Council Directive 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 (80/181/EEC)

[X1ANNEX

Editorial Information

X1 Substituted by Corrigendum to Council Directive 80/181/EEC of 20 December 1979 on the aproximation 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).

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:
[F1Unit of length

A metre is the length of the path travelled in a vacuum by light during 1/299 792 458 seconds.

(Seventeenth CGPM (1983), Resolution 1).**]**
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)).
[[F2]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.

This definition refers to water having the isotopic composition defined by the following amount-of-substance ratios: 0,00015576 mole of ^{2}H per mole of ^{1}H, 0,0003799 mole of ^{17}O per mole of ^{16}O and 0,0020052 mole of ^{18}O per mole of ^{16}O.

(Thirteenth CGPM (1967), resolution 4 and Twenty-third CGPM (2007), resolution 10)**]**
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. **[**[F2]Special name and symbol of the SI derived unit of temperature for expressing Celsius temperature**]**

Quantity	Unit	
	Name	**Symbol**
Celsius temperature	degree Celsius	°C

[[F3]Celsius temperature *[X2t]* is defined as the difference *[X2*$t = T - T_{0|}$ between the two thermodynamic temperatures *[X2T]* and *[X2*T_0 where $T_{0|} = 273{,}15$ K. An interval or difference of temperature may be expressed either in kelvins or in degrees Celsius. The unit ‘degree Celsius’ is equal to the unit ‘kelvin’.**]**

Editorial Information

X2 Substituted by Corrigendum to Directive 1999/103/EC of the European Parliament and of the Council of 24 January 2000 amending Council Directive 80/181/EEC on the approximation of the laws of the Member States relating to units of measurement (Official Journal of the European Communities L 34 of 9 February 2000).

Textual Amendments

F3 Substituted by Directive 1999/103/EC of the European Parliament and of the Council of 24 January 2000 amending Council Directive 80/181/EEC on the approximation of the laws of the Member States relating to units of measurement.

[[F2]1.2. SI derived units**]**

[F4]1.2.1. SI supplementary units

[F4

F4 . . . . . .]

Definitions of SI supplementary units:
Unit of plane angle

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Unit of solid angle

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Textual Amendments

F4 Deleted by Directive 2009/3/EC of the European Parliament and of the Council of 11 March 2009 amending Council Directive 80/181/EEC on the approximation of the laws of the Member States relating to units of measurement (Text with EEA relevance).

[F2]1.2.2. General rule for SI derived units

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

1.2.3. SI derived units with special names and symbols

Quantity	**Unit**		**Expression**	
	Name	**Symbol**	**In terms of other SI units**	**In terms of SI base units**
Plane angle	radian	rad		$m \cdot m^{-1}$
Solid angle	steradian	sr		$m^2 \cdot m^{-2}$
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[a], 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,	volt	V	$W \cdot A^{-1}$	$m^2 \cdot kg \cdot s^{-3} \cdot A^{-1}$

a 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 GCPM resolutions.

potential difference, electromotive force				
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	$cd \cdot sr$	cd
Illuminance	lux	lx	$lm \cdot m^{-2}$	$m^{-2} \cdot cd$
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	$J \cdot kg^{-1}$	$m^2 \cdot s^{-2}$
Catalytic activity	katal	kat		$mol \cdot s^{-1}$

a 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 GCPM resolutions.

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

In particular, derived SI 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

[F3Factor	**Prefix**	**Symbol**
10^{24}	yotta	Y

10^{21}	zetta	Z
10^{18}	exa	E
10^{15}	peta	P
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	**[**[X3]k**]**
10^{2}	hecto	**[**[X3]h**]**
10^{1}	deca	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	µ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a
10^{-21}	zepto	z
10^{-24}	yocto	y**]**

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**

a The two symbols ‘I’and ‘L’ may be used for the litre unit.
(Sixteenth CGPM (1979), resolution 6).

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

Volume	litre	1 or L[a]	1 l = 1 dm^3 = 10^{-3} m^3
Mass	tonne	t	1 t = 1 Mg = 10^3 kg
Pressure, stress	bar	bar[b]	1 bar = 10^5 Pa

a The two symbols ‘I’and ‘L’ may be used for the litre unit.
(Sixteenth CGPM (1979), resolution 6).

b 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*[ab]		1 revolution = 2 π rad
	grade* or gon*	gon*	$1\ \text{gon} = \frac{\pi}{200}\ \text{rad}$
	degree	°	$1^\circ = \frac{\pi}{180}\ \text{rad}$
	minute of angle	′	$1' = \frac{\pi}{10\,800}\ \text{rad}$
	second of angle	″	$1'' = \frac{\pi}{648\,000}\ \text{rad}$
Time	minute	min	1 min = 60 s
	hour	h	1 h = 3 600 s
	day	d	1 d = 86 400 s

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

b 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’.

