ADDENDA

ANSI/ASHRAE Addendum b to
ANSI/ASHRAE Standard 127-2020

Method of Testing for Rating Air-Conditioning Units Serving Data Center (DC) and Other Information Technology Equipment (ITE) Spaces

Approved by ASHRAE and the American National Standards Institute on February 27, 2026.

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Informative Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum b to Standard 127-2020

Update the title as shown.

Method of Testing for Rating ~~Air-Conditioning Units~~ Cooling Equipment Serving Data Center (DC) and Other Information Technology Equipment (ITE) Spaces

Move existing definitions ("[. . .]") to new Section 3.1, "Definitions" and rename Section 3 as shown. Add new definitions to Section 3 as shown.

3. ~~DEFINITIONS~~TERMINOLOGY

3.1 Definitions

[. . .]

application rating: a rating based on tests performed at design conditions other than standard rating conditions.

auxiliary power: net real electrical power consumed by auxiliary devices that are not integral to the operation of the CDU. Auxiliary devices can include, but are not limited to, network switches, external devices, or any devices consuming electrical power not critical to CDU function.

CDU FWS load: the net heat transferred directly from the CDU to the FWS fluid at the specified CDU operating point. This value explicitly excludes heat transferred from the CDU to the FWS fluid by way of room air-cooling equipment or systems.

CDU net capacity: the net heat removed from the TCS fluid at the specified CDU operating point.

CDU operating conditions: Unit operation under specified steady-state conditions; TCS flow rate, FWS flow rate, TCS fluid properties, FWS fluid properties, entering and leaving TCS temperatures, entering and leaving FWS temperatures.

CDU thermal efficiency**:** the ratio of net heat absorbed by the FWS fluid the net heat removed from the TCS fluid expressed as a percentage. (***Informative Note*****:** This is also the CDU FWS load divided by the CDU net capacity at the CDU operating point expressed as a percentage.)

CDU thermal losses: the net heat rejected from the CDU to space ambient air. This measurement includes both convective and radiative heat.

COP_C: coefficient of performance; the cooling efficiency expressed as a dimensionless ratio of net cooling capacity divided by the critical input power.

critical input power: net real electrical power input to the CDU powering any of the following:

a. Pumps
b. Variable-speed drives
c. Controls and instrumentation
d. Cooling fans or other equipment cooling apparatus
e. Any electrically powered device critical to the function of the CDU

energy balance: a dimensionless ratio metric used to check for gross errors in measurement instrumentation and test results (with or without a heat reclaim heat exchanger) and defined as the difference between energy inputs and energy outputs to the CDU package, normalized to a percentage by dividing by the mean of the total input energy and the total output energy. For this standard, the energy inputs are generally limited to the gross cooling capacity and the critical input power, although other auxiliary power inputs are included when analysis demonstrates significance to the energy balance.

facility water system (FWS): a dedicated fluid loop intended to transport the heat from the data center cooling equipment to heat rejection equipment and systems. Heat rejection equipment and systems may include, but are not limited to, dry coolers, chillers, cooling towers, and heat recovery and reuse systems.

flow turndown: the ratio of the unit rated flow and the unit minimum flow rate at which flow can automatically be maintained within the stability requirements of this standard.

FWS pumping losses: the power consumed by facility pumps to circulate water through the FWS side of the CDU. The measurement includes the pressure drop from FWS entering connection to FWS leaving connection and utilizes an assumed standard pump and pump motor efficiency. All manufacturer required appurtenances internal to the CDU will be installed during the test.

FWS total heat rejection: heat rejected to the FWS loop by the CDU as measured at the CDU FWS connections.

liquid-to-liquid (single-phase) coolant distribution unit (CDU) for information technology equipment: a heat exchange assembly or collection of components, "assembly," that separates the TCS coolant from the FWS or intermediate heat-rejection-system coolant (a liquid, which may or may not be water or a mixture of additives with water) where both coolants remain in the liquid phase and no heat is transferred through phase change. A heat-rejection cooling capacity or capacities may be defined for this assembly based on the heat rejected from the TCS coolant at a specified operating point or points using a specified coolant. The assembly will have a measurable approach temperature for each operating point. A TCS coolant delivery flow rate may be defined for this assembly based on the coolant flow that is generated by the assembly at a given coincident pressure differential, fluid composition, and temperature. The assembly will have a measurable efficiency at the specified operating points.

operating condition tolerance: the maximum permissible variation between the time-averaged measurement data observations and the specified (target) operating conditions as established in the test plan.

published ratings: a statement of the assigned values of those performance characteristics, under rating conditions, by which a unit may be chosen to fit its application. These values apply to all units of like nominal size and type or model (identification) produced by the same manufacturer. The term *published rating* includes the rating of all performance characteristics, at stated rating conditions, shown on the unit or published in specifications, advertising, or other literature controlled by the manufacturer at stated rating conditions.

