Petroleum Engineering Handbook

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Contents

SPE Symbols Standard

Overview of the *SPE Symbols Standard*

Principles of Symbols Selection

Since the original reservoir *Symbols Standard* was established in 1956, the principles used in the selection of additional symbols have been as follows.

1. (A) Use single letters only for the main letter symbols. This is the universal practice of the American Natl. Standards Inst. (ANSI), the Intl. Organization for Standardization (ISO), and the Intl. Union of Pure and Applied Physics (IUPAP) in more then 20 formal standards adopted by them for letter symbols used in mathematical equations.
(B) Make available single and multiple subscripts to the main letter symbols to the extent necessary for clarity. Multiple letters, such as abbreviations, are prohibited for use as the main symbol (kernel) for a quantity. A few exceptions are some traditional mathematical symbols, such as log, ln, and lim. Thus, quantities that are sometimes represented by abbreviations in textual material, tables, or graphs are required in the *SPE Symbols Standard* to have single-letter kernels. Examples are gas/oil ratio (GOR), bottomhole pressure (BHP), spontaneous potential (SP), and static SP (SSP), which have the following SPE standard symbols: R, p_{bh}, E_{SP}, and E_{SSP}, respectively.
2. Adopt the letter symbols of original or prior author usage, where *not* in conflict with Principles 3 and 4.
3. Adopt letter symbols consistent or parallel with the existing *SPE Symbols Standard,* minimizing conflicts with that *Standard.*
4. Where pertinent, adopt the symbols already standardized by such authorities as ANSI, ISO, or IUPAP (see Principle 1); minimize conflicts with these standards.
5. Limit the list principally to basic quantities, avoiding symbols and subscripts for combinations, reciprocals, special conditions, etc.
6. Use initial letters of materials, phase, processes, etc., for symbols and subscripts; they are suggestive and easily remembered.
7. Choose symbols that can be readily handwritten, typed, and printed.

Principles of Letter Symbol Standardization

Requirements for Published Quantity.

1. *Symbols should be standard where possible.* In the use of published symbols, authors of technical works (including textbooks) are urged to adopt the symbols in this and other current standards and to conform to the principles stated here. An author should provide a Nomenclature list in which all symbols are listed and defined. For work in a specialized or developing field, an author may need symbols in addition to those already contained in standards. In such a case, the author should be careful to select simple, suggestive symbols that avoid conflict in the given field and in other closely related special fields. Except in this situation, the author should not introduce new symbols or depart from currently accepted notation.
2. *Symbols should be clear in reference.* One should not assign different meanings to a given symbol in such a manner as to make its interpretation in a given context ambiguous. Conflicts must be avoided. A listed alternative symbol or a modifying subscript is often available and should be adopted. Any symbol not familiar to the reading public should have its meaning defined. The units should be indicated whenever necessary.
3. *Symbols should be easily identified.* Because of the many numerals, letters, and signs that are similar in appearance, a writer should be careful in calling for separate symbols that in published form might be confused by the reader. For example, many letters in the Greek alphabet (lower case and

capital) are practically indistinguishable from English letters, and the zero is easily mistaken for the capital O.

4. *Symbols should be economical in publication.* One should try to keep the cost of publishing symbols at a minimum: no one work should use a great variety of types and special characters; handwriting of inserted symbols, in copy largely typewritten and to be reproduced in facsimile, should not be excessive; and often a complicated expression appears as a component part of a given base. Instead, one may introduce, locally, a single nonconflicting letter to stand for such a complicated component. An explanatory definition should then appear in the immediate context.

Secondary Symbols. Subscripts and superscripts are widely used for a variety of conventional purposes. For example, a subscript may indicate the place of a term in a sequence or matrix; a designated state, point, part, time, or system of units; the constancy of one independent physical quantity among others on which a given quantity depends for its value; or a variable with respect to which the given quantity is a derivative. Likewise, for example, a superscript may indicate the exponent for a power, a distinguishing label, a unit, or a tensor index. The intended sense must be clear in each case. Several subscripts or superscripts, sometimes separated by commas, may be attached to a single letter. A symbol with a superscript such as prime (′) or second (″) or a tensor index should be enclosed in parentheses, braces, or brackets before an exponent is attached. So far as logical clarity permits, one should avoid attaching subscripts and superscripts to subscripts and superscripts. Abbreviations, themselves standardized, may appear among subscripts. A conventional sign or abbreviation indicating the adopted unit may be attached to a letter symbol or corresponding numeral. Reference marks, such as numbers in distinctive type, may be attached to words and abbreviations, but not to letter symbols.

Multiple Subscripts—Position Order. The wide variety and complexity of subject matter covered in the petroleum literature make it impossible to avoid use of multiple subscripts with many symbols. To make such usage less confusing, the following guides were used for the order of appearance of the individual letters in multiple subscripts in the symbols list. Use of the same rules is recommended when it becomes necessary to establish a multiple-subscript notation that has not been included in this list.

1. When the subscript r for "relative" is used, it should appear first in subscript order. Examples: k_{ro} and k_{rg}.
2. When the subscript i for "injection," "injected," or "irreducible" is used, it should appear first in subscript order (but after r for "relative"). Examples: B_{ig}, formation volume factor of injected gas, and c_{ig}, compressibility of injected gas.
3. Except for Cases 1 and 2 above (and symbols k_h and L_v), phase, composition, and system subscripts should generally appear first in subscript order. Examples: B_{gi}, initial or original gas FVF; B_{oi}, initial or original oil FVF; $C_{O_2 i}$, initial or original oxygen concentration; B_{ri}, initial or original total system formation volume factor; ρ_{sE}, density of solid particles making up experimental pack; and F_{aF}, G_{Lp}, G_{wgp}, and G_{Fi}.
4. Abbreviation subscripts (such as "ext," "lim," "max," "min"), when applied to a symbol already subscripted, should appear last in subscript order and require that the basic symbol and its initial subscript(s) be first enclosed in parentheses. Examples: $(i_{a1})_{\max}$ and $(S_{hr})_{\min}$.
5. Except for Case 4, numerical subscripts should appear last in subscript order. Examples: q_{oD3}, dimensionless oil-production rate during Time Period 3; p_{R2}, reservoir pressure at Time 2; and $(i_{a1})_{\max}$, maximum air-injection rate during Time Period 1.
6. Except for Cases 4 and 5, subscript D for "dimensionless" usually should appear last in subscript order. Examples: p_{tD}, q_{oD}, and $(q_{oD3})_{\max}$.
7. Except for Cases 4 through 6, the following subscripts usually should appear last in subscript order; regions such as bank, burned, depleted, front, swept, and unburned (*b, b, d, f, s,* and *u*); separation, differential, and flash (*sp, d,* and *f*); and individual component identification (*I* or other). Examples: E_{bD}, R_{sf}, and n_{pj}.

Typography. When appearing as lightfaced letters of the English alphabet, letter symbols for physical quantities and other subscripts and superscripts, whether upper case, lower case, or in small capitals, are printed in italic (slanted) type. Arabic numerals and letters of other alphabets used in mathematic expressions are normally printed in vertical type. When a special alphabet is required, boldface type is preferred over German, Gothic, or script type. It is important to select a typeface that has italic forms and clearly distinguished upper case, lower case, and small capitals. Typefaces with serifs are recommended.

Remarks. Quantity symbols may be used in mathematical expressions in any way consistent with good mathematical usage. The product of two quantities is indicated by writing *ab*. The quotient may be indicated by writing

$$\frac{a}{b},\ a/b, \text{ or } ab^{-1}.$$

If more than one solidus (/) is used in any algebraic term, parentheses must be inserted to remove any ambiguity. Thus, one may write $(a/b)/c$, or a/bc, but not $a/b/c$.

Special Notes.

1. When the mobilities involved are on opposite sides of an interface, the mobility ratio will be defined as the ratio of the displacing phase mobility to the displaced phase mobility, or the ratio of the upstream mobility to the downstream mobility.
2. Abbreviated chemical formulas are used as subscripts for paraffin hydrocarbons: C_1 for methane, C_2 for ethane, C_3 for propane…C_n for C_nH_{2n+2}.
3. Complete chemical formulas are used as subscripts for materials: CO_2 for carbon dioxide, CO for carbon monoxide, O_2 for oxygen, N_2 for nitrogen, etc.
4. The letter *R* is retained for electrical resistivity in well logging usage. The symbol ρ is to be used in all other cases and is that preferred by ASA.
5. The letter *C* is retained for electrical conductivity in well logging usage. The symbol σ is to be used in all other cases and is that preferred by ASA.
6. Dimensions: L=length, m=mass, q=electrical charge, t=time, T=temperature, M=money, and n=amount of substance.
7. Dimensionless numbers are criteria for geometric, kinematic, and dynamic similarity between two systems. They are derived by one of three procedures used in methods of similarity: integral, differential, or dimensional. Examples of dimensionless numbers are Reynolds number, N_{Re}, and Prandtl number, N_{Pr}. For a discussion of methods of similarity and dimensionless numbers, see "Methods of Similarity," by R.E. Schilson, *JPT* (August 1964) 877–879.
8. The quantity x can be modified to indicate an average or mean value by an overbar, $\bar{x}$.

Distinctions Between and Descriptions of Abbreviations, Dimensions, Letter Symbols, Reserve Symbols, Unit Abbreviations, and Units

Confusion often arises as to the proper distinctions between abbreviations, dimensions, letter symbols, reserve symbols, unit abbreviations, and units used in science and engineering. SPE has adhered to the following descriptions.

Abbreviations. For use in textual matter, tables, figures, and oral discussions. An abbreviation is a letter or group of letters that may be used in place of the full name of a quantity, unit, or other entity. *Abbreviations are not acceptable in mathematical equations.*

Dimensions. Dimensions identify the physical nature or the general components of a specific physical quantity. SPE uses seven basic dimensions: mass, length, time, temperature, electrical charge, money, and amount (m, L, t, T, q, M, and n).*

Letter Symbols. For use in mathematical equations. A letter symbol is a *single* letter, modified when appropriate by one or more subscripts, used to represent a specific physical or mathematical quantity in a mathematical equation. A single letter may be used to represent a group of quantities, properly defined. The same letter symbol should be used consistently for the same generic quantity, with special values being indicated by subscripts or superscripts.

Reserve Symbols. A reserve symbol is a single letter, modified when appropriate by one or more subscripts or superscripts, that can be used as an alternative when two quantities (occurring in some specialized works) have the same standard letter symbol. These conflicts may result from use of standard SPE symbols or subscript designations that are the same for two different quantities, or use of SPE symbols that conflict with firmly established, commonly used notation and signs from the fields of mathematics, physics, and chemistry.

To avoid conflicting designations in these cases, use of reserve symbols, reserve subscripts, and reserve-symbol/reserve-subscript combinations is permitted, *but only in cases of symbols conflict*. Author preference for the reserve symbols and subscripts does not justify their use.

In making the choice as to which of two quantities should be given a reserve designation, one should attempt to retain the standard SPE symbol for the quantity appearing more frequently in the paper; otherwise, the standard SPE symbol should be retained for the more basic item (temperature, pressure, porosity, permeability, etc.).

Once a reserve designation for a quantity is used, it must be used consistently throughout a paper. Use of an unsubscripted reserve symbol for a quantity requires use of the same reserve symbol designation when subscripting is required. Reversion to the standard SPE symbol or subscript is not permitted with a paper. For larger works, such as books, consistency within a chapter or section must be maintained.

The symbol nomenclature, which is a required part of each work, must contain each reserve notation used, together with its definition.

Unit Abbreviation. A unit abbreviation is a letter or group of letters (for example, cm for centimeter), or in a few cases a special sign, that may be used in place of the name of a unit. The Intl. Organization for Standardization (ISO) and many other national and international bodies concerned with standardization emphasize the special character of these designations and rigidly prescribe the manner in which the unit abbreviations shall be developed and treated.

Units. Units express the system of measurement used to quantify a specific physical quantity. In SPE usage, units have "abbreviations" but do not have "letter symbols." See the *SI Metric System of Units and SPE Metric Standard.*

*Electrical charge is current times time. ISO uses Mass (m), Length (L), Time (T), Temperature (θ), Electrical current (T), Amount of substance (n), and Luminous Intensity (J).

Basic Symbols in Alphabetical Order

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
English			
a		activity	
a	F_a	air requirement	various
a		decline factor nominal	
a	L_a, L_1	distance between like wells (injection or production) in a row	L
A		amplitude	various
A		atomic weight	m
A	F	Helmboltz function (work function)	mL^2/t^2
b	Y	intercept	various
b	f,F	reciprocal formation volume factor, volume at standard conditions divided by volume at reservoir conditions (shrinkage factor)	
b	w	width, breadth, or thickness (primarily in fracturing)	L
B	C	correction term or correction factor (either additive or multiplicative)	
B	F	formation volume factor, volume at reservoir conditions divided by volume at standard conditions	
c	k, κ	compressibility	Lt^2/m
C		capacitance	q^2t^2/mL^2
C		capital costs or investments	M
C		coefficient of gas-well backpressure curve	$L^{3-2n}t^{4n}/m^{2n}$
C	n_C	components, number of	
C	c,n	concentration	various
C	σ	conductivity (electrical logging)	tq^2/mL^3
C	c,n	salinity	various
C	c	specific heat capacity (always with phase or system subscripts)	L^2/t^2T
C		waterdrive constant	L^4t^2/m
C_{fD}		fracture conductivity, dimensionless	
C_L	c_L,n_L	condensate or natural gas liquids content	various
d		decline factor, effective	
d	D	diameter	L
d	L_d,L_2	distance between adjacent rows of injection and production wells	L
D		deliverability (gas well)	L^3/t
D	y,H	depth	l
D	μ,δ	diffusion coefficient	L^2/t
e	i	influx (encroachment) rate	L^3/t
e_{O_2}	E_{O_2}	oxygen utilization	
e^z	exp z	exponential function	
E	η,e	efficiency	

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
English			
E	V	electromotive force	mL^2/t^2q
E	U	energy	mL^2/t^2
E	Y	modulus of elasticity (Young's modulus)	M/Lt^2
E_A	η_A, e_A	areal efficiency (used in describing results of model studies only): area swept in a model divided by total model reservoir area (see E_p)	
E_c	Φ_c	electrochemical component of the SP	mL^2/t^2q
E_k	Φ_k	electrokinetic component of the SP	mL^2/t^2q
E_n		Euler number	
E_{SP}	Φ_{SP}	SP (measured SP) (self potential)	mL^2/t^2q
$-Ei(-x)$		exponential integral, $\int_x^\infty \frac{e^{-t}}{t}$, d$t$, x positive	
$Ei(x)$		exponential integral, modified $\lim_{\varepsilon\to 0+}\left(\int_{-x}^{-\varepsilon}\frac{e^{-t}}{t}dt+\int_{\varepsilon}^{\infty}\frac{e^{-t}}{t}dt\right)$, x positive	
f	F	fraction (such as the fraction of a flow stream consisting of a particular phase)	
f	v	frequency	$1/t$
f		friction factor	
f		fugacity	m/Lt^2
f_s	Q,x	quality (usually of steam)	
F		degrees of freedom	
F	A,R,r	factor in general, including ratios (always with identifying subscripts)	various
F	f	fluid (generalized)	various
F_R		formation resistivity factor—equals R_0/R_w (a numerical subscript to F indicates the value R_w)	
F_{WV}	γ	specific weight	mL^2/t^2
g	γ	gradient	various
g		gravity, acceleration of	L/t^2
g_c		conversion factor in Newton's second law of motion	
G	g	gas in place in reservoir, total initial	L^3
G	g	gas (any gas, including air), always with identifying subscripts	various
G	f_G	geometrical factor (multiplier) (electrical logging)	
G	E_s	shear modulus	m/Lt^2
G_L	g_L	condensate liquids in place in reservoir, initial	L^3
h	i	enthalpy, specific	L^2/t^2
h	h_h, h_T	heat transfer coefficient, convective	m/t^3T
h	d,e	height (other than elevation)	L
h		hyperbolic decline constant (from equation) $q=q_i/\left(1+\frac{a_i t}{h}\right)^h$	

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
English			
h	d,e	thickness (general and individual bed)	L
H	I	enthalpy (always with phase or system subscripts)	mL^2/t^2
i		injection rate	L^3/t
i		interest rate	1/t
i_R		rate of return (earning power)	
I		income (net revenue minus expenses)	
I	$\imath$ (script i), i	current, electric	q/t
I	I_T, I_θ	heat transfer coefficient, radiation	m/t^3T
I	i	index (use subscripts as needed)	
I	i	injectivity index	L^4t/m
$\mathcal{J}(z)$(script I)		imaginary part of complex number z	
I_R	i_R	resistivity index (hydrocarbon)—equals R_t/R_0	
j	i_R	reciprocal permeability	$1/L^2$
J	j	productivity index	L^4t/m
k	κ	magnetic susceptibility	mL/q^2
k	K	permeability absolute (fluid flow)	L^2
k	r,j	reaction rate constant	L/t
k_h	λ	thermal conductivity (always with additional phase or system subscripts)	mL/t^3T
K	K_b	bulk modulus	m/Lt^2
K		coefficient in the equation of the electrochemical component of the SP (spontaneous electromotive force)	mL^2/t^2q
K	M	coefficient or multiplier	various
K	d	dispersion coefficient	L^2/t
K	k,F_{eq}	equilibrium ratio (y/x)	
K_{ani}	M_{ani}	anisotropy coefficient	
K_c	M_c, K_{ec}	electrochemical coefficient	mL^2/t^2q
K_R	M_R,a,C	formation resistivity factor coefficient ($F_R\phi^m$)	
ln		natural logarithm, base e	
log		common logarithm, base 10	
$\log_a$		logarithm base a	
L	n_L	moles of liquid phase	
L_f	x_f	fracture half-length (specify "in the direction of" when using x_f)	L
L_s	s_s,ℓ_s (script l)	spacing (electrical logging)	L
L_v	λ_v	latent heat of vaporization	L
$\mathcal{L}(y)$ (script L)		Laplace transform of y, $\int_0^\infty y(t)e^{-st}dt$	
m	F_F	fuel consumption	various
m		mass	m
m		porosity exponent (cementation) (in an empirical relation between F_R and ϕ)	
m	F_{Fo},F_{go}	ratio of initial reservoir free-gas volume to initial reservoir oil volume	
m	A	slope	various
M	I	magnetization	m/qt

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
English			
M	F_λ	mobility ratio, general ($\lambda_{\text{displacing}}/\lambda_{\text{displaced}}$)	
M		molecular weight	m
M	$m_{\theta D}$	slope, interval transit time vs. density (absolute value)	tL^2/m
M		volumetric heat capacity	m/Lt^{2}T
n	N	density (indicating "number per unit volume")	1/L^3
n		exponent of backpressure curve, gas well	
n	μ	index of refraction	
n	N	number (of variables, components, steps, increments, etc.)	
n	n	number (quantity)	
n		saturation exponent	
n		number of compounding periods	1/t
n_t	N_t	moles, number of, total	
N	n,C	count rate (general)	1/t
N		neutron [usually with identifying subscript(s)]	various
N		number, dimensionless, in general (always with identifying subscripts)	
N	n	oil (always with identifying subscripts)	various
N	$m_{\phi ND}$	slope, neutron porosity vs. density (absolute value)	L^3/m
N_{GR}	N_γ, C_G	gamma ray count rate	1/t
N_R	N_F	fuel deposition rate	m/L^{3}t
O		operating expense	various
p	P	pressure	m/Lt^2
p		price	M
P		phases, number of	
P		profit total	M
P_c	P_c, p_c	capillary pressure	M/Lt^2
q	Q	production rate or flow rate	L^3/t
Q	q	charge (current times time)	q
Q	q, Φ	heat flow rate	mL^2/t^3
Q_i	q_i	pore volumes of injected fluid, cumulative dimensionless	
Q_{LtD}	$Q_{\ell tD}$ (script *l*)	fluid influx function, linear aquifer, dimensionless	
Q_p	$Q_{\ell tD}$ (script *l*)	fluids, cumulative produced (where N_p and W_p are not applicable)	
Q_{tD}		fluid influx function, dimensionless, at dimensionless time t_D	
Q_V	Z_V	cation exchange capacity per unit pore volume	
r	R	radius	L
r	R	resistance	mL^2/tq^2
R	ρ, r	electrical resistivity (electrical logging)	ml^{3}tq^2
R		gas constant, universal (per mole)	mL^2/t^{2}T
R	F_g, F_{go}	gas/oil ratio, producing	
R	N	molecular refraction	L^3

