



Addendum a to ANSI/ASHRAE Standard 30-2019

Public Review Draft

Method of Testing Liquid Chillers

First Public Review (January 2020)
(Draft shows Proposed Changes to Current Standard)

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FOREWORD

ASHRAE Standard 30 prescribes methods for obtaining performance data relating to liquid-chilling or liquid-heating equipment using any type of compressor. The intent of this standard is to provide uniform test methods to measure the performance of this equipment by addressing the test and instrumentation requirements, test procedures, data to be recorded, and calculations to generate and confirm valid test results.

Addendum ‘a’ includes the following major revisions:

1. Updated *capacity* and *condenser* definitions to align with the rest of the standard.
2. Added enthalpy measurement and capacity calculations.
3. Updated thermal input power calculations.
4. Clarified existing pressure drop correction calculation.
5. Added requirement to test based on operating mode set points defined prior to testing.
6. Simplified existing test data collection and test report requirements.

[Note to Reviewers: This addendum makes proposed changes to the current standard. These changes are indicated in the text by underlining (for additions) and ~~striketrough~~ (for deletions) except where the reviewer instructions specifically describe some other means of showing the changes. Only these changes to the current standard are open for review and comment at this time. Additional material is provided for context only and is not open for comment except as it relates to the proposed changes.]

Addendum a to ANSI/ASHRAE Standard 30-2019

Modify Section 3 Definitions, Abbreviations, and Acronyms as shown below. The remainder of Section 3 is unchanged.

3. DEFINITIONS, ABBREVIATIONS, AND ACRONYMS

capacity: a measurable physical quantity, the rate that heat (*energy*) is added to or removed from the *liquid* side of a *refrigerating system*. *Capacity* is defined as the mass flow rate of the *liquid* multiplied by the difference in enthalpy of *liquid* entering and leaving the heat exchanger. For the purposes of this standard, the enthalpy change is approximated as the sensible heat transfer using specific heat and temperature difference, and in some calculations, also the energy associated with liquid-side pressure losses.

gross heating capacity: the *capacity* of the *water-cooled condenser* as measured by the total heat transferred from the refrigerant to the liquid in the *condenser*. This value includes both the sensible heat transfer and the friction heat losses from pressure drop effects of the *liquid* flow through the *condenser*. This value is used to calculate the *energy balance* of a test.

gross ~~cooling~~refrigerating capacity: the *capacity* of the *evaporator* as measured by the total heat transferred from the liquid to the refrigerant in the *evaporator*. This value includes both the sensible heat transfer and the friction heat losses from pressure drop effects of the *liquid* flow through the *evaporator*. This value is used to calculate the *energy balance* of a test.

net heating capacity: the *capacity* of the *condenser* available for useful heating of the thermal load, external to the liquid chilling system, calculated using only the sensible heat transfer.

net ~~cooling~~refrigerating capacity: the *capacity* of the *evaporator* available for useful cooling of the thermal load, external to the liquid chilling system, calculated using only the sensible heat transfer.

condenser: a *refrigerating system* component which condenses refrigerant from vapor state to liquid state by the removal of heat. De-superheating and sub-cooling of the refrigerant may occur as well.

air-cooled condenser: a *condenser*, including condenser fans, that condenses refrigerant vapor by rejecting heat to air mechanically circulated over a dry heat transfer surface, causing ~~a temperature~~ an *enthalpy* rise in the air.

evaporatively-cooled condenser: a *condenser* which condenses refrigerant vapor by rejecting heat to a water and air mixture mechanically circulated over ~~its a wetted~~ heat transfer surface, causing evaporation of the water and an increase in the enthalpy of the air.

liquid-cooled condenser: a *condenser* that condenses refrigerant vapor by rejecting heat to *liquid* mechanically circulated over its heat transfer surface, causing ~~a temperature~~ an *enthalpy* rise in the *liquid*.

liquid-cooled heat reclaim condenser: a *liquid-cooled condenser*, that may be either a separate parallel *condenser* in a *refrigerating system* using two or more *condensers*, or a portion of a *liquid-cooled condenser* with two or more *liquid* circuits, with the purpose of *heat recovery*.

Modify Section 5 Calculations and Conversion as shown below. The remainder of Section 5 is unchanged.

5. CALCULATIONS AND CONVERSIONS

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

5.4.1 Capacity. One of the following three methods shall be used depending on the available measurements and with consideration of the acceptable test uncertainty required by the ~~parties~~ test plan. Enthalpy capacity method shall be used for setups with significant distance and pressure drop between the temperature and pressure measurements on the inlet and/or outlet external piping. The additional temperature increase due to frictional pressure losses shall be determined by measuring pressure at a location within ± 2 pipe diameters of each temperature measurement point in the external piping. The pressure measurements adjacent to the temperature measurements shall be used when determining the physical properties of enthalpy. The sign convention, positive or negative, is to show all capacity values as positive whether energy is input into the chiller system or energy is removed from the chiller system. Adjust the sign for temperature difference or enthalpy 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.

