COUNCIL DIRECTIVE

of 27 July 1976

amending Directive 71/354/EEC on the approximation of the laws of the Member States relating to units of measurement

(76/770/EEC)

THE COUNCIL OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Economic Community, and in particular Article 100 thereof,

Having regard to the Act of Accession, and in particular Article 29 thereof,

Having regard to Council Directive 71/354/EEC of 18 October 1971 on the approximation of the laws of the Member States relating to units of measurement (1), as amended by the Act of Accession, and in particular Article 1 (4) thereof,

Having regard to the proposal from the Commission,

Having regard to the opinion of the European Parliament (2),

Having regard to the opinion of the Economic and Social Committee (3),

Whereas, pursuant to the Act of Accession, the classification in Annex I to Directive 71/354/EEC of the units of measurement listed in Annex II to that Directive is to be decided on by 31 August 1976 at the latest;

Whereas, in Directive 71/354/EEC, provision is made for the review before 31 December 1977 of the situation as regards the units and names of units listed in Chapter II of Annex I to that Directive;

Whereas the 15th General Conference of Weights and Measures (CGPM), convened on 27 May 1975 in Paris by the International Committee of Weights and Measures (CIPM), adopted new international resolutions concerning the international system of units,

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(1) OJ No L 243, 29. 10. 1971, p. 29.
(2) OJ No C 125, 8. 6. 1976, p. 9.
(3) OJ No C 131, 12. 6. 1976, p. 55.

HAS ADOPTED THIS DIRECTIVE:

Article 1

Article 1 of Directive 71/354/EEC is replaced by the following:

'Article 1

1. Member States shall make the provisions of Chapter A of the Annex mandatory by 21 April 1978 at the latest.

2. Member States shall, with effect from 31 December 1977 at the latest, cease to authorize the use of the units of measurement listed in Chapter B of the Annex.

3. Member States shall, with effect from 31 December 1979 at the latest, cease to authorize the use of the units of measurement listed in Chapter C of the Annex.

4. The units of measurement, names and symbols listed in Chapter D of the Annex shall be reviewed before 31 December 1979.

5. The use of the units of measurement temporarily retained in accordance with the provisions of Chapters B, C and D of the Annex may not be made mandatory by Member States where they have not been authorized since 21 April 1973.'

Article 2

The following Article is added to Directive 71/354/EEC:

'Article 2a

Member States may authorize the use of products, equipment and instruments using units which are not authorized under this Directive, which were already on the market prior to the dates laid down in this Directive and the manu-

facture, placing on the market and use of products and equipment necessary to complete or replace components or parts of such products, equipment and instruments.'

Article 3

Annexes I and II to Directive 71/354/EEC are replaced by the Annex hereto.

Article 4

1. Member States shall bring into force the laws, regulations and administrative provisions necessary in order to comply with this Directive by 31 December 1977 at the latest and shall forthwith inform the Commission thereof.

2. Member States shall communicate to the Commission the texts of the main provisions of national law which they adopt in the field covered by this Directive.

Article 5

This Directive is addressed to the Member States.

Done at Brussels, 27 July 1976.

For the Council

The President

M. van der STOEL

ANNEX

LIST OF CONTENTS

CHAPTER A

UNITS OF MEASUREMENT THE USE OF WHICH MUST BE MADE MANDATORY AS
FROM 21 APRIL 1978 AT THE LATEST

1. SI UNITS AND THEIR DECIMAL MULTIPLES AND SUBMULTIPLES

1.1. SI base units

Quantity	Unit	
	Name	Symbol
Length	metre	m
Mass	kilogramme	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 kilogramme is the unit of mass; it is equal to the mass of the international prototype of the kilogramme.

(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 a vacuum, would produce between these 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

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

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 the perpendicular direction, of a surface of $1/600\ 000\ m^2$ of a black body at the temperature of freezing platinum under a pressure of 101 325 newtons/m^2.

(Thirteenth CGPM (1967), resolution 5).

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 $T_0 = 273·15$ kelvins. An interval of or difference in temperature may be expressed either in kelvins or in degrees Celsius. The unit of 'degree Celsius' is equal to the unit 'kelvin'.

1.2. **Other SI units**

1.2.1. **Supplementary SI units**

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

(Eleventh CGPM, 1960, resolution 12).

Definitions of supplementary SI units:

Plane angle unit

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

(ISO recommendation R 31, Part I, second edition, December 1965).

