Operation Manual / Basic Guide

Highly Accelerated Stress Test System (HAST) / EHS

EHS- 212, 222, 412,
212M, 222M, 412M,
212MD, 222MD, 412MD

4013404000200
November 01, 2017
ESPEC CORP.

■Read this manual thoroughly before operating the chamber.
■Carefully read and familiarize yourself with the "Safety precautions" section before using this product.
■Keep this manual on hand for future reference.

Liability

Always observe the handling instructions detailed in this manual when using the product. ESPEC CORP. assumes NO responsibility whatsoever for accidents or equipment trouble arising from the failure to observe handling instructions contained herein. Do not perform any operation or handle the chamber in any way or form that is not described in this manual or which is herein specifically prohibited. Careless usage of the sort may result in unexpected damage to the chamber or accident.

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Read this section before using the equipment.

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Chapter 6 Alarms and troubleshooting

Appendix

Introduction

Read this section before using the equipment.

For restricted use

This test chamber should be operated only by experienced engineers or persons who have received training in proper usage from an experienced engineer.

■ **Definition of an experienced engineer**

A person who understands the purpose of the product; who has received training in operation methods, daily maintenance and checks, etc.; and who can foresee and prevent risks associated with inherent dangers such as electricity.

Safety indications

The following safety indications are used throughout this manual.

■ **Labels that indicate danger to people**

DANGER	**Improper handling of the chamber can create extremely dangerous conditions that create the risk of death or serious personal injury to the user.**
WARNING	**Improper handling of the chamber can create dangerous conditions that create the risk of death or serious personal injury to the user.**
CAUTION	**Improper handling of the chamber can create dangerous conditions that create the risk of minor or slight personal injury to the user.**

■ **Labels that instruct the user to avoid danger**

PROHIBITED	**This mark means that specific actions are prohibited in order to prevent a dangerous situation from arising.**
Imperative Action Required	**This symbol means that it is imperative for the user to take specific actions (instructions) in order to prevent a dangerous situation from arising.**

■ **Label that indicates information on physical damage and environmental contamination**

Notice	**This label means that dangerous consequences may arise, with the possibility of physical damage to equipment and facilities, or environmental pollution, if the chamber is handled incorrectly.**

Keywords

■ **The following keywords are used throughout this manual.**

Note	**Provides information necessary for gaining full performance from the chamber or information for preventing damage to the equipment.**
Procedure	**Explains how to operate the chamber on a step-by-step basis.**
Reference	**Indicates reference information necessary for gaining full performance from the chamber.**

Regulatory compliance

This chamber is categorized as a small pressure vessel. Article 94 of the "Ordinance on Safety of Boilers and Pressure Vessels", a Ministry of Health, Labour and Welfare Ordinance, requires that a periodical voluntary inspection be performed on the chamber once a year. The relevant article is given below.

■ Article 94

1. With regard to a small-sized boiler or small-sized pressure vessel, the employer shall implement voluntary inspection, periodically, and at least once for every period not exceeding one year after the commencement of operation, on the following matters, provided that this provision shall not apply to a non-use period of small-sized boilers or small-sized pressure vessels which are not used for a period exceeding one year:
   1) For a small-sized boiler, existence of damage or abnormality in the boiler itself, burning apparatus, automatic control systems and fittings.
   2) For a small-sized pressure vessel, existence of damage or wear in the pressure vessel itself, locking bolts of cover plate, tubes or valves.
2. With regard to the small-sized boilers or small-sized pressure vessels described in the provision of the preceding paragraph, the employer shall, before the resumption of use, implement voluntary inspection on the matters as described in each item of the same paragraph.
3. When having implemented the voluntary inspections set forth by the preceding two paragraphs, the employer shall record their results and preserve such records for three years.

(Ordinance on Safety of Boilers and Pressure Vessels)

Periodical voluntary inspection items

Inspection method	Locations and items to inspect
Visual inspection when operation is stopped	① Corrosion or cracks on doors ② Corrosion or cracks on pressure vessel (interior surface of inside area after the packing) ③ Large deformation or cracking of packing ④ 0 MPa when pressure gauge is not used
Visual inspection 1 hour after set point attainment	① Temperature set point and pressure • EHS-212(M), 222(M), 212MD, 222MD Temperature set point: 132.9°C/Humidity set point: 100%rh Indicated pressure: 0.196 MPa • EHS-412(M), 412MD Temperature set point: 151.1°C/Humidity set point: 100%rh Indicated pressure: 0.392 MPa ② Steam leaks from doors (pressure vessel packing) ③ Steam leaks from pressure vessel (pipes: underneath chamber, manual valve)
Visual inspection of electrical system	① Locking of power supply connectors, looseness ② Damage to power cord

List of remaining risks (instructions for avoiding danger)

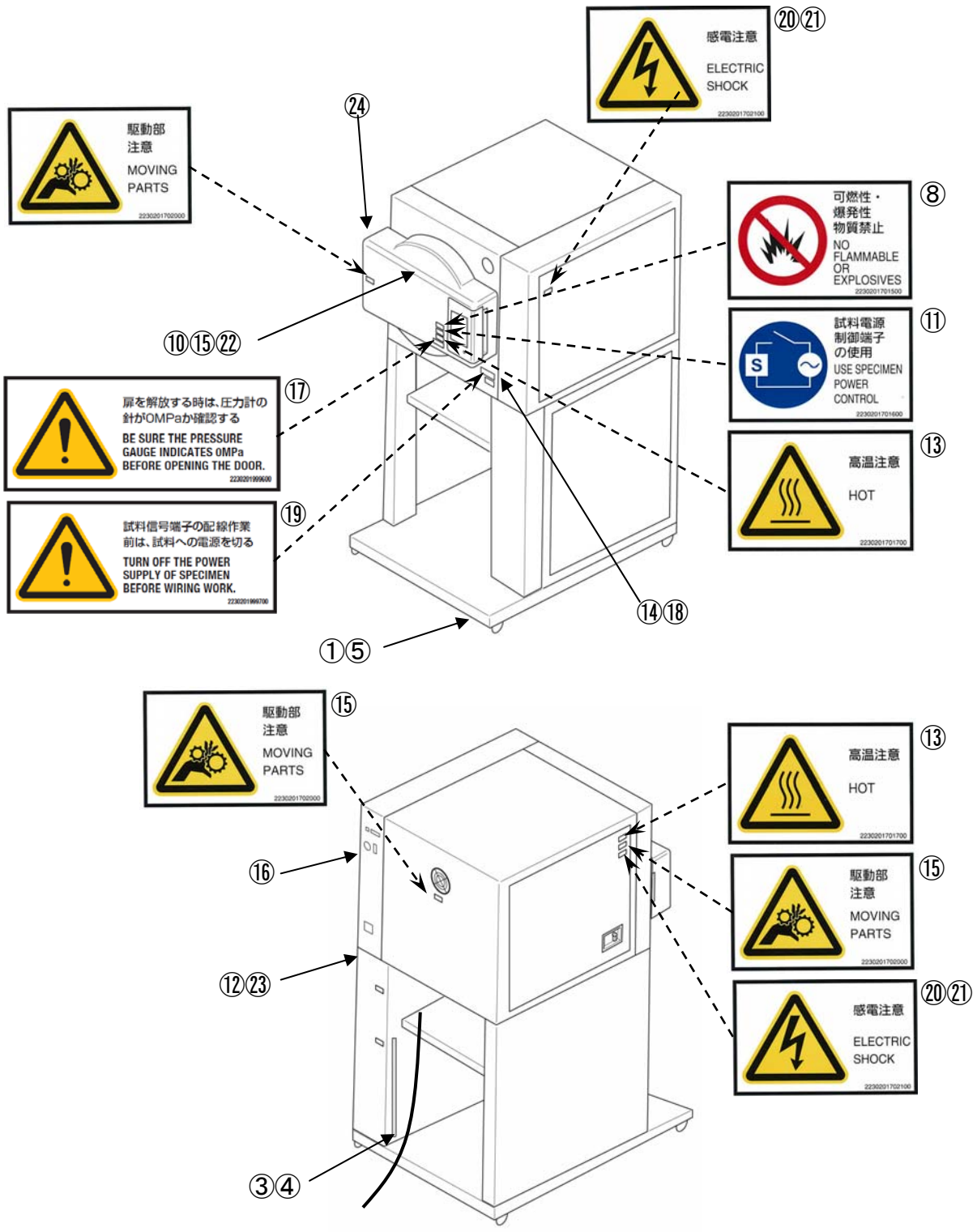
To ensure the safe and correct use of the chamber, this section gives a list of the items that pose the threat of danger and instructions for avoiding said danger. For details, see the pages indicated for the items. Also, the locations corresponding to each item are written on the following pages, so be sure to read all of these pages together.

	Risks and countermeasures during transportation and installation			For details, see
①	WARNING		When lowering the chamber to the floor, work carefully to ensure that no fingers are caught under the chamber and that the chamber does not fall over. Failing to do so can result in injury.	(Page 5 in the Installation Guide)
②	WARNING		Do not install the chamber in an inappropriate location such as outdoors or a highly humid location. Doing so can result in fire and electric shock.	Section 3, (Page 4 in the Installation Guide)
③	WARNING		Turn OFF the primary power supply before performing any wiring. Failing to do so can result in electric shock.	Sections 1.8, 6.1, and 6.3 (Page 13 in the Installation Guide)
④	WARNING		Be sure to provide suitable grounding for the chamber. Failing to do so can result in electric shock.	Section 1.8, (Page 13 in the Installation Guide)
⑤	WARNING		Always lock the casters so the chamber cannot be easily moved. Failing to do so can result in injury.	Section 1.2 (Page 6 in the Installation Guide)
⑥	WARNING		Be careful of hot water when draining the humidifying water. Failing to do so can result in burns.	(Page 10 in the Installation Guide)
⑦	WARNING		Always fill the drainage tank with water up to the steam elimination level. Failing to do so can result in high temperature steam blowing out and causing burns.	(Page 17 in the Installation Guide)
	Risks and countermeasures during usage			For details, see
⑧	DANGER		Do not place explosive or flammable substances in the chamber. Doing so can result in explosion and fire.	Section 1.1
⑨	WARNING		Do not disassemble, modify, or repair this chamber. Doing so can result in fire, electric shock, and injury.	Section 1.8
⑩	WARNING		Do not insert a conductive specimen that may be dispersed into the chamber. Doing so can result in electric shock.	Section 1.1
⑪	DANGER		When supplying power to specimens, be sure to use the specimen power supply control terminals. Failing to do so can result in fire.	Section 4.4
⑫	WARNING		Perform a trip test on the leakage breaker and check that it is operating normally before starting chamber operation. Failing to do so can result in electric shock.	Sections 1.8 and 5.3
⑬	CAUTION		Note that during operation and immediately after operation the inside of the test area and parts of the exterior of the chamber will be extremely hot. There is a risk of being burned.	Sections 4.2 and 5.4
⑭	WARNING		Before starting chamber operation, correctly set the safety device for overheat protection and check that the chamber is operating normally. Failing to do so can result in fire.	Sections 1.4, 4.4, and 5.3
⑮	WARNING		Set the shelves correctly, and use the shelves within their allowable load capacities. Failing to do so can result in injury caused by the shelves falling down.	Section 4.1
⑯	WARNING		When operating the chamber remotely, first confirm the safety in the test area and around the chamber, and then operate the chamber correctly. Failing to do so can result in accidents caused by unexpected operations.	Section 1.7
⑰	CAUTION		When opening the door, confirm that the pressure inside the test area is 0 MPa. Failing to do so can result in injury and burns.	Sections 1.2, 1.3, and 6.1
⑱	CAUTION		Always turn OFF the power before removing the specimen power supply control terminal plug from the connector. Failing to do so can result in electric shock.	Section 4.4
⑲	CAUTION		Always turn OFF the power to the specimen when wiring the specimen signal terminals. Failing to do so can result in electric shock.	Section 4.2
	Risks and countermeasures during cleaning and maintenance			For details, see
⑳	WARNING		Use appropriate methods to periodically clean parts of the chamber, such as the electrical compartment, water circuit compartment, and inside of the pressure vessel. Failing to do so can result in burns, electric shock, and other injuries.	Sections 5.2, 5.4, and 6.1 Section 6.3
㉑	WARNING		Use appropriate methods to replace and inspect the fuses. Failing to do so can result in burns, electric shock, and other injuries.	Section 6.4
㉒	WARNING		For your safety, be sure to wear gloves when cleaning the inner cylinder and pressure vessel. Failing to do so can result in injury.	Section 5.4
㉓	WARNING		Turn OFF the chamber's breaker when working on the chamber. Failing to do so can result in electric shock.	Section 5.4
	Risks and countermeasures during chamber disposal			For details, see
㉔	WARNING		Have two or more people work together to remove the door before disposing of the chamber. Failing to do so can result in injury.	Section 1.6

Map of remaining risks and positions on the product where safety labels are affixed

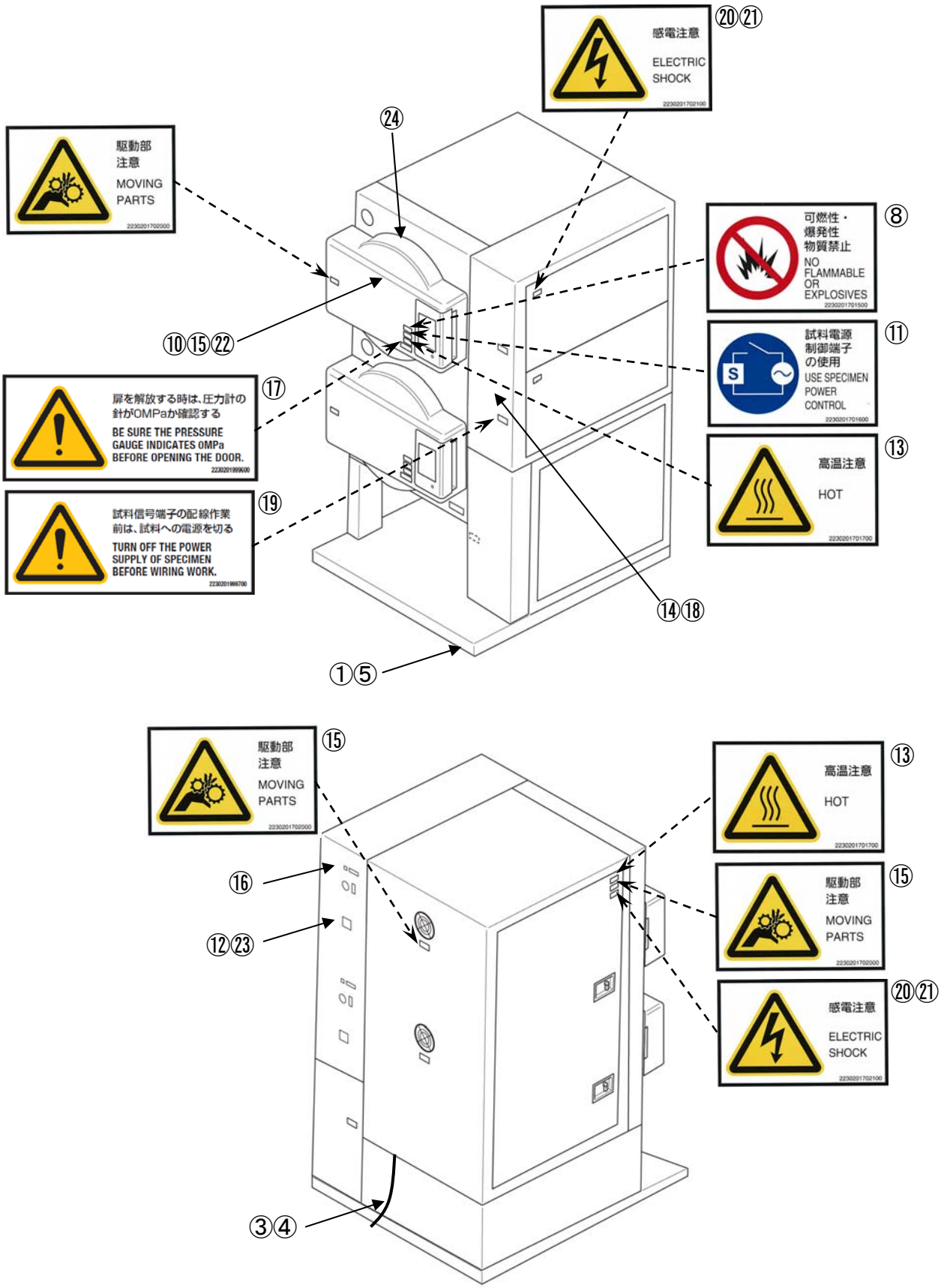
The numbers in the following figures are the item numbers written in the "List of remaining risks".

Single test area model



Remaining risks and positions on the product where safety labels are affixed (1)

Double test area model



Remaining risks and positions on the product where safety labels are affixed (2)

Purchasing new product safety labels

If a product safety label becomes damaged, lost, or the warning display is no longer legible, contact your distributor or ESPEC. A replacement product safety label will be shipped for a fee.

Manuals

The manuals are organized as follows. Refer to the appropriate manual according to the information required.

Installation guide (booklet)	Describes how to carry in, move, and install the chamber. Provided with the chamber. (Also provided on the CD.)
CD operation manual	Contains the following contents.

CD operation manual content

Name		Description
Operation manual	Installation guide	Describes how to carry in, move, and install the chamber.
	Basic guide	Describes the basic operations of the chamber. * For operations of options, read the contents of the appropriate option manual.
	Controller guide	Describes the operations of the controller. * For operations of options, read the contents of the appropriate option manual.
	Network guide	• Web Application Describes how to use a web browser to monitor the chamber operation, configure settings, record data, and send email alerts. • Communication function (Ethernet)
	Options	Describes how to operate the optional equipment and functions.
	Circuit diagram	Electric circuit diagrams and parts lists of the product and options

Understanding the chamber model code

The model name of the chamber is constructed as shown below. See the rating plate (on the front) for the model of the chamber being used.
This manual describes multiple chamber models. Read the sections that are applicable to the chamber that you are using.

EHS - □□ 2 □

- Blank : Single test area model, unsaturated/wet-saturated control
- M : Single test area model, unsaturated/wet-saturated/dry and wet-bulb temperature control
- MD : Double test area model, unsaturated/wet-saturated/dry and wet-bulb temperature control

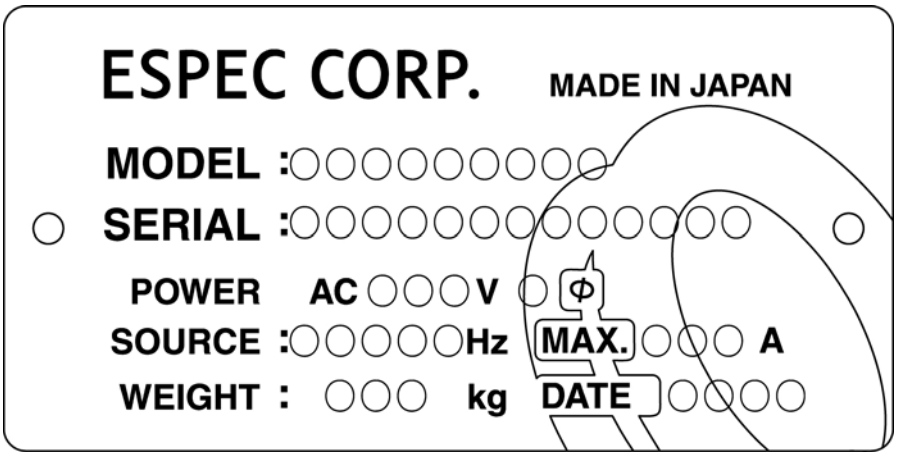
Size/inside capacity 1: 21 L, 2: 51 L

Maximum pressure 2: 0.196 MPa, 4: 0.392 MPa

Serial number

See the rating plate (on the front) for the serial number of the chamber being used.

The model and serial number will be required when making inquiries about the chamber.

