ICS 27.200
CCS J 73

National Standard of the People's Republic of China

GB/T ××××-202×

Thermal management for energy storage - Refrigerating units (heat pumps) for electrochemical energy storage

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(English Translation)

Issue date: 202×-××-××　　Implementation date: 202×-××-××

Issued by　State Administration for Market Regulation

National Standardization Administration

Contents

Foreword

SAC/TC 238 is in charge of this English translation. In case of any doubt about the contents of English translation, the Chinese original shall be considered authoritative.

This document is drafted in accordance with the rules given in GB/T 1.1-2020 *Directives for standardization - Part 1: Rules for the structure and drafting of standardization documents*.

Please note that certain contents of this document may involve patents. The issuing authority of this document assumes no responsibility for identifying these patents.

This document was proposed by the China Machinery Industry Federation.

It falls under the centralized administration of the National Technical Committee for Standardization of Refrigeration and Air-Conditioning Equipment (SAC/TC 238).

Thermal management for energy storage - refrigerating units (heat pumps) for electrochemical energy storage

1 Scope

This document specifies the types, basic parameters, technical requirements, inspection rules, and the requirements for marking, packaging, transportation, and storage of refrigerating units (heat pumps) used in electrochemical energy storage. It also defines the corresponding test methods.

This document applies to refrigerating units (heat pumps) utilizing vapor compression cycles for the thermal management of electrochemical energy storage batteries, including both air conditioning units and chilled/hot water units. Other similar units (such as those designed for the thermal management of electrochemical energy storage batteries together with their associated power modules and energy conversion modules) may be used as a reference.

2 Normative References

The contents in the following documents constitute the essential clauses of this document through normative references in the text. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB 2894-2025 *Safety colours and safety signs*

GB/T 3785.1 *Electroacoustics - Sound level meters - Part 1: Specifications*

GB/T 4208-2017 *Degrees of protection provided by enclosure (IP code)*

GB/T 4706.1-2024 *Safety of household and similar electrical appliances - Part 1: General requirements*

GB 4706.32-2024 *Safety of household and similar electrical appliances - Part 32: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers*

GB 5226.1-2019 *Electrical safety of machinery - Electrical equipment of machines - Part 1: General requirements*

GB/T 9237 *Refrigerating systems and heat pumps - Safety and environmental requirements*

GB/T 9286-2021 *Paints and varnishes - Cross-cut test*

GB/T 13306 *Plates*

GB/T 13384 *General specifications for packing of mechanical and electrical product*

GB/T 17626.2-2018 *Electromagnetic compatibility - Testing and measurement techniques - Electrostatic discharge immunity test*

GB/T 17626.3-2023 *Electromagnetic compatibility - Testing and measurement techniques - Part 3: Radiated, radio-frequency, electromagnetic field immunity test*

GB/T 17758 *Unitary air conditioners*

GB 17799.4-2022 *Electromagnetic compatibility (EMC) - Generic standards - Part 4: Emission for industrial environments*

GB/T 18430.1 *Water chilling (heat pump) packages using the vapor compression cycle - Part 1: Water chilling (heat pump) packages for industrial & commercial and similar applications*

GB 25130-2010 *Safety requirements for unitary air-conditioners*

GB/T 26572 *Requirements of concentration limits for certain restricted substances in electrical and electronic products*

GB/T 29044 *Water quality for heating and air conditioning systems*

GB/T 30790.6-2014 *Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 6: Laboratory performance test methods*

GB/T 36547-2024 *Technical requirements for connecting electrochemical energy storage station to power grid*

JB/T 4330-1999 *Determination of noise emitted by refrigerating and air conditioning equipment*

JB/T 7249 Terminology for refrigeration and air conditioning equipment

3 Terms and Definitions

For the purpose of this document, the terms and definitions given in JB/T 7249 and the following apply.

3.1

Refrigerating Units (Heat Pumps) for Electrochemical Energy Storage

Vapor-compression refrigerating units (heat pumps) designed to control the cell temperature of electrochemical energy storage batteries.

3.2

Cooling Capacity

The total amount of heat removed from electrochemical energy storage battery equipment or equipment rooms by the refrigerating unit (heat pump) through a vapor-compression cycle, free air cooling, or other cooling methods.

Note: The unit is the watt (W).

3.3

Heating Capacity

The total amount of heat supplied to electrochemical energy storage battery equipment or equipment rooms by the refrigerating unit (heat pump) through heat pumps, auxiliary electric heaters, or other heating methods.

Note: The unit is the watt (W).

3.4

Power Consumption

The total electrical power consumed by the refrigerating unit (heat pump) for electrochemical energy storage under specified operating conditions.

Note: The unit is the watt (W).

3.5

Coefficient of Performance (COP)

The ratio of cooling (or heating) capacity to the power consumption of the refrigerating unit (heat pump) for electrochemical energy storage under specified operating conditions.

Note 1: The unit is the watts per watt (W/W). Values are rounded to two decimal places (or at least three decimal places when used as process parameters).

Note 2: The cooling coefficient of performance and heating coefficient of performance are denoted as COP_c and COP_h, respectively.

3.6

Annual Cooling Coefficient of Performance (ACCOP)

Under specified operating conditions, the ratio of the total annual heat removed from electrochemical energy storage battery equipment or equipment rooms during cooling operation to the total annual electrical energy consumed by the refrigerating unit (heat pump).

Note 1: The ACCOP is calculated according to Formula (1).

$$ACCOP = \frac{1}{\frac{1}{COP_{ca}}\tau_a + \frac{1}{COP_{cb}}\tau_b + \frac{1}{COP_{cc}}\tau_c + \frac{1}{COP_{cd}}\tau_d + \frac{1}{COP_{ce}}\tau_e} \quad \cdots\cdots\cdots\cdots\cdots\cdots (1)$$

Where:

COP_{ca}–COP_{ce} – COP for cooling at 100% nominal cooling capacity under operating conditions A to E, expressed in watts per watt (W/W).

τ_a–τ_e – Typical city temperature distribution coefficients, representing the percentage of annual operating hours corresponding to the temperature range of A to E.

Note 2: The unit is the watt-hours per watt-hour [W·h/(W·h)]. Calculated values shall be rounded to two decimal places.

4 Types and Basic Parameters

4.1 Types

4.1.1 Refrigerating units (heat pumps) for electrochemical energy storage (hereinafter referred to as "units") are classified, based on the heat exchange medium on the user side, as follows:

- Air circulation heat exchange type, also known as air conditioning units;
- Liquid circulation heat exchange type, also known as chilled/hot water units.

4.1.2 Units are classified according to the refrigeration method as follows:

- Mechanical refrigeration type;
- Hybrid refrigeration type (free cooling + mechanical refrigeration), further categorized by the free cooling method into:

- Refrigerant circulation free cooling type;
- Secondary coolant circulation free cooling type.

4.1.3 Units are classified according to the number of energy storage devices they connect to and manage as follows:

- Unitary type (one unit connected to and managing a single energy storage device);
- Centralized type (one or more units simultaneously connected to and managing multiple energy storage devices).

4.1.4 Units are classified according to their functions as follows:

- Cooling-only type;
- Heating and cooling type, further classified by heating method into:
  - Electric heater type;
  - Heat pump type;
  - Hybrid type (electric heater + heat pump).

4.1.5 Units are classified according to their structures as follows:

- Split type;
- Integral type.

4.2 Model

The designation of a unit model may be determined by the manufacturer; however, the cooling capacity of the unit under nominal operating conditions shall be reflected in the model designation.

Note: The cooling capacity under nominal operating conditions may be given as an approximation of the nominal cooling capacity.

4.3 Basic Parameters

4.3.1 Operating Conditions

Units shall be capable of normal operation under the environmental conditions specified in Table 1.

Table 1 Operating Conditions

Item	Air circulation heat exchange type		Liquid circulation heat exchange type	
Indoor environment	Indoor DB temperature: -30℃ to 55℃	Indoor relative humidity: 5% to 95%	Liquid inlet temperature: -30℃ to 55℃	Liquid outlet temperature: 15℃ to 30℃
Outdoor DB temperature	-30℃ to 55℃[a]			
Altitude[b]	≤2000 m			
[a] If a unit is not designed to operate under the above service conditions, the manufacturer shall clearly state this and, in consultation with the user, specify additional measures or define the conditions for				

de-rated operation.

[b] When the installation altitude exceeds 2000 m, it is recommended to reduce the outdoor ambient temperature rating by 1℃ for every additional 200 m in altitude.

4.3.2 Test Conditions

4.3.2.1 The test conditions for air circulation heat exchange units shall comply with the requirements specified in Table 2.

Table 2 Test Conditions for Air Circulation Heat Exchange Units

(Unit: ℃)

Operating conditions		Indoor air state		Outdoor air state	
		DB temperature	WB temperature	DB temperature	WB temperature
Nominal cooling capacity[a]		27	19	45	—
Nominal heating capacity	Heat pump type	20	—	-5	-5.7
	Hybrid type				
	Electric heater type	20	—	—	—
High-temperature cooling startup and operation		55[b]	—	55	—
Low-temperature cooling startup and operation		25	—	-30	—
Low-temperature heating startup and operation		-30[c]	—	-30	—
Defrosting		20	—	2	1
Condensation		25	21	23	—

Notes: The symbol "—" in the table indicates that no mandatory requirement applies.

