

ABBREVIATIONS AND SYMBOLS

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THIS CHAPTER contains information about abbreviations and symbols for heating, ventilating, air-conditioning, and refrigerating (HVAC&R) engineers.

Abbreviations are shortened forms of names and expressions used in text, drawings, and computer programs. This chapter discusses conventional English language abbreviations that may be different in other languages. A **letter symbol** represents a quantity or a unit, not its name, and is independent of language. Because of this, use of a letter symbol is preferred over abbreviations for unit or quantity terms. Letter symbols necessary for individual chapters are defined in the chapters where they occur.

Abbreviations are never used for mathematical signs, such as the equality sign (=) or division sign (/), except in computer programming, where the abbreviation functions as a letter symbol. Mathematical operations are performed only with symbols. Abbreviations should be used only where necessary to save time and space; avoid their usage in documents circulated in foreign countries.

Graphical symbols in this chapter of piping, ductwork, fittings, and in-line accessories can be used on scale drawings and diagrams.

Identifying piping by legend and color promotes greater safety and lessens the chance of error in emergencies. Piping identification is now required throughout the United States by the Occupational Safety and Health Administration (OSHA) for some industries and by many federal, state, and local codes.

ABBREVIATIONS FOR TEXT, DRAWINGS, AND COMPUTER PROGRAMS

[Table 1](#) gives some abbreviations, as well as others commonly found on mechanical drawings and abbreviations (symbols) used in computer programming. Abbreviations specific to a single subject are defined in the chapters in which they appear. Additional abbreviations used on drawings can be found in the section on Graphical Symbols for Drawings.

The abbreviations (symbols) used for computer programming for the HVAC&R industries have been developed by ASHRAE Technical Committee 1.5, Computer Applications. These symbols identify computer variables, subprograms, subroutines, and functions commonly applied in the industry. Using these symbols enhances comprehension of the program listings and provides a clearly defined nomenclature in applicable computer programs.

Certain programming languages differentiate between real numbers (numbers with decimals) and integers (numbers without decimals) by reserving certain initial letters of a variable for integer numbers. Many of the symbols listed in this chapter begin with these letters and, in order to make them real numbers, must be prefixed with a noninteger letter.

Some symbols have two or more options listed. The longest abbreviation is preferred and should be used if possible. However,

it is sometimes necessary to shorten the symbol to further identify the variable. For instance, the area of a wall cannot be defined as WALLAREA because some computer languages restrict the number of letters in a variable name. Therefore, a shorter variable symbol is applied, and WALLAREA becomes WALLA or WAREA.

Many advanced computer programming languages such as Basic, C, and C++ do not have the limitations of older computer language compilers. It is good programming practice to include the complete name of each variable and to define any abbreviations in the comments section at the beginning of each module of code. Abbreviations should be used to help clarify the variables in an equation and not to obscure the readability of the code.

In [Table 1](#), the same symbol is sometimes used for different terms. This liberty is taken because it is unlikely that the two terms would be used in the same program. If such were the case, one of the terms would require a suffix or prefix to differentiate it from the other.

LETTER SYMBOLS

Letter symbols include symbols for physical quantities (quantity symbols) and symbols for the units in which these quantities are measured (unit symbols). **Quantity symbols**, such as *I* for electric current, are listed in this chapter and are printed in italic type. A **unit symbol** is a letter or group of letters such as mm for millimetre or a special sign such as ° for degrees and is printed in Roman type. Subscripts and superscripts are governed by the same principles. Letter symbols are restricted mainly to the English and Greek alphabets.

Quantity symbols may be used in mathematical expressions in any way consistent with good mathematical usage. The product of two quantities, *a* and *b*, is indicated by *ab*. The quotient is *a/b*, or *ab⁻¹*. To avoid misinterpretation, parentheses must be used if more than one slash (/) is employed in an algebraic term; for example, (*a/b*)/*c* or *a/(b/c)* is correct, but not *a/b/c*.

Subscripts and superscripts, or several of them separated by commas, may be attached to a single basic letter (kernel), but not to other subscripts or superscripts. A symbol that has been modified by a superscript should be enclosed in parentheses before an exponent is added (*X_a*)³. Symbols can also have alphanumeric marks such as ' (prime), + (plus), and * (asterisk).

More detailed information on the general principles of letter symbol standardization are in standards listed at the end of this chapter. The letter symbols, in general, follow these standards, which are out of print:

Y10.3M	Letter Symbols for Mechanics and Time-Related Phenomena
Y10.4-82	Letter Symbols for Heat and Thermodynamics

Other symbols chosen by an author for a physical magnitude not appearing in any standard list should be ones that do not already have different meanings in the field of the text.

The preparation of this chapter is assigned to TC 1.6, Terminology.