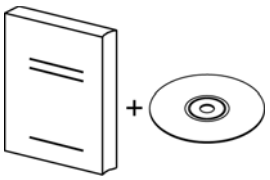


Accessories and spare parts

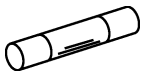
① Shelf

② Specimen signal terminal

③ Operation manual

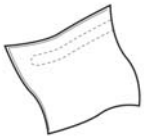


⑤ Cartridge fuse



⑤ Breaker handle stopper

⑥ Wet-bulb wick



⑦ Drain hose nipple

⑧ Eyebolt

No.	Name	Use	Quantity	Check
①	Shelf	Used to hold specimens in the test area.	2 (Double test area model: 4)	
②	Specimen signal terminal	Plugged into connectors inside the test area to wire specimens. (125 V AC/DC, 1 A)	12 (Double test area model: 24)	
③	Operation manual	Documentation necessary for proper chamber use. (Installation guide, CD)	1 set	
④	Cartridge fuse	Protects electric circuits. (250 V) 3 A x 3, 3 A midget x 2, 5 A midget x 1, 10 A x 1 (Double test area model has twice as many fuses)	7 (Double test area model: 14)	
⑤	Breaker handle stopper	Attached to the breaker when the breaker is OFF. Protects against erroneous operation.	1 (Double test area model: 2)	
⑥	Wet-bulb wick	Wet-bulb wick 1 package (50 wicks) (M type and MD type only)	1 package (Double test area model: 2 packages)	
⑦	Drain hose nipple	Attach the drain hose nipple to the overflow drain port and connect a hose for continuous drainage.	1	
⑧	Eyebolt	Used when loading and unloading the chamber from the pallet, and when installing and moving the chamber. (Double test area model only)	4	

Chapter 1 Safety precautions

Read this section before using the equipment.

This chapter describes important precautions that must be followed to ensure safe use of the chamber. Be sure to read this chapter and follow the instructions to prevent the occurrence of accidents involving the user, the chamber, and specimens.
Read this chapter before using the chamber.

1.1 Materials prohibited inside the test area

DANGER

Never place the following explosive or combustible materials, or materials containing them, inside the test area. Also, do not store these materials near the chamber.

Doing so can result in explosion or fire.

Explosive materials

Explosive items

- Nitroglycol, nitroglycerin, nitrocellulose, and other explosive nitric esters
- Trinitrobenzene, trinitrotoluene, picric acid, and other explosive nitro compounds
- Peracetic acid, methyl ethyl ketone peroxide, benzoyl peroxide, and other organic peroxides

Combustible materials

Ignitable items

Lithium metal, potassium metal, sodium metal, yellow phosphorus, phosphorus sulfide, red phosphorus, celluloids, calcium carbide ("carbide"), lime phosphide, magnesium powder, aluminum powder, other metallic powder, and sodium dithionite ("hydrosulfite")

Oxidizing items

- Potassium chlorate, sodium chlorate, ammonium chlorate, and other chlorates
- Potassium perchlorate, sodium perchlorate, ammonium perchlorate, and other perchlorates
- Potassium peroxide, sodium peroxide, barium peroxide, and other peroxides
- Potassium nitrate, sodium nitrate, ammonium nitrate, and other nitrates
- Sodium chlorite and other chlorites
- Calcium hypochlorite and other hypochlorites

Flammable items

- Ethyl ether, gasoline, acetaldehyde, propylene oxide, carbon disulfide, and other substances with an ignition point less than -30°C
- N-hexane, ethylene oxide, acetone, benzene, methyl ethyl ketone, or other substances with an ignition point between -30°C and 0°C
- Methanol, ethanol, xylene, pentyl acetate ("amyl acetate"), and other substances with an ignition point between 0°C and 30°C
- Kerosene, gas oil, oil of turpentine, isopentyl alcohol ("isoamyl alcohol"), acetic acid, and other substances with an ignition point between 30°C and 65°C

Continued on the next page

DANGER

Continued from the previous page

Combustible gases

Hydrogen, acetylene, ethylene, methane, ethane, propane, butane, or other flammable substances in a gas state at 15°C and 1 atmosphere

[Extracted from the attached table of Article 6 of the Order for Enforcement of Industrial Safety and Health Act]

WARNING

Do not insert a conductive specimen that may be dispersed into the chamber.

Doing so can result in electric shock.

Notice

- **When place specimens inside the test area, be careful so that the specimen is not dispersed.**

  Place small, lightweight specimens into a container such as a mesh container with a lid. Specimens wrapped in aluminum foil, for example, will receive blown air over a wider area, making dispersion more likely to occur. Should the specimen, such as aluminum foil, be dispersed, turn OFF the breaker of the chamber and then turn OFF the primary power supply. Next, contact your distributor or ESPEC. Failing to do so can result in electric shock.

- **Do not place corrosive substances inside the test area.**

  Corrosive substances generated by a specimen can cause corrosion of stainless steel and copper and deterioration of plastic and silicone, thereby greatly reducing the operating life of the chamber.
  Corrosive substances include chlorine, chloride, and acids. This also includes substances that become corrosive at high temperature or humidity, even when not corrosive at room temperature.

1.2 Precautions when opening and closing doors

CAUTION

When opening the door, confirm that the pressure inside the test area is 0 MPa.

If the pressure is high, turn the manual drain valve to DRAIN to decrease the pressure inside the test area to 0 MPa. There is a risk of injury and burns because steam will be blown out of the chamber if the door is opened when the pressure is high.

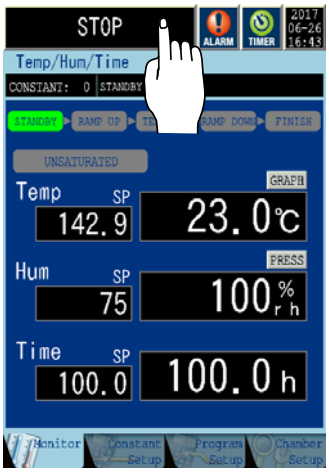
Install the chamber securely.

Opening and closing the door can cause the chamber to move, creating a dangerous situation.

Opening doors

<Procedure>

1) Turn the circuit breaker ON. (On the back side of the chamber)
2) Press and hold the instrumentation power switch for one second.
   * Pressing and holding buttons is a mechanism to prevent mistaken operation.
3) Press the operation mode button at the top of the operation screen.



4) Press the DOOR LOCK button.
   The door is unlocked when the lamp on the button turns off.

5) Confirm that the door is unlocked, and then open the door.

Closing doors

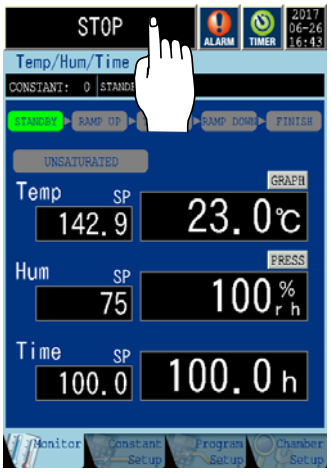
<Procedure>

1) Confirm that the circuit breaker has been turned on.
(Rear of chamber)

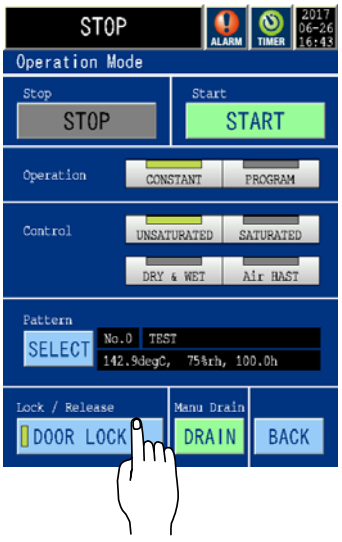
2) Confirm that the instrumentation power switch has been turned on and that the screen is displayed.

3) Close the door. (Push the door into the chamber.)

4) Press the operation mode button at the top of the operation screen.



5) Press the DOOR LOCK button.
The door is locked when the lamp on the button turns on.



1.3 How to open doors in an emergency

CAUTION

When opening the door, confirm that the pressure inside the test area is 0 MPa.

If the pressure is high, turn the manual drain valve to DRAIN to decrease the pressure inside the test area to 0 MPa. There is a risk of injury and burns because steam will be blown out of the chamber if the door is opened when the pressure is high.
After all works, return manual exhaust valve to "close".

Before open the door, confirm the temperature of test vessel is around ambient temperature.

Right after operation, door mechanical part is very hot.

<Procedure>

1) Turn off the breaker.
2) Confirm that the pressure inside the test area is 0 MPa on the pressure gauge.
3) Remove the bolts on the door handle section and open the door cover.

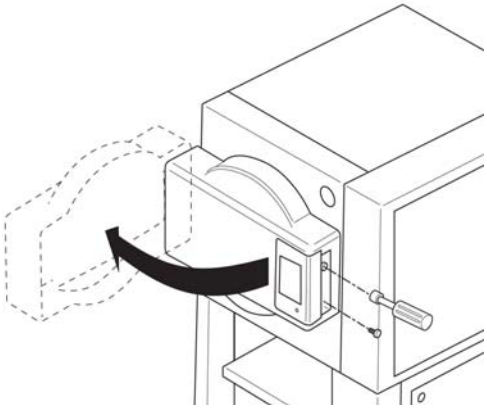


Fig. 1.1 Opening the door cover

4) There is a flywheel on the hinge side of the door lock motor.
   Turn the flywheel by hand in the direction of the arrow to unlock the door, and then open the door.

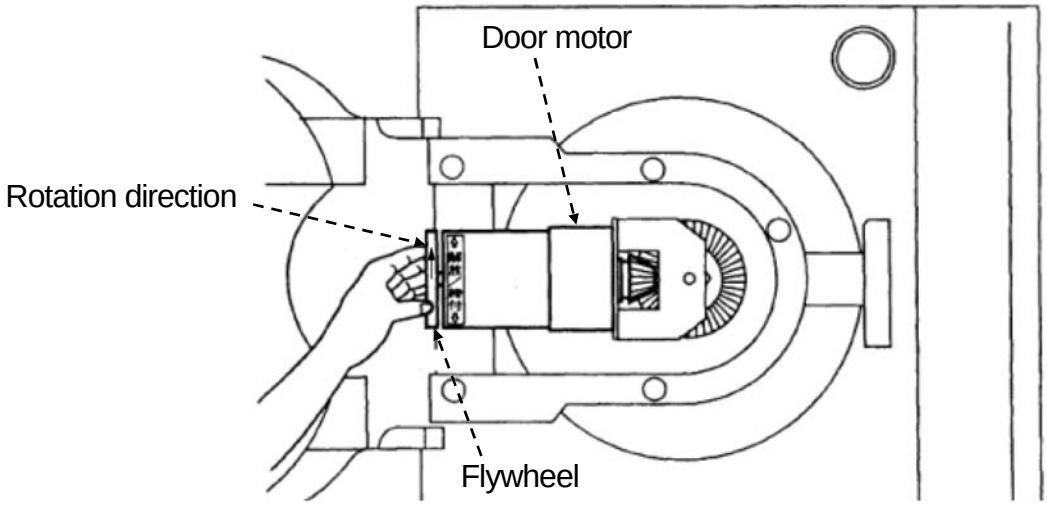


Fig. 1.2 Opening the door

1.4 Safety devices for specimen protection

WARNING

Before starting chamber operation, correctly set the safety device for overheat protection and check that the chamber is operating normally.

If the safety device is not set properly, the specimens may be damaged and, in the worst case, fire may occur if a malfunction occurs.

Although this chamber is operated at the temperature and humidity set on the temperature and humidity controller, certain conditions may make proper temperature and humidity control impossible. To prevent damage to specimens due to the effects of the temperature and humidity in such cases, the chamber is equipped with an overheat protector and a temperature and humidity controller as protection functions.

Table 1.1 List of safety devices and functions

Safety devices and functions		Setting (Value that meets the following conditions)	Safety action	Re marks
Overheat protector		• Set to temperature setting inside test area + 20°C • At or below the specimen's heat-resistance temperature	• Alarm display • Buzzer sound • All heaters stop • Specimen power supply control terminal shuts off	-
Built-in to the temperature and humidity controller	Absolute high limit	• EHS-212 (M, MD), EHS-222 (M, MD): 160°C • EHS-412 (M, MD): 180°C		

Example of safety function settings

■ Temperature upper limit

The following describes an example when the set temperature inside the test area is 60°C and the heat resistance temperature of the specimen is 80°C.
Safety devices and safety functions are set as shown below.

Table 1.2 Overheat protector and upper temperature limit alarm function

Overheat protector		+130°C	• Set to temperature setting inside test area + 20°C • Specimen heat-resistance temperature
Temperature & humidity controller	Absolute high limit	• EHS-212 (M, MD), EHS-222 (M, MD): 160°C • EHS-412 (M, MD): 180°C	• Fixed value

When the temperature inside the test area increases abnormally in this state, the temperature is detected in the order of the overheat protector, temperature alarm, and absolute high limit as shown in the figure, and protective action will be taken. The chamber is equipped with multiple safety devices and functions, so if one should malfunction, the other devices and functions detect abnormal temperature increase and take protective action.

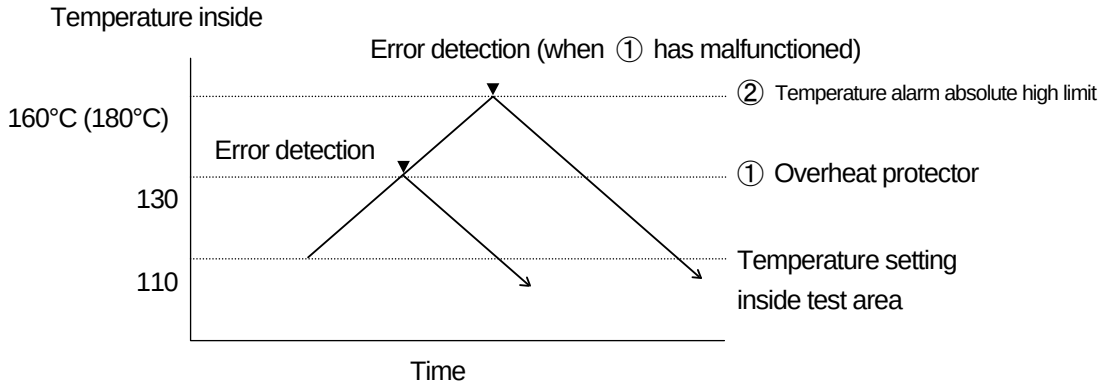


Fig. 1.3 Operation when the temperature inside the test area increases

1.5 Breaker handle stopper

Install the breaker handle stopper as shown in the figure when the breaker is OFF so the power supply is not accidentally turned ON due to erroneous operation of the breaker.
Do not lose the breaker handle stopper when it has been removed.

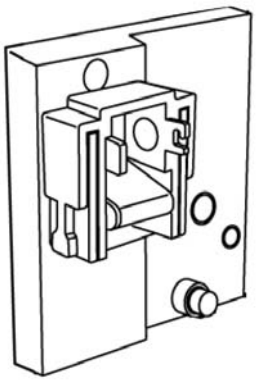


Fig. 1.4 200/220 V

1.6 Disposing of this product

When disposing of this product, treat it as industrial waste.
For safety reasons, remove the doors before the product is disposed of.
To promote resource recycling, ESPEC received certification in a wide area certification system from Japan's Ministry of the Environment on July 3, 2007.
If you no longer need this product, ESPEC can pick up the product and recycle it for a fee.
Contact your distributor or ESPEC when disposing of this product.

Notice

The following items are considered hazardous substances and must be disposed of separately. (Depending on the product, some items may not have been used in the construction of the product.)

- **Electronic components**
  Dispose of these items in accordance with local and national disposal regulations.

Removing doors

WARNING

Before disposing of this product, remove the doors.

During transportation, doors may fling open, resulting in injury.

At least two people should work together when removing the doors, and the doors should be supported by a hand lift.

The door falling or tipping over can result in injury.
The door weight is shown below.
EHS-212 (M, MD): 28.7 kg, EHS-222 (M, MD): 36.2 kg

Prepare pliers, a slotted screwdriver, and an M12 wrench.

<Procedure>

1) Using pliers, disconnect the electrical wires connecting the chamber and door.

2) Remove the bolts on the door handle section and open the door cover.

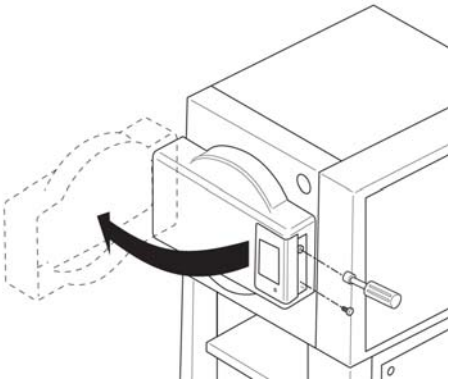


Fig. 1.5 Removing the bolts on the door handle section

3) There is a flywheel on the hinge side of the door lock motor. Turn the flywheel by hand in the direction of the arrow to unlock the door.

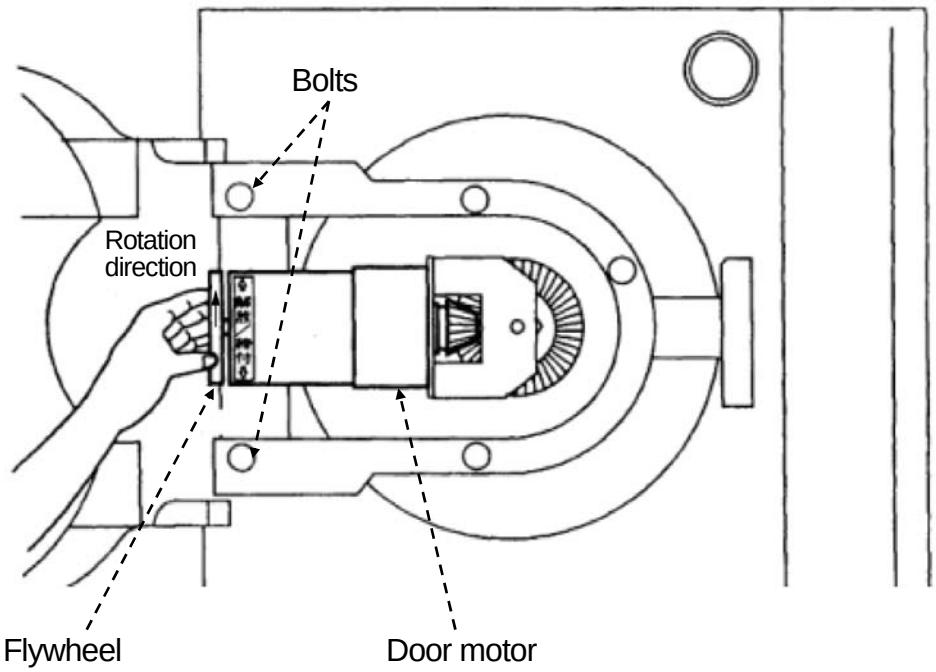


Fig. 1.6 Unlocking the door lock

4) Remove the two bolts at the top and bottom of the door mounting bracket, and then remove the door.

Notice
When disposing of the doors, do so in accordance with local regulations based on the Waste Disposal Act (Waste Management and Public Cleansing Act). This product does not contain asbestos.

1.7 Remote operation

Observe the following precautions when using the chamber.

Remote operation

WARNING

Do not perform operations from a remote point when working inside the test area, around the chamber, or loading and unloading specimens.

When supplying power to the specimen by using the specimen power supply terminal, there is a risk of electric shock by suddenly supplying power to the specimen when operation starts.
When service personnel are performing maintenance, there is a risk of injury from touching rotating bodies and a risk of electric shock. ESPEC CORP. accepts no responsibility for damage or injury in these situations.

For safety, ensure that the chamber clearly displays it is being operated from a remote location, and also properly notify all workers.

Indicate on the chamber in some manner that it is being operated from a remote location.

When working inside the test area or around the chamber, be sure not to perform remote operation over a LAN or other network. In particular, if there is a possibility of operation, take measures, such as by enabling remote operation protection.

Sudden operation of the chamber creates the risk of injury.

When operating the chamber from a remote point, fully ensure safety inside the test area and around the chamber.

1.8 Other precautions

Observe the following precautions when using the chamber.

WARNING

Do not install or use this product outdoors.

Doing so will adversely affect the performance and functionality, and if the electrical components become wet, they will short-circuit, creating the risk of fire, electric shock, or malfunction.

Do not disassemble, modify, or repair this chamber.

This can result in abnormal operation, fire, electric shock, injury, and malfunction. Contact your distributor or ESPEC for repair.

Be sure to ground this chamber.

If this chamber is not grounded, the leakage breaker will not activate even if leakage occurs, which creates the risk of electric shock. See the Installation Guide for details about how to ground this product.

Test the breaker and confirm normal operation before starting chamber operation.

If the breaker does not operate normally, turn OFF the primary power supply, and contact your distributor or ESPEC.
Continued use of the chamber can result in electric shock. For the test method, see ☞ "5.3 Inspection".

CAUTION

When opening the door after the end of operation and removing specimens, do not touch high-temperature parts with your bare skin.

After operation at 55°C and higher, the temperature inside the test area (the specimen, the shelf, the inside of the door, and the inner cylinder) will be extremely high. Touching these parts with your bare skin may lead to burns, so use heat-resistant gloves.