[a] The nominal operating conditions for special scenarios may be defined individually based on user requirements.

[b] This indicates the operating condition during unit startup, with the indoor DB temperature stabilizing at 27℃ and WB temperature at 19℃ after the system reaches steady-state operation.

[c] This indicates the operating condition during unit startup, with the indoor DB temperature stabilizing at 20℃ after the system reaches steady-state operation.

4.3.2.2 The test conditions for liquid circulation heat exchange units shall comply with the requirements specified in Table 3.

Table 3 Test Conditions for Liquid Circulation Heat Exchange Units

Operating conditions		Indoor secondary coolant state		Outdoor air state	
		Secondary coolant flow rate per unit cooling capacity[a] $m^3/(h \cdot kW)$	Liquid outlet temperature ℃	DB temperature ℃	WB temperature ℃
Nominal cooling capacity[b]		0.5	18	45	—
Nominal heating capacity	Heat pump type	0.5	25	-5	-5.7
	Hybrid type				
	Electric heater type	0.5	25	—	—
High-temperature cooling startup and operation		0.5	55[c]	55	—
Low-temperature cooling startup and operation		0.5	18	-30	—
Low-temperature heating startup and operation		0.5	10[d]	-30	—
Defrosting		—	25	2	1
Condensation		0.5	15	55	48

The water-side (user-side) temperature shall be adjusted in accordance with Annex B of GB/T 18430.1-2024 (with a user-side fouling factor of 0.018 $m^2 \cdot ℃/kW$), and the test conditions shall be set based on the adjusted temperature.

Notes: The symbol "—" in the table indicates that no mandatory requirement applies.

[a] The secondary coolant is a 50% glycol solution by volume (freezing point: -37.9℃). The flow rate of the secondary coolant is determined according to the nominal cooling capacity specified for the unit.

[b] The nominal operating conditions for special scenarios may be defined individually based on user requirements.

[c] This indicates the liquid outlet temperature during unit startup; once the system reaches steady-state operation, the liquid outlet temperature stabilizes at 30℃.

[d] This indicates the liquid outlet temperature during unit startup; once the system reaches steady-state operation, the liquid outlet temperature stabilizes at 20℃.

4.3.2.3 The annual cooling performance test conditions are given in Table 4.

Table 4 Annual Cooling Performance Test Conditions

(Unit: ℃)

Item		Unit type	Test condition[a]				
			A	B	C	D	E
Outdoor	Air inlet DB temperature	Air circulation heat exchange type/Liquid circulation heat exchange type	35	25	15	5	-5
Indoors	Air inlet DB temperature	Air circulation heat exchange type	27				
	Air inlet WB temperature		19				
	Liquid inlet temperature	Liquid circulation heat exchange type	[b]				
	Liquid outlet temperature		18				

[a] The test conditions for special scenarios may be defined individually based on user requirements.

[b] The test is conducted based on the flow rate under nominal cooling conditions.

5 Technical Requirements

5.1 General Requirements

5.1.1 Units shall be manufactured in accordance with drawings and technical documents that have been approved through the required procedures.

5.1.2 All ferrous metal surfaces of the units shall undergo anti-corrosion treatment.

5.1.3 Electroplated surfaces shall be smooth, uniform in color, and free from defects such as peeling, exposed substrate, pinholes, visible spots, or scratches. Painted surfaces shall be flat, evenly coated, and uniform in color, free from visible bubbles, flow marks, wrinkles, as well as any coating omissions or exposed primer.

5.1.4 Decorative plastic surfaces shall be flat and smooth, uniform in color, and free from defects such as cracks, bubbles, or visible shrinkage cavities.

5.1.5 All components shall be securely and reliably installed. Rotating components, such as refrigerant compressors and water pumps, shall be provided with anti-vibration measures.

5.1.6 The content of hazardous substances in the control system hardware shall comply with the requirements of GB/T 26572.

5.1.7 Units shall be equipped with anti-vibration mounts, and piping connections shall incorporate vibration isolation measures.

5.1.8 The protection level and corrosion resistance grade of units shall meet the following requirements:

a) For units installed outdoors or in semi-outdoor areas, the electrical control box shall have a protection rating of at least IP55 in accordance with GB/T 4208-2017, and the entire unit shall have a protection rating of no less than IPX5 under the same standard.

b) For liquid-cooled units installed indoors or in the cabin, the electrical control box shall have a protection rating of at least IP20 in accordance with GB/T 4208-2017, and the entire unit shall have a minimum protection rating of IP20 under the same standard.

c) The protection rating of air inlet and outlet meshes shall be no lower than IP2X in accordance with GB/T 4208-2017.

d) The corrosion resistance rating of units installed in urban and industrial atmospheres, or in coastal areas with low salinity shall not be lower than C3 in accordance with GB/T 30790.6-2014.

5.1.9 The water system of the unit shall be equipped with a pressure relief device.

5.2 Strength and Air-tightness

5.2.1 Strength

During the pressure test, all piping components and connections in the water system shall remain free from abnormal deformation, leakage, or other irregularities.

5.2.2 Air-tightness

No refrigerant or secondary coolant shall leak from any part of the refrigeration system.

5.3 Test Run

Units shall start normally during the test run and operate without any abnormalities.

5.4 Nominal Cooling Capacity

5.4.1 The measured nominal cooling capacity of a unit shall be no less than 95% of the declared value, and the nominal cooling power consumption shall not exceed 110% of the declared value.

5.4.2 The measured nominal cooling COP of a unit shall be no less than 95% of the declared value, and shall not fall below the limits specified in Table 5.

5.4.3 The measured head of a liquid circulation heat exchange unit shall be no less than 95% of the declared value.

Table 5 COP Limits

Unit type	COP_c W/W	ACCOP W·h/(W·h)
Air circulation heat exchange type	1.5	3.0
Liquid circulation heat exchange type	1.5	3.0
Note: During low ambient temperature cooling tests, units may operate in free cooling mode.		

5.5 Nominal Heating Capacity

5.5.1 The measured nominal heating capacity of a heat pump unit shall be no less than 95% of the declared value, and the nominal heating power consumption shall not exceed 110% of the declared value.

5.5.2 The measured nominal heating capacity of an electric heater unit shall be no less than 95% of the declared value.

5.5.3 The measured nominal heating capacity of a hybrid heating unit shall be no less than 95% of the declared value, and the nominal heating power consumption shall not exceed 110% of the declared value.

5.6 Annual Cooling Performance

The ACCOP of a unit shall be no less than 95% of the declared value, and shall not fall below the limits specified in Table 5.

5.7 High-temperature Cooling Startup and Operation

During high-temperature cooling startup and operation tests, units shall start normally and operate stably without causing damage to any components, and the overload protector shall not trip.

5.8 Low-temperature Cooling Startup and Operation

During low-temperature cooling startup and operation tests, units shall start normally and operate stably.

5.9 Low-temperature Heating Startup and Operation

During low-temperature heating startup and operation tests, units shall start normally and operate stably.

5.10 Defrosting

For heat pump or hybrid heating/cooling units, the following requirements must be met during defrost test:

a) Units shall continue operating and shall not stop due to the activation of safety protection components.

b) Defrosting shall be performed automatically, with normal operation and complete removal of frost, and the defrost water shall be discharged properly.

c) The defrosting duration shall not exceed 20% of the total test time.

5.11 Water Flow Rate

The measured water flow rate of a liquid circulation heat exchange unit shall be no less than 95% of the nominal water flow rate at the nominal external resistance or nominal head.

5.12 Noise

The measured noise value (sound pressure level) shall not exceed the limits specified in Table 6, nor shall it exceed the declared value by more than +2 dB(A).

Table 6 Noise Limits (Sound Pressure Level)

Nominal cooling capacity (CC) W	Noise dB(A)
CC < 10,000	73
10,000 ≤ CC < 40,000	75
40,000 ≤ CC < 60,000	80
CC ≥ 60,000	85

5.13 Condensation

During the condensation test, any air circulation heat exchange unit shall meet the following requirements:

a) No condensate water shall overflow or be discharged from any location other than the drain outlet.

b) No water droplets shall be present on the unit's exterior surface or at the air outlet.

c) No water droplets shall be present in the supplied air.

5.14 Vibration

The measured vibration level of a unit shall not exceed the declared value.

5.15 Electric Safety

5.15.1 Voltage Variation Performance

During the voltage variation performance test, units shall operate continuously without any abnormalities, and safety protection mechanisms shall not be triggered. Specifically, the overheat protection devices in electric heater or hybrid units shall remain inactive.

5.15.2 Insulation Resistance

The insulation resistance of a unit (measured in a cold state) shall be no less than 2 MΩ.

5.15.3 Leakage Current

The leakage current of a unit shall not exceed 2 mA/kW (calculated based on the declared nominal cooling power consumption), with a maximum of 30 mA.

5.15.4 Electric Strength

During the electric strength test, no breakdown or flashover shall occur in the unit.

5.15.5 Earthing Device

5.15.5.1 The unit shall be provided with a protective earthing device, ensuring that all accessible metal parts are reliably connected to the earthing device. The earthing terminal and its clamping device shall be used exclusively for protective earthing purposes. The earthing device shall be securely connected, and all components of the protective earthing circuit shall be made of corrosion-resistant metal. Each protective earthing point shall be marked or labeled in accordance with the requirements of Section 8.2 of GB/T 5226.1-2019.