5.4.2 Power

5.4.2.1 Thermal input power for a gaseous fuel for a given fluid volume flow rate and higher heating value assuming complete combustion.

$$Q_{input} = V \cdot HHV_v \cdot (T_s \times p) / (T_{abs} \times p_s)$$

$$U_{Q_{input}} = \sqrt{(\theta_V U_V)^2 + (\theta_{HHV_v} U_{HHV_v})^2 + (\theta_p U_p)^2 + (\theta_T U_T)^2}$$

$$\theta_V = HHV_v \cdot (T_s \times p) / (T_{abs} \times p_s)$$

$$\theta_{HHV_v} = V \cdot (T_s \times p) / (T_{abs} \times p_s)$$

$$\theta_p = V \cdot HHV_v \cdot T_s / (T_{abs} \times p_s)$$

$$\theta_{T_{abs}} = -V \cdot HHV_v \cdot (T_s \times p) / (p_s \times T_{abs}^2)$$

5.4.2.2 Thermal input power for a liquid fuel for a given mass flow rate and higher heating value assuming complete combustion.

$$Q_{input} = m \cdot HHV_m$$

$$U_{Q_{input}} = \sqrt{(\theta_m U_m)^2 + (\theta_{HHV_m} U_{HHV_m})^2}$$

$$\theta_m = HHV_m$$

$$\theta_{HHV_m} = m$$

~~5.1.1.1 Thermal input power for a given fluid volume flow rate, and higher heating value, at specified reference conditions for pressure and temperature(), and the pressure and temperature of the fuel. The calculation shall use absolute pressure and absolute temperature~~

~~$$Q_{input} = m \cdot HHV$$

$$U_{Q_{input}} = \sqrt{(\theta_m U_m)^2 + (\theta_{HHV} U_{HHV})^2}$$

$$\theta_m = HHV$$

$$\theta_{HHV} = m$$~~

5.4.4 Liquid Pressure Drop Correction. Measured liquid pressure drop values shall be adjusted to subtract additional static pressure drop due to piping external to the chiller 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, Δp_{test} , the calculated adjustment value, Δp_{adj} , and the final calculated result for liquid pressure drop, $\Delta p_{corrected}$.

$$\Delta p_{adj} = \rho g \left[\sum_i (h_f)_i + \sum_j (h_m)_j \right]$$

5.4.4.1 The adjustment shall not exceed 10% of the measured liquid pressure drop.

5.4.4.2 The corrected pressure drop $\Delta p_{corrected}$ shall be calculated as:

$$\Delta p_{corrected} = \Delta p_{test} - \Delta p_{adj}$$

5.7.5.5 The significance of trailing zeroes in a number not containing a decimal point can be ambiguous. For example, it may not always be clear if a number like 1300 is precise to the nearest unit (and just happens coincidentally to be an exact multiple of a hundred) or if it is only shown to the nearest hundred due to rounding or uncertainty. Various conventions exist to address this issue:

5.7.5.5.1 A bar may be placed over the last significant figure; any trailing zeros following this are insignificant. For example, 13 $\bar{0}$ 0 has three significant figures (and hence indicates that the number is precise to the nearest ten).

5.7.5.5.2 The last significant figure of a number may be underlined; for example, "2000" has two significant figures.

5.7.5.5.3 A decimal point may be placed after the number; for example "100." indicates specifically that three significant figures are meant.

5.7.5.5.4 In the combination of a number and a unit of measurement, the ambiguity can be avoided by choosing a suitable unit prefix. For example, the number of significant figures in a power measurement specified as 1300 W is ambiguous, while a power of 1.30 kW is not.

5.7.5.5.5 Ambiguity can also be avoided by use of scientific notation or exponential notation; for example, 1.30×10^3 W.

Modify Section 6 Test Requirements as shown below. The remainder of Section 6 is unchanged.

6. TEST REQUIREMENTS

6.4 Plan. A test plan shall document all requirements for conducting the test. This includes a list of the required full load and part load test points and associated operating conditions, including adjusted liquid temperature targets based on the rated Fouling Factor Allowance. In addition to the requirements specifically listed in this standard, the test plan shall include all other input signals or controls positions necessary to place the chiller in the operating mode for each test to be performed.

Modify Section 7 Data to Be Recorded as shown below. The remainder of Section 7 is unchanged.

7. DATA TO BE RECORDED

7.1 General. 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.), as calculated per Section 5.2.

7.2 ~~7.1~~ Primary Data. Table 7-1 summarizes the data to be recorded during the test for each of the data point samples.