Notice

- Be careful of condensation water when opening the door immediately after the end of operation.
  Water may drip onto the floor.
  Also be careful of condensation water when placing specimens containing moisture inside the test area.
- **Chamber/system protection**
  Do not repeatedly turn the circuit breaker on and immediately turn it off.

1.9 Chamber materials

Table 1.3 Chamber materials

Material name (some items use generic terms)		Operating weight	Main area of application
Metals			
Stainless steel	SUS316L	46.8 kg	Pressure vessel, door hatch, inner cylinder
	SUS304	11.4 kg	Drainage tank, fan components
	SUS316	0.8 kg	Fan guard
Iron		137.7 kg	Chamber exterior, door lock components
Copper		0.8 kg	Pipes
Brass		3.2 kg	Pipe joints
Aluminum		0.4 kg	Electrical parts chassis
Chemical products (for resin molded parts, the material is displayed on the actual part.)			
Plastics		3.6 kg	Door cover, water tank
Rubber		0.4 kg	Packing
Glass wool		0.7 kg	Insulation
Other			
Electrical parts, electric components, heaters, wires, etc.		24.2 kg	Electrical parts chassis

(For the EHS-222)

Chapter 2 Overview

This chapter provides an overview of the chamber and instrumentation, and describes how to control the temperature (and humidity).

2.1 Main features

Electric and electronic components are manufactured in environments that are strictly controlled to the highest degree. However, moisture absorption in repeated storage and transport after production and rapid vaporization that occurs as a result of temperature shock in the mounting process cause the destruction of components. Additionally, moisture absorption and drying in the markets of products containing those components causes the internal accumulation of moisture, which accelerates the degradation of components. Various types of humidity resistance testing are used as methods to make early assessments and post analysis of the effects of this kind of moisture on components. At present, the Highly Accelerated Stress Test System (HAST) is positioned as a method to generate this highest level of moisture absorption in the shortest testing time.

The HAST chamber can be used to perform the following tests:

- Humidity resistance testing (high humidity)
- Life testing
- Degradation severity testing

2.2 Temperature and humidity control method and the instrumentation

2.2.1 Temperature and humidity control system

The HAST chamber heats water inside a sealed pressure vessel with a humidifying water heater and maintains the inside of the vessel at high pressure with water vapor. This water vapor is reheated by the test area heater and circulated into the inner cylinder by the fan.

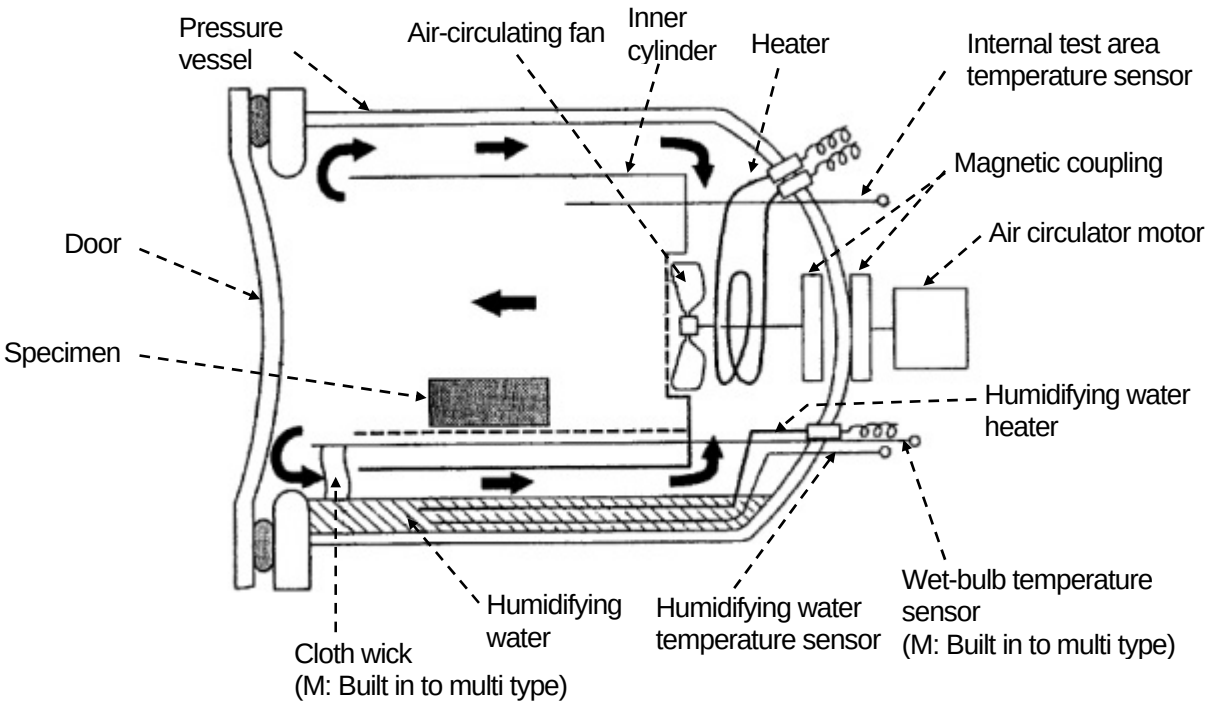


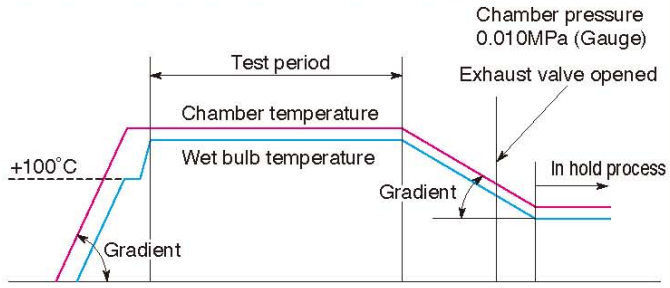
Fig. 2.1 HAST system configuration

2.2.2 Operation methods

Two operation methods (three for the M type) can be selected on the HAST chamber depending on the application.

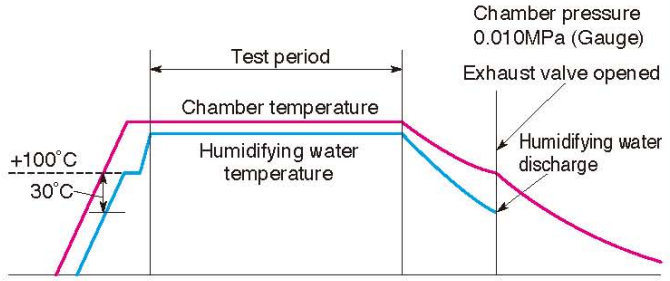
Table 2.1 Temperature and humidity control methods

Wet and dry bulb temperature control (M/MD type)



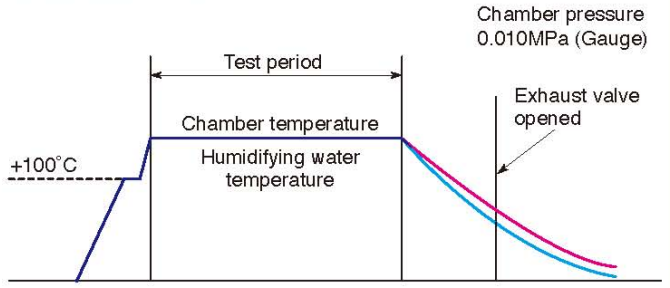
- The temperature and humidity gradient before and after testing can be controlled.
- After testing is complete and chamber pressure reaches 0.010MPa (Gauge), only air is discharged; humidifying water is retained.
- In the hold process, temperature and humidity inside the chamber are maintained at the specified level. (+50 to +95˚C/75 to 95%rh)

Unsaturated control (humidifying water temperature control)



- During temperatureheat - up when condensation can easily occur on the specimen, the temperature of the humidifying water automatically increases while keeping it 30˚C lower than the chamber temperature.
- After testing is complete, the chamber is left to cool and depressurize naturally until chamber pressure reaches 0.010MPa (Gauge). Then both air and water are discharged.

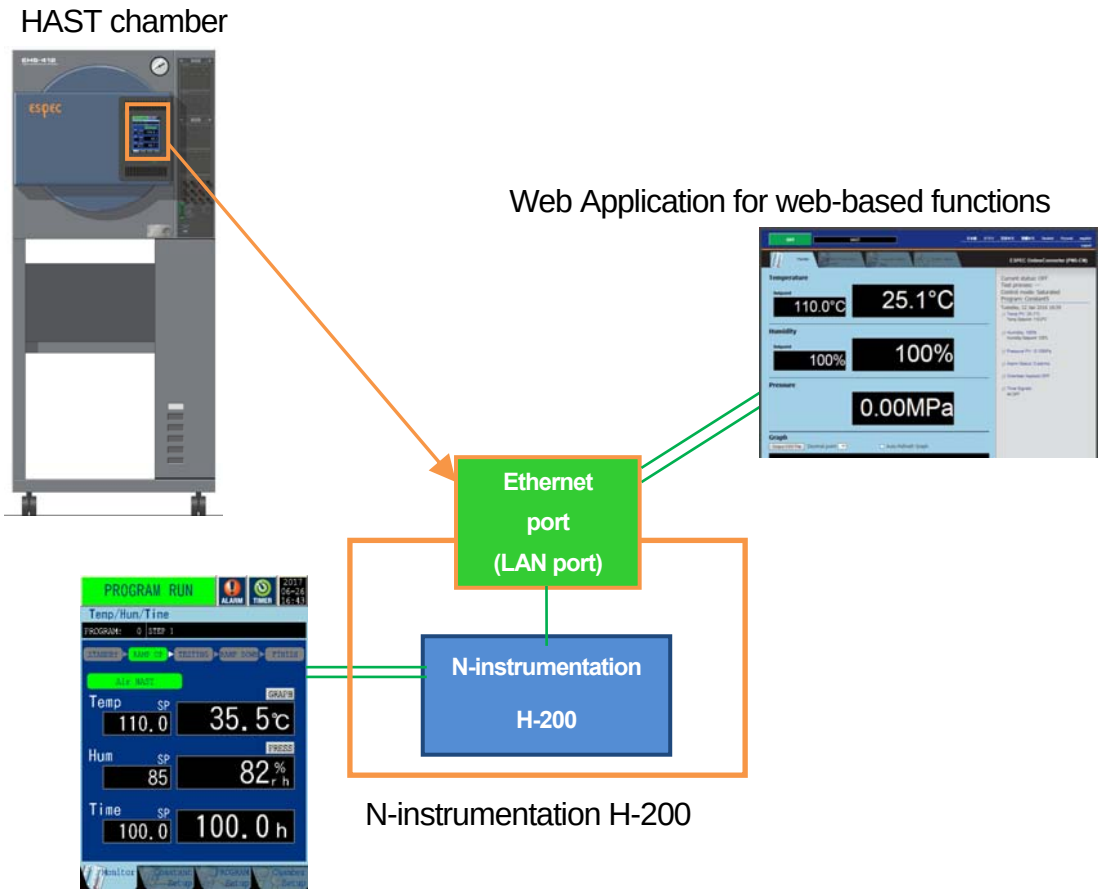
Wet saturated control



- Chamber temperature is controlled through a humidifying heater. (chamber temperature = humidifying water temperature)
- After testing is complete, the chamber is left to cool and depressurize naturally until chamber pressure reaches 0.010MPa (Gauge). Then only air is discharged; humidifying water is retained.

2.2.3 N-instrumentation

N-instrumentation (H-200), which is built into the HAST chamber, is a network device with constant operation, program operation, and web-based functions.



■ Constant operation

Constant operation is a method for setting the temperature, humidity, or other settings to constant values and maintaining the temperature (humidity) inside the test area. This is called constant operation because the chamber operates with the settings at constant values.

Constant operation in the HAST chamber is controlled in order of the ramp up, test, ramp down, and save (M type only) processes.

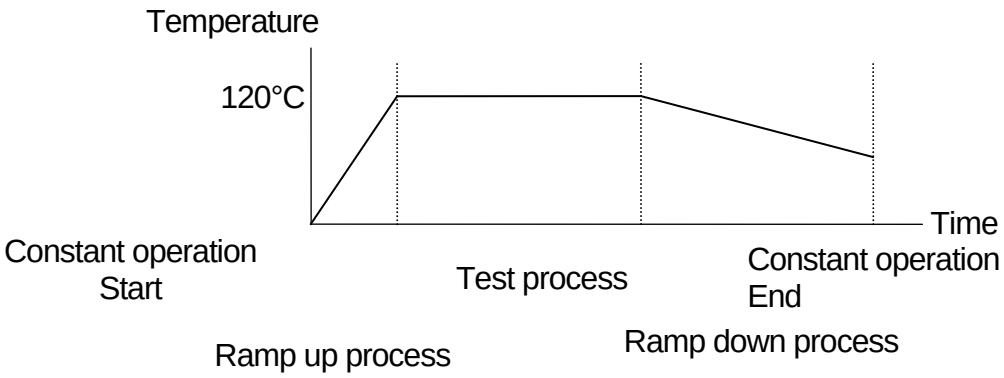


Fig. 2.2 Constant operation

■ Program operation

Program operation is a method for changing the temperature, humidity, and other settings inside the test area according to a program created in advance.
There are several steps within the program. Each step is made up of temperature, humidity, and other settings, similar to the settings of constant operation. During each step, you can either maintain the setting or change it at a specific speed.

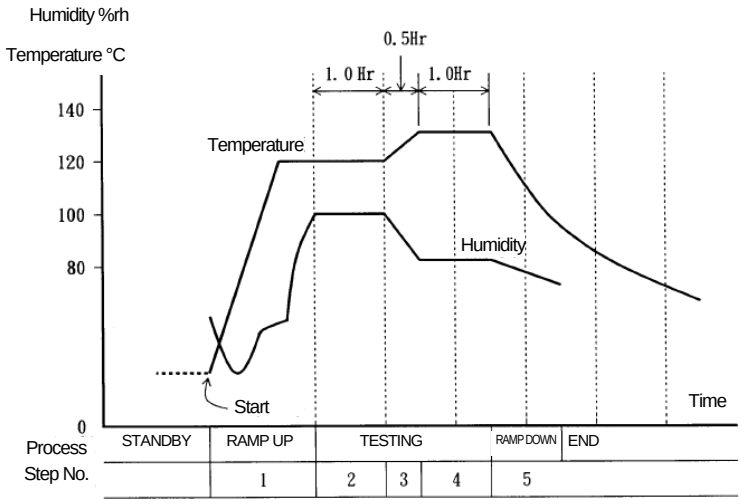


Fig. 2.3 Program operation

■ Web-based functions

The web-based functions let you monitor operation and configure settings from a remote computer or mobile terminal connected over Ethernet. The operations below can be performed using the Web Application.

(1) Chamber operation monitoring and data logging

(2) Constant setup

(3) Program setup

(4) Run/stop

(5) E-mail notification

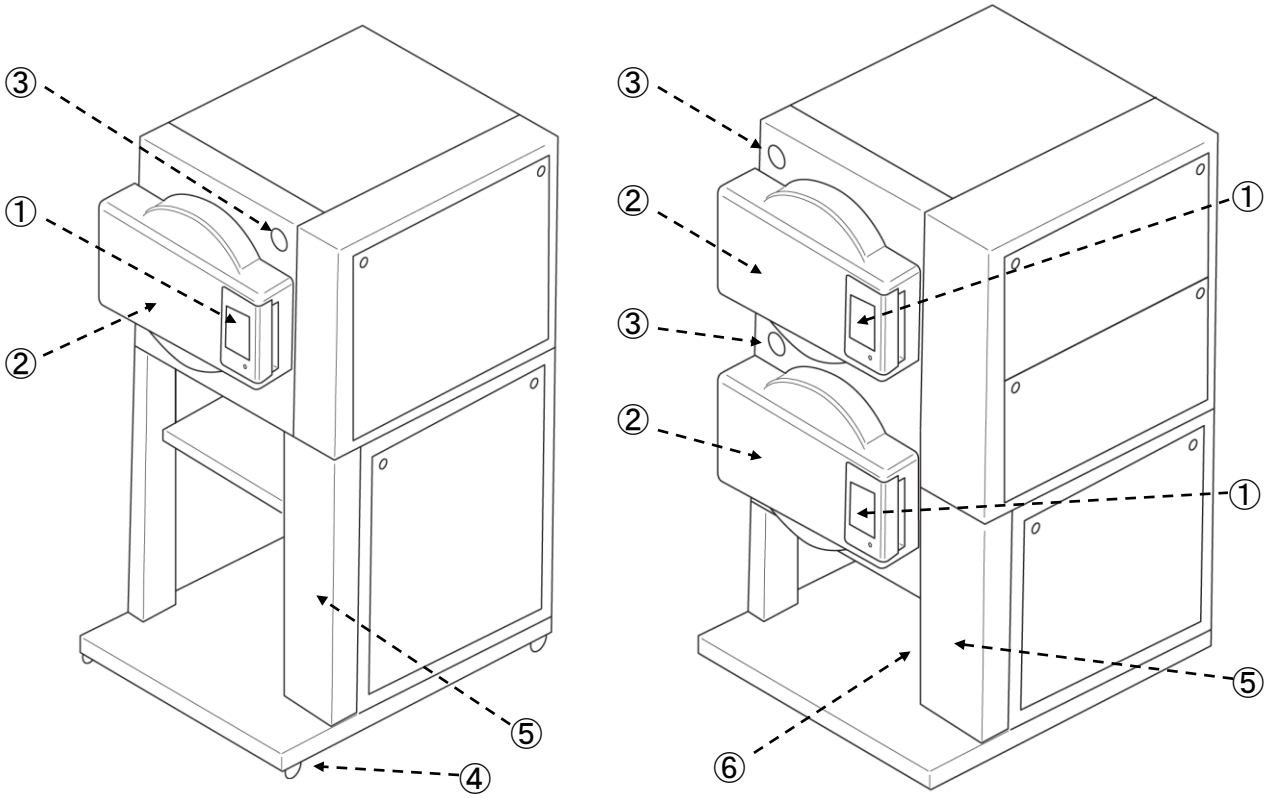
☞ For procedures and detailed information, see "Web Application" in the Network Guide.

Chapter 3 Part names and functions

This chapter describes the part names of the chamber and their functions. Confirm the part names and locations.

3.1 Chamber

■ **Front and right side**



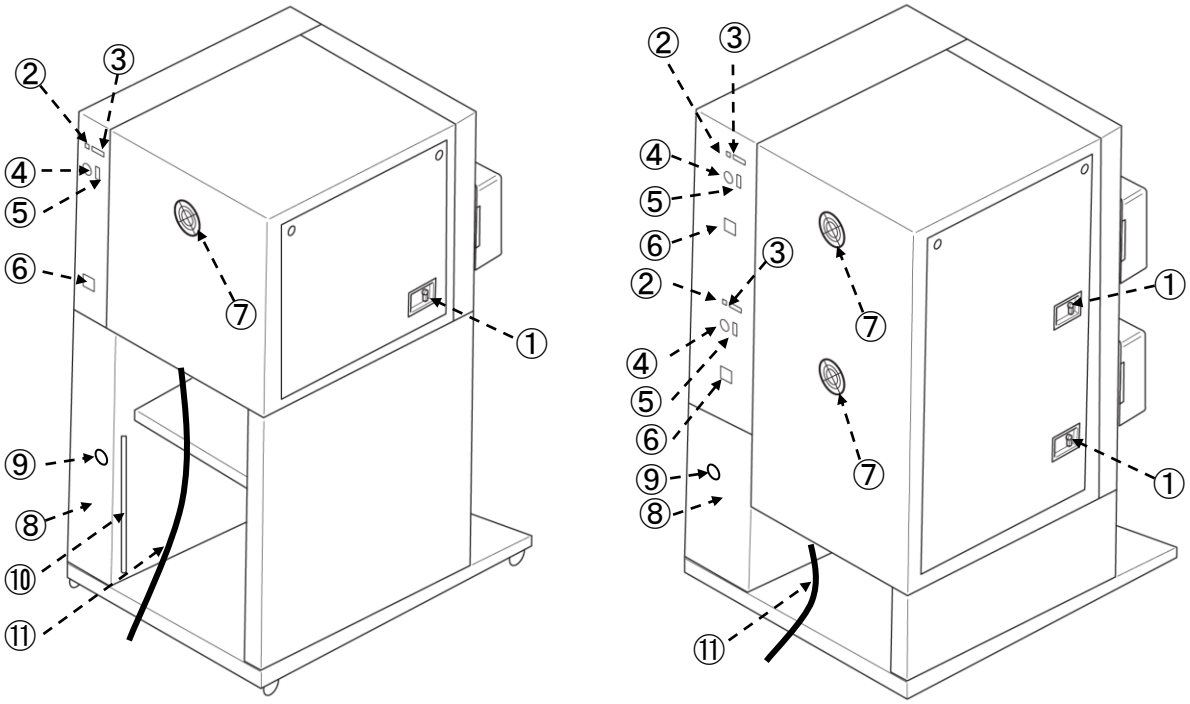
Single test area model Double test area model

Fig. 3.1 Part names and functions (front and side)

Table 3.1 Part names and functions (front and side)

	Name	Function and purpose
①	Operation panel	Used to configure and display test conditions (temperature, humidity, and time) and to lock and unlock the door.
②	Door	Opened and closed when placing specimens inside the test area or removing specimens.
③	Pressure gauge	Indicates the pressure inside the test area. The pressure is indicated as gauge pressure. Absolute pressure is the value of 0.1 MPa added to the indicated value.
④	Caster with stopper (Single test area model only)	Used to move and lock the chamber.
⑤	Water tank	Holds pure water for humidifying.
⑥	Drain hose (Double test area model only)	Combines the water level gauge for the drainage tank and the drain hose.