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
English			
$\mathscr{R}(z)$ (script R)		real part of complex number z	
s	L	displacement	L
s	σ	entropy, specific	L^2/t^2T
s		Laplace transform variable	
s	S, σ	skin effect	various
s		standard deviation of a random variable, estimated	
s^2		variance of a random variable, estimated	
S	σ_t	entropy, total	mL^2/t^2T
S	ρ, s	saturation	
t	τ	time	t
t_{ma}(script t)	Δt_{ma}	matrix interval transit time	t/L
$t_{½}$		half-life	t
T	Θ	period	t
T	θ	temperature	T
T	T	transmissivity, transmissibility	various
u	ψ	flux	various
u	ψ	flux or flow rate, per unit area (volumetric velocity)	L/t
U	U_T, U_θ	heat transfer coefficient, overall	m/t^3T
v	V, u	acoustic velocity	L/t
v	v_s	specific volume	L^3/m
v	V, u	velocity	L/t
V	R, V_t, R_t	gross revenue ("value"), total	M
V	n_v	moles of vapor phase	
V	U	potential difference (electric)	mL^2/q^2
V	v	volume	L^3
V	f_V, F_V	volume fraction or ratio (as needed, use same subscripted symbols as for "volumes"; note that bulk volume fraction is unity and pore volume fractions are ϕ)	various
w	z	Arrhenius reaction-rate velocity constant	L^3/m
w	m	mass flow rate	m/t
W	w	water (always with identifying subscripts)	various
W	w	water in place in reservoir, initial	L^3
W	w, G	weight (gravitational)	mL/t^2
W	w	work	mL^2/t^2
x		mole fraction of a component in liquid phase	
$\vec{x}$		vector of x	
$\vec{\vec{x}}$		tensor of x	
x_D		dimensionless quantity proportional to x	
X		reactance	mL^2/tq^2
y	f	holdup (fraction of the pipe volume filled by a given fluid: y_o is oil holdup; y_w is water holdup; sum of all holdups at a given level is one)	
y		mole fraction of a component in vapor phase	

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
English			
z	Z	gas compressibility factor (deviation factor) ($z=pV/nRT$)	
z		mole fraction of a component in mixture	
z		valence	
Z		atomic number	
Z	D,h	elevation (height or fluid head) referred to datum	L
Z		impedance	various
Greek			
α	β, γ	angle	
α	m_α	attenuation coefficient	1/L
α	a, η_h	heat or thermal diffusivity	L^2/t
α		reduction ratio or reduction term	
α	a, η_h	thermal or heat diffusivity	L^2/t
β	γ	bearing, relative	
β	b	thermal cubic expansion coefficient	1/T
γ		Euler's constant=0.5772	
γ		gamma ray [usually with identifying subscripts(s)]	various
γ	s,F_s	specific gravity (relative density)	
γ	k	specific heat ratio	
γ	ε_s	strain, shear	
$\dot{\gamma}$	$\dot{e}$	shear rate	1/t
δ	Δ	decrement	various
δ		deviation, hole (drift angle)	
δ	F_d	displacement ratio	
δ	r_s	skin depth (logging)	L
Δ		difference or difference operator, finite ($\Delta x=x_2-x_1$ *or* x_1-x_2)	
Δr	ΔR	radial distance (increment along radius)	L
ε		dielectric constant	q^2t^2/mL^3
ε	e, ε_n	strain, normal and general	
η		hydraulic diffusivity ($k/\phi c\mu$ or $\lambda/\phi c$)	L^2/t
θ	β,γ	angle	
θ	θ_V	strain, volume	
θ	α_d	angle of dip	
θ_c	Γ_c,γ_c	contact angle	
λ	C	decay constant ($1/\tau_d$)	1/t
λ		mobility (k/μ)	L^3t/m
λ		wave length ($1/\sigma$)	L
μ	v, σ	Poisson's ratio	
μ	m	azimuth of reference on sonde	
μ	m	magnetic permeability	mL/q^2
v	N	kinematic viscosity	L^2/t
ρ	D	density	m/L^3
ρ	R	electrical resistivity (other than logging)	mL^3/tq^2
σ	γ	electrical conductivity (other than logging)	various

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
Greek			
σ		microscopic cross section	L^2
σ		standard deviation of a random variable	
σ	s	stress, normal and general	M/Lt^2
σ	y, γ	surface tension, interfacial	m/t^2
σ	$\tilde{v}$	wave number ($1/\lambda$)	$1/L$
σ^2		variance of a random variable	
Σ	S	cross section, macroscopic	$1/L$
τ	s_s	stress, shear	m/Lt^2
τ	τ_c	time constant	t
τ		tortuosity	
$\bar{\tau}$	$\bar{t}$	lifetime, average (mean life)	t
τ_d	t_d	decay time (mean life) ($1/\lambda$)	t
ϕ	f, ε	porosity $(V_b-V_s)/V_b$	
Φ	β_d	dip, azimuth of	
Φ	f	potential or potential function	various
ψ		dispersion modulus (dispersion factor)	
Ψ		stream function	various
ω		angular frequency	$1/t$

Economics Symbols in Alphabetical Order

Letter Symbol	Quantity	Dimensions
English		
C	capital (costs) or investments	M
D	depletion, depreciation, or amortization (all nonreal account entries)	
E	expense, total (except income taxes)	M
i	interest rate	1/t
I	income (net revenue minus expenses)	M
n	number of compounding periods	1/t
p	price	M
P	profit	M
r	royalty	various
R	revenue	M
t	time	t
T	tax on income	various
v	value (economic)	M
Subscripts		
ar	after royalty	
at	after taxes	
br	before royalty	
bt	before taxes	
f	future	
k	specific period	
p	present	
po	payout	
pv	present value	
R	rate	
u	unit	
t	total	
Superscript		
′	real*	

*Whether real or nominal moneys are being discussed must be indicated either through the use of a prime (′) to indicate real figures or by clarifying in the text of the publication whether real or nominal amounts are being used.

Examples	
C_k	capital investment in Period *k*
C_{pv}	investment at present value
E_u	expenses per unit
i_R	rate of return (earning power)
I_{bt}	income before taxes
I_{pvk}	income at present value in Period *k*
p_{gk}	price of gas in Period *k*
p_k	price in Period *k*
P_{pvat}	profit at present value after tax
P_{vatk}	profit at present value after tax in Period *k*
r_R	royalty rate
t_{poat}	payout time, after tax
t_{pvpobt}	payout time before tax at present value
T_k	tax in Period *k*
T_R	tax rate
V_p	net present value (NPV)
V_{poat}	payout volume, after tax

Symbols in Alphabetical Order

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
English			
a		activity	
a	F_a	air requirement	various
a		decline factor, nominal	
a	L_a,L_1	distance between like wells (injection or projection) in a row	L
a_E	F_{aE}	air requirement, unit, in laboratory experimental run, volumes of air per unit mass of pack	L^3/m
a_R	F_{aR}	air requirement, unit, in reservoir, volumes of air per unit bulk volume of reservoir rock	
A		amplitude	various
A	S	area	L^2
A		atomic weight	m
A	S	cross section (area)	L^2
A	F	helmholtz function (work function)	mL^2/t^2
A_c		amplitude, compressional wave	various
A_r		amplitude, relative	various
A_s		amplitude, shear wave	various
b	W	breadth, width, or (primarily in fracturing) thickness	various
b	Y	intercept	various
b	f,F	reciprocal formation volume factor, volume at standard conditions divided by volume at reservoir conditions (shrinkage factor)	
b	W	width, breadth, or (primarily in fracturing) thickness	L
b_g	f_g,F_g	reciprocal gas formation volume factor	
b_{gb}	f_{gb},F_{gb}	reciprocal gas formation volume factor at bubblepoint conditions	
b_o	f_o,F_o	reciprocal oil formation volume factor (shrinkage factor)	
B	C	correction term or correction factor (either additive or multiplicative)	
B	F	formation volume factor, volume at reservoir conditions divided by volume at standard conditions	
B_g	F_g	formation volume factor, gas	
B_{gb}	F_{gb}	bubblepoint formation volume factor, gas	
B_{gb}	F_{gb}	formation volume factor at bubblepoint conditions, gas	
B_o	F_o	formation volume factor, oil	
B_{ob}	F_{ob}	bubblepoint formation volume factor, oil	

Dimensions: L=length, m=mass, q=electrical charge, t=time, T=temperature, M=money, and n=amount of substance.

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
English			
B_{ob}	F_{ob}	formation volume factor at bubblepoint conditions, oil	
B_t	F_T	formation volume factor, total (two-phase)	
B_w	F_w	formation volume factor, water	
c	k,κ	compressibility	Lt^2/m
c_f	k_f,κ_f	compressibility, formation or rock	Lt^2/m
c_g	k_g,κ_g	compressibility, gas	Lt^2/m
c_o	k_o,κ_o	compressibility, oil	Lt^2/m
c_{pr}	k_{pr},κ_{pr}	compressibility, pseudoreduced	
c_w	k_w,κ_w	compressibility, water	Lt^2/m
C		capacitance	q^2t^2/mL^2
C	C_t	capital investments, summation of all	M
C		coefficient of gas-well backpressure curve	$L^{3-2n}t^{4n}m^{2n}$
C	n_C	components, number of	
C	c,n	concentration	various
C	σ	conductivity (electrical logging)	tq^2/mL^3
C	K	conductivity, other than electrical (with subscripts)	various
C	c,n	salinity	various
C	c	specific heat (always with phase or system subscripts)	L^2/t^2T
C		waterdrive constant	L^4t^2/m
C_a	σ_a	conductivity, apparent	tq^2/mL^3
C_{C_1}	c_{C_1}	concentration, methane (concentration of other paraffin hydrocarbons would be indicated similarly, C_{C_2}, C_{C_3}, etc.)	various
C_{fD}		conductivity, fraction, dimensionless	
C_i		capital investment, initial	M
C_k		capital investment in period *k*	M
C_L	c_L,n_L	content, condensate or natural gas liquids	various
C_L		waterdrive constant, linear aquifer	L^4t^2/m
C_m	$c_m n_m$	fuel concentration, unit (see symbol *m*)	various
C_{O_2}	c_{O_2}	concentration, oxygen (concentration of other elements or compounds would be indicated similarly, C_{CO_2}, C_{N_2}, etc.)	
C_{pv}		investment at present value	M
C_{wg}	c_{wg},n_{wg}	content, wet-gas	various
d		decline factor, effective	
d	D	diameter	L
d	L_d,L_2	distance between adjacent rows of injection and production wells	L
d_h	d_H,D_h	diameter, hole	L
d_i	d_I,D_i	diameter, invaded zone (electrically equivalent)	L
$\overline{d}_p$	$\overline{D}_p$	diameter, mean particle	L
D		deliverability (gas well)	L^3/t

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
English			
D		depletion, depreciation, or amortization (all nonreal account entries)	various
D	y,H	depth	L
D	μ,δ	diffusion coefficient	L^2/t
e	i	encroachment or influx rate	L^3/t
e_g	i_g	encroachment or influx rate, gas	L^3/t
e_o	i_o	encroachment or influx rate, oil	L^3/t
e_{O_2}	E_{O_2}	oxygen utilization	
e_w	i_w	encroachment or influx rate, water	L^3/t
e^z	$\exp z$	exponential function	
E	η,e	efficiency	
E	V	electromotive force	mL^2/t^2q
E	U	energy	mL^2/t^2
E		expense, total (except income taxes)	M
E	Y	modulus of elasticity (Young's modulus)	m/Lt
E_A	η_A,e_A	efficiency, areal (used in describing results of model studies only): area swept in a model divided by total model reservoir area (see E_P)	
E_c	Φ_c	electrochemical component of the SP	mL^2/t^2q
E_D	η_D,e_D	efficiency, displacement: volume of hydrocarbons (oil or gas) displaced from individual pores or small groups of pores divided by the volume of hydrocarbon in the same pores just prior to	
E_{Db}	η_{Db},e_{Db}	efficiency, displacement, from burned portion of in-situ combustion pattern	
E_{Du}	η_{Du},e_{Du}	efficiency, displacement, from unburned portion of in-situ combustion pattern	
E_I	η_I,e_I	efficiency, invasion (vertical): hydrocarbon pore space invaded (affected, contacted) by the injection fluid or heat front divided by the hydrocarbon pore space enclosed in all layers behind the injected fluid or heat front	
E_k	Φ_k	electrokinetic component of the SP	mL^2/t^2q
E_k		kinetic energy	mL^2/t^2
E_n		Euler's number	
E_{pSP}	Φ_{SP}	pseudo-SP	mL^2/qt^2
E_p	η_P,e_P	efficiency, pattern sweep (developed from areal efficiency by proper weighting for variations in net pay thickness, porosity, and hydrocarbon saturation): hydrocarbon pore space enclosed behind the injected fluid or heat front divided by total hydrocarbon pore space of the reservoir or project	
E_R	η_R,e_R	efficiency, overall reservoir recovery: volume of hydrocarbons recovered divided by volume of hydrocarbons in place at start of project ($E_R=E_PE_IE_D=E_VE_D$)	
E_{SP}	Φ_{SP}	SP (measured SP) (self-potential)	mL^2/t^2q

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
English			
E_{SSP}	Φ_{SSP}	SSP (static SP)	mL^2/t^2q
E_u		expense per unit	M
E_V	η_V, e_V	efficiency, volumetric; product of pattern sweep and invasion efficiencies	
E_{Vb}	η_{Vb}, e_{Vb}	efficiency, volumetric, for burned portion only, in-situ combustion pattern	
$-Ei(-x)$		exponential integral, $\int_x^{\infty} \frac{e^{-t}}{t} \mathrm{d}t$, x positive	
$Ei(x)$		$\lim_{\varepsilon \to 0+} \left(\int_{-x}^{-\varepsilon} \frac{e^{-t}}{t} \mathrm{d}t + \int_{\varepsilon}^{\infty} \frac{e^{-t}}{t} \mathrm{d}t \right)$, x positive	
f	F	fraction (such as the fraction of a flow stream consisting of a particular phase)	
f	ν	frequency	1/t
f		friction factor	
f		fugacity	m/Lt^2
f_g	F_g	fraction gas	
f_g	F_g	mole fraction gas, $V/(L+V)$	
f_L	F_L, f_ℓ (script ℓ)	fraction liquid	
f_L	F_L, f_ℓ (script ℓ)	mole fraction liquid, $L/(L+V)$	
f_s	Q, x	quality (usually of steam)	
f_V	f_{Vb}, V_{bf}	fraction of bulk (total) volume	
$f_{s\phi h}$	ϕ_{igfsh}	fraction of intergranular space ("porosity") occupied by all shales	
$f_{\phi shd}$	$\phi_{\mathrm{imfsh}d}$	fraction of intermatrix space ("porosity") occupied by nonstructural dispersed shale	
$f_{\phi w}$	$\phi_{\mathrm{igf}w}$	fraction of intergranular space ("porosity") occupied by water	
F		degrees of freedom	
F	f	fluid (generalized)	various
F	Q	force, mechanical	mL/t^2
F		ratio or factor in general (always with identifying subscripts)	
F_{aF}		air/fuel ratio	various
F_B		factor, turbulence	
F_R		formation resistivity factor—equals R_0/R_w (a numerical subscript to F indicates the value R_w)	
F_s	F_d	damage ratio or condition ratio (conditions relative to formation conditions unaffected by well operations)	
F_{wF}		water/fuel ratio	various
F_{wo}		water/oil ratio, producing, instantaneous	
F_{wop}		water/oil ratio, cumulative	
F_{WV}	γ	specific weight	mL^2/t^2
g		acceleration of gravity	L/t^2

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
English			
g	γ	gradient	various
g_c		conversion factor in Newton's second law of motion	
g_G	g_g	gradient, geothermal	T/L
G	F	free energy (Gibbs function)	mL^2/t^2
G	g	gas (any gas, including air), always with identifying subscripts	various
G	g	gas in place in reservoir, total initial	L^3
G	f_G	geometric factor (multiplier) (electrical logging)	
G	E_s	shear modulus	m/Lt^2
G_{an}	f_{Gan}	factor, geometric (multiplier), annulus (electrical logging)	
G_{an}	f_{Gan}	geometric factor (multiplier), annulus (electrical logging)	
G_e	g_e	gas influx (encroachment), cumulative	L^3
G_{Fi}	g_{Fi}	free-gas volume, initial reservoir ($=mNB_{oi}$)	L^3
G_{Fp}	g_{Fp}	free gas produced, cumulative	L^3
G_i	g_i	gas injected, cumulative	L^3
G_i	f_{Gi}	geometric factor (multiplier), invaded zone (electrical logging)	L^3
G_L	g_L	condensate liquids in place in reservoir, initial	L^3
G_{Lp}	g_{Lp}	condensate liquids produced, cumulative	L^3
G_m	f_{Gm}	geometric factor (multiplier), mud (electrical logging)	L^3
G_p	g_p	gas produced, cumulative	L^3
G_p	f_{Gp}	geometric factor (multiplier), pseudo (electrical logging)	L^3
G_{pa}	g_{pa}	gas recovery, ultimate	L^3
G_{pE}	g_{pE}	gas produced from experimental tube run	L^3
G_t	f_{Gt}	geometric factor (multiplier), true (noninvaded zone) (electrical logging)	
G_{wgp}	g_{wgp}	wet gas produced, cumulative	L^3
G_{xo}	f_{Gxo}	geometric factor (multiplier), flushed zone (electrical logging)	
h	d,e	bed thickness, individual	L
h	i	enthalpy, specific	L^2/t^2
h	h_h, h_T	heat-transfer coefficient, convective	$m/t^3/T$
h	d,e	height (other than elevation)	L
h		hyperbolic decline constant (from equation) $q=q_i/\left(1+\dfrac{a_i t}{h}\right)^h$	
h	d,e	thickness (general and individual bed)	L
h_{mc}	d_{mc}, e_{mc}	thickness, mud cake	L
h_n	d_n, e_n	thickness, net pay	L
h_t	d_t, e_t	thickness, gross pay (total)	L
H	I	enthalpy (always with phase or system subscripts)	mL^2/t^2

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
English			
H_s	I_s	enthalpy (net) of steam or enthalpy above reservoir temperature	mL^2/t^2
i		discount rate	
i		injection rate	L^3/t
i		interest rate	1/t
i_a		injection rate, air	L^3/t
i_g		injection rate, gas	L^3/t
i_R		rate of return (earning power)	
i_w		injection rate, water	L^3/t
I	$\imath$ (script i), i	current, electric	q/t
I	$\imath$ (script i), i	electric current	q/t
I	I_T, I_θ	heat transfer coefficient, radiation	m/t^3T
I		income (net revenue minus expenses)	M
I	i	index (use subscripts as needed)	
I	i	injectivity index	L^4t/m
$\mathcal{I}(z)$ (script I)		imaginary part of complex number z	
I_{bt}		income before taxes	M
I_f	i_f, I_F, i_F	fracture index	
I_{Ff}	i_{Ff}	free fluid index	
I_H	i_H	hydrogen index	
I_{pwk}		income at present value in period k	M
I_R	i_R	hydrocarbon resistivity index R_t/R_0	
I_s	i_s	injectivity index, specific	L^3t/m
$I_{\text{sh}GR}$	$i_{\text{sh}GR}$	shaliness gamma ray index, $(\gamma_{\log}-\gamma_{cn})/(\gamma_{\text{sh}}-\gamma_{cn})$	
I_ϕ	i_ϕ	porosity index	
$I_{\phi 1}$	$i_{\phi 1}$	porosity index, primary	
$I_{\phi 2}$	$i_{\phi 2}$	porosity index, secondary	
J	ω	reciprocal permeability	$1/L^2$
J	j	productivity index	L^4t/m
J_s	j_s	productivity index, specific	L^3t/m
K	κ	magnetic susceptibility	mL/q^2
K	K	permeability, absolute (fluid flow)	L^2
K	r, j	reaction rate constant	L/t
k_g	K_g	effective permeability to gas	L^2
k_g/k_o	K_g/K_o	gas/oil permeability ratio	
k_h	λ	thermal conductivity (always with additional phase or system subscripts)	
k_o	K_o	effective permeability to oil	L^2
k_{rg}	K_{rg}	relative permeability to gas	
k_{ro}	K_{ro}	relative permeability to oil	
k_{rw}	K_{rw}	relative permeability to water	
k_w	K_w	effective permeability to water	L^2
k_w/k_o	K_w/K_o	water/oil permeability ratio	
K	K_b	bulk modulus	m/Lt^2
K		coefficient in the equation of the electrochemical component of the SP (spontaneous electromotive force)	mL^2/t^2q
K	M	coefficient or multiplier	various