Solid angle unit

The steradian is the solid angle which has its apex at the centre of a sphere and which describes on the surface of the sphere an area equal to that of a square having as its side the radius of the sphere.

(ISO recommendation R 31, Part I, second edition, December 1965).

1.2.2. Derived SI units

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

1.2.3. Derived SI units having names and symbols

Quantity	Unit		Expression	
	Name	Symbol	In other SI units	In terms of base or supplementary SI 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])	watt	W	$J \cdot s^{-1}$	$m^2 \cdot kg \cdot s^{-3}$
Quantity of electricity, electric charge	coulomb	C		$s \cdot A$
Electric tension, electric potential, electromotive force	volt	V	$W \cdot A^{-1}$	$m^2 \cdot kg \cdot s^{-3} \cdot A^{-1}$
Electric resistance	ohm	Ω	$V \cdot A^{-1}$	$m^2 \cdot kg \cdot s^{-3} \cdot A^{-2}$
Electric conductance	siemens	S	$A \cdot V^{-1}$	$m^{-2} \cdot kg^{-1} \cdot s^3 \cdot A^2$
Electric capacitance	farad	F	$C \cdot V^{-1}$	$m^{-2} \cdot kg^{-1} \cdot s^4 \cdot A^2$
Magnetic flux	weber	Wb	$V \cdot s$	$m^2 \cdot kg \cdot s^{-2} \cdot A^{-1}$
Mangetic flux density	tesla	T	$Wb \cdot m^{-2}$	$kg \cdot s^{-2} \cdot A^{-1}$
Electric 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	becquerel	Bq		s^{-1}
Absorbed dose ([2])	gray	Gy	$J \cdot kg^{-1}$	$m^2 \cdot s^{-2}$

[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.

[2] And other quantities of ionizing radiations of the same dimensions.

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

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

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 'gramme' 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

1.4.1. Special names and symbols of decimal multiples and submultiples of SI units

Quantity	Unit		
	Name	Symbol	Value
Volume	litre	l	$1\,l = 1\,dm^3 = 10^{-3}\,m^3$
Mass	metric ton	t	$1\,t = 1\,Mg = 10^3\,kg$
Pressure, stress	bar	bar	$1\,bar = 10^5\,Pa$

1.4.2. Special names and symbols of decimal multiples and submultiples of SI units which may be used only in specialized fields

Quantity	Unit		
	Name	Symbol	Value
Area of farmland and building land	are	a	$1\,a = 10^2\,m^2$
Mass per unit length of textile yarns and threads	tex* [1]	tex*	$1\,tex = 10^{-6}\,kg \cdot m^{-1}$

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

Note: The prefixes and their symbols listed in 1.3 may be used in conjunction with the units and symbols contained in Tables 1.4.1 and 1.4.2.

The multiple 10^2 a is, however, called a 'hectare'.

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* (a)		$1 \text{ revolution} = 2\,\pi \text{ rad}$
	grade* or gon*	gon *	$1 \text{ gon} = \dfrac{\pi}{200} \text{ rad}$
	degree	°	$1° = \dfrac{\pi}{180} \text{ rad}$
	minute of angle	'	$1' = \dfrac{\pi}{10\ 800} \text{ rad}$
	second of angle	"	$1'' = \dfrac{\pi}{648\ 000} \text{ rad}$
Time	minute	min	$1 \text{ min} = 60 \text{ s}$
	hour	h	$1 \text{ h} = 3\ 600 \text{ s}$
	day	d	$1 \text{ d} = 86\ 400 \text{ s}$

(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 symbols only with 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	unified atomic mass unit	u	$1 \text{ u} \approx 1\cdot6605655 \times 10^{-27} \text{ kg}$
Energy	electronvolt	eV	$1\text{eV} \approx 1\cdot6021892 \times 10^{-19} \text{ J}$

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

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	Value
Vergency of optical systems	dioptre*	$1 \text{ dioptre} = 1 \text{ m}^{-1}$
Mass of precious stones	metric carat	$1 \text{ metric carat} = 2 \times 10^{-4} \text{ kg}$

Note: The prefixes listed in 1.3 may be used in conjunction with the above units.

5. COMPOUND UNITS

Compound units are formed by combining the units mentioned in Chapter A.