Table 1 Abbreviations for Text, Drawings, and Computer Programs

Term	Text	Drawings	Program
above finished floor	—	AFF	—
absolute	abs	ABS	ABS
accumulat(e, -or)	acc	ACCUM	ACCUM
air condition(-ing, -ed)	—	AIR COND	—
air-conditioning unit(s)	—	ACU	ACU
air-handling unit	—	AHU	AHU
alteration	altrn	ALTRN	—
alternating current	ac	AC	AC
altitude	alt	ALT	ALT
ambient	amb	AMB	AMB
American National Standards Institute ¹	ANSI	ANSI	—
American wire gage	AWG	AWG	—
ampere	amp	AMP	AMP, AMPS
angle	—	—	ANG
angle of incidence	—	—	ANGI
apparatus dew point	adp	ADP	ADP
approximate	approx.	APPROX	—
area	—	—	A
atmosphere	atm	ATM	—
average	avg	AVG	AVG
azimuth	az	AZ	AZ
azimuth, solar	—	—	SAZ
azimuth, wall	—	—	WAZ
barometer(-tric)	baro	BARO	—
bill of material	b/m	BOM	—
boiling point	bp	BP	BP
Brown & Sharpe wire gage	B&S	B&S	—
Celsius	°C	°C	°C
center to center	c to c	C TO C	—
circuit	ckt	CKT	CKT
clockwise	cw	CW	—
coefficient	coeff.	COEF	COEF
coefficient, valve flow	C _v	C _v	CV
coil	—	—	COIL
compressor	cprsr	CMPR	CMPR
condens(-er, -ing, -ation)	cond	COND	COND
conductance	—	—	C
conductivity	cndct	CNDCT	K
conductors, number of (3)	3/c	3/c	—
contact factor	—	—	CF
cooling load	clg load	CLG LOAD	CLOAD
counterclockwise	ccw	CCW	—
cubic centimeter	cm ³	CC	CC
cubic metre	m ³	CU M	CU M
decibel	dB	DB	DB
degree	deg. or °	DEG or °	DEG
density	dens	DENS	RHO
depth or deep	dp	DP	DPTH
dew-point temperature	dpt	DPT	DPT
diameter	dia.	DIA	DIA
diameter, inside	ID	ID	ID
diameter, outside	OD	OD	OD
difference or delta	diff., Δ	DIFF	D, DELTA
diffuse radiation	—	—	DFRAD
direct current	dc	DC	DC
direct radiation	dir radn	DIR RADN	DIRAD
dry	—	—	DRY
dry-bulb temperature	dbt	DBT	DB, DBT
effectiveness	—	—	EFT
effective temperature ²	ET*	ET*	ET
efficiency	eff	EFF	EFF
efficiency, fin	—	—	FEFF
efficiency, surface	—	—	SEFF

Term	Text	Drawings	Program
electromotive force	emf	EMF	—
elevation	elev.	EL	ELEV
entering	entr	ENT	ENT
entering water temperature	EWT	EWT	EWT
entering air temperature	EAT	EAT	EAT
enthalpy	—	—	H
entropy	—	—	S
equivalent direct radiation	edr	EDR	—
evaporat(-e, -ing, -ed, -or)	evap	EVAP	EVAP
expansion	exp	EXP	XPAN
face area	fa	FA	FA
face to face	f to f	F to F	—
face velocity	fvel	FVEL	FV
factor, correction	—	—	CFAC, CFACT
factor, friction	—	—	FFACT, FF
fan	—	—	FAN
film coefficient, ³ inside	—	—	FI, HI
film coefficient, ³ outside	—	—	FO, HO
flow rate, air	—	—	QAR, QAIR
flow rate, fluid	—	—	QFL
flow rate, gas	—	—	QGA, QGAS
freezing point	fp	FP	FP
frequency	Hz	HZ	—
gage or gauge	ga	GA	GA, GAGE
gram	g	g	G
gravitational constant	g	G	G
greatest temp difference	GTD	GTD	GTD
heat	—	—	HT
heater	—	—	HTR
heat gain	HG	HG	HG, HEATG
heat gain, latent	LHG	LHG	HGL
heat gain, sensible	SHG	SHG	HGS
heat loss	—	—	HL, HEATL
heat transfer	—	—	Q
heat transfer coefficient	U	U	U
height	hgt	HGT	HGT, HT
high-pressure steam	hps	HPS	HPS
high-temperature hot water	hthw	HTHW	HTHW
horsepower	hp	HP	HP
hour(s)	h	h	HR
humidity, relative	rh	RH	RH
humidity ratio	W	W	W
incident angle	—	—	INANG
indicated kilowatt	lkW	lKW	—
International Pipe Std	IPS	IPS	—
iron pipe size	ips	IPS	—
joule	J	J	J
kelvin	K	K	K
kilograms	kg	kg	KG
kilojoules	kJ	kJ	KJ
kilometres per hour	km/h	km/h	KPH
kilopascals	kPa	kPa	KPA
kilowatt	kW	kW	KW
kilowatt hour	kWh	kWh	KWH
latent heat	LH	LH	LH, LHEAT
least mean temp. difference ⁴	LMTD	LMTD	LMTD
least temp. difference ⁴	LTD	LTD	LTD
leaving air temperature	lat	LAT	LAT
leaving water temperature	lwt	LWT	LWT
length	lg	LG	LG, L
liquid	liq	LIQ	LIQ
litre	L	L	L
litres per second	L/s	L/s	LPS
logarithm (natural)	ln	LN	LN

Term	Text	Drawings	Program
logarithm to base 10	log	LOG	LOG
low-pressure steam	lps	LPS	LPS
low-temp. hot water	lthw	LTHW	LTHW
Mach number	Mach	MACH	—
mass flow rate	mfr	MFR	MFR
maximum	max.	MAX	MAX
mean effective temp.	MET	MET	MET
mean temp. difference	MTD	MTD	MTD
medium-pressure steam	mps	MPS	MPS
medium-temp. hot water	mthw	MTHW	MTHW
mercury	Hg	HG	HG
metre	m	m	M
metres per second	m/s	m/s	M/S
millilitres per second	mL/s	mL/s	MLPS
mL/s standard	mL/sS	mL/sS	MLPSS
minimum	min.	MIN	MIN
noise criteria	NC	NC	—
normally open	n o	N O	—
normally closed	n c	N C	—
not applicable	na	N/A	—
not in contract	n i c	N I C	—
not to scale	—	N T S	—
number	no.	NO	N, NO
number of circuits	—	—	NC
number of tubes	—	—	NT
outside air	oa	OA	OA
parts per million	ppm	PPM	PPM
Pascal	Pa	Pa	PA
Pa (absolute)	Pa (abs)	Pa A	PAA
Pa (gage)	Pa (gage)	Pa G	PAG
percent	%	%	PCT
phase (electrical)	ph	PH	—
pipe	—	—	PIPE
pressure	—	PRESS	PRES, P
pressure, barometric	baro pr	BARO PR	BP
critical pressure	—	—	CRIP
pressure, dynamic (velocity)	vp	VP	VP
pressure drop or difference	PD	PD	PD, DELTP
pressure, static	sp	SP	SP
pressure, vapor	vap pr	VAP PR	VAP
primary	pri	PRI	PRIM
radian	—	—	RAD
radiat(-e, -or)	—	RAD	—
radiation	—	RADN	RAD
radius	—	—	R
receiver	rcvr	RCVR	REC
recirculate	recirc.	RECIRC	RCIR, RECIR
refrigerant (12, 22, etc.)	R-12, R-22	R12, R22	R12, R22
relative humidity	rh	RH	RH
resist(-ance, -ivity, -or)	res	RES	RES, OHMS
return air	ra	RA	RA
revolutions	rev	REV	REV
revolutions per minute	rpm	RPM	RPM
revolutions per second	rps	RPS	RPS
roughness	rgh	RGH	RGH, E
safety factor	sf	SF	SF
saturation	sat.	SAT	SAT
Saybolt seconds Furol	ssf	SSF	SSF
Saybolt seconds Universal	ssu	SSU	SSU
sea level	sl	SL	SE
second	s	s	SEC
sensible heat	SH	SH	SH
sensible heat gain	SHG	SHG	SHG
sensible heat ratio	SHR	SHR	SHR
shading coefficient	—	—	SC
solar	—	—	SOL