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
English			
K	d	dispersion coefficient	L^2/t
K	k,F_{eq}	equilibrium ratio (y/x)	
K	M	multiplier or coefficient	various
K_{ani}	M_{ani}	anisotropy coefficient	
K_c	M_c,K_{ec}	electrochemical coefficient	mL^2/t^2q
K_R	M_R,a,C	formation resistivity factor coefficient ($F_R\phi^m$)	
ln		natural logarithm, base e	
log		common logarithm, base 10	
$\log_a$		logarithm, base a	
L	s,ℓ (script l)	distance, length, or length of path	L
L	s,ℓ (script l)	distance, path length, or distance	L
L	n_L	liquid phase, moles of	
L	s,ℓ (script l)	path length, length, or distance	L
L_f	x_f	fracture half-length (specify "in the direction of" when using x_f)	L
L_s	s,ℓ (script l)	spacing (electrical logging)	L
L_v	λ_v	heat of vaporization, latent	L^2/t^2
$\mathcal{L}(y)$ (script L)		transform, Laplace of y, $\int_0^\infty y(t)e^{-st}dt$	
m		cementation (porosity) exponent (in an empirical relation between F_R and ϕ)	
m	F_F	fuel consumption	various
m		mass	m
m	F_{Fo},F_{go}	ratio of initial reservoir free-gas volume to initial reservoir oil volume	
m	A	slope	various
m_E	F_{FE}	fuel consumption in experimental tube run	m/L^3
m_{Eg}	F_{FEg}	fuel consumption in experimental tube run (mass of fuel per mole of produced gas)	m
k		amortization (annual write-off of unamortized investment at end of year k)	M
m_R	F_{FR}	fuel consumption in reservoir	m/L^3
M	I	magnetization	m/qt
M	F_λ	mobility ratio, general ($\lambda_{displacing}/\lambda_{displaced}$)	
M	F_λ	mobility ratio, sharp-front approximation (λ_D/λ_d)	
M		molecular weight	m
M	m	number of compounding periods (usually per year)	m
M	$m_{\theta D}$	slope, interval transit time vs. density (absolute value)	tL^2/m
M		volumetric heat capacity	m/Lt^2T
M_f		magnetization, fraction	
M_L		molecular weight of produced liquids, mole-weighted average	m

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
English			
$M_{\overline{S}}$	M_{Dd}, M_{su}	mobility ratio, diffuse-front approximation $[(\lambda_D+\lambda_d)_{\text{swept}}/(\lambda_d)_{\text{unswept}}]$; mobilities are evaluated at average saturation conditions behind and ahead of front	
M_t	$F_{\lambda t}$	mobility ratio, total, $[(\lambda_t)_{\text{swept}}/(\lambda_t)_{\text{unswept}}]$; “swept” and “unswept” refer to invaded and uninvaded regions behind and ahead of leading edge of displacement front	
n	N	density (indicating “number per unit volume”)	$1/L^3$
n		exponent of backpressure curve, gas well	
n	μ	index of refraction	
n	N	number (of variables, or components, or steps, or increments, etc.)	
n	N	number (quantity)	
n		number of compounding periods	1/t
n		saturation exponent	
n_j	N_j	moles of component j	
n_N		density (number) of neutrons	$1/L^3$
n_{pj}	N_{pj}	moles of component j produced, cumulative	
n_t	N_t	number of moles, total	
N	n, C	count rate (general)	1/t
N		neutron [usually with identifying subscript(s)]	various
N		number, dimensionless, in general (always with identifying subscripts)	
N	n	oil (always with identifying subscripts)	various
N	n	pump strokes, number of, cycles per unit of time	
N	$m_{\theta ND}$	slope, neutron porosity vs. density (absolute value)	L^3/m
N_e		oil influx (encroachment), cumulative	L^3
N_{GR}	N_γ, C_G	gamma ray count rate	1/t
N_i	n_i	oil in place in reservoir, initial	L^3
N_N	N_n, C_N	neutron count rate	1/t
N_p	n_p	oil produced, cumulative	L^3
N_{pa}	n_{pa}	oil recovery, ultimate	L^3
N_R	N_F	fuel deposition rate	m/L^3t
N_{Re}		Reynolds number (dimensionless number)	
p	P	pressure	m/Lt^2
p		price	M
p_a	P_a	pressure, atmospheric	m/Lt^2
p_b	p_s, P_s, P_b	pressure, bubblepoint (saturation)	m/Lt^2
p_{bh}	P_{bh}	pressure, bottomhole	m/Lt^2
p_c	P_c	pressure, critical	m/Lt^2
p_{cf}	P_{cf}	pressure, casing flowing	m/Lt^2
p_{cs}	P_{cs}	pressure, casing static	m/Lt^2
p_d	P_d	pressure, dewpoint	m/Lt^2
p_D	P_D	pressure, dimensionless	
p_e	P_e	pressure, external boundary	m/Lt^2

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
English			
p_{ext}	P_{ext}	pressure, extrapolated	m/Lt^2
p_f	P_f	pressure, front or interface	m/Lt^2
p_{gk}		price of gas in period *k*	M
p_i	P_i	pressure, initial	m/Lt^2
p_{iwf}	P_{iwf}	pressure, bottomhole flowing, injection well	m/Lt^2
p_{iws}	P_{iws}	pressure, bottomhole static, injection well	m/Lt^2
p_k		price in period *k*	M
p_{pc}	P_{pc}	pressure, pseudocritical	m/L^2
p_{pc}	P_{pc}	pseudocritical pressure	m/Lt^2
p_{pr}	P_{pr}	pressure, pseudoreduced	
p_r	P_r	pressure, reduced	
p_{sc}	P_{sc}	pressure, standard conditions	m/Lt^2
p_{sp}	P_{sp}	pressure, separator	m/Lt^2
p_{tD}	P_{tD}	pressure function, dimensionless, at dimensionless time t_D	
p_{tf}	P_{tf}	pressure, tubing flowing	m/Lt^2
p_{ts}	P_{ts}	pressure, tubing static	m/Lt^2
p_w	P_w	pressure, bottomhole general	m/Lt^2
p_{wf}	P_{wf}	pressure, bottomhole flowing	m/Lt^2
p_{ws}	P_{ws}	pressure, bottomhole static	m/Lt^2
p_{ws}	P_{ws}	pressure, bottomhole, at any time after shut-in	m/Lt^2
$\overline{p}$	$\overline{P}$	average pressure	m/Lt^2
$\overline{p}$	$\overline{P}$	pressure, average or mean	m/Lt^2
$\overline{p}_R$	$\overline{P}_R$	pressure, reservoir average	m/Lt^2
P		phases, number of	
P		profit	M
P_c	P_C, p_C	capillary pressure	m/Lt^2
P_{pvat}		profit at present value after tax	M
P_{pvatk}		profit at present value after tax in period *k*	M
q	Q	production rate or flow rate	L^3/t
q_a	Q_a	production rate at economic abandonment	L^3/t
q_{dh}	q_{wf}, q_{DH}, Q_{dh}	volumetric flow rate downhole	L^3/t
q_D	Q_D	production rate, dimensionless	
q_g	Q_g	production rate, gas	L^3/t
q_{gD}	Q_{gD}	production rate, gas dimensionless	
q_i	Q_i	production rate at beginning of period	L^3/t
q_o	Q_o	production rate, oil	L^3/t
q_{oD}	Q_{oD}	production rate, oil, dimensionless	
$q_{\overline{p}}$	$Q_{\overline{p}}$	production rate or flow rate at mean pressure	L^3/t
q_s	Q_s	segregation rate (in gravity drainage)	L^3/t
q_{sc}	q_σ, Q_{sc}	surface production rate	L^3/t
q_{sc}	q_σ, Q_{sc}	volumetric flow rate, surface conditions	L^3/t
q_w	Q_w	production rate, water	L^3/t
q_{wD}	Q_{wD}	production rate, water, dimensionless	
$\overline{q}$	$\overline{Q}$	production rate or flow rate, average	L^3/t
Q	Q	charge	q
Q	q, Φ	heat flow rate	mL^2/t^3

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
English			
Q_i	q_i	pore volumes of injected fluid, cumulative, dimensionless	mL^2/t^3
Q_{LtD}	$Q_{\ell tD}$ (script *l*)	influx function, fluid, linear aquifer, dimensionless	
Q_p	$Q_{\ell tD}$ (script *l*)	fluids, cumulative produced (where N_p and W_p are not applicable)	
Q_p		produced fluids, cumulative (where N_p and W_p are not applicable)	L^3
Q_{tD}		fluid influx function, dimensionless, a dimensionless time t_D	
Q_V	Z_V	cation exchange capacity per unit pore volume	
r	R	radius	L
r	R	resistance	ML^2/tq^2
r		royalty	various
r_d	R_d	drainage radius	L
r_D	R_D	radius, dimensionless	
r_e	R_e	external boundary radius	L
r_H	R_H	hydraulic radius	L
r_R		royalty rate	various
r_s	R_s	radius of well damage or stimulation (skin)	L
r_w	R_w	well radius	L
r_{ws}	R_{wa}	radius of wellbore, apparent or effective (includes effects of well damage or stimulation)	L
R	ρ, r	electrical resistivity (electrical logging)	mL^3/tq^2
R		gas constant, universal (per mole)	mL^2/t^2T
R	F_g, F_{go}	gas/oil ratio, producing	
R	N	molecular refraction	L^3
R		reaction rate	m/L^2
R		revenue	M
$\mathcal{R}(z)$(script *R*)		real part of complex number *z*	
R_a	ρ_a, r_a	apparent resistivity	mL^3/tq^2
R_F	F_{gF}, F_{goF}	free gas/oil ratio, producing (free-gas volume/oil volume)	
R_i	ρ_i, r_i	invaded zone resistivity	mL^3/tq^2
R_m	ρ_m, r_m	mud resistivity	mL^3/tq^2
R_{mc}	ρ_{mc}, r_{mc}	mudcake resistivity	mL^3/tq^2
R_{mf}	ρ_{mf}, r_{mf}	mud-filtrate resistivity	mL^3/tq^2
R_p	F_{gp}, F_{gop}	cumulative gas/oil ratio	
R_s	F_{gs}, F_{gos}	solution gas/oil ratio (gas solubility in oil)	
R_{sb}	F_{gsb}	solution gas/oil ratio at bubblepoint conditions	
R_{sh}	ρ_{sh}, r_{sh}	shale resistivity	mL^3/tq^2
R_{si}	F_{gsi}	solution gas/oil ratio, initial	
R_{sw}		gas solubility in water	
R_t	ρ_t, r_t	true formation resistivity	mL^3/tq^2
R_w	ρ_w, r_w	water resistivity	mL^3/tq^2

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
English			
R_{xo}	ρ_{xo},r_{xo}	flushed-zone resistivity (that part of the invaded zone closest to the wall of the hole, where flushing has been maximum)	mL^3/tq^2
R_z	ρ_z,r_z	apparent resistivity of the conductive fluids in an invaded zone (caused by fingering)	mL^3/tq^2
R_0	ρ_0,r_0	formation resistivity when 100% saturated with water of resistivity R_w	mL^3/tq^2
S		Laplace transform variable	
S	L	displacement	L
S	Σ	entropy, specific	L^2/t^2T
S	S, σ	skin effect	various
S		standard deviation of a random variable, estimated	
s^2		variance of a random variable, estimated	
S	σ_t	entropy, total	mL^2/t^2T
S	ρ,s	saturation	
S	s, σ	storage or storage capacity	various
S_{fD}	S_D	dimensionless fracture storage capacity	
S_g	ρ_g,s_g	gas saturation	
S_{gc}	ρ_{gc},s_{gc}	gas saturation, critical	
S_{gr}	ρ_{gr},s_{gr}	gas saturation, residual	
S_h	ρ_h,s_h	saturation, hydrocarbon	
S_{hr}	ρ_{hr},s_{hr}	residual hydrocarbon saturation	
S_{iw}	ρ_{iw},s_{iw}	irreducible (interstitial or connate) water saturation	
S_L	ρ_L,s_L	liquid saturation, combined total	
S_o	ρ_o,s_o	oil saturation	
S_{og}	ρ_{og},s_{og}	gas-cap interstitial-oil saturation	
S_{or}	ρ_{or},s_{or}	residual oil saturation	
S_w	ρ_w,s_w	water saturation	
S_{wc}	ρ_{wc},s_{wc}	critical water saturation	
S_{wg}	ρ_{wg},s_{wg}	interstitial-water saturation in gas cap	
S_{wi}	ρ_{wi},s_{wi}	initial water saturation	
S_{wo}	S_{wb}	interstitial-water saturation in oil band	
S_{wr}	ρ_{wr},s_{wr}	residual water saturation	
T	τ	time	t
$\mathscr{t}$ (script *t*)	Δt	interval transit time	t/L
t_d	τ_d	time, delay	t
t_{dN}		decay time, neutron (neutron mean life)	t
t_D	τ_D	time, dimensionless	
t_{Dm}	τ_{Dm}	time, dimensionless at condition m	
$\mathscr{t}_{ma}$ (script *t*)	Δt_{ma}	matrix interval transit time	t/L
t_N	τ_N,t_n	neutron lifetime	1/t
t_p	τ_p	time well was on production prior to shut-in, equivalent (pseudotime)	t
t_{poat}		payout time, after tax	t
t_{pypobt}		payout time, before tax at present value	t
t_s	τ_s	time for stabilization of a well	t

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
English			
$\mathscr{t}_{sh}$ (script t)	Δt_{sh}	shale interval transit time	t/L
t_1	τ_1	relaxation time, proton thermal	t
$t_{½}$		half-life	t
t_2	τ_2	relaxation time, free-precession decay	t
T	Θ	period	t
T		tax on income	various
T	θ	temperature	T
T	T	transmissivity, transmissibility	various
T_{bh}	θ_{BH}	bottomhole temperature	T
T_c	θ_c	critical temperature	T
T_f	θ_f	formation temperature	T
T_k		tax in period k	various
T_{pr}	θ_{pr}	pseudoreduced temperature	T
T_r	θ_r	reduced temperature	
T_R	θ_R	reservoir temperature	T
T_R		tax rate	various
T_{sc}	θ_{sc}	temperature, standard conditions	T
u	Ψ	flux	various
u	Ψ	flux or flow rate, per unit area (volumetric velocity)	L/t
u	Ψ	superficial phase velocity (flux rate of a particular fluid phase flowing in pipe; use appropriate phase subscripts)	
U	U_T, U_θ	heat transfer coefficient, overall	m/t^3T
v	V,u	acoustic velocity	L/t
v	v_s	specific volume	L^3/m
v		value (economic)	M
v	V,u	velocity	L/t
v_b	V_b,u_b	burning-zone advance rate (velocity of)	L/t
v_p		net present value (NPV)	M
V	n_v	moles of vapor phase	
V	U	potential difference (electric)	mL^2/qt^2
V	v	volume	L^3
V	$f_v F_v$	volume fraction or ratio (as needed, use same subscripted symbols as for "volumes"; note that bulk volume fraction is unity and pore volume fractions are ϕ)	various
V_b	v_b	bulk volume	L^3
V_{bE}	v_{bE}	bulk volume of pack burned in experimental tube run	L^3
V_{bp}	v_{bp}	volume at bubblepoint pressure	L^3
V_e	V_{pe}, v_e	volume, effective pore	L^3
V_{gr}	v_{gr}	volume, grain (volume of all formation solids except shales)	L^3
V_{ig}	v_{ig}	volume, intergranular (volume between grains; consists of fluids and all shales) (V_v-V_{gr})	
V_{im}	v_{im}	volume, intermatrix (consists of fluids and dispersed shale) (V_b-V_{ma})	L^3

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
English			
V_M	v_m	molal volume (volume per mole)	L^3
V_{ma}	v_{ma}	matrix (framework) volume (volume of all formation solids except dispersed clay or shale)	L^3
V_{ma}	v_{ma}	volume, matrix (framework)(volume of all formation solids except dispersed shale)	L^3
V_p	v_p	pore volume (V_b−V_s)	L^3
V_{pD}	v_{pD}	pore volume, dimensionless	
V_{poat}	v_{pD}	payout volume, after tax	L^3
V_{Rb}		volume of reservoir rock burned	L^3
V_{Ru}		volume of reservoir rock unburned	L^3
V_s	v_s	volume, solids(s) (volume of all formation solids)	L^3
V_{sh}	v_{sh}	volume, shale(s)(volume of all shales: structural and dispersed)	L^3
V_{shd}	v_{shd}	volume, shale, dispersed	L^3
V_{shs}	v_{shs}	volume, shale, structural	L^3
w	z	Arrhenius reaction-rate velocity constant	L^3/m
w	m	mass flow rate	m/t
w	m	rate, mass flow	m/t
W	w	water (always with identifying subscripts)	various
W	w	water in place in reservoir, initial	L^3
W	w, G	weight (gravitational)	mL/t^2
W	w	work	mL^2/t^2
W_e	w_e	water influx (encroachment), cumulative	L^3
W_i	w_i	water injected, cumulative	L^3
W_p	w_p	water produced, cumulative	L^3
x		mole fraction of a component in liquid phase	
$\vec{x}$		vector of x	
$\vec{\vec{x}}$		tensor of x	
$\bar{x}$		mean value of a random variable, x, estimated	
X		reactance	ML^2/tq^2
y	f	holdup (fraction of the pipe volume filled by a given fluid: y_o is oil holdup; y_w is water holdup; sum of all holdups at a given level is 1)	
y		mole fraction of a component in a vapor phase	
z	Z	gas compressibility factor (deviation factor) ($z=pV/nRT$)	
z		mole fraction of a component in mixture	
z		valence	
$Z_{\bar{p}}$	$Z_{\bar{p}}$	gas deviation factor (compressibility factor) at mean pressure	
Z		atomic number	
Z	D, h	elevation referred to datum	L
Z	D, h	height, or fluid head or elevation referred to a datum	L
Z		impedance	various

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
English			
Z_a		impedance, acoustic	m/L^2t
Greek			
α	β,γ	angle	
α	M_α	attenuation coefficient	1/L
α	a,η_h	heat or thermal diffusivity	L^2/t
α		reduction ratio or reduction term	
α	a,η_h	thermal or heat diffusivity	L^2/t
$\alpha_{SP_{sh}}$		reduction ratio, SP, caused by shaliness	
β	γ	bearing, relative	
β	b	thermal cubic expansion coefficient	1/T
γ		gamma ray [usually with identifying subscript(s)]	various
γ	s,F_s	specific gravity (relative density)	
γ	k	specific heat ratio	
γ	ε_s	strain, shear	
$\dot{\gamma}$	$\dot{e}$	shear rate	1/t
γ_g	s_g,F_{gs}	specific gravity, oil	
γ_w	s_w,F_{ws}	specific gravity, water	
δ	Δ	decrement	various
δ		deviation, hole (drift angle)	
δ	F_d	displacement ratio	
δ		drift angle, hole (deviation)	
δ	r_s	skin depth (logging)	L
δ_{ob}	F_{dob}	displacement ratio, oil from burned volume, volume per unit volume of burned reservoir rock	
δ_{ou}	F_{dou}	displacement ratio, oil from unburned volume, volume per unit volume of unburned reservoir rock	
δ_{wb}	F_{dwb}	displacement ratio, water from burned volume, volume per unit volume of burned reservoir rock	
Δ		difference or difference operator, finite ($\Delta x = x_2 - x_1$ or $x_1 - x_2$)	
ΔG_e	Δg_e	gas influx (encroachment) during an interval	L^3
ΔG_i	Δg_i	gas injected during an interval	L^3
ΔG_p	Δg_p	gas produced during an interval	L^3
ΔN_e	Δn_e	oil influx (encroachment) during an interval	L^3
ΔN_p	Δn_p	oil produced during an interval	L^3
Δr	ΔR	radial distance (increment along radius)	L
Δt_{wf}	$\Delta \tau_{wf}$	drawdown time (time after well is opened to production) (pressure drawdown)	t
Δt_{ws}	$\Delta \tau_{ws}$	buildup time; shut-in time (time afterwell is shut in) (pressure buildup, shut-in time)	t
ΔW_e	Δw_e	water influx (encroachment) during an interval	L^3
ΔW_i	Δw_i	water injected during an interval	L^3
ΔW_p	Δw_p	water produced during an interval	L^3