TCS external pump head available: the net head pressure available at the CDU rated TCS flow rate to circulate TCS fluid through the facility TCS piping network. The value is measured from the TCS supply connection to the TCS return connection.

technology cooling system (TCS): a dedicated fluid loop intended to perform heat transfer directly from the IT equipment into the facility water system (FWS)

total input power: the sum of critical input power and auxiliary power to all components of a CDU.

Add new Section 3.2, "Initialisms, Acronyms, and Abbreviations."

CDU	coolant distribution unit
COP	coefficient of performance
FWS	facility water system
REFPROP	(NIST) Reference Fluid Thermodynamic and Transport Properties Database
TCS	technology cooling system

Modify Section 4 as shown.

4. CLASSIFICATION

[. . .]

4.2 Normally, coolant distribution units (CDUs) within the scope of this standard can be classified as shown in Section 4.2.1.

4.2.1 Liquid to Liquid. A unit that removes heat from a liquid-phase TCS fluid and rejects heat to a liquid-phase FWS fluid.

Reorganize and renumber existing Section 6 as shown.

~~6.~~12. CONFORMANCE

Conformance with this standard shall not be claimed or implied unless the air conditioners for which such claims are made meet all applicable testing requirements specified herein.

Add new Section 6 as shown.

6. CALCULATIONS AND CONVERSIONS

6.1 Fluid Properties

6.1.1 Water

6.1.1.1 Use NIST Reference Fluid Thermodynamic and Transport Properties Database (REFPROP): Version 10 to calculate physical properties such as density, specific heat, or enthalpy as a function of both pressure and temperature.

6.1.2 Other Liquids

6.1.2.1 Physical properties of the liquid versus temperature, and by concentration for solutions or mixtures, shall be determined from published data sources such as manufacturer data sheets. Systems using aqueous solutions or mixtures shall be tested to measure or determine the concentration by mass of the liquid. Concentration tests shall be performed within two (2) weeks prior to the date of the CDU tests, or within two (2) days after the tests.

6.2 Data Processing

6.2.1 Data-point measurements collected during the duration of the testing period shall be processed to calculate sample mean and sample standard deviation per the equations provided in ANSI/ASHRAE Standard 30.[12]

6.3 Redundant Measurements

6.3.1 When redundant sensors are used to measure the same property, the average of the sample means shall be used with associated uncertainty when calculating results. Utilize equations provided in ANSI/ASHRAE Standard 30.[12]

6.4 Performance

6.4.1 Capacity. One of the following two methods shall be used, depending on the available measurements and with consideration of the acceptable test uncertainty required by the parties. The sign convention, positive or negative, is to show all capacity values as positive, whether energy is input into the CDU system or energy is removed from the CDU system. Adjust the sign for temperature difference accordingly by subtracting the lesser of inlet and outlet from the greater value. For pressure difference, however, the sign is significant with respect to the direction of energy flow.

6.4.1.1 Gross Capacity and Net Capacity Given Liquid Volume Flow Rate, Inlet and Outlet Temperatures, Pressure Loss, Density, and Specific Heat. Use equations provided in ANSI/ASHRAE Standard 30.[12]

6.4.1.2 Gross Capacity and Net Capacity Given Liquid Mass Flow Rate, Inlet and Outlet Temperatures, Pressure Loss, Density, and Specific Heat. Use equations provided in ANSI/ASHRAE Standard 30.[12]

6.4.1.3 Temperature Difference, Enthalpy Difference, and Pressure Difference. Use equations provided in ANSI/ASHRAE Standard 30.[12]

6.4.2 Power

6.4.2.1 For use in efficiency calculations, determine the CDU critical input power, by summation, including all power inputs—thermal or electrical—to the components identified in the definition of *critical input power*.

$$W_{input} = \sum_i W_i + \sum_j Q_j$$

$$U_{W_{input}} = \sqrt{\sum_i [(\theta_{W_i} U_{W_i})^2] + \sum_j [(\theta_{Q_j} U_{Q_j})^2]}$$

$$\theta_{W_i} = 1$$

$$\theta_{Q_j} = 1$$

6.4.2.2 For use in energy balance calculations, determine the portion of the total power that is transferred into the fluid circuit.

$$W_{fluid} = \sum_i W_i$$

$$U_{W_{fluid}} = \sqrt{\sum_i [(\theta_{W_i} U_{W_i})^2]}$$

$$\theta_{W_i}$$

6.4.3 Energy Efficiency. The coefficient of performance (COP) is defined in Section 6.4.3.1. Other efficiency metrics are derived as variations on the ratio of capacity and input work, or its inverse, and may be used according to the definitions in Section 3.