Term	Text	Drawings	Program
specification	spec	SPEC	—
specific gravity	SG	SG	—
specific heat	sp ht	SP HT	C
sp ht at constant pressure	c_p	c_p	CP
sp ht at constant volume	c_v	c_v	CV
specific volume	sp vol	SP VOL	V, CVOL
square	sq.	SQ	SQ
standard	std	STD	STD
standard time meridian	—	—	STM
static pressure	SP	SP	SP
suction	suct.	SUCT	SUCT, SUC
summ(-er, -ary, -ation)	—	—	SUM
supply	sply	SPLY	SUP, SPLY
supply air	sa	SA	SA
surface	—	—	SUR, S
surface, dry	—	—	SURD
surface, wet	—	—	SURW
system	—	—	SYS
tabulat(-e, -ion)	tab	TAB	TAB
tee	—	—	TEE
temperature	temp.	TEMP	T, TEMP
temperature difference	TD, Δt	TD	TD, TDIF
temperature entering	TE	TE	TE, TENT
temperature leaving	TL	TL	TL, TLEA
thermal conductivity	k	K	K
thermal expansion coeff.	—	—	TXPC
thermal resistance	R	R	RES, R
thermocouple	tc	TC	TC, TCPL
thermostat	T STAT	T STAT	T STAT
thick(-ness)	thkns	THKNS	THK
total	—	—	TOT
total heat	tot ht	TOT HT	—
transmissivity	—	—	TAU
U-factor	—	—	U
unit	—	—	UNIT
vacuum	vac	VAC	VAC
valve	v	V	VLV
vapor proof	vap prf	VAP PRF	—
variable	var	VAR	VAR
variable air volume	VAV	VAV	VAV
velocity	vel.	VEL	VEL, V
velocity, wind	w vel.	W VEL	W VEL
ventilation, vent	vent	VENT	VENT
vertical	vert.	VERT	VERT
viscosity	visc	VISC	MU, VISC
volt	V	V	E, VOLTS
volt ampere	VA	VA	VA
volume	vol.	VOL	VOL
volumetric flow rate	—	—	VFR
wall	—	—	W, WAL
water	—	—	WTR
watt	W	W	WAT, W
wet bulb	wb	WB	WB
wet-bulb temperature	wbt	WBT	WBT
width	—	—	WI
wind	—	—	WD
wind direction	wdir	WDIR	WDIR
wind pressure	wpr	WPR	WP, WPRES
year	yr	YR	YR
zone	z	Z	Z, ZN

¹Abbreviations of most proper names use capital letters in both text and drawings.

²The asterisk (*) is used with ET*, effective temperature, as in [Chapter 8](#) of this volume.

³These are surface heat transfer coefficients.

⁴Letter L also used for *Logarithm* of these temperature differences in computer programming.

LETTER SYMBOLS

Symbol	Description of Item	Typical Units
<i>a</i>	acoustic velocity	m/s
<i>A</i>	area	m ²
<i>b</i>	breadth or width	m
<i>B</i>	barometric pressure	kPa
<i>c</i>	concentration	kg/m ³
<i>c</i>	specific heat	kJ/(kg·K)
<i>c_p</i>	specific heat at constant pressure	kJ/(kg·K)
<i>c_v</i>	specific heat at constant volume	kJ/(kg·K)
<i>C</i>	coefficient	—
<i>C</i>	fluid capacity rate	W/K
<i>C</i>	thermal conductance	W/(m ² ·K)
<i>C_L</i>	loss coefficient	—
<i>C_P</i>	coefficient of performance	—
<i>d</i>	prefix meaning differential	—
<i>d</i> or <i>D</i>	diameter	m
<i>D_e</i> or <i>D_h</i>	equivalent or hydraulic diameter	m
<i>D_v</i>	mass diffusivity	mm ² /s
<i>e</i>	base of natural logarithms	—
<i>E</i>	energy	kJ
<i>E</i>	electrical potential	V
<i>f</i>	film conductance (alternate for <i>h</i>)	W/(m ² ·K)
<i>f</i>	frequency	Hz
<i>f_D</i>	friction factor, Darcy-Weisbach formulation	—
<i>f_F</i>	friction factor, Fanning formulation	—
<i>F</i>	force	N
<i>F_{ij}</i>	angle factor (radiation)	—
<i>g</i>	gravitational acceleration	m/s ²
<i>G</i>	mass velocity	kg/(s·m ²)
<i>h</i>	heat transfer coefficient	W/(m ² ·K)
<i>h</i>	hydraulic head	m
<i>h</i>	specific enthalpy	kJ/kg
<i>h_a</i>	enthalpy of dry air	kJ/kg
<i>h_D</i>	mass transfer coefficient	m/s
<i>h_s</i>	enthalpy of moist air at saturation	kJ/kg
<i>H</i>	total enthalpy	kJ
<i>I</i>	electric current	A
<i>k</i>	thermal conductivity	W/(m·K)
<i>k</i> (or <i>γ</i>)	ratio of specific heats, <i>c_p/c_v</i>	—
<i>K</i>	proportionality constant	—
<i>K_D</i>	mass transfer coefficient	kg/(h·m ²)
<i>l</i> or <i>L</i>	length	m
<i>L_p</i>	sound pressure	dB
<i>L_w</i>	sound power	dB
<i>m</i> or <i>M</i>	mass	kg
<i>M</i>	relative molecular mass	kg/kg mol
<i>n</i> or <i>N</i>	number in general	—
<i>N</i>	rate of rotation	rad/s
<i>p</i> or <i>P</i>	pressure	kPa
<i>p_a</i>	partial pressure of dry air	kPa
<i>p_s</i>	partial pressure of water vapor in moist air	kPa
<i>p_w</i>	vapor pressure of water in saturated moist air	kPa
<i>P</i>	power	kW
<i>q</i>	time rate of heat transfer	W
<i>Q</i>	total heat transfer	kJ
<i>Q</i>	volumetric flow rate	L/s
<i>r</i>	radius	m
<i>r</i> or <i>R</i>	thermal resistance	m ² ·K/W
<i>R</i>	gas constant	J/(kg·K)
<i>s</i>	specific entropy	kJ/(kg·K)
<i>S</i>	total entropy	kJ/K
<i>t</i>	temperature	°C
<i>Δt_m</i> or <i>ΔT_m</i>	mean temperature difference	K
<i>T</i>	absolute temperature	K
<i>u</i>	specific internal energy	kJ/kg
<i>U</i>	total internal energy	kJ
<i>U</i>	overall heat transfer coefficient	W/(m ² ·K)
<i>v</i>	specific volume	m ³ /kg
<i>V</i>	total volume	m ³

