Guide for Developing AHRI SI Standards

Policy on Units of Measurements in AHRI Standards

The AHRI Standards Policy Committee (SPC) has established that all AHRI standards and guidelines will use SI units.

Starting 1 January 2009, all product sections were directed to review their portfolio of standards and guidelines, and at the next scheduled revision, execute one of the following two options:

-- Convert the standard to SI only:
- SI with no soft conversion
- All rating, testing, and certification at rational SI conditions

-- Issue dual standards - an SI standard and an I-P standard:
- SI standard with no soft conversion and
- I-P standard with no soft conversion
- All rating, testing, and certification at the condition(s) selected by the product section: either rational SI, rational I-P, or both
- Each standard shall be identified as SI or I-P and with a unique number
    1. AHRI Standard 365 (I-P)–2009 &
    2. AHRI Standard 366 (SI)-2009

Rational SI units and rational I-P units means using values based on logical or coherent numbers. Rational values are usually, but not necessarily, rounded numbers. Rational values are not soft-converted mathematical equivalents and are sometimes referred to as hard-converted.

Rationale for SI AHRI Standards

AHRI is a global leader in HVAC&R performance rating standards.. It is in AHRI's members' interests to have a single, worldwide standard by which to rate and certify products. While this would be ideal, it is recognized that there are competing performance rating standards, including: ISO TC 86 standards, CEN European standards, Chinese GB standards, and Japanese JRAIA standards. Many of these are

compulsory in their country or region, and AHRI standards may have little or no chance of being used there in the foreseeable future.

However, in other markets (notably India, the Middle East, and Latin America) there is competition among the various HVACR standards. AHRI members have an opportunity to have their standards chosen over the competition, thus giving them the advantage of already being certified in the marketplace. Even in countries or regions that now have their own mandated standards, the indigenous industry might work to harmonize those standards with AHRI standards. For AHRI standards to be accepted in a virtually 100% metric world, they must be offered in SI units.

Guidance in the Development of AHRI Standards

Each product section retains the authority to select its own AHRI standard rating conditions. Their SI standard can simply be the original I-P standard with rating points and other data replaced with rational SI units or the standard rating points can be substantially rewritten to appeal to a targeted market(s). The Standards Policy Committee (SPC) will monitor the product section's selections and recommend common conditions where practical.

Staff will acquire copies of similar standards and make them available to the standards-writing committees for this work. These may include ISO, CEN, and JRAIA standards. In some cases, the product section may desire to incorporate multiple rating points in cases where the product section is looking to serve a variety of markets with different climates. For cases where there is a global consensus single rating point (e.g. a widely-used ISO standard, a prevailing EU-directive-based condition, etc.), the product section may elect to focus on that.

- Examples of AHRI I-P Rational Rating Conditions: 80.0 F, 67.0 F, and 95.0.
- Examples of AHRI SI Rational Rating Conditions: 27.0 C, 19.0 C, and 35.0 C.

It is desirable to retain as many references to the ASHRAE method of testing standards as possible. However, some of our new standards may require use of methods outside

the traditional channels in order to gain acceptance in regions outside of North America. This may include the referencing of ISO or other standards.

Different terminology should be applied as needed to differentiate between I-P rating descriptors and SI rating descriptors that are not comparable.

- Examples of AHRI I-P Rating Descriptors: Capacity = Btu/h, EER = Btu/(W•h), SEER = Btu/(W•h), HSPF = Btu/(W•h), IEER

- Examples of AHRI SI Rating Descriptors: Capacity = watts, EER = watts/watt, COP = watt/watt, ICOP

Resources for Developing AHRI SI Standards:

The current editions of all AHRI standards already include all formulas and equations in both SI and I-P units. All AHRI standards also already include dual units throughout, with both SI units and I-P units included. In most cases, the primary units are I-P rational with soft equivalent SI units included. A few are SI-only with rational SI units provided.

Units for Use in AHRI Standards: The designated I-P units and SI units to be used in AHRI standards shall be those as indicated in the table below. This table is excerpted from the latest version of the *AHRI Standards Policy Committee Policy and Procedures*.

Use the definition for standard air below (also excerpted from the *Policy and Procedures*).

Units for Use in AHRI Standards

Characteristic	I-P Description	Designation	
		I-P	SI
Cooling or Heating Capacity	- Btu per hour	Btu/h	W

Flow Rate	- cubic feet per minute	cfm, ft^3/min	m^3/s
	- gallons per minute	Gpm	L/s
Heat Transfer Coefficient	- Btu per hour·square foot ·degree Fahrenheit	Btu/ h·ft^2·^oF	W/ m^2·^oC
Length	- feet	ft	Mm, m
	- inches	in	mm
Percentage	- percent	%	%
Power	- watts	W	kW
Pressure	- pounds per square inch	psi, lb/in^2	kPa
	- inches of Mercury	in Hg	kPa
	- inches of water	in H_2O	kPa or Pa
Rotational Speed	- revolutions per minute	rpm	Rev/s
Temperature	- thermodynamic	^oF	^oC
	- difference	^oF	^oC
Time	-seconds	s	S
	- minutes	min	S
	- hours	h	S
Velocity	- feet per second	fps, ft/s	m/s
	- feet per minute	fpm, ft/min	m/s
Weight	- pounds	lb	kg

Definition of Standard Air: Use the applicable definition for standard air below for an SI standard or an I-P standard (excerpted from the AHRI Standards *Policy Committee Policy and Procedures*).

For SI Standards: *Standard Air.* Air weighing 1.2 kg/m^3 which approximates dry air at 21^{o}C and at a barometric pressure of 101.3 kPa.

For I-P Standards: *Standard Air.* Air weighing 0.075 lb/ft^3 which approximates dry air at 70^{o}F and at a barometric pressure of 29.92 in Hg.

