vessel)

○ : for copper lines
● : for constantan lines

model #: AFD50-16-26PN-1A (Deutsch)
* Contacts are to be separately prepared. (Deutsch)
copper: 0641-10-2039
constantan: 105371-01

The connector and contact to be prepared by users (female side.)
cf. applicable plug for this receptacle
model #: AFD56-16-26SN-043 (Deutsch)
*Contacts are to be separately prepared. (Deutsch)
copper: 0603-34-2039
constantan: 105372

Figure 3-6 Contact Pin Arrangement for Thermocouple Connectors on Permanent Terminal Board inside Vessel

Table 3-3 Signal Lines, Table of Connection

external terminal block		feed-through		inner-vessel permanent terminal board		
connector No.	receptacle pin #	receptacle #	flange (nozzle #)	receptacle #	receptacle pin #	model # of connectors (to be prepared by users) *
S1-1	A	1	N74-1	1	A	MS3106B18-1S
	B				B	
	C				C	
	D				D	
	E				E	
	F				F	
	G				G	
	H				H	
	I				I	
	J				J	
S1-2	A～J	2		2	A～J	MS3106B18-1S
S1-3	A～J	3		3	A～J	MS3106B18-1S
S1-4	A～J	4		4	A～J	MS3106B18-1S
S1-5	A～J	5		5	A～J	MS3106B18-1S
S1-6	A～J	6		6	A～J	MS3106B18-1S
S1-7	A～J	7		7	A～J	MS3106B18-1S
S1-8	A～J	8		8	A～J	MS3106B18-1S
S1-9	A～J	9		9	A～J	MS3106B18-1S
S1-10	A～J	10		10	A～J	MS3106B18-1S
S1-11	A～J	11		11	A～J	MS3106B18-1S
S1-12	A～J	12		12	A～J	MS3106B18-1S
S1-13	A～J	13		13	A～J	MS3106B18-1S
S1-14	A～J	14		14	A～J	MS3106B18-1S
S1-15	A～J	15		15	A～J	MS3106B18-1S
S1-16	A～J	16		16	A～J	MS3106B18-1S
S1-17	A～J	17		17	A～J	MS3106B18-1S
S1-18	A～J	18		18	A～J	MS3106B18-1S
S1-19	A～J	19		19	A～J	MS3106B18-1S
S1-20	A～J	20		20	A～J	MS3106B18-1S
S2-1	A	1	N72	1	A	JA3106B24-J28SC
	B				B	
	C				C	
	D				D	
	E				E	
	F				F	
	G				G	
	H				H	
	J				J	
	Q				Q	
	K				K	
	R				R	
	M				M	
	L				L	
	N				N	
	P				P	
	S				S	
	T				T	
	U				U	
	V				V	
	W				W	
	X				X	
	Y				Y	
	Z				Z	
S2-2	A～Z	2		2	A～Z	JA3106B24-J28SC
S2-3	A～Z	3		3	A～Z	JA3106B24-J28SC
S2-4	A～Z	4		4	A～Z	JA3106B24-J28SC
S2-5	A～Z	5		5	A～Z	JA3106B24-J28SC

* Users are to prepare female connectors.

Table 3-4 Lines of 60W Power Supplies for Heat Sources, Table of Connection (1/2)

name of power supply	power supply rack				feed-through	inner-vessel permanent terminal board		
	receptacle #	power supply #	receptacle pin #	polarity	flange (nozzle) #	receptacle #	receptacle pin #	model # of connectors (to be prepared by users) *
8mφ 60W power supply rack-1 60V/1A	power supplies 1～5 DC OUTPUT	1	1	＋	N76-1	P05-1	A	MS3106B18-1S
			2	－			B	
		2	3	＋			C	
			4	－			D	
		3	5	＋			E	
			6	－			F	
		4	7	＋			G	
			8	－			H	
		5	9	＋			I	
			10	－			J	
	power supplies 6～10 DC OUTPUT	6	1	＋		P05-2	A	
			2	－			B	
		7	3	＋			C	
			4	－			D	
		8	5	＋			E	
			6	－			F	
		9	7	＋			G	
			8	－			H	
		10	9	＋			I	
			10	－			J	
	power supplies 11～15 DC OUTPUT	11	1	＋		P05-3	A	
			2	－			B	
		12	3	＋			C	
			4	－			D	
		13	5	＋			E	
			6	－			F	
		14	7	＋			G	
			8	－			H	
		15	9	＋			I	
			10	－			J	
	power supplies 16～20 DC OUTPUT	16	1	＋		P05-4	A	
			2	－			B	
		17	3	＋			C	
			4	－			D	
		18	5	＋			E	
			6	－			F	
		19	7	＋			G	
			8	－			H	
		20	9	＋			I	
			10	－			J	
	power supplies 21～25 DC OUTPUT	21	1	＋		P05-5	A	
			2	－			B	
		22	3	＋			C	
			4	－			D	
		23	5	＋			E	
			6	－			F	
		24	7	＋			G	
			8	－			H	
		25	9	＋			I	
			10	－			J	

＊Users are to prepare female connectors.

Table 3-4 Lines of 60W Power Supplies for Heat Sources, Table of Connection (2/2)

name of power supply	power supply rack: receptacle #	power supply rack: power supply #	power supply rack: receptacle pin #	power supply rack: polarity	feed-through: flange (nozzle) #	inner-vessel permanent terminal board: receptacle #	inner-vessel permanent terminal board: receptacle pin #	inner-vessel permanent terminal board: model # of connectors (to be prepared by users) *
8mφ 60W power supply rack-2 60V/1A	power supplies 26～30 DC OUTPUT	26	1	＋	N76-1	P05-6	A	MS3106B18-1S
			2	－			B	
		27	3	＋			C	
			4	－			D	
		28	5	＋			E	
			6	－			F	
		29	7	＋			G	
			8	－			H	
		30	9	＋			I	
			10	－			J	
	power supplies 31～35 DC OUTPUT	31	1	＋		P05-7	A	
			2	－			B	
		32	3	＋			C	
			4	－			D	
		33	5	＋			E	
			6	－			F	
		34	7	＋			G	
			8	－			H	
		35	9	＋			I	
			10	－			J	
	power supplies 36～40 DC OUTPUT	36	1	＋		P05-8	A	
			2	－			B	
		37	3	＋			C	
			4	－			D	
		38	5	＋			E	
			6	－			F	
		39	7	＋			G	
			8	－			H	
		40	9	＋			I	
			10	－			J	
	power supplies 41～45 DC OUTPUT	41	1	＋		P05-9	A	
			2	－			B	
		42	3	＋			C	
			4	－			D	
		43	5	＋			E	
			6	－			F	
		44	7	＋			G	
			8	－			H	
		45	9	＋			I	
			10	－			J	
	power supplies 46～50 DC OUTPUT	46	1	＋		P05-10	A	
			2	－			B	
		47	3	＋			C	
			4	－			D	
		48	5	＋			E	
			6	－			F	
		49	7	＋			G	
			8	－			H	
		50	9	＋			I	
			10	－			J	

＊Users are to prepare female connectors.

Table 3-5 Lines of 2 kW Power Supplies for Heat Sources, Table of Connection

name of power supply	power supply rack				feed-through	inner-vessel permanent terminal board		
	receptacle #	power supply #	receptacle pin #	polarity	flange (nozzle) #	receptacle #	receptacle pin #	model # of connectors (to be prepared by users) *
8mφ 2 kW power supply rack−1 100V/20A	power supplies 1, 2 DC OUTPUT	1	1	+	N78	P20−1	A	MS3106B22−22S
			2	−			B	
		2	3	+			C	
			4	−			D	
	power supplies 3, 4 DC OUTPUT	3	1	+		P20−2	E	
			2	−			F	
		4	3	+			G	
			4	−			H	
	power supplies 5, 6 DC OUTPUT	5	1	+		P20−3	I	
			2	−			J	
		6	3	+			A	
			4	−			B	
	power supplies 7, 8 DC OUTPUT	7	1	+		P20−4	C	
			2	−			D	
		8	3	+			E	
			4	−			F	
	power supplies 9, 10 DC OUTPUT	9	1	+		P20−5	G	
			2	−			H	
		10	3	+			I	
			4	−			J	
8mφ 2 kW power supply rack−2 100V/20A	power supplies 11, 12 DC OUTPUT	11	1	+		P20−6	A	
			2	−			B	
		12	3	+			C	
			4	−			D	
	power supplies 13, 14 DC OUTPUT	13	1	+		P20−7	E	
			2	−			F	
		14	3	+			G	
			4	−			H	
	power supplies 15, 16 DC OUTPUT	15	1	+		P20−8	I	
			2	−			J	
		16	3	+			A	
			4	−			B	
	power supplies 17, 18 DC OUTPUT	17	1	+		P20−9	C	
			2	−			D	
		18	3	+			E	
			4	−			F	
	power supplies 19, 20 DC OUTPUT	19	1	+		P20−10	G	
			2	−			H	
		20	3	+			I	
			4	−			J	

* Users are to prepare female connectors.

Table 3-6 Lines of 3 kW Power Supplies for Heat Sources, Table of Connection

name of power supply	power supply rack				feed-through	inner-vessel permanent terminal board		
	receptacle #	power supply #	receptacle pin #	polarity	flange (nozzle) #	receptacle #	receptacle pin #	model # of connectors (to be prepared by users) *
8mφ 3 kW power supply rack-1 100V/30A	power supplies 1, 2 DC OUTPUT	1	1	+		P50-1	A	MS3106B32-17S
			2	−			B	
		2	3	+			C	
			4	−			D	
	power supplies 3, 4 DC OUTPUT	3	1	+		P50-2	E	
			2	−			F	
		4	3	+			G	
			4	−			H	
	power supplies 5, 6 DC OUTPUT	5	1	+		P50-3	I	
			2	−			J	
		6	3	+			A	
			4	−			B	
	power supplies 7, 8 DC OUTPUT	7	1	+		P50-4	C	
			2	−			D	
		8	3	+			E	
			4	−			F	
	power supplies 9, 10 DC OUTPUT	9	1	+		P50-5	G	
			2	−			H	
		10	3	+			I	
			4	−			J	

* Users are to prepare female connectors.

