CORRIGENDA

Corrigendum to Council Directive 80/181/EEC of 20 December 1979 on the approximation of the laws of the Member States relating to units of measurement and on the repeal of Directive 71/354/EEC

(Official Journal of the European Communities No L 39 of 15 February 1980)

Page 43 : the Annex shall be replaced by the following :

ANNEX

CHAPTER I

LEGAL UNITS OF MEASUREMENT REFERRED TO IN ARTICLE 1 (a)

1. SI UNITS AND THEIR DECIMAL MULTIPLES AND SUBMULTIPLES

1.1. **SI base units**

Quantity	Unit	
	Name	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

Definitions of SI base units :

Unit of length

The metre is the length equal to 1 650 763·73 wavelengths in vacuum of the radiation corresponding to the transition between the levels $2p_{10}$ and $5d_5$ of the krypton-86 atom.

(Eleventh CGPM (1960), resolution 6).

Unit of mass

The kilogram is the unit of mass ; it is equal to the mass of the international prototype of the kilogram.

(Third CGPM (1901), page 70 of the conference report).

Unit of time

The second is the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium-133 atom.

(Thirteenth CGPM (1967), resolution 1).

Unit of electric current

The ampere is that constant current, which if maintained in two straight parallel conductors of infinite length, of negligible circular cross-section, and placed one metre apart in vacuum, would produce between those conductors a force equal to 2×10^{-7} newton per metre of length.

(CIPM (1946), resolution 2, approved by the ninth CGPM (1948)).

Unit of thermodynamic temperature

The kelvin, unit of thermodynamic temperature, is the fraction 1/273·16 of the thermodynamic temperature of the triple point of water.

(Thirteenth CGPM (1967), resolution 4).

Unit of amount of substance

(1) The mole is the amount of substance of a system which contains as many elementary entities as there are atoms in 0·012 kilogram of carbon 12.

(2) When the mole is used, the elementary entities must be specified and may be atoms, molecules, ions, electrons, other particles, or specified groups of such particles.

(Fourteenth CGPM (1971), resolution 3).

Unit of luminous intensity

The candela is the luminous intensity, in a given direction, of a source that emits monochromatic radiation of frequency of 540×10^{12} hertz and that has a radiant intensity in that direction of (1/683) watt per steradian.

(Sixteenth CGPM (1979), resolution 3).

1.1.1. **Special name and symbol of the SI unit of temperature for expressing Celsius temperature**

Quantity	Unit	
	Name	Symbol
Celsius temperature	degree Celsius	°C

Celsius temperature t is defined as the difference $t = T - T_0$ between the two thermodynamic temperatures T and T_0 where $T_0 = 273{\cdot}15$ kelvins. An interval of or difference in temperature may be expressed either in kelvins or in degrees Celsius. The unit 'degree Celsius' is equal to the unit 'kelvin'.

1.2. **Other SI units**

1.2.1. **SI supplementary units**

Quantity	Unit	
	Name	Symbol
Plane angle	radian	rad
Solid angle	steradian	sr

(Eleventh CGPM, 1960, resolution 12).

Definitions of SI supplementary units :

Unit of plane angle

The radian is the plane angle between two radii of a circle which cut off on the circumference an arc equal in length to the radius.

(International standard ISO 31-I, December 1965).

Unit of solid angle

The steradian is the solid angle which, having its vertex at the centre of a sphere, cuts off an area on the surface of the sphere equal to that of a square with sides of length equal to the radius of the sphere.

(International standard ISO 31-I, December 1965).

1.2.2. **SI derived units**

Units derived coherently from SI base units and SI supplementary units are given as algebraic expressions in the form of products of powers of the SI base units and/or SI supplementary units with a numerical factor equal to 1.