6.4.3.1 Cooling Energy Efficiency. The cooling COP, η_{CDU}, shall be calculated using the following:

$$\eta_{CDU} = \frac{Q_j}{W_{TCS}}$$

$$U_{\eta_{CDU}} = \sqrt{[(\theta_{Q_j} U_{Q_j})^2] + [(\theta_{W_{TCS}} U_{W_{TCS}})^2]}$$

$$\theta_{Q_j} = \frac{1}{W_{TCS}}$$

$$\theta_{W_{TCS}} = \frac{Q_j}{W_{TCS}^2}$$

6.4.4 Liquid Pressure Drop Correction. Measured liquid pressure-drop values shall be adjusted to subtract additional static pressure drop due to piping external to the CDU connection points. The additional static pressure drop shall be the sum of all losses between the unit connections and the location of static pressure taps. Record the original measured value, the calculated adjustment value, and the final calculated result for liquid pressure drop. Where applicable, refer to ANSI/ASHRAE Standard 30[12] for equations, processes, and procedures.

6.5 Validation. Test results are validated by checking an energy balance and a voltage balance.

6.5.1 Energy Balance. Based on the first law of thermodynamics (the law of conservation of energy), an energy balance calculation evaluates all of the measured energy flow into and out of a control volume. If there is a nonzero difference between energy flow in and energy flow out, greater than the energy balance measurement uncertainty, then either (a) the system is not at steady state (lack of equilibrium), (b) some significant heat gain or heat loss has been omitted from the calculation, or (c) there is a measurement error to be corrected. The control volume shall include the entire CDU package. In many cases, heat losses or heat gain caused by radiation, convection, bearing friction, etc., are relatively small and may be either included or excluded without a problem in the overall energy balance.

6.5.1.1 Refer to ANSI/ASHRAE Standard 30[12] for equations, processes, and procedures. For liquid-to-liquid CDUs, utilize the definition of *critical input power* in this standard.

6.5.1.2 A typical summation omitting the effect of the small heat losses and gains mentioned in Section 5.5.1.2:

$$E_{in} = \sum_i E_{in_i} = Q + (W_{TCS})$$

6.5.2 Voltage Balance

6.5.2.1 Refer to ANSI/ASHRAE Standard 30[12] for equations, processes, and procedures.

6.5.3 All equations described in this standard assume consistent units. It is imperative that users of this standard ensure proper unit conversions in all calculations.

6.5.4 One (1) Btu (IT) = 1055.05585262 J (exact conversion).

6.5.5 For all other unit conversions, refer to NIST Special Publication 811,[13] or other authoritative source for appropriate unit conversions.

6.6 Rounding and Significant Digits

6.6.1 Refer to ANSI/ASHRAE Standard 30[12] for equations, processes, and procedures.

Reorganize and renumber existing Section 7 and add new references as shown.

~~7.~~13. REFERENCES

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15. ASHRAE. 2016. ANSI/ASHRAE Standard 41.8, *Standard Methods for Liquid Flow Measurement*. Peachtree Corners, GA: ASHRAE.
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20. ASME. 2006. ASME Standard MFC-11, *Measurement of Fluid Flow by Means of Coriolis Mass Flowmeters*. New York: American Society of Mechanical Engineers.
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Add new Section 7 as shown.

7. TEST REQUIREMENTS

7.1 Except where specifically stated within this standard, follow the requirements identified in ANSI/ASHRAE Standard 30.[12] References to "chiller" or "chillers" should be replaced with "CDU" or "CDUs." References to chilled water should be replaced with FWS. References to condenser water should be replaced with TCS.

Table 7-1 Requirements for Test Instrumentation

Measurement	Measurement System Accuracy[b,c,d,e]	Measurement Resolution[f,g]	Selected, Installed, Operated, Maintained in Accordance with:
Fluid temperature	±0.11 D°C (±0.2 D°F)	0.005°C (0.01°F)	ANSI/ASHRAE Standard 41.1[14]
Air temperature	±0.11 D°C (±0.20 D°F)	0.05°C (0.1°F)	ANSI/ASHRAE Standard 41.1[14]
Fluid mass flow rate[a]	±1.0% RDG	4 significant figures	ANSI/ASHRAE Standard 41.8[15] or ASME Power Test Code PTC 19.5[16] (flow measurement)
			ASME MFC-16[17] (electromagnetic type)
			ASME MFC-3M[18] (orifice and venturi type)
			ASME MFC-6M[19] (vortex type)
			ASME MFC-11[20] (Coriolis type)
			ASME MFC-21[21] (thermal dispersion)
			ISA Standard RP31[22] (turbine type)
Differential pressure	±1.0% RDG	3 significant figures	ASME Power Test Code PTC 19.2[23]
Electrical power		4 significant figures	ANSI/ASHRAE Standard 41.11[24] and IEEE C57.13[25]
≤600V	±1.0% FS, ±2.0% RDG	V, A, kW, Hz	
>600V	±1.5% FS, ±2.5% RDG		
Atmospheric pressure	±1.0 kPa (±0.15 psia)	0.1 kPa (0.01 psia)	ASME Power Test Code PTC 19.2[23]