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
Greek			
ε		dielectric constant	q^2t^2/mL^3
ε	e,ε_n	strain, normal and general	
η		hydraulic diffusivity ($k/\phi c\mu$ or $\lambda/\phi c$)	L^2/t
θ	β,γ	angle	
θ	θ_V	strain, volume	
Θ	α_d	angle of dip	
Θ_a	α_{da}	dip, apparent angle of	
Θ_c	Γ_c,γ_c	contact angle	
λ	C	decay constant($1/\tau_d$)	1/t
λ		mobility (k/μ)	L^3t/m
λ		wavelength($1/\sigma$)	L
λ_g		mobility, gas	L^3t/m
λ_o		mobility, oil	L^3t/m
λ_t	Λ	mobility, total, of all fluids in a particular region of the reservoir [e.g., ($\lambda_o+\lambda_g+\lambda_w$)]	L^3t/m
λ_w		mobility, water	L^3t/m
μ	M	azimuth of reference on sonde	
μ	m	magnetic permeability	mL/q^2
μ		mean value of a random variable	
μ	υ,σ	Poisson's ratio	
μ	η	viscosity, dynamic	m/Lt
μ_a	η_a	viscosity, air	m/Lt
μ_c		chemical potential	
μ_g	η_g	viscosity, gas	m/Lt
μ_{ga}	η_{ga}	viscosity, gas, at 1 atm	m/Lt
μ_o	η_o	viscosity, oil	m/Lt
$\mu_{\bar{p}}$	$\eta_{\bar{p}}$	viscosity at mean pressure	m/Lt
μ_w	η_w	viscosity, water	m/Lt
v	N	kinematic viscosity	L^2/t
v	N	viscosity, kinematic	L^2/t
ρ	D	density	m/L^3
ρ	R	resistivity, electrical (other than logging)	mL^3tq^2
ρ_a	D_a	density, apparent	m/L^3
ρ_b	D_b	density, bulk	m/L^3
ρ_f	D_f	density, fluid	m/L^3
ρ_F	D_F	density, fuel	m/L^3
ρ_g	D_g	density, gas	m/L^3
ρ_{ma}	D_{ma}	density, matrix (solids, grain)	m/L^3
ρ_o	D_o	density, oil	m/L^3
ρ_{sE}	D_{sE}	density of solid particles making up experiment pack	m/L^3
ρ_t	D_t	density, true	m/L^3
ρ_w	D_w	density, water	m/L^3
ρ_{xo}	D_{xo}	density, flushed zone	m/L^3
$\bar{\rho}_L$	$\bar{D}_L$	density of produced liquid, weight-weighted average	m/L^3
σ	γ	conductivity, electrical (other than logging)	various
σ		cross section, microscopic	1/L
σ	s	cross section of a nucleus, microscopic	L^2

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
Greek			
σ	y, γ	interfacial surface tension	m/t^2
σ		microscopic cross section	L^2
σ		standard deviation of a random variable	
σ	s	stress, normal and general	m/Lt^2
σ	y, γ	surface tension, interfacial	m/t^2
σ	$\tilde{v}$	wave number ($1/\lambda$)	1/L
σ^2		variance of a random variable	
Σ	S	cross section, macroscopic	1/L
Σ		summation (operator)	
τ	s_s	stress, shear	m/Lt^2
τ	τ_c	time constant	t
τ_d	t_d	decay time (mean life) ($1/\lambda$)	t
τ_d	t_{dt}	mean life (decay time) ($1/\lambda$)	t
τ_e		tortuosity, electric	
τ_H		hydraulic tortuosity	
τ_H		tortuosity, hydraulic	
$\overline{\tau}$	$\overline{t}$	lifetime, average (mean life)	t
ϕ	f, ε	porosity $(V_b - V_s)/V_b$	
ϕ_a	f_a, ε_a	porosity, apparent	
ϕ_e	f_e, ε_e	porosity, effective (V_{pe}/V_b)	
ϕ_E	f_E, ε_E	porosity of experimental pack	
ϕ_h	f_h, ε_h	porosity, hydrocarbon-filled, fraction or percent of rock bulk volume occupied by hydrocarbons	
ϕ_{ig}	f_{ig}, ε_{ig}	"porosity" (space), intergranular $(V_b - V_{gr})/V_b$	
ϕ_{im}	f_{im}, ε_{im}	"porosity" (space), intermatrix $(V_b - V_{ma})/V_b$	
ϕ_{ne}	f_{ne}, ε_{ne}	porosity, noneffective $(V_{pne})/V_b$	
ϕ_R	f_R, ε_R	porosity of reservoir or formation	
ϕ_t	f_t, ε_t	porosity, total	
Φ	β_d	dip, azimuth of	
Φ	f	potential of potential function	various
ψ		dispersion modulus (dispersion factor)	
Ψ		stream function	various
ω		angular frequency (acentric factor)	1/t
Math			
$\propto$		proportional to	
$-$		average or mean (overbar)	
$<$		smaller than	
$\leq$		equal to or smaller than	
$>$		larger than	
$\geq$		equal to or larger than	
$\sim$		asymptotically equal to	
$\approx$		approximately equal to or is approximated by (usually with functions)	
∇		del (gradient operator)	
$\nabla \cdot$		divergence operator	

Letter Symbol	Reserve SPE Letter Symbol	Quantity	Dimensions
Math			
∇^2		Laplacian operator	
∇x		curl	
erf		error function	
erfc		error function, complementary	
lim		limit	
b	γ	intercept	various
E_n		Euler's number	
$Ei(x)$		exponential integral, modified $\lim_{\varepsilon \to 0+}\left(\int_{-x}^{-\varepsilon}\frac{e^{-t}}{t}\mathrm{d}t+\int_{\varepsilon}^{\infty}\frac{e^{-t}}{t}\mathrm{d}t\right)$, x positive	
$-Ei(-x)$		exponential integral, $\int_{x}^{\infty}\frac{e^{-t}}{t}\mathrm{d}t$, x positive	
e^z	exp z	exponential function	
F		ratio	
f	F	fraction	
$\mathcal{I}(z)$		imaginary part of complex number z	
$\mathcal{L}(y)$		Laplace transform of y, $\int_0^{\infty} y(t)e^{st}\mathrm{d}t$	
ln		logarithm, natural, base e	
log		logarithm, common, base 10	
$\log_a$		logarithm, base a	
m	A	slope	various
N		number, dimensionless	
n		number (of variables, or steps, or increments, etc.)	
$\mathcal{R}(z)$		real part of complex number z	
s		Laplace transform variable	
s		standard deviation of a random variable, estimated	
s^2		variance of a random variable, estimated	
$\overline{x}$		mean value of a random variable, x, estimated	
$\vec{x}$		vector of x	
$\vec{\vec{x}}$		tensor of x	
α	β,γ	angle	
γ		Euler's constant=0.5772	
Δ		difference ($\Delta x = x_2 - x_1$ or $x_1 - x_2$)	
Δ		difference operator, finite	
μ		mean value of a random variable	
σ		standard deviation of a random variable	
σ^2		variance of a random variable	
Φ	f	potential or potential function	various
Ψ		stream function	various

Subscript Symbols in Alphabetical Order

Letter Subscript	Reserve SPE Subscript	Subscript Definition
Greek and Numerical		
ε	E	strain
η		diffusivity
θ		angle, angular, or angular coordinate
λ	M	mobility
ρ		density
ϕ	f,ε	porosity
ϕ	f,ε	porosity data, derived from tool-description subscripts: see individual entries such as "amplitude log," "neutron log," etc.
0 (zero)	zr	formation 100% saturated with water (used in R_0 only)
1	p,pri	primary
1,2,3, etc.		location subscripts; usage is secondary to that for representing times or time periods
1,2,3, etc.		numerical subscripts (intended primarily to represent times or time periods; available secondarily as location subscripts or for other purposes)
1,2,3, etc.		times or time periods
½		half
2	s,sec	secondary
∞		conditions for infinite dimensions
English		
a	A	abandonment
a	A,α	acoustic
a		active, activity, or acting
a		altered
a	Ap	apparent (general)
a	A	atmosphere, atmospheric
aF		air/fuel
an	AN	annulus apparent (from log readings: use tool description subscripts)
anh		anhydrite
ani		anisotropic
ar		after royalty
at		after taxes
A	a	amplitude log
A		areal
b	B	band or oil band
b		bank or bank region
b	r,β	base
b		bubble
b	s,bp	bubblepoint (saturation)
b	B,t	bulk (usually with volume, V_b)
b	B	burned or burning
bE		burned in experimental tube run (usually with volume, V_{bE})

Letter Subscript	Reserve SPE Subscript	Subscript Definition
English		
bh	*w,*BH	bottomhole
bp		bubblepoint or saturation (usually with volume, V_{bp})
Br		before royalty
Bt	*B*	before taxes
B		turbulence (used with *F* only, F_B)
BT	bt	breakthrough
c	*C*	capillary (usually with capillary pressure, P_c)
c	cg	casing or casinghead
c		chemical
c	*C*	compressional wave
c	*C*	constant
c	*C*	contact (usually with contact angle, θ_c)
c		conversion (usually with conversion factor in Newton's laws of motion, g_c)
c	*C*	core
c	cr	critical
c	ec	electrochemical
cap		capture
cb	*CB*	cement bond log
cf		casing, flowing (usually with pressure)
cl	cla	clay
cn	cln	clean
cor		corrected
cp		compaction
cs		casing, static (usually with pressure)
C	calc	calculated
C	*c*	caliper log
C	*c*	coil
C		components(s)
C		convective
CB	*cb*	bond log, cement
CD	*cd*	compensated density log
CL	*cl*	chlorine log
CN	*cn*	compensated neutron log
CO		carbon monoxide
CO_2		carbon dioxide
C_1		methane
C_2		ethane
d		decay
d	*δ*	delay
d	*δ*	depleted region, depletion
d		dewpoint
d		differential separation
d		dip (usually with angle, α_d)
d	*D*	dispersed
d	*s,D*	displaced
d		drainage (usually with drainage radius, r_d)
dh	DH	downhole
dol		dolomite

Letter Subscript	Reserve SPE Subscript	Subscript Definition
English		
dy	dty	dirty (clayey, shaly)
D	*d*	density log
D		dimensionless quantity
D	*s,σ*	displacing or displacement (efficiency)
DI	*di*	dual induction log
*D*LL	*dℓℓ*(script *ll*)	dual laterolog
DM	dm	diplog, dipmeter
DR	dr	directional survey
DT	*dt*	differential temperature log
Db		displacement from burned portion of in-situ combustion pattern (usually with efficiency, E_{Db})
Dm		dimensionless quantity at condition *m*
Du		displacement from unburned portion of in-situ combustion pattern (usually with efficiency, E_{Du})
e	*o*	boundary conditions, external
e	*i*	cumulative influx (encroachment)
e	*E*	earth
e		effective (or equivalent)
e	*E*	electric, electrical
e	*E*	entry
e	*o*	external or outer boundary conditions
el	*eℓ* (script *el*)	electron
eq	EV	equivalent
ext		extrapolated
E	*e*	electrode
E	EM	empirical
E	est	estimated
E	EX	experimental
E_g		experimental value per mole of produced gas (usually with fuel consumption, m_{Eg})
EL	*el,ES*	electrolog, electrical log, electrical survey
EP	*ep*	electromagnetic pipe inspection log
f	*F*	finger or fingering
f	*F*	flash separation
f	*fl*	fluid
f	fm	formation (rock)
f	*R*	fraction or fractional
f	*F*	fracture, fractured, or fracturing
f	*F*	front, front region, or interface
d		future
f	fm	rock (formation)
F	*F*	fill-up
F	*f*	free (usually with gas or gas/oil ration quantities)
F		fuel (usually with fuel properties, such as ρ_F)
Ff		free fluid
Fi		free value, initial (usually with gas, G_{Fi})
F_P		cumulative produced free value (usually with gas G_{Fp})
G	*G*	gas

Letter Subscript	Reserve SPE Subscript	Subscript Definition
English		
ga		gas at atmospheric conditions
gb		gas at bubblepoint conditions
gD		gas, dimensionless
gr		grain
gyp		gypsum
G		geometrical
ls	lst	limestone
L	ℓ (script *l*)	lateral, lineal
L	ℓ (script *l*)	lateral (resistivity log)
L	ℓ (script *l*)	liquid or liquid phase
L_p		cumulative produced liquid (usually with condensate, G_{Lp})
LL	ℓℓ (script *ll*)	laterolog (add further tool configuration subscripts as needed)
LL*D*	ℓℓ (script *ll*)	deep laterolog
LL*S*	ℓℓ*s* (script *ll*)	shallow laterolog
LOG	log	log
L_p		liquid produced, cumulative (usually with condensate, G_{Lp})
LP	ℓ*p* (script *l*)	light phase
M		mass of fuel (usually with fuel concentration, C_m)
M		mud
ma		grain (matrix, solids)
ma		matrix [solids except (nonstructural) clay or shale]
max		maximum
mc		mudcake
Mf		mud filtrate
min		minimum
M	*z,m*	mixture
M		molal (usually with volume, V_M)
M	*m*	*M*th period or interval
M	*z,m*	slurry (“mixture”)
ML	*m*ℓ (script *l*)	contact log, microlog, minilog
*M*LL	*m*ℓℓ (script *ll*)	microlaterolog
n		net
n		normal
n	*r,R*	normalized (fractional or relative)
ne		noneffective
nw	*NW*	nonwetting
N	*n*	neutron
N	*n*	neutron log
N	*n*	normal (resistivity) log (add numerical spacing to subscript *N*; e.g., *N*16)
N_2		nitrogen
NA	*na*	neutron activation log
NE	*ne*	neutron log, epithermal
NF	*nf*	neutron log, fast
NL	*n*ℓ (script *l*)	neutron lifetime log, TDT
NM	*nm*	nuclear magnetism log
NT	*nt*	neutron log, thermal
o	*N*	oil (except when used with resistivity)

Letter Subscript	Reserve SPE Subscript	Subscript Definition
English		
ob		oil at bubblepoint conditions (usually with formation volume factor, B_{ob})
ob		oil from burned volume (usually with displacement ratio, δ_{ob})
oD		oil, dimensionless
og		oil in gas cap (usually with saturation, S_{og})
ou		oil from unburned volume (usually with displacement ratio, δ_{ou})
O_2		oxygen
p		particle (usually with diameter, d_p)
p	*P*	pore (usually with volume, V_p)
P		present
p	*P*	produced
p		produced, cumulative
p	*P*	production period (usually with time, t_p)
p		pseudo
$\overline{p}$		pressure, mean or average
pc		pseudocritical
pD		pore value, dimensionless (usually with volume, V_{pD})
pD		pseudodimensionless
pE		produced in experiment
pj		produced component *j* (usually with moles, n_{pj})
po		payout
pr		pseudoreduced
pSP		pseudo-SP
pv		present value
P		pattern (usually with pattern efficiency, E_p)
P		phase or phases
P	*p*	proximity log
r	*R*	radius, radial, or radial distance
r		reduced
r	*b,ρ*	reference
r	*R*	relative
r	*R*	residual
R		rate
R		ratio
R		recovery (usually with recovery efficiency, E_R)
R	*r*	reservoir
R		resistivity
R	*r,ρ*	resistivity log
Rb		reservoir rock, burned
Ru		reservoir rock, unburned
Re		Reynolds (used with Reynolds number only, N_{Re})
s	*d*	damage or damaged (includes “skin” conditions)
s		formation, surrounding
s		gas/oil ratio, solution
s	*S,σ*	segregation (usually with segregation rate, q_s)
s	*τ*	shear
s	*τ*	shear wave
s	*S*	skin (stimulation or damage)
s	*σ*	slip or slippage

Letter Subscript	Reserve SPE Subscript	Subscript Definition
English		
s	*σ*	solid (usually with volume or density)
s		solution (usually with gas/oil ratios)
s		spacing
s		specific (usually with *J* and *I*)
s	*S*	stabilization (usually with time)
s	*S*	steam or steam zone
s	*S*	stimulation (includes "skin" conditions)
s	*σ*	surface
s		surrounding formation
s	*S,σ*	swept or swept region
s	*σ*	system
sb		solution at bubblepoint conditions (usually with gas/oil ratio, R_{sb})
sc		scattered, scattering
sc	*σ*	standard conditions
sd	sa	sand
sE		solids in experiment
sh	sha	shale
si		solution, initial (usually with gas/oil ratio, R_{si})
sl	slt	silt
sp		separator conditions
sp		single payment
ss	sst	sandstone
st		stock-tank conditions
st	*s*	structural
sw		solution in water (usually with gas solubility in water, R_{sw})
S	SW	sidewall
S	*s,σ*	storage or storage capacity
$\overline{S}$	$\overline{s}, \overline{\rho}$	saturation, mean or average
SN	*sn*	neutron log, sidewall
SP	*sp*	self potential
SSP		spontaneous self potential
SV	*sv*	sonic, velocity, or acoustic log
SWN	*swn*	sidewall neutron log
t	*T*	gross (total)
t	*T*	total
t	*T*	treatment or treating
t	tr	true (electrical logging) (opposed to apparent)
t	tg	tubing or tubinghead
tD		time, dimensionless
tf		tubing flowing (usually with pressure)
ti		total initial in place in reservoir
ts		tubing, static (usually with pressure)
T	*h,θ*	temperature
T	*t,h*	temperature log
T	*t*	tool, sonde
T	*t*	transmissibility
TV	*tv*	televiewer log, borehole
u		unburned

Letter Subscript	Reserve SPE Subscript	Subscript Definition
English		
u	*U*	unit
u	*U*	unswept or unswept region
u	*U*	upper
ul	*a*	ultimate
v	*V*	vaporization, vapor, or vapor phase
v	*V*	velocity
V	*v*	vertical
V	*v*	volume or volumetric
Vb		volumetric or burned portion of in-situ combustion pattern (usually with efficiency, E_{Vb})
VD	*vd*	microseismogram log, signature log, variable density log
w	*W*	water
w		well conditions
w	*W*	wetting
wa		wellbore, apparent (usually with wellbore radius, r_{wa})
wb		water from burned volume (usually with displacement ratio, δ_{wb})
wD		water, dimensionless
wf		bottomhole, flowing (usually with pressure or time)
wf	*f*	well, flowing conditions (usually with time)
wF		water/fuel
wg		water in gas cap (usually with saturation, S_{wg})
wg		wet gas (usually with composition or content, C_{wg})
wgp		wet gas produced
wh	*th*	wellhead
wo		water/oil (usually with instantaneous producing water/oil ratio, F_{wo})
wop		water/oil, produced (cumulative) (usually with cumulative water/oil ratio, F_{wop})
ws		static bottomhole (usually with pressure or time)
ws	*s*	well, static, or shut-in conditions (usually with time)
W	*w*	weight
xo		flushed zone
Y		Young's modulus, refers to
z		conductive liquids in invaded zone
z		zone, conductive invaded

SI Metric Conversion Factors

The following conversion factors are taken from the SPE Metric Standard. The complete standard can be found at www.SPE.org/spe-site/spe/spe/papers/authors/Metric_Standard.pdf.