Table 3-7 Lines of 5 kW Power Supplies for Heat Sources, Table of Connection

name of power supply	power supply rack				feed-through	inner-vessel permanent terminal board		
	receptacle #	power supply #	receptacle pin #	polarity	flange (nozzle) #	receptacle #	receptacle pin #	model # of connectors (to be prepared by users) *
8mφ 5 kW power supply rack-1 100V/50A	power supplies 1, 2 DC OUTPUT	1	1	+		P50-6	A	MS3106B32-17S
			2	−			B	
		2	3	+			C	
			4	−			D	
	power supplies 3, 4 DC OUTPUT	3	1	+		P50-7	A	
			2	−			B	
		4	3	+			C	
			4	−			D	
	power supplies 5 DC OUTPUT	5	1	+		P50-10	A	
			2	−			B	
		—					C	
							D	
8mφ 5 kW power supply rack-2 100V/50A	power supplies 6, 7 DC OUTPUT	6	1	+		P50-8	A	
			2	−			B	
		7	3	+			C	
			4	−			D	
	power supplies 8, 9 DC OUTPUT	8	1	+		P50-9	A	
			2	−			B	
		9	3	+			C	
			4	−			D	
	power supplies 10 DC OUTPUT	10	1	+		P50-11	A	
			2	−			B	
		—					C	
							D	

* Users are to prepare female connectors.

Table 3-8 Lines of 800W Power Supplies for Heat Sources for 13mφ Chamber, Table of Connection

name of power supply	power supply rack				feed-through	inner-vessel permanent terminal board		
	receptacle #	power supply #	receptacle pin #	polarity	flange (nozzle) #	receptacle #	receptacle pin #	model # of connectors (to be prepared by users) *1
13mφ 800 W power supply rack	J1	1	1	+		P05-11	A	MS3106B18-1S
			2	−			B	
		2	3	+			C	
			4	−			D	
		3	5	+			E	
			6	−			F	
	J2	4	1	+			G	
			2	−			H	
		5	3	+			I	
			4	−			J	
		6	5	+		P05-12	A	
			6	−			B	
	J3	7	1	+			C	
			2	−			D	
		8	3	+			E	
			4	−			F	
		9	5	+			G	
			6	−			H	
	J4	10	1	+			I	
			2	−			J	

*1. Users are to prepare female connectors.

3.3. TS Supporter

(1) TS dolly

A TS dolly mounts a TS such as a satellite, etc., to move and place it inside the chamber. The surface of the dolly in the visual field range from a TS is covered with a shroud just as the chamber is. Also, the locations of the hard points which are the I/F to a TS are common to those of the 13mφ Space Chamber and the 6mφ Radiometer Space Chamber, which suggests compatibility among the facilities. A TS weighing up to 4,000 kg can be mounted on the dolly. Its dimensions and external view are shown in Figures 3-7 and 3-8, respectively.

(2) Hard points for mounting TS

Those hard points help fixing a TS directly inside the chamber without using a TS dolly. With a dolly, the height from the upper planes of the rails to the tops of the fixing hard points is 425 mm, while it can be shortened to 40 mm by means of the TS-mounting hard points equipped on the chamber floor. Each hard point can withstand an item weighing up to 2,000 kg. Figure 3-9 shows a drawing of hard points for mounting a TS.

There also are metal hangers for a TS on the shroud at the height of 6,500 mm from the rails upper planes. Each hanger can suspend an item weighing up to 1,000 kg. For the details of their locations, refer to Figure 3-9.

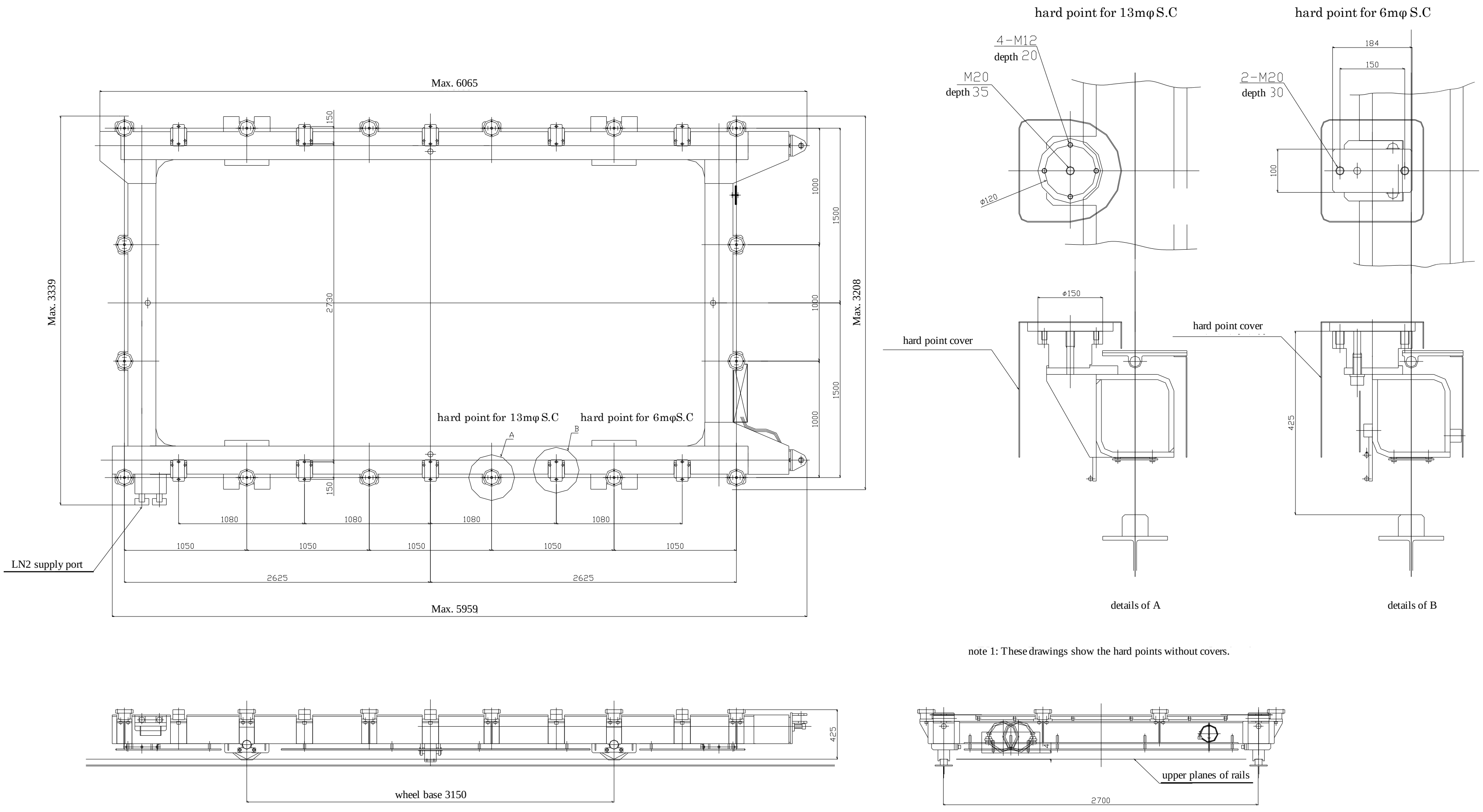
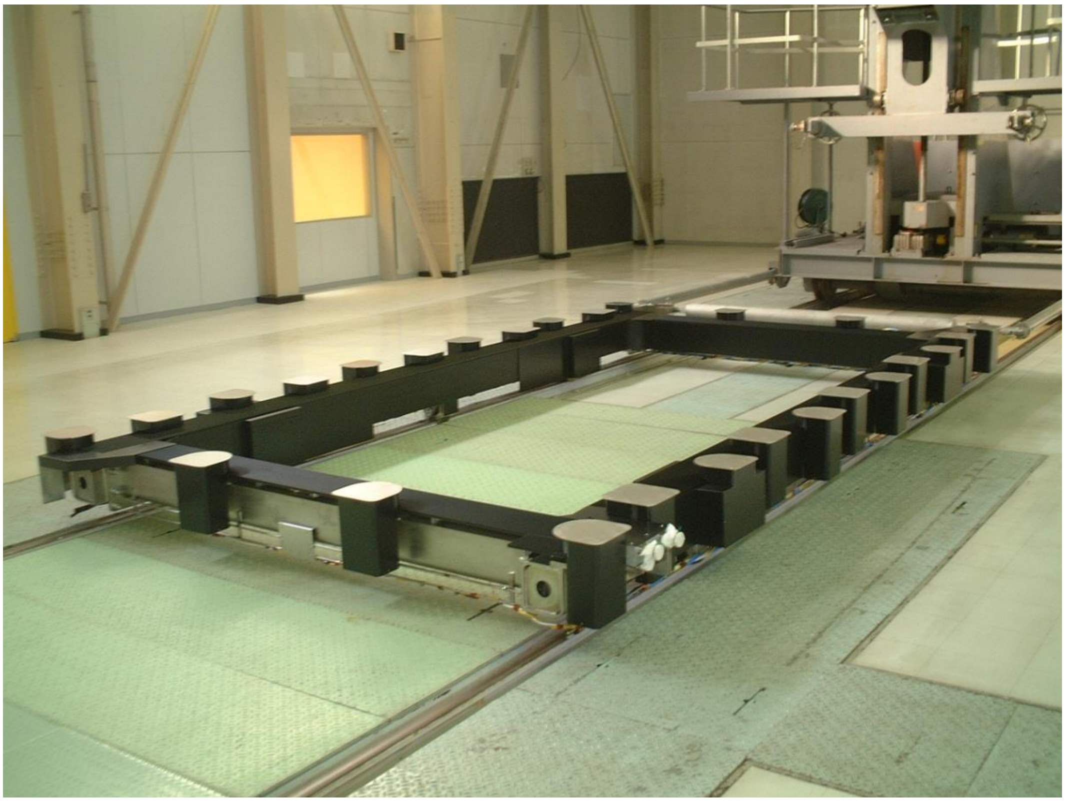