Symbol	Description of Item	Typical Units
<i>V</i>	linear velocity	m/s
<i>w</i>	mass rate of flow	g/s
<i>W</i>	weight	N
<i>W</i>	humidity ratio of moist air (dry air basis)	g/kg
<i>W</i>	work	J
<i>W_s</i>	humidity ratio of moist air at saturation (dry air basis)	g/kg
<i>x</i>	mole fraction	—
<i>x</i>	quality, mass fraction of vapor	—
<i>x, y, z</i>	lengths along principal coordinate axes	m
<i>Z</i>	figure of merit	—
<i>α</i>	absolute Seebeck coefficient	V/K
<i>α</i>	absorptivity, absorptance radiation	—
<i>α</i>	linear coefficient of thermal expansion	1/K
<i>α</i>	thermal diffusivity	m ² /s
<i>β</i>	volume coefficient of thermal expansion	1/K
<i>γ</i> (or <i>k</i>)	ratio of specific heats, <i>c_p/c_v</i>	—
<i>γ</i>	specific weight	N/m ³
<i>Δ</i>	difference between values	—
<i>ε</i>	emissivity, emittance (radiation)	—
<i>θ</i>	time	s, h
<i>η</i>	efficiency or effectiveness	—
<i>λ</i>	wavelength	nm
<i>μ</i>	degree of saturation	—
<i>μ</i>	dynamic viscosity	mPa·s
<i>ν</i>	kinematic viscosity	m ² /s
<i>ρ</i>	density	kg/m ³
<i>ρ</i>	reflectivity, reflectance (radiation)	—
<i>ρ</i>	volume resistivity	Ω·m
<i>σ</i>	Stefan-Boltzmann constant	W/(m ² ·K ⁴)
<i>σ</i>	surface tension	N/m
<i>τ</i>	stress	N/m ²
<i>τ</i>	time	s
<i>τ</i>	transmissivity, transmittance (radiation)	—
<i>φ</i>	relative humidity	—

DIMENSIONLESS NUMBERS

Fo	Fourier number	$\alpha\tau/L^2$
Gr	Grashof number	$L^3\rho^2\beta g(\Delta t)/\mu^2$
Gz	Graetz number	$w c_p/kL$
<i>j_D</i>	Colburn mass transfer	$Sh/ReSc^{1/3}$
<i>j_H</i>	Colburn heat transfer	$Nu/RePr^{1/3}$
Le	Lewis number	α/D_v
M	Mach number	V/a
Nu	Nusselt number	hD/k
Pe	Peclet number	GDc_p/k
Pr	Prandtl number	$c_p\mu/k$
Re	Reynolds number	$\rho V D/\mu$
Sc	Schmidt number	$\mu/\rho D_v$
Sh	Sherwood number	$h_p L/D_v$
St	Stanton number	h/Gc_p
Str	Strouhal number	fd/V

MATHEMATICAL SYMBOLS

equal to	=
not equal to	≠
approximately equal to	≈
greater than	>
less than	<
greater than or equal to	≥
less than or equal to	≤
plus	+
minus	−
plus or minus	±
<i>a</i> multiplied by <i>b</i>	$ab, a \cdot b, a \times b$
<i>a</i> divided by <i>b</i>	$\frac{a}{b}, a/b, ab^{-1}$
ratio of the circumference of a circle to its diameter	π

a raised to the power n	a^n
square root of a	$\sqrt{a}$, $a^{0.5}$
infinity	∞
percent	%
summation of	Σ
natural log	ln
logarithm to base 10	log

SUBSCRIPTS

These are to be affixed to the appropriate symbols. Several subscripts may be used together to denote combinations of various states, points, or paths. Often the subscript indicates that a particular property is to be kept constant in a process.