■ **Rear and left side**



Single test area model Double test area model

Fig. 3.2 Part names and functions (rear and side)

Table 3.2 Part names and functions (rear and side)

	Name	Function and purpose
①	Manual drain valve	Drains humidifying water when cleaning inside the test area.
②	Ethernet port (LAN port)	LAN cable connection port. Used as the interface for web-based functions and the communications function when performing chamber tasks such as control monitoring, data management, and operations from a remote computer.
③	Connector for communications function (Optional)	Used when performing RS-485 or RS-232C communications with an external device.
④	Recorder power outlet (Optional)	Used as the power connector for the optional recorder.
⑤	Recorder output terminals (Optional)	Connectors for the signals for temperature, humidity, and pressure inside the test area.
⑥	Breaker	Cuts off the power supply. Cuts off the power supply when overcurrent occurs.
⑦	Chamber internal cooling fan	Circulates air inside the control panel to prevent overheating.
⑧	Drainage tank	Used to cool and temporarily hold steam and used humidifying water drained from the inside of the test area after the test has ended.
⑨	Overflow drain port	When drainage facilities are available, use the included hose nipple and connect a hose.
⑩	Drain hose (Single test area model only)	Combines the water level gauge for the drainage tank and the drain hose.
⑪	Power cable	Connect to the primary power supply.

■ Specimen signal terminals, front panel

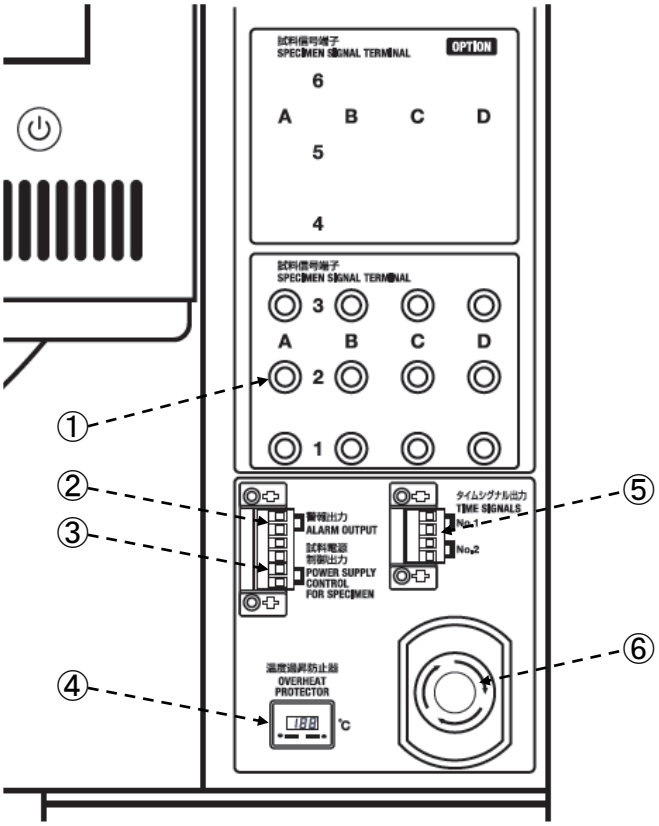


Fig. 3.3 Part names and functions

Table 3.3 Part names and functions

	Name	Function and purpose
①	Specimen signal terminals (outside) (MAX 125 V AC/DC, 1 A)	These terminals are connected to the specimen signal terminals (inside), and they can be used to apply voltage or send signals to the specimens inside the test area.
②	External alarm terminal (MAX 125 V AC, 1 A)	This terminal is used to output a signal (relay contact output) by closing a contact when a problem occurs.
③	Specimen power supply control terminals (MAX 125 V AC, 1 A)	Terminals that are used to supply power to the specimen. When a problem occurs, the contact is opened and power to the specimen is interrupted.
④	Overheat protector	Stops operation to prevent the allowable upper limit temperature of the specimen from being exceeded.
⑤	Time signal terminals (MAX 125 V AC, 1 A) (Optional)	These terminals output signals (relay contact output) when linked to external devices.
⑥	Emergency stop switch (Optional)	Used to manually stop the chamber when an emergency occurs.

■ **Inside test area**

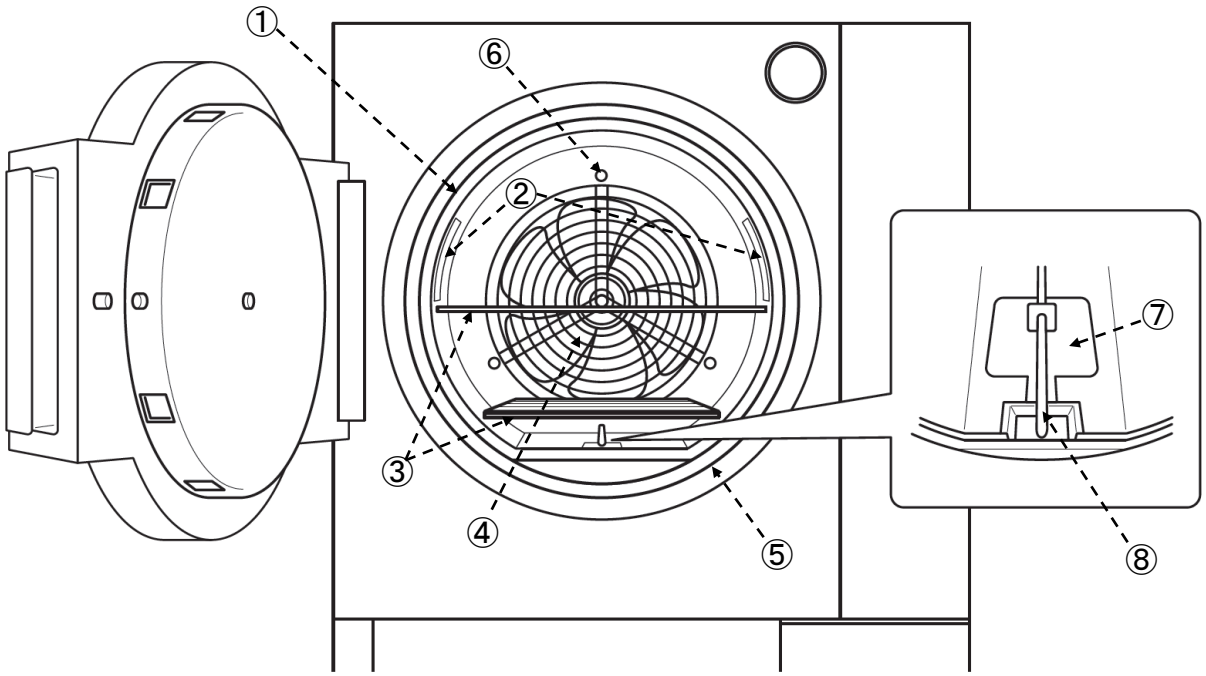


Fig. 3.4 Part names and functions

Table 3.4 Part names and functions

	Name	Function and purpose
①	Inner cylinder	The inside of the test area where specimens are placed. This prevents water that has condensed on the ceiling of the interior of the pressure vessel from falling on the specimens.
②	Specimen signal terminals (inside)	These terminals are connected to the specimen signal terminals (outside), and they can be used to apply voltage or send signals to the specimens inside the pressure vessel.
③	Specimen racks	Two levels of shelves that can hold specimens up to 3 kg.
④	Fan	Circulates the air inside the pressure vessel to maintain an atmosphere with a constant temperature and humidity.
⑤	Door packing	Used to maintain the airtightness of the pressure vessel.
⑥	Internal test area temperature sensor	Detects the temperature inside the test area.
⑦	Drain filter cover	Remove when cleaning the drain filter.
⑧	Wet-bulb temperature sensor (Built into M type and MD type only)	Used when performing dry and wet-bulb temperature control. Always confirm that the cloth wick is attached to the wet-bulb temperature sensor.

3.2 Operation panel

■ Operation panel

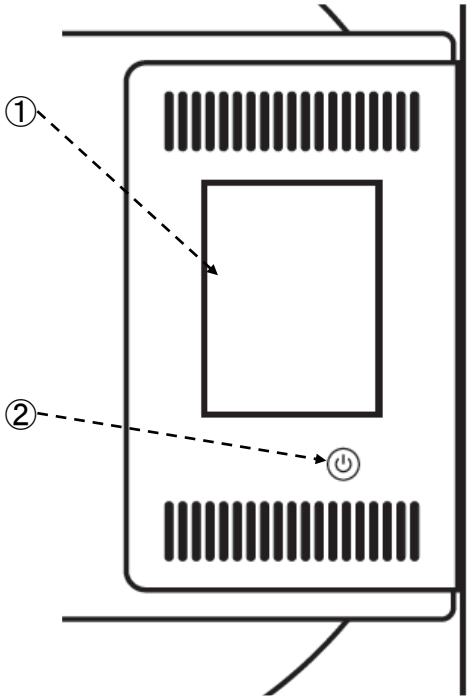
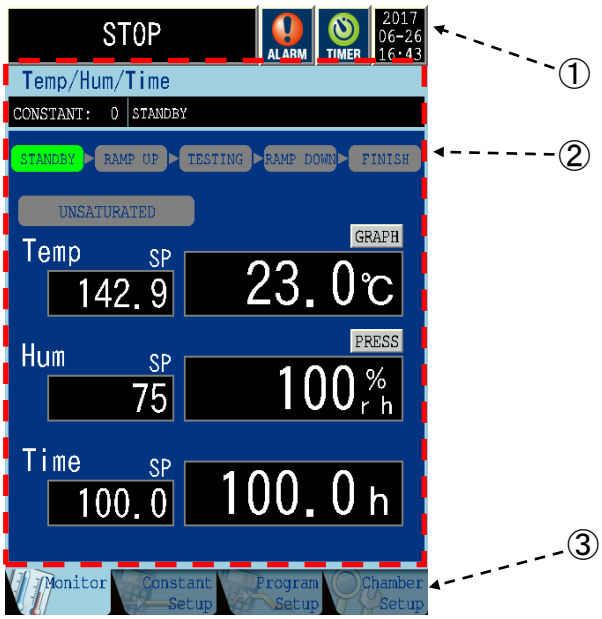


Fig. 3.5 Part names and functions (operation panel)

Table 3.5 Part names and functions (operation panel)

	Name	Function and purpose
①	Instrumentation	Used to control the controller to perform operations such as setting the temperature (humidity) and starting and stopping operation. See the next section for details.
②	Instrumentation power switch	Turns the instrumentation ON/OFF.

■ Instrumentation



	Name	Function and purpose
①	Common operations area	Displays and is used to set the operation state (operation mode), alarm, timer settings, and date/time.
②	Display screen	Displays and sets the main menu screens.
③	Tabs	Displays tabs for switching menus.

■ Common operations area

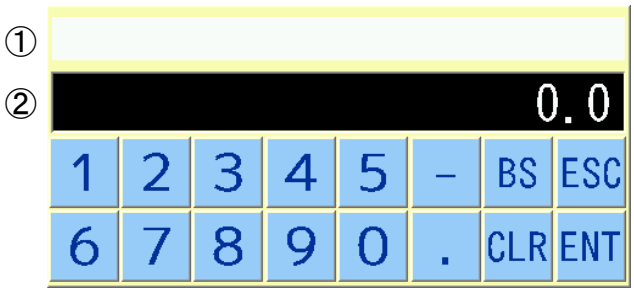
Displays the operation state and the Operation Mode screen

Displays the alarm occurrence status and the alarm occurrence screen

Displays the screen for configuring, setting, and canceling timers

Date and time display
Touch the screen to display the date/screen setup screen.

■ Numeric keypad operations



①: Displays a message about the content to enter.
②: Displays the value being entered.
BS: Deletes the initial value.
CLR: Clears the entered value.
ESC: Discards the entered value and closes the window.
ENT: Applies the entered value and closes the window.
The buzzer will sound if the entered value exceeds the input range.
(The window will not close in this case.)

3.3 Electrical compartment

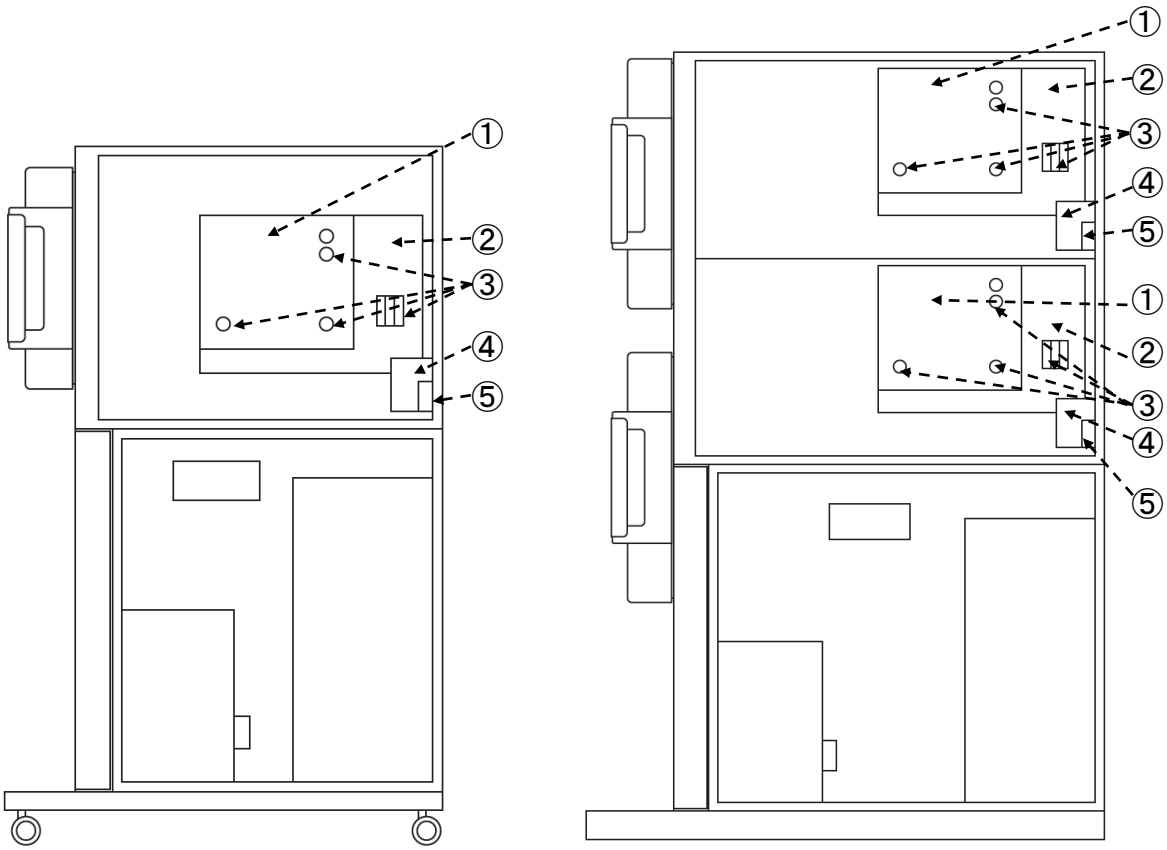
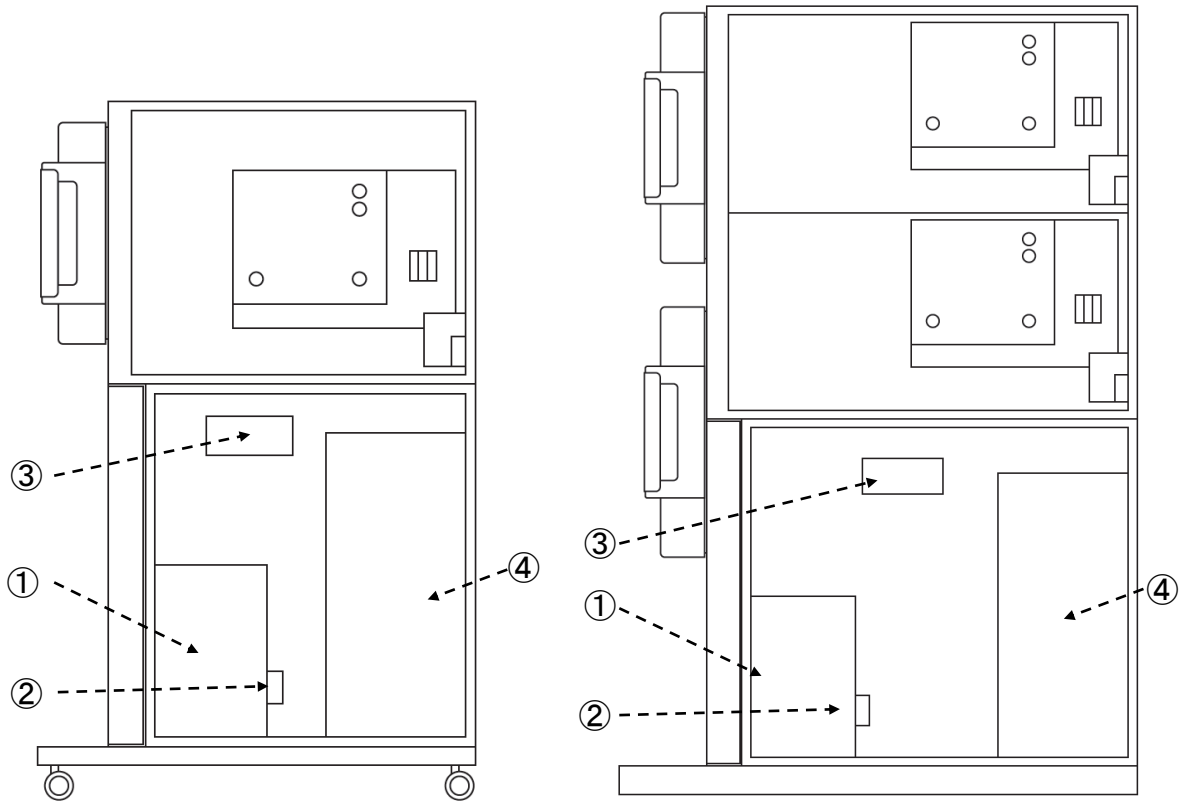


Fig. 3.6 Part names and functions (electrical compartment)

Table 3.6 Part names and functions (electrical compartment)

	Name	Function and purpose
①	Temperature & humidity controller	Controls the temperature and humidity set inside the test area.
②	Electrical parts chassis	Distributes electrical power to the heaters, etc.
③	Fuses	Prevents and protects against burnout when overcurrent occurs by melting and shutting off the power.
④	Breaker	Turns power to the chamber ON and OFF. The breaker will trip and shut off the power when ground leakage or overcurrent occurs.
⑤	Electrical compartment door switch	Detects whether the door is open or closed. Turn OFF the breaker when opening the door to prevent electric shock.

3.4 Water circuit compartment



Single test area model Double test area model

Fig. 3.7 Part names and functions (water circuit compartment)

Table 3.7 Part names and functions (water circuit compartment)

	Name	Function and purpose
①	Water tank	Holds the humidifying water that is supplied to the inside of the test area.
②	Water level sensor	Detects the water level in the water tank. An alarm will be displayed on the instrumentation if the water level is less than what is required for the test.
③	Water supply pump	Pumps the humidifying water into the test area.
④	Drainage tank	Holds water drained from the test area. In order to cool vented steam, you must fill the tank with a sufficient amount of water up to the steam elimination level.

Chapter 4 Operation preparation

This chapter describes the preparation and confirmation steps that must be taken before operating the chamber.
For details about how to operate the chamber, see the Controller Guide.