5.15.5.2 The protective earthing circuit of the unit shall maintain electrical continuity. The maximum voltage dip measured during the test, conducted in accordance with the method specified in Section 6.4.15, shall not exceed the values given in Table 7. Alternatively, the earthing resistance test equipment shall be capable of carrying 1.5 times the rated current. The earthing resistance test shall be performed in accordance with GB/T 4706.1-2024. The earthing resistance of the unit shall not exceed 0.1 Ω.

Table 7 Maximum Voltage Dip of the Protective Earthing Circuit

Minimum effective cross-sectional area of the tested protective conductor branch circuit (mm^2)	Maximum voltage dip (measured at a test current of 10 A) V
1.0	3.3
1.5	2.6
2.5	1.9
4.0	1.4
> 6	1.0

5.16. Control

5.16.1 Communication Function

The unit shall be provided with an independent communication port for receiving external control commands. This port shall also be capable of transmitting the unit's critical operating parameters and fault information.

5.16.2 Fault Detection

The unit shall be equipped with a fault alarm function. During operation, the unit shall output the corresponding fault alarm signal when a fault occurs. The unit shall incorporate protective functions against leakage, overheating, overcurrent, and short-circuit conditions. The unit shall be provided with an emergency shutdown function. Upon activation, the unit shall immediately cease operation.

5.17 Electromagnetic Compatibility

5.17.1 The electrostatic discharge immunity of the unit shall comply with Immunity Level 3 as specified in GB/T 17626.2-2018.

5.17.2 The radio-frequency electromagnetic field immunity of the unit shall comply with Test Level 3 as specified in GB/T 17626.3-2023.

5.17.3 The electromagnetic emission in the test of the unit shall comply with the requirements specified in GB 17799.4-2022.

5.18 Grid Frequency Adaptability

The unit's grid frequency adaptability shall comply with the requirements specified in Section 9.3 of GB/T 36547-2024.

5.19 High Voltage Ride Through (HVRT)

The unit shall be equipped with HVRT capability and shall comply with the requirements specified in Section 8.2 of GB/T 36547-2024.

5.20 Low Voltage Ride Through (LVRT)

The unit shall be equipped with LVRT capability and shall comply with the requirements specified in Section 8.1 of GB/T 36547-2024.

6 Test Methods

6.1 Test Conditions

6.1.1 Site Conditions

6.1.1.1 The atmospheric pressure at the test site shall be within (101±10) kPa. If the pressure is outside this range, corrections shall be made in accordance with the relevant standards or by mutual agreement.

6.1.1.2 The test room's space shall meet the installation requirements of the unit.

6.1.1.3 The airflow rate of the treated air in the test room shall not be lower than that of the outdoor air.

6.1.1.4 During the test, the air velocity near a unit shall not exceed 2.5 m/s.

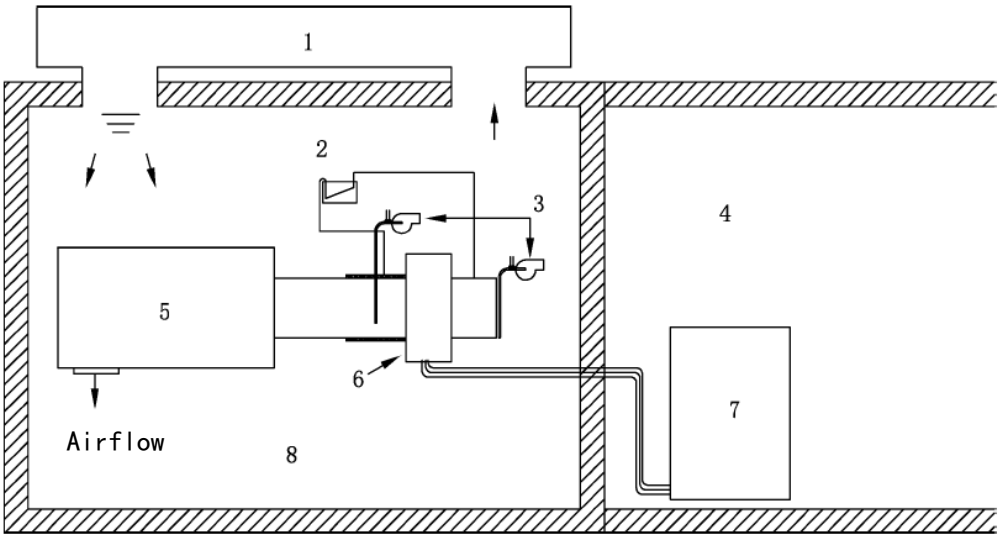
6.1.1.5 For air circulation heat exchange units, the volume of the test room shall be designed to maintain air circulation conditions equivalent to normal operation, preventing thermal short-circuiting of return air due to limited space. The airflow rate of the ODU and IDU shall not be lower than that of the energy storage equipment under test. After being processed under the specified operating conditions, the air shall be returned to the test room uniformly at low speed. The unit shall preferably be positioned at the center of the room.

6.1.1.6 The clearance between the test room wall and the air-discharge side of the ODU shall not be less than 1.8 m. The clearance between other sides of the unit and the test room wall shall not be less than 0.9 m.

6.1.1.7 The test equipment shall comply with the following provisions:

a) The test device for the air circulation heat exchange unit is shown in Figure 1. The IDU shall be placed in the enthalpy difference laboratory's wind tunnel. DB and WB temperature sensors shall be installed at the air inlet and return port of the IDU. Pressure gauges

shall be positioned at the wind tunnel nozzle and at the air outlet of the IDU. The test shall be conducted as per the methods specified in Annex A of GB/T 17758-2023.



Index number description:

1 - Room air conditioning device;

2 - Pressure gauge;

3 - Temperature sampler;

4 - ODU test room;

5 - Airflow rate measurement device;

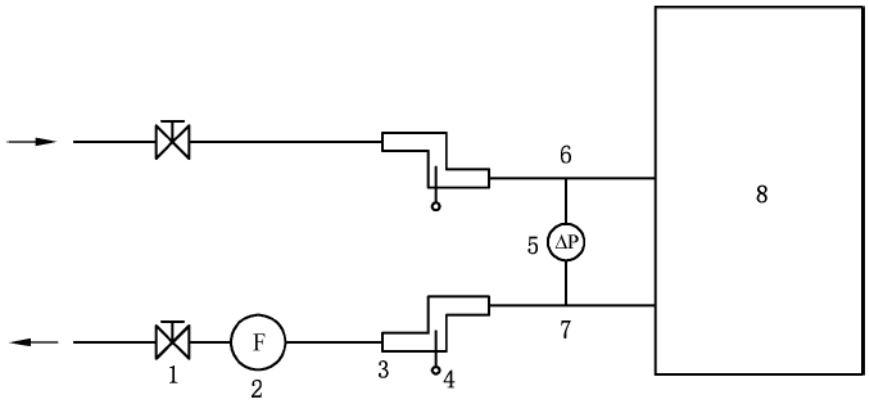
6 - IDU;

7 - ODU;

8 - IDU test room.

Figure 1 Test Devices for an Air Circulation Heat Exchange Unit

b) The test devices for an air circulation heat exchange unit are shown in Figure 2. A water flow measurement device shall be installed at the unit's outlet. Temperature sensors and differential pressure gauges shall be installed at both the water inlet and outlet. The temperature sensors shall be located in the Z-shaped pipe section, oriented in the water flow direction, to ensure accurate measurement. The pipeline sections between the water temperature measurement points and the unit's water inlet and outlet shall be insulated.



Index number description:

1 – Stop valve;

2 – Flow meter;

3 – Z-shaped pipe;

4 – Temperature sensor;

5 – Differential pressure gauge

6 – Water inlet;

7 – Water outlet;

8 – Chiller.

Figure 2 Test Devices for a Liquid Circulation Heat Exchange Unit

6.1.2 Test Resources

6.1.2.1 The power supply shall provide the rated voltage and frequency required by the unit and shall meet the following requirements:

a) The frequency deviation shall not exceed ±0.5 Hz.

b) The voltage deviation shall not exceed ±5% of the rated voltage.

6.1.2.2 The quality of the secondary coolant shall comply with the requirements of GB/T 29044.

6.1.3 Instrumentation

6.1.3.1 The types and accuracies of instrumentation used for testing shall comply with the requirements specified in GB/T 17758. All the instrumentation shall be verified or calibrated by an authorized metrological inspection body, and within the validity period.

6.1.3.2 The density of the glycol solution shall be measured using a densimeter with an accuracy of ±1% or better.

6.1.4 Tooling Equipment

6.1.4.1 The measurement of air-side temperature for the unit shall comply with the requirements of GB/T 17758.

6.1.4.2 The measurement of water-side pressure loss, flow rate, and temperature for the unit shall comply with the requirements of GB/T 18430.1.

6.1.4.3 The measurement of static pressure at the unit's air outlet shall comply with the requirements specified in Annex A.

6.2 Installation

6.2.1 The tested unit shall be securely installed in accordance with the requirements specified in the user manual or the manufacturer's relevant regulations.