a. Accuracy requirement also applies to volumetric type meters.
b. Measurement system accuracy shall apply over the range of use during testing, as indicated by the turndown ratio determined during calibration—i.e., from full scale down to a value of full scale divided by the turndown ratio. For many types of instruments and/or systems, this may require exceeding the accuracy requirement at full scale.
c. %RDG = percent of reading; %FS = percent of full scale for the usable range of the measurement instrument or measurement system.
d. If dual requirements are shown in the table, FS and RDG, then both requirements shall be met.
e. Current transformers and potential transformers shall have a metering accuracy class of 0.3 or better, rated in accordance with IEEE C57.13.[25]
f. Measurement resolution shown is the minimum requirement (most coarse resolution allowable). Better (finer) resolution is acceptable for instrument or panel displays or computer screen displays. Resolution includes all parts of the measurement system, such as analog-to-digital conversion.
g. Significant figures (also known as significant digits) are determined in accordance with ANSI/ASHRAE Standard 30, Section 5.7.

Table 7-2 Definition of Operating Condition Tolerances and Stability Criteria

Measurement or Calculation Result		Applicable Operating Modes	Values Calculated from Data Samples: Mean	Values Calculated from Data Samples: Std. Dev.	Operating Condition Tolerance Limits	Stability Criteria
Net capacity (cooling or heating)		Cooling, heating, heat recovery	Q	—	Unit with continuous unloading: Part-load test capacity shall be within 2% of the target part-load capacity.[a] $\frac{\lvert\bar{Q} - Q_{target}\rvert}{Q_{100\%}} \le 2.000\%$ Units with discrete capacity steps: Part-load test points shall be taken as close as practical to the specified part-load rating points as stated in the test plan.	No requirement
FWS	Entering fluid temperature	Cooling	$\bar{T}$	s_T	No requirement	$s_T \le 0.10\ \Delta°C\ [0.18\ \Delta°F]$
	Leaving fluid temperature				$\lvert\bar{T} - T_{target}\rvert \le 2.28\Delta°C\ [0.50\Delta°F]$	
TCS	Leaving fluid temperature					
	Entering fluid temperature				No requirement	
FWS or TCS[a]			T	s_T	$\lvert T - T_{target}\rvert \le 0.56\Delta°C\ [1.00\Delta°F]$	$s_T \le 0.42\Delta°C\ [0.75\Delta°F]$
Fluid flow (volumetric, entering)			$\bar{V}_w$	s_{V_w}	$\frac{\lvert\bar{V} - V_{w,\ target}\rvert}{V_{w,\ target}} \le 5.000\%$	$\frac{s_{V_w}}{V_w} \le 0.750\%$
Voltage[b] (If multiphase, this is the average of all phases.)			$\bar{V}$	s_V	$\frac{\lvert\bar{V} - V_{target}\rvert}{V_{target}} \le 10.000\%$	$\frac{s_V}{V} \le 0.500\%$
Frequency[b]			$\bar{\omega}$	s_ω	$\frac{\lvert\bar{\omega} - \omega_{target}\rvert}{\omega_{target}} \le 1.000\%$	$\frac{s_\omega}{\omega} \le 0.500\%$
Governor control pump speed[c]			$\bar{n}$	s_n	$\frac{\lvert\bar{n} - n_{target}\rvert}{n_{target}} \le 0.500\%$	$\frac{s_n}{n} \le 0.250\%$

a. The ±2.0% tolerance shall be calculated as 2.0% of the full-load rated capacity (kW). For example, a nominal 50.0% part-load point shall be tested between 48.0% and 52.0% of the full-load capacity to be used directly for efficiency calculations. Outside this tolerance, interpolation shall be used.

b. For electrically driven machines, voltage and frequency shall be maintained at the nameplate rating values within tolerance limits and stability criteria on voltage and frequency when measured at the locations specified in ANSI/ASHRAE Standard 30, Section 6.3.1.7. For dual nameplate voltage ratings, tests shall be performed at the lower of the two voltages.

c. For speed-controlled pumps, the speed shall be maintained at the nameplate rating value within the tolerance limits.

Add new Sections 8 through 11 as shown.