Conversion Factors: For converting values from I-P units to SI units, use the conversion factors from the table below. This table is extracted from the 1991 *ASHRAE Terminology of Heating, Ventilation, Air-Conditioning and Refrigeration*, page 140.

CONVERSION FACTORS

Reference: ASHRAE *Terminology* (1991), page 140

Multiply	By	To Obtain
Bar	100	kPa
barrel (42 gal)	159	L
Acre	0.405	Ha
Btu	1.055	kJ
Btu/ft^3	37.3	kJ/m^3, J/L
Btu/gal (US)	0.279	kJ/L
Btu•in/ft^2•hr•°F (k, thermal conductivity)	144	W•mm/m^2•°C
Btu/h	0.293	W
Btu/ft^2	11.4	kJ/m^2
Btu/h•ft^2	3.15	W/m^2
Btu/ft^2•hr•°F (U, overall heat trans coeff), (C, thermal conductance)	5.68	W/m^2•°C
Btu/lb	2.33	kJ/kg

Btu/lb•°F (c, specific heat)	4.19	kJ/kg•°C
Bushel	0.0352	m^3
Calorie, gram	4.19	J
calorie, kilogram; kilocalorie	4.19	kJ
centipoise (μ, dynamic viscosity)	1.00	mPa•s
centistokes (μ/p, kinematic viscosity)	1.00	Mm^2/s
cents per gallon	0.264	¢ / L
cents per gallon (no. 2 fuel oil)	0.0677	$ / GJ
cents per gallon (no. 6 fuel oil)	0.0632	$ / GJ
cents per gallon (propane)	0.112	$ / GJ
cents per kWh	2.78	$ / GJ
cents per therm	0.0948	$ / GJ
cost, $ per square (100 sq ft)	0.108	$ / m^2
cost, $ per square foot	10.8	$ / m^2
cost, $ per pound	2.205	$ / kg
cost, $ per ton (refrigeration)	0.284	$ / kW
EDR hot water (150 Btu/h)	44.0	W
EDR steam (240 Btu/h)	70.3	W
ft^2•h•°F/Btu (R, thermal resistance)	0.176	m^2•°C/W
ft	0.3048	M
ft	304.8	Mm
ft/min, fpm	0.00508	m/s

ft/s, fps	0.3048	m/s
ft of water	2.99	kPa
ft^2	0.0929	m^2
ft^2/s (μ/p, kinematic viscosity)	92,900	mm^2/s
ft^3	28.3	L
ft^3	0.0283	m^3
ft^3/h, cfh	7.87	mL/s
ft^3/min, cfm	0.472	L/s
ft^3/s, cfs	28.3	L/s
ft-lb (work)	1.36	J
ft-lb/min (power)	0.0226	W
gallon (US)	3.79	L
gallon (US)	0.00379	m^3
gph (US)	1.05	mL/s
Gpm (US)	0.0631	L/s
grain (1 / 7,000 lb)	0.0648	G
gr/gal	17.1	Mg/L
gr/lb	0.143	g/kg
horsepower (boiler)	9.81	kW
horsepower	0.746	kW
inch	25.4	Mm
in of mercury	3.38	kPa

In of water	249	Pa
in/100 ft, thermal expansion	0.833	mm/m
in^2	645	mm^2
In^3 (volume)	16.4	mL
in^3/min (SCIM)	0.273	mL/s
in^3 (section modulus)	16,400	mm^3
in^4 (section moment)	416,000	mm^4
km/h	0.278	m/s
kWh	3.60	MJ
kilopond (kg force)	9.81	N
kip	4.45	kN
kip/in^2(ksi)	6.90	MPa
Litre	0.001	m^3
micron of mercury	133	mPa
Mile	1.61	Km
mile, nautical	1.85	Km
Mph	1.61	km/h
Mph	0.447	m/s
Millibar	0.100	kPa
mm of mercury (torr)	0.133	kPa
mm of water (20°C)	9.79	Pa
metre of water	9.79	kPa

ounce (mass, avoir)	28.3	G
ounce (force or thrust)	0.278	N
Ounce (liquid)	29.6	mL
ounce inch (torque, moment)	7.06	mN•m
ounce (avoir) per gallon	7.49	g/L
perm (permeance)	57.4	µg/kPa•s•m^2
perm inch (permeability)	1460	µg•mm/kPa•s•m^2 (perm mm)
pint (liquid)	473	mL
lb (mass)	0.454	Kg
lb (force or thrust)	4.45	N
lb (mass)	454	G
lb/ft (uniform load)	1.49	kg/m
lb/ft•h (µ, dynamic viscosity)	0.413	mPa•s
lb/ft•s (µ, dynamic viscosity)	1 488	mPa•s
lb/h	0.126	g/s
lb/min	0.00756	kg/s
lb of steam per hour @ 212°F (100°C)	0.284	kW
lbf/ft^2	47.9	Pa
$lbf•s/ft^2$ (µ, dynamic viscosity)	47,900	mPa•s
lbm/ft^2	4.88	kg/m^2
lb/ft^3(p, density)	16.0	kg/m^3

lb/gallon	120	kg/m^3
lb ft (torque or moment)	1.36	N•m
lb in (torque or moment)	113	mN•m
ppm	1.00	mg/kg
psi	6.89	kPa
quart (liquid)	0.946	L
square (100 sq ft)	9.29	m^2
Tablespoon	15	mL
Teaspoon	5	mL
Therm	106	MJ
ton, long (2,240 lb)	1.02	Mg (tonne)
ton, short (2,000 lb)	0.907	Mg (tonne)
ton, refrigeration	3.52	kW
watt per square foot	10.8	W/m^2
yd	0.914	M
yd^2	0.836	m^2
yd^3	0.765	m^3