ALPHABETICAL LIST OF UNITS
(symbols of SI units given in parentheses)

To Convert From	To	Multiply By**	
abampere	ampere (A)	1.0*	E+01
abcoulomb	coulomb (C)	1.0*	E+01
abfarad	farad (F)	1.0*	E+09
abhenry	henry (H)	1.0*	E−09
abmho	Siemens (S)	1.0*	E+09
abohm	ohm (Ω)	1.0*	E−09
abvolt	volt (V)	1.0*	E−08
acre-foot (U.S. survey)(1)	meter^3 (m^3)	1.233 489	E+03
acre (U.S. survey)(1)	meter^2 (m^2)	4.046 873	E+03
ampere hour	coulomb (C)	3.6*	E+03
are	meter^2 (m^2)	1.0*	E+02
angstrom	meter (m)	1.0*	E−10
astronomical unit	meter (m)	1.495 979	E+11
atmosphere (standard)	pascal (Pa)	1.013 250*	E+05
atmosphere (technical=1 kgf/cm^2)	pascal (Pa)	9.806 650*	E+04
bar	pascal (Pa)	1.0*	E+05
barn	meter^2 (m^2)	1.0*	E−28
barrel (for petroleum, 42 gal)	meter^3 (m^3)	1.589873	E−01
board foot	meter^3 (m^3)	2.359 737	E−03
British thermal unit (International Table)(2)	joule (J)	1.055 056	E+03
British thermal unit (mean)	joule (J)	1.055 87	E+03
British thermal unit (thermochemical)	joule (J)	1.054 350	E+03
British thermal unit (39°F)	joule (J)	1.059 67	E+03
British thermal unit (59°F)	joule (J)	1.054 80	E+03
British thermal unit (60°F)	joule (J)	1.054 68	E+03
Btu (International Table)-ft/(hr-ft^2-°F) (thermal conductivity)	watt per meter Kelvin [W/(m-K)]	1.730 735	E+00
Btu (thermochemical)-ft/(hr-ft^2-°F) (thermal conductivity)	watt per meter Kelvin [W/(m-K)]	1.729 577	E+00
Btu (International Table)-in./(hr-ft^2-°F) (thermal conductivity)	watt per meter Kelvin [W/(m-K)]	1.442 279	E−01
Btu (thermochemical)-in./(hr-ft^2-°F) (thermal conductivity)	watt per meter Kelvin [W/(m-K)]	1.441 314	E−01
Btu (International Table)-in./(s-ft^2-°F) (thermal conductivity)	watt per meter Kelvin [W/(m-K)]	5.192 204	E+02

*An asterisk indicates that the conversion factor is exact using the numbers shown; all subsequent number are zeros.
**See footnote.
(1)Since 1893, the U.S. basis of length measurement has been derived from metric standards. In 1959, a small refinement was made in the definition of the yard to resolve discrepancies both in this country and abroad, which changed its length from 3600/3937 m to 0.9144 m exactly. This resulted in the new value being shorter by two parts in a million. At the same time, it was decided that any data in feet derived from and published as a result of geodetic surveys within the U.S. would remain with the old standard (1 ft=1200/3937 m) until further decision. This foot is named the U.S. survey foot. As a result, all U.S. land measurements in U.S. customary units will relate to the meter by the old standard. All the conversion factors in these tables for units referenced to this footnote are based on the U.S. survey foot, rather than the international foot. Conversion factors for the land measure given below may be determined from the following relationships:

1 league=3 miles (exactly)
1 rod=16½ ft (exactly)
1 chain=66 ft (exactly)
1 section=1 sq mile
1 township=36 sq miles

(2)This value was adopted in 1956. Some of the older International Tables use the value 1.055 04 E+03. The exact conversion factor is 1.055 055 852 62* E+03.

To Convert From	To	Multiply By**	
Btu (thermochemical)-in./(s-ft^2-°F) (thermal conductivity)	watt per meter Kelvin [W/(m-K)]	5.188 732	E+02
Btu (International Table)/hr	watt (W)	2.930 711	E−01
Btu (thermochemical)/hr	watt (W)	2.928 751	E−01
Btu (thermochemical)/min	watt (W)	1.757 250	E+01
Btu (thermochemical)/s	watt (W)	1.054 350	E+03
Btu (International Table)/ft^2	joule per meter^2 (J/m^2)	1.135 653	E+04
Btu (thermochemical)/ft^2	joule per meter^2 (J/m^2)	1.134 893	E+04
Btu (thermochemical)/(ft^2-hr)	watt per meter^2 (W/m^2)	3.152 481	E+00
Btu (thermochemical)/(ft^2-min)	watt per meter^2 (W/m^2)	1.891 489	E+02
Btu (thermochemical)/(ft^2-s)	watt per meter^2 (W/m^2)	1.134 893	E+04
Btu (thermochemical)/(in.^{2}-s)	watt per meter^2 (W/m^2)	1.634 246	E+06
Btu (International Table)/(hr-ft^2-°F) (thermal conductance)	watt per meter^2 kelvin [W/(m^2-K)]	5.678 263	E+00
Btu (thermochemical)/(hr-ft^2-°F) (thermal conductance)	watt per meter^2 kelvin [W/(m^2-K)]	5.674 466	E+00
Btu (International Table)/(s-ft^2-°F)	watt per meter^2 kelvin [W/(m^2-K)]	2.044 175	E+04
Btu (thermochemical)/(s-ft^2-°F)	watt per meter^2 kelvin [W/(m^2-K)]	2.042 808	E+04
Btu (International Table)/lbm	joule per kilogram (J/kg)	2.326*	E+03
Btu (thermochemical)/lbm	joule per kilogram (J/kg)	2.324 444	E+03
Btu (International Table)/(lbm-°F) (heat capacity)	joule per kilogram Kelvin [J/(kg-K)]	4.186 8*	E+03
Btu (thermochemical)/(lbm-°F) (heat capacity)	joule per kilogram Kelvin [J/(kg-K)]	4.184 000	E+03
bushel (U.S.)	meter^3 (m^3)	3.523 907	E−02
caliber (inch)	meter (m)	2.54*	E−02
calorie (International Table)	joule (J)	4.186 8*	E+00
calorie (mean)	joule (J)	4.190 02	E+00
calorie (thermochemical)	joule (J)	4.184*	E+00
calorie (15°C)	joule (J)	4.185 80	E+00
calorie (20°C)	joule (J)	4.181 90	E+00
calorie (kilogram, International Table)	joule (J)	4.186 8*	E+03
calorie (kilogram, mean)	joule (J)	4.190 02	E+03
calorie (kilogram, thermochemical)	joule (J)	4.185*	E+03
cal (thermochemical)/cm^2	joule per meter^2 (J/m^2)	4.184*	E+04
cal (International Table)/g	joule per kilogram (J/kg)	4.184*	E+03
cal (International Table)/(g-°C)	joule per kilogram kelvin [J/(kg-K)]	4.186 8*	E+03
cal (thermochemical)/(g-°C)	joule per kilogram Kelvin [J/(kg-K)]	4.184*	E+03
cal (thermochemical)/min	watt (W)	6.973 333	E−02
cal (thermochemical)/s	watt (W)	4.184*	E+04
cal (thermochemical)/(cm^2-min)	watt per meter^2 (W/m^2)	6.973 333	E+02
cal (thermochemical)/(cm^2-s)	watt per meter^2 (W/m^2)	4.184*	E+04
cal (thermochemical)/(s-°C)	watt per meter kelvin [W/(m-K)]	4.184*	E+02
capture unit (c.u.=10^{-3}cm^{-1})	per meter (m^{-1})	1.0*	E−01
carat (metric)	kilogram (kg)	2.0*	E−04
centimeter of mercury (0°C)	pascal (Pa)	1.333 22	E+03
centimeter of water (4°C)	pascal (Pa)	9.806 38	E+01
centipoises	pascal second (Pa·s)	1.0*	E−03

To Convert From	To	Multiply By**	
centistrokes	meter^2 per second (m^2/s)	1.0*	E−06
circular mil	meter^2 (m^2)	5.067 075	E−10
cio	kelvin meter^2 per watt [K-m^2/W]	2.003 712	E−01
cup	meter^3 (m^3)	2.365 882	E−04
curie	becquerel (Bq)	3.7*	E+10
cycle per second	hertz (Hz)	1.0*	E+00
day (mean solar)	second (s)	8.640 000	E+04
day (sidereal)	second (s)	8.616 409	E+04
degree (angle)	radian (rad)	1.745 329	E−02
degree Celsius	kelvin (K)	$T_K = T_{°C} + 2.73.15$	
degree centigrade (see degree Celsius)			
degree Fahrenheit	degree Celsius	$T_{°C} = (T_{°F} – 32)/1.8$	
degree Fahrenheit	kelvin (K)	$T_K = (T_{°F} + 459.67)/1.8$	
degree Rankine	Kelvin (K)	$T_K = T_{°F}/1.8$	
°F-hr-ft^2/Btu (International Table) (thermal resistance)	kelvin meter^2 per watt [(K-m^2)/W]	1.781 102	E−01
°F-hr-ft^2/Btu (thermochemical) (thermal resistance)	kelvin meter^2 per watt [(K-m^2)/W]	1.762 250	E−01
Denier	kilogram per meter (kg/m)	1.111 111	E−07
Dyne	newton (N)	1.0*	E−05
dyne-cm	newton meter (N·m)	1.0*	E−07
dyne/cm^2	pascal (Pa)	1.0*	E−01
electronvolt	joule (J)	1.602 19	E−19
EMU of capacitance	farad (F)	1.0*	E+09
EMU of current	ampere (A)	1.0*	E+01
EMU of electric potential	volt (V)	1.0*	E−08
EMU of inductance	henry (H)	1.0*	E−09
EMU of resistance	ohm (Ω)	1.0*	E−09
ESU of capacitance	farad (F)	1.112 650	E−12
ESU of current	ampere (A)	3.335 6	E−10
ESU of electric potential	volt (V)	2.997 9	E+02
ESU of inductance	henry (H)	8.987 554	E+11
ESU of resistance	ohm (Ω)	8.987 554	E+11
Erg	joule (J)	1.0*	E−07
erg/cm^2-s	watt per meter^2 (W/m^2)	1.0*	E−03
erg/s	watt (W)	1.0*	E−07
faraday (based on carbon-12)	coulomb (C)	9.648 70	E+04
faraday (chemical)	coulomb (C)	9.649 57	E+04
faraday (physical)	coulomb (C)	9.652 19	E+04
fathom	meter (m)	1.828 8	E+00
fermi (femtometer)	meter (m)	1.0*	E−15
fluid ounce (U.S.)	meter^3 (m)^3	2.957 353	E−05
foot	meter (m)	3.048*	E−01
foot (U.S. survey)[(1)]	meter (m)	3.048 006	E−01
foot of water (39.2°F)	pascal (Pa)	2.988 98	E+03
sq ft	meter^2 (m^2)	9.290 304*	E−02
ft^2/hr (thermal diffusivity)	meter^2 per second (m^2/s)	2.580 640*	E−05
ft^2/s	meter^2 per second (m^2/s)	9.290 304*	E−02
cu ft (volume; section modulus)	meter^3 (m^3)	2.831 685	E−02
ft^3/min	meter^3 per second (m^3/s)	4.719 474	E−04

To Convert From	To	Multiply By**	
ft^3/s	meter³ per second (m^3/s)	2.831 685	E−02
ft^4 (moment of section)[4]	meter⁴ (m^4)	8.630 975	E−03
ft/hr	meter per second (m/s)	8.466 667	E−05
ft/min	meter per second (m/s)	5.080*	E−03
ft/s	meter per second (m/s)	3.048*	E−01
ft/s^2	meter per second² (ms/s^2)	3.048*	E−01
footcandle	lux (lx)	1.076 391	E+01
footlambert	candela per meter² (cd/m^2)	3.426 259	E+00
ft-lbf	ioule (J)	1.355 818	E+00
ft-lbf/hr	watt (W)	3.766 161	E−04
ft-lbf/min	watt (W)	2.259 697	E−02
ft-lbf/s	watt (W)	1.355 818	E+00
ft-poundal	joule (J)	4.214 011	E−02
free fall, standard (g)	meter per second² (m/s^2)	9.806 650*	E+00
cm/s^2	meter per second² (m/s^2)	1.0*	E−02
gallon (Canadian liquid)	meter³ (m^3)	4.546 090	E−03
gallon (U.K. liquid)	meter³ (m^3)	4.546 092	E−03
gallon (U.S. dry)	meter³ (m^3)	4.404 884	E−03
gallon (U.S. liquid)	meter³ (m^3)	3.785 412	E−03
gal (U.S. liquid)/day	meter³ per second (m^3/s)	4.381 264	E−08
gal (U.S. liquid)/min	meter³ per second (m^3/s)	6.309 020	E−05
(SFC, specific fuel consumption)	meter³ per joule (m^3/J)	1.410 089	E−09
gamma (magnetic field strength)	ampere per meter (A/m)	7.957 747	E−04
gamma (magnetic flux density)	tesla (T)	1.0*	E−09
gauss	tesla (T)	1.0*	E−04
gilbert	ampere (A)	7.957 747	E−01
gill (U.K.)	meter³ (m^3)	1.420 654	E−04
gill (U.S.)	meter³ (m^3)	1.182 941	E−04
grad	degree (angular)	9.0*	E−01
grad	radian (rad)	1.570 796	E−02
grain (1/7000 lbm avoirdupois)	kilogram (kg)	6.479 891*	E−05
grain (lbm avoirdupois/7000)/gal (U.S. liquid)	kilogram per meter³ (kg/m^3)	1.711 806	E−02
gram	kilogram (kg)	1.0*	E−03
g/cm^3	kilogram per meter³ (kg/m^3)	1.0*	E+03
$gram-force/cm^2$	pascal (Pa)	9.806 650*	E+01
hectare	meter² (m^2)	1.0*	E+04
horsepower (550 ft-lbf/s)	watt (W)	7.456999	E+02
horsepower (boiler)	watt (W)	9.809 50	E+03
horsepower (electric)	watt (W)	7.460*	E+02
horsepower (metric)	watt (W)	7.354 99	E+02
horsepower (U.K.)	watt (W)	7.4570	E+02
hour (mean solar)	second (s)	3.600 000	E+03
hour (sidereal)	second (s)	3.590 170	E+03
hundredweight (long)	kilogram (kg)	5.080 235	E+01
hundredweight (short)	kilogram (kg)	4.535 924	E+01
inch	meter (m)	2.54*	E−02
inch of mercury (32°F)	pascal (Pa)	3.386 38	E+03
inch of mercury (60°F)	pascal (Pa)	3.376 85	E+03
inch of water (39.2°F)	pascal (Pa)	2.490 82	E+02

[3] The exact conversion factor is 1.638 706 4*E−05.

To Convert From	To	Multiply By**	
inch of water (60°F)	pascal (Pa)	2.488 4	E+02
sq in.	meter^2 (m^2)	6.451 6*	E−04
cu in. (volume; section modulus)(3)	meter^3 (m^3)	1.638 706	E−05
in.^{3}/min	meter^3 per second (m^3/s)	2.731 177	E−07
in.^{4} (moment of section)(4)	meter^4 (m^4)	4.162 314	E−07
in./s	meter per second (m/s)	2.54*	E−02
in./s^2	meter per second^2 (m/s^2)	2.54*	E−02
kayser	1 per meter (1/m)	1.0*	E+02
Kelvin	degree Celsius	$T_{°C}=T_K–273.15$	
kilocalorie (International Table)	joule (J)	4.186 8*	E+03
kilocalorie (mean)	joule (J)	4.190 02	E+03
kilocalorie (thermochemical)	joule (J)	4.184*	E+03
kilocalorie (thermochemical)/min	watt (W)	6.973 333	E+01
kilocalorie (thermochemical)/s	watt (W)	4.184*	E+03
kilogram-force (kgf)	newton (N)	9.806 65*	E+00
kgf·m	newton meter (N·m)	9.806 65*	E+00
kgf·s^2/m (mass)	kilogram (kg)	9.806 65*	E+00
kgf/cm^2	pascal (Pa)	9.806 65*	E+04
kg/m^2	pascal (Pa)	9.806 65*	E+00
kgf/mm^2	pascal (Pa)	9.806 65*	E+06
km/h	meter per second (m/s)	2.777 778	E−01
kilopond	newton (N)	9.806 65*	E+00
kilowatt-hour (kW-hr)	joule (J)	3.6*	E+06
kip (1000 lbf)	newton (N)	4.448 222	E+03
kip/in.^{2} (ksi)	pascal (Pa)	6.894 757	E+06
knot (international)	meter per second (m/s)	5.144 444	E−01
lambert	candela per meter^2 (cd/m^2)	1/π*	E+04
lambert	candela per meter^2 (cd/m^2)	3.183 099	E+03
langley	joule per meter^2 (J/m^2)	4.184*	E+04
league	meter (m)	(see Footnote 1)	
light year	meter (m)	9.460 55	E+15
liter(5)	meter^3 (m^3)	1.0*	E−03
Maxwell	weber (Wb)	1.0*	E−08
mho	siemens (S)	1.0*	E+00
microinch	meter (m)	2.54*	E−08
microsecond/foot	microsecond (μs/m)	3.280 840	E+00
micron	meter (m)	1.0*	E−06
mil	meter (m)	2.54*	E−05
mile (international)	meter (m)	1.609 344*	E+03
mile (statute)	meter (m)	1.609 3	E+03
mile (U.S. survey)(1)	meter (m)	1.609 347	E+03
mile (international nautical)	meter (m)	1.852*	E+03
mile (U.K. nautical)	meter (m)	1.853 184*	E+03
mile (U.S. nautical)	meter (m)	1.852*	E+03
sq mile (international)	meter^2 (m^2)	2.589 988	E+06
sq mile (U.S survey)	meter^2 (m^2)	2.589 998	E+06
mile/hr (international)	meter per second (m/s)	4.470 4*	E−01
mile/hr (international)	kilometer per hour (km/h)	1.609 344*	E+00
mile/min (international)	meter per second (m/s)	2.682 24*	E+01

(4) This sometimes is called the moment of inertia of a plane section about a specified axis.
(5) In 1964, the General Conference on Weights and Measures adopted the name “liter” as a special name for the cubic decimeter. Prior to this decision, the liter differed slightly (previous value: 1.000 028 dm^3), and in expression of precision volume measurement, this fact must be kept in mind.

To Convert From	To	Multiply By**	
mile/s (international)	meter per second (m/s)	1.609 344*	E+03
millibar	pascal (Pa)	1.0*	E+02
millimeter of mercury (0°C)	pascal (Pa)	1.333 22	E+02
minute (angle)	radian (rad)	2.908 882	E−04
minute (mean solar)	second (s)	6.0*	E+01
minute (sidereal)	second (s)	5.983 617	E+01
month (mean calendar)	second (s)	2.628 000	E+06
oersted	ampere per meter (A/m)	7.957 747	E+01
ohm centimeter	ohm meter (Ω·m)	1.0*	E−02
ohm circular-mil per ft	ohm millimeter^2 per meter [(Ω·mm^2/m]	1.66 426	E−03
ounce (avoirdupois)	kilogram (kg)	2.834 952	E−02
ounce (troy or apothecary)	kilogram (kg)	3.110 348	E−02
ounce (U.K. fluid)	meter^3 (m^3)	2.841 307	E−05
ounce (U.S. fluid)	meter^3 (m^3)	2.957 353	E−05
ounce-force	newton (N)	2.780 139	E−01
ozf-in.	newton meter (N·m)	7.061 552	E−03
oz (avoirdupois)/gal (U.K. liquid)	kilogram per meter^3 (kg/m^3)	6.236 021	E+00
oz (avoirdupois)/gal (U.S. liquid)	kilogram per meter^3 (kg/m^3)	6.236 021	E+00
oz (avoirdupois)/in.^{3}	kilogram per meter^3 (kg/m^3)	1.729 994	E+03
oz (avoirdupois)/ft^2	kilogram per meter^2 (kg/m^2)	3.051 517	E−01
oz (avoirdupois)/yd^2	kilogram per meter^2 (kg/m^2)	3.390 575	E−02
parsec	meter (m)	3.085 678	E+16
pack (U.S.)	meter^3 (m^3)	8.809 768	E−03
pennyweight	kilogram (kg)	1.555 174	E−03
perm (°C)(6)	kilogram per pascal second meter^2 [kg/(Pa·s·m^2)]	5.721 35	E−11
perm (23°C)(6)	kilogram per pascal second meter^2 [kg/(Pa·s·m^2)]	5.745 25	E−11
perm-in. (0°C)(7)	kilogram per pascal second meter [kg/(Pa·s·m)]	1.453 22	E−12
perm-in. (23°C)(7)	kilogram per pascal second meter [km/(Pa·s·m)]	1.459 29	E−12
phot	lumen per meter^2 (lm/m^2)	1.0*	E+04
pica (printer's)	meter (m)	4.217 518	E−03
pint (U.S. dry)	meter^3 (m^3)	5.506 105	E−04
pint (U.S. liquid)	meter^3 (m^3)	4.731 765	E−04
point (printer's)	meter (m)	3.514 598*	E−04
poise (absolute viscosity)	pascal second (Pa·s)	1.0*	E−01
pound (lbm avoirdupois)(8)	kilogram (kg)	4.535 924	E−01
pound (troy or apothecary)	kilogram (kg)	3.732 417	E−01

(6) Not the same as reservoir "perm."
(7) Not the same dimensions as "millidarcy-foot."
(8) The exact conversion factor is 4.535 923 7*E−01.