1.2.3. **SI derived units having names and symbols**

Quantity	Unit		Expression	
	Name	Symbol	In other SI units	In terms of SI base or supplementary units
Frequency	hertz	Hz		s^{-1}
Force	newton	N		$m \cdot kg \cdot s^{-2}$
Pressure, stress	pascal	Pa	$N \cdot m^{-2}$	$m^{-1} \cdot kg \cdot s^{-2}$
Energy, work ; quantity of heat	joule	J	$N \cdot m$	$m^2 \cdot kg \cdot s^{-2}$
Power (1), radiant flux	watt	W	$J \cdot s^{-1}$	$m^2 \cdot kg \cdot s^{-3}$
Quantity of electricity, electric charge	coulomb	C		$s \cdot A$
Electric potential, potential difference, electromotive force	volt	V	$W \cdot A^{-1}$	$m^2 \cdot kg \cdot s^{-3} \cdot A^{-1}$
Electric resistance	ohm	Ω	$V \cdot A^{-1}$	$m^2 \cdot kg \cdot s^{-3} \cdot A^{-2}$
Conductance	siemens	S	$A \cdot V^{-1}$	$m^{-2} \cdot kg^{-1} \cdot s^3 \cdot A^2$
Capacitance	farad	F	$C \cdot V^{-1}$	$m^{-2} \cdot kg^{-1} \cdot s^4 \cdot A^2$
Magnetic flux	weber	Wb	$V \cdot s$	$m^2 \cdot kg \cdot s^{-2} \cdot A^{-1}$
Magnetic flux density	tesla	T	$Wb \cdot m^{-2}$	$kg \cdot s^{-2} \cdot A^{-1}$
Inductance	henry	H	$Wb \cdot A^{-1}$	$m^2 \cdot kg \cdot s^{-2} \cdot A^{-2}$
Luminous flux	lumen	lm		$cd \cdot sr$
Illuminance	lux	lx	$lm \cdot m^{-2}$	$m^{-2} \cdot cd \cdot sr$
Activity (of a radionuclide)	becquerel	Bq		s^{-1}
Absorbed dose, specific energy imparted, kerma, absorbed dose index	gray	Gy	$J \cdot kg^{-1}$	$m^2 \cdot s^{-2}$
Dose equivalent	sievert	Sv	$J \cdot kg^{-1}$	$m^2 \cdot s^{-2}$

(1) Special names for the unit of power : the name volt-ampere (symbol 'VA') when it is used to express the apparent power of alternating electric current, and var (symbol 'var') when it is used to express reactive electric power. The 'var' is not included in CGPM resolutions.

Units derived from SI base units or supplementary units may be expressed in terms of the units listed in Chapter I.

In particular, SI derived units may be expressed by the special names and symbols given in the above table ; for example, the SI unit of dynamic viscosity may be expressed as $m^{-1} \cdot kg \cdot s^{-1}$ or $N \cdot s \cdot m^{-2}$ or $Pa \cdot s$.

1.3. **Prefixes and their symbols used to designate certain decimal multiples and submultiples**

Factor	Prefix	Symbol	Factor	Prefix	Symbol
10^{18}	exa	E	10^{-1}	deci	d
10^{15}	peta	P	10^{-2}	centi	c
10^{12}	tera	T	10^{-3}	milli	m
10^{9}	giga	G	10^{-6}	micro	μ
10^{6}	mega	M	10^{-9}	nano	n
10^{3}	kilo	k	10^{-12}	pico	p
10^{2}	hecto	h	10^{-15}	femto	f
10^{1}	deca	da	10^{-18}	atto	a

The names and symbols of the decimal multiples and submultiples of the unit of mass are formed by attaching prefixes to the word 'gram' and their symbols to the symbol 'g'.

Where a derived unit is expressed as a fraction, its decimal multiples and submultiples may be designated by attaching a prefix to units in the numerator or the denominator, or in both these parts.

Compound prefixes, that is to say prefixes formed by the juxtaposition of several of the above prefixes, may not be used.

1.4. **Special authorized names and symbols of decimal multiples and submultiples of SI units**

Quantity	Unit		
	Name	Symbol	Value
Volume	litre	l or L (1)	$1\ l = 1\ dm^3 = 10^{-3}\ m^3$
Mass	tonne	t	$1\ t = 1\ Mg = 10^3\ kg$
Pressure, stress	bar	bar (2)	$1\ bar = 10^5\ Pa$

(1) The two symbols 'l' and 'L' may be used for the litre unit. (Sixteenth CGPM (1979), resolution 6).

(2) Unit listed in the International Bureau of Weights and Measures booklet as among the units to be permitted temporarily.

Note: The prefixes and their symbols listed in 1.3 may be used in conjunction with the units and symbols contained in Table 1.4.

2. UNITS WHICH ARE DEFINED ON THE BASIS OF SI UNITS BUT ARE NOT DECIMAL MULTIPLES OR SUBMULTIPLES THEREOF

Quantity	Unit		
	Name	Symbol	Value
Plane angle	revolution* (1) (a)		1 revolution = 2 π rad
	grade* or gon*	gon*	$1\ gon = \frac{\pi}{200}\ rad$
	degree	°	$1° = \frac{\pi}{180}\ rad$
	minute of angle	′	$1′ = \frac{\pi}{10\,800}\ rad$
	second of angle	″	$1″ = \frac{\pi}{648\,000}\ rad$
Time	minute	min	1 min = 60 s
	hour	h	1 h = 3 600 s
	day	d	1 d = 86 400 s

(1) The character (*) after a unit name or symbol indicates that it does not appear in the lists drawn up by the CGPM, CIPM or BIPM. This applies to the whole of this Annex.

(a) No international symbol exists.

Note: The prefixes listed in 1.3 may only be used in conjunction with the names 'grade' or 'gon' and the symbol 'gon'.