4.1 Setting specimens in place

Fig. 4.1 shows the working space inside the test area. Place the specimens within this working space. The working space is the space in which the temperature gradient and temperature variation in space listed in the specifications are satisfied. There are two levels of shelves that can hold specimens up to maximum of 3 kg.

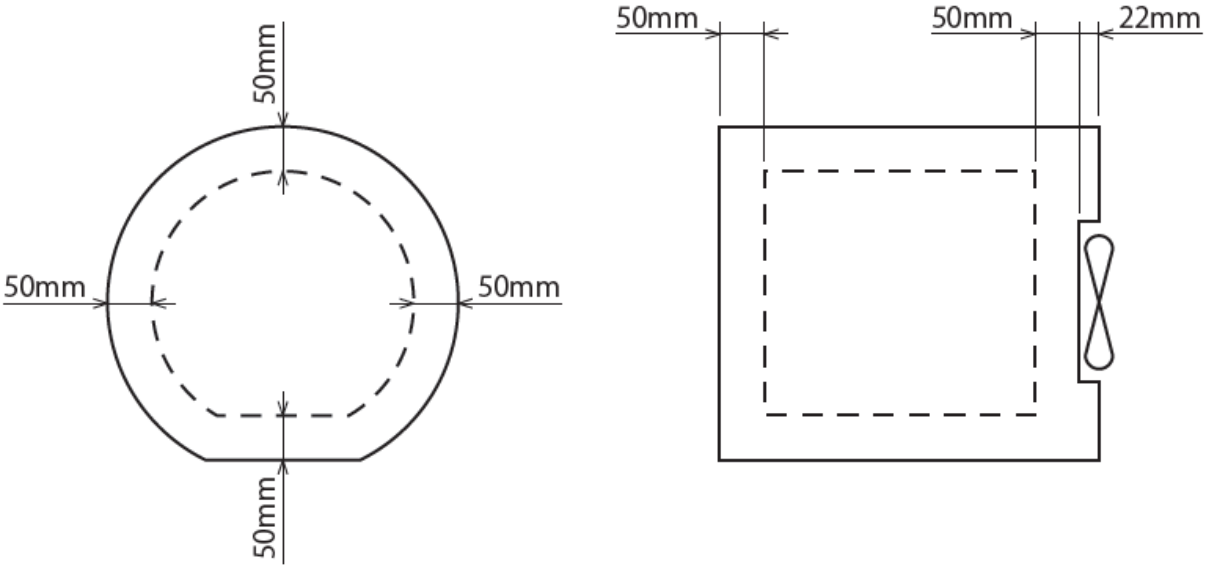


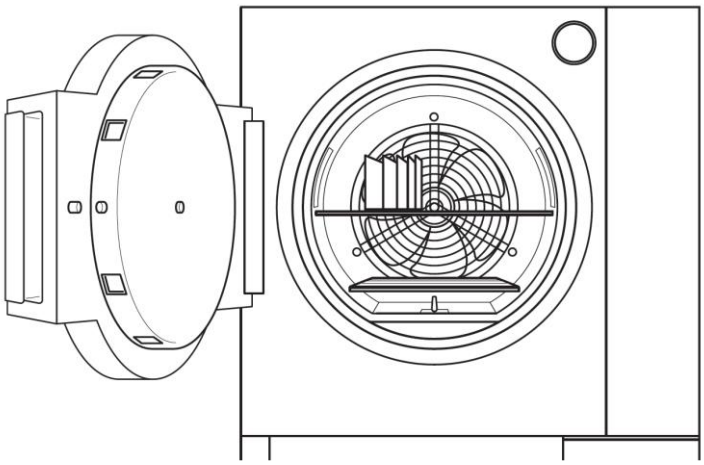
Fig. 4.1 Working space inside test area

The methods of placing specimens inside the test area will depend on the shape of those specimens. This example describes how to place integrated circuits in the test area as specimens.

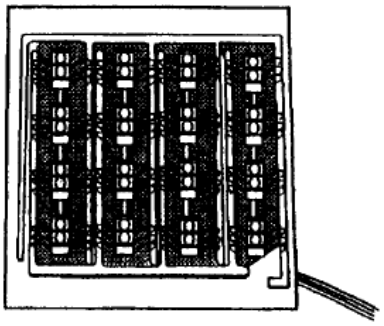
<Procedure>

1) Insert the specimen racks into the test area and place them on the shelf brackets.

2) Do not place the sample integrated circuits directly into the specimen rack. Instead, place them on an insulating, heat-resistant substrate. Because the substrate will be held in the test area, select a type that will not produce impurities due to the HAST test. Place the specimens with an appropriate amount of space between them to ensure that the test conditions will be uniform.



Example of placing substrates inside the test area



Example of wiring the substrate

Fig. 4.2 Example of placing substrates inside the test area

3) Place dummy substrates at both ends so that the test conditions do not change due to the position of the substrate. Stand up the substrates and ensure they do not block the flow of hot air.

WARNING

Set the shelves correctly, and use the shelves within their allowable load capacities.

Failing to do so can result in injury caused by the shelves falling down.

4.2 Specimen signal terminals

CAUTION

Always allow the temperature of the pressure vessel to cool to room temperature before wiring specimens inside the test area.

After operation at 55°C and higher, the temperature inside the test area (the specimen, the shelf, the inside of the door, and the inner cylinder) will be extremely high. Touching these parts with your bare skin may lead to burns.

First turn OFF the power to the specimens when wiring the specimen signal terminals.

Failing to do so can result in electric shock.

When applying voltage to the sample integrated circuits described in the previous section, lower the lead wires from the sample substrates under the specimen rack, and then connect them to the specimen signal terminals (inside). (Fig. 4.3)
The connectors on the inside of the test area correspond to the specimen signal terminals (outside) as shown in Fig. 4.3.

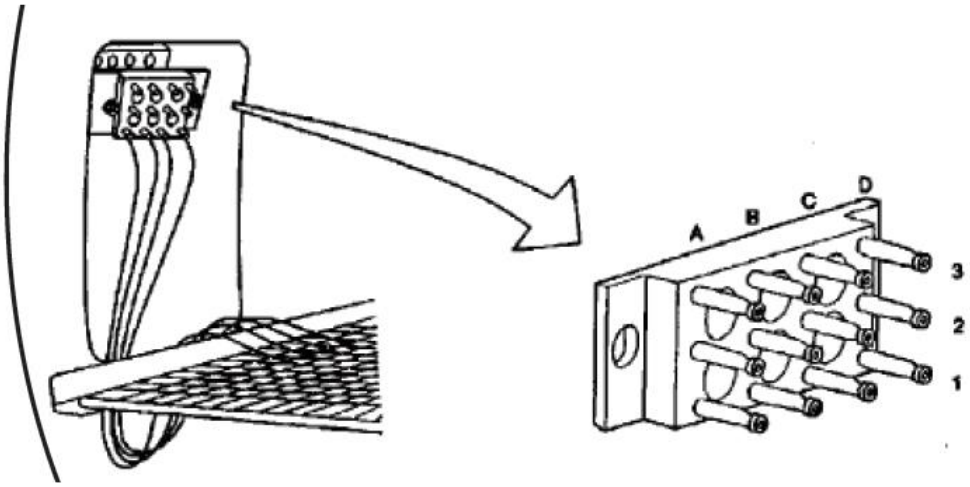
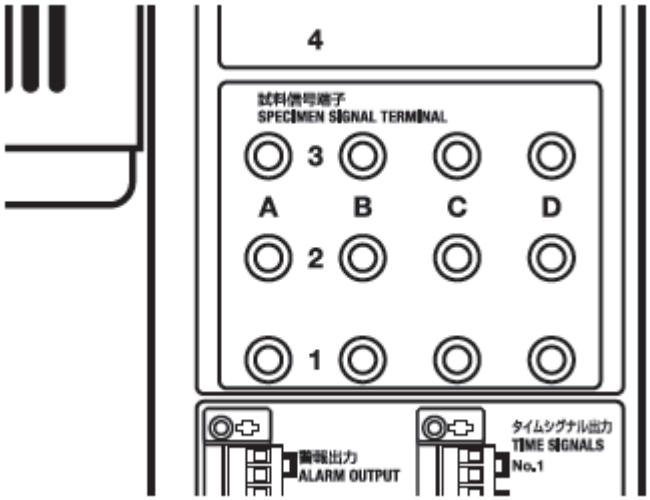


Fig. 4.3 Inside of test area



A1, A2, and the other connectors on the inside of the test area

Fig. 4.4 Outside of test area

Notice

- **Keep the wires inside and outside of the test area slack and in a U-shape.**
  If dew forms on the electrical wire and flows into a specimen or terminal, the specimen may be damaged.
- **Do not apply a load to the terminals that exceeds the rating (125 V AC/DC, 1 A).**
  There is a risk of chamber failure.

◆ **Note** ◆

The terminals must be periodically replaced. Inspect and replace the terminals when they have been used about 3,000 times.

How to use the connectors inside the test area

The pin for the connector on the inside of the test area is a type made of a threaded connector and sheath. Unscrew the connector and sheath and use them according to the following procedure.

<Procedure>

1) Pass the lead wire from the specimen through the sheath.

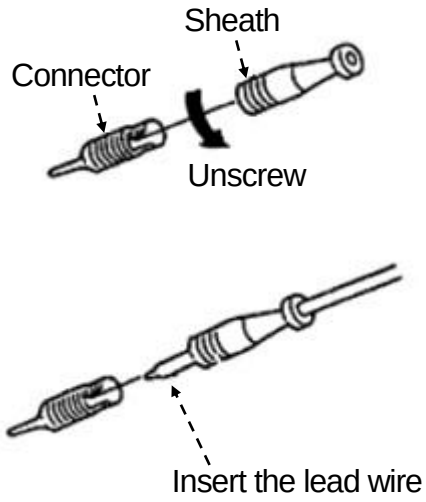


Fig. 4.5 Pin for connector (1)

2) Solder the lead wire that was passed through the sheath to the connector.

3) Screw the connector and sheath together.

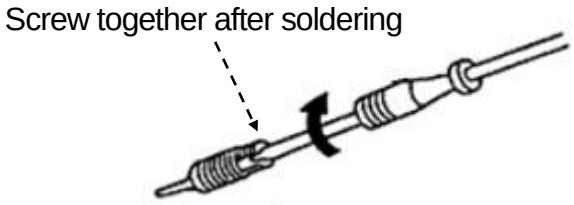


Fig. 4.6 Pin for connector (2)

4) Plug into the specimen signal terminal (inside).

Fig. 4.7 Pin for connector (3)

4.3 Installing the cloth wick (M type, MD Type, dry & wet-bulb control only)

Put the cloth wick on the wet-bulb temperature sensor when performing dry and wet-bulb temperature control with the following models: EHS-212M, EHS-212MD, EHS-222M, EHS-222MD, EHS-412M, and EHS-412MD. Fig. 4.8 shows how to put the wick on the wet-bulb temperature sensor. The service life of the wick is 200 hours of continuous operation with no specimens.

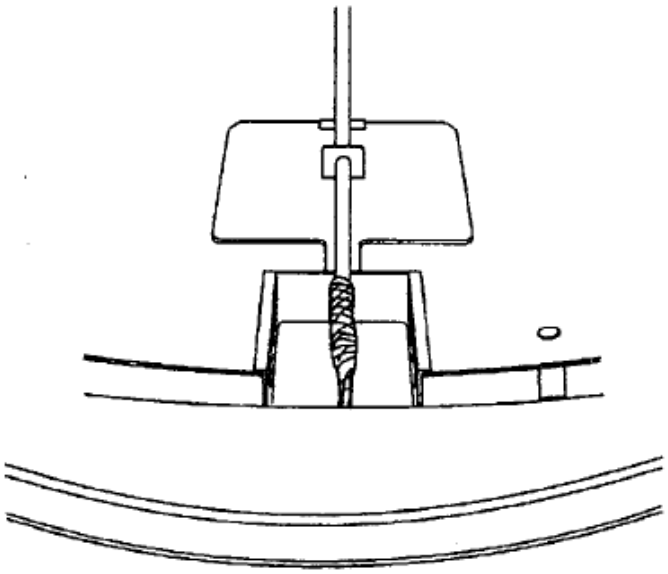


Fig. 4.8 Cloth wick

Promptly replace the wick when the wick alarm appears on the operation panel.

4.4 Supplying power to specimens (only when supplying power to a specimen is required)

Use the specimen power supply control terminals to supply power to specimens.
The rated capacity of the specimen power supply control terminals is 250 VAC 1 A, and the applicable electrical wire diameter is 0.3 to 2 mm^2.

DANGER

When supplying power to specimens, be sure to use the specimen power supply control terminals.

If the specimen power supply control terminals are not used, the heat generated from the specimen can raise the temperature inside the test area, damaging the specimens. In the worst case, it can result in fire.

WARNING

Always turn OFF the power before disconnecting terminal plugs from the connectors when electrical wires are connected to the specimen power supply control terminals.

Disconnecting terminal plugs with the power ON can result in electric shock.

Before performing a test in which power is supplied to the specimen, first create a situation where a problem occurs in the chamber, such as an overtemperature situation, and confirm that the power supplied to the specimen stops when that problem occurs.

In case the specimen power supply control terminals do not operate, power will continue to be supplied to the specimen. This will cause the chamber temperature to increase and, in the worst case, a fire may occur.

Notice

Keep the wires inside and outside of the test area slack and in a U-shape.

If dew forms on the electrical wire and flows into a specimen or terminal, the specimen may be damaged.

◆ **Note** ◆

In order to protect the specimen, we recommend that you implement a second layer of protection in addition to that provided by the chamber by installing, in the vicinity of the specimen, a thermal fuse or other device that can directly interrupt the supply of power without going through the chamber.

■ Wiring when supplying less than 1 A to the specimen

Be sure to insert a fuse that has the appropriate specification.

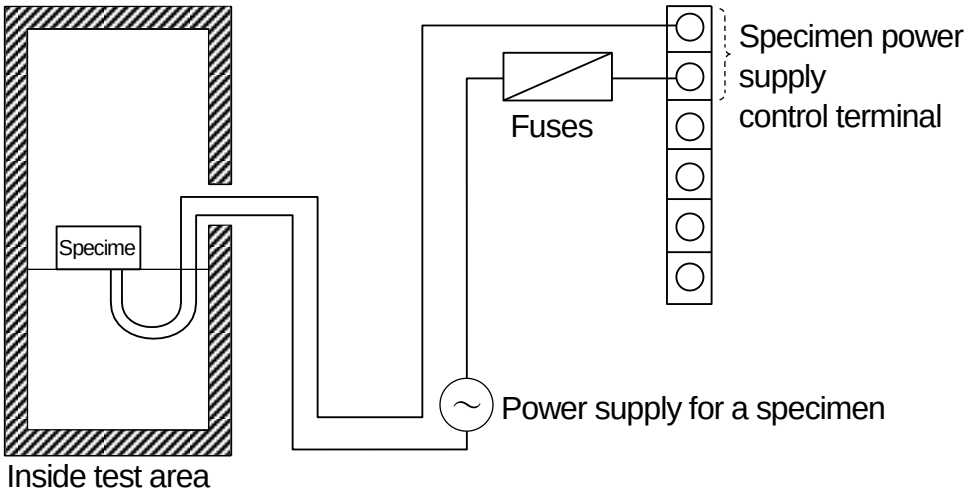


Fig. 4.9 Wiring for supplying power to the specimen (less than 1 A)

■ Wiring when supplying 1 A or more to the specimen

Be sure to insert an electro-magnetic contactor and fuse that have the appropriate specifications.

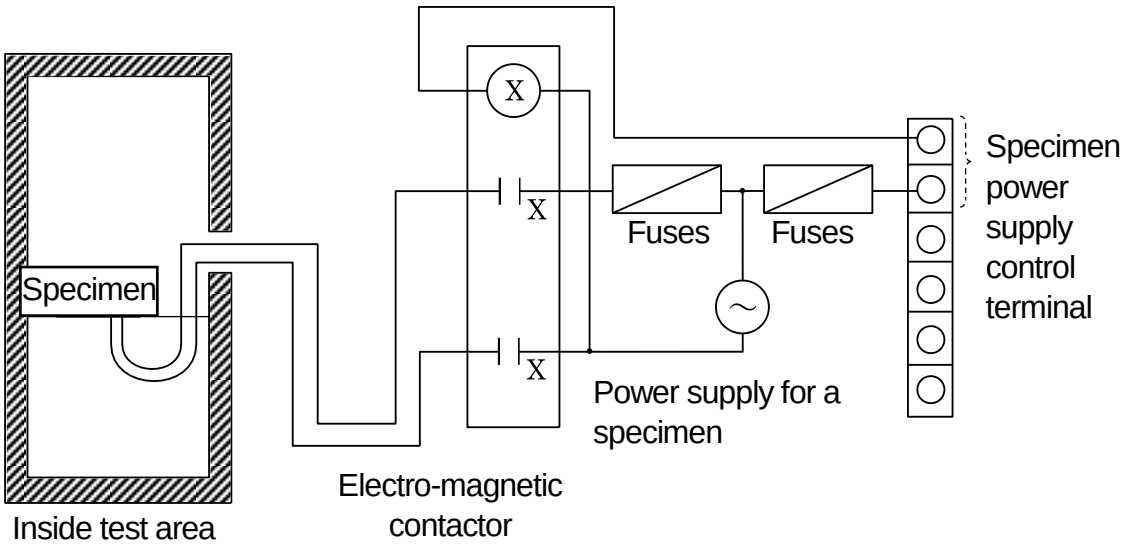


Fig. 4.10 Wiring for supplying power to the specimen (1 A or more)

<Procedure>

1) Remove the terminal plug from the connector on the front of the chamber.

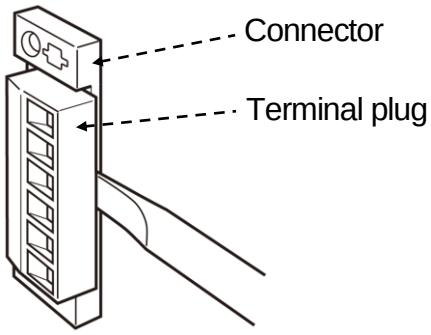


Fig. 4.11 Removing the terminal plug

2) Connect the electrical wire to the specimen power supply control terminal.
Insert the electrical wires into the two top terminal plugs and use a slotted screwdriver to tighten the screws.

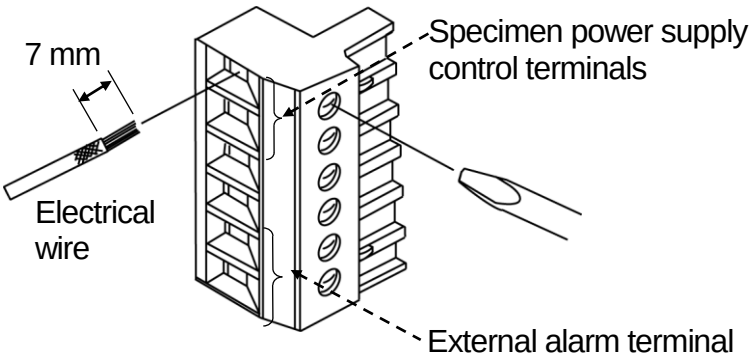


Fig. 4.12 Connecting electrical wire to the specimen power supply control terminal

3) Attach the terminal plug to the connector on the chamber.

4.5 Checking the water level of the water tank

Check the water level of the water tank. If the water level is low, refer to "11. Supplying water and checking the drain valve" in the Installation Guide and fill the water tank with water.

◆ Reference ◆

The water tank holds approximately 10 L (single test area model) or approximately 20 L (double test area model) of pure water.
The low water alarm will occur when the pure water in the water tank falls below 2 L, and the test cannot be started in this state.
For details about the alarms, see "6.2 List of alarms" in Chapter 6.

Chapter 5 Inspection and maintenance

This chapter describes how to perform regular inspection and maintenance to ensure the long operating life of the chamber.

5.1 List of consumables and regular replacement parts

The following parts must be replaced regularly. Replace the parts as soon as the replacement period is reached.
ESPEC also provides inspection and maintenance services.
To request a part, contact your distributor or ESPEC.

Table 5.1 List of consumables

Part name	Recommended replacement period	Replacement method
Wet-bulb cloth wick (M type and MD type)	After performing dry and wet-bulb control operation or 200 hours of continuous operation	See "4.3 Installing the cloth wick".