6.2.2 The refrigerant shall be charged according to the nameplate specifications. No adjustment of the refrigerant charge shall be made during testing.

6.2.3 For liquid circulation heat exchange units, the cooling medium shall be configured as specified on the nameplate. No adjustment of the cooling medium composition shall be made during testing.

6.2.4 The unit shall be powered at the rated voltage and frequency, or at the voltage and frequency specified in this document.

6.3 Data Processing

6.3.1 During testing, the allowable deviation of each parameter shall comply with the requirements specified in Tables 8 and 9.

Note 1: Average variation range—The deviation between the measured average value and the specified value for each test condition.

Note 2: Maximum variation range—The deviation between the measured maximum or minimum value and the specified value for each test condition during testing.

Note 3: A unit shall be considered to have reached a stable operating condition when it operates steadily under various working conditions and the relevant readings comply with the tolerances specified in Table 8.

Table 8 Reading Tolerance for Test Conditions (Average Variation Range)

Operating conditions	User side					Heat source side	
	Air circulation heat exchange type			Liquid circulation heat exchange type		—	
	DB temperature ℃	WB temperature ℃	Airflow	Liquid outlet temperature ℃	Secondary coolant flow rate	DB temperature ℃	WB temperature ℃
Nominal cooling capacity	±0.3	±0.2	±3%	±0.3	±5%	±0.3	—
Nominal heating capacity	±0.3	—	±3%	±0.3	±5%	±0.3	±0.3
High-temperature cooling startup and operation	±0.5	±0.3	±3%	±0.5	±5%	±0.5	—

Low-temperature cooling startup and operation	±0.5	±0.3	±3%	±0.5	±5%	±0.5	—
Low-temperature heating startup and operation	±0.5	—	±3%	±0.5	±5%	±0.5	±0.5
Defrosting	±0.5	±0.5	±3%	±0.5	±5%	±1	±0.5
Condensation	±0.5	±0.3	±3%	±0.5	±5%	±0.5	—

Table 9 Reading Tolerance for Test Conditions (Maximum Variation Range)

Operating conditions	User side					Heat source side	
	Air circulation heat exchange type			Liquid circulation heat exchange type		—	
	DB temperature ℃	WB temperature ℃	Airflow	Liquid outlet temperature ℃	Secondary coolant flow rate	DB temperature ℃	WB temperature ℃
Nominal cooling capacity	±0.5	±0.5	±5%	±0.5	±5%	±0.5	—
Nominal heating capacity	±0.5	—	±5%	±0.5	±5%	±0.5	±0.5
High-temperature cooling startup and operation	±1	±1	±5%	±1	±5%	±1	—
Low-temperature cooling startup and operation	±1	±1	±5%	±1	±5%	±1	—
Low-temperature heating startup and operation	±1	—	±5%	±1	±5%	±1	±1
Defrosting	±1	±1	±5%	±1	±5%	±1	±1
Condensation	±1	±1	±5%	±1	±5%	±1	—

6.3.2 Data collection and processing shall comply with the requirements specified in GB/T 17758 and GB/T 18430.1.

6.4. Test Steps

6.4.1 Strength Test

Perform a hydrostatic test at 1.25 times the design pressure or a pneumatic test at 1.15 times the design pressure on the water circuit system. Maintain the pressure for at least 10 minutes, and inspect the water system for abnormalities such as deformation or leakage.

6.4.2 Air Tightness Test

Refrigerant leakage test for the fluorine system: Place the unit in a positive-pressure chamber with no strong air currents, maintaining an ambient temperature between 15℃ and 35℃. Under the refrigerant charge specified on the unit nameplate, test the refrigerant tightness using a refrigerant leak detector with a sensitivity of 1×10^{-6} Pa·m^3/s. Check all welded joints and connecting components for abnormalities or leaks.

Secondary coolant leakage test for the water system (for liquid circulation heat exchange units): Seal both ends of the unit's water inlet and outlet pipes, and fill the system with nitrogen until the pipeline pressure reaches 0.3 MPa. Immerse the unit's water circuit in water for 5 minutes, and inspect it for any deformation or leakage.

6.4.3 Test Run

Perform a power-on test run at the rated voltage and frequency on the unit to check whether the unit starts and operates normally, and whether there is any leakage, abnormal noise, or other irregularities during operation.

6.4.4 Nominal Cooling Performance

Conduct a cooling capacity test on the unit under the nominal cooling conditions specified in Table 2, Table 3, or Table 4, in accordance with the methods prescribed in GB/T 17758 and GB/T 18430.1.

For air circulation heat exchange units, calculate the cooling capacity using Formula (2).

$$q_c = Q_{mi}(h_{a1} - h_{a2})/[V'_n(1+W_n)] \quad \cdots\cdots(2)$$

Where:

q_c – User-side cooling capacity, expressed in watts (W);

Q_{mi} – Measured airflow rate, expressed in cubic meters per second (m^3/s);

h_{a1} – Enthalpy of air entering the user side (for wet air composed of 1 kg of dry air), expressed in joules per kilogram (J/kg);

h_{a2} – Enthalpy of air leaving the user side (for wet air composed of 1 kg of dry air), expressed in joules per kilogram (J/kg);

V'_n – Specific volume of air at the nozzle, expressed in cubic meters per kilogram (m^3/kg);

W_n – Moisture content of air at the nozzle (for wet air composed of 1 kg of dry air), expressed in kilograms per kilogram (kg/kg).

For liquid circulation heat exchange units, calculate the cooling capacity using Formula (3).

$$q_c = C\rho Q_{ml}(t_1 - t_2) + a \quad \cdots\cdots(3)$$

Where:

q_c - User-side cooling capacity, expressed in watts (W);

C - Specific heat capacity of the secondary coolant at the average unit inlet and outlet temperature, expressed in joules per kilogram per degree Celsius (J/kg·℃);

ρ - Density of the secondary coolant at the average unit inlet and outlet temperature, expressed in kilograms per cubic meter (kg/m^3);

Q_{ml} - Volume flow rate of the user-side secondary coolant, expressed in cubic meters per second (m^3/s);

t_1 - Temperature of the user-side secondary coolant at the inlet, expressed in degrees Celsius (℃);

t_2 - Temperature of user-side secondary coolant at the outlet, expressed in degrees Celsius (℃);

a - Correction term accounting for heat transfer from the ambient air to the user-side secondary coolant, expressed in watts (W).

The cooling power consumption of an air circulation heat exchange unit shall include the power consumed by the compressor, fan, and electrical control equipment. The cooling power consumption of a liquid circulation heat exchange unit shall include the power consumed by the compressor, fan, water pump, and electrical control equipment.

Calculate the cooling COP of a unit, denoted as COP_c, using Formula (4).

$$COP_c = q_c / N_{co} \quad \cdots\cdots(4)$$

Where:

COP_c - Cooling coefficient of performance, expressed in watts per watt (W/W);

q_c - User-side cooling capacity, expressed in watts (W);

N_{co} - Power consumption for cooling, expressed in watts (W).

During the nominal cooling performance test of a liquid circulation heat exchange unit, the unit head (namely, the water pressure difference between the inlet and outlet) shall be measured in accordance with the methods specified in GB/T 18430.1.

Note: During the nominal cooling performance test, the built-in pump of a liquid circulation heat exchange unit shall be adjusted to operate at the nominal speed corresponding to the nominal flow rate of the cooling secondary coolant.

6.4.5 Nominal Heating Performance

Carry out a heating capacity test on the unit under the conditions specified in Table 2 or Table 3, with the unit's cooling function deactivated. The heating capacity shall include the effective heat generated by the power-consumed devices such as the electric heater, fan

motor, and electrical control equipment. During the heating capacity test, the fan speed (airflow rate) shall be consistent with that used in the standard cooling capacity test. The auxiliary electric heater's power consumption refers exclusively to the power consumed by the electric heater.

Perform a heat pump heating performance test on the unit under the standard operating conditions specified in Table 2 or Table 3, in accordance with the methods prescribed by GB/T 17758 and GB/T 18430.1. Measure and calculate the heat pump heating capacity and heating power consumption, excluding the heating capacity and power consumption of the electric heater.

For liquid circulation heat exchange units, calculate the heating capacity using Formula (5).

$$q_h = C\rho Q_{ml}(t_2 - t_1) + a \quad \cdots\cdots(5)$$

Where:

q_h - User-side heating capacity, expressed in watts (W);

C - Specific heat capacity of the secondary coolant at the average temperature, expressed in joules per kilogram per degree Celsius (J/kg·℃);

ρ - Density of the secondary coolant at the average temperature, expressed in kilograms per cubic meter (kg/m^3);

Q_{ml} - Volume flow rate of the user-side cold/hot water, expressed in cubic meters per second (m^3/s);

t_1 - Temperature of the user-side cold/hot water at the inlet, expressed in degrees Celsius (℃);

t_2 - Temperature of the user-side cold/hot water at the outlet, expressed in degrees Celsius (℃);

a - Correction term accounting for heat transfer from the ambient air to the user-side secondary coolant, expressed in watts (W).

The heating power consumption of a liquid circulation heat exchange unit shall include the power consumed by the compressor, fan, water pump, and electrical control equipment.