$a, b, \dots$	referring to different phases, states or physical conditions of a substance, or to different substances
a	air
a	ambient
b	barometric (pressure)
c	referring to critical state or critical value
c	convection
db	dry bulb
dp	dew point
e	base of natural logarithms
f	referring to saturated liquid
f	film
fg	referring to evaporation or condensation
F	friction
g	referring to saturated vapor
h	referring to change of phase in evaporation
H	water vapor
i	referring to saturated solid
i	internal
if	referring to change of phase in melting
ig	referring to change of phase in sublimation
k	kinetic
L	latent
m	mean value
M	molar basis
o	referring to initial or standard states or conditions
p	referring to constant pressure conditions or processes
p	potential
r	refrigerant
r	radiant or radiation
s	referring to moist air at saturation
s	sensible
s	referring to isentropic conditions or processes
s	static (pressure)
s	surface
t	total (pressure)
T	referring to isothermal conditions or processes
v	referring to constant volume conditions or processes
v	vapor
v	velocity (pressure)
w	wall
w	water
wb	wet bulb
$1, 2, \dots$	different points in a process, or different instants of time

GRAPHICAL SYMBOLS FOR DRAWINGS

Graphical symbols have been extracted from ASME *Standard* Y32.2.3 and ASME *Standard* Y32.2.4. Some of these symbols have been modified, and others have been added to reflect current practice. Symbols and quotations are used with permission of the publisher, the American Society of Mechanical Engineers.

Piping**Heating**

High-pressure steam	——HPS——
Medium-pressure steam	——MPS——
Low-pressure steam	——LPS——

High-pressure condensate	——HPC——
Medium-pressure condensate	——MPC——
Low-pressure condensate	——LPC——
Boiler blowdown	——BBD——
Pumped condensate	——PC——
Vacuum pump discharge	——VPD——
Makeup water	——MU——
Atmospheric vent	——ATV——
Fuel oil discharge	——FOD——
Fuel oil gage	——FOG——
Fuel oil suction	——FOS——
Fuel oil return	——FOR——
Fuel oil tank vent	——FOV——
Low-temperature hot water supply	——HWS——
Medium-temperature hot water supply	——MTWS——
High-temperature hot water supply	——HTWS——
Low-temperature hot water return	——HWR——
Medium-temperature hot water return	——MTWR——
High-temperature hot water return	——HTWR——
Compressed air	——A——
Vacuum (air)	——VAC——
Existing piping	——(NAME)E——
Pipe to be removed	XX (NAME) XX

Air Conditioning and Refrigeration

Refrigerant discharge	——RD——
Refrigerant suction	——RS——
Brine supply	——B——
Brine return	——BR——
Condenser water supply	——C——
Condenser water return	——CR——
Chilled water supply	——CWS——
Chilled water return	——CWR——
Fill line	——FILL——
Humidification line	——H——
Drain	——D——
Hot/chilled water supply	——HCS——
Hot/chilled water return	——HCR——
Refrigerant liquid	——RL——
Heat pump water supply	——HPWS——
Heat pump water return	——HPWR——

Plumbing

Sanitary drain above floor or grade	——SAN——
Sanitary drain below floor or grade	----SAN----
Storm drain above floor or grade	——ST——
Storm drain below floor or grade	----ST----
Condensate drain above floor or grade	——CD——
Condensate drain below floor or grade	----CD----
Vent	-----
Cold water	-----
Hot water	-----
Hot water return	-----
Gas	—G—G
Acid waste	——ACID——
Drinking water supply	——DWS——
Drinking water return	——DWR——
Vacuum (air)	——VAC——
Compressed air	——A——
Chemical supply pipes ^a	——(NAME)——
Floor drain	□ _D
Funnel drain, open	Y

Fire Safety Devices^b**Signal Initiating Detectors**

Heat (thermal)		Gas	
Smoke		Flame	

Valves**Valves for Selective Actuators**

Air line	
Ball	
Butterfly	
Diaphragm	
Gate	
Gate, angle	
Globe	
Globe, angle	
Plug valve	
Three way	

Valves Actuators

Manual	
Non-rising sun	
Outside stem & yoke	
Lever	
Gear	
Electric Motor	
Solenoid	
Pneumatic Motor	
Diaphragm	

Valves, Special Duty

Check, swing gate	
Check, spring	
Control, electric-pneumatic	
Control, pneumatic-electric	
Hose end drain	
Lock shield	
Needle	
Pressure reducing (number and specify)	
Quick opening	

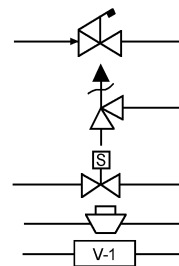
Quick closing, fusible link

Relief (R) or safety (S)

Solenoid

Square head cock

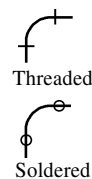
Unclassified (number and specify)

**Fittings**

The following fittings are shown with screwed connections. The symbol for the body of a fitting is the same for all types of connections, unless otherwise specified. The types of connections are often specified for a range of pipe sizes, but are shown with the fitting symbol where required. For example, an elbow would be:

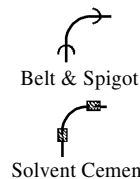


Flanged



Threaded

Soldered



Belt & Spigot

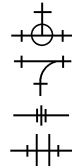
Solvent Cement

Fitting

Fitting	Symbol
Bushing	
Cap	
Connection, bottom	
Connection, top	
Coupling (joint)	
Cross	
Elbow, 90°	
Elbow, 45°	
Elbow, turned up	
Elbow, turned down	
Elbow, reducing (show sizes)	
Elbow, base	
Elbow, long radius	
Elbow, double branch	
Elbow, side outlet, outlet up	
Elbow, side outlet, outlet Down	
Lateral	
Reducer, concentric	
Reducer, eccentric straight invert	
Reducer, eccentric straight crown	
Tee	
Tee, outlet up	
Tee, outlet down	
Tee, reducing (show sizes)	
Tee, side outlet, outlet up	

^a See section on Piping Identification in this chapter.^b Refer to *Standard for Fire Safety Symbols*, 1999 Edition (NFPA Standard 170).^a Includes fusion, specify type.