3. UNITS DEFINED INDEPENDENTLY OF THE SEVEN SI BASE UNITS

The unified atomic mass unit is one-twelfth of the mass of an atom of the nuclide ^{12}C.

The electronvolt is the kinetic energy acquired by an electron passing in a vacuum from one point to another whose potential is one volt higher.

Quantity	Unit		
	Name	Symbol	Value
Mass	unifed atomic mass unit	u	$1u \approx 1{\cdot}660\,565\,5 \times 10^{-27}\ kg$
Energy	electronvolt	eV	$1eV \approx 1{\cdot}602\,189\,2 \times 10^{-19}\ J$

The value of these units, expressed in SI units, is not known exactly.

The above values are taken from CODATA Bulletin No 11 of December 1973 of the International Council of Scientific Unions.

Note: The prefixes and their symbols listed in 1.3 may be used in conjunction with these two units and with their symbols.

4. UNITS AND NAMES OF UNITS PERMITTED IN SPECIALIZED FIELDS ONLY

Quantity	Unit		
	Name	Symbol	Value
Vergency of optical systems	dioptre*		1 dioptre = 1 m^{-1}
Mass of precious stones	metric carat		1 metric carat = 2 × 10^{-4} kg
Area of farmland and building land	are	a	1 a = 10^2 m^2
Mass per unit length of textile yarns and threads	tex*	tex*	1 tex = 10^{-6} kg · m^{-1}

Note: The prefixes listed in 1.3 may be used in conjunction with the above units. The multiple 10^2 a is, however, called a 'hectare'.

5. COMPOUND UNITS

Combinations of the units listed in Chapter I form compound units.

CHAPTER II

LEGAL UNITS OF MEASUREMENT REFERRED TO IN ARTICLE 1 (b)

QUANTITIES, NAMES OF UNITS, SYMBOLS AND VALUES

Quantity	Unit		
	Name	Symbol	Value
Blood pressure	millimetre of mercury (*)	mm Hg (*)	1 mm Hg = 133·322 Pa
Plane angle		g^c (1)	$1^g = \frac{\pi}{200}$ rad
Activity (of a radionuclide)	curie	Ci	1 Ci = $3{\cdot}7 \times 10^{10}$ Bq
Absorbed dose	rad	rad (2)	1 rad = 10^{-2} Gy
Dose equivalent	rem *	rem *	1 rem = 10^{-2} Sv
Exposure (X and γ rays)	röntgen	R	1 R = $2{\cdot}58 \cdot 10^{-4}$ C · kg^{-1}
Dynamic viscosity	poise	P	1 P = 10^{-1} Pa · s
Kinematic viscosity	stokes	St	1 St = 10^{-4} $m^2 \cdot s^{-1}$

(1) Symbol for 'grade'.

(2) When there is risk of confusion with the symbol for radian, rd may be used as symbol for rad.

Note The prefixes and their symbols listed in 1.3 of Chapter I may be used in conjunction with the units and symbols contained in this section, with the exception of millimetre of mercury and its symbol and the symbol 'g'.

Until the date indicated in Article 1 (b), the units listed in Chapter II may be combined with each other or with those in Chapter I to form compound units.

CHAPTER III

LEGAL UNITS OF MEASUREMENT REFERRED TO IN ARTICLE 1 (c)

QUANTITIES, NAMES OF UNITS, SYMBOLS AND APPROXIMATE VALUES

Length		
inch	1 in	= $2{\cdot}54 \times 10^{-2}$ m
foot	1 ft	= 0·3048 m
fathom (1)	1 fm	= 1·829 m
mile	1 mile	= 1 609 m
yard	1 yard	= 0·9144 m
Area		
square foot	1 sq ft	= $0{\cdot}929 \times 10^{-1}$ m^2
acre	1 ac	= 4 047 m^2
square yard	1 sq yd	= 0·8361 m^2
Volume		
fluid ounce	1 fl oz	= $28{\cdot}41 \times 10^{-6}$ m^3
gill	1 gill	= $0{\cdot}1421 \times 10^{-3}$ m^3
pint	1 pt	= $0{\cdot}5683 \times 10^{-3}$ m^3
quart	1 qt	= $1{\cdot}137 \times 10^{-3}$ m^3
gallon	1 gal	= $4{\cdot}546 \times 10^{-3}$ m^3
Mass		
ounce (avoirdupois)	1 oz	= $28{\cdot}35 \times 10^{-3}$ kg
troy ounce	1 oz tr	= $31{\cdot}10 \times 10^{-3}$ kg
pound	1 lb	= 0·4536 kg
Energy		
therm	1 therm	= $105{\cdot}506 \times 10^{6}$ J

(1) For marine navigation only.

Until the date to be fixed under Article 1 (c), the units listed in Chapter III may be combined with each other or with those in Chapter I to form compound units.