Table 5.2 List of regular replacement parts

Part name	Recommended replacement period	Replacement method
Door packing (inside/outside)	5,000 hours to 7,000 hours	Contact your distributor or ESPEC.
Air-circulating fan		Contact your distributor or ESPEC.
Specimen signal terminal	5,000 hours or insertion/removal frequency of 3,000 times	Contact your distributor or ESPEC.

* Instrumentation backup battery
The instrumentation backup battery must be replaced about every 5 years. Contact your distributor or ESPEC.

5.2 Inspection and maintenance items list and periodical voluntary inspection

WARNING

Use appropriate methods to periodically clean parts of the chamber, such as the electrical compartment, water circuit compartment, inner cylinder, and inside of the pressure vessel.

Failing to do so can result in burns, electric shock, and other injuries.

■ Inspection items at the start and end of operation

For a description of each item, see ☞ "5.3 Inspection".

If any of the inspection items listed below does not operate properly, contact your distributor or ESPEC.

Table 5.3 Inspection items

Inspection item	Inspection period
Breaker trip test	• Once a month • Before long-term continuous operation
Overheat protector operation test	• Before starting operation
Water tank	• Before starting operation
Door packing	• Before starting operation
Water level of the drainage tank	• Before starting operation

■ Maintenance items

For a description of each item, see ☞ "5.4 Maintenance".

Table 5.4 Maintenance items

Maintenance item	Period
Replace the wet-bulb cloth wick (M type and MD type only)	Replace after approximately 200 hours of continuous operation
Clean the inner cylinder and pressure vessel	Once a month or at the end of operation
Clean the drain filter	Once a month or at the end of operation
Clean the water tank	Once a month or at the end of operation
Check door operation and checking for unusual noises	Once a month or at the end of operation
Door auto-locking mechanism (grease)	Once a year Contact your distributor or ESPEC.

■ Periodical voluntary inspection

The HAST chamber is categorized as a small pressure vessel.
Article 94 of the "Ordinance on Safety of Boilers and Pressure Vessels", a Ministry of Health, Labour and Welfare Ordinance, requires that a periodical voluntary inspection be performed on the chamber once a year. Be sure to perform this periodical voluntary inspection.

Inspection items

Inspection method	Locations to inspect and results
Visual inspection when operation is stopped	① Door — Corrosion — Yes: □ / No: □ Cracks — Yes: □ / No: □ ② Pressure vessel (Interior surface) * — Corrosion — Yes: □ / No: □ Cracks — Yes: □ / No: □ ③ Packing — Large deformation — Yes: □ / No: □ Cracks — Yes: □ / No: □ ④ Pressure gauge — 0 MPa when not being used Pass: □ / Fail: □
Operation ↓ Set point attainment ↓ Visual inspection 1 hour later	① Temperature set point and pressure • EHS-212(M), 222(M), 212MD, 222MD Temperature set point: 132.9°C/Humidity set point: 100%rh Indicated pressure: 0.196 MPa Pass: □ / Fail: □ • EHS-412(M), 412MD Temperature set point: 151.1°C/Humidity set point: 100%rh Indicated pressure: 0.392 MPa Pass: □ / Fail: □ ② Door (pressure vessel packing) Steam leak — Yes: □ / No: □ ③ Pressure vessel (pipes: underneath chamber, manual valve) Steam leak — Yes: □ / No: □
Electrical system ↓ Visual inspection	① Locking of power supply connectors Looseness — Yes: □ / No: □ ② Damage to power cord — Yes: □ / No: □

* Interior surface of inside area after the pressure vessel packing (surface exposed to the high temperature and high humidity environment).

The periodically voluntary inspection sheet is included in the appendix. Use this sheet when performing the voluntary inspection. Article 94 of the "Ordinance on Safety of Boilers and Pressure Vessels", a Ministry of Health, Labour and Welfare Ordinance, requires that the record of voluntary inspections be retained for a period of three years.

5.3 Inspection

Primary breaker trip test

WARNING

Perform a trip test on the leakage breaker and check that it is operating normally before starting chamber operation.

Failing to do so can result in electric shock.

Test the breaker operation once a month or before starting long-term continuous operation. While the breaker is ON, gently press the test button. If the breaker's lever trips to the lower position, the breaker is working properly.

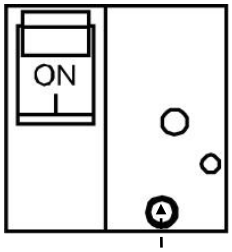


Fig. 5.1 Test button

◆ **Note** ◆

When the breaker lever falls, it stops at a point halfway between ON and OFF. To turn ON the power, turn the power OFF with the lever, and then turn the power back ON.

Overheat protector operation test

WARNING

Before starting chamber operation, check that the overheat protector is operating normally.

Failing to do so can result in damage to specimens.

Before starting chamber operation, test the operation of the overheat protector.

<Procedure>

1) Confirm that the circuit breaker has been turned on.

2) Press the instrumentation power switch to turn ON the instrumentation.
The menu will be displayed.

3) Specify the settings on the Constant Setup tab and start the constant operation.
Set the temperature close to room temperature or the temperature currently on the monitor.

4) Set the overheat protector to a temperature that is approximately 5°C lower than the temperature inside the test area.
If the overheat protector is operating normally, the buzzer will sound and an alarm will be displayed on the instrumentation screen. All digits of the setter display will flash.

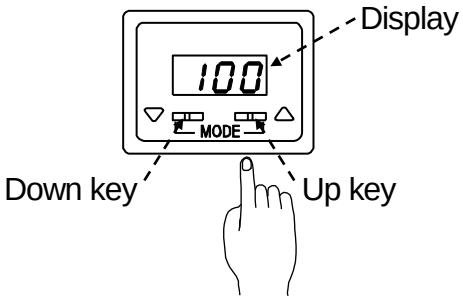


Fig. 5.2 Overheat protector

5) To stop the buzzer, press the ALARM icon.
This will cause the overheat protector setting to return to its original value.

Inspecting the water level of the water tank

Check the water in the water tank before starting operation.
If the water level in the water tank is low, fill the tank with the specified pure water.

Inspecting the door packing

Check that the door packing attached to the body of the chamber fits evenly into the groove of the flange on the pressure vessel before starting operation.

Water level of the drainage tank

Check the water level of the drainage tank to prevent high temperature and high pressure water vapor from being vented into the air after the end of the test.
Fill the drainage tank with water if the water level is lower than the steam elimination level.

5.4 Maintenance

Checking the wet-bulb cloth wick (M type, MD type only)

Replace the wet-bulb cloth wick after approximately 200 hours of continuous operation.
For the installation and replacement procedure, see "4.3 Installing the cloth wick".

Cleaning the inner cylinder and pressure vessel

CAUTION

Always allow the temperature inside the pressure vessel to cool to room temperature before cleaning.

After operation, the temperature inside the test area (the specimen, the shelf, the inside of the door, and the inner cylinder) will be extremely high. Touching these parts with your bare skin may lead to burns.

For your safety, be sure to wear gloves.

Be careful of cuts or other injuries because there are projections and sharp edges in the test area.

◆ **Note** ◆

Do not use detergent or similar cleaning products. Residue from such products may damage the chamber or have a negative effect on test results.

<Items to prepare>

Brush, rags, and pure water

<Procedure>

1) Turn OFF the power by switching OFF the breaker on the rear of the chamber. Next, turn the manual drain valve to DRAIN to drain the water in the chamber.
2) If pins are plugged into the specimen signal terminals (inside), unplug them. Remove the specimens and shelves.
3) Unscrew the inner cylinder fastening screws (4 locations).

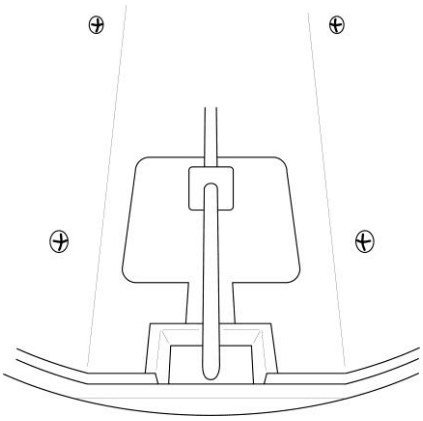


Fig. 5.3 Inner cylinder

4) Remove the drain filter cover and drain filter inside the test area.
5) Pull the inner cylinder straight out.

◆ Note ◆

The internal test area temperature sensor is installed at the top of the rear of the inner cylinder. In the M type and MD type, the wet-bulb temperature sensor is also installed at the bottom of the inner cylinder. Be careful not to damage these sensors when removing the inner cylinder.

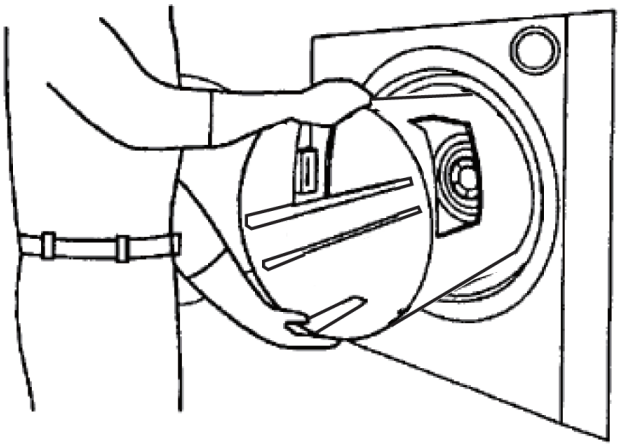


Fig. 5.4 Removing the inner cylinder

6) After the inner cylinder is removed, the heater, humidifying water heater, air-circulating fan, internal test area temperature sensor, humidifying water temperature sensor, wet-bulb temperature sensor (M type and MD type only), and the boil-dry protector installed on the rear wall of the pressure vessel are exposed. Remove the fan while being careful not to damage these parts.

◆ Note ◆

Do not allow any magnetized objects to come near the removed fan.

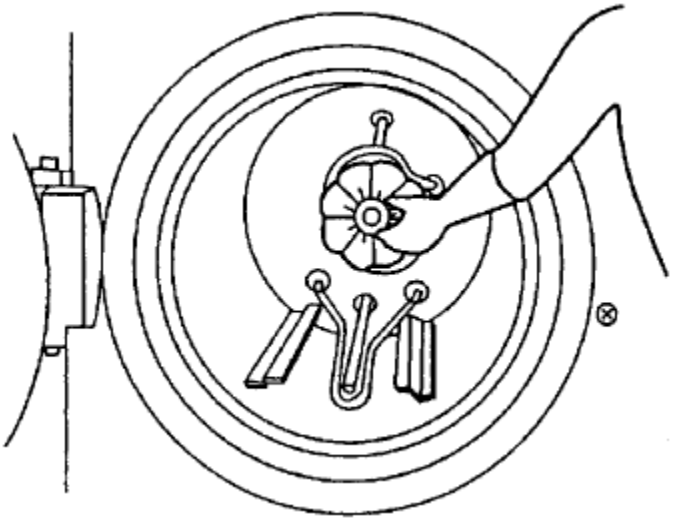


Fig. 5.5 Removing the fan

7) Clean off dirt on the inner surface of the pressure vessel, inner and outer surfaces of the inner cylinder, and the fan. Carefully clean off any dirt using the brush and clean rags while rinsing with pure water. Carefully clean the bottom of the pressure vessel where the humidifying water is held.
Ensure that any debris from the brush does not enter the drainage pipe. Failing to do so can result in malfunction.

8) Reinstall the fan and inner cylinder in that order. Be extremely careful not to damage the sensors or heaters installed at the rear of the pressure vessel when doing so.

9) Reinstall the drain filter and drain filter cover in that order.

10) Fasten the inner cylinder fastening screws (4 locations).

11) Turn the manual drain valve to CLOSE, and turn ON the breaker.

12) Fill the water tank with pure water and perform test operation. Do not place any specimens in the chamber at this time.

Conditions for test operation
EHS-212 (M, MD) and EHS-222 (M, MD)
Temperature: 142.9°C, humidity: 75%rh, time: 1.0 hour
EHS-412 (M, MD)
Temperature: 162.2°C, humidity: 75%rh, time: 1.0 hour

Cleaning the drain filter

CAUTION

Always allow the temperature inside the pressure vessel to cool to room temperature before cleaning.

After operation, the temperature inside the test area (the specimen, the shelf, the inside of the door, and the inner cylinder) will be extremely high. Touching these parts with your bare skin may lead to burns.

◆ Note ◆

Do not use detergent or similar cleaning products. Residue from such products may damage the chamber or have a negative effect on test results. Under certain ambient conditions, suddenly stopping operation following low-temperature operation can cause condensation to form on the chamber surface.

Clean the drain filter as necessary when it has been determined to be dirty. When the inside of the pressure vessel is filled with pure water, dirt may float on the water. The drain filter is dirty in this case. Clean the drain filter.

<Items to prepare>

Brush and pure water

<Procedure>

1) Turn OFF the power by switching OFF the breaker on the rear of the chamber. Next, turn the manual drain valve to DRAIN to drain the water in the chamber.

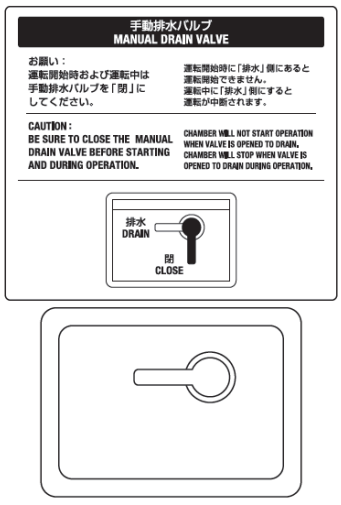


Fig. 5.6 Manual drain valve label on left side of chamber

2) Remove the drain cover inside the test area. First pull it forward, and then lift it up. For the M type, be careful of the wet-bulb temperature sensor when removing the cover.

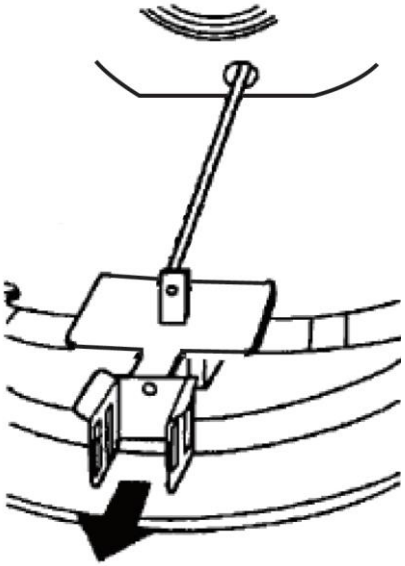


Fig. 5.7 Drain cover

3) Remove the drain filter and clean it with a brush.

4) Rinse the drain filter with pure water.

5) Reinstall the drain filter and drain filter cover.

6) Turn the manual drain valve to CLOSE, and turn ON the breaker.

Cleaning the water tank

<Procedure>

1) Remove the bottom right side plate of the chamber.
2) Remove the cap together with the water supply tube from the rear of the tank.
3) Pull out the water tank.
4) Clean the inside of the tank. Use pure water to clean the inside of the tank. Do not use detergent or similar cleaning products.
5) When finished cleaning, reinstall the tank in the chamber in the reverse order. At that time, ensure that the tip of the water supply tube reaches the bottom of the tank.
6) When finished reinstalling the tank, supply water to the tank and confirm that water is automatically supplied when starting operation.

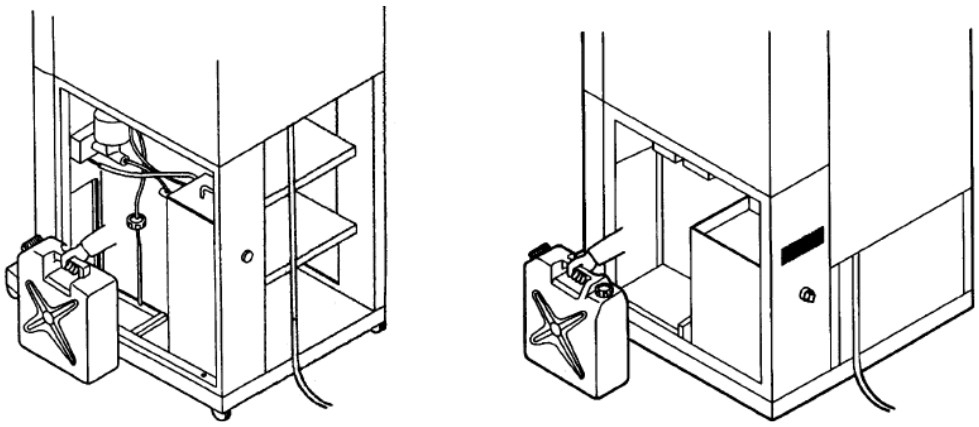


Fig. 5.8 Water tank

Checking door operation and checking for unusual noises

If there are unusual noises when locking or unlocking the automatic door, or if the door gets caught or there is an abnormality when opening and closing the door, contact your distributor or ESPEC.

◆ Note ◆

- A lubricant is applied to the surface of the door packing when the chamber is shipped from the factory to prevent the packing from sticking to the door. Do not wipe the surface of the packing. If this lubricant comes off, the packing may stick to the door.
- The auto-locking mechanism must be inspected once a year, and it must be greased. If you fail to grease the mechanism, the fuse for the circuit may blow, resulting in the following problems:
  - The door cannot be opened when closed.
  - The door cannot be closed and the test cannot be started.

For maintenance, contact your distributor or ESPEC.

Maintenance before an extended period of non-use

If the chamber will not be used for an extended period of time, be sure to perform the steps shown below. Failure to do so may result in inaccurate testing and reduce the operating life of the chamber.

CAUTION

Turn OFF the chamber's breaker when working on the chamber.

Failing to do so can result in electric shock.

When cleaning inside the test area, always allow the temperature inside the pressure vessel to cool to room temperature.

After operation, the temperature inside the test area (the specimen, the shelf, the inside of the door, and the inner cylinder) will be extremely high. Touching these parts with your bare skin may lead to burns.

<Procedure>

1) Turn OFF the breaker.
2) Open the manual drain valve and drain the humidifying water inside the test area.
3) Remove the water tank and discard the water in the tank.
4) Discard the water in the drainage tank.
5) Clean the inside of the test area.

5.5 Other maintenance and inspection items

Replacing the door packing

Replace the door packing if it sticks to the door when the door is opened or if cracks appear in the packing.
Inspect and replace the door packing after a total testing time of approximately 5,000 to 7,000 hours. Contact your distributor or ESPEC to purchase the door packing.

<Procedure>

1) Remove the old door packing from the chamber.

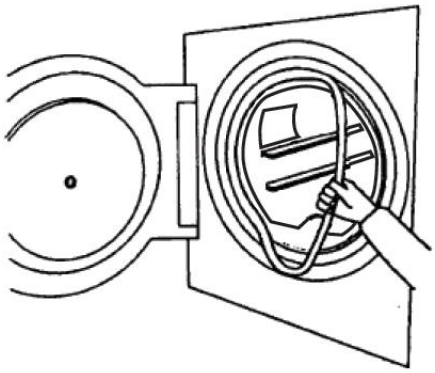


Fig. 5.9 Removing the packing

2) Uniformly fit the new door packing into the groove of the flange on the pressure vessel.

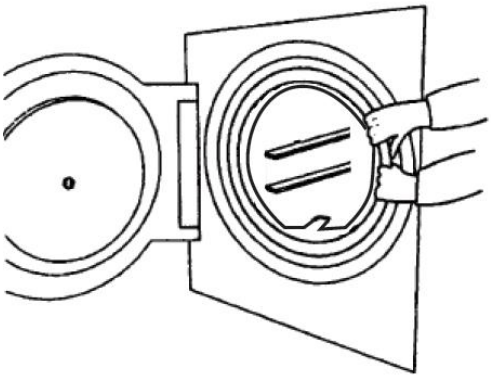


Fig. 5.10 Installing the packing

3) Open and close the door a number of times and confirm that no part of the packing is sagging and that the packing does not stick to the door.

◆ Note ◆
A lubricant is applied to the surface of the door packing when the chamber is shipped from the factory to prevent the packing from sticking to the door. Do not wipe the surface of the packing. If this lubricant comes off, the packing may stick to the door.

Replacing the air-circulating fan

Inspect and replace the air-circulating fan after a total testing time of approximately 5,000 to 7,000 hours. Promptly replace the air-circulating fan if it makes unusual noises during operation. Contact your distributor or ESPEC.

Chapter 6 Alarms and troubleshooting

This section describes alarms and other troubles, their possible causes, and actions to take. Contact your distributor or ESPEC in the following cases.

- When the chamber does not operate properly even after taking the actions listed here
- When a malfunction occurs for which a "service call" is advised in this manual.