Table 7-1 Data to be Recorded During the Test			
Type		Data Item	
All Types	General	Date and Time of day for each data point sample	
		Atmospheric pressure	
	Evaporator	T _{in}	
		T _{out}	
		m _w or V _w	
	Δp _{test}		
Liquid-cooled Condenser	Condenser	T _{in}	
Liquid-cooled Heat Reclaim Condenser		T _{out}	
		m _w or V _w	
		Δp _{test}	
Air-cooled Condenser	Condenser	Spatial average dry-bulb temperature of entering air	
Evaporatively-cooled Condenser	Condenser	Spatial average dry-bulb temperature of entering air	
		Spatial average wet-bulb temperature of entering air	
		Make up water flow rate	
		Make up water temperature	
Without Condenser	Compressor	Discharge temperature	
		Discharge pressure	
	Liquid Line	Liquid refrigerant temperature entering the expansion device	
		Liquid pressure entering the expansion device	
Electric Drive	Chiller	W _{input} (and W _{refrig} if needed)	
		Voltage for each phase	
		If 3-phase: average voltage	
		Frequency for one phase	
Non-Electric Drive	Chiller	W _{input} (and W _{refrig} if needed)	
		If Steam Turbine: Steam consumption Steam supply pressure Steam supply temperature Steam exhaust pressure	
		If Gas Turbine or Gas Engine: fuel consumption (natural gas or propane) calorific value	
		If Internal Combustion Engine: liquid fuel consumption (diesel or gasoline) calorific value	

7.3 Auxiliary Data. Table 7-2 summarizes the auxiliary data that shall be recorded for the test.

Table 7-2. Auxiliary Data to be Recorded	
Type	Data Item
All	Date, place, and time of test
	Names of test supervisor and witnessing personnel
	Ambient temperature at test site
	Nameplate data, including make, model, size, serial number, voltage, frequency, and refrigerant designation number (in accordance with ASHRAE 34), sufficient to completely identify the liquid chiller. Unit voltage and frequency shall be recorded.
	Prime mover nameplate data (motor, engine, or turbine).
Non-electric Drive	Fuel specification (if applicable) and calorific value

Modify Section 9 Reporting of Results as shown below. The remainder of Section 9 is unchanged.

9. REPORTING OF RESULTS

9.1 General. Table 9-1 summarizes the results to be reported for each test type.

Table 9-1 Data to be Reported¹	
Type	Report Item
General	Name and address of the chiller test facility
	Report identification number
Chiller Operation	Operating mode (Cooling, Heating, Simultaneous Heating and Cooling, or Heat Recovery)
	All inputs necessary to ensure that the equipment under test runs in the operating mode tested ²
Capacity	Net capacity
	Gross capacity values as used for energy balance
	Heat reclaim capacity ³
Input Power	Total input power
	List of components that utilize auxiliary power
Energy Efficiency⁴	One or more of the <i>energy efficiency</i> metrics per Section 5.4.3
Liquid Pressure Drop⁵	Liquid corrected pressure drop at water temperatures per the test plan, measured per Section 8.4 and corrected per Section 5.4.4
Test Validation	Energy Balance when required per Sections 5.5.1 and 5.5.1.4
	Voltage Balance per Section 5.5.2
Correction Values	Δp_{adj} per Section 5.4.4
	Any other correction values required by the test plan
Test Plan	Attach a copy of the test plan in accordance with Section 6.4 or provide target operating condition values such as capacity, temperature, and flow.
Test Data	All data recorded in accordance with Section 7
Uncertainty Analysis	Results of the uncertainty analysis in accordance with Section 6.7.3.
Notes:	
<ol style="list-style-type: none"> 1. Test Results shall be rounded to the number of significant figures identified in Section 5.7, using the definitions in Section 3, and rounding rules and formats in Section 5.7. 2. Example: In the case that a unit operates in “Heating” mode only when the ambient temperature is below 12.8°C (55.0°F), the report shall state the temperature and how the ambient temperature signal is provided to the equipment under test. 3. Required for <i>liquid-cooled heat reclaim condenser</i> only. 4. Pump energy associated with pressure drop through the chiller heat exchangers is not included in the <i>total input power</i>. This is done because any adjustment to the chiller 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 system pump energy and to include the pump power into the overall equations for system efficiency. 5. Liquid pressure drop shall be reported in units of pressure differential, not in head or liquid column height. <i>Note:</i> Due to industry typical practice, Liquid Pressure Drop is often reported in head (ft H₂O) and corrected to a reference temperature (e.g., 60 °F); however, test data is acquired in pressure, psid, for use in calculations. 	

9.1.1 Refrigerant designation shall be in accordance with ANSI/ASHRAE Standard 34.

9.1.2 Report shall identify Net Refrigerating Capacity or Net Heating Capacity (equations in Section 5.4.1), W (Btu/h or ton_R).

