



Authors' Manual



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Some pages include key words in **orange**. Mouse over these words to see additional information about a relevant topic.

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Before You Begin...

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7. Every figure must be referenced in the text by name/number, where “Figure” is capitalized (e.g., “...as shown in Figure 2.”).
8. Figures must be numbered consecutively as they appear in the text.
9. Prepare a list of captions for figures and place it at the end of the manuscript (**this applies to papers only; it is not applicable for book projects**).

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1. All **table** titles should be descriptive but concise.
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7. Vertical and horizontal lines should be avoided except to delineate the top and bottom of a table and to separate the heading row from the data, unless lines are otherwise necessary for clarity or organization of the data.
8. Label each column with a heading and include units of measurement and other necessary qualifying information. Units should be set off with a comma (e.g., “Velocity, m/s”).
9. Provide **dual units** for all **measurements**.
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ASHRAE policy requires dual units of measurement—inch-pound (I-P) and International System of Units (SI). You are required to provide dual units when submitting manuscripts; ASHRAE staff will not convert units for you. See ASHRAE's *SI Guide for HVAC&R* for comprehensive guidance on using SI units. Some **guidelines** are as follows:

1. The units used in calculating the work being reported should be listed first with the alternate system of units **following in parentheses**.
2. Always spell out all units when they are used without a number.
3. Do not mix **symbols and names** in the same expression.
4. Do not express **plurals** by adding an “s”.
5. Do not use **periods** with units of measurement.
 - **EXCEPTION:** in. for inch
6. Leave a **space** between the numerical value and the unit of measurement.
 - **EXCEPTION:** There is no space between number and degree of plane angle or degrees of temperature (45°, 62°F, 20°C) or the number and the percent symbol (5%).
7. “L” is the symbol for litre, not lowercase “ell” or script “ell.”
8. “Centi-” is not an acceptable SI prefix, and the use of **cm** should be avoided.
9. For currency, include the monetary unit of the country where the research is based followed by the U.S. dollar conversion in parentheses.

Each significant **equation or formula** should be displayed on a separate line. Center equations and place consecutive equation numbers flush right in parentheses.

EXAMPLE:

$$a^2 + b^2 = f^2 \quad (1)$$

where

a^2 = apples

b^2 = bananas

f^2 = fruit salad

If an equation requires more than one line, break it before an **operational sign**, and align the operational signs on the left.

EXAMPLE:

$$E = (a + b + c)/(m + n + o) \quad (2)$$
$$\times d + e + f$$

If two or more displayed equations are grouped together, leave space between the individual equations:

$$a + b = c \quad (3)$$

$$D = f - ab^2 \quad (4)$$

$$mon + rst \quad (5)$$

Spell out the word “equation” and capitalize it in the text when **referring** to specific, numbered equations. In a highly mathematical or theoretical work, consider developing equations in appendices rather than in the body of the manuscript.

Please note that all equations must be retyped in our pagemaking program—this is one reason we require a hard copy of the manuscript—and therefore should be checked thoroughly by the author at the proofreading stage.

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1. The author indicates intent to submit a manuscript to [Special Publications](#) and receives the [Authors' Manual](#).
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3. The cognizant ASHRAE Technical Committee selects qualified reviewers.
4. Reviewers send [reviews and comments](#) to the author.
5. The author revises the manuscript and/or rebuts comments and provides a revised manuscript or rebuttal to the cognizant Technical Committee.
6. Reviewers complete an additional review.
7. The review process continues until the manuscript is accepted or rejected for publication by the cognizant Technical Committee.
8. After the manuscript is approved for publication, the author submits a final [Microsoft® Word](#) file and separate figure files [electronically](#) to [Special Publications](#) (see [Book Submission Guidelines](#)) and the author is informed of a tentative publication schedule.
9. Special Publications editors edit the manuscript for grammar, punctuation, clarity, and consistency with ASHRAE policies, as well as completeness of parts. It is then laid out into pages, with the figures and tables incorporated.
10. The editors send a PDF proof to the author, often including queries that require responses from the author. The author [proofreads](#) the manuscript and returns replies to the editors' queries within a mutually agreed upon (hopefully short) timeframe.
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12. The author receives a complimentary copy of the published book.