Figure 3-7 Dimensions of TS Dolly



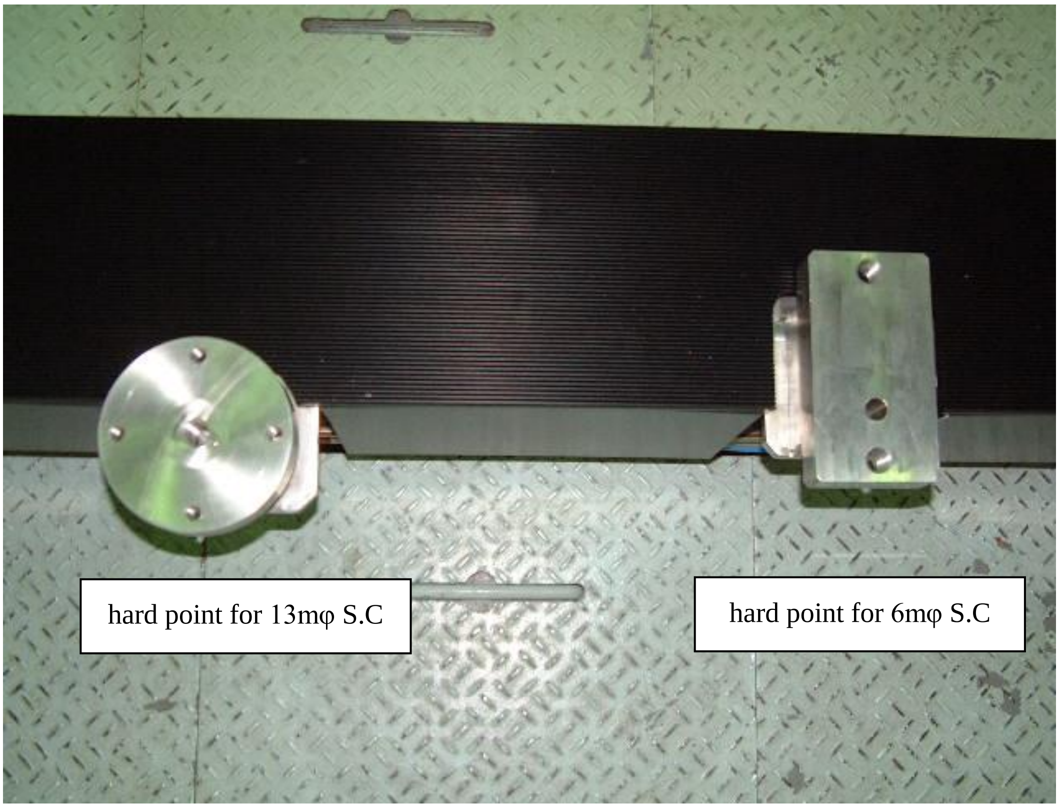


Figure 3-8 External View of TS Dolly

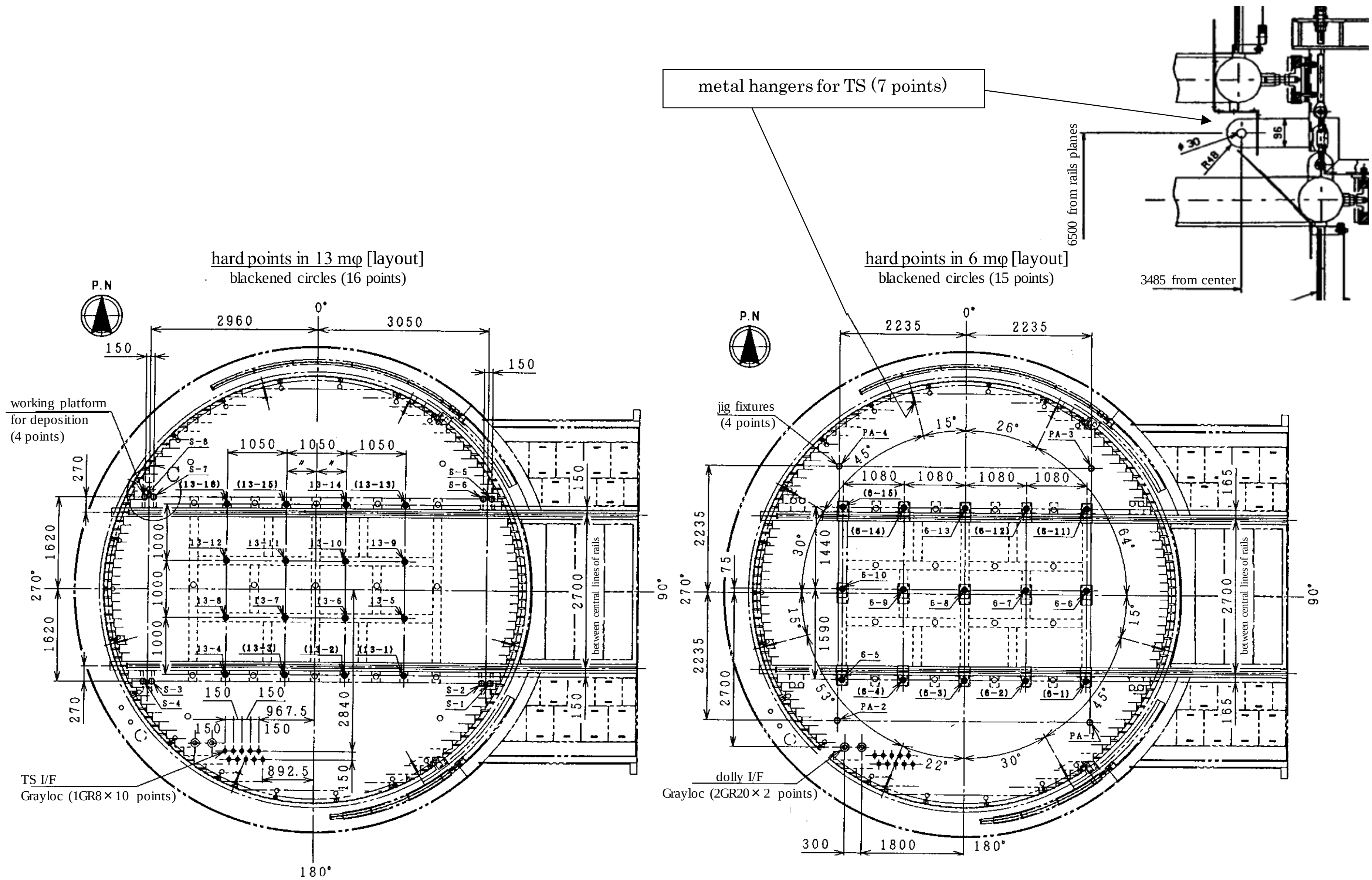


Figure 3-9 Hard Points for Mounting TS (1/2)