9.1.3 Total input power to chiller, W or kW or MW, shall be identified.

9.1.3.1 Excluding power input to integrated liquid pumps, when present (refer to Section 6.3.1.7.2).

9.1.4 Report shall identify Energy Efficiency, expressed as Energy Efficiency Ratio, Coefficient of Performance, or Power Input per Capacity, with qualifier to indicate operating mode (Cooling, Heating, Simultaneous Heating and Cooling, or Heat Recovery), Btu/W·h or W/W or kW/kW or kW/ton_R.

It is important to note that pump energy associated with pressure drop through the chiller heat exchangers is not included in the chiller input power. This is done because any adjustment to the chiller 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 system pump energy and to include the pump power into the overall equations for system efficiency.

9.1.5 Chilled liquid entering and leaving temperatures, °C (°F), or leaving liquid temperature and temperature difference, Δ°C(Δ°F)

9.1.5.1 Chillers with an integral pump: Evaporator heat exchanger Liquid Pressure Drop at rated water temperatures, kPa (ft H₂O (at 60°F) or psid)

9.1.5.2 Chillers without an integral pump: Chilled Liquid Pressure Drop at rated water temperature (customer inlet to customer outlet), kPa (ft H₂O (at 60°F) or psid).

Note: Due to industry typical practice, Liquid Pressure Drop is often reported in head (ft H₂O); however, test data is acquired in pressure, psid, for use in calculations.

9.1.6 Chilled liquid flow rate, L/s or m³/h (gpm), at entering heat exchanger conditions.

9.1.7 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.

9.1.8 Components that utilize Auxiliary Power shall be listed.

9.1.9 Part load weighted efficiency metric IPLV.IP or NPLV.IP, expressed as Energy Efficiency Ratio, Coefficient of Performance, or Power Input per Capacity, Btu/W·h or W/W or kW/kW or kW/ton_R, for Cooling operating mode only.

9.1.10 Test Results. Test Results shall be rounded to the number of significant figures identified in Section 5.7, using the definitions in Section 3, and rounding rules and formats in Section 5.7. A written test report shall be generated including the data included in Section 7 for each test point at a specific load and set of operating conditions.

9.2 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.).

9.3 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.

9.4 Results. Report the test results following calculations and procedures identified in Sections 5 and 8. Table 9-1 provides a generic summary;

Table 9-1 Results to be Reported		
Item	Units of Measure	
	SI	IP

Net Capacity (heating and/or cooling as applicable; corrected if applicable)	kW or W	ton_R or Btu/h
Gross Capacity (heating and cooling, only for liquid-cooled condenser type)	kW or W	ton_R or Btu/h
Input Power (W_{input}; and W_{refrig} as applicable)	kW or W	kW or W
Efficiency (corrected if applicable)	COP	kW/ton_R, EER, or COP
$\Delta p_{corrected}$	kPa	ft H₂O (at 60°F)
Energy Balance	%	%
Voltage Balance	%	%

9.4.1 Test Results Reporting Requirements. Tests shall report calculated results in accordance with methods and procedures described in this method of test, Section 5 and Section 8. The final test report shall include the following:

- ~~a. Name and address of the chiller test facility.~~
- ~~b. Report identification number and disclaimer.~~
- ~~c. Description of test chiller, including Model and Serial numbers.~~
- ~~d. Date and time of tests.~~
- ~~e. Instrumentation and calibration list from test facility.~~
- ~~f. Chilled Water Capacity.~~
- ~~g. Total Input Power.~~
- ~~h. Efficiency.~~
- ~~i. Chilled Water Pressure Drop.~~
- ~~j. Water-cooled Condenser.~~
 - ~~1. Total Heat Rejection.~~
 - ~~2. Condenser Water Pressure Drop.~~
 - ~~3. Energy Balance.~~
- ~~k. Air Cooled Condenser.~~
 - ~~1. Total Input Power.~~
 - ~~2. Condenser Entering Air Temperature.~~
- ~~l. Evaporatively-cooled Condenser.~~
 - ~~1. Total Input Power.~~
 - ~~2. Condenser Entering Air Temperature Dry Bulb.~~
 - ~~3. Condenser Entering Air Temperature Wet Bulb.~~
 - ~~4. Make Up Water Flow Rate.~~
 - ~~5. Make Up Water Temperature.~~
- ~~m. Water-cooled Condenser with Heat Reclaim.~~
 - ~~1. Heat Rejection of Condenser.~~
 - ~~2. Heat Reclaim Rejection.~~

Modify Section 10 Nomenclature as shown below. The remainder of Section 10 is unchanged.

10. NOMENCLATURE

Some symbols use a subscript suffix; multiple subscripts are separated by a comma. Equations in this standard use the following units of measure for dimensional consistency. See Section 5.6 for converting to or from other units of measure.