8. DATA TO BE RECORDED

8.1 Primary Data. Table 8-1 summarizes the data to be recorded during the test for each of the data point samples.

8.2 Auxiliary Data. Table 8-2 summarizes the auxiliary data that shall be recorded for the test.

8.3 Optional Auxiliary Data. Table 8-3 summarizes optional auxiliary data (nonmandatory) that may be recorded during the test for diagnostic information.

8.4 Refer to Normative Appendix B for schematics of each system type and the physical location of measurement instruments.

9. TEST PROCEDURES

9.1 Purpose. This section prescribes a method of testing for liquid-to-liquid CDUs and to verify capacity and power requirements at a specific set of steady- state conditions.

9.1.1 Testing shall be conducted at a facility designed specifically for that purpose where instrumentation is in place and load stability can be obtained.

Table 8-1 Data to Be Recorded During the Test

Type		Data Item
All types	General	• Time of day for each data point sample • Atmospheric pressure
	FWS, TCS	• T_{in} • T_{out} • m_w or V_w • Δp_{test}
Electric drive	CDU	• W_{input} • Voltage for each phase • If three-phase, average voltage • Frequency for one phase

Table 8-2 Auxiliary Data to Be Recorded

Type	Data Item
All	• Date, place, and time of test • Names of test supervisor and witnessing personnel • Ambient temperature within test cell[a] • Nameplate data, including make, model, size, serial number, and refrigerant designation numbers or manufacturer's fluid designation (product name, generic industry name, and batch number or chemistry test results per Section 6.1.2) for FWS and TCS fluids, sufficient to completely identify the CDU. Unit voltage and frequency shall be recorded. • Prime mover nameplate data (motor, engine, or turbine)

a. Test cell temperature is not subject to the stability requirements identified in Table 7-2.

Table 8-3 Optional Auxiliary Data to Be Recorded

Type	Data Item
Open-type pump	Pump rotational speed
Electric drive	Current for each phase of electrical input to CDU
All	Liquid pump input power for integral pumps

9.1.2 Testing shall not be conducted in field installations to the provisions of this standard. Steady-state conditions and requirements for consistent, reliable measurement are difficult to achieve in field installations.

9.2 Test Procedures. For each test point at a specific load and set of operating conditions, the test will measure capacity, critical input power, and liquid-side pressure drop. Capacity is a measurement of the heat removed from the liquid as it passes through the heat exchanger according to the test plan. Net capacity is always required, and gross capacity is required when an energy balance requirement applies. Each test point will collect multiple data points versus time. The test shall use instrumentation meeting the requirements in Section 7 and calculations in Section 6.

9.3 Setup. The CDU to be tested shall be set up at the test facility in accordance with the manufacturer's instructions, including, but not limited to, support of installation mounting points, connections for liquid, connections for power supply, test instrumentation, etc. Noncondensable gases, if present, shall be removed from the system.

9.3.1 The test cell must maintain an ambient dew-point temperature no less than 2.0°C (3.6°F) below the TCS leaving fluid temperature for the rating conditions.

9.4 Condition of Heat Transfer Surfaces. The as-tested fouling factors shall be assumed to be zero (R_{foul} = 0.000 $m^2 \cdot K/kW$ = 0.00 $h \cdot ft^2 \cdot °F/Btu$). Tests conducted in accordance with this standard may require cleaning of the heat transfer surfaces (in accordance with manufacturer's instructions) prior to conducting the test.

9.5 Operation. After setup is complete, the CDU will be started and operated to attain the target conditions of the test point per the test plan. The CDU is not required to operate continuously between different test points; shutdown and restart between test points is allowable.

9.5.1 General

9.5.1.1 Refer to ANSI/ASHRAE Standard 30[12] for requirements.

9.5.2 Adjustments

9.5.2.1 Controls. Manual operation of CDU controls is allowed to avoid cycling and disruption of test stability.

9.6 Liquid Pressure Drop Measurement Procedure

9.6.1 Refer to ANSI/ASHRAE Standard 30.[12] Replace references to "liquid-to-refrigerant heat exchangers" with "liquid-to-liquid heat exchangers."

9.7 Test Point

9.7.1 Refer to Table 9-1 for test points. Test point values shown are based on water on the FWS side of the CDU and 25% propylene glycol on the TCS side of the CDU.

9.7.1.1 Test point values are to be adjusted based on the fluid chemistry used in the specific test. Refer to ANSI/ASHRAE Standard 30[12] for additional information.

10. REPORTING OF RESULTS

10.1 General

10.1.1 All data reported from test for rating will be derived from instrumentation integral to the test facility. Instrumentation integral to the equipment may not be used for data input for rating.