Tee, side outlet, outlet down



Tee, single sweep



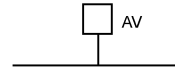
Union, screwed



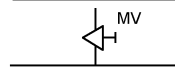
Union, flanged

**Piping Specialties**

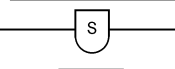
Air vent, automatic



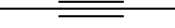
Air vent, manual



Air separator



Alignment guide



Anchor, intermediate



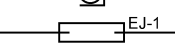
Anchor, main



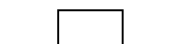
Ball joint



Expansion joint



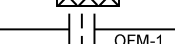
Expansion loop



Flexible connector



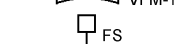
Flowmeter, orifice



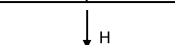
Flowmeter, venturi



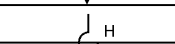
Flow switch



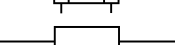
Hanger rod



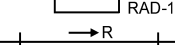
Hanger spring



Heat exchanger, liquid

Heat transfer surface
(indicate type)

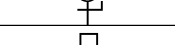
Pitch of pipe, rise (R) drop (D)



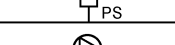
Pressure gage and cock



Pressure switch



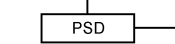
Pump (indicate use)



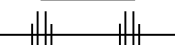
Pump suction diffuser



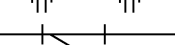
Spool piece, flanged



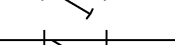
Strainer



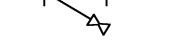
Strainer, blow off



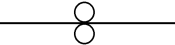
Strainer, duplex



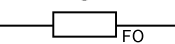
Tank (indicate use)



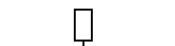
Thermometer



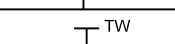
Thermometer well, only



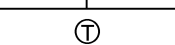
Thermostat, electric



Thermostat, pneumatic



Thermostat, self-contained



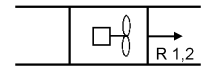
Traps, steam (indicate type)



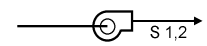
Unit heater (indicate type)

**Air Moving Devices and Components****Fans (indicate use)^a**

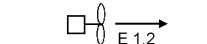
Axial flow



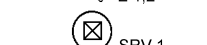
Centrifugal



Propeller



Roof ventilator, intake



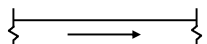
Roof ventilator, exhaust



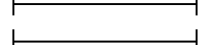
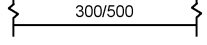
Roof ventilator, louvered

**Ductwork^b**

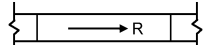
Direction of flow



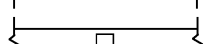
Duct size, first figure is side down

Duct section, positive pressure,
first figure is top

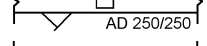
Duct section, negative pressure

Change of elevation
rise (R) drop (D)Access doors, vertical or
horizontal

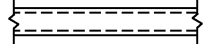
Acoustical lining (insulation)



Cowl, (gooseneck) and flashing



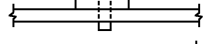
Flexible connection



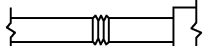
Flexible duct



Sound attenuator



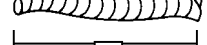
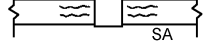
Terminal unit, mixing



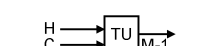
Terminal unit, reheat



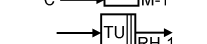
Terminal unit, variable volume

Transition^a

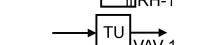
Turning vanes



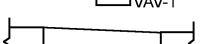
Detectors, fire and/or smoke

**Dampers**

Backdraft damper



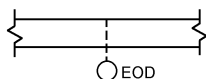
Pneumatic operated damper



^a Units of measurement are not shown herein, but should be shown on drawings. The first of the two dimensions on ducts indicates the side of the duct showing; on duct sections, the top; on grilles and registers, the horizontal edge.

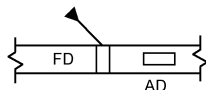
^b Adapted from SMACNA, Symbols for Ventilation and Air Conditioning Figure 4.2. HVAC Duct System Design.

Electric operated damper

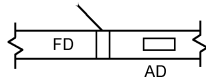


Fire Damper and sleeve (provide access door)

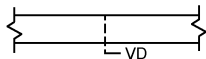
Vertical position



Horizontal position



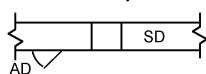
Manual volume



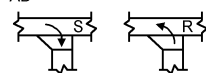
Manual Splitter



Smoke damper (provide access door)



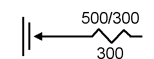
Standard branch, supply or return, no splitter



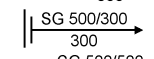
Duct, electric heater

**Grilles, Register and Diffusers^b**

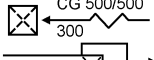
Exhaust grille or register



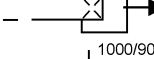
Supply grille or register



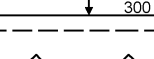
Grille or register, ceiling



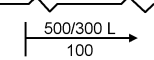
Heat stop for fire rated ceiling



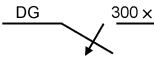
Louver and screen



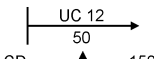
Louver, door, or wall



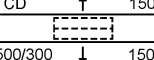
Door grille



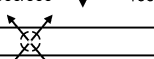
Undercut door



Ceiling diffuser, rectangular



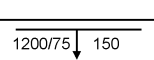
Ceiling diffuser, round



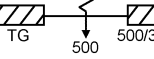
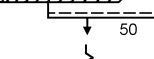
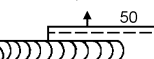
Diffuser, linear



Diffuser and light fixture combination



Transfer grille assembly

**Refrigeration****Compressors**

Centrifugal



Reciprocating

Rotary

Rotary screw

Condensers

Air cooled

Evaporative

Water cooled, (specify type)

Condensing UnitsAir cooled^aWater cooled^a**Condenser-Evaporator (Cascade System)****Cooling Towers**