ASHRAE Authors' Manual

Paper Publication Process

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2. The author [prepares](#) the paper, including artwork, according to the Authors' Manual and the [Author's Template for Technical Papers](#) or the [Author's Template Conference Papers](#).
3. The author uploads the paper through the applicable website as indicated in the [Technical Papers Submission Requirements](#) and [Conference Papers Submission Requirements](#).
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5. The reviewers carefully review the paper and submit reviews online.
6. The author receives [reviews and comments](#). The author revises the paper and/or rebuts the comments and uploads a revised paper or rebuttal.
7. The reviewers are notified that a revised paper requires additional review.
8. The review process continues until the paper is accepted or rejected.
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10. The accepted paper is scheduled for presentation at an ASHRAE Winter or Annual Conference or a Topical Conference.
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Technical Papers Submission Requirements

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All Technical Papers undergo critical, **double-blind** peer review by three or more competent **specialists** to ensure high quality of content. A paper must be accepted by three reviewers to be approved for an **ASHRAE Winter or Annual Conference**. The Technical Paper review activity is coordinated by the **ASHRAE Conference Program Administrator**, who can be contacted if you have any questions during the paper submission and review process. **File submission is done online via Manuscript Central. Manuscript Central Upload Instructions** are available in the “Instructions & Forms” section of that website.

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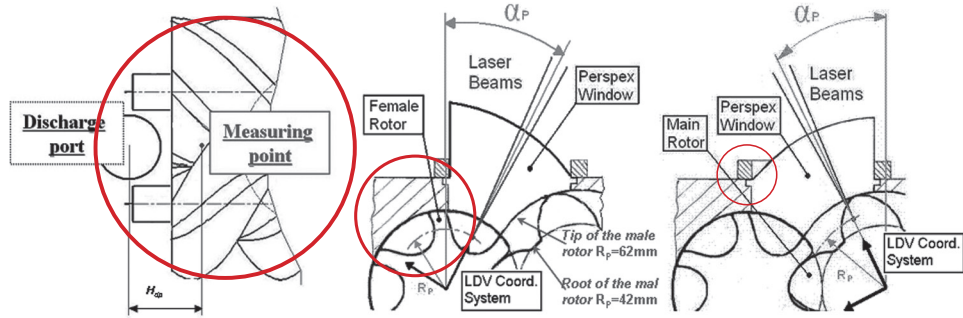
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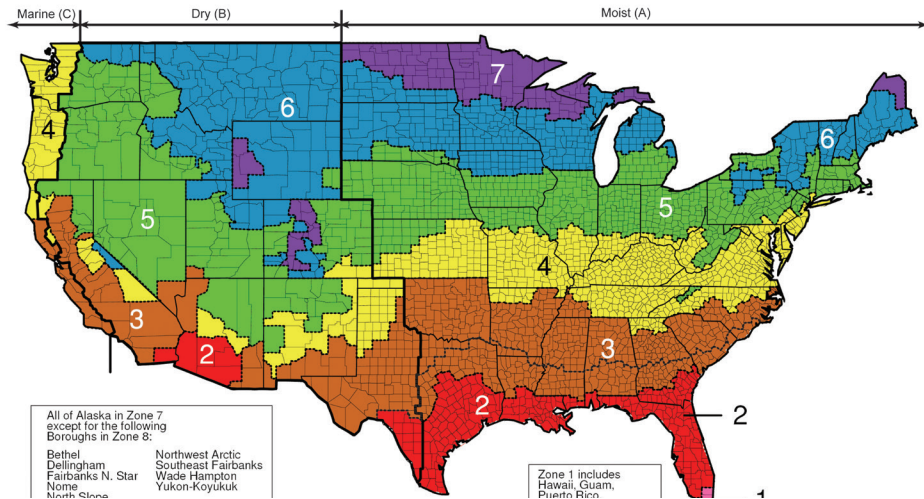
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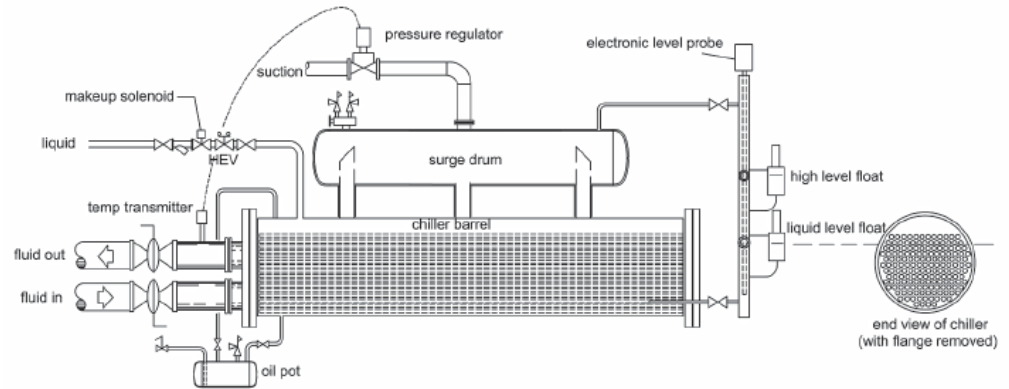
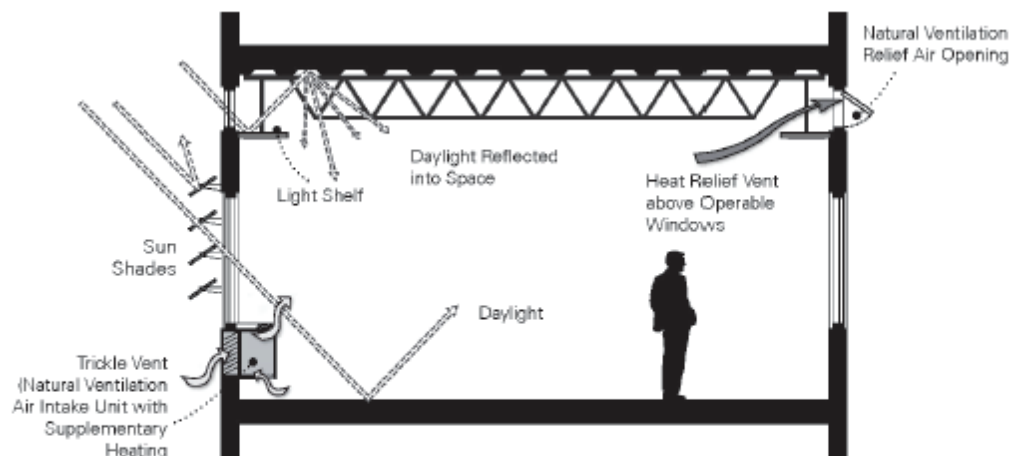