CHAPTER B

UNITS OF MEASUREMENT REFERRED TO IN ARTICLE 1 (2)

6. SPECIAL UNITS

Quantities, names of units, symbols and values:

6.1. Volume (forestry and timber industry)

Festmeter*	$1 \ Fm^* = 1 \ m^3$
Raummeter*	$1 \ Rm^* = 1 \ m^3$

6.2. Force

kilogramme force	
kilopond*	$\left. \begin{array}{l} 1 \ kgf \\ 1 \ kp^* \end{array} \right\} = 9.806 \ 65 \ N$

6.3. Pressure

torr	$1 \ torr = \dfrac{101\ 325}{760} \ Pa$
technical atmosphere*	$1 \ at^* = 98\ 066.5 \ Pa$
metre of water* (conventionally: 1 mH$_2$O)	$1 \ mH_2O^* = 9\ 806.65 \ Pa$
millimetre of mercury* (¹) (conventionally: 1 mmHg)	$1 \ mmHg^* = 133.322 \ Pa$

6.4. Power

Pferdestärke*	
paardekracht*	
cheval vapeur*	
cavallo vapore*	$\left. \begin{array}{l} 1 \ PS^* \\ 1 \ pk^* \\ 1 \ CV^* \\ 1 \ cv^* \end{array} \right\} = 735.498 \ 75 \ W$

6.5. Quantity of heat

calorie 15 °C	$1 \ cal^*_{15} = 4.185 \ 5 \ J$
thermie*	$1 \ th^* = 4.185 \ 5 \times 10^6 \ J$
frigorie*	$1 \ fg^* = 4.185 \ 5 \times 10^3 \ J$
calorie IT	$1 \ cal_{IT} = 4.186 \ 8 \ J$
thermo-chemical calorie*	$1 \ cal^*_{th \ ch} = 4.184 \ J$

6.6. Luminance

stilb	$1 \ sb = 10^4 \ cd \cdot m^{-2}$

Note: The prefixes and their symbols listed in 1.3 may be used in conjunction with the units and symbols contained in 6.5 and 6.6, with the torr and with the metre of water (see 6.3.).

7. SPECIAL CASE OF TEMPERATURE

The name 'degree kelvin' and the symbol '°K' (instead of kelvin, symbol K) may be used until 31 December 1977.

(¹) Except where this unit is used for measuring blood pressure (see Chapter C, section 11).

8. IMPERIAL UNITS*

Quantities, names of units, symbols and approximate values

8.1. Length

chain   1 chain = 20·12 m

furlong   1 fur = 201·2 m

nautical mile (UK)   1 nautical mile = 1 853 m

8.2. Area

rood   1 rood = 1 012 m^2

8.3. Volume

cubic yard   1 cu yd = 0·7646 m^3

bushel   1 bu = 36·37 × 10^{-3} m^3

8.4. Mass

dram   1 dr = 1·772 × 10^{-3} kg

cental   1 ctl = 45·36 kg

8.5. Pressure

inch of water   1 in H_2O = 249·089 Pa

8.6. Force

ton-force   1 tonf = 9·964 × 10^3 N

8.7. Illuminance

foot candle   1 ft candle = 10·76 lx

8.8. Speed

knot (UK)   1 knot = 0·51477 m · s^{-1}

CHAPTER C

UNITS OF MEASUREMENT TO IN ARTICLE 1 (3)

9. IMPERIAL UNITS*

Quantities, names of units, symbols and approximate values

9.1. Length

hand	1 hand = 0·1016 m
yard	1 yd = 0·9144 m

9.2. Area

square inch	1 sq in = 6·452 × 10⁻⁴ m²
square yard	1 sq yd = 0·8361 m²
square mile	1 sq mile = 2·59 × 10⁶ m²

9.3. Volume

cubic inch	1 cu in = 16·39 × 10⁻⁶ m³
cubic foot	1 cu ft = 0·0283 m³
cran	1 cran = 170·5 × 10⁻³ m³

9.4. Mass

grain	1 gr = 0·0648 × 10⁻³ kg
stone	1 st = 6·35 kg
quarter	1 qr = 12·70 kg
hundredweight	1 cwt = 50·80 kg
ton	1 ton = 1 016 kg

9.5. Force

pound-force	1 lbf = 4·448 N

9.6. Energy

British thermal unit	1 Btu = 1055·06 J
foot pound-force	1 ft lbf = 1·356 J
therm	1 therm = 105·506 × 10⁶ J

