

**METRIC UNITS AND CONVERSION FACTORS
FOR FOREST FIRE QUANTITIES**

by

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ABSTRACT

This report presents a suggested list of metric units and conversion factors for quantities commonly used in forest fire research, and suitable also for practical use in operational work. It follows the approved standards of the International System of Units (SI).

Résumé

L'auteur fournit une énumération des unités métriques et facteurs de conversion des quantités utilisées couramment en recherches sur les incendies de forêts, et aussi utiles lors des opérations sur le terrain. Cette énumération est conforme aux normes officielles du Système international (SI).

METRIC UNITS AND CONVERSION FACTORS FOR

FOREST FIRE QUANTITIES

C.E. Van Wagner¹

Here is a list of suggested metric units and conversion factors for use in forest fire research, and suitable also for practical use in forest fire operational work. It follows the approved standards of the International System of Units (SI). It includes the main items encountered in the forest fire business, but not by any means all possible related quantities.

In addition to English units, some widely used units in the old metric system have been ruled either inadmissible or undesirable. These include the calorie, the millibar, and the centipoise. Means of converting them to approved SI units is therefore included.

Where several possibilities existed, the units chosen were those that a) seemed to provide the most useful mental image, or b) provided a numerical scale that matched the former usage as well as possible. The SI units for single and compound forest fire quantities listed here differ somewhat from those mentioned in the Metric Practice Guide for Forest Research issued by the Metric Commission Sector Committee on Forestry.

This list of units is presented in the hope that it will be adopted generally in the forest fire business throughout Canada as the process of metric conversion in forestry proceeds. Other units may sometimes be desired; if so, they should at least follow the basic SI rules. In case of question, the official reference for SI practice in Canada is the Metric Practice Guide issued by the Canadian Standards Association, CAN3-Z234.1-76 (or its successor).

The units presented here are mainly the result of discussion among the forest fire research staff of the Canadian Forestry Service (CFS), especially those working in the CFS regional Forest Research Centres and National Forestry Institutes concerned with forest fire danger rating. These individuals are acknowledged below. Also consulted was the Subcommittee on Metric Conversion² of the Canadian Committee on Forest Fire Control, made up of representatives of the forest fire control agencies throughout Canada. It could be said, therefore, that this list represents a consensus among people in Canada involved in both fire research and fire control.

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This publication consists of three sections:

- Section 1 - a list of individual units and their symbols, both SI and non-SI.
- Section 2 - a list of recommended units and compound quantities for forest fire work.
- Section 3 - a list of conversion factors between SI and non-SI quantities.

CFS forest fire research staff who contributed through suggestions or opinions to this list of SI forest fire quantities include:

D.B. Bradshaw	-	Newfoundland Forest Research Centre
Z. Chrosciewicz	-	Northern Forest Research Centre
A.D. Kiil	-	"
B.D. Lawson	-	Pacific Forest Research Centre
S.J. Muraro	-	"
P.M. Paul	-	Forest Fire Research Institute
L. Pouliot	-	Atmospheric Environment Service, Quebec
D. Quintilio	-	Northern Forest Research Centre
G.S. Ramsey	-	Forest Fire Research Institute
R.H. Silversides	-	Pacific Forest Research Centre
B.J. Stocks	-	Great Lakes Forest Research Centre
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SECTION ONE

SI or SI-approved Unit Symbols in Forest Fire Quantities

°C	-	degree Celsius	kg	-	kilogram
mm	-	millimetre	t	-	tonne *
cm	-	centimetre	ha	-	hectare
m	-	metre	kJ	-	kilojoule
km	-	kilometre	kW	-	kilowatt
s	-	second	mPa	-	millipascal
min	-	minute	kPa	-	kilopascal
h	-	hour	ℓ	-	litre
g	-	gram			

* This is the metric tonne, equal to 1000 kg. Not to be confused with the English ton of 2000 lb.