To Convert From	To	Multiply By**	
lbm-ft^2 (moment of inertia)	kilogram $meter^2$ ($kg{\cdot}m^2$)	4.214 011	E−02
lbm-in^2 (moment of inertia)	kilogram $meter^2$ ($kg{\cdot}m^2$)	2.926 397	E−04
lbm/ft-hr	pascal second (Pa·s)	4.133 789	E−04
lbm/ft-s	pascal second (Pa·s)	1.488 164	E+00
lbm/ft^2	kilogram per $meter^2$ (kg/m^2)	4.882 428	E+00
lbm/ft^3	kilogram per $meter^3$ (kg/m^3)	1.601 846	E+01
lbm/gal (U.K. liquid)	kilogram per $meter^3$ (kg/m^3)	9.977 633	E+01
lbm/gal (U.S. liquid)	kilogram per $meter^3$ (kg/m^3)	1.198 264	E+02
lbm/hr	kilogram per second (kg/s)	1.259 979	E−04
lbm/hr lbm/(hp-hr) (SFC, specific fuel consumption)	kilogram per joule (kg/J)	1.689 659	E−07
lbm/$in.^3$	kilogram per $meter^3$ (kg/m^3)	2.767 990	E+04
lbm/min	kilogram per second (kg/s)	7.559 873	E−03
lbm/s	kilogram per second (kg/s)	4.535 924	E−01
lbm/yd^3	kilogram per $meter^3$ (kg/m^3)	5.932 764	E−01
poundal	newton (N)	1.382 550	E−01
poundal/ft^2	pascal (Pa)	1.488 164	E+00
poundal-s/ft^2	pascal second (Pa·s)	1.488 164	E+00
pound-force (lbf)(9)	newton (N)	4.448 222	E+00
lbf-ft(10)	newton meter (N·m)	1.355 818	E+00
lbf-ft(11)	newton meter per meter [(N·m)/m)]	5.337 866	E+01
lbf-in.(11)	newton meter (N·m)	1.129 848	E−01
lbf-in./in.(11)	newton meter per meter [(N·m)/m)]	4.448 222	E+00
lbf-s/ft^2	pascal second (Pa·s)	4.788 026	E+01
lbf/ft	newton per meter (N/m)	1.459 390	E+01
lbf/ft^2	pascal (Pa)	4.788 026	E+01
lbf/in.	newton per meter (N/m)	1.751 268	E+02
lbf/$in.^2$ (psi)	pascal (Pa)	6.894 757	E+03
lbf/lbm (thrust/weight [mass] ratio)	newton per kilogram (N/kg)	9.806 650	E+00
quart (U.S. dry)	$meter^3$ (m^3)	1.101 221	E−03
quart (U.S. liquid)	$meter^3$ (m^3)	9.463 529	E−04
rad (radiation dose absorbed)	gray (Gy)	1.0*	E−02
rhe	1 per pascal second [1/(Pa·s)]	1.0*	E+01
rod	meter (m)	(see Footnote 1)	
roentgen	coulomb per kilogram (C/kg)	2.58	E−04
second (angle)	radian (rad)	4.848 137	E−06
second (sidereal)	second (s)	9.972 696	E−01

(9)The exact conversion factor is 4.448 615 260 5*E+00.
(10)Torque unit; see text discussion of "Torque and Bending Moment."
(11)Torque divided by length; see text discussion of "Torque and Bending Moment."

To Convert From	To	Multiply By**	
section	meter^2 (m^2)	(see Footnote 1)	
shake	second(s)	1.000 000*	E−08
slug/(ft-s)	pascal second (Pa·s)	4.788 026	E+01
slug/ft^3	kilogram per meter^3 (kg/m^3)	5.153 788	E+02
statampere	ampere (A)	3.335 640	E−10
statcoulomb	coulomb (C)	3.335 640	E−10
statfarad	farad (F)	1.112 650	E−12
stathenry	henry (H)	8.987 554	E+11
statmho	seimens (S)	1.112 650	E−12
statohm	ohm (Ω)	8.987 554	E+11
statvolt	volt (V)	2.997 925	E+02
stere	meter^3 (m^3)	1.0*	E+00
stilb	candela per meter^2 (cd/m^2)	1.0*	E+04
strokes (kinematic viscosity)	meter^2 per second (m^2/s)	1.0*	E−04
tablespoon	meter^3 (m^3)	1.478 676	E−05
teaspoon	meter^3 (m^3)	4.928 922	E−06
tex	kilogram per meter (kg/m)	1.0*	E−06
therm	joule (J)	1.055 056	E+08
ton (assay)	kilogram (kg)	2.916 667	E−02
ton (long, 2.240 lbm)	kilogram (kg)	1.016 047	E+03
ton (metric)	kilogram (kg)	1.0*	E+03
ton (nuclear equivalent of TNT)	joule (J)	4.184	E+09[12]
ton (refrigeration)	watt (W)	3.516 800	E+03
ton (register)	meter^3(m^3)	2.831 685	E+00
ton (short, 2,000 lbm)	kilogram (kg)	9.071 847	E+02
ton (long)/yd^3	kilogram per meter^3 (kg/m^3)	1.328 939	E+03
ton (short)/hr	kilogram per second (kg/s)	2.519 958	E−01
ton-force (2,000 lbf)	newton (N)	8.896 444	E+03
tonne	kilogram (kg)	1.0	E+03
torr (mm Hg, 0°C)	pascal (Pa)	1.333 22	E+02
township	meter^2 (m^2)	(see Footnote 1)	
unit pole	weber (Wb)	1.256 637	E−07
watthour (W-hr)	joule (J)	3.60*	E+03
W·s	joule (J)	1.0*	E+00
W/cm^2	watt per meter^2 (W/m^2)	1.0*	E+04
W/in.^{2}	watt per meter^2 (W/m^2)	1.550 003	E+03
yard	meter (m)	9.144	E−01
yd^2	meter^2 (m^2)	8.361 274	E−01
yd^3	meter^3 (m^3)	7.645 549	E−01
yd^3/min	meter^3 per second (m^3/s)	1.274 258	E−02
year (calendar)	second (s)	3.153 600	E+07
year (sidereal)	second (s)	3.155 815	E+07
year (tropical)	second (s)	3.155 693	E+07

(12)Defined (not measured) value.

CONVERSION FACTORS FOR THE VARA*

Location	Value of Vara in Inches	Conversion Factor, Varas to Meters	
Argentina, Paraguay	34.12	8.666	E−01
Cadiz, Chile, Peru	33.37	8.476	E−01
California, except San Francisco	33.3720	8.476 49	E−01
San Francisco	33.0	8.38	E−01
Central America	33.87	8.603	E−01
Colombia	31.5	8.00	E−01
Honduras	33.0	8.38	E−01
Mexico		8.380	E−01
Portugal, Brazil	43.0	1.09	E+00
Spain Cuba, Venezuela, Philippine Islands	33.38**	8.479	E−01
Texas,			
26 January 1801 to 27 January 1838	32.8748	8.350 20	E−01
27 January 1838 to 17 June 1919, for surveys of state land made for land office	33 1/3	8.466 667	E−01
27 January 1838 to 17 June 1919, on private surveys (unless change to 33 1/3 by custom arising to dignity of law and overcoming former law)	32.8748	8.350 20	E−01
17 June 1919 to present	33 1/3	8.466 667	E−01

*Per P.G. McElwee (*The Texas Vara*; available from the General Land Office, State of Texas, Austin, 30 April 1940) it is evident that accurate defined lengths of the vara vary significantly, according to historical data and locality used. For work requiring accurate conversions, the user should check closely into the date and location of the surveys involved, with due regard to what local practice may have been at that time and place.

**This value quoted from *Webster's New International Dictionary*.

"MEMORY JOGGER"—METRIC UNITS

Customary Unit	"Ballpark" Metric Values (Do *Not* Use as Conversion Factors)	
acre	4000	square meters
	0.4	hectare
barrel	0.16	cubic meter
British thermal unit	1000	joules
British thermal unit per pound-mass	2300	joules per kilogram
	2.3	kilojoules per kilogram
calorie	4	joules
centipoise	1*	millipascal-second
centistokes	1*	square millimeter per second
darcy	1	square micrometer
degree Fahrenheit (temperature *difference*)	0.5	Kelvin
dyne per centimeter	1*	millinewton per meter
foot	30	centimeters
	0.3	meter
cubic foot (cu ft)	0.03	cubic meter
cubic foot per pound-mass (ft^3/lbm)	0.06	cubic meter per kilogram
square foot (sq ft)	0.1	square meter
foot per minute	0.3	meter per minute
	5	millimeters per second
foot-pound-force	1.4	joules
foot-pound-force per minute	0.02	watt
foot-pound-force per second	1.4	watts
horsepower	750	watts (¾ kilowatt)
horsepower, boiler	10	kilowatts
inch	2.5	centimeters
kilowatt-hour	3.6*	megajoules
mile	1.6	kilometers
ounce (avoirdupois)	28	grams
ounce (fluid)	30	cubic centimeters
pound-force	4.5	newtons
pound-force per square inch (pressure, psi)	7	kilopascals
pound-mass	0.5	kilogram
pound-mass per cubic foot	16	kilograms per cubic meter
	260	hectares
section	2.6	million square meters
	2.6	square kilometers
ton, long (2240 pounds-mass)	1000	kilograms
ton, metric (tonne)	1000*	kilograms
ton, short	900	kilograms

*Exact equivalents

NOMENCLATURE FOR TABLES 1 AND 2 (see pages 153–170)

Unit Symbol	Name	Quantity	Type of Unit
A	ampere	electric current	base SI unit
a	annum (year)	time	allowable (not official SI) unit
Bq	becquerel	activity (of radionuclides)	derived SI unit =1/s
bar	bar	pressure	allowable (not official SI) unit,=10^3 Pa
C	coulomb	quantity of electricity	derived SI unit, =1 A·s
cd	candela	luminous intensity	base SI unit
°C	degree Celsius	temperature	derived SI unit =1.0 K
°	degree	plane angle	allowable (not official SI) unit
d	day	time	allowable (not official SI) unit, =24 hours
F	farad	electric capacitance	derived SI unit, =1 A·s/V
G_y	gray	absorbed dose	derived SI unit, =J/kg
g	gram	mass	allowable (not official SI) unit, =10^{-3} kg
H	henry	inductance	derived SI unit, =1 V·s/A
h	hour	time	allowable (not official SI) unit, =3.6×10^3 s
Hz	hertz	frequency	derived SI unit, =1 cycle/s
ha	hectare	area	allowable (not official SI) unit, =10^4 m^2
J	joule	work, energy	derived SI unit, =1 N·m
K	kelvin	temperature	base SI unit
kg	kilogram	mass	base SI unit
kn	knot	velocity	allowable (not official SI) unit, =$5.144\ 444\times10^{-1}$m/s =1.852 km/h
L	liter	volume	allowable (not official SI) unit, =1 dm^3
lm	lumen	luminous flux	derived SI unit, =1 cd·sr
lx	lux	illuminance	derived SI unit, =1 lm/m^2
m	meter	length	base SI unit
min	minute	time	allowable (not official SI) unit
'	minute	plane angle	allowable cartography (not official SI) unit
N	newton	force	derived SI unit, =1 kg·m/s^2
naut. mile	U.S. nautical mile	length	allowable (not official SI) unit, =1.852×10^3 m
Ω	ohm	electric resistance	derived SI unit, =1 V/A
Pa	pascal	pressure	derived SI unit, =1 N/m^2
rad	radian	plane angle	supplementary SI unit
S	siemens	electrical conductance	derived SI unit, =1 A/V
s	second	time	base SI unit
"	second	plane angle	allowable cartography (not official SI) unit
sr	steradian	solid angle	supplementary SI unit
T	tesla	magnetic flux density	derived SI unit, =1 Wb/m^2
t	tonne	mass	allowable (not official SI) unit, =10^3 kg =1 Mg
V	volt	electric potential	derived SI unit, =1 W/A
W	watt	power	derived SI unit, =1 J/s
Wb	weber	magnetic flux	derived SI unit, =1 V·s

TABLE 1—TABLES OF RECOMMENDED SI UNITS

Quantity and SI Unit		Customary Unit	Metric Unit: SPE Preferred	Metric Unit: Other Allowable	Conversion Factor:* Multiply Customary Unit by Factor To Get Metric Unit	
		SPACE,** TIME				
Length	m	naut mile	km		1.852*	E+00
		mile	km		1.609 344*	E+00
		chain	m		2.011 68*	E+01
		link	m		2.011 68*	E−01
		fathom	m		1.828 8*	E+00
		m	m		1.0*	E+00
		yd	m		9.144*	E−01
		ft	m		3.048*	E−01
				cm	3.048*	E+01
		in.	mm		2.54*	E+01
				cm	2.54*	E+00
		cm	mm		1.0*	E+01
				cm	1.0*	E+00
		mm	mm		1.0	E+00
		mil	μm		2.54*	E+01
		micron (μ)	μm		1.0*	E+00
Length/length	m/m	ft/mi	m/km		1.893 939	E−01
Length/volume	m/m^3	ft/U.S. gal	m/m^3		8.051 964	E+01
		ft/ft^3	m/m^3		1.076 391	E+01
		ft/bbl	m/m^3		1.917 134	E+00
Length/temperature	m/K	see "Temperature, Pressure, Vacuum"				
Area	m^2	sq mile	km^2		2.589 988	E+00
		section	km^2		2.589 988	E+00
				ha	2.589 988	E+02
		acre	m^2		4.046 856	E+03
				ha	4.046 856	E−01
		ha	m^2		1.0*	E+04
		sq yd	m^2		8.361 274	E−01
		sq ft	m^2		9.290 304*	E−02
				cm^2	9.290 304*	E+02
		sq in.	mm^2		6.451 6*	E+02
				cm^2	6.451 6*	E+00
		cm^2	mm^2		1.0*	E+02
				cm^2	1.0*	E+00
		mm^2	mm^2		1.0*	E+00
Area/volume	m^2/m^3	ft^2	m^2/cm^3		5.699 291	E−03
Area/mass	m^2/kg	cm	m^2/kg		1.0*	E−01
			m^2/g		1.0*	E−04

*An asterisk indicates that the conversion factor is exact using the numbers shown; all subsequent number are zeros.

**Conversion factors for length, area, and volume (and related quantities) in Table 1 are based on the international foot. See Footnote 1 in the Alphabetical List of Units.

TABLE 1—TABLES OF RECOMMENDED SI UNITS (continued)

Quantity and SI Unit		Customary Unit	Metric Unit: SPE Preferred	Metric Unit: Other Allowable	Conversion Factor:* Multiply Customary Unit by Factor To Get Metric Unit	
			SPACE,** TIME			
Volume, capacity	m^3	cubem	km^3		4.168 182	E+00(1)
		acre-ft	m^3		1.233 489	E+03
				ha·m	1.233 489	E−01
		m^3	m^3		1.0*	E+00
		cu yd	m^3		7.645 549	E−01
		bbl (42 U.S. gal)	m^3		1.589 873	E−01
		cu ft	m^3		2.831 685	E−02
			dm^3	L	2.831 685	E+01
		U.K. gal	m^3		4.546 092	E−03
			dm^3	L	4.546 092	E+00
		U.S. gal	m^3		3.785 412	E−03
			dm^3	L	3.785 412	E+00
		liter	dm^3	L	1.0*	E+00
		U.K. qt	dm^3	L	1.136 523	E+00
		U.S. qt	dm^3	L	9.463 529	E−01
		U.S. pt	dm^3	L	4.731 765	E−01
Volume, capacity	m^3	U.K. fl oz	cm^3		2.841 308	E+01
		U.S. fl oz	cm^3		2.957 353	E+01
		cu in.	cm^3		1.638 706	E+01
		mL	cm^3		1.0*	E+00
Volume/length (linear displacement)	m^3/m	bbl/in.	m^3/m		6.259 342	E+00
		bbl/ft	m^3/m		5.216 119	E−01
		ft^3/ft	m^3/m		9.290 304*	E−02
		U.S. gal/ft	m^3/m		1.241 933	E−02
			dm^3/m	L/m	1.241 933	E+01
Volume/mass	m^3/kg	see "Density, Specific Volume, Concentration, Dosage"				
Plane angle	rad	rad	rad		1.0*	E+00
		deg (°)	rad		1.745 329	E−02(2)
				°	1.0*	E+00
		min (')	rad		2.908 882	E−04(2)
				'	1.0*	E+00
		sec (")	rad		4.848 137	E−06(2)
				"	1.0*	E+00
Solid angle	sr	sr	sr		1.0*	E+00
Time	s	million years (MY)	Ma		1.0*	E+00(4)
		yr	a		1.0*	E+00
		wk	d		7.0*	E+00
		d	d		1.0*	E+00
		hr	h		1.0*	E+00
				min	6.0*	E+01
		min	s		6.0*	E+01
				h	1.666 667	E−02
				min	1.0*	E+00
		s	s		1.0*	E+00
		millimicrosecond	ns		1.0*	E+00

TABLE 1—TABLES OF RECOMMENDED SI UNITS (continued)

Quantity and SI Unit		Customary Unit	Metric Unit: SPE Preferred	Metric Unit: Other Allowable	Conversion Factor:* Multiply Customary Unit by Factor To Get Metric Unit	
MASS, AMOUNT OF SUBSTANCE						
Mass	kg	U.K. ton (long ton)	Mg	t	1.016 047	E+00
		U.S. ton (short ton)	Mg	t	9.071 847	E−01
		U.K. ton	kg		5.080 235	E+01
		U.S. cwt	kg		4.535 924	E+01
		kg	kg		1.0*	E+00
		lbm	kg		4.535 924	E−01
		oz (troy)	g		3.110 348	E+01
		oz (av)	g		2.834 952	E+01
		g	g		1.0*	E+00
		grain	mg		6.479 891	E+01
		mg	mg		1.0*	E+00
		g	g		1.0*	E+00
Mass/length	kg/m	see “Mechanics”				
Mass/area	kg/m^2	see “Mechanics”				
Mass/volume	kg/m^3	see “Density, Specific Volume, Concentration, Dosage”				
Mass/mass	kg/kg	see “Density, Specific Volume, Concentration, Dosage”				
Amount of substance	mol	lbm mol	kmol		4.535 924	E−01
		g mol	kmol		1.0*	E−03
		std m^3 (0°C, 1 atm)	kmol		4.461 58	E−02 (3, 13)
		std m^3 (15°C, 1 atm)	kmol		4.229 32	E−02 (3, 13)
		std ft^3 (60°F, 1 atm)	kmol		1.195 3	E−03 (3, 13)
CALORIFIC VALUE, HEAT, ENTROPY, HEAT CAPACITY						
Calorific value (mass basis)	J/kg	Btu/lbm	MJ/kg		2.326	E−03
			kJ/kg	J/g	2.326	E+00
				(kW·h)/kg	6.461 112	E−04
		cal/g	kJ/kg	J/g	4.184*	E+00
		cal/lbm	J/kg		9.224 141	E+00
Calorific value (mole basis)	J/mol	kcal/g mol	kJ/kmol		4.184*	C+03 (13)
		Btu/lbm mol	MJ/kmol		2.326	E−03 (13)
			kJ/kmol		2.326	E+00 (13)

TABLE 1—TABLES OF RECOMMENDED SI UNITS (continued)