10.1.2 Report shall identify net cooling capacity (W [Btu/h]).

Table 9-1 Test Points—Liquid to Liquid CDU

	FWS Temperatures	TCS Temperatures	
Test Point[b]	EFT	LFT	EFT
Full capacity (100%)	26°C (78.8°F)	30°C (86°F)	39.6°C (103.3°F)
75% capacity	26°C (78.8°F)	30°C (86°F)	37.2°C (99.0°F)
50% capacity	26°C (78.8°F)	30°C (86°F)	34.8°C (94.6°F)
25% capacity	26°C (78.8°F)	30°C (86°F)	32.4°C (90.3°F)
Minimum capacity[a]	26°C (78.8°F)	30°C (86°F)	N/A

a. Minimum capacity test point to be performed with automatic flow controls active at the minimum flow rate at which the CDU automatically maintains TCS side flow within the required flow test tolerances. listed in Table 7-2.
b. Tests for 100%, 75%, 50%, and 25% capacity are performed at constant TCS flow rate equal to the flow rate used for the 100% capacity point.

10.1.3 Critical input power to CDU (W, kW, or MW), as defined in this standard, shall be identified.

10.1.4 Excluding auxiliary input power when present.

10.1.5 Report shall identify energy efficiency, expressed as energy efficiency ratio (EER), coefficient of performance (COP), or power input per capacity, Btu/W·h or W/W or kW/kW.

Informative Note: It is important to note that pump energy associated with pressure drop through the FWS loop portion of the CDU is not included in the critical input power. This is because any adjustment to the CDU performance would confuse the overall system analysis for capacity and efficiency. It is therefore important for any system analysis to account for the cooling loads associated with the FCS loop pump energy and to include the pump power into the overall equations for system efficiency.

10.1.6 Entering and leaving temperatures (°C [°F]) or leaving liquid temperature and temperature difference (Δ°C [Δ°F]) for TCS loop and FWS loop.

10.1.6.1 TCS-side available external head pressure and FWS-side pressure drop in kPa (ft of water at 60°F or psid).

Informative Notes:

1. Due to typical industry practice, liquid pressure drop is often reported in head (kPa [ft of water]); however, test data are acquired in pressure (psid) for use in calculations.
2. To establish the available external head pressure, the pump is manually set at 100% speed, and valves on the test block are adjusted until the CDU TCS flow reaches the test point value within the required tolerance. The differential pressure is then recorded to establish the TCS-side available external head pressure.

10.1.7 Flow Rate. Liquid flow rate of TCS loop and FWS loop (L/s or m^3/h [gpm]) at entering heat exchanger conditions.

10.1.8 Voltage. Nominal voltage (V or kV) and frequency (Hz) for which ratings are valid. For units with a dual nameplate voltage rating, testing shall be performed at the lower of the two voltages. Components that use auxiliary power shall be listed.

10.1.9 Fluid Properties. Identify fluids used on both FWS and TCS side of CDU.

10.1.10 Test Results. Test results shall be rounded to the number of significant figures identified in ANSI/ASHRAE Standard 30, Section 6.6 using the definitions in Section 3 and rounding rules and formats in Section 6.6. A written test report shall be generated that contains the data included in Section 8 for each test point at a specific load and set of operating conditions.

10.1.11 Data. For each test point, at a specific load and set of operating conditions, report the test time period and number of data-point measurements. Include the sample mean and sample standard deviation for each measurement value (temperature, flow, pressure drop, power, etc.).

Table 10-1 Results to Be Reported

	Units of Measure	
Item	**SI**	**I-P**
Net cooling capacity (corrected if applicable)	kW or W	Btu/h
Net heat to FWS (corrected if applicable)	kW or W	Btu/h
Input power (W_{input} as applicable)	kW or W	kW or W
Efficiency (corrected if applicable)	COP	EER, or COP
$\Delta p_{available\ TCS}$	kPa	ft of water (at 60°F)
$\Delta p_{corrected\ FWS}$	kPa	ft of water (at 60°F)
Facility pumping power required	kW or W	BHP
TCS pump turndown ratio	Ratio	ratio
Energy balance	%	%
Net heat rejection to space ambient	kW or W	Btu/h
Unit power factor	PF	PF
Voltage balance	%	%

10.1.12 Calculations. Report the correction adjustment values Δp_{adj} and ΔT_{adj}, correction factors CF_Q and CF_η when applicable, and associated input data used for the correction calculations. Report the density, specific heat capacity, and mass flow values used for capacity calculations. Report all values of Q used in energy balance calculations.

10.1.13 Results. Report the test results following calculations and procedures identified in Sections 6 and 9. Table 10-1 provides a generic summary.

10.1.14 Additional Information to Report

10.1.14.0.1 Name and address of the CDU test facility.

10.1.14.0.2 Report identification number and disclaimer.

10.1.14.0.3 Description of test CDU, including model and serial numbers.

10.1.14.0.4 Date and time of tests.

10.1.14.0.5 Instrumentation and calibration list from test facility.

11. NOMENCLATURE

11.1 Some symbols use a subscript suffix; multiple subscripts are separated by a comma. Refer to ANSI/ASHRAE Standard 30[12] for information regarding use of units and converting equations based on other units of measure.