Non-SI Unit Symbols

°F	-	degree Fahrenheit	T	-	ton
in	-	inch	Btu	-	British thermal unit
ft	-	foot	gal	-	gallon (Canadian)
mi	-	mile	cal	-	calorie
mph	-	miles per hour	kcal	-	kilocalorie
ac	-	acre	mb	-	millibar
lb	-	pound	cP	-	centipoise
psi	-	pounds per square inch			

SECTION TWO

Recommended SI Units and Compound
Quantities for Forest Fire Work

1) Weather

- a) Temperature - °C
- b) Wind - km/h
- c) Rain - mm
- d) Air pressure - kPa

2) Distance (e.g., length or perimeter of fire)

- a) For large-scale mental image - km
- b) For small-scale mental image - m

3) Rate of Spread (Linear)

- a) For general use - m/min
- b) For long-term mental image - km/h

Replace ft/min with m/min and mph with km/h. Rate of spread in m/s is needed for calculation of fire intensity, but does not provide an easy mental image of rate of spread when quoted for its own sake.

4) Fire Area

For general use - ha

5) Fuel Size

- a) Diameter or depth - cm
- b) Surface/volume ratio - cm^{-1}

6) Fuel Load

- a) For general use - kg/m^2
- b) For large-scale mental image - t/ha

7) Fuel Bulk Density

- a) For general use - kg/m^3
- b) For small-scale mental image - g/cm^3

8) Heat of Combustion

For general use - kJ/kg

Recommended because it uses the same units as other compound quantities listed here. Same numerical value as J/g.

9) Energy per unit area

For general use - kJ/m²

10) Fire Intensity

a) Frontal or line intensity

For general use - kW/m

To replace Btu/(s-ft). kW/m provides better mental image and numerical range than W/cm or W/m, at same time being consistent with other recommended units. A watt (power) is a joule per second, and thus combines energy and time in one unit.

b) Area or reaction intensity

For general use - kW/m²

To replace Btu/(s-ft²). Same remarks as for above.

11) Heat Transfer Rate per Unit area

For general use - kW/m²

Applies for energy emitted, received or travelling through space.

12) Mass Flow Rate

For general use - kg/(m²·s)

13) Pumps and Hose

a) Flow rate - ℓ/min

b) Pressure - kPa

c) Pressure drop per unit length - kPa/m

d) Viscosity - mPa·s

Factors for converting all the above quantities to and from English (or old metric) units are listed by item number in the next section.

SECTION THREE

Conversion Factors

Factors are given to five significant digits. If less, the value is exact.

To convert English (or old metric) values to SI, multiply by the inverse factor in the right-hand column.

All conversions involving kJ or kW are based on the "thermochemical" standard, in which 1 calorie equals 4.184 joules. The difference between this and the "International" standard is about 1 part in 1500.

The gallon in Item 13a is the Canadian gallon. The U.S. gallon equals 0.83267 Canadian gallon.

Conversion Factors

Item	SI quantity	=	English (or old metric) quantities	Inverse factors
1a	1°C	=	1.8°F	0.55556
b	1 km/h	=	0.62137 mph	1.6093
c	1 mm	=	0.039370 in	25.4
d	1 kPa	=	10 mb	0.1
	1 kPa	=	0.29530 in Hg	3.3864
2a	1 km	=	0.62137 mi	1.6093
b	1 m	=	3.2808 ft	0.3048
3a	1 m/min	=	3.2808 ft/min	0.3048
b	See Item 1b			
4	1 ha	=	2.4711 ac	0.40469
5a	1 cm	=	0.39370 in	2.54
b	1 cm ⁻¹	=	2.54 in ⁻¹	0.39370
6a	1 kg/m ²	=	0.20482 lb/ft ²	4.8824
b	1 t/ha	=	0.44609 T/ac	2.2417
7a	1 kg/m ³	=	0.062428 lb/ft ³	16.018
b	1 g/cm ³	=	62.428 lb/ft ³	0.016018
8	1 kJ/kg	=	0.43021 Btu/lb	2.3244
	1 kJ/kg	=	0.23901 cal/g	4.184
9	1 kJ/m ²	=	0.088114 Btu/ft ²	11.349
10a	1 kW/m	=	0.28909 Btu/(s.ft)	3.4592
	1 kW/m	=	0.23901 kcal/(s.m)	4.184
b	1 kW/m ²	=	0.088114 Btu/(s.ft ²)	11.349
11	See Item 10b			
12	1 kg/(m ² .s)	=	0.20842 lb/(ft ² .s)	4.8824
13a	1 l/min	=	0.21997 gal/min	4.5461
b	1 kPa	=	0.14504 psi	6.8948
c	1 kPa/m	=	0.044208 psi/ft	22.621
	1 kPa/m	=	4.4208 psi/100ft	0.22621
d	1 mPa.s	=	1 cP	1