Quantity and SI Unit		Customary Unit	Metric Unit: SPE Preferred	Metric Unit: Other Allowable	Conversion Factor:* Multiply Customary Unit by Factor To Get Metric Unit	
CALORIFIC VALUE, HEAT, ENTROPY, HEAT CAPACITY						
Calorific value	J/m^3	therm/U.K. gal	MJ/m^3	kJ/dm^3	2.320 80	E+04
(volume basis–			kJ/m^3		2.320 80	E+07
solids and liquids)				(kW·h)/dm^3	6.446 660	E+00
		Btu/U.S. gal	MJ/m^3	kJ/dm^3	2.787 163	E−01
			kJ/m^3		2.787 163	E+02
				(kW·h)/m^3	7.742 119	E−02
		Btu/U.K. gal	MJ/m^3	kJ/dm^3	2.320 8	E−01
			kJ/m^3		2.320 8	E+02
				(kW·h)/m^3	6.446 660	E−02
		Btu/ft^3	MJ/m^3	kJ/dm^3	3.725 895	E−02
			kJ/m^3		3.725 895	E+01
				(kW·h)/m^3	1.034 971	E−02
		kcal/m^3	MJ/m^3	kJ/dm^3	4.184*	E−03
			kJ/m^3		4.184*	E−03
		cal/mL	MJ/m^3		4.184*	E+00
		ft-lbf/U.S. gal	kJ/m^3		3.581 692	E−01
Calorific value	J/m^3	cal/mL	kJ^3/m	J/dm^3	4.184*	E+03
(volume basis–		kcal/m^3	kJ/m^3	J/dm^3	4.184*	E+00
gases)		Btu/ft^3	kJ/m^3	J/dm^3	3.725 895	E+01
				(kW·h)/m^3	1.034 971	E−02
Specific entropy	J/kg·K	Btu/(lbm-°R)	kJ(kg·K)	J(g·K)	4.186 8*	E+00
		cal/(g-°K)	kJ(kg·K)	J(g·K)	4.184*	E+00
		kcal/(kg-°C)	kJ(kg·K)	J(g·K)	4.184*	E+00
Specific heat	J/kg·K	kW-hr/(kg-°C)	kJ(kg·K)	J(g·K)	3.6*	E+03
capacity		Btu/(lbm-°F)	kJ(kg·K)	J(g·K)	4.186 8*	E+00
(mass basis)		kcal(kg-°C)	kJ(kg·K)	J(g·K)	4.184*	E+00
Molar heat	J/mol·K	Btu/(lbm mol-°F)	kJ (kmol·K)		4.186 8*	E+00(13)
capacity		cal/(g mol-°C)	kJ (kmol·K)		4.184*	E−00(13)
TEMPERATURE, PRESSURE, VACUUM						
Temperature	K	°R	K		5/9	
(absolute)		°K	K		1.0*	E+00
Temperature	K	°F	°C		(F−32)/1.8	
(traditional)		°C	°C		1.0*	E+00
Temperature	K	°F	K	°C	5/9	E+00
(difference)		°C	K	°C	1.0*	E+00
Temperature/length (geothermal gradient)	K/m	°F/100 ft	mK/m		1.822 689	E+01
Length/temperature (geothermal step)	m/K	ft°F	m/K		5.486 4*	E−01

TABLE 1—TABLES OF RECOMMENDED SI UNITS (continued)

Quantity and SI Unit		Customary Unit	Metric Unit SPE Preferred	Metric Unit Other Allowable	Conversion Factor:* Multiply Customary Unit by Factor To Get Metric Unit	
TEMPERATURE, PRESSURE, VACUUM						
Pressure	Pa	atm (760 mm Hg at 0°C or 14.696 (lbf/in.^{2})	MPa		1.013 25*	E−01
			kPa		1.013 25*	E+02
				bar	1.013 25*	E+00
		bar	MPa		1.0*	E−01
			kPa		1.0*	E+02
				bar	1.0*	E+00
		at (technical atm, kbf/cm^2)	MPa		9.806 65*	E−02
			kPa		9.806 65*	E+01
				bar	9.806 65*	E−01
Pressure	Pa	lbf/in.^{2} (psi)	MPa		6.894 757	E−03
			kPa		6.894 757	E+00
				bar	6.894 757	E−02
		in. Hg (32°F)	kPa		3.386 38	E+00
		in. Hg (60°F)	kPa		3.376 85	E+00
		in. H_2O (39.2°F)	kPa		2.490 82	E−01
		in. H_2O (60°F)	kPa		2.488 4	E−01
		Mm Hg (0°C)=torr	kPa		1.333 224	E−01
		Cm H_2O (4°C)	kPa		9.806 38	E−02
		lbf/ft^2 (psf)	kPa		4.788 026	E−02
		μm Hg (0°C)	Pa		1.333 224	E−01
		μbar	Pa		1.0*	E−01
		dyne/cm^2	Pa		1.0*	E−01
Vacuum, draft	Pa	in. Hg (60°F)	kPa		3.376 85	E+00
		in. H_2O (39.2°F)	kPa		2.490 82	E−01
		Mm Hg (0°C)=torr	kPa		1.333 224	E−01
		Cm H_2O (4°C)	kPa		9.806 38	E−02
Liquid heat	m	ft	m		3.048*	E−01
		in.	mm		2.54*	E+01
				cm	2.54*	E+00
Pressure drop/length	Pa/m	psi/ft	kPa/m		2.262 059	E+01
		psi/100 ft	kPa/m		2.262 059	E−01
DENSITY, SPECIFIC VOLUME, CONCENTRATION, DOSAGE						
Density (gases)	kg/m^3	lbm/ft^3	kg/m^3		1.601 846	E+01
			g/m^3		1.601 846	E+04
Density (liquids)	kg/m^3	lbm/U.S. gal	kg/m^3		1.198 264	E+02
				g/cm^3	1.198 264	E−01
		lbm/U.K. gal	kg/m^3		9.997 633	E+01
				kg/dm^3	9.977 633	E−02
		lbm/ft^3	kg/m^3		1.601 846	E+01
				g/cm^3	1.601 846	E−02
		g/cm^3	kg/m^3		1.0*	E+03
				kg/dm^3	1.0*	E+00
		°API	g/cm^3		141.5/(131.5+°API)	

TABLE 1—TABLES OF RECOMMENDED SI UNITS (continued)

Quantity and SI Unit		Customary Unit	Metric Unit SPE Preferred	Metric Unit Other Allowable	Conversion Factor:* Multiply Customary Unit by Factor To Get Metric Unit	
DENSITY, SPECIFIC VOLUME, CONCENTRATION, DOSAGE						
Density (solids)	kg/m^3	lbm/ft^3	kg/m^3		1.601 846	E+01
Specific volume (gases)	m^3/kg	ft^3/lbm	m^3/kg		6.242 796	E−02
			m^3/g		6.242 796	E−05
Specific volume (liquids)	m^3/kg	ft^3/lbm	dm^3/kg		6.242 796	E+01
		U.K. gal/lbm	dm^3/kg	cm^3/g	1.002 242	E+01
		U.S. gal/lbm	dm^3/kg	cm^3/g	8.345 404	E+00
Specific volume	ft^3/mol	L/g mol	$m^3/kmol$		1.0*	E+00 (13)
(mole basis)		ft^3/lbm mol	$m^3/kmol$		6.242 796	E−02 (13)
Specific volume (clay yield)	m^3/kg	bbl/U.S. ton	m^3/t		1.752 535	E−01
		bbl/U.K. ton	m^3/t		1.564 763	E−01
Yield (shale distillation)	m^3/kg	bbl/U.S. ton	dm^3/t	L/t	1.752 535	E+02
		bbl/U.K. ton	dm^3/t	L/t	1.564 763	E+02
		U.S. gal/U.S. ton	dm^3/t	L/t	4.172 702	E+00
		U.S. gal/U.K. ton	dm^3/t	L/t	3.725 627	E+00
Concentration (mass/mass)	kg/kg	wt%	kg/kg		1.0*	E−02
			g/kg		1.0*	E+01
		wt ppm	mg/kg		1.0*	E+00
Concentration (mass/volume)	kg/m^3	lbm/bbl	kg/m^3	g/dm^3	2.853 010	E+00
		g/U.S. gal	kg/m^3		2.641 720	E−01
		g/U.K. gal	kg/m^3	g/L	2.199 692	E−01
Concentration (mass volume)	kg/m^3	lbm/1,000 U.S. gal	g/m^3	mg/dm^3	1.198 264	E+02
		lbm/1,000 U.K. gal	g/m^3	mg/dm^3	9.977 633	E+01
		grains/U.S. gal	g/m^3	mg/dm^3	1.711 806	E+01
		$grains/ft^3$	mg/m^3		2.288 352	E+03
		lbm/1,000 bbl	g/m^3	mg/dm^3	2.853 010	E+00
		mg/U.S. gal	g/m^3	mg/dm^3	2.641 720	E−01
		grains/100 ft^3	mg/m^3		2.288 352	E+01
Concentration (volume/volume)	m^3/m^3	bbl/bbl	m^3/m^3		1.0*	E+00
		ft^3/ft^3	m^3/m^3		1.0*	E+00
		bbl/acre-ft	m^3/m^3		1.288 923	E−04
				$m^3/ha{\cdot}m$	1.288 923	E+00
		vol %	m^3/m^3		1.0*	E−02
		U.K. gal/ft^3	dm^3/m^3	L/m^3	1.605 437	E+02
		U.S. gal/ft^3	dm^3/m^3	L/m^3	1.336 806	E+02
		mL/U.S. gal	dm^3/m^3	L/m^3	2.641 720	E−01
		mL/U.K. gal	dm^3/m^3	L/m^3	2.199 692	E−01
		vol ppm	cm^3/m^3		1.0*	E+00
			dm^3/m^3	L/m^3	1.0*	E−03
		U.K. gal/1,000 bbl	cm^3/m^3		1.859 406	E+01
		U.S. gal/1,000 bbl	cm^3/m^3		2.380 952	E+01
		U.K. pt/1,000 bbl	cm^3/m^3		3.574 253	E+00

TABLE 1—TABLES OF RECOMMENDED SI UNITS (continued)

Quantity and SI Unit		Customary Unit	Metric Unit: SPE Preferred	Metric Unit: Other Allowable	Conversion Factor:* Multiply Customary Unit by Factor To Get Metric Unit	
DENSITY, SPECIFIC VOLUME, CONCENTRATION, DOSAGE						
Concentration	mol/m³	lbm mol/U.S. gal	kmol/m³		1.198 264	E+02
		lbm mol/U.K. gal	kmol/m³		9.977 633	E+01
		lbm mol/ft³	kmol/m		1.601 846	E+01
		std ft³ (60°F, 1 atm)/bbl	kmol/m³		7.518 18	E−03
Concentration	m³/mol	U.S. gal/1,000 std ft³ (60°F/60°F)	dm³/kmol	L/kmol	3.166 93	E+00
(volume/mole)		bbl/million std ft³ (60°F/60°F)	dm³/kmol	L/kmol	1.330 11	E−01
FACILITY THROUGHPUT, CAPACITY						
Throughput	kg/s	million lbm/yr	t/a	Mg/a	4.535 924	E+02
(mass basis)		U.K. ton/yr	t/a	Mg/a	1.016 047	E+00
		U.S. ton/yr	t/a	Mg/a	9.071 847	E−01
		U.K. ton/D	t/d	Mg/d	1.016 047	E+00
				t/h, Mg/h	4.233 529	E−02
		U.S. ton/D	t/d		9.071 847	E−01
				t/h, Mg/h	3.779 936	E−02
		U.K. ton/hr	t/h	Mg/h	1.016 047	E+00
		U.S. ton/hr	t/h	Mg/h	9.071 847	E−01
		lbm/hr	kg/h		4.535 924	E−01
Throughput	m³/s	bbl/D	t/a		5.803 036	E+01[7]
(volume basis)				m³/d	1.589 873	E−01
			m³/h		6.624 471	E−03
		ft³/D	m³/d		2.831 685	E−02
		bbl/hr	m³/h		1.589 873	E−01
		ft³/h	m³/h		2.831 685	E−02
		U.K. gal/hr	m³/h		4.546 092	E−03
				L/s	1.262 803	E−03
		U.S. gal/hr	m³/h		3.785 412	E−03
				L/s	1.051 503	E−03
		U.K. gal/min	m³/h		2.727 655	E−01
				L/s	7.576 819	E−02
		U.S. gal/min	m³/h		2.271 247	E−01
				L/s	6.309 020	E−02
Throughput	mol/s	lbm mol/hr	kmol/h		4.535 924	E−01
(mole basis)				kmol/s	1.259 979	E−04[6]

TABLE 1—TABLES OF RECOMMENDED SI UNITS (continued)

Quantity and SI Unit		Customary Unit	Metric Unit: SPE Preferred	Metric Unit: Other Allowable	Conversion Factor:* Multiply Customary Unit by Factor To Get Metric Unit	
			FLOW RATE			
Pipeline capacity	m^3/m	bbl/mile	m^3/km		9.879 013	E−02
Flow rate	kg/s	U.K. ton/min	kg/s		1.693 412	E+01
(mass basis)		U.S. ton/min	kg/s		1.511 974	E+01
		U.K. ton/hr	kg/s		2.822 353	E−01
		U.S. ton/hr	kg/s		2.519 958	E−01
		U.K. ton/D	kg/s		1.175 980	E−02
		U.S. ton/D	kg/s		1.049 982	E−02
		million lbm/yr	kg/s		5.249 912	E+02
		U.K. ton/yr	kg/s		3.221 864	E−05
		U.S. ton/yr	kg/s		2.876 664	E−05
		lbm/s	kg/s		4.535 924	E−01
		lbm/min	kg/s		7.559 873	E−03
		lbm/hr	kg/s		1.259 979	E−04
Flow rate	m^3/s	bbl/D	m^3/d		1.589 873	E−01
(volume basis)				L/s	1.840 131	E−03
		ft^3/D	m^3/d		2.831 685	E−02
				L/s	3.277 413	E−04
		bbl/hr	m^3/s		4.416 314	E−05
				L/s	4.416 314	E−02
		ft^3/hr	m^3/s		7.865 791	E−06
				L/s	7.865 791	E−03
		U.K. gal/hr	dm^3/s	L/s	1.262 803	E−03
		U.S. gal/hr	dm^3/s	L/s	1.051 503	E−03
		U.K. gal/min	dm^3/s	L/s	7.576 820	E−02
		U.S. gal/min	dm^3/s	L/s	6.309 020	E−02
		ft^3/min	dm^3/s	L/s	4.719 474	E−01
		ft^3/s	dm^3/s	L/s	2.831 685	E+01
Flow rate	mol/s	lbm mol/s	kmol/s		4.535 924	E−01 (13)
(mole basis)		lbm mol/hr	kmol/s		1.259 979	E−04 (13)
		million scf/D	kmol/s		1.383 449	E−02 (13)
Flow rate/length	kg/s·m	lbm/(s-ft)	kg/(s·m)		1.488 164	E+00
(mass basis)		lbm/(hr-ft)	kg/(s·m)		4.133 789	E−04
Flow rate/length	m^2/s	U.K. gal/(min-ft)	m^2/s	$m^3/(s·m)$	2.485 833	E−04
		U.S. gal/(min-ft)	m^2/s	$m^3/(s·m)$	2.069 888	E−04
		U.K. gal/(hr-in.)	m^2/s	$m^3/(s·m)$	4.971 667	E−05
		U.S. gal/(hr-in.)	m^2/s	$m^3/(s·m)$	4.139 776	E−05
		U.K. gal/(hr-ft)	m^2/s	$m^3/(s·m)$	4.143 055	E−06
		U.S. gal/(hr-ft)	m^2/s	$m^3/(s·m)$	3.449 814	E−06
Flow rate/area	$kg/s·m^2$	$lbm/(s-ft^2)$	$kg/s·m^2$		4.882 428	E+00
(mass basis)		$lbm/(hr-ft^2)$	$kg/s·m^2$		1.356 230	E−03

TABLE 1—TABLES OF RECOMMENDED SI UNITS (continued)

Quantity and SI Unit		Customary Unit	Metric Unit: SPE Preferred	Metric Unit: Other Allowable	Conversion Factor:* Multiply Customary Unit by Factor To Get Metric Unit	
FLOW RATE						
Flow rate/area	m/s	$ft^3/(s\text{-}ft^2)$	m/s	$m^3/(s·m^2)$	3.048*	E−01
		$ft^3/(min\text{-}ft^2)$	m/s	$m^3/(s·m^2)$	5.08*	E−03
		U.K. gal/(hr-in.^{2})	m/s	$m^3/(s·m^2)$	1.957 349	E−03
		U.S. gal/(hr-in.^{2})	m/s	$m^3/(s·m^2)$	1.629 833	E−03
		U.K. gal/(min-ft^2)	m/s	$m^3/(s·m^2)$	8.155 621	E−04
		U.S. gal/(min-ft^2)	m/s	$m^3/(s·m^2)$	6.790 972	E−04
		U.K. gal/(hr-ft^2)	m/s	$m^3/(s·m^2)$	1.359 270	E−05
		U.S. gal/(hr-ft^2)	m/s	$m^3/(s·m^2)$	1.131 829	E−05
Flow rate/ pressure drop (productivity index)	$m^3/s·Pa$	bbl/(D-psi)	$m^3/(d·kPa)$		2.305 916	E−02
ENERGY, WORK, POWER						
Energy, work	J	quad	MJ		1.055 056	E+12
			TJ		1.055 056	E+06
			EJ		1.055 056	E+00
				MW·h	2.930 711	E+08
				GW·h	2.930 711	E+05
				TW·h	2.930 711	E+02
		therm	MJ		1.055 056	E+02
			kJ		1.055 056	E+05
				kW·h	2.930 711	E+01
		U.S. tonf-mile	MJ		1.431 744	E+01
		hp-hr	MJ		2.684 520	E+00
			kJ		2.684 520	E+03
				kW·h	7.456 999	E−01
		ch-hr or CV-hr	MJ		2.647 796	E+00
			Kj		2.647 796	E+03
				kW·h	7.354 99	E−01
		kW-hr	MJ		3.6*	E+00
			kJ		3.6*	E+03
		Chu	kJ		1.899 101	E+00
				kW·h	5.275 280	E−04
		Btu	kJ		1.055 056	E+00
				kW·h	2.930 711	E−04
		kcal	kJ		4.184*	E+00
		cal	kJ		4.184*	E−03
		ft-lbf	kJ		1.344 818	E−03
		lbf-ft	kJ		1.355 818	E−03
		J	kJ		1.0*	E−03
		lbf-ft^2/s^2	kJ		4.214 011	E−05
		erg	J		1.0*	E−07

TABLE 1—TABLES OF RECOMMENDED SI UNITS (continued)

Quantity and SI Unit		Customary Unit	Metric Unit: SPE Preferred	Metric Unit: Other Allowable	Conversion Factor:* Multiply Customary Unit by Factor To Get Metric Unit	
ENERGY, WORK, POWER						
Impact energy	J	kgf·m	J		9.806 650*	E+00
		lbf-ft	J		1.355 818	E+00
Work/length	J/m	U.S. tonf-mile/ft	MJ/m		4.697 322	E+01
Surface energy	J/m^2	erg/cm^2	mJ/m^2		1.0*	E+00
Specific impact energy	J/m^2	$kgf·m/cm^2$	J/cm^2		9.806 650*	E−00
		$lbf·ft/in.^2$	J/cm^2		2.101 522	E−01
Power	W	quad/yr	MJ/a		1.055 056	E+12
			TJ/a		1.055 056	E+06
			EJ/a		1.055 056	E+00
		erg/a	TW		3.170 979	E−27
			GW		3.170 979	E−24
		million Btu/hr	MW		2.930 711	E−01
		ton of refrigeration	kW		3.516 853	E+00
		Btu/s	kW		1.055 056	E+00
		kW	kW		1.0*	E+00
		hydraulic horsepower—hhp	kW		7.460 43	E−01
		hp (electric)	kW		7.46*	E−01
		hp (550 ft-lbf/s)	kW		7.456 999	E−01
		ch or CV	kW		7.354 99	E−01
		Btu/min	kW		1.758 427	E−02
		ft·lbf/s	kW		1.355 818	E−03
		kcal/hr	W		1.162 222	E+00
		Btu/hr	W		2.930 711	E−01
		ft·lbf/min	W		2.259 697	E−02
Power/area	W/m^2	$Btu/s·ft^2$	kW/m^2		1.135 653	E+01
		$cal/hr·cm^2$	kW/m^2		1.162 222	E−02
		$Btu/hr·ft^2$	kW/m^2		3.154 591	E−03
Heat flow unit—hfu (geothermics)		$\mu cal/s·cm^2$	mW/m^2		4.184*	E+01
Heat release rate, mixing power	W/m^2	hp/ft^3	kW/m^3		2.633 414	E+01
		$cal/(hr·cm^3)$	kW/m^3		1.162 222	E+00
		$Btu/(s·ft^3)$	kW/m^3		3.725 895	E+01
		$Btu/(hr·ft^3)$	kW/m^3		1.034 971	E−02
Heat generation unit—hgu (radioactive rocks)		$cal/(s·cm^3)$	$\mu W/m^3$		4.184*	E+12
Cooling duty (machinery)	W/W	Btu/(bhp-hr)	W/kW		3.930 148	E−01
Specific fuel consumption (mass basis)	kg/J	lbm/(hp-hr)	mg/J	kg/MJ	1.689 659	E−01
				kg/(kW·h)	6.082 774	E−01
Specific fuel consumption	m^3/J	$m^3/(kW-hr)$	dm^3/MJ	mm^3/J	2.777 778	E+02
				$dm^3/(kW·h)$	1.0*	E+03