Group	Symbol	Description	SI		IP	
			Unit Name	Unit Symbol	Unit Name	Unit Symbol
General						
	HHV	higher heating value (mass or volume basis) at a specified reference temperature (Ts) and pressure (Ps)	kilojoule per cubic meter or kilojoule per kilogram	kJ/m^3 or kJ/kg	British thermal unit (IT) per cubic foot or British thermal unit (IT) per pound	Btu/ft^3 or Btu/lb
Capacity						
	T_{abs}	absolute temperature	Kelvin	K	degree Rankin	$^{\circ}\text{R}$

Subscripts	Description
<u>abs</u>	<u>absolute</u>
<u>fuel</u>	<u>fuel for combustion as a thermal input power source</u>
<u>m</u>	<u>mass or mass basis</u>
<u>s</u>	<u>specified reference condition for use with HHV_v or HHV_m values</u>
<u>v</u>	<u>volume basis</u>
<u>V</u>	<u>volume</u>

Modify Appendix B Measurement Points as shown below.

NORMATIVE APPENDIX B - MEASUREMENT POINTS

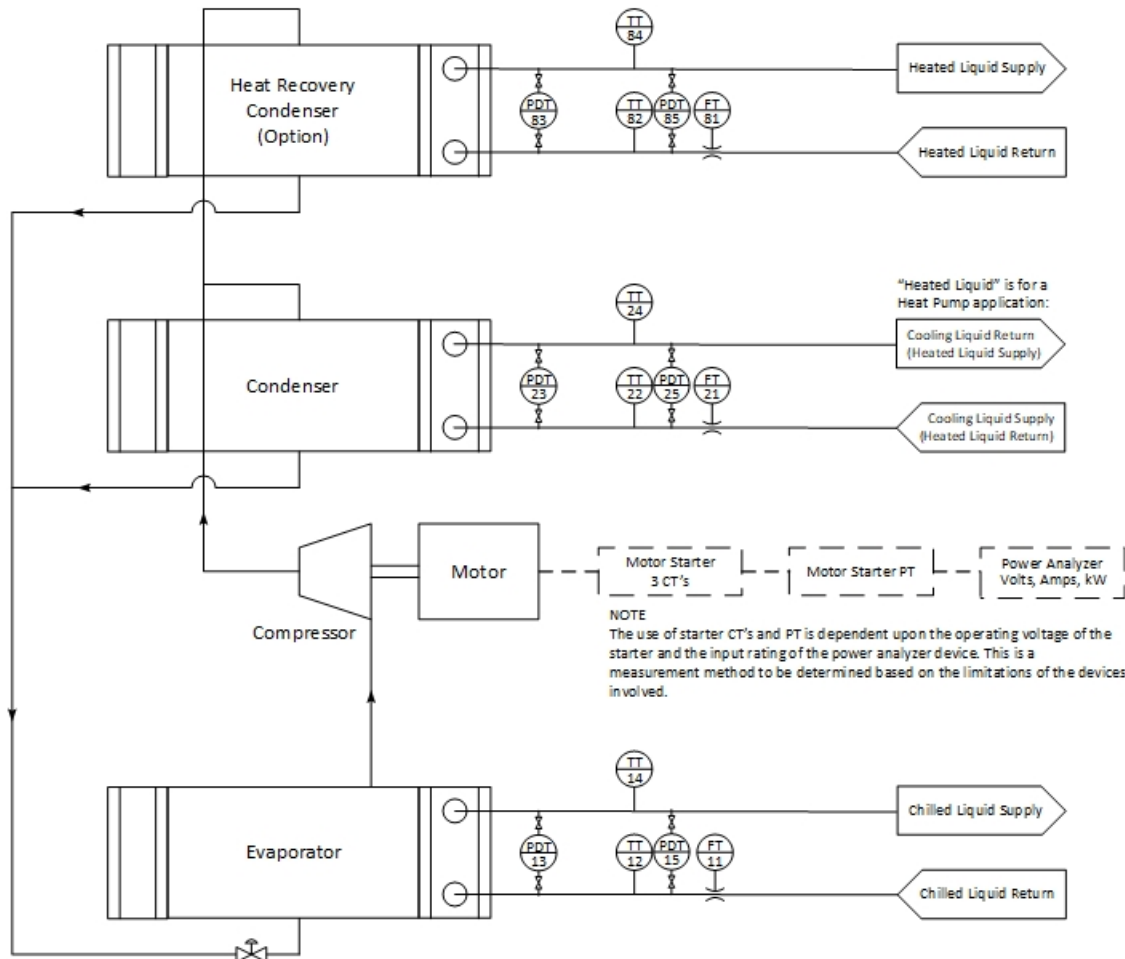


Figure B.1: Electrically-Driven Liquid-Cooled Chiller (with or without Heat Recovery) or Heat Pump