9.7. Power

horsepower	1 hp = 745·7 W

9.8. Temperature

degree Fahrenheit	$1 \ ^\circ F = \left(\dfrac{5}{9} \right) K$

10. CGS UNITS

Quantities, names of units, symbols and values

Quantity	Unit		
	Name	Symbol	Value
Force	dyne	dyn	1 dyn = 10⁻⁵ N
Energy	erg	erg	1 erg = 10⁻⁷ J
Dynamic viscosity	poise	P	1 P = 10⁻¹ Pa · s
Kinematic viscosity	stokes	St	1 St = 10⁻⁴ m² · s⁻¹
Acceleration of free fall	gal	Gal	1 Gal = 10⁻² m · s⁻²

11. OTHER UNITS

Quantities, names of units, symbols and values

Quantity	Unit		
	Name	Symbol	Value
Wavelength, atomic distances	ångström	Å	$1 \text{ Å} = 10^{-10}$ m
Effective cross-sectional area	barn	barn	$1 \text{ b} = 10^{-28}$ m^2
Mass	quintal* (a)		$1 \text{ quintal} = 10^2$ kg
Pressure	standard atmosphere	atm	$1 \text{ atm} = 101\ 325$ Pa
Blood pressure	millimetre of mercury* (conventionally: 1 mmHg)	mmHg*	$1 \text{ mmHg} = 133 \cdot 322$ Pa
Volume (forestry and timber trade)	stere	st	$1 \text{ st} = 1$ m^3

(a) No international symbol exists.

Note: The prefixes and their symbols listed in 1.3 may be used in conjunction with the units and symbols contained in sections 10 and 11, apart from the 'quintal'.

CHAPTER D

UNITS, NAMES AND SYMBOLS REFERRED TO IN ARTICLE 1 (4)

12. IMPERIAL UNITS*

Quantities, names of units, symbols and approximate values

12.1 Length

inch	$1 \text{ in} = 2 \cdot 54 \times 10^{-2} \text{ m}$
foot	$1 \text{ ft} = 0 \cdot 3048 \text{ m}$
fathom ([1])	$1 \text{ fm} = 1 \cdot 829 \text{ m}$
mile	$1 \text{ mile} = 1\ 609 \text{ m}$

12.2 Area

square foot	$1 \text{ sq ft} = 0 \cdot 929 \times 10^{-1} \text{ m}^2$
acre	$1 \text{ ac} = 4\ 047 \text{ m}^2$

12.3. Volume

fluid ounce	$1 \text{ fl oz} = 28 \cdot 41 \times 10^{-6} \text{ m}^3$
gill	$1 \text{ gill} = 0 \cdot 1421 \times 10^{-3} \text{ m}^3$
pint	$1 \text{ pt} = 0 \cdot 5683 \times 10^{-3} \text{ m}^3$
quart	$1 \text{ qt} = 1 \cdot 137 \times 10^{-3} \text{ m}^3$
gallon	$1 \text{ gal} = 4 \cdot 546 \times 10^{-3} \text{ m}^3$

12.4. Mass

ounce (avoirdupois)	$1 \text{ oz} = 28 \cdot 35 \times 10^{-3} \text{ kg}$
troy ounce	$1 \text{ oz tr} = 31 \cdot 10 \times 10^{-3} \text{ kg}$
pound	$1 \text{ lb} = 0 \cdot 4536 \text{ kg}$

[1] For marine navigation only.

13. OTHER UNITS

Quantities, names of units, symbols and values

Quantity	Unit		
	Name	Symbol	Value
Activity of a radioactive source	curie	Ci	$1 \text{ Ci} = 3 \cdot 7 \times 10^{10} \text{ Bq}$
Plane angle		g* ([1])	$1 \text{ g} = \dfrac{\pi}{200} \text{ rad}$
Absorbed dose	rad	rd ([2])	$1 \text{ rd} = 10^{-2} \text{ Gy}$
Equivalent absorbed dose	rem*	rem*	$1 \text{ rem} = 1 \text{ rd}$
Exposure to ionizing radiations	röntgen	R	$1 \text{ R} = 2 \cdot 58 \times 10^{-4} \text{ C} \cdot \text{kg}^{-1}$

[1] Symbol for 'grade'.
[2] The symbol recommended by the International Bureau of Weights and Measures (BIPM) is 'rad'.

Note: The prefixes and their symbols listed in 1.3 may be used in conjunction with the units and symbols contained in this section, with the exception of 'g'.

14. COMPOUND UNITS (TO BE USED TEMPORARILY)

Until the dates indicated in Article 1, the units listed in Chapters B, C and D may be used in conjunction with one another or with those contained in Chapter A to form compound units.