Calculate the heating COP of a unit, denoted as COP_h, using Formula (6).

$$COP_h = \frac{q_h}{N_{ho}} \quad \cdots\cdots(6)$$

Where:

COP_h - Heating energy efficiency, expressed in Watts per Watt (W/W);

q_h - User-side heating capacity, expressed in watts (W);

N_{ho} - Power consumption for cooling, expressed in watts (W).

Note: During the nominal heating performance test, the built-in pump of a liquid circulation heat exchange unit shall be adjusted to operate at the nominal speed corresponding to the nominal flow rate of the heating secondary coolant.

6.4.6 Annual Cooling Performance

Test ACCOP on the unit in accordance with the procedure specified in Annex B.

6.4.7 High-temperature Cooling Startup and Operation

Under the high-temperature cooling startup and operating conditions specified in Table 2 or Table 3, start and operate the unit at the minimum allowable operating voltage until steady-state conditions are reached, and then continue operation for 1 hour. Shut down the unit and after 3 minutes, restart the unit at the maximum allowable operating voltage, re-establish steady-state conditions, and continue operation for an additional 1 hour.

6.4.8 Low-temperature Cooling Startup and Operation

Under the low-temperature cooling startup and operating conditions specified in Table 2 or Table 3, start and operate the unit at the minimum allowable operating voltage until steady-state conditions are reached, and then continue operation for 1 hour. Shut down the unit and after 3 minutes, restart the unit at the maximum allowable operating voltage, re-establish steady-state conditions, and continue operation for an additional 1 hour.

6.4.9 Low-temperature Heating Startup and Operation

Under the low-temperature heating startup and operating conditions specified in Table 2 or Table 3, start and operate each heat pump or hybrid unit at the minimum allowable operating voltage until steady-state conditions are reached, and then continue operation for 1 hour. Shut down the unit and after 3 minutes, restart the unit at the maximum allowable operating voltage, re-establish steady-state conditions, and continue operation for an additional 1 hour.

Start and operate each electric heater unit under the low-temperature heating startup and operating conditions specified in Table 2 or Table 3. After steady-state conditions are achieved, continue operation for 1 hour.

6.4.10 Defrosting Test

Operate the unit under the defrosting conditions specified in Table 2 and Table 3. The test duration shall begin at the end of the first defrost cycle (either automatic or manually initiated) and shall continue for two complete heating-defrost cycles or 3 hours, whichever is longer. For the following cases, the test duration shall be adjusted as specified:

a) If no defrost occurs during the 3 hours of continuous operation, the test shall be extended until the completion of the first defrost after this 3-hour period.

b) If a defrost cycle begins but is not completed within the 3 hours of continuous operation, the test shall be extended until that defrost cycle is completed.

6.4.11 Water Flow Rate

During the nominal cooling test under the specified liquid outlet temperature conditions, adjust the built-in pump of the unit to operate at the nominal speed corresponding to the nominal flow rate of the cooling secondary coolant. Adjust the test devices to ensure that

the external resistance or head of the unit is not less than the declared value. Then measure the water flow rate.

6.4.12 Noise Test

During the nominal cooling performance test, measure the noise level in accordance with the method specified in Annex C.

6.4.13 Condensation Test

Conduct the condensation test as follows:

a) In accordance with the manufacturer's specifications, adjust the set temperature, fan speed, dampers, and directional grilles to the conditions most likely to produce condensation. Fill the drain pan with water up to the drain outlet level.

b) At rated frequency and rated voltage, operate the unit under the condensation conditions specified in Table 2. After steady-state conditions are reached, keep it running for an additional 4 hours.

c) During the test, the compressor frequency and the fan speeds of the ODU and IDU shall remain consistent with those set during the nominal cooling capacity test.

6.4.14 Vibration Test

Measure the vibration as follows:

a) The measuring instrument shall have a frequency range of 10 Hz to 500 Hz. The relative sensitivity within this range shall be referenced to the sensitivity at 80 Hz, and the sensitivity at all other frequencies shall remain within －20% to +10% of the reference value.

b) Install the unit on a platform. The installation platform and foundation shall not introduce additional vibration or cause unit resonance. During operation, the vibration level of the installation platform shall be less than 10% of the maximum vibration level measured on the unit.

c) Test the unit under standard operating conditions at the rated frequency and rated voltage of the input power supply.

d) Measure at the four outermost bottom corners of the unit in the X, Y, and Z directions.

e) The instrument sensor shall maintain firm contact with each measurement point and ensure a reliable connection.

f) The vibration value of the unit shall be determined from the maximum value measured at each measurement point.

6.4.15 Electric Safety Test

6.4.15.1 Voltage Variation Performance Test

During nominal cooling and heating tests, adjust the input voltage of the unit to 110% of the rated voltage and keep the unit running for 1 hour. Then adjust the input voltage to 90% of

the rated voltage and keep the unit running for an additional 1 hour. Inspect the operating status of the unit throughout the test.

6.4.15.2 Insulation Resistance Test

Measure the insulation resistance between live parts and accessible metal parts of the unit with an insulation resistance tester rated at 500 V voltage.

6.4.15.3 Leakage Current Test

Perform the test with the unit at room temperature and disconnected from the power supply. Apply the following AC voltage between live parts and accessible metal parts of the unit, and measure the leakage current within 5 seconds after application of the test voltage:

a) For single-phase units, the voltage shall be 1.06 times the rated voltage.

b) For three-phase units, the voltage shall be 1.06 times the rated voltage divided by $\sqrt{3}$.

6.4.15.4 Electric Strength Test

Perform the test with the unit at room temperature and disconnected from the power supply. Apply a sinusoidal voltage at the frequency of 50 Hz or 60 Hz between live parts and accessible metal parts of the unit. The test voltage shall be the voltage value corresponding to the basic insulation in Table 10, and the test duration shall be 1 minute. Alternatively, the test duration may also be 1 second, in which case the test voltage shall be 1.2 times the voltage value corresponding to the basic insulation in Table 10.

Apply a sinusoidal voltage at the frequency of 50 Hz or 60 Hz between live parts and the control panel of the unit. The test voltage shall be the voltage value corresponding to the reinforced insulation in Table 10, and the test duration shall be 1 minute. Alternatively, the test duration may also be 1 second, in which case the test voltage shall be 1.2 times the voltage value corresponding to the reinforced insulation in Table 10.

Note: In control circuits within the specified voltage range, electronic devices used in control loops where the voltage to ground is less than 30 V AC (r.m.s. value) or 30 V DC may be exempted from the electric strength test.

Table 10 Electric Strength Test Voltages

Insulation	Test voltage V			
	Rated voltage			Operating voltage
	Safety extra-low voltage	≤ 150	> 150 – 250	> 250
Basic insulation	500	1000	1000	1.2U + 700
Reinforced insulation	—	2500	3000	2.4U + 2400
Note 1: If the circuit under test contains diodes or capacitors, a DC test voltage shall be used. The DC test voltage shall be $\sqrt{2}$ times the AC voltage value. Note 2: For multiphase appliances, the rated voltage refers to the voltage between a phase conductor and				

the neutral point or earth wire. For multiphase appliances with a rated voltage of 480 V, the test voltage shall be selected with reference to a rated voltage of 250 V.

Note 3: For appliances with a rated voltage not exceeding 150 V, the test voltage shall be applied to components operating at voltages greater than 150 V but not exceeding 250 V.

6.4.15.5 Earthing Device Test

Verify the protective earthing devices for compliance with related requirements by visual inspection and manual tests.

The method for testing the continuity of the protective earthing circuit is as follows:

a) For units with a rated current of at least 25 A, or where test equipment cannot supply 1.5 times the rated current, test the continuity of the protective earthing circuit using the loop impedance method. The test can be conducted using a 12 V voltage from a protective extra-low voltage (PELV) power source at 50 Hz or 60 Hz, with a current of at least 10 A for a duration of at least 10 seconds. Conduct the test between the PE terminal and the relevant points of the protective earthing circuit components, in accordance with Section 22.3 in GB 25130-2010.

b) For units with a rated current of no more than 25 A, or where test equipment can supply 1.5 times the rated current, the connection between the earthing terminal and the protective earthing circuit may alternatively be tested for earthing resistance in accordance with Section 27.5 in GB/T 4706.1-2024.

6.4.16 Control

6.4.16.1 Communication Function

Verify whether the unit is equipped with a communication port capable of receiving external control commands. Check the operational parameters and fault information reported through the communication port.

6.4.16.2 Fault Detection

Simulate the alarm functions of the unit in sequence. Check whether the unit displays alarm information and executes the appropriate protective actions. When the emergency shutdown function is triggered during operation, verify that the unit stops immediately.

6.4.17 Electromagnetic Compatibility

6.4.17.1 Conduct the electrostatic discharge immunity test on the unit in accordance with GB/T 17626.2-2018.

6.4.17.2 Conduct the radio frequency electromagnetic field immunity test on the unit in accordance with GB/T 17626.3-2023.