ID	Description of Measurement
FT-11	Evaporator liquid flow
TT-12	Evaporator inlet temperature
PDT-13	Evaporator pressure difference
TT-14	Evaporator outlet temperature
PDT-15 ^a	<u>Evaporator pressure difference at temperature measurement location</u>
FT-21	Condenser liquid flow
TT-22	Condenser inlet temperature
PDT-23	Condenser pressure difference
TT-24	Condenser outlet temperature
PDT-25 ^a	<u>Condenser pressure difference at temperature measurement location</u>
FT-81	Heat recovery condenser (when included) liquid flow
TT-82	Heat recovery condenser (when included) inlet temperature
PDT-83	Heat recovery condenser (when included) difference
TT-84	Heat recovery condenser (when included) outlet temperature
PDT-85 ^a	<u>Heat recovery condenser (when included) pressure difference at temperature measurement location</u>
Not identified	Power consumption for the chiller, including any auxiliary systems contained in the test boundary, includes voltage balance measurement
Notes:	
a. <u>Optional pressure measurement used for enthalpy capacity calculation method.</u>	

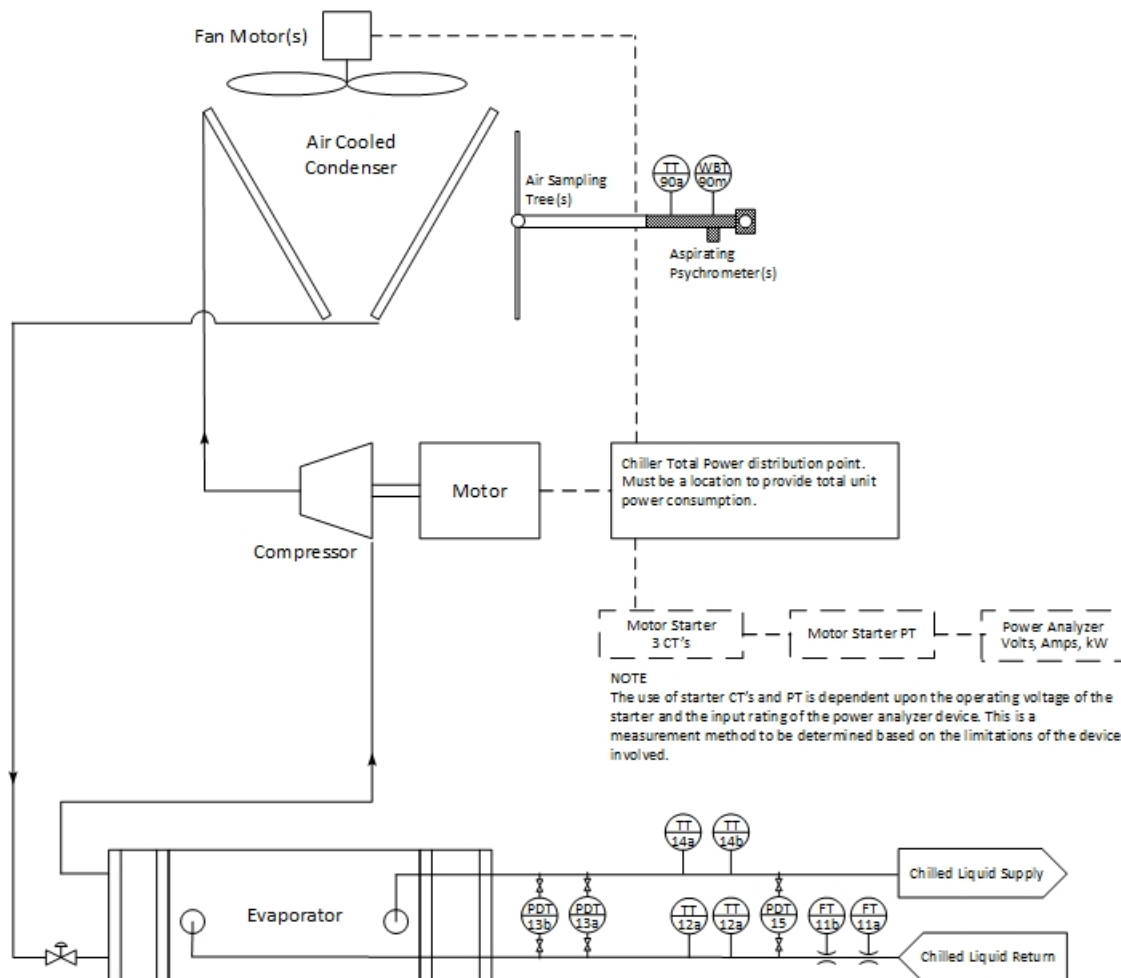


Figure B.2 Electrically Driven Air-Cooled Chiller

ID	Description of Measurement
FT-11a, b	Evaporator liquid flow (redundant measurements)
TT-12a, b	Evaporator inlet temperature (redundant measurements)
PDT-13a, b	Evaporator pressure difference (redundant measurements)
TT-14a, b	Evaporator outlet temperature (redundant measurements)
PDT-15 ^a	Evaporator pressure difference at temperature measurement location
TT-90a to n	Ambient air temperature (one or more aspirating psychrometers)
WBT-90m	Entering wet-bulb temperature for evaporatively cooled or air-cooled in heating mode
Not identified	Power consumption for the chiller, including any auxiliary systems contained in the test boundary; includes voltage balance measurement.
Notes:	
a.	Optional pressure measurement used for enthalpy capacity calculation method.