Figure 5.7 Schematic of a flooded liquid chiller.

Courtesy J. Denkmann



Source: Indoor Air Quality Guide

Figure 8-11 Daylight used in combination with shading and mixed-mode ventilation.

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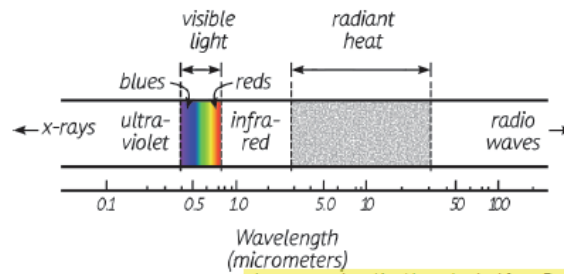


Image courtesy Lisa Ng, adapted from Dean (1981)

Figure 8-12 Light spectrum.

Table 2.4 Indicative Embodied Specific Carbon Footprints for Materials and Resources Commonly Used in Refrigerated Facilities and Associated Equipment¹

Material	Embodied CF, kg CO _{2eq} /kg (lb _m CO _{2eq} /lb _m)	Source and Comments
Aggregate (gravel)	0.003; 0.0052	EPLCA (2016); Hammond and Jones (2011)
Aluminum		
• Construction	9.2; 11 (virgin)	Hammond and Jones (2011); IBU (2016)
• Manufactured equipment	12.6 (virgin), 0.63 (recycled)	IIR (2016) (typically 67% for recycled)
Asphalt (6% bitumen)	0.076	Hammond and Jones (2011)
Cardboard packaging	1.0	Hammond and Jones (2011); Burke (2016)
Concrete	0.11–0.15	Hammond and Jones (2011); EPLCA (2016)
+ Reinforcing	+ 0.077	Hammond and Jones (2011)
+ Casting	+ 0.029	Hammond and Jones (2011)
Copper		
• Tube	0.98–2.7	Copper Alliance 2015; IBU (2016); Hammond and Jones (2011)
• Manufactured equipment	3.0 (virgin) 2.46 (recycled)	IIR (2016) (typically 40% for recycled)

Table 4.3 Indicative Conductivity Values for Several Insulation Materials¹

Material	Thermal Conductivity ²	
	W/m·K	Btu/h·ft·°F
Polyurethane board	0.026	0.015
Polysocyanurate	0.027	0.016
Polystyrene, extruded	0.035	0.020
Polystyrene, expanded	0.037	0.021
Fiberglass	0.044	0.025