[F3 3. UNITS USED WITH THE SI, WHOSE VALUES IN SI ARE OBTAINED EXPERIMENTALLY

Quantity	**Unit**		
	Name	**Symbol**	**Definition**
Energy	Electronvolt	eV	The electron volt is the kinetic energy acquired by an

Note:

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

			electron in passing through a potential difference of 1 volt in vaccum
Mass	Unified atomic mass unit	u	The unified atomic mass units is equal to 1/12 of the mass of an atom of the nuclide ^{12}C.

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}
Blood pressure and pressure of other body fluids	Millimetre of mercury	mm Hg(*)	1 mm Hg = 133,322 Pa
Effective cross-sectional area	Barn	b	1 b = 10^{-28} m^2

Note:

[F1The prefixes and their symbols listed in 1.3 may be used in conjunction with the above units and symbols, with the exception of the millimetre of mercury and its symbol. The multiple of 10^2a is, however, called a ‘hectare’.**]**

5. COMPOUND UNITS

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

[F5CHAPTER II

LEGAL UNITS OF MEASUREMENT REFERRED TO IN ARTICLE 1 (b), PERMITTED FOR SPECIFIC USES ONLY

Field of application	**Unit**			
	Name	**Approximate value**		**Symbol**
Road traffic signs, distance and speed measurement	mile	1 mile =	1 609 m	mile
	yard	1 yd =	0,9144 m	yd
	foot	1 ft =	0,3048 m	ft
	inch	1 in =	$2{,}54 \times 10^{-2}$m	in
Dispense of draught beer and cider; milk in returnable containers	pint	1 pt =	$0{,}5683 \times 10^{-3}m^3$	pt
[F4]				
Transaction in precious metals	troy ounce	1 oz tr =	$31{,}10 \times 10^{-3}$ kg	oz tr

[F2 The units listed in this Chapter may be combined with each other or with those in Chapter I to form compound units.**]]**

Textual Amendments

F5 Substituted by Council Directive of 27 November 1989 amending Directive 80/181/EEC on the approximation of the laws of the Member States relating to units of measurement (89/617/EEC).

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
[F6]		
mile	1 mile	= 1 609 m
yard	1 yard	= 0·9144 m
Area		
a **[F6]**		

QUANTITIES, NAMES OF UNITS, SYMBOLS AND APPROXIMATE VALUES		
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	= $0{\cdot}8361$ 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	= $0{\cdot}4536$ kg
Energy		
therm	1 therm	= $105{\cdot}506 \times 10^{6}$ J
a [F6]		

Textual Amendments

F6 Deleted by Council Directive of 27 November 1989 amending Directive 80/181/EEC on the approximation of the laws of the Member States relating to units of measurement (89/617/EEC).

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.**]**

[F7CHAPTER IV

LEGAL UNITS OF MEASUREMENT REFERRED TO IN ARTICLE I (d), PERMITTED IN SPECIALIZED FIELDS ONLY

Field of application	**Unit**			
	Name	**Approximate value**		**Symbol**
Marine navigation	fathom	1 fm =	1,829 m	fm
Beer, cider, waters, lemonades and fruit juices	pint	1 pt =	$0{,}5683 \times 10^{-3} m^3$	pt
	fluid ounce	1 fl oz =	$28{,}41 \times 10^{-6} m^3$	fl. oz

in returnable containers				
Spirit drinks	gill	1 gill =	$0{,}142 \times 10^{-3} m^3$	gill
Goods sold loose in bulk	ounce (avoir dupois)	1 oz =	$28{,}35 \times 10^{-3}$ kg	oz
	pound	1 lb =	0,4536 kg	lb
Gas supply	therm	1 therm =	$105{,}506 \times 10^{6} J$	therm

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

Textual Amendments

F7 Inserted by Council Directive of 27 November 1989 amending Directive 80/181/EEC on the approximation of the laws of the Member States relating to units of measurement (89/617/EEC).