BSR/ASHRAE Addendum b to
ANSI/ASHRAE Standard 30-2019

Public Review Draft

Proposed Addendum b to Standard 30-2019, Method of Testing Liquid Chillers

Second Public Review (January 2021)
(Draft Shows Proposed Independent Substantive Changes to Previous Public Review Draft)

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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 ‘b’ includes the following major revisions:

1. Changed "water" to "liquid" where applicable.
2. Clarified requirements for Δp_{adj}.
3. Replaced reference to ASME and ISA standards with exclusive reference to ASHRAE 41 series standards.
4. Added an Excel workbook to facilitate calculates in accordance with Table 6-2.
5. Removed ft H2O from the standard.

This is a review of Independent Substantive Changes that were made since the last (first) Public Review (PPR1) but includes text from PPR1 for context. Proposed revisions are delineated as follows:

- red = added text compared to PPR1 (ISC PPR2)
- underline or ~~strikeout~~ = all proposed changes (PPR1 and ISC PPR2)

Only red text shown as underline or ~~strikeout~~ is open for comment at this time. All other material is provided for context only and is not open for comment except as it relates to the proposed changes.

Addendum b to ANSI/ASHRAE Standard 30-2019

Modify Section 3 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*~~*liquid-cooled condenser* as measured by the total heat transferred from the refrigerant to the ~~liquid~~*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.

energy balance: a dimensionless ratio metric used to check for gross errors in measurement instrumentation and test results for units with a ~~water~~liquid-cooled condenser (with or without ~~water~~liquid-cooled heat reclaim condenser) and defined as the difference between energy inputs and energy outputs to the liquid-chilling 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 refrigerating capacity and the input power, although other auxiliary power inputs are included when analysis demonstrates significance to the energy balance.

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

5. CALCULATIONS AND CONVERSIONS

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, if any such external piping is installed for the test. 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 $\Delta p_{corrected}$. The density values (ρ_{in} and ρ_{out}) shall be determined respectively at the time-averaged mean of the entering and leaving temperatures, corresponding to the operating test conditions of the test plan and not to non-operating or standby conditions.

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

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

5.4.4.1 The correction adjustment shall not exceed 10% of the measured liquid pressure drop (Δp_{test}).

5.4.4.2 If Δp_{adj} is less than or equal to 10% of Δp_{test}, t~~T~~he corrected pressure drop ($\Delta p_{corrected}$,) shall be calculated as follows:

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

If Δp_{adj} is greater than 10% of Δp_{test}, either (1) piping external to the chiller connection points shall be reconfigured to allow Δp_{adj} to be less than or equal to 10% of Δp_{test} and the test repeated, or (2) $\Delta p_{corrected}$ shall be calculated as follows, and, in accordance with Section 9 the test report, shall state that Δp_{adj} exceeded 10% of Δp_{test}:

$$\Delta p_{corrected} = \Delta p_{test} - 10\% \Delta p_{test}$$

Modify Section 8 as shown below. The remainder of Section 8 is unchanged.

8. TEST PROCEDURES

8.4 Liquid Pressure Drop Measurement Procedure

8.4.1 Purpose. The purpose of this section is to prescribe a measurement method for Liquid Pressure Drop and, when required, a correction method to compensate for friction losses associated with external piping measurement sections when installed per Section 6.3.1.6. The measurement method only applies to pipe of circular cross section.

8.4.2 Background. As a certified test point for the liquid to refrigerant heat exchangers, the liquid-side pressure drop needs to be determined by test with acceptable measurement uncertainty. In some cases, the measured Liquid Pressure Drop per this standard will be determined by using static pressure taps in piping external to the unit. When using external piping, adjustment factors are allowed to compensate the reported pressure drop measurement. Numerous studies conclude that the determination of a calculated correction term for these external components may contain significant sources of error, and therefore, the use of external correction factors will be restricted to limit the magnitude of these potential errors. For units with small connection sizes, it is feasible that straight pipe sections be directly connected to the units with adequate length to obtain static pressure measurements with acceptable systematic errors due to instrument installation location. This is the preferred connection methodology. Units with larger size connections may have spatial limits in the connection arrangement such that elbows or pipe diameter changes may be necessary to accommodate the available space at the test facility, or to provide mechanical support for piping weight loads. While this may increase the measurement uncertainty, it is a practical compromise considering capital costs of test facilities.

8.4.3 Correction Method. The average measured Liquid Pressure Drop value~~s~~ Δp_{test} during test shall be adjusted to subtract additional static pressure drop Δp_{adj} due to external piping. 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 corrected test result for Liquid Pressure Drop $\Delta p_{corrected}$.

8.4.3.1 The adjustment shall not exceed 10% of the measured Liquid Pressure Drop.

8.4.3.2 Refer to Section 5.4.4 for the equations to be used.

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

9. REPORTING OF RESULTS

Table 9-1 Data to be Reported[1]	
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 Efficiency[4]	One or more of the *energy efficiency* metrics per Section 5.4.3
Liquid Pressure Drop[5]	Liquid corrected pressure drop ($\Delta p_{corrected}$) at operating conditions ~~water temperatures~~ per the test plan, measured per Section 8.4 and corrected per Section 5.4.4
	If $\Delta p_{adj} > 10\% \Delta p_{test}$ then report the value of Δp_{adj} and include the statement "Δp_{adj} exceeded 10% of Δp_{test}"
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 (even if exceeding 10% of Δp_{test})
	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:

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 *liquid-cooled heat reclaim condenser* only.
4. Pump energy associated with pressure drop through the chiller heat exchangers is not included in the *total 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.
5. Liquid pressure drop shall be reported in units of pressure differential, not in head or liquid column height.

   Note: Due to industry typical practice, Liquid Pressure Drop is often reported in head (ft H_2O) and corrected to a reference temperature (e.g. 60 °F); however, test data is acquired in pressure, psid, for use in calculations and test result reporting.

Modify Section 11 as shown below.

11. NORMATIVE REFERENCES

Crane Technical Paper Number 410, 2009 edition.

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NIST. 2008. NIST Special Publication 811, *Guide for the Use of the International System of Units (SI)*, NIST Standard Reference, Gaithersburg, MD: National Institute of Standards and Technology.

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ASHRAE. 2016. ANSI/ASHRAE Standard 41.8 *Standard Methods for Liquid Flow Measurement*. Atlanta: ASHRAE.

~~ASME. 2004 (R2013). ASME Standard PTC 19.5, *Flow Measurement*, New York: American Society of Mechanical Engineers.~~

~~ASME. 2014. ASME Standard MFC-16, *Measurement of Liquid Flow in Closed Conduits With Electromagnetic Flowmeters*. New York: American Society of Mechanical Engineers.~~

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~~ASME. 2013. ASME Standard MFC-6M, *Measurement of Fluid Flow in Pipes Using Vortex Flowmeters*. New York: American Society of Mechanical Engineers.~~

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~~ISA. 1977. ISA Standard RP31.1, *Recommended Practice Specification, Installation, and Calibration of Turbine Flowmeters*. Research Triangle Park, NC: Instrument Society of America.~~

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