6.4.17.3 Conduct the electromagnetic emission test on the unit in accordance with GB 17799.4-2022.

6.4.18 Grid Frequency Adaptability Test

Test steps:

a) Connect the unit to a simulated power grid device.

b) Set the unit to cooling mode.

c) Adjust the frequency of the simulated power grid device to within 49.52 Hz to 50.18 Hz. Select several measurement points within this range (at least three points, with the critical points being mandatory). Keep the unit operating continuously for at least 1 minute at each point. Then, record the operating status of the unit.

d) Adjust the frequency of the simulated power grid device to within 48.02 Hz to 49.48 Hz. Select several measurement points within this range (at least three points, with the critical points being mandatory). Keep the unit operating continuously for at least 4 seconds at each point. Then, record the operating status, corresponding action frequency, and action time.

e) Adjust the frequency of the simulated power grid device to within 50.22 Hz to 50.48 Hz. Select several measurement points within this range (at least three points, with the critical points being mandatory). Keep the unit operating continuously for at least 4 seconds at each point. Then, record the operating status, corresponding action frequency, and action time.

f) Adjust the frequency of the simulated power grid device to 47.98 Hz. Keep the unit operating continuously for at least 4 seconds. Then, record the operating status, corresponding action frequency, and action time.

g) Adjust the frequency of the simulated power grid device to 50.52 Hz. Keep the unit operating continuously for at least 4 seconds. Then, record the operating status, corresponding action frequency, and action time.

h) Set the unit to heating mode and repeat steps c) through g).

6.4.19 HVRT Test

6.4.19.1 Preparations:

a) Connect the unit to the grid fault simulation device and the data acquisition device.

b) Within each of the voltage ranges ($110\%U_N \leqslant U \leqslant 120\%U_N$, $120\%U_N \leqslant U \leqslant 125\%U_N$, and $125\%U_N \leqslant U \leqslant 130\%U_N$), select at least one high-voltage point, and determine the rise time according to Figure 3.

Note: U represents the voltage point selected during the test; U_N represents the rated operating voltage of the unit.

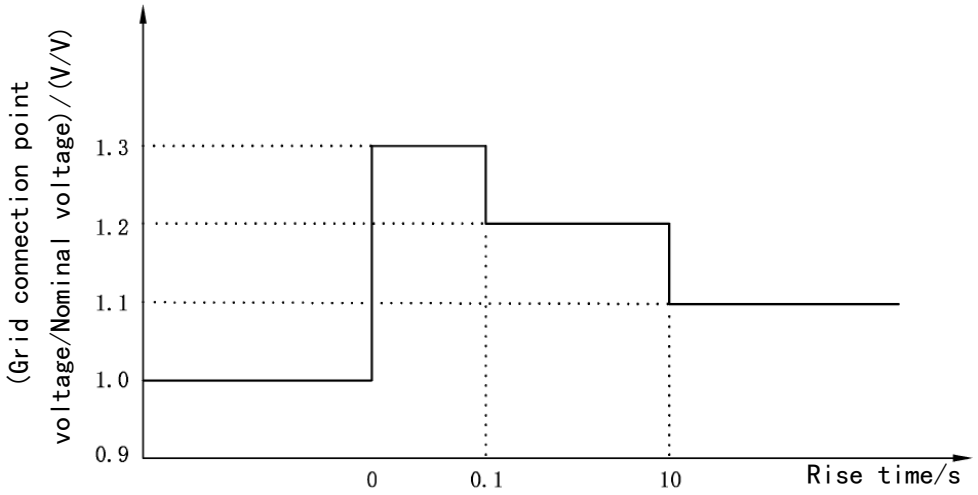


Figure 3 HVRT Curve

6.4.19.2 Perform the no-load test (standby condition) as follows:

a) Adjust the grid fault simulation device to simulate a voltage rise at the grid connection point. The voltage rise points (the voltage values during the rise) shall be selected in accordance with the requirements of Section 8.2 in GB/T 36547-2024.

b) Record the operating status and the corresponding action time of the unit.

6.4.19.3 Perform the HVRT load test after the no-load test is confirmed to comply with the HVRT curve. During the test, the grid fault simulation device configuration shall remain consistent with that during the no-load test. Test steps:

a) Set the unit to cooling mode.

b) Adjust the unit's output power to within 10% to 30% of the rated power.

c) Control the grid fault simulation device to apply a three-phase symmetrical voltage rise.

d) Record the voltage and current waveforms of the unit, capturing data from at least 10 seconds before the voltage dip until 6 seconds after the voltage has returned to normal.

e) Adjust the unit's input power to the rated power and repeat step d).

f) Set the unit to heating mode and repeat steps c) through e).

6.4.20 LVRT Test

6.4.20.1 Preparations:

a) Connect the unit to the grid fault simulation device and the data acquisition device.

b) Within each of the voltage ranges ($0\%U_N \leqslant U \leqslant 5\%U_N$, $20\%U_N \leqslant U \leqslant 25\%U_N$, $25\%U_N \leqslant U \leqslant 50\%U_N$, $50\%U_N \leqslant U \leqslant 75\%U_N$, and $75\%U_N \leqslant U \leqslant 90\%U_N$), select at least one dip point, and determine the dip time according to Figure 4.

Note: U represents the voltage point selected during the test; U_N represents the rated operating voltage of the unit.

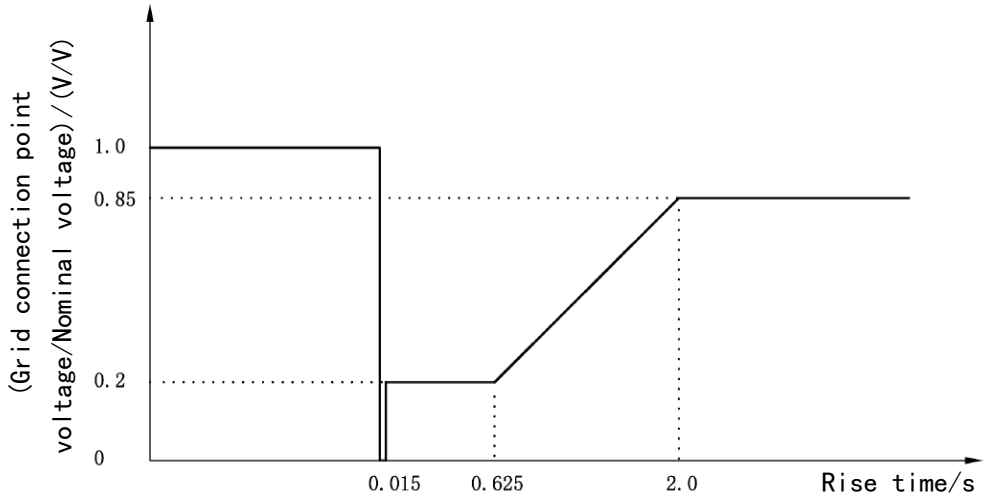


Figure 4 LVRT Curve

6.4.20.2 Perform the no-load test (standby condition) as follows:

a) Adjust the grid fault simulation device to simulate a voltage dip at the grid connection point. The voltage dip points (the voltage values during the dip) shall be selected in accordance with the requirements of Section 8.1 in GB/T 36547-2024.

b) Adjust the grid fault simulation device to simulate inter-phase short-circuit faults (AB, BC, CA) or phase-to-ground short-circuit faults as specified in Table 11. The voltage dip points shall be selected in accordance with the requirements of Section 8.1 in GB/T 36547-2024.

c) Record the operating status and the corresponding action time of the unit.

Table 11 Types of Line Asymmetrical Faults

Fault type	Fault phase		
Single-phase-to-ground short-circuit	Phase A to ground	Phase B to ground	Phase C to ground
Phase-phase short-circuit	Phase A to Phase B	Phase B to Phase C	Phase C to Phase A
Two-phase-to-ground short-circuit	Phases A and B to ground	Phases B and C to ground	Phases C and A to ground

6.4.20.3 Perform the LVRT load test after the no-load test is confirmed to comply with the LVRT curve. During the load test, the grid fault simulation device configuration shall remain consistent with that during the no-load test. Test steps:

a) Set the unit to cooling mode.

b) Adjust the unit's output power to within 10% to 30% of the rated power.

c) Control the grid fault simulation device to apply a three-phase symmetrical voltage dip.

d) Record the voltage and current waveforms of the unit, capturing data from at least 10 seconds before the voltage dip until 6 seconds after the voltage has returned to normal.

e) Control the grid fault simulation device to perform an asymmetric voltage dip.

f) Record the voltage and current waveforms of the unit, capturing data from at least 10 seconds before the voltage dip until 6 seconds after the voltage has returned to normal.

g) Adjust the unit's output power to the rated power and repeat steps c) through f).

h) Set the unit to heating mode and repeat steps c) through f).

6.4.21 Other Tests

6.4.21.1 Salt Spray Test

Conduct the salt spray test based on the corrosion resistance grade specified for the unit in accordance with GB/T 30790.6-2014. The tests include neutral salt spray tests and condensation tests, with the test duration determined by the unit's corrosion resistance grade. Prior to testing, clean the coating surface of the sample to remove oil. After the test, rinse all salt residues from the sample surface using clean water, and then inspect the corrosion condition of the metal coating.

6.4.21.2 Coating Adhesion Test

Test the coating adhesion of a unit in accordance with the requirements of GB/T 9286-2021.

7 Inspection Rules

7.1 Inspection of a unit shall include factory inspection, sampling inspection, and type inspection. Inspection items, technical requirements, and inspection methods shall comply with the specifications listed in Table 12.