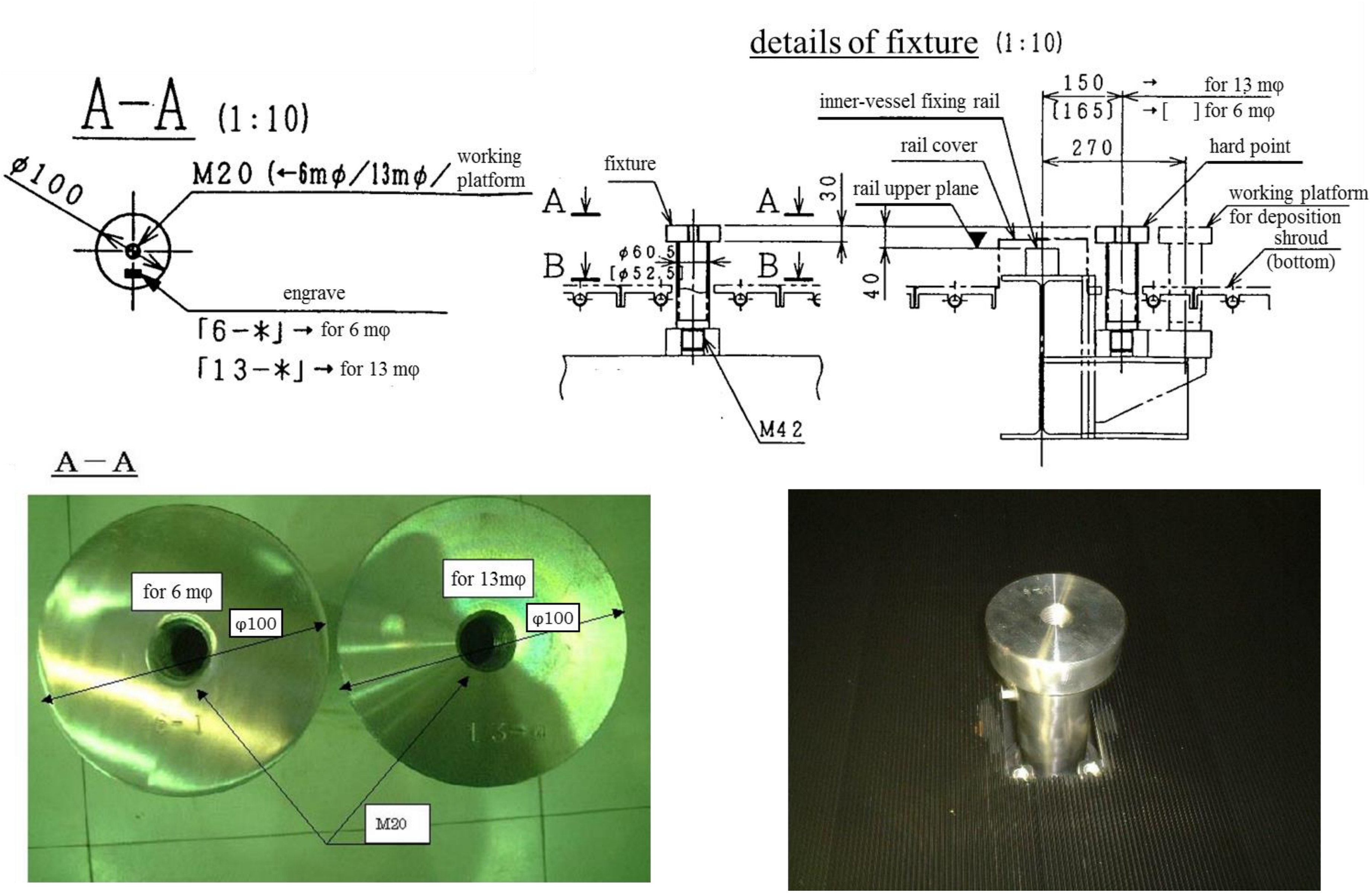


Figure 3-9 Hard Points for Mounting TS (2/2)

3.4. LN_2/GN_2 Supply Ports for TS

There are five LN_2/GN_2 supply ports for a TS in this facility. They are lined up next to the LN_2 ports for cooling a TS dolly in the left back of the floor in the vacuum vessel (cf. Figure 3-9.)

They supply LN_2 from the storage tank and GN_2 from the evaporator, whose flow rates are controlled by the automatic valves in the valve box for a TS installed on the 1st floor of the chamber (the supply lines cannot be individually designated for LN_2 or GN_2.)

It is not necessary to take procedures based on the High Pressure Gas Safety Law when using LN_2/GN_2 for a TS (that is, they are not classified as high pressure gas facilities.) However, valves other than the pre-installed automatic valves are not to be installed, because they could cause sealed liquid.

The LN_2/GN_2 supply ports are connected via Grayloc Connectors, and therefore users are to pay attention to the following matters when laying pipes by themselves.

(1) The hubs and seal rings of Grayloc Connectors are to be prepared by users.

(2) Since it normally takes 3 months to have the hubs of Grayloc Connectors procured (seal rings also take long for procurement), users are to confirm with the manufacturer (Nikkiso Co., Ltd.) for the procurement lead time when they plan for laying pipes. The LN_2/GN_2 supply/return ports for a TS are shown in Table 3-9. Also, the I/F connector for a Grayloc Connector is depicted in Figure 3-10.

Table 3-9 I/F for TS

purpose	quantity	size of pipe	type of I/F connector
LN_2/GN_2 supply	5	15A	Grayloc Connector
LN_2/GN_2 return	5	15A	Grayloc Connector

3.5. Building

Refer to Figure 3-11 for the locations of the rooms and cranes in the building. A TS is carried in via the route of the unpacking room (1F) → the lifting room (1F) → the 2nd preparation room (3F) → the 1st preparation room (3F.) The layout of the rooms along the route, as well as of the cranes, are shown in Figure 3-12.

Moreover, the route of carrying in the test devices, etc., for a TS is the chamber room (1F) → the test measurement room (3F.) The locations and specifications of the cranes, which are 1t hoist cranes, are shown in Figure 3-11 and Table 2-5, respectively.

3.5.1. Unpacking Room

A TS, jigs, etc., are to be carried into the facility from the unpacking room. In the course of that, make sure that the shutter of the unpacking room facing the lifting room is to be kept closed while the opposite shutter to the atmosphere is open to carry in a TS; then in turn, the latter shutter is to be closed while a TS is carried into the lifting room.

3.5.2. 1st Preparation Room/2nd Preparation Room

The 1st /2nd preparation rooms are available to users as their working area for a test in the chamber.

3.5.3. Distribution Boards Facility for Tests

As the power supplies for users, UPS output relay terminal boards are being installed. The details on their voltage, current capacity, grounding, etc., are shown in Table 3-10.

Max. total output capacity: 30 kVA (including about 2 kVA for the facility)
backup time: 10 min or longer

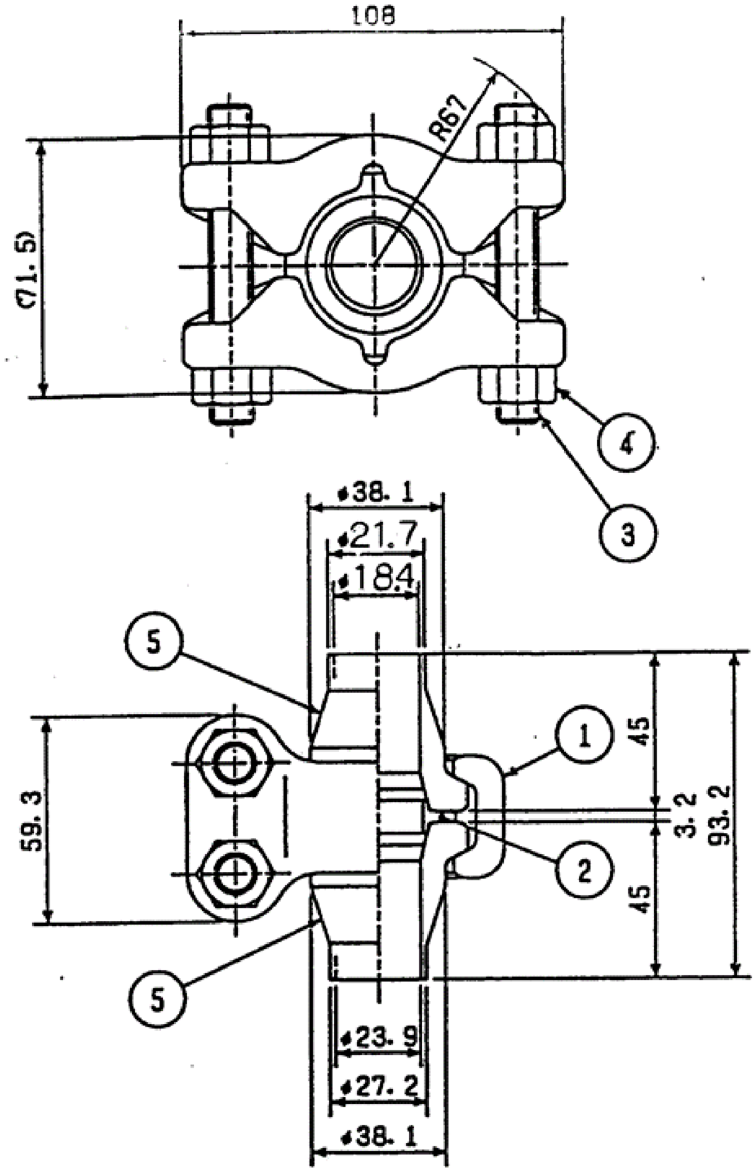
3.5.4. Test Measurement Room

The test measurement room can be used as the users' anteroom. Users can bring in test devices for a TS, etc., and set them in this room. Be cautious, though, not to place concentrated load on the floor when bringing in an item weighing 300 kg or more.

The room also has a whiteboard, which enables users to hold a meeting there.

Table 3-10 UPS Output Relay Terminal Boards

No		voltage		breaker capacity (A)	UPS output breaker capacity	notes
4-1	①	3φ 4W 200V	U, V, W, N phases, E	50A	200V 100A	connected to 13mφ 800W power supply rack
	②	3φ 4W 200V	U, V, W, N phases, E	50A		
	③	3φ 4W 200V	U, V, W, N phases, E	50A		
	④	3φ 4W 200V	U, V, W, N phases, E	50A		
	①	1φ 2W 200V	U, V phases, E	50A		
	②	1φ 2W 200V	V, W phases, E	50A		
	③	1φ 2W 200V	U, W phases, E	50A		
	①	1φ 2W 100V	U, N phases, E	50A		
	②	1φ 2W 100V	V, N phases, E	50A		
	③	1φ 2W 100V	W, N phases, E	50A		
4-2	①	3φ 3W 200V	U, V, W phases, E	50A		connected to 13mφ 800W power supply rack
	②	3φ 3W 200V	U, V, W phases, E	50A		
	③	3φ 3W 200V	U, V, W phases, E	50A		
	④	3φ 3W 200V	U, V, W phases, E	50A		
	④	1φ 2W 200V	U, V phases, E	50A		
	⑤	1φ 2W 200V	V, W phases, E	50A		
	⑥	1φ 2W 200V	U, W phases, E	50A		
	④	1φ 2W 100V	U, N phases, E	50A		20A is used by facility.
	⑤	1φ 2W 100V	V, N phases, E	50A		
	⑥	1φ 2W 100V	W, N phases, E	50A		



6				
5	welded hub	SUSF304	2	1GR8 (GL-32-4815)
4	nut	SA194-Gr8	4	M12x1. 75
3	bolt	SA193-B8	4	M12x1. 75xL89
2	seal ring	17-4PH /PT-24	1	NO. 8
1	clamp	SA182-F304	1 set	1GR 8
ITEM	NAME	MATERIAL	QUANT	DESCRIPTION

Figure 3-10 Diagram of Grayloc Connector for LN_2/GN_2 Supply Ports

(1F)