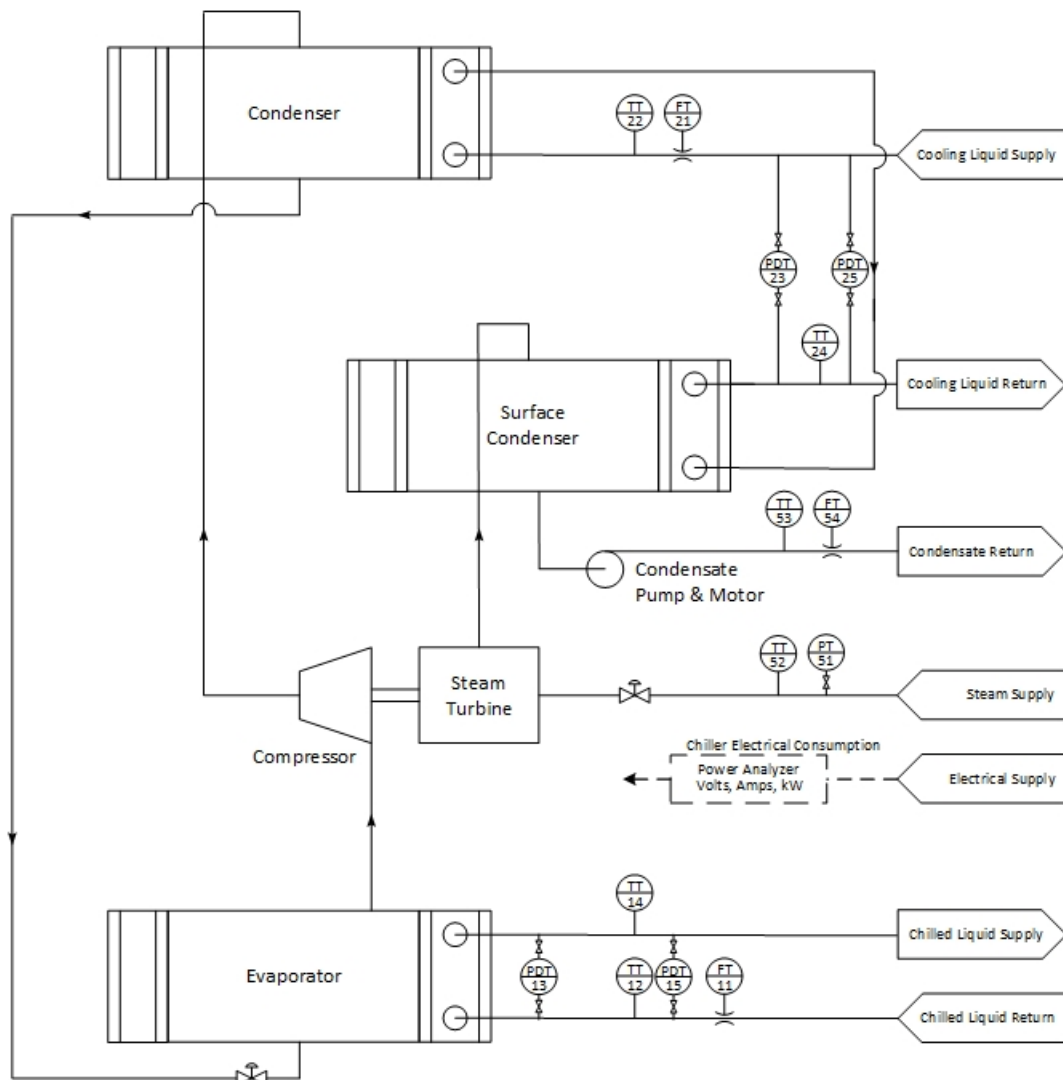


Figure B.3 Steam Turbine-Driven Liquid-Cooled Chiller

ID	Description of Measurement
FT-11	Evaporator liquid flow
TT-12	Evaporator inlet temperature
PDT-13	Evaporator pressure difference
TT-14	Evaporator outlet temperature
PDT-15^a	Evaporator pressure difference at temperature measurement location
FT-21	Condenser liquid flow
TT-22	Condenser inlet temperature
PDT-23	Condenser pressure difference
TT-24	Condenser outlet temperature
PDT-25^a	Condenser pressure difference at temperature measurement location
PT-51	Steam supply pressure
TT-52	Steam supply inlet temperature
TT-53	Steam condensate temperature
FT-54	Steam condensate flow
Not identified	Power consumption for the chiller, including any auxiliary systems contained in the test boundary; includes voltage balance measurement
Notes:	
a.	Optional pressure measurement used for enthalpy capacity calculation method.