7.2 Each unit shall be inspected and approved by the manufacturer's quality inspection department prior to leaving the factory.

7.3 The manufacturer's product quality control measures shall incorporate sampling inspections, particularly for mass-produced units. Specific sampling plans, inspection levels, and acceptable quality levels (AQL) may be determined by the manufacturer.

7.4 Type inspection shall be conducted every four years. Additionally, type inspection shall be performed for the first unit under any of the following conditions:

- New product development or significant improvements in finalized products;

- Introduction of a brand-new production line;

- Relocation of or major upgrades to a production line.

Table 12 Inspection Items

No.	Item	Factory inspection	Sampling inspection	Type inspection	Technical requirements	Test method
1	General requirements	—	—	√	5.1	—

No.	Item		Factory inspection	Sampling inspection	Type inspection	Technical requirements	Test method
2	Strength		√	√	√	5.2.1	6.4.1
3	Sealing performance		√	√	√	5.2.2	6.4.2
4	Test run		√	√	√	5.3	6.4.3
5	Nominal cooling capacity		—	—	√	5.4	6.4.4
6	Nominal heating capacity		—	—	√	5.5	6.4.5
7	High-temperature cooling startup and operation		—	—	√	5.7	6.4.7
8	Low-temperature cooling startup and operation		—	—	√	5.8	6.4.8
9	Low-temperature heating startup and operation		—	—	√	5.9	6.4.9
10	Defrosting		—	√	√	5.10	6.4.10
11	Water flow rate		—	—	√	5.11	6.4.11
12	Noise		—	√	√	5.12	6.4.12
13	Condensation		—	√	√	5.13	6.4.13
14	Vibration		—	—	√	5.14	6.4.14
15	Electric safety	Voltage variation performance	√	√	√	5.15.1	6.4.15.1
16		Insulation resistance	√	√	√	5.15.2	6.4.15.2
17		Leakage current	√	√	√	5.15.3	6.4.15.3
18		Electrical strength	—	—	√	5.15.4	6.4.15.4
19		Earthing device	√	√	√	5.15.5	6.4.15.5
20	Control		—	—	√	5.16	6.4.16
21	Electromagnetic compatibility		—	—	√	5.17	6.4.17
22	Grid frequency adaptability		—	—	√	5.18	6.4.18
23	HVRT		—	—	√	5.19	6.4.19
24	LVRT		—	—	√	5.20	6.4.20
25	Salt spray test		—	—	√	—	6.4.21.1
26	Coating adhesion test		—	√	√	—	6.4.21.2
Note: "√" indicates items that require inspection, while "—" indicates items that do not require inspection.							

8 Marking, Packaging, Transportation, and Storage

8.1 Marking

8.1.1 Each unit shall be equipped with a permanent nameplate securely fixed in a conspicuous location. The nameplate shall comply with the requirements of GB/T 13306 and include the specific information listed in Table 13. For units using flammable refrigerants, the nameplate shall additionally display a "Caution: Fire Risk" warning symbol in accordance with GB 2894-2025. The vertical height of the symbol shall be no less than 30 mm.

Table 13 Nameplate Description

No.	Mark description		Mark requirements	
	Name	Unit	Air circulation heat exchange type	Liquid circulation heat exchange type
1	Product name and model	—	√	√
2	Manufacturer and trademark	—	√	√
3	Production date and product No.	—	√	√
4	Rated voltage, number of phases, and frequency	V, —, Hz	√	√
5	Maximum operating current	A	√	√
6	Refrigerant No. and amount	—, kg	√	√
7	Dimensions	mm	√	√
8	Total mass	kg	√	√
9	Nominal cooling capacity	kW	√	√
10	Nominal power consumption in cooling mode	kW	√	√
11	Nominal cooling performance coefficient	kW/kW	√	√
12	Nominal heating capacity	kW	√	√
13	Nominal power consumption in heating mode	kW	√	√
14	Combined ACCOP	kW/kW	√	√
15	Noise (sound pressure level)	dB(A)	√	√
16	Water flow rate	m^3/h	—	√

Note 1: "—" indicates that marking is not required while "√" indicates that marking is required; however, units without the corresponding function do not need to carry this marking.

Note 2: In addition to the nominal operating condition parameters specified in this document, units may also display performance parameters corresponding to designated operating conditions.

8.1.2 The unit shall have operating status indicators (such as rotation direction, water flow direction, instrument displays, control buttons) and safety markings (such as earthing devices, warning labels) applied to relevant components.

8.1.3 The unit shall be marked with the number of this document in appropriate locations, such as the product manual and nameplate.

8.2 Packaging

8.2.1 Prior to packaging, the unit shall be thoroughly cleaned. All components must be clean and dry, and anti-rust agents shall be applied to corrosion-prone parts. The unit shall be wrapped in plastic bags or moisture-proof paper and secured inside the box to prevent moisture ingress and mechanical damage during transportation.

8.2.2 Before packaging, the unit shall be charged with or maintain the specified amount of refrigerant, or be filled with dry nitrogen at 0.02 MPa－0.03 MPa (gauge pressure).

8.2.3 The package shall incorporate accompanying documents which include the product certificate, user manual, and packing list.

a) The contents of the product certificate shall include:

- Product model and name;
- Product serial number;
- Manufacturer's name;
- Inspection conclusion;
- Signatures and seals of the inspector and the inspection supervisor with the date.

b) The contents of the user manual shall include:

- Product model and name, operating principle, scope of application, number of this document, and main technical parameters (in addition to the main technical performance parameters indicated on the nameplate, including cold/hot water side pressure loss, head, flow rate, and power of the circulating pump, and maximum operating current);
- Product structural diagram, system diagram, electrical diagram, and wiring diagram;
- Installation instructions and requirements (for units using flammable refrigerants, the installation shall follow the requirements of GB/T 9237);
- Operation and maintenance instructions and precautions (for units using flammable refrigerants, the maintenance shall comply with the requirements of Annex DD in GB/T 4706.32-2024, in addition to the requirements of GB/T 9237).

8.2.4 The unit shall be protected with dust-proof measures, such as being wrapped in heat-shrink film or stretch wrap, and the packaging shall comply with the requirements of GB/T 13384.

8.3 Transportation and Storage

8.3.1 Units shall be protected from collision, tilting, and exposure to rain or snow during transportation and storage.

8.3.2 Units shall be stored in a dry, well-ventilated area, with adequate measures in place to protect the electrical system from moisture.

Annex A

(Normative)

Measurement Method for Outlet Air Static Pressure

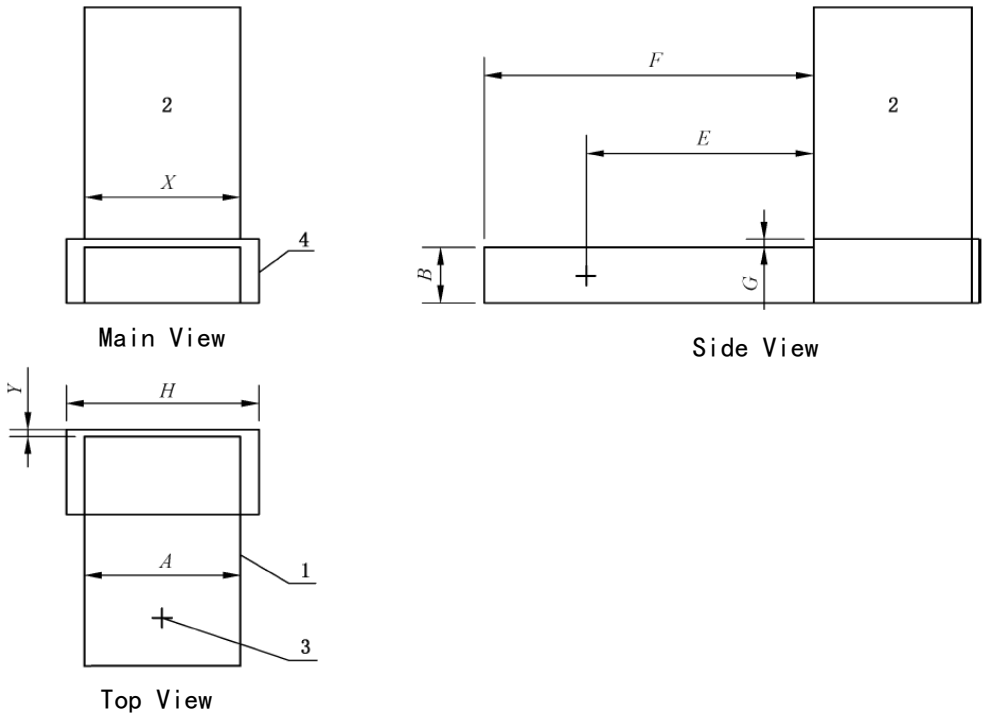
A.1 Horizontal Air Supply

The connecting duct dimensions for a horizontal air supply unit, as well as the measurement of external static pressure, shall comply with the requirements of Section A.7 in GB/T 17758-2023.

A.2 Bottom Air Supply

The connecting duct for a bottom air supply unit shall be fabricated in accordance with Figure A.1. The measurement of external static pressure shall comply with the requirements of Section A.7 in GB/T 17758-2023.