Table 11-1 Nomenclature

			SI		I-P	
Group	**Symbol**	**Description**	**Unit**	**Symbol**	**Unit**	**Symbol**
General						
	CF	correction factor for atmospheric pressure adjustment				
	E	energy flow rate (thermal or electrical)	watt	W	British thermal unit (IT) per second	Btu/s
	E_{bal}	energy balance				
	L	length dimension	meter	m	foot	ft
	W	width dimension	meter	m	foot	ft
	H	height dimension	meter	m	foot	ft
	n	rotational speed (such as motor or compressor)	revolution per minute	rpm	revolution per minute	rpm
	t	time	second	s	second	s
		date and time display formats: dd-mmm-yyyy hh:mm:ss.s				
	Δ_t	time interval	second	s	second	s
	T_{ol}	tolerance				
	V	voltage	volt	V	volt	V
	W	power, rate at which work is performed	watt	W	watt	W
	θ	sensitivity coefficient for uncertainty				
	ω	frequency (electrical)	hertz	Hz	hertz	Hz
Flow						
	m	mass flow rate	kilogram per second	kg/s	pound per second	lb/s
	V	volumetric flow rate	cubic meter per second	m^3/s	cubic foot per second	ft^3/s
	ρ	density	kilogram per cubic meter	kg/m^3	pound per cubic foot	lb/ft^3
Capacity						
	Q	net capacity, heat flow rate	watt	W	British thermal unit (IT)	Btu/h
	Q′	gross capacity, heat flow rate	watt	W	British thermal unit (IT)	Btu/h
	Q%	percent load				
	c_p	specific heat at constant pressure	kilojoule per kilogram kelvin	kJ/(kg·K)	British thermal unit (IT) per pound degree Fahrenheit	Btu/(lb·°F)
	h	enthalpy	kilojoule per kilogram	kJ/kg	British thermal unit (IT) per pound	Btu/lb

Table 11-1 Nomenclature

Group	Symbol	Description	SI Unit	SI Symbol	I-P Unit	I-P Symbol
	Δh	enthalpy differential	kilojoule per kilogram	kJ/kg	British thermal unit (IT) per pound	Btu/lb
	T	temperature	degree Celsius	°C	degree Fahrenheit	°F
	ΔT	temperature differential (temperature interval)	degree Celsius	Δ°C	degree Fahrenheit	Δ°F
Efficiency						
	η	efficiency, COP	watt per watt	W/W = 1	watt per watt	W/W = 1
Pressure Drop						
	d	pipe inside diameter dimension	millimeter	mm	inch	in
	p	pressure	kilopascal	kPa	pound-force per square inch	psia
	Δp	pressure differential	kilopascal	kPa	pound-force per square inch	psid or ft of water (at 60°F)

Table 11-2 Subscripts

Subscripts	Description
atm	atmospheric
avg	average, equivalent to arithmetic mean
corrected	corrected value representing an adjustment to a test value
DB	dry-bulb, referring to temperature
FL	full-load, referring to rated capacity at design conditions
i	index value
in	inlet, entering, input
input	input
j	index value
liq	liquid
FWS	facility water system
TCS	Technology Cooling System
mean	mean, referring to arithmetic mean
Q	capacity
test	test, result from a test measurement
w	water
X%	denoting a value for X% part load capacity (i.e., 75%)
h	efficiency

Add new Normative Appendix F as shown.

(This appendix is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

INFORMATIVE APPENDIX G
USE OF STANDARD FOR APPLICATION TESTING

This standard defines the Method of Test for Rating of Data Center Cooling Equipment. The intent is to enable products to be compared for steady-state capacity and efficiency based on a defined set of standard performance points. It is imperative to understand this document does not define method of testing equipment for transient response, project-specific applications, control stability, or other similar parameters. It is common to test equipment at project- or application-specific operating points or under specific operating conditions which do not fall under this standard. These alternative tests are Application Tests. Measurement points, instrumentation requirements, and other parameters defined within this standard may be used as reference to develop an independent test regimen or facility for an Application Test but should not be confused with or inferred to be a test complying with this standard.

Reorder existing Informative Appendix F as shown.

(This appendix is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

~~INFORMATIVE APPENDIX F~~
INFORMATIVE APPENDIX G
PERFORMANCE RATING TABLE FROM AHRI 1360

Add new Informative Appendix H as shown.

(This is a normative appendix and is part of this standard.)