6.1 Alarms and actions

WARNING

Before working on the primary side of the breaker, be sure to turn OFF the main power supply switch at your facility. Also, take measures to prevent power from flowing to the chamber accidentally.

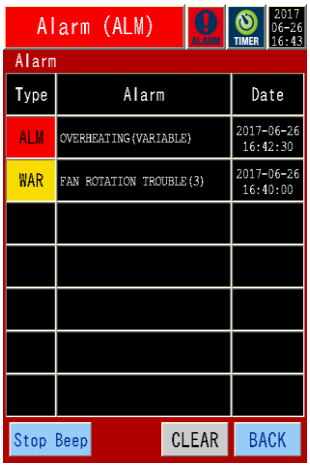
Attempting to solve a problem with the power ON can result in an electric shock. Use the supplied breaker handle stopper to prevent the breaker from being turned ON accidentally.

When opening the electrical compartment door or mechanical compartment door, be sure to first turn OFF the breaker.

The details of the displayed problem are described in the alarm list. Take the appropriate action according to the details listed. If the chamber does not operate properly even after taking the actions listed here, contact your distributor or ESPEC.

If an alarm occurs, the buzzer will sound and the ALARM icon will flash. Press the ALARM icon to display the Alarm screen and stop the alarm sound. Press [Stop Beep] for the alarm sound of the status indicator lights (optional equipment).

Alarm screen



Notice

Disabling the error buzzer sound or alarm buzzer sound prevents audible notification and may delay discovery of the error or alarm. Therefore, do not disable these sounds whenever possible.

If the buzzer sounds are disabled, notification is only provided by the red flashing operation lamp and alarm screen display, so be careful.

◆ **Reference** ◆

The operation of the alarm and error buzzer can be set with the volume on Set Date/Screen on the Chamber Setup menu.

Opening doors

Use the following procedure to open a door.

<Procedure>

1) Press the operation mode button at the top of the operation screen.

2) Press the [Quick Finish] button. The process display will change to "END".

3) Confirm that the pressure gauge indicates 0 MPa.

CAUTION

When unlocking the door, confirm that the pressure inside the test area is 0 MPa.

There is a risk of injury and burns because steam will be blown out of the chamber if the door is opened when the pressure is high.

4) Press the DOOR LOCK button.
The door is unlocked when the lamp on the button turns off.

5) Confirm that the door is unlocked, and then open the door.

Alarms and actions to take

Take the following actions when an alarm occurs.
Alarms are divided into alarms and warnings, and the action to take can vary.

Alarm When the chamber malfunctions or component devices malfunction resulting in an error status.
Warning When there is no malfunction but operation may become affected, such as a maintenance announcement.

◆ Note ◆

- Even if an alarm occurs, operation may continue depending on the type of alarm. Operation continues during a warning.
- For details about the alarms, see ☞ "6.2 List of alarms".
- When an alarm occurs, check the details of the problem together with the following items.
  - Control method being used
  - State of the process
  - Value of the pressure gauge
  - Value of the temperature monitor
  - Value of the humidity monitor

① In case of an alarm

<Procedure>

1) Press the ALARM icon to display the Alarm screen. Stop the buzzer.

2) Troubleshoot the problem according to the operation manual and take action.

② In case of a warning

<Procedure>

1) Press the ALARM icon to display the Alarm screen. Stop the buzzer.

2) Troubleshoot the problem according to the operation manual and take action.

3) When the action has been completed, press and hold [CLEAR] on the alarm help screen for one second.

6.2 List of alarms

When an alarm occurs, view the actions required, perform these actions, and then restart or continue operations.
If an error or warning occurs again even after taking action, contact a service representative.

The <option name> is listed for the alarms that occur when the chamber is equipped with an option as well as for the causes and actions to perform for these alarms.
The possible cause and the action vary depending on the equipped options, so check the possible causes and actions for the different options.
For alarm numbers in the communications function, see "Web Application" in Operation Manual / Network Guide.
The entries in the following table are listed alphabetically according to the names of the alarms.

Alarm name	Description	Probable cause	Action
SENSOR BURN-OUT(TEC1 to TEC4, RTD)	Chamber operation has stopped because sensor input on the temperature control unit has been disconnected.	• Sensor disconnection	• Turn breaker OFF and then ON again
OVER PRESSURE	Chamber operation has stopped because the pressure exceeded the allowable maximum pressure.	• Gas produced from specimens	• Check if gas was produced from the specimens, and eliminate the gas if present • Turn breaker OFF and then ON again
OVERHEATING (VARIABLE, FIXED TYPE)	Power to the heater has stopped because the temperature inside the test area exceeded the set point of the overheat protector. (Air circulator continues operation.)	• Too many specimens or too large an amount of the specimen • Air flow inside the test area has been blocked • Ambient temperature change equal to or greater than ±10°C • Air circulator problem	• If there are too many specimens, divide them up • If air flow inside the test area has been blocked, remove the blockage • Check the change in the ambient temperature • Check for unusual noises from the air circulator • Turn breaker OFF and then ON again
ABS HIGH LIMIT: TEMP(TEC1)	The temperature inside the test area exceeded the absolute high limit: EHS-212 (M, MD), EHS-222 (M, MD): 160°C, EHS-412 (M, MD): 180°C Power to the heater has stopped. (Air circulator continues operation.)	• Too many specimens or too large an amount of the specimen • Air flow inside the test area has been blocked • Ambient temperature change equal to or greater than ±10°C • Air circulator problem	• If there are too many specimens, divide them up • If air flow inside the test area has been blocked, remove the blockage • Check the change in the ambient temperature • Check for unusual noises from the air circulator • Turn breaker OFF and then ON again
HUMIDIFIER BOIL-DRY	Power to the heater has stopped because the boil-dry protector was activated. (Air circulator continues operation.)	• Manual drain valve is open • Steam leaking from door packing	• Close the manual drain valve • Check if the door packing has deteriorated, or if it is damaged or out of position • Turn breaker OFF and then ON again
ABS HIGH LIMIT: TEMP(TEC2)	The temperature inside the test area exceeded the absolute high limit: EHS-212 (M, MD), EHS-222 (M, MD): 160°C, EHS-412 (M, MD): 180°C Power to the heater has stopped. (Air circulator continues operation.)	• Manual drain valve is open • Steam leaking from door packing	• Close the manual drain valve • Check if the door packing has deteriorated, or if it is damaged or out of position • Turn breaker OFF and then ON again
CANNOT UNLOCK DOOR, CANNOT LOCK DOOR, LIMIT SWITCH TROUBLE, DOOR OPEN WHILE LOCK	The door unlock/lock operation has stopped because a problem occurred in the door unlock/lock operation.	• Failure of door auto-locking mechanism • Failure of door limit switch	• Turn breaker OFF and then ON again

Alarm name	Description	Probable cause	Action
WATER SUPPLY ERROR	The water supply operation has stopped because water was not supplied to the inside of the pressure vessel within the specified time.	• Manual drain valve is open • The chamber was not installed in a level location • Insufficient water in the water tank	• Close the manual drain valve • Check that the chamber is level • Check the amount of water in the water tank • Turn breaker OFF and then ON again
FAN ROTATION TROUBLE	A rotation problem has occurred with the air-circulating fan or air circulator motor. (The chamber continues operation.)	• Air circulator problem	• Turn breaker OFF and then ON again
WICK ERROR	The wet-bulb temperature sensor cannot measure correctly. (The chamber continues operation.)	• The cloth wick is dry or requires replacement	• Replace the cloth wick with a new cloth wick
POWER FAILURE	Chamber operation has stopped because a power failure of 3 minutes or longer occurred during operation.	• Power failure of 3 minutes or longer	• Turn breaker OFF and then ON again
MOMENTARY BLACKOUT	A power failure of less than 3 minutes occurred during operation, and chamber operation has recovered automatically.	• Power failure of less than 3 minutes	• Auto recovery
OPERATION PANEL ERROR	Power to the heater has stopped because a communications error was detected with the operation panel or an operation panel error was detected.	• Communications error • Operation panel error	• Turn breaker OFF and then ON again
DOOR OPEN AFTER "RAMP UP"	Power to the heater has stopped because the door limit switch was activated during operation.	• Failure of door limit switch	• Turn breaker OFF and then ON again
PRESSURE SWITCH BROKEN	Chamber operation has stopped because of a problem with the atmospheric pressure detection switch.	• Failure of atmospheric pressure detection switch	• Turn breaker OFF and then ON again
PROG.TOTAL TIME OVER	Power to the heater has stopped because a program pattern with a total time exceeding 999.9 hours was set.	• Program set incorrectly	• Correctly set the program
EMERGENCY STOP <OPTION>	Chamber operation has stopped because of the emergency stop switch was pressed. (Breaker turned OFF approximately 10 seconds later.)	• Emergency stop switch was pressed	• Reset emergency stop switch

6.3 Troubleshooting

WARNING

Before working on the primary power supply to which the chamber's breaker is connected, be sure to turn off the main power supply switch at your facility and ensure that the line is not energized. Also, take measures to prevent power from flowing to the chamber accidentally.

Attempting to solve a problem with the power ON is extremely dangerous as it can result in electric shock.
Use the supplied breaker handle stopper to prevent the breaker from being turned ON accidentally.

When opening the electrical compartment door or mechanical compartment door, be sure to first turn OFF the breaker.

This section describes problems that cannot be detected with the self-diagnostic function and operation errors that are easy to mistake for malfunctions.
If the chamber does not operate properly even after taking the actions listed here, contact your distributor or ESPEC.

Table 6.1 Troubleshooting

Problem	Cause	Solution
Nothing is displayed when the instrumentation power switch is pressed.	Not pressed and held for 1 second.	Press and hold for 1 second. This is a mechanism to prevent mistaken operation.
	The main power supply switch at your facility is off.	Turn on the main power supply switch at your facility.
	The breaker is not ON.	Turn ON the breaker.
	The electrical compartment door is open	Close the door.
	The power supply is in open phase.	Make the proper connection. See the Installation Guide.
	The fuse has blown.	Replace fuse F2. See ☞ "6.4 Actions to take". If the fuse blows immediately after replacement, make a service call.
	The backup battery is dead	The life of the backup battery is approximately 5 years. Make a service call.
The display immediately turns off. Alternatively, incorrect information is displayed	System error or internal board error	Turn ON the chamber's breaker again. If this occurs again after resuming operation, make a service call.
The door is difficult to close.	An object is blocking the door.	Remove the object.

Continued on the next page

Problem	Cause	Solution
Unusual smell	An unusual smell remains in the chamber.	Clean the inside of the test area. See ☞ "5.4 Maintenance".
	The specimen is emitting an unusual smell.	This is not a malfunction. Continue operation.
The wet-bulb wick has dried out.	Bacteria is growing in the water tank.	Clean the water tank. See ☞ "5.4 Maintenance".
The temperature and humidity are unstable.	The ambient temperature has changed 5°C or more in a few minutes.	Resume testing after the ambient temperature has stabilized.
The temperature has gradually increased above the set temperature.	The heat-generation load of the specimen is high.	Reduce the heat-generation load of the specimen.
Settings cannot be changed.	The key lock is enabled.	Disable the key lock.
It takes a long time to increase the temperature.	The specimen heat load is high.	Reduce the number of specimens.
	The ambient temperature is too low.	Increase the ambient temperature.
Poor temperature uniformity.	The air flow inside the test area is poor.	Improve the air flow.
	The specimen heat load is high.	Reduce the number of specimens.

6.4 Actions to take

Replacing fuses

When a fuse blows, replace it with a supplied fuse.

WARNING

Use appropriate methods, as shown below, to replace the fuse.

Failing to do so can result in electric shock.

◆ **Note** ◆

If the new fuse blows as soon as the power is turned back on, contact your distributor or ESPEC.

<Procedure>

1) Turn OFF the breaker.

2) Remove the electrical compartment door.

3) Replace the blown fuse with a new fuse.

Fuse capacity
F1 to F3: 3 A
F4 and F5: Midget 3 A
F6: Midget 5 A
F7: Midget 10 A

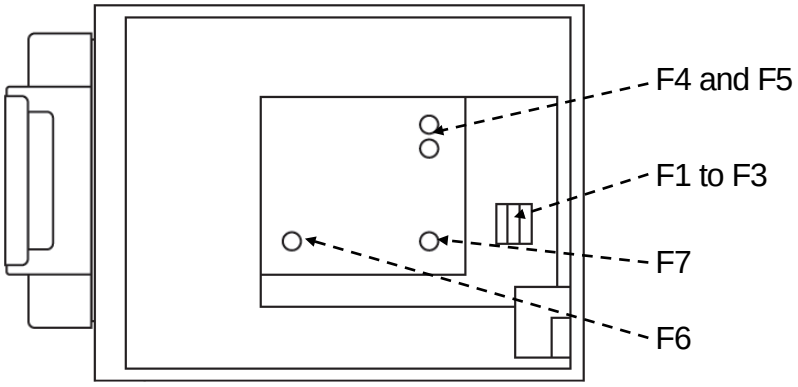


Fig. 6.1 Replacing fuses

4) Attach the electrical compartment door.

Appendix

A. Operation manual glossary

	Term	Description
B	Boil-dry protector	A device that prevents abnormal heating of the humidifying heater when there is little or no water for chambers that use a humidifier by heating water.
C	Condensation	The phenomenon whereby water vapor in the air changes from a gas to a liquid and condenses to water. This is determined by the air temperature and humidity. Condensation occurs when the air temperature is lower than the dew point for that air. For example, the dew point temperature when the air has a temperature of 85°C and a humidity of 85%rh is 80.9°C.
	Constant setting control	The method of controlling the temperature and humidity with constant values.
D	Dry-bulb temperature	The air temperature measured using a dry-bulb thermometer.
H	Heat load	The generation of heat from a specimen inside the test area. It is called this because it is the heat load from the perspective of the chamber.
	Humidifying water	Water that is used to humidify the inside of the test area. The humidifying water is evaporated by the humidifying heater to generate humidity.
	Humidity fluctuation	Difference, after stabilization between the maximum and minimum humidity at any point in the effective area during a specified interval of time.
	Humidity gradient	The maximum value of the average humidity variation between two points in the working space at any given instant in time after stabilization.
	Humidity variation in space	Difference in mean value after stabilization, at any moment in time between the humidity at the center of the working space and any other point in the working space.
M	Maximum current	The maximum current is the maximum value of the current flowing to the primary power cable when the chamber is operating.
	Minimum temperature	The minimum temperature that can be reproduced inside the test area.
O	Overheat protector	A hardware safety device that prevents the inside of the test area from becoming abnormally hot due to chamber trouble or specimen heat generation.
P	Program operation	The method of changing the air and specimen temperature according to a program created in advance.
S	Specimen power supply control terminals	The terminal that interrupts the power supply of the specimen when an error occurs and the chamber operation stops during a current test of the specimen.

	Term	Description
T	Temperature and humidity control range	The range of temperature and humidity that can be reproduced in inside the test area. This is normally expressed with a diagram, whereby the vertical axis is humidity, the horizontal axis is humidity, and the horizontal axis is temperature.
	Temperature fluctuation	Difference, after stabilization between the maximum and minimum temperatures at any point in the working space during a specified interval of time.
	Temperature gradient	Maximum difference in mean temperature between 2 points in the working space at any point in time after the temperature has stabilized.
	Temperature range	The range of temperatures that can be reproduced inside the test area.
	Temperature variation in space	Difference in mean value after stabilization, at any moment in time between the temperature at the center of the working space and any other point in the working space.
	Test area	The space partitioned to obtain the desired temperature or humidity.
W	Wet-bulb cloth wick	A cloth used for the wet-bulb thermometer. It is moistened with water when in use. Although gauze is used for meteorological purposes, a non-woven fabric is used for an environmental test chamber because of its superior resistance to heat and cold.
	Wet-bulb temperature	The temperature measured by wrapping a thermometer with a wet cloth to measure the humidity. The relative humidity can be obtained from the air temperature (dry-bulb temperature) and this wet-bulb temperature.
	Working space	The space inside the test area wherein prescribed temperature and humidity conditions can be maintained within the allowable range. This is the internal space excluding one-tenth (min. 50 mm) of the space between the surfaces opposite the inside of the test area from each wall surface inside the test area.

B. Main specifications

Table A.1 EHS specifications

Model				EHS-212 (M, MD)	EHS-222 (M, MD)	EHS-412 (M, MD)
Power supply				200 V AC, 1 Ø, 2 W, 50/60 Hz (power supply voltage fluctuation: 180 to 220 V)		
Control methods				Single test area, unsaturated control/wet saturated control/dry and wet-bulb temperature control		
Pressure vessel type				Small pressure vessel as specified in the Enforcement Order of Industrial Safety and Health Law in Japan		
Ambient operating temperature				+5°C to +40°C/75%rh max.		
Performance*1	Unsaturated control	Temperature range		+105.0 to +142.9°C		+105.0 to +162.2°C
		Humidity range		75 to 100%rh		
		Pressure range		0.020 to 0.196 MPa (gauge)		0.020 to 0.392 MPa (gauge)
		Temperature fluctuation		±0.3°C		
		Temperature gradient		3.0°C		
		Temperature variation in space		3.0°C		
		Humidity fluctuation		±2.5%rh		
		Heat up and pressurization time		0 → 0.196 MPa (gauge)		0 → 0.392 MPa (gauge)
				Approx. 30 min.	Approx. 60 min.	Approx. 45 min.
	Wet-saturated control	Temperature range		+105.0 to +132.9°C		+105.0 to +151.1°C
		Pressure range		0.020 to 0.196 MPa (gauge)		0.020 to 0.392 MPa (gauge)
		Temperature fluctuation		±0.3°C		
		Temperature gradient		3.0°C		
		Temperature variation in space		3.0°C		
		Heat up and pressurization time		0 → 0.196 MPa (gauge)		0 → 0.392 MPa (gauge)
				Approx. 45 min.	Approx. 75 min.	Approx. 60 min.
Performance* 1	Dry & wet-bulb control	Temp. heat-up	Temperature range	+105.6 to +142.9°C		+105.6 to +162.2°C
			Humidity range	75 to 95%rh		
			Heat up and pressurization time	0 → 0.196 MPa (gauge)		0 → 0.392 MPa (gauge)
				Approx. 60 min.	Approx. 90 min.	Approx. 75 min.
		Test process	Temperature range	+105.6 to +142.9°C		+105.6 to +162.2°C
			Humidity range	75 to 98%rh		
			Pressure range	0.020 to 0.196 MPa (gauge)		0.020 to 0.392 MPa (gauge)
			Temperature fluctuation	±0.3°C		
			Temperature gradient	3.0°C		
		Test process	Temperature variation in space	3.0°C		
			Humidity fluctuation	±2.5%rh		
		Temp. pull-down	Temperature range	+50.0 to +95.0°C		
			Temperature pull-down time	From +142.9°C 75%rh to +85.0°C 85%rh		From +162.2°C 75%rh to +85.0°C 85%rh
				Approx. 120 min.	Approx. 120 min.	Approx. 120 min.
		Save process	Temperature range	+50.0 to +95.0°C		
			Humidity range	75 to 95%rh		

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Model		EHS-212 (M, MD)	EHS-222 (M, MD)	EHS-412 (M, MD)
Inside capacity (L) *2		21 (×2)	51 (×2)	21 (×2)
Dimensions *2	Inside dimensions*3	Ø294×D318 (296)	Ø394×D426 (404)	Ø294×D318 (296)
	External dimensions (W×H×D mm)	640 × 1483 × 850 (760 × 1796 × 1000)	740 × 1553 × 1000 (860 × 1796 × 1000)	640 × 1483 × 850 (760 × 1796 × 1000)
Weight (kg) *2		190 (350)	230 (390)	190 (350)

*1 Temperature and humidity chamber based on JIS C60068-3-5:2006, JTM K07:2007, JIS C60068-3-6:2008, and JTM K09:2009; ambient temperature of +23°C; relative humidity of 65 ± 20%rh; rated voltage; no specimen.