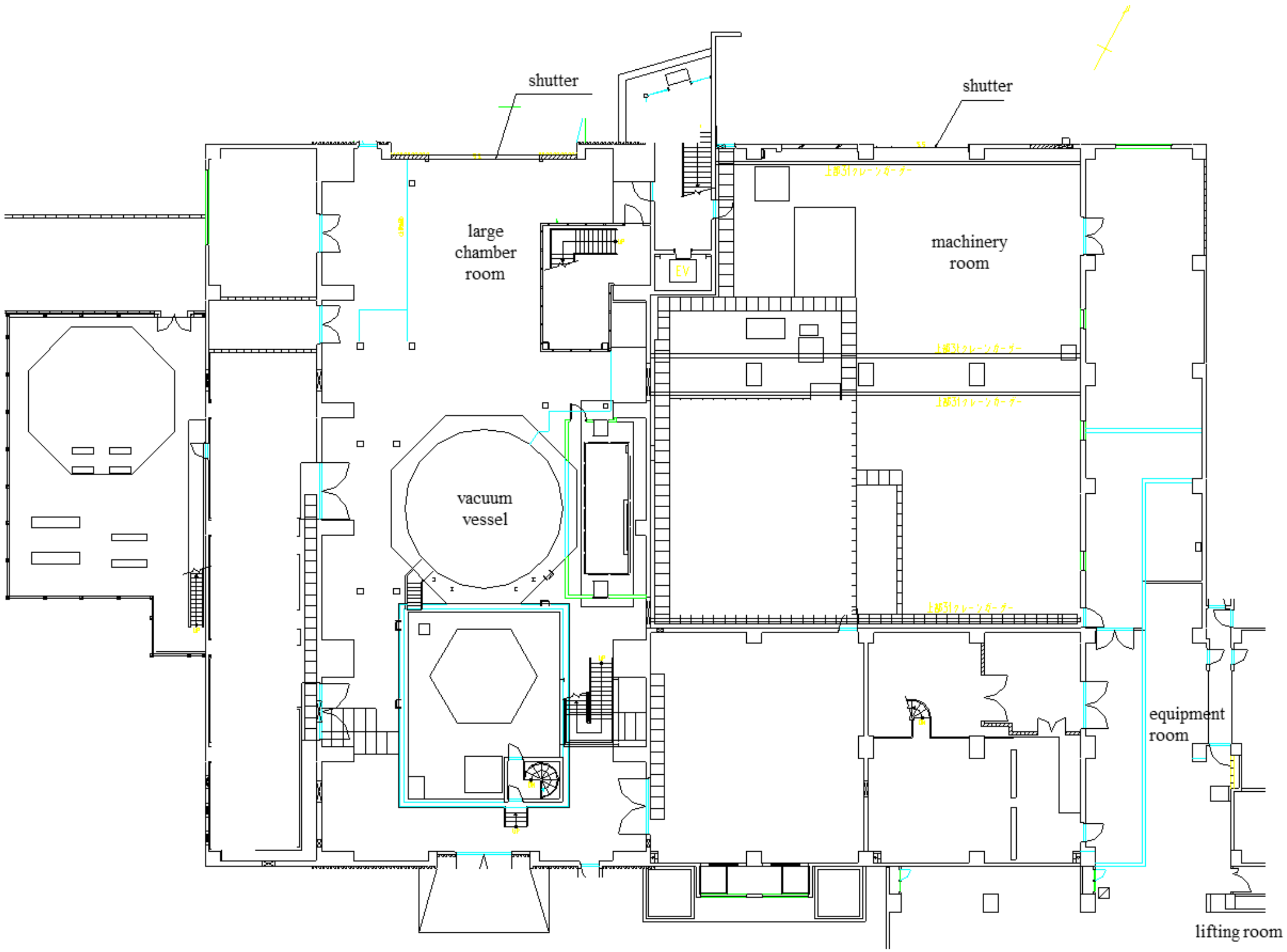


Figure 3-11 Layout of Building (1/3)

(2F)

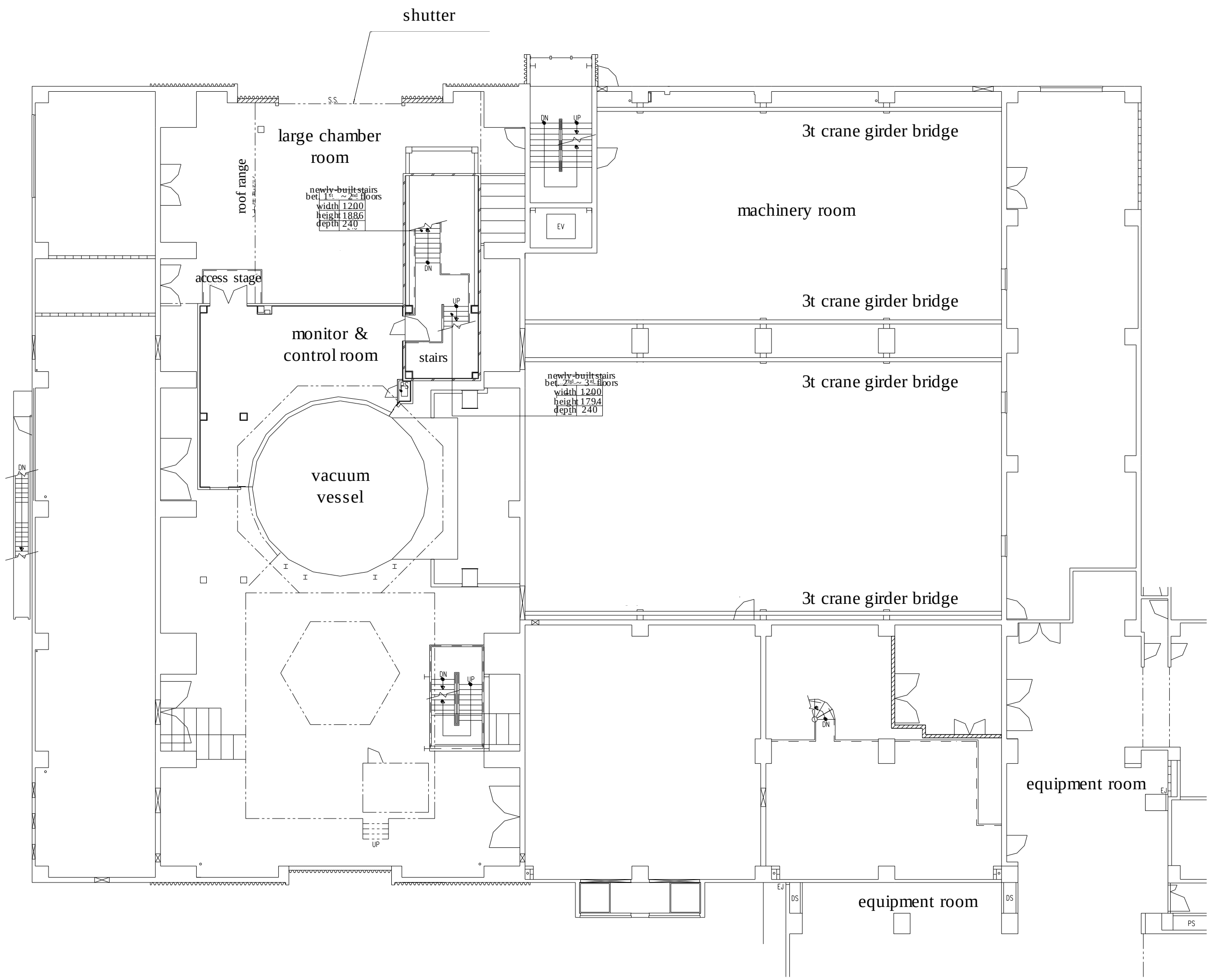


Figure 3-11 Layout of Building (2/3)

(3F)