NORMATIVE APPENDIX H
MEASUREMENT POINTS FOR LIQUID TO LIQUID CDUs

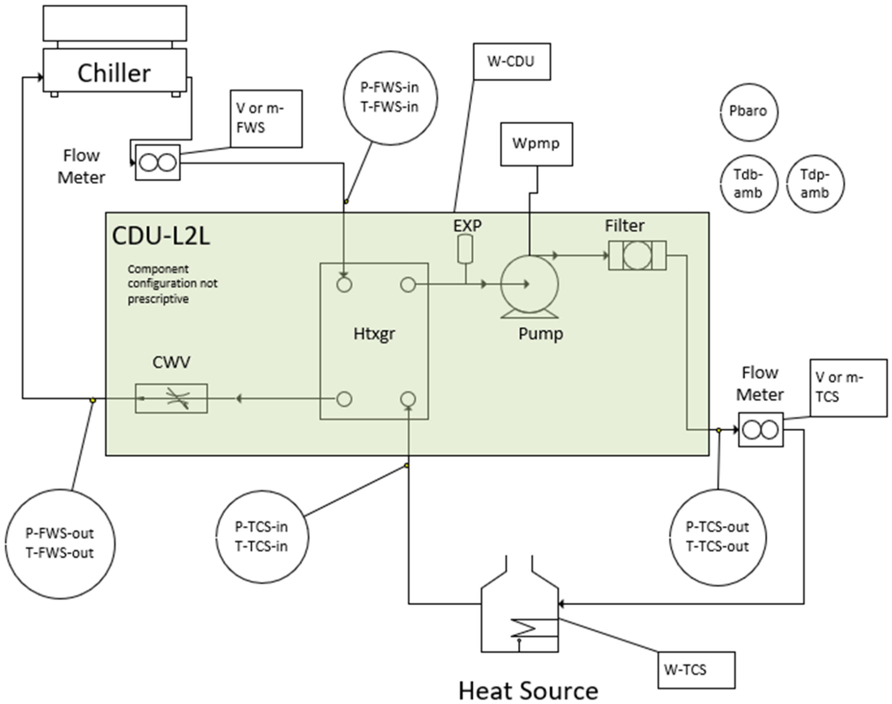

Table H-1 Test Measurement Points

	Description	Units SI	Units I-P
m_{FWS}	Mass flow rate of the FWS working fluid into the CDU	kg/s	lb/s
m_{TCS}	Mass flow rate of the TCS working fluid out of the CDU	kg/s	lb/s
V_{FWS}	Volume flow rate of the FWS working fluid into the CDU	m^3/s	ft^3/s
V_{TCS}	Volume flow rate of the TCS working fluid out of the CDU	m^3/s	ft^3/s
$P_{FWS\text{-}in}$	FWS liquid pressure entering the CDU	kPa	psia
$T_{FWS\text{-}in}$	FWS liquid temperature entering the CDU	°C	°F
$P_{FWS\text{-}out}$	FWS liquid pressure leaving the CDU	kPa	psia
$T_{FWS\text{-}out}$	FWS liquid temperature leaving the CDU	°C	°F
$P_{TCS\text{-}in}$	TCS liquid pressure entering the CDU	kPa	psia
$T_{TCS\text{-}in}$	TCS liquid temperature entering the CDU	°C	°F
$P_{TCS\text{-}out}$	TCS liquid pressure leaving the CDU	kPa	psia
$T_{TCS\text{-}out}$	TCS liquid temperature leaving the CDU	°C	°F
P_{baro}	Barometric pressure surrounding the CDU	kPa	psia
T_{DBamb}	Dry-bulb temperature surrounding CDU during test	°C	°F
T_{DPamb}	Dew-point temperature surrounding CDU during test	°C	°F
W_{CDU}	Electrical power supplied to the CDU	W	W
W_{pmp}	Electrical power supplied to the CDU Pump (optional)	W	W
W_{TCS}	Power supplied to the TCS fluid	W	W

POLICY STATEMENT DEFINING ASHRAE'S CONCERN FOR THE ENVIRONMENTAL IMPACT OF ITS ACTIVITIES

ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted Standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the Standards and Guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive Technical Committee structure, continue to generate up-to-date Standards and Guidelines where appropriate and adopt, recommend, and promote those new and revised Standards developed by other responsible organizations.

Through its *Handbook*, appropriate chapters will contain up-to-date Standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating Standards and Guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.

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About ASHRAE

Founded in 1894, ASHRAE is a global professional society committed to serve humanity by advancing the arts and sciences of heating, ventilation, air conditioning, refrigeration, and their allied fields.

As an industry leader in research, standards writing, publishing, certification, and continuing education, ASHRAE and its members are dedicated to promoting a healthy and sustainable built environment for all, through strategic partnerships with organizations in the HVAC&R community and across related industries.

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