Cooling tower

Spray pond

Evaporators^b

Finned coil

Forced convection

Immersion cooling unit

Plate coil

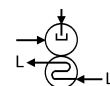
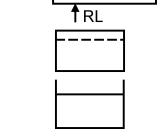
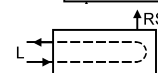
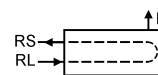
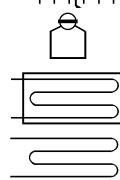
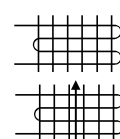
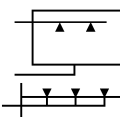
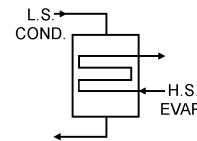
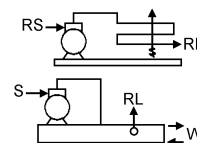
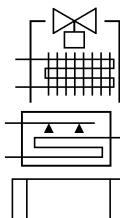
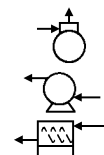
Pipe coil^a**Liquid Chillers (Chillers only)**Direct expansion^bFlooded^b

Tank, closed

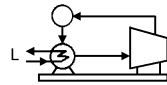
Tank, open

Chilling Units

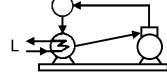
Absorption

^a Indicate flat on bottom or top (FOB or FOT), if applicable.^b Show volumetric flow rate at each device.^a L = Liquid being cooled, RL = Refrigerant liquid, RS = Refrigerant suction.^b Specify manifolding.

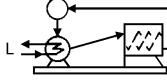
Centrifugal



Reciprocating



Rotary screw



Controls

Refrigerant Controls

Capillary tube



Expansion valve, hand



Expansion valve, automatic



Expansion valve, thermostatic



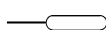
Float valve, high side



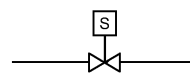
Float valve, low side



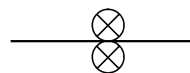
Thermal bulb



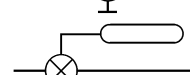
Solenoid valve



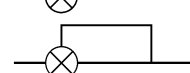
Constant pressure valve, suction



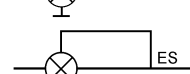
Evaporator pressure regulating valve, thermostatic, throttling



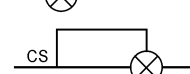
Evaporator pressure regulating valve, thermostatic, snap-action



Evaporator pressure regulating valve, throttling-type, evaporator side



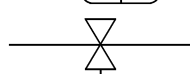
Compressor suction valve, pressure-limiting, throttling-type, compressor side



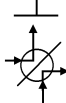
Thermosuction valve



Snap-action valve



Refrigerant reversing valve

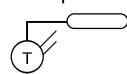


Temperature or Temperature-Actuated Electrical or Flow Controls

Thermostat, self-contained

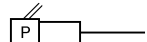


Thermostat, Remote Bulb



Pressure or Pressure-Actuated Electrical or Flow Controls

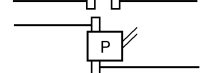
Pressure switch



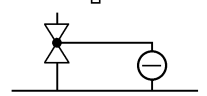
Pressure switch, dual (high-low)



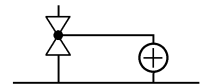
Pressure switch, differential oil pressure



Valve, automatic reducing



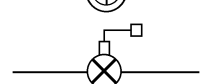
Valve, automatic bypass



Valve, pressure-reducing



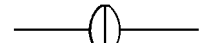
Valve, condenser water regulating



Auxiliary Equipment

Refrigerant

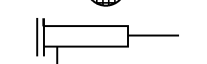
Filter



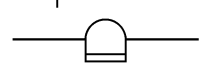
Strainer



Filter and drier



Scale trap



Drier



Vibration absorber



Heat exchanger



Oil separator



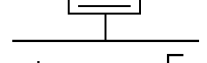
Sight glass



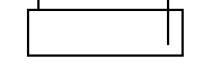
Fusible plug



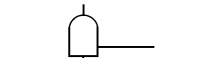
Rupture disk



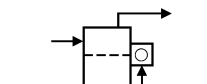
Receiver, high pressure, horizontal



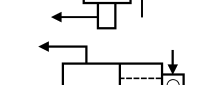
Receiver, high-pressure, vertical



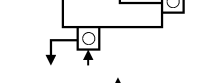
Receiver, low-pressure



Intercooler



Intercooler/desuperheater

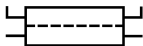


^a Frequently used diagrammatically as evaporator and/or condenser with label indicating name and type.

^b L = Liquid being cooled, RL = Refrigerant liquid, RS = Refrigerant suction.

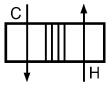
Energy Recovery Equipment

Condenser, double bundle

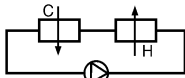


Air to Air Energy Recovery

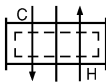
Rotary heat wheel



Coil loop



Heat pipe



Fixed plate

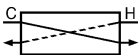
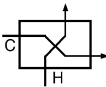


Plate fin, crossflow



Power Sources

Motor, electric (number for identification of description in specifications)



Engine (indicate fuel)



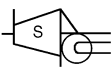
Gas turbine



Steam turbine



Steam turbine, condensing



Electrical Equipment^a

Symbols for electrical equipment shown on mechanical drawings are usually geometric figures with an appropriate name or abbreviation, with details described in the specifications. The following are some common examples.^b

Motor control



Disconnect switch, unfused



Disconnect switch, fused



Time clock



Automatic filter panel



Lighting panel



Power panel



PIPING SYSTEM IDENTIFICATION

The material in piping systems is identified to promote greater safety and lessen the chances of error, confusion, or inaction in times of emergency. Primary identification should be by means of a lettered legend naming the material conveyed by the piping. In addition to, but not instead of lettered identification, color can be used to identify the hazards or use of the material.

The data in this section have been extracted from ASME *Standard* A13.1.

Definitions

Piping Systems. Piping systems include pipes of any kind, fittings, valves, and pipe coverings. Supports, brackets, and other accessories are not included. Pipes are defined as conduits for the transport of gases, liquids, semiliquids, or fine particulate dust.