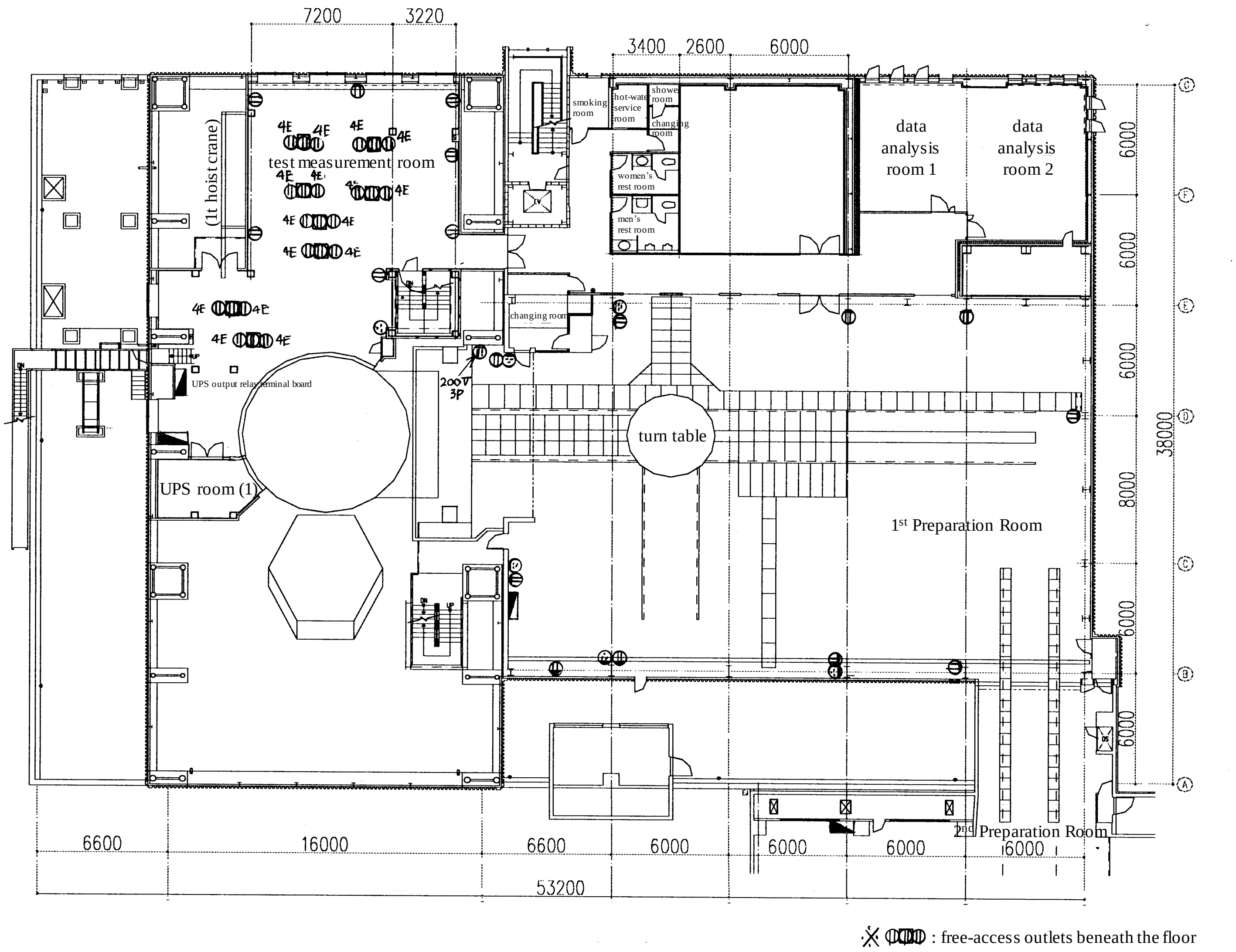
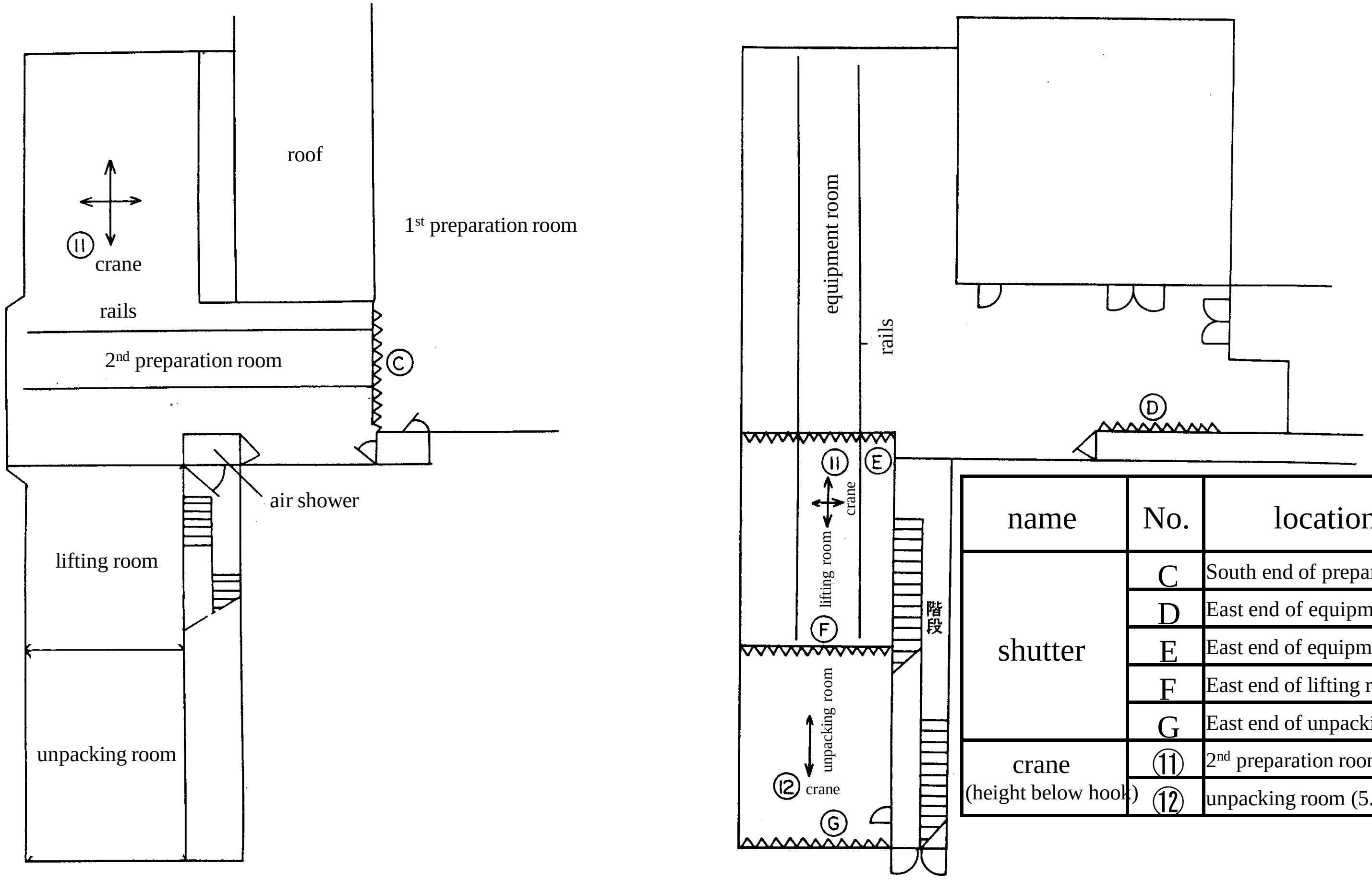


Figure 3-11 Layout of Building (3/3)



name	No.	location	size (m) width	size (m) height
shutter	C	South end of preparation room	5.0	7.0
	D	East end of equipment room	3.6	5.5
	E	East end of equipment room	4.6	5.5
	F	East end of lifting room	4.6	8.0
	G	East end of unpacking room	5.9	7.9
crane (height below hook)	⑪	2nd preparation room (5.0t)	11.87	
	⑫	unpacking room (5.0t)	12.44	

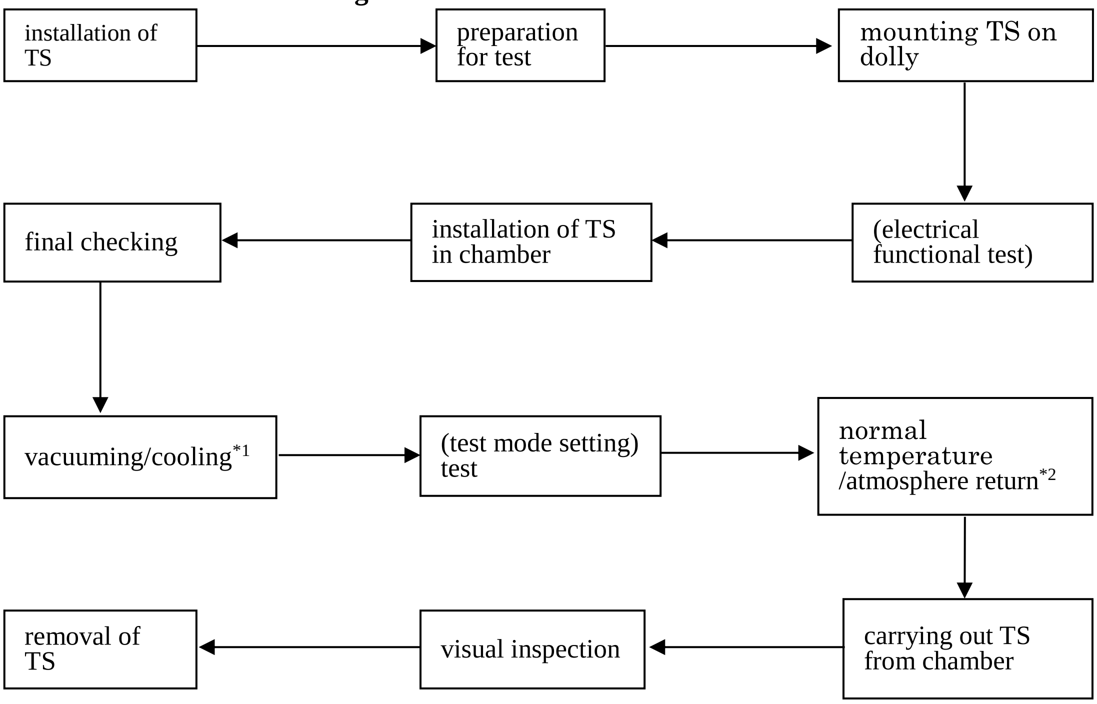
Figure 3-12 Layout of Rooms along Route of Carrying in TS

4. Execution of Tests

4.1. Test-related Work Procedure (for reference)

Each work in the course of a test is executed based on the test implementation plan/test procedure sheet presented by the TS side. The following Figure 4-1 shows a general flow of test-related work.

Figure 4-1 Test-related Work Flow



*1 A test schedule is to be arranged the way low vacuuming starts at 11:00 when the access door of the chamber had been closed since the previous day, and at 13:00 when the door was closed on the very day of the test.

*2 The starting time for atmosphere return is to be scheduled at either 11:00 or 23:00.

4.2. General Description of Tests (for reference)

In this facility, environmental tests, e. g., solar radiation thermal balance/thermal vacuum tests, IR radiation thermal balance/thermal vacuum tests, etc., can be performed. The general description of each environmental test is provided below. The environmental conditions for each test are described in Table 4-1.