1. Based on ASHRAE Handbook—Refrigeration, Chapter 24, Table 1 (ASHRAE 2018).

2. Based on materials aged for 180 days.

Sample Table

Table 1. Review of the Research on the Two-Phase Heat Transfer at Micro Scale

Researcher	Working Liquid	Dimension of the Channel	Single/Array of Microchannel(s)	Heat Transfer Coefficient, $W/(cm^2/K)$
Munkejord et al. (2002)	Peopane	63–155 μm	Array of microchannels	7.1 ~ 8.4
Cuta et al. (1996)	Water	Width: 100~300 μm Depth: 1 mm	Array of microchannels	1 ~ 2
Darabi and Ekula (2003)	HFE-7100		Single channel	1.8
Qu and Ma (2002)	Water	About 10 μm	Single channel	25
Brooks et al. (1999)	Water	Width: 50~200 μm Depth: 0.5~3 mm	Array of microchannels	25 W/cm^2 (heat flux)
Park and Lee (2003)	Water	150 μm	Single channel	1.4
Tran et al. (1996)	R-12	2.46 mm	Single channel	0.2 ~ 1
Bao et al. (2000)	R-11	1.95 mm	Single channel	0.7~1.4
Bao et al. (2000)	R-123	1.95 mm	Single channel	0.5~1.4
Lin et al. (2001)	R-141b	1.1 mm	Single channel	0.2~0.6
Lazarek and Black (1982)	R-113	3.1 mm	Single channel	0.7-1.1
Wambsganss et al. (1993)	R-113	2.92 mm	Single channel	0.1~0.5

PERFORMANCE EVALUATION FUNCTION

First Level

The performance of any air-conditioning system depends on two factors:

- a. thermal comfort
- b. energy consumption

Second Level

Thermal Comfort

The most important variables that influence the condition of thermal comfort are air temperature, water vapor pressure in ambient air, relative air velocity, mean radiant temperature, activity level (heat production in the body), thermal resistance of the clothing, and purity of the air. Fanger (1970) defined a thermal sensation index by considering air temperature, water vapor pressure in ambient air, relative air velocity, mean radiant temperature, activity level, and thermal resistance of the clothing. PMV is the thermal sensation index given by Fanger (1970) and is internationally standardized. It is easy to use PMV when controlling an air-conditioning system because PMV is an index of human thermal sensation with one value for all seasons and is effective for all temperatures that are neither extremely high nor extremely low. PMV ranges from -3 (cold) to $+3$ (hot). When PMV is zero, then thermal sensation will be neutral, i.e., neither cold nor hot. Broadly speaking, when PMV approaches zero then thermal comfort increases.

The first term on the right-hand side of Equation 14 indicates the mass of moisture in the incoming air, which comes in contact with the evaporator wall, and the mass of moisture in the outgoing air. The humidity of the incoming air is calculated from a psychrometric chart with the help of the second-order curve-fitting method. The multiplying factor, $(1 - b)$, corresponds to the bypass factor of the evaporator. The second term amounts to mass of moisture in the incoming air bypassed through the evaporator and the mass of moisture in the outgoing air. The multiplying factor b corresponds to the bypass factor of the evaporator. The rate of change of specific humidity of supply air when the evaporator wall temperature is more than the dew-point temperature is given by

$$(\rho_a V_d) dW_s / dt = v \rho_a ((1 - \xi) W_3 + \xi W_0 - W_s) . \quad (1)$$

The first two terms on the right-hand side of Equation 15 correspond to absolute or specific humidity of incoming air, and the third term corresponds to outgoing supply air humidity.

Specific Humidity of Thermal Space. The rate of change of the specific humidity of the thermal space is given by

Third Level

ASHRAE Authors' Manual

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- Set the width for 24 in. and the height for 24 in. and choose “OK.”
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Indent **items in a list**, preceded by a number and period. Introduce all lists.

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The HVAC system was designed to accommodate the following:

1. Placement of research equipment and walls anywhere in the laboratory without major modification
2. Minimal energy consumption

Short listed items may be indented and preceded by a bullet.

EXAMPLE:

... are the following:

- relative equipment first cost,
- relative future cost of gas and electric energy, and
- relative amounts of heating and cooling loads.

Separate items in a list within text using numbers in parentheses.

EXAMPLE:

... the following: (1) relative equipment first cost, (2) relative future cost of gas and electric energy, and (3) relative amounts of heating and cooling loads.

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Acronyms should not be used without first giving the full expanded name.

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Journal

Veronica, D.A. 2010. Detecting cooling coil fouling automatically—Part 2: Results using a multilayer perceptron. *HVAC&R Research* 16(5):599–616.

Standard

ASHRAE. 2001. ANSI/ASHRAE Standard 52.2-2001, *Method of testing general ventilation air-cleaning devices for removal efficiency by particle size*. Atlanta: ASHRAE.

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Emmerich, S. 1997. *Use of computational fluid dynamics to analyze indoor air quality issues*. Report NISTIR 5997. Gaithersburg, MD: National Institute of Standards and Technology.

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