TABLE 1—TABLES OF RECOMMENDED SI UNITS (continued)

Quantity and SI Unit		Customary Unit	Metric Unit: SPE Preferred	Metric Unit: Other Allowable	Conversion Factor:* Multiply Customary Unit by Factor To Get Metric Unit	
ENERGY, WORK, POWER						
(volume basis)		U.S. gal/(hp-hr)	dm^3/MJ	mm^3/J	1.410 089	E+00
				dm^3(kW·h)	5.076 321	E+00
		U.K. pt/(hp-hr)	dm^3/MJ	mm^3/J	2.116 809	E−01
				dm^3/(kW·h)	7.620 512	E−01
Fuel consumption	m^3/m	U.K. gal/mile	dm^3/100 km	L/100 km	2.824 811	E+02
(automotive)		U.S. gal/mile	dm^3/100 km	L/100 km	2.352 146	E+02
		mile/U.S. gal	km/dm^3	km/L	4.251 437	E−01
		mile/U.K. gal	km/dm^3	km/L	3.540 060	E−01
MECHANICS						
Velocity (linear),	m/s	knot	km/h		1.852*	E+00
speed		mile/hr	km/h		1.609 344*	E+00
		m/s	m/s		1.0*	E+00
		ft/s	m/s		3.048*	E−01
				cm/s	3.048*	E+01
				m/ms	3.048*	E−04[8]
		ft/min	m/s		5.08*	E−03
				cm/s	5.08*	E−01
		ft/hr	mm/s		8.466 667	E−02
				cm/s	8.466 667	E−03
		ft/D	mm/s		3.527 778	E−03
				m/d	3.048*	E−01
		in.	mm/s		2.54*	E+01
				cm/s	2.54*	E+00
		in./min	mm/s		4.233 333	E−01
				cm/s	4.233 333	E−02
Velocity (angular)	rad/s	rev/min	rad/s		1.047 198	E−01
		rev/s	rad/s		6.283 185	E+00
		degree/min	rad/s		2.908 882	E−04
Interval transit time	s/m	s/ft	s/m	µs/m	3.280 840	E+00[9]
Corrosion rate	m/s	in./yr (ipy)	mm/a		2.54*	E+01
		mil/yr	mm/a		2.54*	E−02
Rotational	rev/s	rev/s	rev/s		1.0*	E+00
frequency		rev/min	rev/s		1.666 667	E−02
		rev/min	rad/s		1.047 198	E−01
Acceleration	m/s^2	ft/s^2	m/s^2		3.048*	E−01
(linear)				cm/s^2	3.048*	E+01
		gal (cm/s^2)	m/s^2		1.0*	E−02
Acceleration	rad/s^2	rad/s^2	rad/s^2		1.0*	E+00
(rotational)		rpm/s	rad/s^2		1.047 198	E−01
Momentum	kg·m/s	lbm·ft/s	kg·m/s		1.382 550	E−01

TABLE 1—TABLES OF RECOMMENDED SI UNITS (continued)

Quantity and SI Unit		Customary Unit	Metric Unit SPE Preferred	Metric Unit Other Allowable	Conversion Factor:* Multiply Customary Unit by Factor To Get Metric Unit	
			MECHANICS			
Force	N	U.K. tonf	kN		9.964 016	E+00
		U.S. tonf	kN		8.896 443	E+00
		kgf (kp)	N		9.806 650*	E+00
		lbf	N		4.448 222	E+00
		N	N		1.0*	E+00
		pdl	mN		1.382 550	E+02
		dyne	mN		1.0*	E−02
Bending moment, torque	N·m	U.S. tonf-ft	kN·m		2.711 636	E+00[10]
		kgf-m	N·m		9.806 650*	E+00[10]
		lbf-ft	N·m		1.355 818	E+00[10]
		lbf-in.	N·m		1.129 848	E−01[10]
		pdl-ft	N·m		4.214 011	E−02[10]
Bending moment/ length	N·m/m	(lbf-ft)/in.	(N·m)/m		5.337 856	E+01[10]
		(kgf-m)/m	(N·m)/m		9.806 650*	E+00[10]
		(lbf-in.)/in.	(N·m)/m		4.448 222	E+00[10]
Elastic moduli (Young's, shear bulk)	Pa	lbf/in.^{2}	GPa		6.894 757	E−06
Moment of inertia	kg·m^2	lbm-ft^2	kg·m^2		4.214 011	E−02
Moment of section	m^4	in.^{4}	cm^4		4.162 314	E+01
Section modulus	m^3	cu in.	cm^3		1.638 706	E+01
		cu ft	cm^3		1.638 706	E+04
				mm^3	2.831 685	E+04
				m^3	2.831 685	E−02
Stress	Pa	U.S. tonf/in.^{2}	MPa	N/mm^2	1.378 951	E+01
		kgf/mm^2	MPa	N/mm^2	9.806 650*	E+00
		U.S. tonf/ft^2	MPa	N/mm^2	9.576 052	E−02
		lbf/in.^{2} (psi)	MPa	N/mm^2	6.894 757	E−03
		lbf/ft^2 (psf)	kPa		4.788 026	E−02
		dyne/cm^2	Pa		1.0*	E−01
Yield point, gel strength (drilling fluid)		lbf/100 ft^2	Pa		4.788 026	E−01
Mass/length	kg/m	lbm/ft	kg/m		1.488 164	E+00
Mass/area structural loading, bearing capacity (mass basis)	kg/m^2	U.S. ton/ft^2	Mg/m^2		9.764 855	E+00
		lbm/ft^2	kg/m^2		4.882 428	E+00
Coefficient of thermal expansion	m/(m·K)	in./(in.-°F)	mm/(mm·K)		5.555 556	E−01

TABLE 1—TABLES OF RECOMMENDED SI UNITS (continued)

Quantity and SI Unit		Customary Unit	Metric Unit: SPE Preferred	Metric Unit: Other Allowable	Conversion Factor:* Multiply Customary Unit by Factor To Get Metric Unit	
TRANSPORT PROPERTIES						
Diffusivity	m^2/s	ft^2/s	mm^2/s		9.290 304*	E+04
		cm^2/s	mm^2/s		1.0*	E+02
		ft^2/hr	mm^2/s		2.580 64*	E+01
Thermal resistance	$(k{\cdot}m^2)/W$	$(°C\text{-}m^2{\cdot}hr)/kcal$	$(K{\cdot}m^2)kW$		8.604 208	E+02
		$(°F\text{-}ft^2\ hr)/Btu$	$(K{\cdot}m^2)kW$		1.761 102	E+02
Heat flux	W/m^2	$Btu/(hr\text{-}ft^2)$	kW/m^2		3.154 591	E−03
Thermal conductivity	W/(m·K)	$(cal/s\text{-}cm^2\text{-}°C/cm)$	W/(m·K)		4.184*	E+02
		$Btu/(hr\text{-}ft^2\text{-}°F/ft)$	W/(m·K)		1.730 735	E+00
				$kJ{\cdot}m/(h{\cdot}m^2{\cdot}K)$	6.230 646	E+00
		$kcal/(hr\text{-}m^2\text{-}°C/m)$	W/(m·K)		1.162 222	E+00
		$Btu/(hr\text{-}ft^2\text{-}°F/in.)$	W/(m·K)		1.442 279	E−01
		$cal/(hr\text{-}cm^2\text{-}°C/cm)$	W/(m·K)		1.162 222	E−01
Heat transfer coefficient	$W/(m^2{\cdot}K)$	$cal/(s\text{-}cm^2\text{-}°C)$	$kW/(m^2{\cdot}K)$		4.184*	E+01
		$Btu/(s\text{-}ft^2\text{-}°F)$	$kW/(m^2{\cdot}K)$		2.044 175	E+01
		$cal/(hr\text{-}cm^2\text{-}°C)$	$kW/(m^2{\cdot}K)$		1.162 222	E−02
		$Btu/(hr\text{-}ft^2\text{-}°F)$	$kW/(m^2{\cdot}K)$		5.678 263	E−03
				$kJ(h{\cdot}m^2{\cdot}K)$	2.044 175	E+01
		$Btu/(hr\text{-}ft^2\text{-}°R)$	$kW/(m^2{\cdot}K)$		5.678 263	E−03
		$kcal/(hr\text{-}m^2\text{-}°C)$	$kW/(m^2{\cdot}K)$		1.162 222	E−03
Volumetric heat transfer coefficient	$kW/(m^3{\cdot}K)$	$Btu/(s\text{-}ft^3\text{-}°F)$	$kW/(m^3{\cdot}K)$		6.706 611	E+01
		$Btu/(hr\text{-}ft^3\text{-}°F)$	$kW/(m^3{\cdot}K)$		1.862 947	E−02
Surface tension	N/m	dyne/cm	mN/m		1.0*	E+00
Viscosity (dynamic)	Pa·s	$(lbf\text{-}s)/in.^2$	Pa·s	$(N{\cdot}s)/m^2$	6.894 757	E+03
		$(lbf\text{-}s)/ft^2$	Pa·s	$(N{\cdot}s)/m^2$	4.788 026	E+01
		$(kgf\text{-}s)/m^2$	Pa·s	$(N{\cdot}s)/m^2$	9.806 650*	E+00
		lbm/(ft-s)	Pa·s	$(N{\cdot}s)/m^2$	1.488 164	E+00
		$(dyne\text{-}s)/cm^2$	Pa·s	$(N{\cdot}s)/m^2$	1.0*	E−01
		cp	Pa·s	$(N{\cdot}s)/m^2$	1.0*	E−03
		lbm/(ft-hr)	Pa·s	$(N{\cdot}s)/m^2$	4.133 789	E−04
Viscosity (kinematic)	m^2/s	ft^2/s	mm^2/s		9.290 304*	E+04
		$in.^2/s$	mm^2/s		6.451 6*	E+02
		m^2/hr	mm^2/s		2.777 778	E+02
		cm^2/s	mm^2/s		1.0*	E+02
		ft^2/hr	mm^2/s		2.580 64*	E+01
		cSt	mm^2/s		1.0*	E+00
Permeability	m^2	darcy	μm^2		9.869 233	E−01 (11)
		millidarcy	μm^2		9.869 233	E−04 (11)
				$10^{-3}\mu m^2$	9.869 233	E−01 (11)

TABLE 1—TABLES OF RECOMMENDED SI UNITS (continued)

Quantity and SI Unit		Customary Unit	Metric Unit: SPE Preferred	Metric Unit: Other Allowable	Conversion Factor:* Multiply Customary Unit by Factor To Get Metric Unit	
ELECTRICITY, MAGNETISM						
Admittance	S	S	S		1.0*	E+00
Capacitance	F	μF	μF		1.0*	E+00
Capacity, storage battery	C	A·hr	kC		3.6*	E+00
Charge density	C/m^3	C/mm^3	C/mm^3		1.0*	E+00
Conductance	S	S	S		1.0*	E+00
		Ω(mho)	S		1.0*	E+00
Conductivity	S/m	S/m	S/m		1.0*	E+00
		Ω/m	S/m		1.0*	E+00
		m Ω/m	mS/m		1.0*	E+00
Current density	A/m^2	A/mm^2	A/mm^2		1.0*	E+00
Displacement	C/m^2	C/cm^2	C/cm^2		1.0	E+00
Electric charge	C	C	C		1.0*	E+00
Electric current	A	A	A		1.0*	E+00
Electric dipole moment	C·m	C·m	C·m		1.0*	E+00
Electric field strength	V/m	V/m	V/m		1.0*	E+00
Electric flux	C	C	C		1.0*	E+00
Electric polarization	C/m^2	C/m^2	C/m^2		1.0*	E+00
Electric potential	V	V	V		1.0*	E+00
		mV	mV		1.0*	E+00
Electromagnetic moment	$A·m^2$	$A·m^2$	$A·m^2$		1.0*	E+00
Electromotive force	V	V	V		1.0*	E+00
Flux of displacement	C	C	C		1.0*	E+00
Frequency	Hz	cycles/s	Hz		1.0*	E+00
Impedance	Ω	Ω	Ω		1.0*	E+00
Interval transit time	s/m	μs/ft	μs/m		3.280 840	E+00
Linear current density	A/m	A/mm	A/mm		1.0*	E+00
Magnetic dipole moment	Wb·m	Wb·m	Wb·m		1.0*	E+00
Magnetic field strength	A/m	A/mm	A/mm		1.0*	E+00
		oersted	A/m		7.957 747	E+01
		gamma	A/m		7.957 747	E−04
Magnetic flux	Wb	mWb	mWb		1.0*	E+00
Magnetic flux density	T	mT	mT		1.0*	E+00
		gauss	T		1.0*	E−04
Magnetic induction	T	mT	mT		1.0*	E+00
Magnetic moment	$A·m^2$	$A·m^2$	$A·m^2$		1.0*	E+00

TABLE 1—TABLES OF RECOMMENDED SI UNITS (continued)

Quantity and SI Unit		Customary Unit	Metric Unit: SPE Preferred	Metric Unit: Other Allowable	Conversion Factor:* Multiply Customary Unit by Factor To Get Metric Unit	
ELECTRICITY, MAGNETISM						
Magnetic polarization	T	mT	mT		1.0*	E+00
Magnetic potential difference	A	A	A		1.0*	E+00
Magnetic vector potential	Wb/m	Wb/m	Wb/m		1	
Magnetization	A/m	A/mm	A/mm		1	
Modulus of admittance	S	S	S		1	
Modulus of impedance	Ω	Ω	Ω		1	
Mutual inductance	H	H	H		1	
Permeability	H/m	μH/m	μH/m		1	
Permeance	H	H	H		1	
Permittivity	F/m	μF/m	μF/m		1	
Potential difference	V	V	V		1	
Quantity of electricity	C	C	C		1	
Reactance	Ω	Ω	Ω		1	
Reluctance	H^{-1}	H^{-1}	H^{-1}		1	
Resistance	Ω	Ω	Ω		1	
Resistivity	Ω·m	Ω·cm	Ω·cm		1	
		Ω·m	Ω·m		1	(12)
Self inductance	H	mH	mH		1	
Surface density of charge	C/m^2	mC/m^2	mC/m^2		1	
Susceptance	S	S	S		1	
Volume density of charge	C/m^3	C/mm^3	C/mm^3		1	
ACOUSTICS, LIGHT, RADIATION						
Absorbed dose	Gy	rad	Gy		1.0*	E−02
Acoustical energy	J	J	J		1	
Acoustical intensity	W/m^2	W/cm^2	W/m^2		1.0*	E+04
Acoustical power	W	W	W		1	
Sound pressure	N/m^2	N/m^2	N/m^2		1	
Illuminance	lx	footcandle	lx		1.076 391	E+01
Illumination	lx	footcandle	lx		1.076 391	E+01
Irradiance	W/m^2	W/m^2	W/m^2		1	
Light exposure	lx·s	footcandle·s	lx·s		1.076 391	E+01
Luminance	cd/m^2	cd/m^2	cd/m^2		1	
Luminous efficacy	lm/W	lm/W	lm/W		1	

TABLE 1—TABLES OF RECOMMENDED SI UNITS (continued)

Quantity and SI Unit		Customary Unit	Metric Unit: SPE Preferred	Metric Unit: Other Allowable	Conversion Factor:* Multiply Customary Unit by Factor To Get Metric Unit	
ACOUSTICS, LIGHT, RADIATION						
Luminous exitance	lm/m^2	lm/m^2	lm/m^2		1	
Luminous flux	lm	lm	lm		1	
Luminous intensity	cd	cd	cd		1	
Quantity of light	ℓm·s	talbot	ℓm·s		1.0*	E+00
Radiance	$W/(m^2 \cdot sr)$	$W/(m^2 \cdot sr)$	$W/(m^2 \cdot sr)$		1	
Radiant energy	J	J	J		1	
Radiant flux	W	W	W		1	
Radiant intensity	W/sr	W/sr	W/sr		1	
Radiant power	W	W	W		1	
Wavelength	m	Å	nm		1.0*	E−01
Capture unit	m^{-1}	$10^{-3}cm^{-1}$	m^{-1}		1.0*	E+01
				$10^{-3}cm^{-1}$	1	
		m^{-1}	m^{-1}		1	
Radioactivity		curie	Bq		3.7*	E+10

TABLE 2—SOME ADDITIONAL APPLICATION STANDARDS

Quantity and SI Unit		Customary Unit	Metric Unit: SPE Preferred	Metric Unit: Other Allowable	Conversion Factor:* Multiply Customary Unit by Factor To Get Metric Unit	
Capillary	Pa	ft (fluid)	m (fluid)		3.048*	E−01
Compressibility of	Pa^{-1}	psi^{-1}	Pa^{-1}		1.450 377	E−04
reservoir fluid				kPa^{-1}	1.450 377	E−01
Corrosion allowance	m	in.	mm		2.54*	E+01
Corrosion rate	m/s	mil/yr (mpy)	mm/a		2.54*	E−02
Differential orifice	Pa	in. H_2O	kPa		2.488 4	E−01
pressure		(at 60°F)		cm H_2O	2.54*	E+00
Gas-oil ratio	m^3/m^3	scf/bbl	"standard" m^3/m^3		1.801 175	E−01 (1)
Gas rate	m^3/s	scf/D	"standard" m^3/d		2.863 640	E−02 (1)
Geologic time	s	yr	Ma			
Heat (fluid mechanics)	m	ft	m		3.048*	E−01
				cm	3.048*	E+01
Heat exchange rate	W	Btu/hr	kW		2.930 711	E−04
				kJ/h	1.055 056	E+00
Mobility	$m^2/Pa{\cdot}s$	d/cp	$\mu m^2/mPa{\cdot}s$		9.869 233	E−01
				$\mu m^2/Pa{\cdot}s$	9.869 233	E+02
Net pay thickness	m	ft	m		3.048*	E−01
Oil rate	m^3/s	bbl/D	m^3/d		1.589 873	E−01
		short ton/yr	mg/a	ta	9.071 847	E−01
Particle size	m	micron	μm		1.0*	
Permeability-thickness	m^3	md-ft	md·m	$\mu m^2{\cdot}m$	3.008 142	E−04
Pipe diameter (actual)	m	in.	cm		2.54*	E+00
				mm	2.54*	E+01
Pressure buildup per cycle	Pa	psi	kPa		6.894 757	E+00 (2)
Productivity index	$m^3/Pa{\cdot}s$	bbl/(psi-D)	$m^3(kPa{\cdot}d)$		2.305 916	E−02 (2)
Pumping rate	m^3/s	U.S. gal/min	m^3/h		2.271 247	E−01
				L/s	6.309 020	E−02
Revolutions per minute	rad/s	rpm	rad/s		1.047 198	E−01
				rad/m	6.283 185	E+00
Recovery/unit	m^3/m^3	bbl/(acre-ft)	m^3/m^3		1.288 931	E−04
volume (oil)				$m^3/ha{\cdot}m$	1.288 931	E+00
Reservoir area	m^2	sq mile	km^2		2.589 988	E+00
		acre		ha	4.046 856	E−01

TABLE 2—SOME ADDITIONAL APPLICATION STANDARDS (continued)

Quantity and SI Unit		Customary Unit	Metric Unit: SPE Preferred	Metric Unit: Other Allowable	Conversion Factor:* Multiply Customary Unit by Factor To Get Metric Unit	
Reservoir volume	m^3	acre-ft	m^3		1.233 482	E+03
				ha·m	1.233 482	E−01
Specific productivity index	m^3/Pa·s·m	bbl/(D-psi-ft)	m^3/(kPa·d·s)		7.565 341	E−02 (2)
Surface or interfacial tension in reservoir capillaries	N/m	dyne/cm	mN/m		1.0*	E+00
Torque	N·m	lbf-ft	N·m		1.355 818	E+00 (4)
Velocity (fluid flow)	m/s	ft/s	m/s		3.048*	E−01
Vessel diameter	m					
1–100 cm		in.	cm		2.54*	E+00
above 100 cm		ft	m		3.048*	E−01

*An asterisk indicates the conversion factor is exact using the numbers shown; all subsequent numbers are zeros.