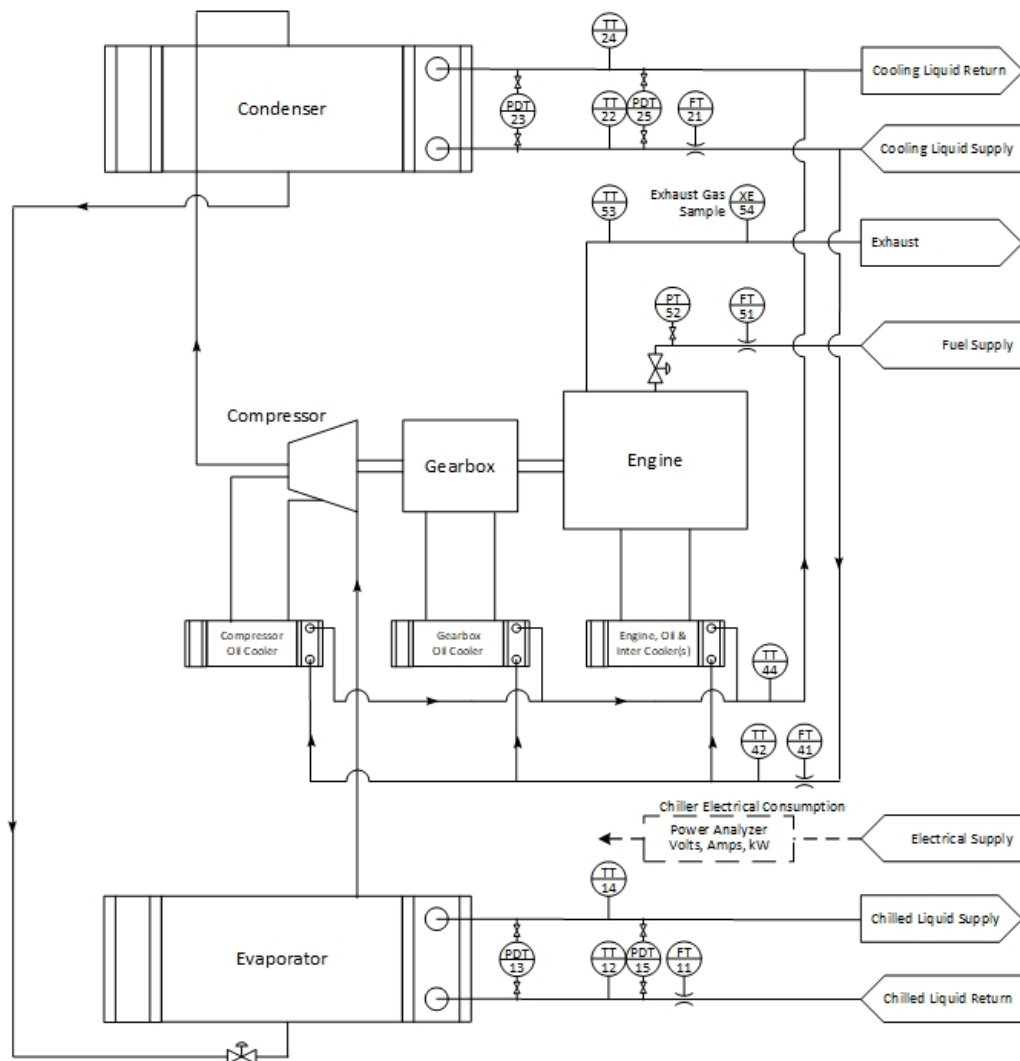


Figure B.4 Engine-Driven Liquid-Cooled Chiller

ID	Description of Measurement
FT-11	Evaporator liquid flow
TT-12	Evaporator inlet temperature
PDT-13	Evaporator pressure difference
TT-14	Evaporator outlet temperature
PDT-15 ^a	Evaporator pressure difference at temperature measurement location
FT-21	Condenser liquid flow
TT-22	Condenser inlet temperature
PDT-23	Condenser pressure difference
TT-24	Condenser outlet temperature
PDT-25 ^a	Condenser pressure difference at temperature measurement location
FT-41	Cooling system liquid flow
TT-22	Cooling system liquid inlet temperature
TT-23	Cooling system liquid outlet temperature
PT-51	Fuel supply flow
TT-52	Fuel supply inlet pressure
TT-53	Exhaust temperature
Not identified	Power consumption for the chiller, including any auxiliary systems contained in the test boundary; includes voltage balance measurement
Notes:	
a.	Optional pressure measurement used for enthalpy capacity calculation method.