Unit: cm



Main View

Side View

Top View

Index number/letter description:

1 - Connecting duct;

2 - Unit;

3 - External static pressure measurement point;

4 - Air plenum;

A - Air outlet width;

B - Connecting duct height;

E - Distance between the external static pressure measurement point and the air outlet;

F - Total length of the connecting duct;

G – Height difference between the air plenum and the connecting duct;

H – Air plenum width;

X – Unit width.

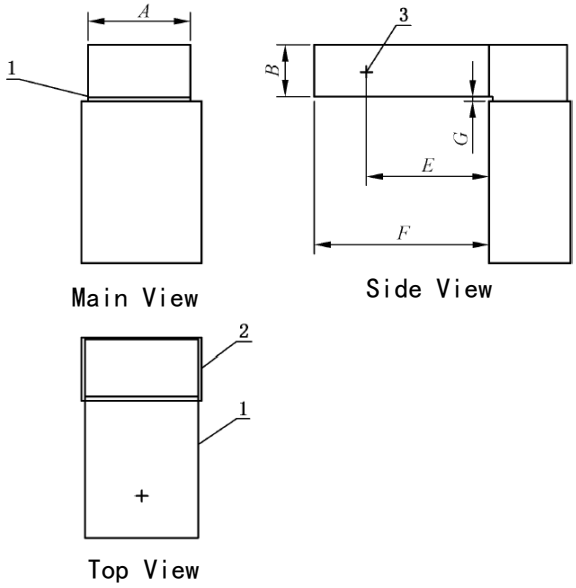
Note: B = 60 cm; E = 2 × $\sqrt{A \times B}$; F ≥ 2.5 × $\sqrt{A \times B}$; G ≥ 5 cm; H ≥ 1.2 × X; Y ≥ 5 cm.

Figure A.1 Connecting Duct of a Bottom Air Supply Unit

A.3 Top Air Supply

The connecting duct for a top air supply unit shall be fabricated in accordance with Figure A.2. The measurement of external static pressure shall comply with the requirements of Section A.7 in GB/T 17758-2023.

Unit: cm



Index number/letter description:

1 – Connecting duct;

2 – Unit;

3 – External static pressure measurement point;

A – Air outlet width;

B – Connecting duct height;

E – Distance between the external static pressure measurement point and the air outlet;

F – Total length of the connecting duct;

G – Height difference between the air plenum and the connecting duct.

Note: B = 60 cm; E = 2 × $\sqrt{A \times B}$; F ≥ 2.5 × $\sqrt{A \times B}$; G ≥ 5 cm.

Figure A.2 Top Air Supply Duct

Annex B

(Normative)

Test Method for ACCOP

B.1 Operating Conditions

The test conditions for ACCOP shall comply with the standard operating conditions specified in Table 4.

B.2 Operating Conditions

B.2.1 The measured cooling capacity under conditions A, B, C, D, and E shall not be lower than that under nominal conditions.

B.2.2 The measured airflow and static pressure of an air circulation heat exchange unit under conditions A, B, C, D, and E shall be consistent with those under nominal conditions.

B.2.3 The measured liquid flow rate of a liquid circulation heat exchange unit under conditions A, B, C, D, and E shall be consistent with that under nominal conditions.

B.2.4 For units equipped with a free cooling function, this function may be activated during the ACCOP test under conditions A, B, C, D, and E.

B.3 Temperature Distribution Coefficient

This document selects Beijing as the representative city and adopts its temperature distribution coefficients (see Table B.1) to uniformly assess the combined ACCOP of units.

The temperature distribution coefficients for typical cities in China are given in Table C.1 of GB/T 19413-2024. When necessary, an appropriate typical city may be selected according to the unit's operating region to evaluate its ACCOP.

Table B.1 Unit Runtime Distribution Coefficients

Runtime distribution coefficient	T_A	T_B	T_C	T_D	T_E
City	Temperature distribution range ℃				
	≥ 30	20 to 30 (excluded)	10 to 20 (excluded)	0 to 10 (excluded)	< 0
Beijing	7.2%	28.1%	23.1%	21%	20.6%

Annex C

(Normative)

Noise Test Method

C.1 Measurement Site

The measurement site shall be a semi-free sound field above a reflective plane or a laboratory with sound-deadening treatment. The ambient sound field in the laboratory shall be corrected in accordance with the method specified in Annex A of JB/T 4330-1999. For an approximately free field above a reflective plane, the difference between the unit's noise and the background noise shall be more than 6 dB(A). In anechoic or semi-anechoic chambers, the difference between the unit's noise and the background noise shall be more than 10 dB(A).

C.2 Measuring Instruments

Sound pressure meters of Type I or higher, as specified in GB/T 3785.1, shall be used, along with other testing instruments of equivalent precision.

C.3 Installation and Operating Conditions

The unit shall be installed in a laboratory in accordance with its user manual. For the ODU noise test, the unit shall operate stably at rated voltage and frequency, under operating conditions closely approximating the specified standard cooling and heating conditions.

C.4 Measurement Point Location

C.4.1 General Requirements

The difference in noise values (sound pressure levels) between adjacent measurement points shall be less than 5 dB(A). If the difference exceeds 5 dB(A), additional measurement points shall be added until the difference is less than 5 dB(A).

C.4.2 Side Discharge

Measurements shall be taken at a distance of 1 meter from both the air discharge side and any side of the unit, as illustrated in Figure C.1. The measurement points shall be located at the intersections of three parallel lines located 0.5 m above the central axis on the plane positioned 1 m from each side of the unit. The average sound pressure level of the unit shall be calculated using Formula (C.1).

$$\overline{\mathrm{LP}} = 10\lg \frac{1}{3}\left[\sum_{i=1}^{3} 10^{0.1L_{pi}}\right] \qquad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (\mathrm{C.1})$$

Where:

$\overline{LP}$ – A-weighted average sound pressure level noise, expressed in decibels [dB(A)];

L_{pi} – The sound pressure level noise at point i, expressed in decibels [dB(A)].

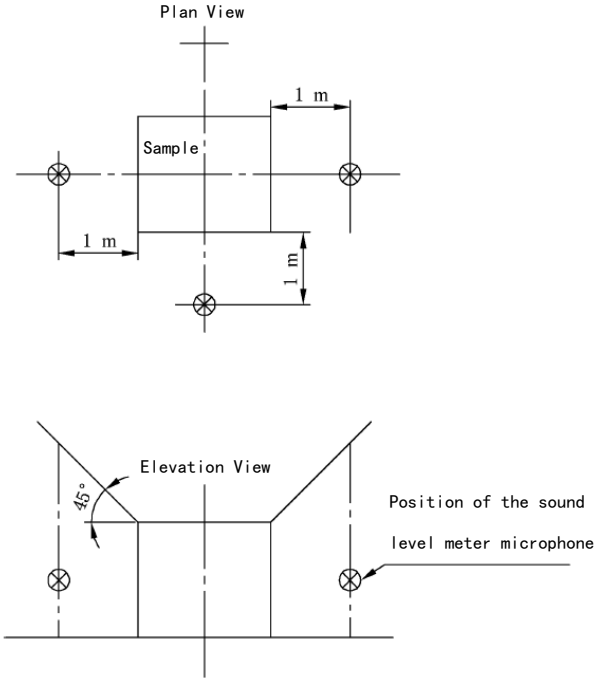


Figure C.1 Measurement Points of Side Discharge ODU

C.4.3 Top Discharge

Measurements shall be taken at a distance of 1 meter from each side of the unit, as illustrated in Figure C.2. The measurement points shall be located at the intersections of four parallel lines located 0.5 m above the central axis on the plane positioned 1 m from each side of the unit. The average sound pressure level of the unit shall be calculated using Formula (C.1).

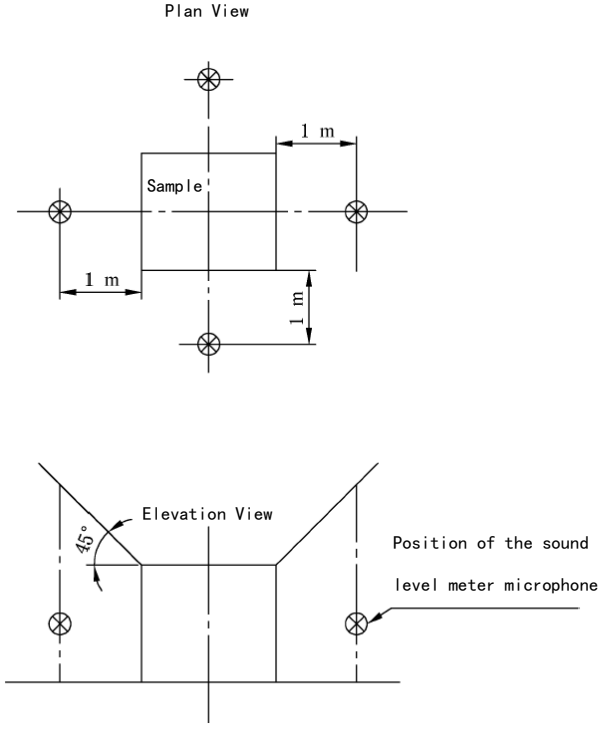


Figure C.2 Measurement Points of Top Discharge ODU

Reference

[1] GB/T 19413-2024 Air conditioning units for data center and communication room