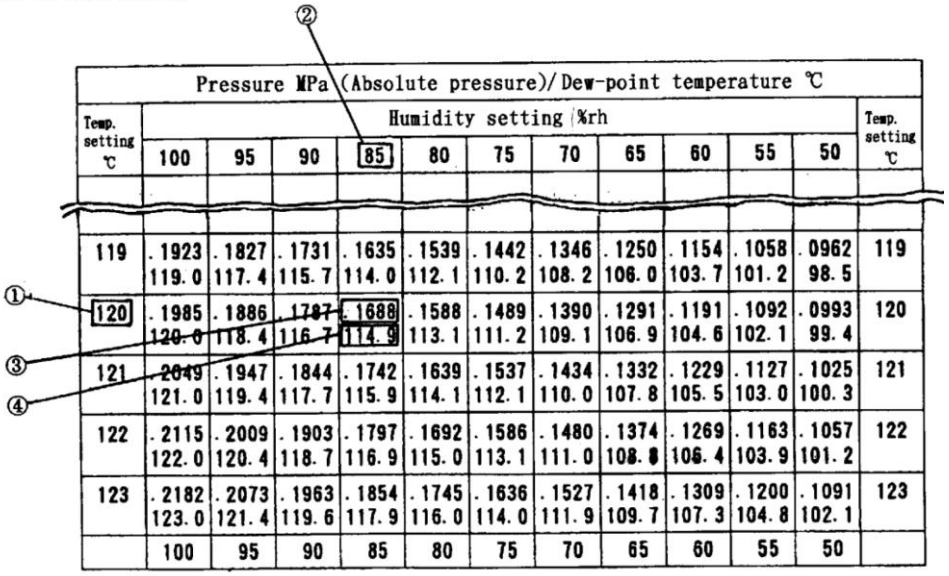
*2 Values in parentheses ( ) are for the double test area model (MD).

*3 Values in parentheses ( ) are the dimension excluding the protrusion of the fan guard.

C. Relationship between temperature and humidity set points and pressure

With the attached steam saturation tables, it is possible to obtain saturated steam pressure and dew-point temperature from the temperature and humidity settings.

(How to read tables)



Pressure MPa (Absolute pressure)/Dew-point temperature ℃

Temp. setting ℃	Humidity setting %rh											Temp. setting ℃
	100	95	90	85	80	75	70	65	60	55	50	
119	.1923 119.0	.1827 117.4	.1731 115.7	.1635 114.0	.1539 112.1	.1442 110.2	.1346 108.2	.1250 106.0	.1154 103.7	.1058 101.2	.0962 98.5	119
120	.1985 120.0	.1886 118.4	.1787 116.7	.1688 114.9	.1588 113.1	.1489 111.2	.1390 109.1	.1291 106.9	.1191 104.6	.1092 102.1	.0993 99.4	120
121	.2049 121.0	.1947 119.4	.1844 117.7	.1742 115.9	.1639 114.1	.1537 112.1	.1434 110.0	.1332 107.8	.1229 105.5	.1127 103.0	.1025 100.3	121
122	.2115 122.0	.2009 120.4	.1903 118.7	.1797 116.9	.1692 115.0	.1586 113.1	.1480 111.0	.1374 108.8	.1269 106.4	.1163 103.9	.1057 101.2	122
123	.2182 123.0	.2073 121.4	.1963 119.6	.1854 117.9	.1745 116.0	.1636 114.0	.1527 111.9	.1418 109.7	.1309 107.3	.1200 104.8	.1091 102.1	123
	100	95	90	85	80	75	70	65	60	55	50	

In the tables, the temperature setting is given as the vertical axis, whereas the humidity setting is given as the horizontal axis.

Example: For a set temperature of 120℃ and set humidity of 85%rh

120.0℃ (along vertical axis) ····· ①

85%rh (along horizontal axis) ····· ②

0.1688 (top number in □) ····· ③

114.9 (bottom number in □) ····· ④

What this indicates is that, for a set temperature of 120.0℃ and set humidity of 85%rh, pressure of the atmosphere inside the test area will be 0.1688 MPa (absolute) when steam saturates, whereas dew-point temperature will be 114.9℃.

However, the pressure gauge gives its own detected pressure and not the absolute pressure.

In any case, the relationship between gauge pressure and absolute pressure is expressed as follows.

Absolute (MPa) − 0.1013 MPa = Gauge pressure (MPa)

0.1013 MPa is the absolute pressure at ground level zero (atmospheric pressure).

In the above example the gauge will read 0.0675 MPa by the following computation.

0.1688 MPa − 0.1013 MPa = 0.0675 MPa

Steam Saturation Table

For temperature setting in 100℃ to 123℃ range

Pressure MPa (Absolute pressure)/Dew-point temperature ℃												
Temp. setting ℃	Humidity setting %rh											Temp. setting ℃
	100	95	90	85	80	75	70	65	60	55	50	
100	.1013 100.0	.0963 98.6	.0912 97.1	.0861 95.5	.0811 93.9	.0760 92.1	.0709 90.3	.0659 88.4	.0608 86.3	.0557 84.1	.0507 81.7	100
101	.1050 101.0	.0997 99.6	.0945 98.1	.0892 96.5	.0840 94.8	.0787 93.1	.0735 91.2	.0682 89.3	.0630 87.2	.0577 85.0	.0525 82.6	101
102	.1088 102.0	.1033 100.6	.0979 99.0	.0925 97.5	.0870 95.8	.0816 94.0	.0761 92.2	.0707 90.2	.0653 88.1	.0598 85.9	.0544 83.5	102
103	.1127 103.0	.1070 101.5	.1014 100.0	.0958 98.4	.0901 96.8	.0845 95.0	.0789 93.1	.0732 91.2	.0676 89.0	.0620 86.8	.0563 84.3	103
104	.1167 104.0	.1108 102.5	.1050 101.0	.0992 99.4	.0933 97.7	.0875 95.9	.0817 94.1	.0758 92.1	.0700 90.0	.0642 87.7	.0583 85.2	104
105	.1208 105.0	.1148 103.5	.1087 102.0	.1027 100.4	.0966 98.7	.0906 96.9	.0846 95.0	.0785 93.0	.0725 90.9	.0664 88.6	.0604 86.1	105
106	.1250 106.0	.1188 104.5	.1125 103.0	.1063 101.3	.1000 99.6	.0938 97.8	.0875 96.0	.0813 93.9	.0750 91.8	.0688 89.5	.0625 87.0	106
107	.1294 107.0	.1229 105.5	.1165 103.9	.1100 102.3	.1035 100.6	.0971 98.8	.0906 96.9	.0841 94.9	.0776 92.7	.0712 90.4	.0647 87.9	107
108	.1339 108.0	.1272 106.5	.1205 104.9	.1138 103.3	.1071 101.6	.1004 99.8	.0937 97.8	.0870 95.8	.0803 93.6	.0736 91.3	.0669 88.8	108
109	.1385 109.0	.1316 107.5	.1247 105.9	.1177 104.3	.1108 102.5	.1039 100.7	.0970 98.8	.0900 96.7	.0831 94.5	.0762 92.2	.0693 89.7	109
110	.1433 110.0	.1361 108.5	.1289 106.9	.1218 105.2	.1146 103.5	.1074 101.7	.1003 99.7	.0931 97.7	.0860 95.5	.0788 93.1	.0716 90.6	110
111	.1481 111.0	.1407 109.5	.1333 107.9	.1259 106.2	.1185 104.5	.1111 102.6	.1037 100.7	.0963 98.6	.0889 96.4	.0815 94.0	.0741 91.5	111
112	.1532 112.0	.1455 110.5	.1378 108.9	.1302 107.2	.1225 105.4	.1149 103.6	.1072 101.6	.0996 99.5	.0919 97.3	.0842 94.9	.0766 92.3	112
113	.1583 113.0	.1504 111.5	.1425 109.8	.1346 108.1	.1267 106.4	.1187 104.5	.1108 102.5	.1029 100.4	.0950 98.2	.0871 95.8	.0792 93.2	113
114	.1636 114.0	.1554 112.4	.1473 110.8	.1391 109.1	.1309 107.3	.1227 105.5	.1145 103.5	.1064 101.4	.0982 99.1	.0900 96.7	.0818 94.1	114
115	.1691 115.0	.1606 113.4	.1522 111.8	.1437 110.1	.1352 108.3	.1268 106.4	.1183 104.4	.1099 102.3	.1014 100.0	.0930 97.6	.0845 95.0	115
116	.1746 116.0	.1659 114.4	.1572 112.8	.1485 111.1	.1397 109.3	.1310 107.4	.1223 105.3	.1135 103.2	.1048 100.9	.0961 98.5	.0873 95.9	116
117	.1804 117.0	.1714 115.4	.1624 113.8	.1533 112.0	.1443 110.2	.1353 108.3	.1263 106.3	.1173 104.1	.1082 101.9	.0992 99.4	.0902 96.8	117
118	.1863 118.0	.1770 116.4	.1677 114.7	.1583 113.0	.1490 111.2	.1397 109.3	.1304 107.2	.1211 105.1	.1118 102.8	.1025 100.3	.0931 97.7	118
119	.1923 119.0	.1827 117.4	.1731 115.7	.1635 114.0	.1539 112.1	.1442 110.2	.1346 108.2	.1250 106.0	.1154 103.7	.1058 101.2	.0962 98.5	119
120	.1985 120.0	.1886 118.4	.1787 116.7	.1688 114.9	.1588 113.1	.1489 111.2	.1390 109.1	.1291 106.9	.1191 104.6	.1092 102.1	.0993 99.4	120
121	.2049 121.0	.1947 119.4	.1844 117.7	.1742 115.9	.1639 114.1	.1537 112.1	.1434 110.0	.1332 107.8	.1229 105.5	.1127 103.0	.1025 100.3	121
122	.2115 122.0	.2009 120.4	.1903 118.7	.1797 116.9	.1692 115.0	.1586 113.1	.1480 111.0	.1374 108.8	.1269 106.4	.1163 103.9	.1057 101.2	122
123	.2182 123.0	.2073 121.4	.1963 119.6	.1854 117.9	.1745 116.0	.1636 114.0	.1527 111.9	.1418 109.7	.1309 107.3	.1200 104.8	.1091 102.1	123
	100	95	90	85	80	75	70	65	60	55	50	

Steam Saturation Table

For temperature setting in 124℃ to 147℃ range

Pressure MPa (Absolute pressure)/Dew-point temperature ℃												
Temp. setting ℃	Humidity setting %rh											Temp. setting ℃
	100	95	90	85	80	75	70	65	60	55	50	
124	.2250 124.0	.2138 122.4	.2025 120.6	.1913 118.8	.1800 116.9	.1688 115.0	.1575 112.8	.1463 110.6	.1350 108.2	.1238 105.7	.1125 103.0	124
125	.2321 125.0	.2205 123.3	.2089 121.6	.1973 119.8	.1857 117.9	.1741 115.9	.1625 113.8	.1509 111.5	.1393 109.2	.1277 106.6	.1160 103.8	125
126	.2393 126.0	.2274 124.3	.2154 122.6	.2034 120.8	.1915 118.9	.1795 116.8	.1675 114.7	.1556 112.5	.1436 110.1	.1316 107.5	.1197 104.7	126
127	.2468 127.0	.2344 125.3	.2221 123.6	.2097 121.7	.1974 119.8	.1851 117.8	.1727 115.7	.1604 113.4	.1481 111.0	.1357 108.4	.1234 105.6	127
128	.2544 128.0	.2418 126.3	.2289 124.6	.2162 122.7	.2035 120.8	.1908 118.7	.1780 116.6	.1653 114.3	.1526 111.9	.1399 109.3	.1272 106.5	128
129	.2621 129.0	.2490 127.3	.2359 125.5	.2228 123.7	.2097 121.7	.1966 119.7	.1835 117.5	.1704 115.2	.1573 112.8	.1442 110.2	.1311 107.4	129
130	.2701 130.0	.2566 128.3	.2431 126.5	.2296 124.7	.2161 122.7	.2026 120.6	.1891 118.5	.1756 116.2	.1621 113.7	.1486 111.1	.1351 108.3	130
131	.2783 131.0	.2644 129.3	.2505 127.5	.2366 125.6	.2227 123.7	.2087 121.6	.1948 119.4	.1809 117.1	.1670 114.6	.1531 112.0	.1392 109.1	131
132	.2867 132.0	.2724 130.3	.2580 128.5	.2437 126.6	.2294 124.6	.2150 122.5	.2007 120.3	.1864 118.0	.1720 115.5	.1577 112.9	.1433 110.0	132
133	.2953 133.0	.2805 131.3	.2658 129.5	.2510 127.6	.2362 125.6	.2215 123.5	.2067 121.3	.1919 118.9	.1772 116.4	.1624 113.8	.1476 110.9	133
134	.3041 134.0	.2889 132.3	.2737 130.4	.2585 128.5	.2433 126.5	.2281 124.4	.2129 122.2	.1976 119.9	.1824 117.4	.1672 114.7	.1520 111.8	134
135	.3131 135.0	.2974 133.2	.2818 131.4	.2661 129.5	.2505 127.5	.2348 125.4	.2192 123.1	.2035 120.8	.1878 118.3	.1722 115.6	.1565 112.7	135
136	.3223 136.0	.3062 134.2	.2901 132.4	.2739 130.5	.2578 128.4	.2417 126.3	.2256 124.1	.2095 121.7	.1934 119.2	.1773 116.5	.1611 113.5	136
137	.3317 137.0	.3151 135.2	.2986 133.4	.2820 131.4	.2654 129.4	.2488 127.3	.2322 125.0	.2156 122.6	.1990 120.1	.1824 117.4	.1659 114.4	137
138	.3414 138.0	.3243 136.2	.3072 134.4	.2902 132.4	.2731 130.4	.2560 128.2	.2390 126.0	.2219 123.5	.2048 121.0	.1878 118.2	.1707 115.3	138
139	.3513 139.0	.3337 137.2	.3161 135.3	.2986 133.4	.2810 131.3	.2635 129.2	.2459 126.9	.2283 124.5	.2108 121.9	.1932 119.1	.1756 116.2	139
140	.3614 140.0	.3433 138.2	.3252 136.3	.3072 134.3	.2891 132.3	.2710 130.1	.2530 127.8	.2349 125.4	.2168 122.8	.1988 120.0	.1807 117.1	140
141	.3717 141.0	.3531 139.2	.3346 137.3	.3160 135.3	.2974 133.2	.2788 131.1	.2602 128.8	.2416 126.3	.2230 123.7	.2044 120.9	.1859 117.9	141
142	.3823 142.0	.3632 140.2	.3441 138.3	.3250 136.3	.3058 134.2	.2867 132.0	.2676 129.7	.2485 127.2	.2294 124.6	.2103 121.8	.1912 118.8	142
143	.3931 143.0	.3735 141.2	.3538 139.3	.3342 137.3	.3145 135.2	.2948 133.0	.2752 130.6	.2555 128.2	.2359 125.5	.2162 122.7	.1966 119.7	143
144	.4042 144.0	.3840 142.2	.3638 140.2	.3436 138.2	.3234 136.1	.3032 133.9	.2829 131.6	.2627 129.1	.2425 126.4	.2223 123.6	.2021 120.6	144
145	.4155 145.0	.3947 143.1	.3740 141.2	.3532 139.2	.3324 137.1	.3116 134.8	.2909 132.5	.2701 130.0	.2493 127.3	.2285 124.5	.2078 121.4	145
146	.4271 146.0	.4057 144.1	.3844 142.2	.3630 140.2	.3417 138.0	.3203 135.8	.2990 133.4	.2776 130.9	.2563 128.2	.2349 125.4	.2135 122.3	146
147	.4389 147.0	.4170 145.1	.3950 143.2	.3731 141.1	.3511 139.0	.3292 136.7	.3072 134.4	.2853 131.8	.2634 129.2	.2414 126.3	.2195 123.2	147
	100	95	90	85	80	75	70	65	60	55	50	

Steam Saturation Table

For temperature setting in 148℃ to 170℃ range

Pressure MPa (Absolute pressure)/Dew-point temperature ℃												
Temp. setting ℃	Humidity setting %rh											Temp. setting ℃
	100	95	90	85	80	75	70	65	60	55	50	
148	.4510 148.0	.4285 146.1	.4059 144.2	.3834 142.1	.3608 139.9	.3383 137.7	.3157 135.3	.2932 132.8	.2706 130.1	.2481 127.2	.2255 124.1	148
149	.4634 149.0	.4402 147.1	.4170 145.1	.3939 143.1	.3707 140.9	.3475 138.6	.3244 136.2	.3012 133.7	.2780 131.0	.2549 128.1	.2317 124.9	149
150	.4760 150.0	.4522 148.1	.4284 146.1	.4046 144.0	.3808 141.9	.3570 139.6	.3332 137.2	.3094 134.6	.2856 131.9	.2618 129.0	.2380 125.8	150
151	.4889 151.0	.4645 149.1	.4400 147.1	.4156 145.0	.3911 142.8	.3667 140.5	.3422 138.1	.3178 135.5	.2933 132.8	.2689 129.8	.2444 126.7	151
152	.5021 152.0	.4770 150.1	.4519 148.1	.4268 146.0	.4017 143.8	.3766 141.5	.3515 139.0	.3264 136.4	.3012 133.7	.2761 130.7	.2510 127.6	152
153	.5155 153.0	.4898 151.1	.4640 149.0	.4382 146.9	.4124 144.7	.3867 142.4	.3609 140.0	.3351 137.4	.3093 134.6	.2835 131.6	.2578 128.4	153
154	.5293 154.0	.5028 152.1	.4764 150.0	.4499 147.9	.4234 145.7	.3970 143.3	.3705 140.9	.3440 138.3	.3176 135.5	.2911 132.5	.2646 129.3	154
155	.5433 155.0	.5162 153.0	.4890 151.0	.4618 148.9	.4347 146.6	.4075 144.3	.3803 141.8	.3532 139.2	.3260 136.4	.2988 133.4	.2717 130.2	155
156	.5577 156.0	.5298 154.0	.5019 152.0	.4740 149.8	.4461 147.6	.4183 145.2	.3904 142.7	.3625 140.1	.3346 137.3	.3067 134.3	.2788 131.1	156
157	.5723 157.0	.5437 155.0	.5151 153.0	.4865 150.8	.4578 148.6	.4292 146.2	.4006 143.7	.3720 141.0	.3434 138.2	.3148 135.2	.2862 131.9	157
158	.5872 158.0	.5579 156.0	.5285 153.9	.4992 151.8	.4698 149.5	.4404 147.1	.4111 144.6	.3817 141.9	.3523 139.1	.3230 136.1	.2936 132.8	158
159	.6025 159.0	.5724 157.0	.5422 154.9	.5121 152.7	.4820 150.5	.4519 148.1	.4217 145.5	.3916 142.9	.3615 140.0	.3314 137.0	.3012 133.7	159
160	.6181 160.0	.5872 158.0	.5563 155.9	.5254 153.7	.4945 151.4	.4635 149.0	.4326 146.5	.4017 143.8	.3708 140.9	.3399 137.9	.3090 134.6	160
161	.6339 161.0	.6023 159.0	.5706 156.9	.5389 154.7	.5072 152.4	.4755 150.0	.4438 147.4	.4121 144.7	.3804 141.8	.3487 138.7	.3170 135.4	161
162	.6502 162.0	.6176 160.0	.5851 157.9	.5526 155.7	.5201 153.3	.4876 150.9	.4551 148.3	.4226 145.6	.3901 142.7	.3576 139.6	.3251 136.3	162
163	.6667 163.0	.6334 161.0	.6000 158.8	.5667 156.6	.5334 154.3	.5000 151.8	.4667 149.3	.4334 146.5	.4000 143.6	.3667 140.5	.3333 137.2	163
164	.6836 164.0	.6494 162.0	.6152 159.8	.5810 157.6	.5468 155.2	.5127 152.8	.4785 150.2	.4443 147.4	.4101 144.5	.3760 141.4	.3418 138.0	164
165	.7008 165.0	.6657 162.9	.6307 160.8	.5957 158.6	.5606 156.2	.5256 153.7	.4905 151.1	.4555 148.4	.4205 145.4	.3854 142.3	.3504 138.9	165
166	.7183 166.0	.6824 163.9	.6465 161.8	.6106 159.5	.5747 157.2	.5387 154.7	.5028 152.1	.4669 149.3	.4310 146.3	.3951 143.2	.3592 139.8	166
167	.7362 167.0	.6994 164.9	.6626 162.8	.6258 160.5	.5890 158.1	.5522 155.6	.5153 153.0	.4785 150.2	.4417 147.2	.4049 144.1	.3681 140.7	167
168	.7545 168.0	.7167 165.9	.6790 163.7	.6413 161.5	.6036 159.1	.5658 156.6	.5281 153.9	.4904 151.1	.4527 148.1	.4150 145.0	.3772 141.5	168
169	.7731 169.0	.7344 166.9	.6958 164.7	.6571 162.4	.6184 160.0	.5798 157.5	.5411 154.8	.5025 152.0	.4638 149.0	.4252 145.8	.3865 142.4	169
170	.7920 170.0	.7524 167.9	.7128 165.7	.6732 163.4	.6336 161.0	.5940 158.4	.5544 155.8	.5148 152.9	.4752 149.9	.4356 146.7	.3960 143.3	170
	100	95	90	85	80	75	70	65	60	55	50	

MEMO

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