(1) Solar radiation thermal balance/thermal vacuum test

A thermal balance test confirms the thermal design, etc., of a TS in the high vacuum and cryogenic temperature that simulate outer space, while a thermal vacuum test confirms the environmental resistance of equipment, etc., mounted on a TS to the thermal environment in space, that is, high and low temperatures and the back-and-forth transition between them. Solar simulators are used as the heat sources.

(2) IR radiation thermal balance/thermal vacuum test

A thermal balance test and a thermal vacuum test are performed for the same purposes as of solar radiation tests, adopting IR lamps or heaters as the heat sources.

Table 4-1 Kinds of Tests and Environmental Conditions

	solar radiation thermal balance/ thermal vacuum test	IR radiation thermal balance/ thermal vacuum test
(1) pressure	1.33×10^{-4} Pa or less	1.33×10^{-4} Pa or less
(2) solar intensity	about 1 solar (about 1.4 kW/m^2) (Max. 1.8 solar)	———
(3) IR intensity	———	depends on specifications of individual equipment brought in by the TS side
(4) shroud temperature	100K or lower	100K or lower

4.3. Power Failure Protective Measures

The general flow of measures against momentary power interruption or power failure is shown in Figure 4-2.

(1) Momentary power interruption

(a) The cryopump and the solar simulator system are aborted at the momentary power interruption of a second or shorter. The instrument air compressor is also aborted, but has no influence on the actions of automatic valves, owing to the automatic back-up by GN_2.

(b) The abort of the cryopump due to momentary power interruption raises the inner-chamber pressure up to around 9×10^{-5} Pa, but not to the range where discharge is likely to take place, which suggests that discharge prevention measures are not necessarily to be taken by the TS side as long as the momentary power interruption lasts no longer than a second.

(c) The solar simulator system aborted due to momentary power interruption is reactivated in about 20 ~ 30 minutes, fully recovering the state where it can apply solar radiation again.

(2) Power failure

(a) In the power failure of a second or longer, all the mechanical vacuuming pumps, e. g., cryosorption pumps, etc., are aborted, except for the cooler for shrouds and scavenger cryopanels. Then, it is to be determined whether to keep cooling the shrouds to avoid rapid pressure raise or stop cooling them by introducing GN_2, based on the power failure duration and the state of excessive cooling protection measures being taken for a TS. (Generally, continuous cooling of shrouds is chosen while waiting for power recovery.)

(b) A 30 kVA UPS is prepared in the UPS room for users. It is recommended that the heater systems (e. g., power supply for heat sources) wished to be heated during power failure or the checkout devices, etc., wished to be controlled and monitored during power failure be connected to the UPS in advance (the power supply cables between a UPS and the power supply for heat sources are prepared by the facility side.) Refer to section 3.5.3 for how to connect the UPS for users.

(c) The control device, data processing device, a remote setting PC for the power supply for heat sources, communication system, and oximeter are connected to a UPS (uninterruptible power supply) which can supply power for 10 minutes or longer.

(d) After about 10 minutes of power failure, the emergency power generator in the power building of Tsukuba Space Center starts supplying EP. Its pre-activation stand-by time and EP capacity vary depending on the state of its application by other facilities and equipment.

(e) In case power failure is not recovered for 10 minutes or longer, the saved data is to be stored in the external medium to make provision for hard disc failure due to the forced termination of the data acquisition system (measurement can be continued.)

(f) The power supply from the emergency power generator in the power building of Tsukuba Space Center is finite. Therefore, unnecessary lights or devices are to be turned off while the emergency power generator is supplying EP, for the sake of saving EP to the extent possible.

(g) Once the emergency power generator in the power building of Tsukuba Space Center starts to supply EP, the inner-chamber pressure can be maintained at about 9×10^{-5} Pa with the help of vacuuming by cryosorption pumps and turbo molecular pumps. Figure 4-3 shows the pressure transition inside the chamber when power failure lasts for 20 minutes, with EP started to be supplied from the emergency power generator in the power building of the Tsukuba Space Center after 10 minutes from the occurrence of power failure. (Bear in mind that the pressure transition varies widely depending on the power failure duration.)

(h) Without the recovery of power failure for 15 minutes or longer, or the power supply from the emergency power generator after 10 minutes from the occurrence of power failure, the inner-chamber pressure reaches the range which is generally considered as susceptible to discharge (1.3×10^{-3} Pa) in about 15 ~ 20 minutes. As soon as power failure takes place, therefore, take discharge prevention measures by shifting the operational mode of a TS into the launch mode, for example.

(3) Power restoration

(a) A momentary power interruption takes place at the moment of power restoration when power supply shifts from the emergency power generator in the power building of Tsukuba Space Center to the regular power supply. Therefore, power restoration is informed to users via simultaneous broadcasting in the building or via contact from the facility-side personnel, to urge users to turn off the equipment not connected to a UPS for a moment.

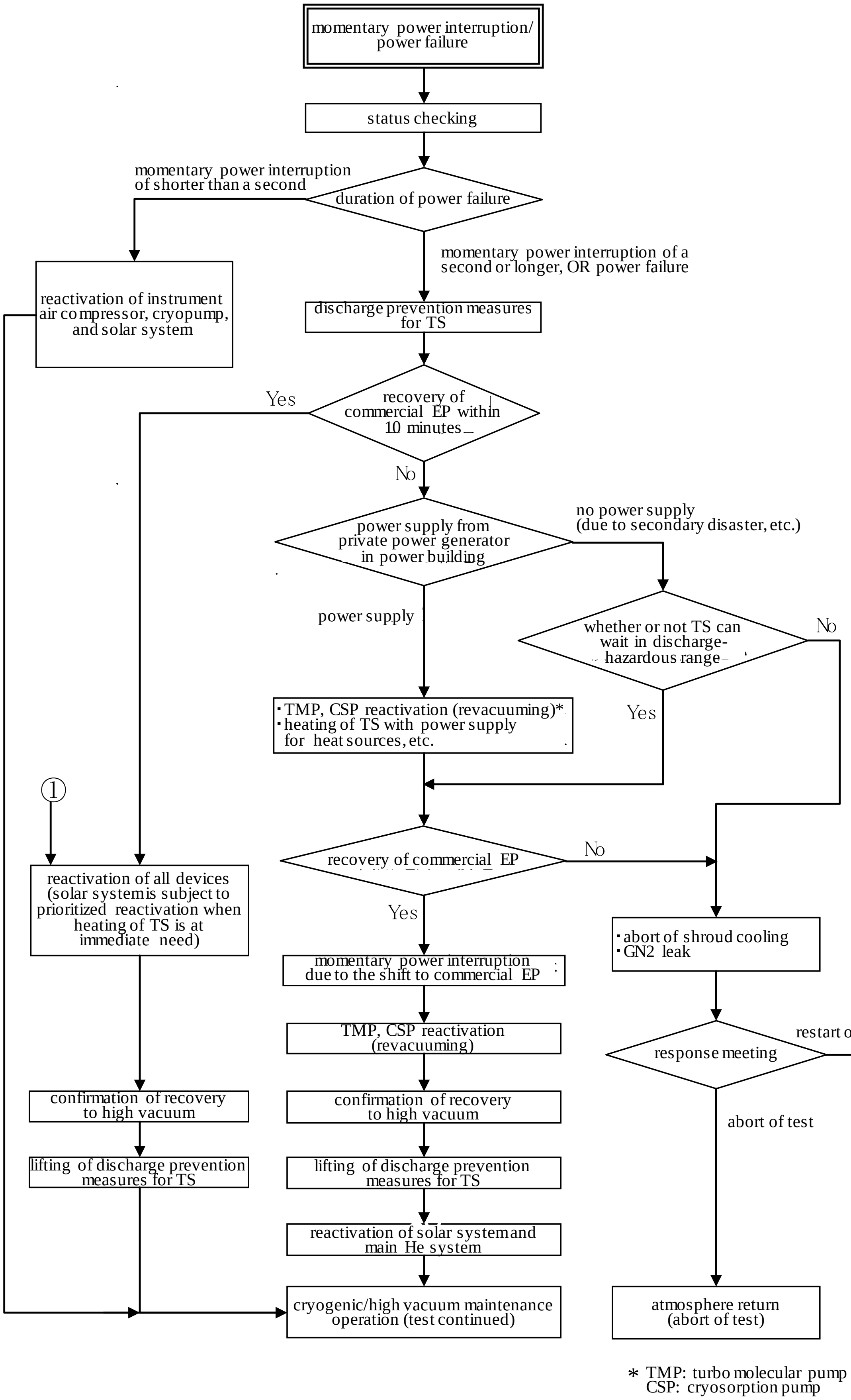


Figure 4-2 Standard Flow in Momentary Power Interruption and Power Failure

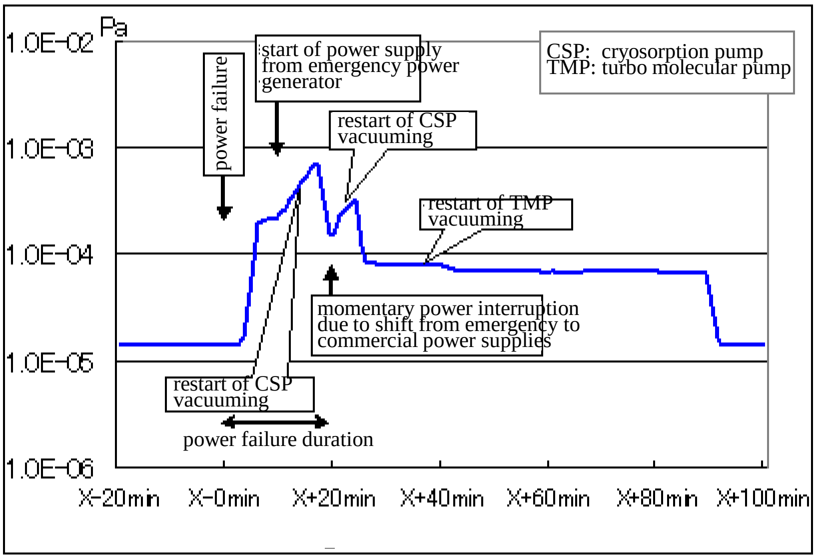


Figure 4-3 Inner-Chamber Pressure Transition during 20-minute Power Failure

4.4. Matters to be Confirmed for Test (Important)

Once vacuumed, the environment in the space chamber is the same as outer space in that it cannot be accessed promptly. Bearing that in mind, the following matters are to be checked.