Materials Inherently Hazardous to Life and Property. There are four categories of hazardous materials:

- Flammable or explosive materials that are easily ignited, including materials known as fire producers or explosives
- Chemically active or toxic materials that are corrosive or are in themselves toxic or productive of poisonous gases
- Materials at extreme temperatures or pressures that, when released from the piping, cause a sudden outburst with the potential for inflicting injury or property damage by burns, impingement, or flashing to vapor state
- Radioactive materials that emit ionizing radiation

Materials of Inherently Low Hazard. All materials that are not hazardous by nature, and are near enough to ambient pressure and temperature that people working on systems carrying these materials run little risk through their release.

Fire Quenching Materials. This classification includes sprinkler systems and other piped fire fighting or fire protection equipment. This includes water (for fire fighting), chemical foam, CO₂, Halon, and so forth.

Method of Identification

Legend. The legend is the primary and explicit identification of content. Positive identification of the content of the piping system is by lettered legend giving the name of the contents, in full or abbreviated form, as shown in [Table 2](#). Arrows should be used to indicate the direction of flow. Use the legend to identify contents exactly and to provide temperature, pressure, and other details necessary to identify the hazard.

The legend shall be brief, informative, pointed, and simple. Legends should be applied close to valves and adjacent to changes in direction, branches, and where pipes pass through walls or floors, and as frequently as needed along straight runs to provide clear and positive identification. Identification may be applied by stenciling, tape, or markers (see [Figure 1](#)). The number and location of identification markers on a particular piping system is based on judgment.

Color. Colors listed in [Table 3](#) are used to identify the characteristic properties of the contents. Color can be shown on or contiguous to the piping by any physical means, but it should be used in combination with a legend. Color can be used in continuous total length coverage or in intermittent displays.

Table 2 Examples of Legends

HOT WATER
AIR 700 kPa
H.P. RETURN
STEAM 700 kPa (gage)

^a See ARI *Standard* 130 for preferred symbols of common electrical parts.

^b Number each symbol if more than one; see ASME *Standard* Y32.4.

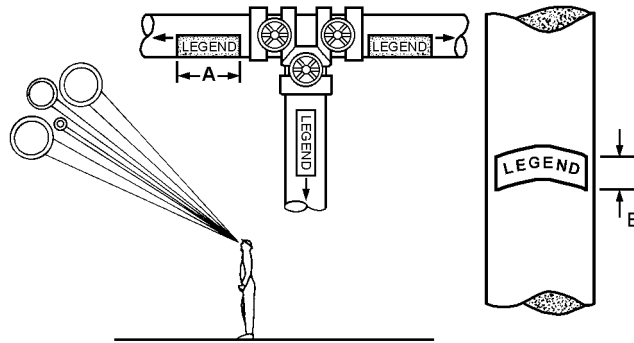


Fig. 1 Visibility of Pipe Markings

Visibility. Pipe markings should be highly visible. If pipe lines are above the normal line of vision, the lettering is placed below the horizontal centerline of the pipe (Figure 1).

Type and Size of Letters. Provide the maximum contrast between color field and legend (Table 3). Table 4 shows the size of letters recommended. Use of standard size letters of 13 mm or larger is recommended. For identifying materials in pipes of less than 20 mm in diameter and for valve and fitting identification, use a permanently legible tag.

Unusual or Extreme Situations. When the piping layout occurs in or creates an area of limited accessibility or is extremely complex, other identification techniques may be required. While a certain amount of imagination may be needed, the designer should always clearly identify the hazard and use the recommended color and legend guidelines.

Table 3 Classification of Hazardous Materials and Designation of Colors^a

Classification	Color Field	Colors of Letters for Legend
Materials Inherently Hazardous		
Flammable or explosive	Yellow	Black
Chemically active or toxic	Yellow	Black
Extreme temperatures or pressures	Yellow	Black
Radioactive ^b	Purple	Yellow
Materials of Inherently Low Hazard		
Liquid or liquid admixture ^c	Green	Black
Gas or gaseous admixture	Blue	White
Fire Quenching Materials		
Water, foam, CO ₂ , Halon, etc.	Red	White

^aWhen the color scheme above is used, the colors should be as recommended in the latest revision of NEMA Standard Z535.1.

^bPreviously specified radioactive markers using yellow or purple are acceptable if already installed and/or until existing supplies are depleted, subject to applicable federal regulations.

^cMarkers with black letters on a green color field are acceptable if already installed and/or until existing supplies are depleted.

Table 4 Size of Legend Letters

Outside Diameter of Pipe or Covering, mm	Length of Color Field A, mm	Size of Letters B, mm
20 to 32	200	13
40 to 50	200	20
65 to 150	300	32
200 to 250	600	65
over 250	800	90

CODES AND STANDARDS

- ARI. 1982. Graphic electrical symbols for air-conditioning and refrigeration equipment. *Standard* 130.
- ASME. 1996. Scheme for the identification of piping systems. *Standard* A13.1.
- ASME. 1988. Glossary of terms concerning letter symbols. *Standard* Y10.1.
- ASME. 1984. Letter symbols and abbreviations for quantities used in acoustics. *Standard* Y10.11.
- ASME. 1987. Letter symbols for illuminating engineering. *Standard* Y10.18.
- ASME. 1999. Abbreviations and acronyms. *Standard* Y14.38-1999 (Revision and redesignation of ASME Y1.1-1989).
- ASME. 1999. Graphical symbols for pipe fittings, valves, and piping. *Standard* Y32.2.3.

- ASME. 1998. Graphical symbols for heating, ventilating, and air conditioning. *Standard* Y32.2.4.
- ASME. 1999. Graphic symbols for plumbing fixtures for diagrams used in architecture and building construction. *Standard* Y32.4.
- IEEE. 1998. American national standard letter symbols for units of measurement. *IEEE Standard* 260.1-1993.
- IEEE. 1993. Mathematical signs and symbols for use in physical science and technology. *Standard* 260.3-1993.
- IEEE. 1996. Letter symbols and abbreviations used in acoustics. *Standard* 260.4-1996.
- NEMA. 1998. Safety color code. *Standard* Z535.1.
- NFPA. 1999. Standard for fire safety symbols, 1999 Edition. *Standard* 170.