(1) Matters concerning chamber contamination

- Whether or not anything with high steam pressure or susceptibility to evaporation from heating is used in the chamber.
- Whether or not commercial products that are not made for the usage in space are being used. (Are there commercially available glues or adhesive tapes being used?)
- Is the applied material less likely to generate outgas?
- For the purpose of preventing any phenomenon that can influence on test environments, e. g., degradation of vacuum levels, etc., users of the facility are to make a list of articles that are brought into this space chamber facility by themselves (example: TS, jigs, feed-through terminals, cables, etc.) and submit it at a kickoff meeting (K/O) with the results of prior confirmation on each of the articles in the form “List of Articles Brought into Chamber by Users” shown in Table 4-2.

(2) Matters concerning vacuum

- Whether or not there is gas leakage from gas-sealed equipment.
- Whether or not there is any chance that MLI might block vent holes (See if MLI does not cover the vent holes of tanks, etc.)
- Whether or not MLI has vent holes, or one end of it is not fixed.
- Whether or not there is a problem when inner or outer pressure is loaded.
- Whether or not the vacuum seals on vacuum seal connectors have been closely inspected.
- Whether or not leakage has been thoroughly inspected in case the vacuum vessel has any feed-through equipment (waveguide, tube, etc.)

(3) Harmful effects of low temperature

- Whether or not the material has low temperature brittleness that can cause a problem.
- Whether or not the risks of low temperature brittleness or outgas are deeply taken into account when polymer material (rubber, etc.) is used in the parts that become cold.
- Whether or not there is any item whose temperature won't go up readily during normal temperature atmosphere return. If there is any, it is to be checked if it is equipped with any mechanism to raise its temperature.
- Whether or not a fluid is freeze-proven, if it is planned to be used.

(4) Matters concerning vacuum discharge

- Electric discharge is generally said to take place in the pressure range around $1.33 \times 10^{-3} \sim 1.33 \times 10^{4}$Pa, where loading of high voltage may damange a TS due to electric discharge (cf. JERG-2-130-HB005 Handbook of Thermal Vacuum Test, section 3.7.1.)
- It is required that the electric-discharge-hazardous pressure range be determined by the TS side and reported to the facility-side personnel in advance.
- It is to be confirmed that loading of voltage is avoided in the electric-discharge-hazardous pressure range, or discharge prevention measures are taken in case that is not possible.

(5) Considerations for high pressure gas safety law

- The LN_2/GN_2 pipes for a TS in this facility are not subject to the High Pressure Gas Safety Law. When users prepare an LN_2 panel, etc., make sure they do not correspond to the regulated objects of the law (no valves, no sealed liquid, etc.)

(6) The I/F to the facility is to be checked not only by a drawing, but also by visual observation on it.

- I/F to TS supporter
  (The hard ports being made of SUS304, users are to watch out for "seizure" if they prepare screws that are SUS products)
- I/F to LN_2 systems
- I/F to solar simulator flax
- I/F to inner-chamber protruding objects (sensors, tubes, etc.), etc.
- Table 4-3 "Requirement for Facility" is to be submitted at the K/O meeting.
- Emergency stop switches are installed on the door shroud, the 1st preparation room, and the monitor & control room. Users are to make sure of their actual locations. The appearance of an emergency stop switch in the vacuum vessel (installed on the door shroud) and where the switches are located are shown in Figures 4-4 and 4-5, respectively.

<u>how to operate</u>

Turn the plug anticlockwise to the limit while grabbing its root, then unplug it.

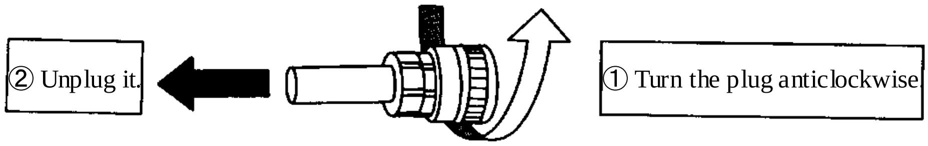


Figure 4-4 Emergency Stop Switch inside Vacuum Vessel

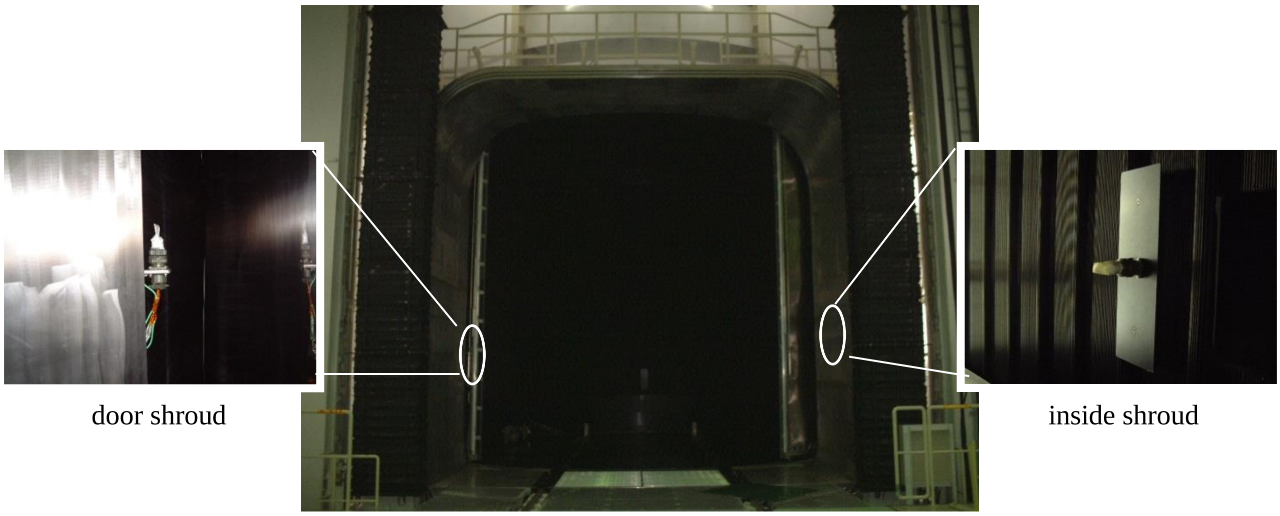


Figure 4-5 Locations of Emergency Stop Switches inside Vacuum Vessel

Note) The actual locations are to be checked for sure.

Table 4-2 List of Articles Brought into Chamber by Users

used chamber: 8mφ Space Chamber Date: YEAR MONTH DAY

name of test: test period: ～ user's name: No.

No.	articles brought in	qty	results of prior confirmation on certain points		nonmetallic material being used									
			confirmed points*1	results of prior confirmation	material	used qty	TML	CVCM	pre-test baking					operating experience
									w/ baking*2				w/o baking*3	
									temperature	time	pressure environment	drying time	reason for no baking	

*1 Fill in the space “confirmed points” with the corresponding number below, along with the results of pre-test confirmation on each of them. When there is no corresponding choice, leave the section blank.

＜confirmed points＞

① When there are structures that can be air dead space in test specimen or jig, check if air vent ports exist.
② Check if everything including test specimen and jig (incl. paint) is put through baking before thermal vacuum test.
③ Check if airtightness of feed-through terminals (ex. SMA terminal), etc., brought in by users is confirmed in advance.
④ Check if there is any article brought into chamber that is made of material possibly turning into contaminants.
⑤ When cooling medium tube, etc., go through vacuum vessel, check in advance for the airtightness at their joints. (those to be installed at site are to be checked at task briefing.)
⑥ When pressurized vessel is put into chamber, check if airtightness of its sealed parts is confirmed in advance.
⑦ Others

*2 If baking was executed, baking conditions (temperature, time, pressure environment during baking, drying time) are to be written here.

*3 If baking was not executed, the reason for that decision is to be precisely written here.

Table 4-3 Requirements for Facility

／／／These requirements are to be submitted at K/O meeting to the personnel in charge of operating the facility. ／／／

name of test		notes
manufacturer of test specimen		
facility user's name		
documentation date		
inner-chamber pressure		generally 1.33×10^{-3}Pa or less
discharge-hazardous range		-
shroud temperature		generally 100K or lower
environment of test specimen in clean room	temperature: humidity: cleanliness:	temperature: 23±3℃ humidity: 45±15℃ cleanliness: ISO class 8 (class 100,000)
Check either one.		
solar simulator	use / not use （Max. irradiance: kW/m^2 radiation time: ）	within 2.5 kW/m^2
test specimen dolly	use / not use	
power supplies for heat sources	use / not use ☐ 5 kW: / Max 10 (number of power supplies) ☐ 3 kW: / Max 10 (number of power supplies) ☐ 2 kW: / Max 10 (number of power supplies) ☐ 60 W: / Max 10 (number of power supplies)	
LN_2/GN_2 for test specimen	use / not use	
data acquisition device	use / not use	
test specimen mass	kg	within 4,000 kg
test specimen dimensions	(incl. jig)	within 5m☐ × height 5.7m

Note) Attach a test profile.
Clarify the following matters in the test profile.
The scheduled start time for the main event.
The irradiance and radiation time at each mode for solar simulator.

(other special notes)